Appendix

List

APPENDIX 1: Minutes of Meeting on JCC for PG/R

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

MINUTES OF MEETING

ON

THE JOINT COORDINATION COMMITTEE (JCC)

FOR

PROGRESS REPORT

Agreed upon in Kigali on August 8th, 2019
between

Eng. Aime Muzola
Chief Executive Officer
Water and Sanitation Corporation
WASAC,
The Government of Rwanda

Mr. Takemasa Mamiya
Team Leader/Water Supply Planning 1
JICA Study Team

MINUTES OF MEETING

Water and Sanitation Corporation (hereinafter referred to as "WASAC"), as the Counterpart Agencies for the Project for Water Supply Master Plan for City of Kigali in the Republic of Rwanda (hereinafter referred to as "the Study"), held the Joint Coordination Committee (JCC) chaired by Eng. Aime Muzola, the Chief Executive Officer of WASAC (hereinafter referred to as "CEO"), on July 26th, 2019.

The participants of the meeting are concerned parties from Rwandan side, Embassy of Japan in Rwanda, JICA Rwanda office, and the project team including counterpart (C/P) of WASAC and JICA Study Team headed by Mr. Mamiya Takemasa with the members from Nihon Suido Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd. from Japan to implement the Study. Those who were participated in the JCC are as listed in the Attachment-1.

At the JCC Meeting, the JICA Study Team presented the Progress Report and explained the main content of the report including present progress so far made, a summary of the content of the Progress Report, and way forward.

As a result of the discussion, all the JCC members confirmed that several parts of the basic setting for the water demand projection presented in the Progress Report shall be revised toward the preparation of the Interim Report that is scheduled to be prepared in February 2020. Points of the modifications are as follows:

1 **Percentages of residents living in urban area**

All parties confirmed that the applied percentages of residents who live in urban area in 2050 for the adjacent seven sectors shall be re-considered for the following sectors with reviewing urbanization trends in the neighboring sectors:

- Rugalika Sector in Kamonyi District
- Ntarama Sector in Bugesera District
- Muyumbu/ Gahengeri/ Nyakariro Sectors in Rwamagana District

2 **Definition and setting of service ratio**

All parties confirmed that the way of explanation of service ratio shall be revised, specifically, in addition to the service ratio for individual house connection and for public tap, service ratio for sharing connection shall also be indicated in the figure of the service coverage so that the total service coverage reaches 100% in 2024.

3 **Average family size**

All parties confirmed that the applied average family size should be updated with reference to the result of Integrated Household Living Conditions Survey 5 (EICV 5) that is available in Rwanda Poverty Profile Report 2016/17.

In addition, during the discussion, several attendants including representatives of the JICA Rwanda Office, the City of Kigali, and the counterpart of WASAC pointed out high energy consumption in the existing system. Although it is not avoidable due to hilly geographical characteristics in the City of Kigali and its surrounding area, it is important to consider energy saving in the planning process that would contribute to improvement of financial status and business efficiency of WASAC.

Further, following the discussion, the Chief Representative of JICA Rwanda Office and WASAC CEO gave official closing speech as summarized below.

1 **Closing speech by the Chief Representative of JICA Rwanda Office**

In his closing speech, he emphasized following points;

- In the course of the planning process, it is important to pay careful attention to comprehend existing situation and analyzing what and how it should be addressed to identify possible solutions.
- To discuss water resource utilization plan in the course of formulating WASAC/JICA M/P, it is indispensable to facilitate cooperation among concerned potential water users including irrigation and hydropower sectors.
- All members of JCC should recognize and keep in mind again, that the WASAC/JICA M/P is not just a kind of a work leaving all tasks to a consultant, but it is a sort of "Technical Cooperation Program" under which the Rwandan side including C/P will be actively involved in the process of planning with the JICA Study Team. Further, the JICA Study Team is not just a group of consultants who are entrusted to work by a client, but the team of experts who will work close together with the C/P of WASAC to prepare JICA/WASAC M/P.
- In the above-mentioned context, after the completion of the Project, WASAC should update the WASAC/JICA M/P at regular intervals by itself with seeing social economic trends and/or technology advance in future, in order to make the WASAC/JICA M/P realistic and practical. In other words, there is no organization but to WASAC to keep the WASAC/JICA M/P being realistic after the completion of the Project therefore we do hope the C/P team member should be actively involved in the planning work to develop capacity individually and organizationally.

2 **Closing speech by the CEO of WASAC**

In his closing speech, he emphasized following points;

- The output of WASAC/JICA M/P will be a good planning tool for us in future. However, in order to keep it realistic and practical, it is indispensable to keep updating from time to time.
- As shown in the demand forecast, we have to recognize that big gap lies between future water demand and current production capacity. In case a required funding delays, it will cause serious impact to future water supply service.

- Now that all JCC members aware that there is big gap to fill the future demand, the output of the WASAC/JICA M/P can be a strong message to the government of Rwanda.
- To fill the above mentioned gap, water resource availability should carefully reviewed in the planning process. It is expected that the all possible alternatives should be considered including transmitting water from distant water source even from Kivu Lake, for example.

3

Attachment-1

List of Participants

【Rwanda side】

Government of Rwanda and Other related organization

Mpimbazimana Venuste	UWSSE, MININFRA
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Emmanuel Iyakaremye	Chief Engineer Network Assets, REG/EUCL
Theogene Gahunzire	Director of OSC, Rwamagana District
Glody Uwase	Professional intern,RURA
Nzabahimana James	water and sanitation officer, Kamonyi district
Mugorozi Theophile	Senior water supply monitoring officer,RURA
Innocent Hagenimana	Transport Econimist Engineer, RTDA
Ndagijimana Joel	Water and Energy Engineer, kicukiro District
Fidele Tuyisenge	Water and sanitation Engineer,COK
Amandine Umukesha	Senior W&S expert, AfDB

WASAC

Aime Muzola	CEO
Yaramba Albert	National WATSAN Master Plans
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Emmanuel Ngendahayo	R&D Specialist
Gemma Mniraruta	WSDPI Officer
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Joseph Ndagijimana	Water Supply Engineer
Ben Byanyima	Environmental Specialist
Twubahe Pascal	Ag. Head of Public Relations

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Bahige J. Berchmas	NRW Manager, UWSSD
Mutamba Jane	Head of Nyamirambo Branch
Saranda Catherine	Head of Nyarugenge Branch
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【Japanese side】

Embassy of Japan in Rwanda

Saori Ono	Development Cooperation Specialist

JICA Rwanda Office

Shin Maruo	Chief Representative
Masanobu Mayusumi	JICA Expert in WASAC
Koji Nakashima	Water and Sanitation Program Manager
Virgile Kwizera	JICA Water and Sanitation Officer

JICA Study Team

Takemasa Mamiya	Team Leader / Water Supply Planning 1 Nihon Suido Consultants Co., Ltd.
Tetsuji Kawamura	Co-Team Leader / Water Supply Planning 2 Nihon Suido Consultants Co., Ltd.
Kenji Yoshida	Water Resource / Water Quality/ Hydrogeology Yachiyo Engineering Co., Ltd.
Shinkichi Kobayashi	Water Supply Pipeline Planning Nihon Suido Consultants Co., Ltd.
Yoshiaki Oshima	Cost Estimator / Implementation planning / Study Coordinator Nihon Suido Consultants Co., Ltd.
Yoshiyuki Choso	Organization/ Institution Yachiyo Engineering Co., Ltd.

Noboru Osakabe	Economic and Financial Analyst Yachiyo Engineering Co., Ltd.
Uyu Tanaka	Environment and Social Consideration Yachiyo Engineering Co., Ltd.
Nteziryayo Francois Xavier	Supporting Staff for Civil Engineering (Planning /Water Supply Pipeline /Water Treatment Plant)
Dushimimana Sandrine	Office Secretary
Habakubaho Theogene	Consultant SEA, Socio-Economic, BESST Ltd

APPENDIX 2: Minutes of meeting on the 1st Stake Holder Meeting for PG/R and Meeting Memo for TWG

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

MINUTES OF MEETING

ON

FIRST STAKEHOLDERS CONSULTATIVE MEETING

FOR

PROGRESS REPORT

Mr. METHODE Rutagungira
Project Director of Kigali Water
Supply Masterplan Project
Water and Sanitation Corporation
WASAC,
The Government the Republic of
Rwanda

Mr. MAMIYA Takemasa
Team Leader/Water Supply Planning 1
JICA Study Team

A - 1

MINUTES OF MEETING

1. Introduction

On August 6th 2019, the Water & Sanitation Cooperation (hereinafter referred to as "WASAC"), leading Agency for the Project for Water Supply Master Plan for City of Kigali in the Republic of Rwanda (hereinafter referred to as "the WASAC/JICA M/P"), held first stakeholder meeting for explaining progress of the WASAC/JICA M/P under the scheme of technical cooperation supported by Japanese International Cooperation Agency (JICA).

Participants to the meeting include stakeholders from various institutions in Rwanda, Embassy of Japan in Rwanda, JICA Rwanda office, and the Working Team members that includes counterpart (C/P) of WASAC and JICA Study Team headed by Mr. Mamiya Takemasa, with the members from Nihon Suido Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd., from Japan to implement the WASAC/JICA M/P. Various national media were also invited to cover the meeting. The list of all participants is presented in Attachment-2.

The purpose of the stakeholder meeting was: (i) to inform stakeholders the progress made on study (future water demand and social-economic scenario), (ii) to invite local stakeholders for participation and provision of opinions into decision making process comments and inputs to the WASAC/JICA M/P and, (iii) to develop contacts list and communication channel for the WASAC/JICA M/P. To meet the purpose mentioned above, a stakeholder meeting was held to ensure the accountability and transparency of the WASAC/JICA M/P.

2. Opening remarks

In his opening remarks, the representative of JICA, Mr. Koji Nakashima, emphasized that the proposed study is an opportunity to think about the future of Kigali in coping with increasing populations and water demand. He appreciated the presence of various stakeholders from the government, from private sector, civil society and the media. He encouraged them to provide inputs and comments. The WASAC representative, Mr. Bahige J. Berchmas, in his opening remarks informed the participant that the proposed master plan is an important Planning Tool, which will help WASAC and the country to achieve its target. Further, the Master Plan will contribute to the proper planning and avoid the past mistake where the project was planned and implemented to address emergencies and present need without thinking about the future.

3. Presentations and discussions

After the opening session, two presentations were provided by WASAC. The first presentation was provided by Mr. Innocent Kimpaye from WASAC and focused on the project background, project schedule and implementation strategy. The second presentation was provided by Mr. Tetsuji Kawamura, Co-team Leader of the JICA Study Team and provide progress on Socio-Economic Scenario and Future Water Demand Forecast. After, each presentation, participants were provided with time for questions, comments and inputs to the WASAC/JICA M/P. Important

comments, suggestions and opinions provided are summarized as follows:

1) **Linkage of Kigali Master Plan and other land use master Plan:** all Stakeholders confirmed the importance of aligning the other ongoing Master Plan such as City of Kigali Master Plan (CoK M/P), National Water Supply and Sanitation Master Plan (AfDB M/P) and existing integrated Water Resource Master Plan. The study team confirmed that the water supply master plan is being developed in considering other master plans.
2) **Spatial Coverage of study:** some stakeholders suggested to include more sectors which are outside of Kigali such as Kinzuzi and Ntarabana on the Kigali-Byumba Road. They are showing signs of development to be urbanized. It was clarified that the WASAC/JICA M/P will cover Kigali city and seven adjacent seven (7) sectors and other areas are covered under National Water and Sanitation Master Plan based on the Record of Discussion.
3) **Measures to reduce Non-revenue water:** It was confirmed that in addition to the proposed increased number of staffs, other technological measures should be considered in order to reduce non-revenue water. The study team and WASAC informed that practical measures will be studied in the master plan.
4) **Definition and setting of service ratio:** All parties suggested that the way of explanation on service ratio should be revised. Especially, the service ratio for individual house connection, public tap, and sharing connection are considered as important indexes which targeted the total service coverage reaches 100% in 2024. In this regards, the given figure of those indexes by the study was inconsistent with the existing study such as EICV5 by NISR.
5) **Source of water:** Stakeholders suggested that all source of water, including surface water, groundwater, and rainwater should be explored and identified. Further, stakeholders requested an assessment of the efficiency of groundwater abstraction and surface water abstraction in current production, and then advise on future projects.
6) **Population and Water Demand Projection scenario:** Some stakeholders suggested that both low, medium, and high growth scenario should be assessed. Further, it was suggested that the target for service coverage of the intermediate target might optimized. The study team took note of the suggestion. The current scenario was considered to be on the safer side to be aligned with other development plans such as the CoK M/P that considers high growth scenario.
7) **The production capacity of the private operators:** Some stakeholders indicated that the production capacity of the private operators is not covered in the study. Currently, there are several private operators having a business in the area, and it should be considered in the project.

Other questions, comments and suggestions provided in the meeting are provided in Attachment 1.

4. Closing session

The Closing remark was provided by the Representative of MININFRA, Mpimbazimana Venuste, appreciated the active participation of stakeholders and urged them to support the study team in providing information available in their respective institutions. He highlighted the importance of this Master Plan in country planning process and in urban water supply in particular. He appreciated the progress made by the study team and urged the team to continue engaging stakeholders in order to produce the final Report. He also expressed his gratitude for the support provided to Rwanda by Government of Japan through JICA especially in the water sector.

Attachment 1: Questions, Comments, suggestions and answers

#	Questions/Comments	By	Response	By
First session				
1	How many feasibility studies will be conducted and water level of details for these feasibility studies under the WASAC/JICA M/P	Water for people Representative	A 15 years investment Plan will be prepared. Among them, one feasibility study is planned for entire water supply system in Kigali City (WTP, Reservoir and Pipeline), and it may be divided into further sub-projects considering project scale.	JST
2	How Kigali Water Supply is linked with the CoK M/P and the AfDB M/P	Water aid Representative	The WASAC/JICA M/P refers both master plans that are going ahead. For example, the CoK M/P is referred for the trends of population increase and development phasing, and information, which is not available in the CoK M/P and/or information for the adjacent sectors are referred to AfDB M/P.	JST
3	Does the WASAC/JICA M/P Consider the assessment of consequences of groundwater abstraction, geological formation and cost effectiveness of both surface water and Groundwater	National Representative	The presentation focused on Socio-economic scenario and future water demand forecast but going forward other area of study will be presented	WAS AC
4	Is the Recruitment of additional staff/ technician the only measures for reducing Non-Revenue Water? Or other technological solution considered?	WASAC representative	Recruitment of maintenance staff is only one of measures to reduce In the Master Plan several measures will be studied including pressure control, replacement of old pipes and monitoring system.	WAS AC
5	How much money is invested in this project? And when the project will start?	Select Magazine	The WASAC/JICA M/P is a planning tool that will provide an idea for project development, but not a implementation stage of the project	WAS AC

A - 5

6	Why only 7 sector were considered outside of Kigali while there are other sectors that are being urbanized such as Kinzuzi and Ttarabana in Rulindo	Water for People representative	The WASAC/JICA M/P will cover Kigali city and seven adjacent sectors and other areas are covered under the AfDB M/P.	WAS AC
7	Was there any old water supply master Plan that guided the past and ongoing project in Kigali?	RURA representative	There was no water supply master plan for Kigali City and projects were implemented ad-hoc basis based on need and emergency, and that is why WASAC and Kigali City are facing challenges in meeting water demand in the city. However, the WASAC/JICA M/P will include assessment of the existing facilities, required projects, and advise on future investment.	WAS AC
8	It would be good to consider all source of water including surface water, ground water and Rainwater in order to meet future demand and advise on its development	Gasabo district representative	Any possible and practical sources of water will be considered	JST
9	What about other regulations and Requirements such as expropriations?	Gasabo district representative	Applicable regulations will be reviewed and described and during project development all aspects will be considered	WAS AC
Second Session				
10	Why not having another scenario where 100% of service coverage can be achieved before 2050 as committed by Government	Water for People Representative	The idea is noted but it should be noted that scenarios are developed based on other urban development plans including CoK M/P and AfDB M/P, which the WASAC/JICA M/P does not have control. To avoid discrepancies with other related master plans, the WASAC/JICA M/P should keep harmonized with those superior plans.	JST

A - 6

11	It would be good to use data from EICV 5 where the service coverage is 34 instead of 28 presented in EICV 4	WASAC representative	This has also been raised in the previous Joint Coordination Committee (JCC) on 26/July/2019 and it will be considered to revise the demand projection.	JST
12	Why the current status is presented for Kigali City but not in 7 sectors? Are they starting from 0%?	LODA	Baseline service coverage for seven sectors are not available therefore the same assumption is being applied both for the City and the adjacent area. Depending on availability of new reliable data it will be discussed with the working team of the C/P of WASAC	JST
13	Does the High Growth scenario consider other government initiative such as development of secondary cities to reduce pressure on Kigali?	UR representative	The WASAC/JICA M/P follows the high growth scenario in line with the CoK M/P, because it considers timing of development phase and land use transition in detail	JST
14	Why Nzove Water Treatment Plant (WTP) is not working at its optimal Capacity	UR representative	The WTP team of the working team of the WASAC/JICA M/P is assessing conditions of all plants and will share results in future presentations	JST
15	It would be good to use data from other water operator not only data from WASAC given that there other operators providing water to the communities	Water Aid	This was noted. We hope cooperation for sharing data.	JST
16	When WASAC increased water tariffs there is an indication that water use has decreased? Does the WASAC/JICA M/P consider to explorer other parameters that may affect projected water demand?	WASAC	The decrease in water use observed after the new water tariffs may results in different factors such as efficient use of water by households but this may be temporary and may not have a significant impacts on Projected water demand	WAS AC

A - 7

17	It would be good to have a team looking at regular replacement of old structure such as pipe and reservoir.	Water for people Representative	The working team under the WASAC/JICA M/P is working on reviewing conditions of reservoirs, transmission and distribution pipes, in order to draft up propose strategies. It shall be noted that expansion and necessity shall be considered for replacement. Therefor it is not effective to have independent team for regular replacement.	JST
18	Is there any possibility of other stakeholders to join various team formed under the Master Plan	Water for people Representative	The Working Teams have been established to conduct study for the WASAC/JICA M/P. Other stakeholders will have opportunities to be asked when it is necessary for the Working Team to have their opinion	WAS AC

A - 8

Attachment 2: List of participants

1. Government of Rwanda

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2. Media and Others

A - 9

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A - 10

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A - 11

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4. WASAC

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Meeting Memo for TWG on 20th February, 2020

Time & Date: 9:00 to 12:00, 20th February, 2020
Venue: Conference room (4th floor), Ministry of Infrastructure (MININFRA)
Subject: Presentation on Interim Report including master scenario and priority projects, the Project for Water Supply Master Plan for City of Kigali (WASAC/JICA M/P)

Mr. METHODE Rutagungira
Project Director of Kigali Water Supply Masterplan Project
Water and Sanitation Corporation WASAC,
The Government the Republic of Rwanda

Mr. KAWAMURA Tetsuji
Co-Team Leader/Water Supply Planning 2
JICA Study Team

1

Agenda:

8:30 – 9:00 Registration

9:00 – 9:20 Opening address
- by MININFRA
- by WASAC
- by JICA (Rwanda Office)

9:20 – 10:30 Presentation by JST
- General
- Financial & Organizational Issues
- Update of Demand Forecast
- Water Resource Development Plan
- Socio Economic Survey & SEA
- Master Scenario & Candidate Projects (JST)
- Way Forward (JST)

Break

10:45 – 11:30 Questions and Answers/ Discussion

11:30 – 11:45 Closing Note:
- by JICA (Rwanda Office),
- by WASAC
- by MININFRA,

1. Self-introduction by each attendant

Self-introduction from the individual participants.

2. Opening remarks

- Opening speech by Ms. KAYITESI Marcelline, WATSAN Div. Manager, MININFRA, explaining the background and history how the Study had been realized from the signing of R/D between JICA and Rwanda side. She further added the master plan study (WASAC/JICA M/P) is for achieving SDGs and the national target that aims at 100% access to safe water (500 m distance from a sources for rural and 200 m in urban).

- Then, Mr. Methode Rutagungira, Director of Urban Water and Sanitation Services (UWSS), WASAC, gave his speech, explaining the background and objectives of the Study, with emphasizing that the Study has so far been conducted under the close collaboration among the working teams of the Study that consist of the counterpart (C/P) members of WASAC and the JST.

- Further, Mr. NAKASHIMA Koji, JICA Rwanda Office, noted that big challenges are being laid out ahead the years to come for Rwandan side including WASAC and MININFRA to approach the SDGs targets as

well as future demand according to the Study. Then, he emphasized that the WASAC/JICA M/P is not just a kind of a work leaving all tasks to a consultant, but it is a sort of "Technical Cooperation Program" under which the Rwandan side including C/P are actively involved in the process of planning with the JICA Study Team (JST). He added that, in this context, the JST is not just a group of consultants who are entrusted to work by a client, but the team of experts who will work together with the C/P of WASAC closely to prepare JICA/WASAC M/P.

- Prior to the presentation by the JST, the Co-Team Leader of the JST highlighted that the interim result of the Study implies that the huge investment is inevitable to cover future water demand and in this context he added that today's meeting to share the Study progress among the concerned development partners would help Rwandan side including WASAC and MININFRA to seek future financial sources.

3. Questions, answers and comments raised during discussion

Summary of the Q&A as well as comments raised during the meeting are attached as Annex-1.

4. Closing note

On the wrap-up of the meeting, following comments were raised:

- WATSAN Div. Manager, MININFRA:
  - expressed her interest on the longlist of the candidate projects presented in the ITR, and encouraged the further participation of the development partners regardless of its capability of investment scale in order for MININFRA and WASAC to seek any possible funding source.
  - expressed her gratitude to everyone presented including JST and the counterpart of WASAC for the work done. Additionally, she has appreciated the presentation and feedbacks from the attendants including development partners.
  - urged the working teams for the Study to continue with this approach.
- Representative of the JICA Rwanda office expressed the gratitude and requested to all the participants of continuing cooperation for the Study.
- Director of UWSS, WASAC:
  - expressed his best hope for the possibility of the two identified priority projects (A1 and A2 in the candidate projects) could be financed by the Japanese side as well as the candidate for the Japan's Grant Aid Scheme (combination of A4 and A5).
  - added that more discussions with MININFRA and other development partners are going to continue during Phase II of the Study for finding a way of financing for the priority projects.

Annex-1

Summary of Q&A Session

Q: Questions, A: Answers, C: Comments

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1.	**Organizational capacity development and structure** Q WATSAN Div. Manager,, MININFRA: How does WASAC proceed to enhance the organization capacity for dealing with the operational issues. A JST: Organizational capacity development focus on an increasing productivity. A Director of UWSS, WASAC: Increase training opportunity for staff, empowering staff for decision making on site are promoted to staff's working motivation that lead to increase productivity. WASAC also aims to creating an organization for sharing skill and knowledge inter directorate/section to improve business operation. Q WATSAN Div. Manager,, MININFRA: Apart from increasing productivity, proper management system of data such as customer and GIS data are important. A JST: Agreed. It will be considered in data management process for the MP report.
2.	**Financing for the Project** Q WATSAN Div. Manager, MININFRA: What does it mean "Transparency of tariff" in Page87? A The structure of tariff setting is unclear in WASAC. For example, the tariff is set based on capital cost and O&M cost due to strategy of "Full cost recovery" in Japan.
3.	Priority Projects: Q WATSAN Div. Manager,, MININFRA: Expansion in phase 1 is small (3,000 m3/day) and may be integrated into the phase 2 (30,000 m3/day). A JST: The proposal intended to minimize the initial investment cost for rehabilitation in Phase 1. JST will review the phasing plan in the F/S because it was recommended in the JCC that Karenge WTP expansion should be prioritized.

4

Annex-1

4.	Water supply roadmap, small-scale water supply scheme, and priority projects: Q (NGO) 1. There seems to be a contradiction between the government's target "100% safe water access by 2024" and the vision in the masterplan "(100% improved drinking water sources and) 87% piped water supply". 2. Small scale water supply projects were not proposed in the M/P. 3. Would like to know the cost information for the candidate projects. 4. It seems not efficient to have a two WTPs in Karenge and Masaka. A JST: 1. There is no contradiction because the remaining population of 87% will have access to safe water by public taps or the improved springs in our vision of the M/P. The people will gain access to individual connection progressively towards 2050. 2. Noted. JST and WASAC will appreciate if the presenting developing partners have specific ideas for the Small Scale Water Services. 3. The Costs are shown in the IT/R. It will be presented as per requested. 4. Water Sources and the locations of the two WTPs are so different that they cannot be integrated into one. Technically, having only one WTP is not efficient. The result presented today is the one we optimized the capacities of WTPs according to their locations compared to the water demands.

5

Annex-1

5.	**Water Resource Development Plan (Alignment with Water Resource Master Plan):** Q WATSAN Div. Manager, MININFRA: What is the alignment of the existing water resources and Proposed water resources in masterplan? A JST: Water Resources Master Plan indicates the water balance (available water) at each catchment and do not mention particular groundwater potential site to develop. Those sites mentioned here were previously studied or under investigation. A JST: Potential sites for Water resources development were taken into consideration based on existing data from previous studies, (for example at Nzove both side of the river banks were previously studied), And also at Masaka , groundwater investigation will be conducted to know potentiality of the site and volume of water that can be extracted. Of course, discussions with RWFA were conducted but there is an issue of groundwater data even if even RWFA is trying to establish groundwater monitoring network. Regarding surface water, RWFA is monitoring through hydrological stations and data available on water balance are catchment-based which include all water usage. Thus, some measures for water allocation are available to avoid conflict between water users. In terms of water quality, groundwater is preferable compared surface water and also by considering cost-effective water source.
6.	**Water Resource Development Plan (Alignment with Water Resource Master Plan):** Q Rural Water Supply Senior Eng., MININFRA: The Ministry of environment is conducting a study to rehabilitate Rwesero Dam on Muhazi lake (downstream) for water supply purpose. Is there any possibility to use the water for drinking water purpose for the City of Kigali? A Director of UWSS, WASAC: Muhazi lake is reserved as a water source for eastern province including Rwamagana instead they are considering water from Butamuwa Dam.
7.	**Water Quality Survey p (#54)** Q World Vision Rwanda: (p.54 of the slide) In the water quality survey, have you checked arsenic? A JST: The water quality tests result in the presentation has omitted some items which are detecting nothing. The parameters you've mentioned were not included in our test, since it is targeted for spring. A JST: The parameter you've mentioned will be tested in groundwater tests. However, it has been delayed due to land occupation issue and access problem by flooding. It will be carried out including two (2) parameters you've mentioned.

6

Annex-1

8.	**Status of Concession Agreement between GoR and WASAC:** C JST (Request to MININFRA) : The agreement has not been signed long time since the independence of WASAC in 2014. Ms. Chairperson is a member of WASAC Board of Director. Kindly take initiatives to promote this issue. A WATSAN Div. Manager, MININFRA: WASAC has completed the procedures including drafting the agreement. The necessary procedures will be followed like below: • To hold the shareholders' meeting and pass the resolution. • To get the Cabinet approval • To sign by both parities
9.	**Water Tariff:** C JST (Request to MININFRA): Cash Flow of WASAC is positive; however, profit is negative. The reason is the low level of tariff which is 30% lower than the entire cost including the depreciation of fixed assets. Obviously it means that the future renewal and replacement costs cannot be covered by the operation profit. Kindly push RURA and get it to take more consideration about this. A WATSAN Div. Manager, MININFRA: She asked whether the JST has ever met the RURA staff. She advised the JST to get a direct contact with them if yes.

7

Annex-1

[Attendance List]

Member of Thematic Working Group

Name	*Title*	*Organization*
Marcelline Kayitesi	Water and Sanitation Division Manager	MININFRA
Fidele Nteziyaremye	WATSAN DM, Ag	MININFRA
Venuste Mpimbazimana	Urban Water Supply Senior Engineer	MININFRA
Kagaga Monique	M& E Expert	MININFRA
Leoncia Mukamwiza	Policy Research & Rent Expert	MININFRA
Hategekimana Uwitonze Bova	WATSAN Economist	MININFRA
Rwabizi Felix	Intern	MININFRA
Emmanuel Hategekimana	Rural Water Supply Senior Engineer	MININFRA
Nakashima Koji	Water and Sanitation Program Manager	JICA Rwanda Office
Kwizera Virgile	Water and Sanitation Program Officer	JICA Rwanda Office
Amos Shyaka Kazora	Head of Sewerage Operations Unit	WASAC
Amandine Umukesha	Senior W&S Expert	AfDB
Nicole Mukunzi	HP&WASH Specialist	USAID
Uwonkunda Bruce	S.P.O	Water for People
Gratien Nizeyimana	Wash & Health Technical Design Manager	WUR
Olivier Ndizeye	MEL Coordinator	Water Aid
Uwingabire Alphonsine	Wash for All Project Officer	UPHLS
Ntakirende JMV	Programs Manager	Living Water Int.
Duhirimana Theogene	Legal Advisor of Ayateke, Representative of FEPEAR (Forum des Exploitants Privé des systèmes d'Eau et d'Assainissement au Rwanda).	FEPEAR
Fiordalisio Omar	Country Manager, Novimento Lotta Fame Mondo (NLFM)	MLFM
Hirwa Christian	Technical Director	Water Access Rwanda
Musabyimana Gedeon	WASH Officer	UNICEF

Working Team for WASAC/JICA M/P

Name	*Title*	*Organization*
Rutagungira Methode	Director, UWSSD	WASAC
Gashugi Innocent	Manager Water Operation Service, UWSSD	WASAC
Lobga M. Monia	Water Production Manager, UWSSD	WASAC
Kawamura Tetsuji	Co-Team Leader / Water Supply Planning 2	JICA Study Team
Yoshida Kenji	Water Resource / Water Quality/ Hydrogeology	JICA Study Team
Kobayashi Shinkichi	Water Supply Pipeline Planning	JICA Study Team
Matsubara Koichi	Hydraulic Analysis / GIS Database	JICA Study Team
Oshima Yoshiaki	Cost Estimator / Implementation Planning / Study Coordinator	JICA Study Team
Choso Yoshiyuki	Organization/ Institution	JICA Study Team
Osakabe Noboru	Economic and Financial Analyst	JICA Study Team
Tanaka Uyu	Environment and Social Consideration	JICA Study Team
Nteziryayo Francois Xavier	Supporting Staff for Civil Engineering (Planning /Water supply Pipeline /Water Treatment Plant)	JICA Study Team
Dushimimana Sandrine	Office Secretary	JICA Study Team
Uwiringiyimana Janvier	Specialist in Water Resource Engineering	JICA Study Team

8

APPENDIX 3: Minutes of Meeting on JCC for ITR

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

MINUTES OF MEETING

ON

THE JOINT COORDINATING COMMITTEE (JCC)

FOR

INTERIM REPORT

Agreed upon in Kigali on February 21, 2020
between

WATER AND SANITATION CORPORATION
CHIEF EXECUTIVE OFFICER

Eng. Aime Muzola
Chief Executive Officer
Water and Sanitation Corporation
WASAC,
The Government the Republic of
Rwanda

川村 均司

Mr. Mamiya Takemasa
Team Leader/Water Supply Planning 1
JICA Study Team

MINUTES OF MEETING

Water and Sanitation Corporation (WASAC), as the Counterpart Agency for the Project for Water Supply Master Plan for City of Kigali in the Republic of Rwanda (the Study), held the Joint Coordinating Committee (JCC) chaired by Eng. Aime Muzola, the Chief Executive Officer of WASAC (CEO), on February 13th, 2020.

The participants of the meeting are concerned parties from Rwandan side, JICA Headquarters in Tokyo, JICA Rwanda office, WASAC and the JICA Study Team (JST) headed by Mr. Mamiya Takemasa with the members from Nihon Suido Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd. from Japan to implement the Study. Those who were participated in the JCC are listed in the Attachment-1.

At the beginning of the JCC Meeting, Mr. Methode Rutagungira, Director of Urban Water and Sanitation Services (UWSS), WASAC, gave his presentation, explaining the agenda of the meeting as well as background and objectives of the Study, with emphasizing that the Study has so far been conducted under the close collaboration among the working teams of the Study that consist of the counterpart members of WASAC and the JST. The presentation was then followed by the JST to explain the content of the Interim Report (IT/R) including present progress so far made, a summary of the IT/R, and way forward by each member in charge of the Study.

As a result of the discussion, all the JCC members confirmed the content of the IT/R that includes the revision after the Progress Report presented in July 2019 and the newly added parts including the Water Resource Development Plan, the Master Scenario, and the candidate projects for 15-Year Investment Plan.

Several components including the Water Resource Development Plan and the Master Scenario shall be further discussed between the counterpart members of WASAC and the JST within February 2020 in order for the working teams of the Study to initiate finalizing the Master Plan which is expected to be submitted in August 2020, and to start preparation work for the Feasibility Study (F/S).

Further, the following candidate projects that are regarded most urgent toward 2035 were discussed in detail at the meeting:

- A1: Masaka Water Treatment Plant
- A2: Karenge Water Treatment Plant (Rehabilitation and Expansion)
- A3: Nzove 1 (Reconstruction)
- A4: NRW Reduction for Ntora-Remera Area (Pressure control and pipe renewal)
- A5: NRW Reduction through pipe renewal and pressure control

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- A6: Capacity Development for Sustainable Use of Water Resources and Water Supply Facilities
- A7: Kigali Central Transmission Main

The conclusions are summarized as below:

1 **Identification of the two (2) priority projects for the F/S under the Study**

All parties confirmed that A1: Masaka Water Treatment Plant and A2: Karenge Water Treatment Plan (Rehabilitation and Expansion) were selected for the F/S under the Study.

2 **Identification of Spin-out project**

All parties confirmed that the Spin-out project, which is regarded as one of the most urgent projects among the list of the candidate projects and would be applied for Japan's Grant Aid, will be selected as the following manner:

- The Spin-out project should be a part of the combination of A4: NRW Reduction for Ntora-Remera Area (Pressure control and pipe renewal) and A5: NRW Reduction through pipe renewal and pressure control.
- The combined project should be conducted in a phased manner, considering the Spin-out project as one of its phases.
- The scale of the project will be further reviewed by the working teams in order to fit Japan's Grant Aid, in consultation with JICA.

3 **Finalizing Master Scenario**

All parties confirmed that the case "2035-1 Baseline" and "2035-3 Gahanga/Masaka oriented" are preferable for the year 2035, and further confirmed that the Master Scenario will be finalized within February 2020, incorporating the result of the Stakeholder meeting on February 25, 2020 in order for the working teams to step forward.

Following will be revised to be reflected to the next report based on the comments raised at the meeting:

- Introducing new technology and equipment shall be considered to improve O&M efficiency in addition to increasing productivity by capacity development is not only way to improve O&M..
- New organizational structure should be considered for implementing the priority project.
- New tariff structure should be suggested in the course of the Study for implementing the projects of the M/P.
- Financial source and funds including private funds should be considered in the course of

the Study.

- Explanation on the environmental and social aspects should be added to the evaluation criteria for the Master Scenario.
- Nyabarongo Dam II should be considered in the Water Resource Development Plan.
- Possibility of dam construction at Yanze River should be considered.
- Water balance should be summarized and presented in the Water Resources Development Plan considering usage by other water users,
- Cost comparison for the Master Scenario should be updated if more precise data can be obtained.
- 40,000 m^3/d should be considered for the F/S of the Masaka WTP.
- 40,000m^3/d should be considered for the total capacity after the expansion of the Karenge WTP instead of 18,000 m^3/d.
- Other errors and discrepancies found in the IT/R should be corrected

Further, after the discussion, representative of JICA Headquarters in Tokyo, the Chief Representative of JICA Rwanda Office, and WASAC CEO gave closing speech as summarized below.

1 Closing speech by the Representative of JICA Headquarters in Tokyo

In her closing speech, she mentioned the following points;

- She expressed her appreciation for the fact that the content of IT/R is virtually accepted among the JCC members.
- She added that the content of the IT/R should be well disseminated in the forthcoming stakeholder meeting scheduled on February 25, 2020.

2 Closing speech by the Chief Representative of JICA Rwanda Office

In his closing speech, he mentioned the following points;

- As the representative of JICA Rwanda, he expressed his sincere gratitude and appreciation to the effort having been made by all concerned people to keep the Study schedule on track without any delay.
- As commented in the previous JCC, he commented that after the completion of the Study, WASAC should update the WASAC/JICA M/P at regular intervals by itself independently in order to make the WASAC/JICA M/P realistic and practical. He emphasized that the counterpart members of WASAC should be actively involved in the planning work and keep in mind once again that the individual counterpart members should be a part of the Study.

3 Closing speech by the CEO of WASAC

In his closing speech, he emphasized the following points;

- As mentioned by the Chief Representative of JICA Rwanda Office, he expressed his

appreciation for the active participation of the counterpart members in the Study as well as the fact that the Study schedule is being on track without any delay.

- In order to reflect the comments and suggestions raised at today's JCC meeting to the Study, it is necessary for the counterpart staff as well as the concerned organizations to provide full cooperation to the project team.

4

Attachment-1

List of Participants

【Rwanda side】

Government of Rwanda and Other related organization

Jacqueline Nyirakamana	Transboundary Water Resources Cooperation Specialist, Ministry of Environment
Emmanuel K. Asaba	City Engineer, City of Kigali
Nkurunziza K. Egide	Director of One Stop Center, Bugesera District
Patric Mayira	Water Supply Monitoring Officer, RURA
Jean Damascene Ndayisabye	Water and Sanitation Unit, RURA
Patric Rimenyande	Planning Engineer, EDCL/REG
Innocent Hagenimana	Transport Economist Engineer, RTDA
Gatete Benefique	Research Officer, REMA

WASAC

Aime Muzola	CEO, WASAC
Murekezi Dominique	Ag. Coordinator of SPIU, WASAC
Dr.Francois Xavier Nshimiyimana	R&D Specialist, WASAC
Evode Ishimwe	Sanitation Engineer , WASAC

WASAC C/P (Working Team)

Rutagungira Methode	Director, UWSSD, WASAC
Gashugi Innocent	Manager Water Operation Service, UWSSD, WASAC
Vedaste Tuyisenge	Head of Gikondo Branch, WASAC
Umuhoza Mbateye Francine Aimee	Planning & Research, UWSSD, WASAC
Shumbusho Marcellin	Head of Karenge WTP, UWSSD, WASAC
Nkeramihigo jean pierre	UWSSD, WASAC
Uwitonze Desire	UWSSD, WASAC
Musabyeyezu Jeanne	Head of Kacyiru Branch, WASAC
Lobga M. Monia	Water Production Manager, UWSSD, WASAC
Bahige J. Berchmas	NRW Manager, UWSSD, WASAC
Mutamba Jane	Head of Nyamirambo Branch, WASAC
Saranda Catherine	Head of Nyarugenge Branch, WASAC
Desire Kayiru	Head of Billing Management, Commercial Department, WASAC
Rubayita Gilbert	Head of Remera Branch, WASAC
Dushime Rene	Ag. Water Treatment Plant Officer, WASAC

A - 1

Sindikubwabo Theoneste	Sanitation Central Laboratory Officer, UWSSD, WASAC
Murekezi Rukundo Frank	Public Relations, WASAC
Iraguha Richard Dani	Head of Public Relations, WASAC

Media

Rutayisire Emile	Journalist, Imvaho Nshya
Felix Nsengumukiza	Reporter, Flash TV FM
Gisa Innocent	Cameraman, RBA
Paul Rutikanga	Journalist, RBA
Serge Iradukunda	Journalist, IGIHE

【Japanese side】

JICA Headquarters in Tokyo

SHOJI Izumi	Senior Deputy Director, Water Resources Team 2, Global Environment Dept., JICA HQ

JICA Rwanda Office

MARUO Shin	Chief Representative, JICA Rwanda Office
NAKASHIMA Koji	Water and Sanitation Program Manager, JICA Rwanda Office
Kwizera Virgile	Water and Sanitation Program Officer, JICA Rwanda Office
Aimable Uwimana	Public Relations Officer, JICA
MAYUSUMI Masanobu	JICA Long Term Expert (NRW), JICA/WASAC

JICA Study Team

MAMIYA Takemasa	Team Leader / Water Supply Planning 1, JICA Study Team
KAWAMURA Tetsuji	Co-Team Leader / Water Supply Planning 2, JICA Study Team
YOSHIDA Kenji	Water Resource / Water Quality/ Hydrogeology, JICA Study Team
KOBAYASHI Shinkichi	Water Supply Pipeline Planning, JICA Study Team
MATSUBARA Koichi	Hydraulic Analysis / GIS Database, JICA Study Team
OSHIMA Yoshiaki	Cost Estimator / Implementation planning / Study Coordinator, JICA Study Team
CHOSO Yoshiyuki	Organization/ Institution, JICA Study Team
TANAKA Uyu	Environment and Social Consideration, JICA Study Team
Nteziryayo Francois Xavier	Supporting staff for Civil Engineering (Planning /Water supply pipeline /Water treatment plant), Trust Facility Services
Uwiringiyimana Janvier	Specialist in water resource engineering, Trust Facility Services
Habakubaho Theogene	Consultant SEA, Socio-Economic, BESST Ltd
Dushimimana Sandrine	Office Secretary, Trust Facility Services

6

A - 2

APPENDIX 4: Minutes of Meeting on JCC for MP/R

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

MINUTES OF MEETING

ON

THE JOINT COORDINATING COMMITTEE (JCC)

FOR

THE KIGALI WATER SUPPLY MASTERPLAN

Agreed upon in Kigali on November 26, 2020
between

WATER AND SANITATION CORPORATION
WASAC
CHIEF EXECUTIVE OFFICER

Ms. Umuhumuza Gisele
Deputy Chief Executive Officer
Water and Sanitation Corporation
WASAC,
The Government of the Republic of
Rwanda

Mr. Mamiya Takemasa
Team Leader/Water Supply Planning 1
JICA Study Team

MINUTES OF MEETING

Water and Sanitation Corporation (WASAC), as the Counterpart Agency for the Project for Water Supply Master Plan for the City of Kigali in the Republic of Rwanda (the Study), held the Joint Coordinating Committee (JCC) chaired by Eng. Mr. Aime Muzola, the Chief Executive Officer of WASAC (CEO), on November 26, 2020, for the purpose of sharing, discussing and reaching consensus of the content of the Kigali Water Supply Masterplan, which has been drafted under the activities of the Study, among the JCC members concerned.

The participants of the meeting are concerned parties from the Rwandan side, JICA Headquarters in Tokyo, JICA Rwanda office, WASAC, and the JICA Study Team (JST) headed by Mr. Mamiya Takemasa with the members from Nihon Suido Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd. from Japan to implement the Study. Those who were participated in the JCC are listed in the **Attachment-1**.

At the beginning of the JCC Meeting, **Eng. Mr. Aime Muzola, the CEO of WASAC** and **Mr. Nagase Tomonori, the JICA Rwanda Office representative,** gave their opening addresses.

Mr. Methode Rutagungira, Director of Urban Water and Sanitation Services (UWSS), WASAC, gave his presentation, explaining the agenda of the meeting as well as the background and objectives of the Study, with emphasizing that the Study has so far been conducted under the close collaboration among the working teams of the Study that consist of the counterpart members of WASAC and the JST. The presentation was then followed by the JST to explain the content of the Kigali Water Supply Masterplan, including present progress of the feasibility studies (Expansion of Karenge WTP and Construction of Masaka WTP) so far made, a summary of the Kigali Water Supply Masterplan, and way forward by each member in charge of the Study.

After the presentation, technical comments and inputs were provided from the Mr. Asaba Katabarwa Emmanuel, City Engineer, City of Kigali (CoK), Mr. Vital Munyandinda, Division Manager, Water Permission, Rwanda Water Resource Board (RWB), Ms. Marceline, WATSAN Division Manager, Ministry of Infrastructure (MININFRA), Mr. Fred Sabiti, Technical Advisor to the Minister, MINECOFIN, Mr. Mark Manyifika, Director General in charge of Land, Water and Forestry in Ministry of Environment (MOE). The comments and inputs are summarized in the **Attachment-2**.

As a result of the discussion, all the JCC members confirmed the content of the Kigali Water Supply Masterplan that includes the newly added parts of the Water Resource Development Plan, the finalized Master Scenario, a 15-Year Investment Plan, Financial and Economic Analysis of the 15-Year Investment Plan, a proposal for the new organizational arrangement (including Water Resource Unit, One Strategic Team, and Program Committee) and the overall recommendation for the Masterplan.

The conclusions are summarized below:

1

1. Confirmation on the contents of Kigali Water Supply Masterplan

All parties confirmed that the contents of the Kigali Water Supply Masterplan in this JCC subject to the consideration of the provided comments and inputs. The consideration should be made before finalizing the Masterplan as per the summary of the comment in the **Attachment-2**.

2. Schedule of Feasibility studies (F/s) and necessity of the amendment of Record of Discussion (R/D)

All parties acknowledged the schedule of F/s for 1) the Expansion of Karenge WTP and 2) the Construction of Masaka WTP. All parties also acknowledge that the procurement of a water tanker and the need for Business Continuity Plan have to be added in a scope of work of the Project under the unexpected effect of COVID-19.The additional works and integration of them into the Final Report require an extension of the duration of the project, which was determined in the Record of Discussion dated December 5, 2017 between JICA and WASAC.

Further, after the discussion, the representative of JICA Headquarters in Tokyo, and the WASAC Deputy CEO gave their closing speeches.

Attachment-1 List of Participants
Attachment-2 Comment on JCC and Responses from WASAC/JST

2

Attachment-1

List of Participants

【Rwanda side】

Government of Rwanda and Other related organization

Emmanuel K. Asaba	City Engineer, City of Kigali
MUNYANDINDA Vital	Water Permits Division Manager, RWB
Alsaad Ndayizeye	Hydrology Officer, RWB
Marcelline Kayitesi	Water and Sanitation Division Manager, MININFRA
Mpimbazimana Venuste	Urban Water Supply Senior Engineer, MININFRA
NGENDAHIMANA Alain	Financial Analyst, MINECOFIN
SABITI Fred	Technical advisor, MINECOFIN
NSENGIYUMVA Jacques	REMA Ag. DER&PC, REMA
MARC Manyifika	General Director of Land Water and forest, MOE
BIZUMUREMYI Jean Danascene	Division Manager National and Urban Roads, RTDA
NTEZIRYAYO Florien	Manager of GIS Services, REG/EDCL
Kabananiye Janvier	Engineering Planning Coordinator, EUCL
KANANGA Damascene	WASH Officer, Bugesera District
HABINSHUTI J. Pierre	Energy & Water Engineer, Gasabo District
Nzabahimana James	Water and Sanitation Officer, Kamonyi District
Ndagijimana Joel	Water and Energy Engineer, Kicukiro District
MUKANDAYISHIMIYE Olive	District infrastructure & property management officer, Rwamagana District
NIYONIRINGIYE Felicien	Director of One Stop Center & Infrastructure, Rulindo District

WASAC

Aime Muzola	CEO, WASAC
Umuhumuza Gisele	Deputy CEO, WASAC
Mwijukye James	Director, Commercial Services, WASAC
Hategekimana Samson	Manager Corporate Planning, WASAC
MUGWANEZA Vincent de Paul	Rural Water Services, WASAC
NDAHIRO Eugene	Head of Monitoring & Evaluation unit, WASAC
Murekezi Dominique	Manager of Infrastructure and Planning, WASAC

Francois Xavier Nshimiyimana	R&D Specialist, WASAC
Emmanuel Ngendahayo	R&D Specialist, WASAC

WASAC C/P (Working Team)

Rutagungira Methode	Director, UWSSD, WASAC
Gashugi Innocent	Manager Water Operation Service, UWSSD, WASAC
Vedaste Tuyisenge	Head of Gikondo Branch, WASAC
Sindikubwabo Theoneste	Sanitation Central Laboratory Officer, UWSSD, WASAC
Bushayija Yasin	Head of Nzove WTP, UWSSD, WASAC
Shumbusho Marcellin	Head of Karenge WTP, UWSSD, WASAC
Nkeramihigo Jean Pierre	UWSSD, WASAC
Anaclet Mukiza	Head of Kanombe Branch, WASAC
Desire Ntamuturano	UWSSD, WASAC
Lobga M. Monia	Water Production Manager, UWSSD, WASAC
Bahige J. Berchmas	NRW Manager, UWSSD, WASAC
Mutamba Jane	Head of Nyamirambo Branch, WASAC
Saranda Catherine	Head of Nyarugenge Branch, WASAC
Rubayita Gilbert	Head of Remera Branch, WASAC
Kabasha Asaph Mercy	Project Manager Scale Project, WASAC
Karuwi Daniel	IT Support, WASAC

【Japanese side】

JICA Headquarters in Tokyo

HATTORI Yoko	Director, Water Resources Team 2, Global Environment Dept., JICA HQ
SHOJI Izumi	Senior Deputy Director, Water Resources Team 2, Global Environment Dept., JICA HQ
YOKOTA Yoshiaki	International Cooperation Expert, JICA HQ
MURAKAMI Toshio	In-house Consultant, JICA HQ

JICA Rwanda Office

NAGASE Tomonori	Deputy Chief Representative, JICA Rwanda Office
NAKASHIMA Koji	Water and Sanitation Program Manager, JICA Rwanda Office
Kwizera Virgile	Water and Sanitation Program Officer, JICA Rwanda Office
MAYUSUMI Masanobu	JICA Long Term Expert (NRW), JICA/WASAC

JICA Study Team

MAMIYA Takemasa	Team Leader / Water Supply Planning 1, JICA Study Team
KAWAMURA Tetsuji	Co-Team Leader / Water Supply Planning 2, JICA Study Team
YOSHIDA Kenji	Water Resource / Water Quality/ Hydrogeology, JICA Study Team
OSAKABE Noboru	Financial and Economic Analysis, JICA Study Team
KOBAYASHI Shinkichi	Water Supply Pipeline Planning, JICA Study Team
MATSUBARA Koichi	Hydraulic Analysis / GIS Database, JICA Study Team
OSHIMA Yoshiaki	Cost Estimator / Implementation planning / Study Coordinator, JICA Study Team
CHOSO Yoshiyuki	Organization/ Institution, JICA Study Team
TANAKA Uyu	Environment and Social Consideration, JICA Study Team
NISHIDA Kosei	Business Continuity Plan/ Water Supply Pipeline Planning 2/ Procurement Plan 2, JICA Study Team
Nteziryayo Francois Xavier	Supporting staff for Civil Engineering (Planning /Water supply pipeline /Water treatment plant), Trust Facility Services
Uwiringiyimana Janvier	Specialist in water resource engineering, Trust Facility Services
Dushimimana Sandrine	Office Secretary, Trust Facility Services

Attachment-2-1

KIGALI WATER SUPPLY MASTER PLAN PROJECT
ONLINE JCC MEETTING: KIGALI, 26 NOVEMBER 2020
COMPILED COMMENTS FROM PARTICIPANTS

1. Mr. ASABA KATABARWA EMMANUEL / CITY ENGINEER, CITY OF KIGALI

- To dispute the number (numeration of slides)
- The figure of 64% of population connected is low in sense of water supply
- High percentage of NRW (38%): M/P to show tangible measures to reduce it looking for type of materials, pipe bursting, ...
- The M/P didn't show how to help poor people of CoK to connect to the network (WASAC water supply system)
- High cost of water to people who are not connected to tap water (a jerrycan is costing from 20 RWF to 100 RWF and more; the tariff set by RURA is not respected)
- Install a system of payment progressively (based on water consumed) like in REG for electricity
- To reduce the number of public taps accordingly to the review of Kigali master plan and the improvement of informal settlement under planning to be eliminated in some areas (Biryogo, Gatenga, Gitega, Kimisagara, Nyabisindu...)
- Better to achieve 100 % household connection before year 2050
- Water quality issues not addressed in this M/P presentation
- WASAC to teach people how to conserve water for a better use

2. VITAL MUNYANDINDA/ DIVISION MANAGER, WATER PERMITTING/RWB

- National policy for water resource management developed back in 2011 considered domestic water supply as a priority among other water users like irrigation, mining, ...
- Important sources for water supply for City of Kigali are two: Nyabarongo and Yanze rivers
- Water demand is increasing but not on the same level as water availability (e.g: Yanze river: available amount of water is 30.000 m3/day; WASAC is consuming 24.000 m3/d, over 80%)
- Strategies developed by RWB to ensure that water quality and water quantity are secured: catchment restauration, erosion control strategy, flood control intervention, water use permit application; knowledge development strategy (information-dissemination)
- Mechanism of using water efficiently: recycle, multipurpose use

- Water storage development (infrastructure, facilities, storage, mentality) based on availability of water during rainy season and dry season

3. Ms MARCELLINE/ WATSAN DIVISION MANAGER, MININFRA

- M/P as a tool to reach universal access by 2024 and SDG's target by 2030
- Figure (slide No 51): fundamental targets to be aligned with national targets (SDG's targets)
- Missing in the M/P: increase the percentage of householder water connection, the availability of water needed, water quality
- Recommendation to review the M/P in 2030: why (after 10 years)?
- To show the link between the Water resource development plan under this M/P and the current water resource masterplan under development by Rwanda Water Resources Board
- NRW: reduction of NRW (2%) in 10 years from year 2025 (25%) to year 2035 (23%)???
- SDG's planned 25% in year 2024

4. Mr. FRED SABITI/TECHNICAL ADVISOR TO THE MINISTER, MINECOFIN

- The naming of this M/P mixed of names: City of Kigali Masterplan-Kigali Water Supply masterplan- the Greater Kigali Water Supply Masterplan
- Proposed name: City of Kigali Water Supply Masterplan (but check in the documents of MINECOFIN the real name of the project written down)
- Key valuable used to develop specific scenarios based on population projection: to be revised 3.8 million of people of CoK is higher!!!
- Additional of other key institution: e.g.: Ministry of Agriculture
- The M/P to take care of existing issues WASAC has such as water leakages, old pipes, quality of pipes using during the drafting and the designing of this water supply M/P
- Use of new water channels accordingly to the new Kigali Masterplan (review to the water network and avoid lot of cost for expropriation and relocation of pipes)
- Economic evaluation: the benefit cost is too small (it could be changed from 1.11 up to 2)
- The Ministry of Finance and Economic Planning is now responsible (mandate) for approving and coordinating all the sectoral and District sectoral masterplans; this M/P will pass through MINECOFIN will (information)
- Review of population projection: CoK and adjacent sectors

5. Mark MANYIFIKA/ DIRECTOR GENERAL IN CHARGE OF LAND, WATER AND FORESTRY IN MOE

- Upcoming Nyabarongo II dam: request MININFRA to facilitate a sitting room with RWB, REG, WASAC and MoE for the alternative to have a common understanding of this issue#
- Issue of rainwater harvesting for water flooding, water demand and water shortage crisis: look how we can valorise it instead to being a problem
- How this M/P will be connected to waste water treatment and possible reuse
- Link of Water use assessment with the rehabilitation of wetland in the CoK and their conservation (calculation of hydraulic method)
- Support from MoE for land acquisition in case of water treatment facilities and other water infrastructures: evaluation and costing in strategic manner.

SUMMARY OF PERTINENT COMMENTS

1. MP to be aligned to government planning targets especially NST1 (2024) and SDG's (2030)
2. Establish a link between this M/P and Water Resources Development Plan under preparation by Rwanda Water Resources Board
3. SEA Plan not yet submitted, the M/P will be meaningless without a SEA
4. The benefit cost of economic evaluation is too small, reduce NRW is a must
5. Coordination of M/P is very important: where??who will be responsible
6. Alternative of a multipurpose dam, this has to be explored
7. Other issues mentioned by some participants: high NRW, sensitisation of customers, tariff structure, substandard water materials, accuracy of data (population, NRW, etc.....)
8. Proposed title for the study: **KIGALI WATER SUPPLY MASTER PLAN**

Done at Kigali on 27th November 2020

Prepared by

Francois NTEZIRYAYO
JST

Edited by

Innocent GASHUGI
WASAC

Attachment-2-2

The Comments at JCC dated 26 Nov. 2020 and WASAC/JICA team's Responses

Summary of Comments at JCC	Response from WASAC/JICA Study Team
1. MP to be aligned to government planning targets especially NST1 (2024) and SDG's (2030)	The visual of Chapter 5 (Water Supply Vision, a figure equivalent to Slide 51) was corrected accordingly. The water supply vision itself was actually aligned with the GoR's target "100% access to safe water in urban areas by 2024". There was a misunderstanding among the participants because the terminology was mixed up in the slide (The slide says, "Improved Drinking Water Sources" but actually the target should be "Basic Services"). That misunderstanding led to speculation by some JCC members that the investment was not enough. For that question, we answer that the amount of investment is adequate in accordance with the water demand in the study area. So if we increase or bring forward the investment, it will be excessive if water demand does not change locally or as a whole. In the draft M/P report, the terminologies of the SDGs were elaborated and interpreted considering the local context, while the figure mixed up the terminologies. The figure was corrected, and the pertinent expressions was also carefully reviewed.
2. Establish a link between this M/P and Water Resources Development Plan under preparation by Rwanda Water Resources Board	A new unit in charge of water resources management is recommended in MP, and this new unit will be responsible for the water resources development plan by RWB. The M/P team has been already consulted with the concerned staff of RWB, at the time it was RWFA, about the plan during the course of study.
3. SEA report not yet submitted, the M/P will be meaningless without a SEA	SEA report has already been submitted. The required process of SEA regarding the Masterplan has been completed including the response to comments from REMA.
4. The benefit cost of economic evaluation is too small, reduce NRW is a must	JST understands that the higher score of evaluation is comparatively important for profit-seeking projects; however, it is not always an absolute requirement for Water Supply Projects because their products are essential for human life as basic human needs. It hereby is more material whether the projects are feasible or not. MP is assessed feasible accordingly. JST will analyze it in the F/S stage as well.

The Comments at JCC dated 26 Nov. 2020 and WASAC/JICA team's Responses

Summary of Comments at JCC	Response from WASAC/JICA Study Team
5. Coordination of M/P is very important: where??who will be responsible	The Masterplan stated the concept of the One Strategic Team (PMU) and Program Committee (PC) and was agreed upon among the JCC members. The next step (toward the Final Report) is to design "Where" and "Who" will be responsible and to define the detailed assignments of the unit members.
6. Alternative of a multipurpose dam, this has to be explored.	Nyabarongo II multipurpose dam project has been studied by EDCL, the F/S included the water source for water supply but was unfortunately finally excluded as the GoR's decision. In the future, if there is another multipurpose dam plan in the RWB in the future (possibly far located water source), the new water resource unit in WASAC will be able to discuss it in time so as not to miss jointly exploring the development project.
7. Other issues mentioned by some participants: high NRW, sensitisation of customers, tariff structure, substandard water materials, accuracy of data (population, NRW, etc.....)	*High NRW:* We have studied and elaborated the issues on NRW (**Chapter 5**), and planned the vision based on its knowledge. i.e. **1) Sub-standard materials & construction**: Smaller diameter pipes (under 32mm) causes large part of the numbers of leakages, especially made of Galvanized Steel, faulty made PE and faulty installed PVC. They are installed near the customers and sometimes at a high pressure. Replacement of those materials will improve NRW dramatically. **2) Block Zoning**: Randomly expanded pipelines and small capacity of distribution sub-mains made the existing distribution system uncontrollable. Constructing Zone Reservoir, well designed DMA, hydraulic separation and flow meters Distribution Management by flow measurement and Pressure control. The measures for the NRW improvement is the key component of the M/P and tangible projects are planned in the 15 years investment plan. The M/P also proposed the "BASIC TECHNICAL CRITERIA OF WATERWORKS FACILITY IN RWANDA" in the **Appendix 5**, in order that the re-constructed system should be established based on a high-quality standard. *Tariff Structure:* The Masterplan presented the average tariff based on the estimated investment. This is an indicative figure to cover the entire costs, which will help WASAC and RURA to work on setting up the actual tariff table in the future.
8. Proposed title for the study: **KIGALI WATER SUPPLY MASTER PLAN**	The report was corrected.

APPENDIX 5: Minutes of meeting on Stake Holder Meeting for MPR

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

OUTCOME

OF

THE STAKEHOLDER MEETING

FOR

KIGALI WATER SUPPLY MASTER PLAN

Agreed upon in Kigali on August 27, 2021
between

Mr. METHODE Rutagungira
Project Director of Kigali Water Supply Masterplan Project
Water and Sanitation Corporation WASAC,
The Government the Republic of Rwanda

Mr. MAMIYA Takemasa
Team Leader/Water Supply Planning 1
JICA Study Team

OUTCOME OF STAKEHOLDER MEETING ON KIGALI WATER SUPPLY MASTER PLAN, HELD ON AUGUST 27, 2021

1. Introduction

The Kigali Water Supply Master Plan was prepared by Water and Sanitation Corporation Limited (WASAC) under the financing agreement signed between the Government of Rwanda and the Government of Japan. The Master Plan was prepared with the support of JICA study team and counterparts from WASAC. Now Master Plan is prepared and due to nature of public works, WASAC as an enacting body, must show transparency in their actions. In disclosing information of their business plans, WASAC will enhances reliability and "legitimacy" of the MP and WASAC itself. Stakeholder meeting for the Master Plan is required for following objectives:

- To share MP (business plan of the WASAC) for whom it may affects
- To share current standing point of the water supply sector and necessity of support from public and relating agencies.

2. Participants

Participates to the stakeholder meeting included representative from the City of Kigali, WASAC, representative of districts officials (Rwamagana, Bugesera, Kamonyi and Rulindo, representative of NGos working in water sector, JICA study team and members of Media. List of participants is provided in annex 1.

3. Presentations

The opening remarks was provided by MR. Ntagungira Methodes who welcome all participants and urged them to actively participate in the workshop. He indicated that the objective of the workshop is to present results of work done by WASAC and JICA study team including the Master Plan, the 15years Investment plan and feasibility study of two selected projects as well as the conclusion of Strategic Environmental Assessment.

The Opening remarks was followed by the presentation provided by Mrs Francine Mbateye Umuhoza from WASAC. The presentation focused on the Master Plan Process, key components of the Master Plan and key conclusion of the master Plan. Key issues highlighted in the presentation include the coverage of the Master Plan, water demand forecast, water resource development and water supply master scenarios. She also presented the 15Years Investment Plan with two selected projects that undergone Feasibility Study-Masaka Water Treatment Plan and Rehabilitation of Karenge Water Treatment Plant. She concluded her presentation with the objective and findings of Strategic Environmental Assessment prepared for the master Plan. The Key conclusion

2

from the SEA is that No Project option cannot be considered and project implementation with mitigation measures is recommended. She also informed participants that in addition to the SEA prepared for the Master Plan, two Environmental Impacts assessment were prepared for two selected projects, Masaka and Karenge.

4. **Comments, inputs and discussions**

After the presentation, participants were provided with the opportunity to provide comments, questions and inputs to the Master Plan. The Table 1 presents key outcome of this session

Table 1: Record of Q&A session during SHM meeting on 27th August, 2021

	Question	Answer
1	**Water aid Representative**	
	In terms of water source, MP is heavily depends on Nyabarongo River, and Akagera River catchment. What is the reason for excluding Nyabugogo and Muhazi Lake as water source?	JST: there were existing water resource development plan. Therefore, JST didn't considered Nyabagogo River as water source for the MP. WASAC: Muhazi Lake had two (2) water supply projects. Therefore, the MP could not allocate water from Nyabugogo and Muhazi Lake.
	As a one of the option in the future, recycled water should be considered as one of the water sources. (comment)	WASAC: So far, we didn't consider recycle water as water source since there is no information about wastewater treatment masterplan. It may be considered when the masterplan on wastewater treatment is in place.
	In MP, are there any consideration to other water use such as agriculture sector, power sector, and industry sector?	WASAC: The master Plan was prepared in consultation with Rwanda Water Board and it considered available water resources and other users. Further water abstracted permit will be requested to ensure compliance with Water Resource Master Plan
	Through SEA, if there is any alerting issue, please share.	JST/BESST LTD: There is no alarming issues but key environmental and social issues were identified in SEA and recommendations were provided. Key issues identified are land acquisition and involuntary resettlement, floods issues and sludge management as well as issues related to climate change.

2	Member of the media	
	Why the objectives and target targeted in 2024 were not achieved and what is the guarantee that the Master Plan target will be achieved in 2050?	WASAC: WASAC is working with its stakeholders to achieve all target for 2024. He also provided information on ongoing projects including the rehabilitation of water supply network in Kigali and construction of new plants under AfDB funding. For the implementation of this Master Plan, the Government will work with its partners and private investors to implement projects included in The Master Plan and 15-Years Investment Plan
3	Water for People	
	To attract investors, I suggest to WASAC to have followings; - Detail design studies for the project - Above mentioned design documents should be available for the investors	WASAC So far, two projects were included in the Master Plan study but WASAC will explorer the possibility and funding opportunities to conduct other feasibility study which can be used for investors
4	Bugesera District	
	If possible, we want to add two (2) more sectors such as Mwogo and Juru in Bugesera as part of this MP.	WASAC The Master Plan considered only 7sectors outside Kigali which are considered as the expansion area for Kigali population. However, other sectors are covered in the National Water Supply and Sanitation under preparation.

3. Closing remarks

In his closing remarks, Mr. Methodes from WASAC appreciated the active participation of all invites and urged them to convey the message on general public and invited them to visit WASAC website to consultant details material related to the Master Plan.

Annex 1: List of Participants to the SHM of August 27, 2021

Government of Rwanda and Other related organization

KANANGA Jean Damascene	Water and Sanitation officer, BUGESERA District
KARANGWA Lambert	Senior WASH Expert, WaterAid
DUSINGIZUMUREMYI Eugene	Water for People Program Manager, Water for People

WASAC Management Team

RUTAGUNGIRA Methode	Director, Urban Water and Sanitation Service
GASHUGI Innocent	Manager Water Operations Services
MIREIZ TUTUSAUS	Expert, VEI/WASAC
KABASHA ASAPH Mercy	Project Manager, VEI/WASAC
NDAGIJIMANA Joseph	Water Supply Engineer, WASAC
BUSHAYIJA Yasin	Head of Nzove WTP, WASAC
MAZIMPAKA Claudien	Zoning & Mapping, WASAC
MWIJUKYE Jmes	DCS, WASAC
KAMIRU Desire	DCS, WASAC
TUYISENGE Vedaste	Head of Gikondo Branch, WASAC
MURENZI Rukundo Frank	P.R/Communication, WASAC
UMUHOZA Mbateye Francine	Planning Officer, WASAC
NTIRANDEKURA Valerien	Water Sector Specialist, WASAC
SHUMBUSHO Marcellin	Head of Karenge WTP, WASAC
MUKIZA Anaclet	Head of KANOMBE Branch
MUGWANEZA Vincent de Paul	Director of Rural Water Services
MUSABYEYEZU Jeanne	Head of KACYIRU Branch
LOBGA Monia	Water Production Manager
BAHIGE Jean Berchimans	NRW Manager
NIWENSHUTI Emmanuel	Head of Water and Sanitation Cooperation Unit
DUSHIME Réné	WTP Engineer, Kimisagara WTP
HAKIZUWERA Patrick	Water Distribution Officer, Kacyiru Branch
UWITONZE Desire	Ag. Zoning and Mapping Service, UWSS
RUBAYITA Gilbert	Head of REMERA Branch
SHUMBUSHO Cyrille	Water Distribution Services Officer, UWSS
MBATEYE Francine UMUHOZA	Planning Officer
Egide IYAKARE	Water Distribution Officer/Rwamagana Branch

5

JICA HQs/TOKYO

YAMAKI Tetsuya	Assistant Director, Water Resource Team 2

JICA Rwanda

NAKASHIMA Koji	Water and Sanitation Program Manager
KWIZERA Virgile	Water and Sanitation Program Officer

JICA Study Team in Venue

MAMIYA Takemasa	Team Leader / Water Supply Planning 1, JICA Study Team
KAWAMURA Tetsuji	Co-Team Leader / Water Supply Planning 2, JICA Study Team
NISHIDA Kosei	Business continuity Plan, JICA Study Team
MATSUMOTO Yuichi	Procurement & Quotation of Water Tanker
CHOSO Yoshiuki	Organization/ Institution
SAITO Shuichi	Electromechanical Engineer
KOBAYASHI Shinkichi	Water Supply Pipeline Planning
YOSHIDA Kenji	Water Resource / Water Quality/ Hydrogeology
MATSUBARA Koichi	Hydraulic Analysis / GIS Database
OSAKABE Noboru	Financial and Economic Analysis Specialist
NTEZIRYAYO Francois Xavier	Supporting staff for Civil Engineering (Planning /Water supply pipeline /Water treatment plant), Trust Facility Services
UWIRINGIYIMANA Janvier	Specialist in water resource engineering, Trust Facility Services
NIYIBAHO Jean Robert	Cost Estimate/ Electromechanical Engineer, Trust Facility Services
DUSHIMIMANA Sandrine	Office Secretary, Trust Facility Services
HABUKUBAHO Theogene	Consultant SEA, EIA, Socio-Economic, BESST Ltd

Media

BISERUKA Jean D'amour	Journalist, GASABO.Net
FLORENCE UWAMALIYA	Journalist, IMENA
NTIHABOSE DIEUDONNE	Journalist, OASISGOZETTE.RW
IMANIRIHO Gabriel	Journalist, Isango Star
BANGANIRIHO Thomas	Journalist, lematin d'Afrique
MUVUNYI Leonce	Reporter, The East African Rwanda Today
TALIBU Abdoul	Journalist, KIGALI Today

6

NTIRUSHWA Anaclet	Journalist, UKURI.RW
AHIMANA Theoneste	Journalist, Muburezsi.com
MPOREBUKE Noel	Journalist, umurabyo.rw
BAGABO John	Reporter, ISANO Radio
GATARAYIHA P. CELESTIN	Cameraman, RBA
KWIZERA John Patrick	Reporter, RBA
KAYITESI CARINE	Journalist, umwezi
NDABATEZE Jean Bosco	Journalist, Radio umucyo
UFITINEMA Ame Q.	Journalist, Impuruza

7

APPENDIX 6: Minutes of Meeting on JCC for DF/R

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

MINUTES OF MEETING

ON

THE JOINT COORDINATING COMMITTEE (JCC)

FOR

DRAFT FINAL REPORT

Agreed upon in Kigali on August 19, 2021
between

Ms. Gisèle UMUHUMUZA
Acting Chief Executive Officer
Water and Sanitation Corporation
WASAC,
The Government the Republic of
Rwanda

Mr. MAMIYA Takemasa
Team Leader/Water Supply Planning 1
JICA Study Team

MINUTES OF MEETING

Water and Sanitation Corporation (WASAC), as the Counterpart Agency for the Project for Water Supply Master Plan for City of Kigali in the Republic of Rwanda (the Study), held the Joint Coordinating Committee (JCC) chaired by **Ms. Gisele UMUHUMUZA, the Acting Chief Executive Officer of WASAC (Ag. CEO)**, on August 19th, 2021.

The participants of the meeting are concerned parties from the Rwandan side, JICA Headquarters in Tokyo, JICA Rwanda office, WASAC and the JICA Study Team (JST) headed by Mr. Mamiya Takemasa with the members from Nihon Suido Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd. from Japan to implement the Study. The list of those who participated in the JCC is on **Attachment-1**.
The main topic of the JCC is the content of the Draft Final Report (DF/R), which is organized as follows.

- The Kigali Water Supply Master Plan (the M/P)
- Feasibility Study for The Project for Expansion of Karenge Water Supply System (Karenge F/S)
- Feasibility Study for The Project for Construction of Masaka Water Supply System (Masaka F/S)

JST focused on the explanation of Karenge F/S and Masaka F/S since the content of the M/P and its 15-Year Investment Plan (15-YIP) have already been discussed at the previous JCC conducted on November 26, 2020, as well as a series of meetings convened by the Hon. Minister of MININFRA in May and June 2021.

1 OPENING SPEECH

1.1 Speech by the JICA Rwanda Office

JCC Meeting was started with the opening speech by Mr. Maruo Shin, Chief Representative, JICA Rwanda Office. The points of his comments are as follows:

- He expressed special thanks to the Working Team of the Study as well as all JCC members for active involvement and cooperation to materialize the DF/R that includes the M/P with 15-YIP and two Feasibility Studies, in an adverse situation under COVID-19.
- He also expressed special thanks to Hon. Claver Gatete, Minister of MININFRA of his active role to convene a series of meetings held in May and June 2021, so that the concerned stakeholders could comprehend the content of the M/P and 15-YIP to obtain their feedback.
- He commented that after this Study, the Project for Improvement of Water Supply Services in North-Central Kigali, which is listed in the 15-YIP as one of the priority projects, will be initiated very soon under the JICA's grant aid scheme, and a new technical cooperation project is expected near future. Besides, WASAC is now maintaining talks with the Hungarian side on the F/S for the Project for Expansion of Karenge Water Supply System. These facts show positive progress of what is itemized in the 15-YIP under the M/P.
- He expected a lot from the development partners active in Rwanda show their interest to the other projects listed in the M/P.

1.2 SPEECH BY THE AG. CEO OF WASAC

After the Chief Representative of JICA, Rwanda Office, Ms. Gisele UMUHUMUZA, WASAC Acting Chief Executive Officer delivered her speech which articulated of the following points:

- She expressed her gratitude to all participants present today and those who have been present since the launching of this study in March 2019.
- She commented that the water and sanitation sector has been given a high priority by the Rwandan Government; this is captured in the Seven (7) Years National Programme (2017-2024) where the Government is committed to ensure full water coverage by 2024. Therefore, the Kigali Water Supply Master Plan study is really a strategic document to achieve this goal.
- She reminded the brief history of the Study activity and its deliverable to date,
  - March 2019: JCC for the IC/R.
  - July 2019: JCC for the PG/R that includes (i) the existing status of water supply, ongoing projects, and issues related to water supply system in the Study Area; (ii) population projection and water demand projection in 2050.
  - February 2020: JCC for the IT/R, which focused on: (i) water resources development plan, (ii) Results of socio-economic survey; (iii) Master Plan scenario for water supply development and (iv) proposition and selection of Candidates projects for 15 Years investment plan.
  - November 2020: JCC for the Draft M/P Report which includes detailed information on 15 Years Investment Plan, that is listing up (i) Feasibility Study for Expansion of Karenge Water Supply System, (ii) Feasibility Study for Masaka Water Supply System, and (iii) Reduction of NRW for Ntora-Remera area that will be initiated very soon through the JICA's grant-aid scheme. Those selected priority projects will be the most promising ones to cope with the water shortage in the City of Kigali and its peri-urban areas.
  - May and June 2021: Discussions on the M/P and its 15-Year Investment Plan chaired by the Hon. Minister of MINIFRA, having the participation of concerned ministers as well as the Mayor of the City of Kigali.
  - August 2021: JCC for the DF/R, which consists of (i) the M/P Study including 15-Year Investment Plan, (ii) F/S for Masaka Water Supply System, and (iii) Expansion of Karenge Water Supply System
- She also emphasized that the DF/R will be a guiding document for decision-makers and planners in the water sector during the 30 coming years. In this context, the proposed projects listed in the 15-YIP including Masaka and Karenge will be keys to solve the problem of water shortage in Kigali City and its peri-urban areas.

2 PRESENTATION OF THE CONTENT OF THE DF/R

After the opening speech, the Study's Working Team members, both from WASAC's counterpart and the JST made the presentation of the content of the DF/R.

3 COMMENTARY SPEECH

Following the presentation by the WASAC's counterpart and JST, the following key participants gave their commentary notes.

3.1 Speech by RWB

The representative of RWB gave his comments as follows:

- He appreciated how the project has been done by WASAC and JICA Study Team.
- RWB has a mandate to ensure enough water availability for all populations.
- Since many of the identified sources are groundwater, monitoring groundwater is crucial. Therefore, he expects that this project will also install a monitoring well to picture the fluctuation of the aquifer.
- For Masaka F/S, consider other plans like railway alignment to avoid conflict of the land use.
- It is recommended to consider the future dyke construction for an irrigation scheme in Masaka wetland, as it may have negative impacts on Masaka WTP project.
- RWB will work closely with WASAC to increase the efficiency of water use and how it will be implemented near future.
- Up to 2050, Kigali and the adjacent 7 sectors need a huge amount of water; therefore the collaborative work among different institutions is necessary for the development of water storage and infrastructures like a dam as in Yanze sub-catchment. We can look at how we can implement it so that we can ensure enough water for Kimisagara WTP although there is an issue related to irrigation in dry season.

3.2 Speech by MININFRA

In her speech, Ms. Marcelline, the WATSAN Division Manager in MININFRA focused on the following points:

- She acknowledged the supports of JICA for this Master Plan to the development of the water sector.
- She also appreciated the good work done by the Master Plan Team.
- She emphasized that MININFRA is responsible for a national target to reach universal access for water supply, and this M/P is the key guiding document to achieve that.
- This M/P is up to 2050, which is relevant to reach SDGs target by 2030 as the GoR commits it.
- Implementation of the M/P is of a high priority.
- MININFRA expects WASAC to implement the government's projects with other partners.
- MININFRA has started to talk to different partners about how we can implement the M/P and they will continue engaging more partnerships for fund mobilization and joint implementation with different stakeholders including private sectors.

NISHIDA Kosei	Business Continuity Plan/ Water Supply Pipeline Planning 2/ Procurement Plan 2, JICA Study Team
MATSUMOTO Yuichi	Water Tanker Specialist, JICA Study Team
NTEZIRYAYO Francois Xavier	Supporting staff for Civil Engineering (Planning /Water supply pipeline /Water treatment plant), Trust Facility Services
UWIRINGIYIMANA Janvier	Specialist in water resource engineering, Trust Facility Services
NIYIBAHO Jean Robert	Cost Estimate/ Electromechanical Engineer
HABUKUBAHO Theogene	Consultant SEA, EIA, Socio-Economic, BESST Ltd

Attachment-2

Q&A Session

(MoE)

The spatial planning aspect is very key in M/P formulation; thus, it is better to explain how the spatial water supply plan is developed for the City of Kigali which clarifies the existing and planned connections and how it is affecting the M/P.

-> (JST)

We agree on the importance of the spatial planning aspect. Water source and water transmission system are determined in the Master Scenario up to 2050. We will also share GIS data of the updated existing and proposed transmission pipeline routes. In addition, the future arrangement of facilities is shown in the schematic drawing of the water supply network for the entire city.

(RWB)

Did the study team consider the railway construction project near Masaka? Also, please consider the concern/ recommendation of avoiding access road dyke in the wetland to avoid potential flooding in the area. You can propose other alternatives reducing/avoiding soil dumping/dyke in the wetland.

-> (JST)

Regarding the railway project near the New Masaka WSS, we have already interviewed the relating authority (RTDA) and visited on-site to check the location where they reserve for the railway & road construction during making the EIA. In conclusion, we need to double-check with the person in charge of EIA but, in principle, we carefully avoid the effect of the railway, and it is possible. Regarding the dyke, we haven't yet determined the exact locations of wells as well as the access road so that should be considered during Detail design.

A - 3

6.2 Speech by Ag. CEO of WASAC

In her closing speech, Ms. Gisele UMUHUMUZA, Acting Chief Executive Officer of WASAC, wrapped up the JCC meeting, with the following comments:

- She expressed special thanks again to all the participants.
- She raised the importance of collaborative work among the JCC members as well as having the stakeholder's understanding to obtain their cooperation.
- She emphasized that the key to the success of realizing the M/P and the 15-YIP is that all the JCC members should keep what is mentioned in the recommendations in the DF/R in mind and execute them one by one for sure.

5

ATTACHMENT-1

List of Participants

【Rwanda side】

Government of Rwanda and Other related organization

KAYITESI Marcelline	Water and Sanitation Division Manager, MININFRA
SABITI Fred	Technical advisor, MINECOFIN
RUTEHENDA Frank	Infrastructure Sector Monitoring Officer, MINECOFIN
NDAYIZEYE Alsaad	Hydrology Officer, RWB
RUTAGENGWA Alex	Land Management Authority
HABINSHUTI Jean Pierre	WATSAN Officer, Gasabo District
UWERA Martine	Environmental Auditor, REMA
IRAGUHA Jerome	WATSAN, Rulindo District
NYIRIMANA Emmanuel	Acting Director of National Investment and Quality Assurance, MINECOFIN
NZABAHIMANA James	WATSAN Officer, Kamonyi District
UMUKESHA Amandine	Senior Water and Sanitation Expert, AfDB
MASENGESHO Fabien	Planning Officer, MINECOFIN
BUTERA Tom	Resource Mobilization Officer, MINECOFIN
UWIZEYIMANA Innocent	Representative of Rulindo District (* He is Support Engineer of WASAC. He attended the JCC as representative of the District)
MUNYANEZA Etienne	Rwanda Land Management and Use Authority, MoE

WASAC MANAGEMENT TEAM

Gisele UMUHUMUZA	Acting CEO
BARIGYE George	Director of Support Services
HATEGEKIMANA Samson	Manager Corporate Planning
MUGWANEZA Vincent de Paul	Director of Rural Water Services
TUYISHIME Lambert	Acting Head of Business analysis and Planning Unit
MUREKEZI Dominique	Ag. Director of Water and Sanitation Services Development
UWINEZA Marie Christine	Head of Muhazi WTP
Alex KANSIIME	Manager of Revenues Collection
NSHIMIYIMANA Vital	Manager of Sanitation Projects, SPIU
DUSHIME Rene	WTP Engineer, Kimisagara WTP
BIMENYIMANA Alexandre	Acting Head of Rusizi Branch
HAGUMINEMA Boris	Ag. Financial Controller

A - 1

RUTAGUNGIRA Methode	Director, Urban Water and Sanitation Service
GASHUGI Innocent	Manager Water Operations Services
TUYISENGE Vedaste	Head of Gikondo Branch
SINDIKUBWABO Theoneste	Ag. Head Water Central Laboratory
HABUMUREMYI Telesphore	Head of Maintenance Services
BUSHAYIJA Yasin	Head of Nzove WTP
SHUMBUSHO Marcellin	Head of Karenge WTP
MUKIZA Anaclet	Head of Kanombe Branch
MUTAMBA Jane	Head of Nyamirambo Branch
SARANDA Catherine	Head of Nyarugenge Branch
RUBAYITA Gilbert	Head of Remera Branch
MUSABYEYEZU Jeanne	Head of Kacyiru Branch
UMUHOZA Francine	Water Resources and Environmental Engineer
KARUWI Daniel	IT Webmaster

【Japanese side】

JICA Headquarters in Tokyo

HATTORI Yoko	Director, Water Resources Team 2, Global Environment Dept., JICA HQ
YOKOTA Yoshiaki	International Cooperation Expert, JICA HQ
MURAKAMI Toshio	In-house Consultant, JICA HQ
KAJI Takashi	Water Resources Team 2, Global Environment Dept., JICA HQ

JICA Rwanda Office

MARUO Shin	Chief Representative, JICA Rwanda Office
NAKASHIMA Koji	Water and Sanitation Program Manager, JICA Rwanda Office
KWIZERA Virgile	Water and Sanitation Program Officer, JICA Rwanda Office

JICA Study Team

MAMIYA Takemasa	Team Leader / Water Supply Planning 1, JICA Study Team
KAWAMURA Tetsuji	Co-Team Leader / Water Supply Planning 2, JICA Study Team
YOSHIDA Kenji	Water Resource / Water Quality/ Hydrogeology, JICA Study Team
KOBAYASHI Shinkichi	Water Supply Pipeline Planning, JICA Study Team
MATSUBARA Koichi	Hydraulic Analysis / GIS Database, JICA Study Team
CHOSO Yoshiyuki	Organization/ Institution, JICA Study Team
TANAKA Uyu	Environment and Social Consideration, JICA Study Team
OSAKABE Noboru	Financial and Economic Analysis Specialist, JICA Study Team
OSHIMA Yoshiaki	Cost Estimator / Implementation planning / Study Coordinator, JICA Study Team

A - 2

NISHIDA Kosei	Business Continuity Plan/ Water Supply Pipeline Planning 2/ Procurement Plan 2, JICA Study Team
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Q&A Session

(MoE)

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-> (JST)

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(RWB)

Did the study team consider the railway construction project near Masaka? Also, please consider the concern/ recommendation of avoiding access road dyke in the wetland to avoid potential flooding in the area. You can propose other alternatives reducing/avoiding soil dumping/dyke in the wetland.

-> (JST)

Regarding the railway project near the New Masaka WSS, we have already interviewed the relating authority (RTDA) and visited on-site to check the location where they reserve for the railway & road construction during making the EIA. In conclusion, we need to double-check with the person in charge of EIA but, in principle, we carefully avoid the effect of the railway, and it is possible. Regarding the dyke, we haven't yet determined the exact locations of wells as well as the access road so that should be considered during Detail design.

A - 3

(AfDB)

Regarding the NRW, the NRW was at 38 % but where are we today? The target is to reach 25% by 2024. Can you clarify the short-time strategy that will help WASAC to reach this milestone in the remaining time? For WASAC, what is the current in-house capacity to make this happen? What is needed from the GoR, and partners to help WASAC achieve the goal? It was showed that most of the losses are within small pipes which mainly are worked on by WASAC in their daily operations, what do you think is the main cause and how to address this internally? I stress on the NRW as this impact WASAC financial sheets, and make financiers doubt on the performance of the institution and also on how bankable their projects can be.

-> (JST)

The strategy to reduce the NRW is presented in the M/P report. We showed the timeline not only for the long-term but also short-term until 2025. The WASAC's target for the NRW reduction in the short term until 2024 is 25%. This is very ambitious and needs extensive rehabilitation and reconstruction of the distribution systems, apart from the daily maintenance and capacity development. Though most of the leakages occur in smaller pipes, it needs complete replacement which could not be dealt with the daily maintenance but needs an extensive rehabilitation campaign. The main thing covered by this master plan is this scheduled facility investment which is emergent. For this JICA starts to cooperate with two projects 1) Grant Aid project for Ntora-Remera which starts within a few months and 2) Technical cooperation project which successes the fruit of the ongoing NRW reduction project. The WASAC and GoR need to continue the investment to expand the results of the Grant Aid Project. The continuous investment may not be materialized only by the GoR's budget so we need financial assistance from development partners.

(RWB)

During dry season, there is water shortage in the Yanze River. In order to solve water shortage, consider the construction of dam (reservoir)

-> (JST)

There is no active hydrological station at the Yanze River, and no information regarding seasonal fluctuation of the river flow. In addition, according to Nyabugogo catchment management plan published by Ministry of Environment, the water balance calculation showed that the available water will not be enough in 2050 because of high water demand in Yanze sub-catchment. Therefore, more study including the above points is needed before the decision of dam (reservoir) construction.

A - 4

(REMA)

Consider climate change and environmental sustainability are of high level. Have SEA for the M/P and EIA for two F/S been prepared? Take care of the wetland protection in Masaka during implementation. You need to hydrologically consider the catchment of the area including the issue of water shortage in the dry season.

-> (WASAC & JST)

Climate change and environmental sustainability have been covered in the SEA study and its measures are considered in the M/P. Result of SEA is submitted and reviewed by REMA. EIA for two projects have been carried out. For Karenge F/S, it has already approved by RDB. For Masaka F/S, it is now under evaluation by RDB. Regarding the hydrological perspective for F/S, we have considered the water shortage in the dry season. By selecting relatively stable water source such as underflow water as newly developing water source, the project is minimizing the risk of having effect from the water shortage.

A - 5

APPENDIX 7: WATER BALANCE OF THE STUDY AREA

1 INTRODUCTION

The available water resources are being used by various sectors such as water supply, irrigation, coffee washing, mining, hydropower station and so on. Quantified information on current sector wise water resources utilization is limited due to unregulated and lack of the inventory of water use. In addition to the present water use, water demand projection by the above mentioned sectors are also not studied well. In Kigali, studies were not conducted regarding sector wise water use and water demand projection. Water balance and future water demand of Level 1 catchments were studied and described under the National Water Resources Master Plan (NWRMP) (2015). A portion of those under Level 2 catchments are being studied by the Ministry of Environment (2018) and the RWFA (2020 on going).

Thus, sector wise present and future water balance in the Study Area will be explained by using the available data. It should be noted that the results pertaining to water balance under a scale of L1 catchments as shown in the NWRMP (2015) and that under a scale of L2 catchments carried out recently do not match exactly. For example, water inventory carried out by the NWRMP can be regarded as outdated. On the other hand, the studies under L2 catchment management are being conducted recently (2019-on going). In addition, change of land use obviously affect water resources' generation and gives impact on the amount of renewable water resource at the catchment. This is also one of the reasons for discrepancy in the results between L1 and L2 catchment studies. Moreover, the water demand projection for the Study does not reflect the result of catchment studies.

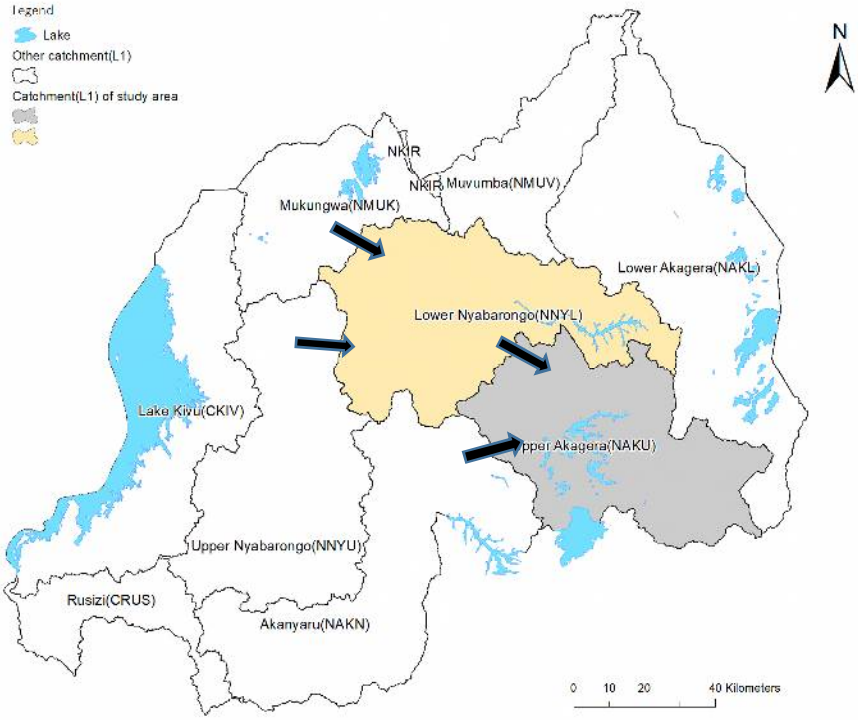
2 WATER BALANCE AND WATER DEMAND UNDER LEVEL 1 CATCHMENT

Water Balance (water availability minus water use) of Level 1 catchments is included in the NWRMP. The Study Area comprises a part of the Nybarongo Lower Catchment (NNYL) and the Akagera Upper Catchment (NAKU). The area is shown in **Figure A2-1**, **A2-2** and its water balance (2012) is shown in **TableA2-1**.

Table A2-1 Water Balance of Two Level 1 Catchments (2012)

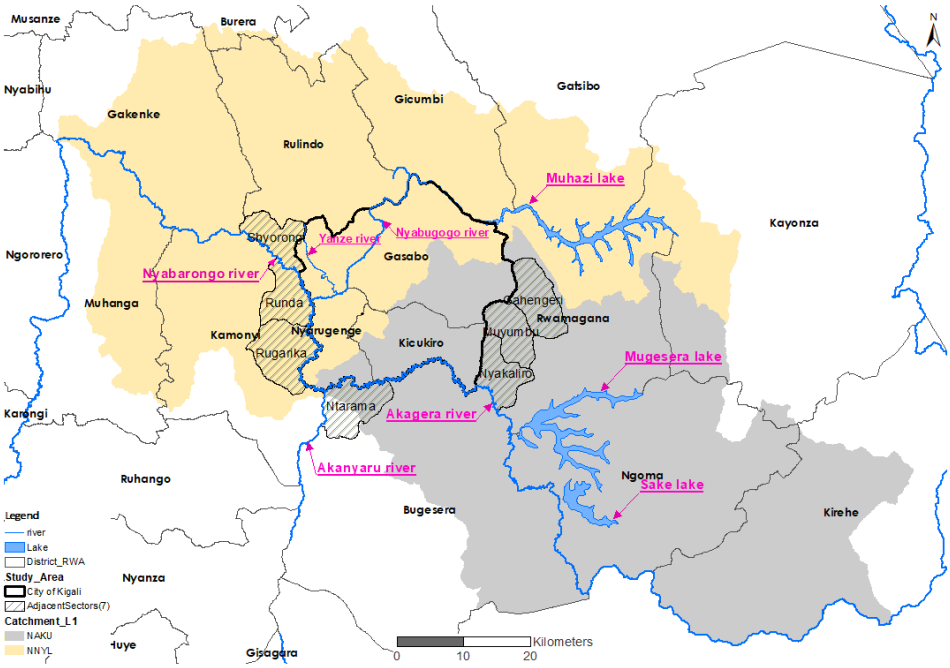
Name of the catchment	Code	Renewable water source (m^3/year)	Water supply use (m^3/year)	Irrigation water use (m^3/year)	Total water use (m^3/year)	% of total water use over resource
Nyabarongo Lower	NNYL	899,000,000	11,983,000	7,983,000	19,966,000	2.22%
Akagera Upper	NAKU	504,000,000	9,776,000	16,034,000	25,810,000	5.12%

Source: NWRMP, Renewable water source means the average rainfall minus the volume of evaporation and plant transpiration in a catchment area.



Source: JST

FigureA2-1 Level 1 Catchments



Source: JST

FigureA2-2 Two Level 1 Catchments overlapping with the Study Area

At the NNYL, water use is just over 2% of the annual renewable sources. At the NAKU, it is about 5%, which is higher than that of the other catchments in Rwanda. At the NNYL, water supply use is more than irrigation use due to the water use in the Kigali city.

Unadjusted and adjusted water demands by 2040 were also estimated under the NWRMP. In case of unadjusted demand, projected demand is based on population and indicators (irrigation area, energy production, number of cattle etc.) which are applied uniformly for all the catchments and no consideration is given to actual resource availability for this demand. On the other hand, water demand in each sector is reviewed and adjusted whenever necessary in case of adjusted water demand.

As seen in the following tables, amount of irrigation water has changed significantly after adjusting and is reduced to avoid the over exploitation of water resources. Considering adjusted water demand, total water consumption by all sectors in 2040 becomes 51% at the NNYL and 65% at the NAKU. This means that water resources will be consumed widely in future due to the high water demand.

Table A2-2 Water Balance Projection in 2040 at NNYL

	Nyabarongo Lower (NNYL)			
	Unadjusted water demand (m^3/year)	**% of water use over renewable water source**	**Adjusted water demand (m^3/year)**	**% of water use over renewable water source**
Water supply (Urban and Rural)	170,810,000	19	170,810,000	19
Irrigation	368,590,000	41	215,760,000	24
Industry	53,940,000	6	35,960,000	4
Mining	17,980,000	2	17,980,000	2
Livestock			8,990,000	1
Fish ponds			8,990,000	1
		68		**51**

Source: The NWRMP

Table A2-3 Water Balance Projection in 2040 at NAKU

	Akagera Upper (NAKU)			
	Unadjusted water demand (m^3/year)	**% of water use over renewable water source**	**Adjusted water demand (m^3/year)**	**% of water use over renewable water source**
Water supply (Urban and Rural)	90,720,000	18	90,720,000	18
Irrigation	463,680,000	92	196,560,000	39
Industry	25,200,000	5	15,120,000	3
Mining	10,080,000	2	10,080,000	2
Livestock	5,040,000	1	5,040,000	1
Fish ponds	10,080,000	2	10,080,000	2
		120		**65**

Source: The NWRMP

It is concluded under the NWRMP that the catchment's own renewable resources are sufficient to meet the water demand over the next thirty years or so at the scale of the Level 1. In addition, it is recommended under the NWRMP that comprehensive monitoring of actual water use and renewable resources are needed. Water source inventory and water demand projection were conducted in 2012. Therefore, this demand projection may not be valid under the present situation. It is obvious that water amount used by the Kigali water supply is underestimated.

3 WATER BALANCE AND FUTURE WATER DEMAND AT LEVEL 2 CATCHMENT

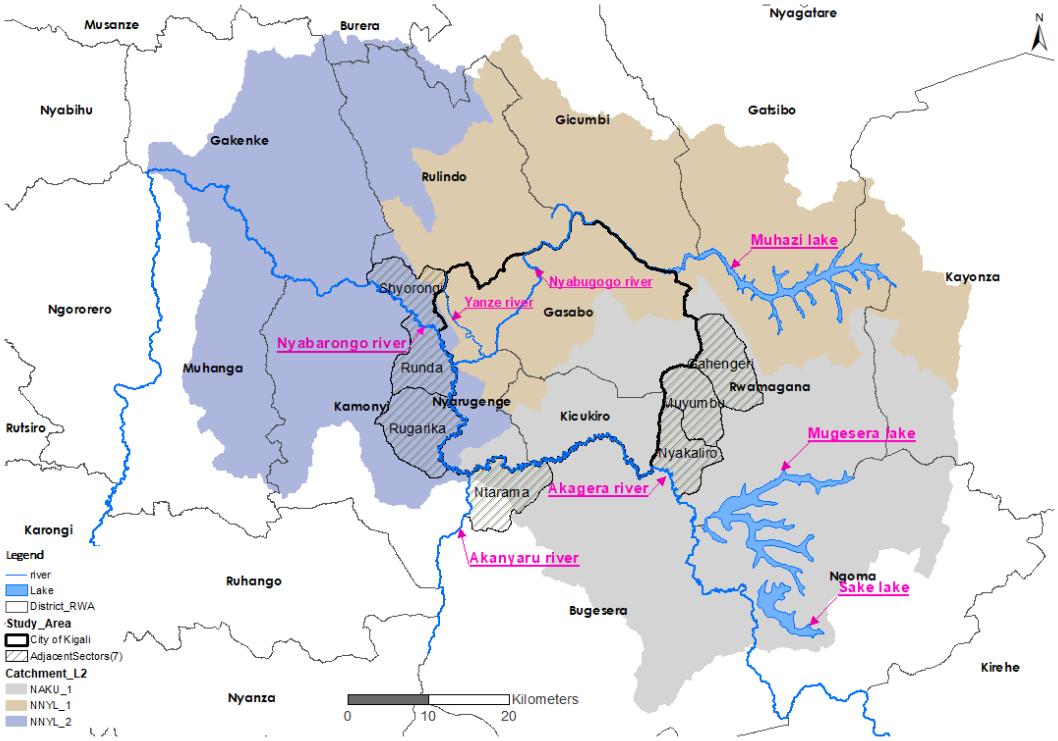
Level I catchments can be divided into Level 2 Catchments (Sub-Catchments). Two level 1 catchments in the Study Area have the following four (4) sub-catchments (Level 2 catchments).

Table A2-4 Name of Level 2 Catchments under NNYL and NAKU

Name of the level 1catchment	Code	Name of the level 2 catchment	Code	Area (km^2)
Nyabarongo Lower	NNYL	Nyabugogo	NNYL_1	1,540
		Mambu/ Base	NNYL_2	1764
Akagera Upper	NAKU	Mugesera/Sake	NAKU_1	1,888
		Rweru	NAKU_2	

Source: JST, Project area is 1,129 km^2

Within these four (4) catchments, three (3) catchments namely, NNYL_1, NNYL_2, and NAKU_1 cover the Study Area. The areas are shown in **Figure A2-3**.



Source: JST

Figure A2-3 Three Level 2 Sub-Catchments in the Study Area

At this moment, water balance study is carried out only at the Nyabugogo catchment (NNYL_1) and the Mugesera/ Sake catchment (NAKU_1).

(1) The Nyabugogo catchment (NNYL_1)

The Nybugogo catchment management plan (2018) was formulated by the Ministry of Environment. **TableA2-5** shows the sector wise water use. It shows that 8% of renewable water source is used at the catchment. This means that the Nyabugogo catchment is currently able to provide enough water to satisfy the demand. Its usage is more than the NNYL Level 1 catchment estimated under the NWRMP. Sector wise, irrigation has the highest water consumption and water supply comes second. Renewable water source is estimated to be 463 MCM/year. The catchment management plan mentioned that manageable water in surface water body and groundwater is very limited. Water balance projection in 2050 shows that 45% of renewable water source at the catchment would be used.

TableA2-5 Water Balance of the Nyabugogo Catchment

	2018		2035		2050	
	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source
Irrigation	18,493,500	4.0%	55,658,160	12.0%	117,795,032	25.4%
Water supply	9,276,360	2.0%	27,829,080	6.0%	51,395,886	11.1%
Industry	4,638,180	1.0%	13,914,540	3.0%	29,113,502	6.3%
Livestock	4,638,180	1.0%	6,493,452	1.4%	12,067,208	2.6%
		8.0%		**22.4%**		**45.4%**

Source: Nyabugogo catchment management plan, water balance projection in 2035 is not available in this study and estimated by JST using data of 2018 and 2050.

(2) The Mugesera / Sake catchment (NAKU_1)

The catchment study, carried out by the RWFA, is presently on-going. Renewable water source for this catchment is estimated to be 557 MCM/year. Water balance study shows that 8.8% of renewable water source in the catchment was used in 2019.

Table A2-6 Water Balance of the Mugesera / Sake Catchment

	2019		2035		2050	
	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source
Irrigation	22,203,300	4.0%	83,529,000	15.0%	144,192,200	25.9%
Water supply	17,716,200	3.2%	38,980,200	7.0%	56,740,900	10.2%
Industry	36,000	0.01%	278,430	0.05%	684,000	0.1%
Fish ponds	351,600	0.1%	556,860	0.1%	448,000	0.1%
Livestock	8,514,200	1.5%	11,137,200	2.0%	16,273,900	2.9%
Mining	178,600	0.03%	167,058	0.03%	237,700	0.04%
Coffee washing	10,100	0.002%	16,706	0.003%	22,400	0.004%
		8.8%		**24.2%**		**39.3%**

Source: RWFA, water balance projection in 2035 is not available in the study and estimated by JST using data of 2019 and 2050.

Sector wise proportion of water consumption against renewable water source at this catchment is very much similar to that of the Nyabugogo catchment. This may indicate that these two catchments have similar natural and social environment for water consumption. Sector wise water use by 2050 is around 40% of renewable water source at this catchment. It is lower than that of the Nyabugogo catchment. Moreover, this value (40%) is relatively small when compared with that of the Level 1 catchment (NAKU) under the NWRMP. It also indicated that water consumption by irrigation will be a very large portion of renewable water source by 2050 and it is more than 6 times than the present use under the scale of the Level 2 catchments.

4 COMPARISON WITH DEMAND PROJECTION BY THE KIGALI WATER SUPPLY MASTER PLAN

Water balance studies under the Level 2 catchment indicate that 22-24% of renewable water source at the catchment will be used by all sectors by 2035 and 40% to 45% by 2050. Water consumption by water supply (urban and rural) will be 6% to 7% of renewable water source by 2035 and 10% to 11% by 2050. However, these water demand prediction for water supply does not include the result of the Study. Water demand projection for water supply in Kigali indicated that the amount of 122,275,000 m^3/year (335,000 m^3/day) will be needed by 2035 and 390,550,000 m^3/year (1,070,000 m^3/day) by 2050 in order to meet the water demand. The water demand is compared with those in the three combined catchments.

Table A2-7 Comparison of Water Supply Demand by Catchment Study and Kigali Water Supply Master Plan Study

	2035	2050
Water demand by water supply (urban and rural) at three catchment (m^3/year) *	101,910,200	145,586,000
Water demand by water supply at Kigali estimated by Kigali Water Supply MP (m^3/year)	122,275,000	390,550,000
Proportion of amount of water needed in Kigali against total amount of water supply at three catchments	120%	268%

Source: JST,
* It is assumed 7% of renewable water source at three catchment in 2035 and 10% in 2050.Renewable water source of three catchment is estimated as 1,456 MCM/year in total which 463 MCM/year at Nyabugogo, 557 MCM/year at Mugesera / Sake., 436 MCM/year at Mambu/ Base, Renewable water source of Mambu/ Base is not available then used that of Nybarongo Lower (L1) minus Nyabugogo (L2).

Table A2-7 shows that the amount of water supply estimated in the three catchments is much smaller than that in Kigali. This means that water demand projection for water supply is obviously underestimated under the Level 2 catchment studies. In order to adjust this, water balance at the three catchments by 2035 and 2050 are revised and shown in **TableA2-8**. It is assumed that 30% of total amount of water supply in the three catchments is derived from Kigali. It can be seen that total water use by 2035 at the three catchments is around 30% of renewable water source and water use by 2050 becomes 68%. Due to the high usage of water in Kigali, water demand by water supply (urban and rural) in the three catchment becomes higher than irrigation by 2035 and 2050. Revised amount of total water demand by 2035 and 2050 is still within the limitation of renewable water source In other words, renewable source is sufficient to cater for the projected demand including Kigali water supply. However, in order to avoid the over exploitation of water resources in the catchments, efficiency of water use must be improved. Comprehensive monitoring of actual water use and renewable resources will be also required.

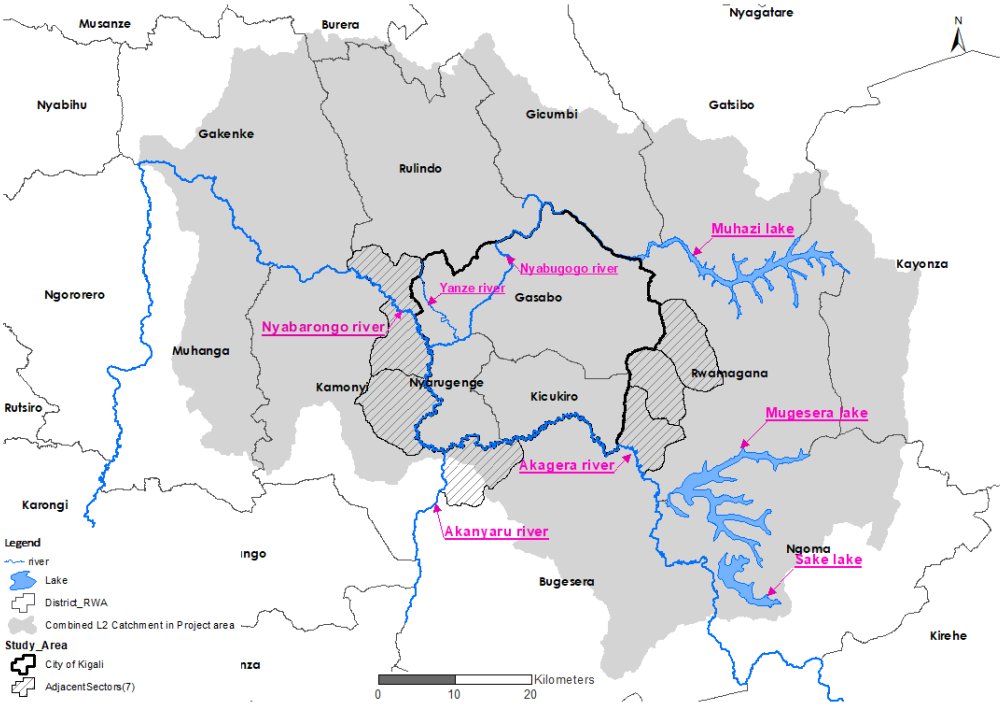


Figure A2-4 Area of combined three L2 Catchments

Table A2-8 Estimated Water Balance at combined three L2 catchments

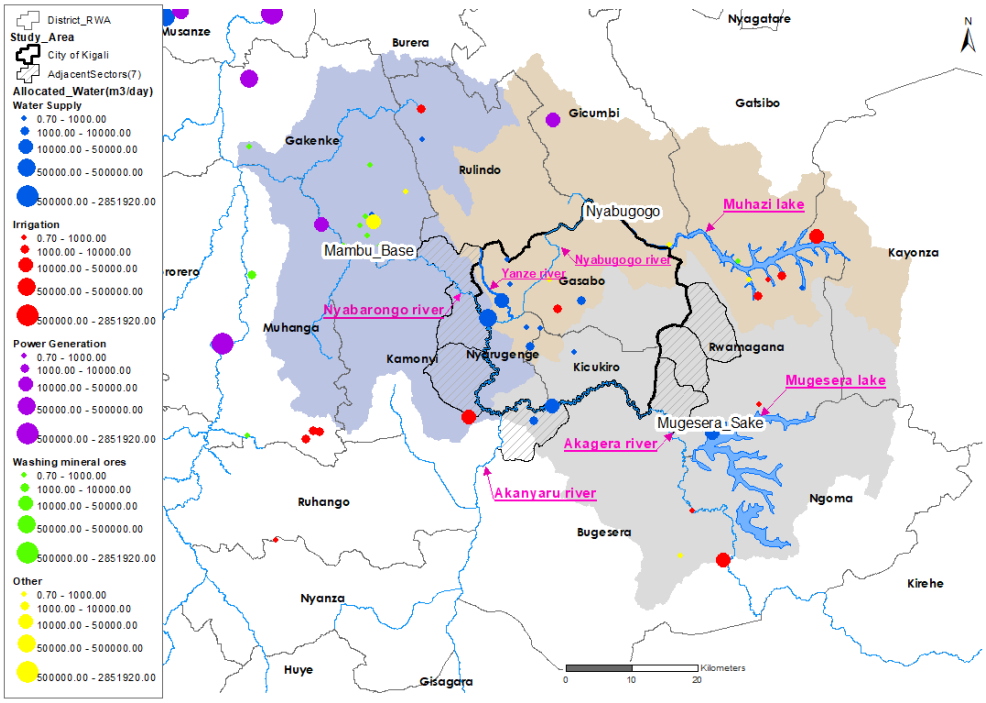
	2035		2050	
	Water demand (m^3/year)	**% of water use over renewable water source**	**Water demand (m^3/year)**	**% of water use over renewable water source**
Irrigation	174,703,200	12.0%	378,523,600	26.0%
Water supply except Kigali	71,337,140	4.9%	101,910,200	7.0%
Kigali water supply	122,275,000	8.4%	390,550,000	26.8%
Industry	43,675,800	3.0%	87,351,600	6.0%
Livestock	14,558,600	1.0%	29,117,200	2.0%
Total	426,549,740	29.3%	987,452,600	67.8%

Source: JST, Renewable water source in three catchments is estimated 1,456 MCM/year

This is a very rough estimation since no study regarding the WRM in Kigali is conducted. However, this information is very useful and gives the degree of impact of Kigali water supply to the renewable water resource at the catchment level.

5 REGISTERED WATER USERS IN THE STUDY AREA

As described under the previous section, at three sub-catchments of the Study Area water resources have been used by various sectors. **Figure A2-5** shows the locations of registered water users (2019) and the amount of water used.



Source: JST, data taken from RWFA

Figure A2-5 Registered Water Users in the Study Area in 2019

Allocated amount of water for each user at the three catchments is shown in **Table A2-9**. It can be inferred from the table that water supply is the main water user and it occupies nearly 60% of the total registered water at the combined three catchments. Renewable water source in the three catchments is estimated as 3,988,521 m^3/day. This means that more than 11% of renewable water source at the three catchments are already registered by users.

Table A2-9 Registered Water Users of three catchments in 2019

No	Water User	Amount allocated (m^3/day)
1	Irrigation	85,747
2	Hydropower station	51,840
3	**Water Supply**	**269,901**
4	Mining	1,242
5	Other(Coffee washing station, Fish ponds)	48,747
Total		**457,478**

Source: JST

APPENDIX 8: Sector Wise Population of the City of Kigali

Sector-wise Population of the City of Kigali

District	Sector	2012 Census				Area
		Total	Urban	Rural	Density	km²
City of Kigali		1,132,686	859,332	273,354	1,554	729
1. Gasobo (15 sectors)	Bumbogo	35,381	4,246	31,135	584	61
	Gatsata	37,110	37,110	0	6,163	6
	Gikomero	16,625	0	16,625	474	35
	Gisogi	44,003	44,003	0	5,300	8
	Jabana	33,577	9,271	24,306	923	36
	Jali	25,057	3,808	21,249	671	37
	Kacyiru	37,088	37,088	0	6,413	6
	Kimihurura	21,672	21,672	0	4,274	5
	Kimironko	57,430	57,430	0	5,068	11
	Kinyinya	57,846	53,162	4,684	2,391	24
	Ndera	41,764	33,469	8,295	829	50
	Nduba	25,370	0	25,370	545	47
	Remera	43,279	43,279	0	5,957	7
	Rusororo	35,453	20,833	14,620	679	52
	Rutunga	17,906	0	17,906	419	43
	Total	529,561	365,371	164,190	1,234	429
2. Kicukiro (10 sectors)	Gahanga	27,808	11,698	16,110	756	37
	Gatenga	48,640	46,306	2,334	3,911	12
	Gikondo	17,146	17,146	0	5,065	3
	Kagarama	14,385	14,385	0	1,800	8
	Kanombe	44,426	44,426	0	1,932	23
	Kicukiro	16,450	16,450	0	8,033	2
	Kigarama	43,907	43,907	0	5,252	8
	Masaka	39,548	19,369	20,179	750	53
	Miboye	26,197	26,197	0	5,212	5
	Nyarugunga	40,057	40,057	0	2,632	15
	Total	318,564	279,941	38,623	1,908	167
3. Nyaruge nge (10 sectors)	Gitega	28,728	28,728	0	24,482	1
	Kanyinya	21,859	0	21,859	904	24
	Kigali	30,023	4,748	25,275	1,022	29
	Kimisagara	46,753	46,753	0	14,116	3
	Mageragere	23,407	0	23,407	428	55
	Muhima	29,768	29,768	0	10,115	3
	Nyakabanda	25,666	25,666	0	10,589	2
	Nyamirambo	40,292	40,292	0	4,608	9
	Nyarugenge	21,302	21,302	0	4,605	5
	Rwezamenyo	16,763	16,763	0	16,328	1
	Total	284,561	214,020	70,541	2,148	132

Source: NIS

APPENDIX 9: Hydrological information on the level 1 catchment units

Hydrological information on the level 1 catchment units

Catchment Number	1	2	3	4	5	6	7	8	9
Code NWRMP	CKIV	CRUS	NNYU	NMUK	NNYL	NAKN	NAKU	NAKL	NMUV
Name:	Lake Kivu	Rusizi	Upper Nyaborongo	Mukungwa	Lower Nyabarongo	Akanyaru	Upper Akagera	Lower Akagera	Muvumba
Surface area [km²] in Rwanda	2,425 km²	1,005 km²	3,348 km²	1,887 km²	3,305 km²	3,402 km²	3,053 km²	4,288 km²	1,565 km²
Total surface area [km²]	7,323 km² incl. lake 2, 695 km²	2,011 km², total basin: 9,334 km²	3,348 km²	1,949 km²	3,305 km²	5,328 km²	3,053 level 1 basin, total basin 30,632 km²	6,648 level 1 basin, total basin 37,288 km²	3,711 km²
Upstream national dependencies	none	Lake Kivu	none	none	Upper Nyaborongo & Mukungwa	none	Upper & Lower Nyabarongo & Akanyaru	Upper Akagera	none
Upstream international dependencies	none	Lake Kivu DRC	none	Insignificant (Uganda)	none	none	none	Ruvubu river Burundi	none
Shared catchment	2,203 km² DRC	368 km² DRC 638 km² Burundi	none	62 km² Uganda	none	1,926 km² Burundi	13,714 km² Burundi	2,354 km² Tanzania	2,146 km² Uganda
Av. annual rainfall [mm/yr]	1,240	1,295	1,365	1,315	1,191	1,225	925	835	995
Av. annual evaporation (water balance) [mm/yr]	870	865	980	851	919	990	760	624	872
Av. annual surface water runoff [mm/yr]	370	430	385	464	272	235	165	211	123
Base flow* [m³/s]	1.8°	3.8°	34.2	21.5	66.8+	16.4°	198.0+	200.0+	3.5
Av. annual ground water recharge [mm/yr]	250	350	292	322	165	227	115	125	71
Ground water volume storage [MCM]	2,425	5,025	25,110	4,870	8,673	5,103	4,580	4,820	1,570
Ground water mean resident time [year]	4	14	26	8	16	7	13	9	14
Ratio surface water / rainfall - annual [-]	0.30	0.33	0.28	0.35	0.23	0.19	0.18	0.25	0.12

Catchment Number	1	2	3	4	5	6	7	8	9
Code NWRMP	CKIV	CRUS	NNYU	NMUK	NNYL	NAKN	NAKU	NAKL	NMUV
Ratio ground water / rainfall - annual [-]	0.20	0.27	0.21	0.24	0.14	0.18	0.12	0.15	0.07

*: Base flow: when number marked with an ° it is for a partial catchment (Sebeya for CKIV, Rubyiro for CRUS and upstream for NAKN); when marked with a + the base flow comprises flow from upstream catchments.

Source: Rwanda National Water Resources Master Plan MINIRENA-RNRA October 2015

APPENDIX 10: Application Form for Surface Water Abstraction

Annex5. Application form for surface water abstraction

SURFACE WATER ABSTRACTION APPLICATION FORM (Part A)

REPUBLIC OF RWANDA

MINISTRY OF NATURAL RESOURCES
RWANDA WATER AND FORESTRY AUTHORITY

APPLICATION FOR SURFACE WATER ABSTRACTION

Article 32, 34, Law N°62/2008 of 10/09/2008 relating to the use, conservation, protection and management of water resources

Article 6, 9 of the Ministerial Order N°002/16.01 of 24/05/2013 determining the procedure for declaration, authorization and concession for the utilization of water

IDENTIFICATION OF APPLICANT	**DETAILS**
1. Full name of Applicant (In Block Letters)	
2. Category of Applicant (Individual, Company, Cooperative, Organization, Institution, Other (specify)	
3. ID/Passport Number of Applicant (Individual) or Certificate of Registration/Legal personality for Companies, Cooperative or Organization	Attach copy
Contact address of Applicant	
1. P.O Box	
2. Town, Province, District, Cell, Village	
3. Telephone contact (Mobile)	
4. Telephone contact (Landline)	
5. Email Address	
Alternative Contact Person	

1. Full names of Alternative Contact Person	
2. ID/Passport Number	
3. Town, Province, District, Cell, Village	
4. Telephone contact (Mobile)	
5. Telephone contact (Landline)	
6. Email Address	

SOURCE OF WATER	DETAILS
Select the Source where water will be abstracted from	☐ Lake ☐ River ☐ Dam ☐ Stream ☐ Swamp ☐ Other (specify)
Name of the Source of Water	
Tributary to	
Location of the Source of Water (Point(s) of abstraction (Town, Province, District, Cell, Village)	Attach geographic/topographic maps indicating clearly the point(s) of abstraction
Catchment Name and Level (1 and 2)	
Reliability of water source	☐ Water always available ☐ Frequently Dry ☐ Dry during certain season
Discharge of source of water	m^3/s

PROPOSED USE OF WATER								
Tick one or more boxes as appropriate		☐ Commercial Irrigation ☐ Mining ☐ Industrial ☐ Aquaculture ☐ Water supply ☐ Electricity generation ☐ Other (specify)						
Quantity of water to be abstracted for each of the proposed purposes	Purpose	Flow rate m^3/s	Maximum daily m^3	Maximum monthly	Maximum yearly m^3	Hours/day		
	1.							
	2.							
Total								
Refer to the checklist attached hereto and provide required information corresponding to the proposed use of water								
Return flow quantity and quality		m^3/day						
Method of water abstraction (pumping system or deviation channel/diversion)		Type		Dimension		Capacity (m^3/s)		
Method of measuring the quantity of water to be abstracted								
Potential effects of proposed activity (positive or adverse)								
Any actions to take to avoid, remedy or mitigate any adverse effects identified								
Period for which the Authorization is required								

PROJECT DESCRIPTION	**DETAILS**
Provide a detailed description of your project, including but not limited to the method of water abstraction, description of facilities, type of construction activity, area to be graded or excavated, and a general overview of how you will operate the project.	Attach separate copies and documents as necessary.
Project Location (Town, Province, District, Cell, Village)	Attach geographic/topographic maps indicating clearly the place of use

OWNERSHIP OF ADJOINING LAND	
Do you own all of the land where the water will be abstracted, and used?	☐ Yes ☐ No
If your answer is No, do you have a recorded easement or written consent of land owner or lease agreement allowing access to the land?	Attach copies
If you don't have easement or authorization allowing access, provide the names and addresses of all affected landowners and describe your process for obtaining access	Landowner's Name: District: City/Province: Village: Cell: Plot/Parcel N^{0}:

PAYMENT INFORMATION	**DETAILS**
A non-refundable application fee of thirty five thousand (35,000) Rwandan francs payable at National Bank of Rwanda, on FONERWA account n^{o} 120-28-26 must accompany this application	Attach proof of payment

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge, the information provided in this application and the information submitted in support of this application is true and accurate. I agree to provide any further information which may be required and I am aware of the penalties against providing false information.

Dated _____, at _____

Date Location

Signature of Applicant or duly Authorized Agent _____ Seal/Stamp

Full names _____ Title or Relationship _____

OFFICIAL SECTION

Reception date _____ day of _____ 20 ____

Full names _____ Title/Position _____

Signature of Ministry Official _____

CHECKLIST (Part B)

NOTE: Information requested hereunder must be provided through attachments submitted with the Application form

WATER USE AND DEMAND

IRRIGATION							
Type of Crop			Type of Production System (out door, Green House, hydroponics)	Type of irrigation technology/method (overhead, micro-sprinkler, drip)	Expected Rate of Water Use (m^3/ha/day)	Total irrigated area (ha)	Total Expected Water demand at the harvesting time (assuming no rainfall)
Type	Growing season (months)						
	From	To					
TOTAL							

Storage facilities, if proposed (Reservoirs, tanks, etc)	
Facility	**Capacity (m^3)**
Attach plans/drawings of water diversion relative to fields to be irrigated	
What percentage of water flow will be diverted for agricultural use?	
Describe what diversion/withdrawal/drainage works will be constructed on the irrigated land.	
How will you dispose of unused water? Name the water source to which it will be returned.	

WATER SUPPLY		
	Number	Volume of water required (m^2)
Population to be served (number of people/number of dwellings)		
Estimated use per capita (m^3/day)		
Water Demand per day (number of		

person*m^3/day)		
How much water will be abstracted? (m^3/day)		
Type and number of storage facilities		
How much storage capacity (m^3)		
Total of volume (m^3)		

Aquaculture									
Species									
Ponds	IS THE POND CONSTRUCTED IN THE WATER SOURCE CHANNEL OR OFF WATER SOURCE?					Yes		No	
	Length m	Width m	Surface (m^2/ha)	Storage Capacity (m^3)	Amount of water to be diverted (m^3)		Amount of water Returned (m^3/day) Returned to(Name of Stream)		
In water source aquaculture	Total area (m^2/ha)	Estimated dry season losses due to evaporation (m^3/day)					(Calculation)		

INDUSTRIAL	
Type of Industry (tick whichever is appropriate)	
Food Processing	
Horticultural Packaging	
Chemical Manufacturing	
Mineral water	
Brewing/Beverage manufacturing	
Fruit and vegetable canning or pickling	
Others (explain)	
Water Requirements	
Water required for Plant /Processing (m^3/day)	
Water required for Sanitation Facilities (m^3/day)	
Water required for other purposes (m^3/day)	
Total Water Requirements (m^3/day)	

ELECTRICITY GENERATION		
1. Capacity of Power Plant (output)		
2. Gross fall or head available for power production at the following river stage (Altitude)	At low stage (meters)	At high stage (meters)
3. The net fall or head to be used in 1 above	Meters	
4. The water needed to be used in 1 above	m^3/s	
5. Amount of water to be diverted	(m^3)	
6. How will water be returned to its sources after use?		
7. State length of any return channel	meters	
8. Distance between dam and Power Plant	m or km	
9. Is there any water user along this distance?		

MINING	
Water required for Physical separation (m^3/day)	
Water required for washing equipment (m^3/day)	
Total Water Requirements (m^3/day)	

CONSTRUCTION OF WORKS FOR THE USE OF WATER (Water flow alteration and construction of Diversion works structures in water flow)	
Purpose of construction (objectives)	
Description of the construction project (Materials, quantities, excavation, construction methods, temporary facilities, etc)	
Expected period of time required for construction within water flow	

Liability during construction						
Topographic site Map (show boundaries of the site and existing conditions						
Plans or maps showing proposed alterations and/or constructions at the end of construction works						
Required for water flow diversion only						
Maps showing location of intake and discharges						
Submit drawings/plans including sizes, materials, pipes and fixtures (valves, backflow control devices, meters, etc). Include pump capacity and water storage facilities. Clearly indicate all existing conditions and proposed alteration.						
Submit drawings/plans showing configuration of the intake structure, indicating the stream level at different seasonal flows. Show direction, velocities, detailed sizes and configuration of diversion structures.						
Location of point (s) of diversion	Intake	Flow (m^3/s)	Latitude	Longitude	Elevation (m)	
Location points of discharge	Discharge	Flow (m^3/s)	Latitude	Longitude	Elevation (m)	

APPENDIX 11: Application Form for Ground Water Abstraction

Annex6. Application form for ground water abstraction

GROUNDWATER ABSTRACTION APPLICATION FORM (Part A)

REPUBLIC OF RWANDA

MINISTRY OF NATURAL RESOURCES
RWANDA WATER AND FORESTRY AUTHORITY

APPLICATION FOR GROUNDWATER ABSTRACTION

Article 32, 34, 35, Law N°62/2008 of 10/09/2008 relating to the use, conservation, protection and management of water resources

Article 6, 9 of the Ministerial Order N°002/16.01 of 24/05/2013 determining the procedure for declaration, authorization and concession for the utilization of water

IDENTIFICATION OF APPLICANT	**DETAILS**
1. Full name of Applicant (In Block Letters)	
2. Category of Applicant (Individual, Company, Cooperative Organization, Institution, Other (specify)	
3. ID/Passport Number of Applicant (Individual) or Certificate of Registration/Legal personality for Companies, Cooperative or Organization	Attach copy
Contact address of Applicant	
1. P.O Box	
2. Town, Province, District, Cell, Village	
3. Telephone contact (Mobile)	
4. Telephone contact (Landline)	
5. Email Address	

Alternative Contact Person	
1. Full names of Alternative Contact Person	
2. ID/Passport Number	
3. Town, Province, District, Cell, Village	
4. Telephone contact (Mobile)	
5. Telephone contact (Landline)	
6. Email Address	

SOURCE OF WATER	**DETAILS**
Select the Source of water to be abstracted	Aquifer ☐ Natural spring ☐ Borehole/Well
Location of the Source of Water (Town, Province, District, Cell, Village)	Attach geographic/topographic maps clearly indicating the point(s) of abstraction
Catchment Name and Level (1 and 2)	
Borehole/Well ID (if known)	

PROPOSED USE OF WATER							
Tick one or more boxes as appropriate	☐ Commercial Irrigation ☐ Industrial ☐ Water supply ☐ Other (specify)			☐ Mining ☐ Aquaculture ☐ Electricity generation			
Quantity of water to be abstracted for each of the ticked purposes	Purpose	Flow rate m^3/s	Maximum daily m^3	Maximum monthly	Maximum yearly m^3	Hours/day
	1.					
	2.					
Total						
Refer to the checklist attached hereto and provide required information corresponding to the proposed use of water						
Method of measuring the quantity of water to be abstracted						
Potential effects of proposed activity (positive or adverse)						
Any actions to take to avoid, remedy or mitigate any adverse effects identified						
Period for which the Authorization is required						

PROJECT DESCRIPTION	**DETAILS**
Provide a detailed description of your project, including but not limited to the method of water abstraction, description of facilities, type of construction activity, area to be graded or excavated, and a general overview of how	Attach separate copies and documents as necessary.

you will operate the project.	
Project Location (Town, Province, District, Cell, Village)	Attach geographic/topographic maps

DESCRIPTION OF BOREHOLE/WELL								
Details of the borehole/well	Type:		Dug well	Driven well		Drilled well/Borehole		
	Drilling period:		Begin			End		
	Dimensions:	Total Depth (m)	Hole Diameter (mm)		Water discovered at (m)		Volume inserted in annular space (m^3)	
Pumping particulars	Type of pump	Expected operating head (m)	Delivery Rate at expected operating head (m^3/s)		Operating (hrs./day)	hours	Available quantity of water after operating hours (l/m^3)	

OWNERSHIP OF ADJOINING LAND	
Do you own all of the land where the borehole/well will be drilled/ constructed and water will be used	☐ Yes ☐ No
If your answer is No, do you have a recorded easement or written consent of land owner or lease agreement allowing access to the land?	Attach copies
If you don't have easement or authorization allowing access, provide the names and addresses of all affected landowners and describe your process for obtaining access	Landowner's Name: City/Province: District: Cell: Village: Plot/Parcel N°:
Location of land where the	(Attach a sketch map, showing land boundaries, the

borehole/well will be (Town, Province, District, Cell, Village)	approximate position of the proposed borehole/well,
Area of that land (in hectares)	

PAYMENT INFORMATION	
A non-refundable application fee of thirty five thousand (35,000) Rwandan francs payable at National Bank of Rwanda, on FONERWA account n° 120-28-26 must accompany this application	Attach proof of payment

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge, the information provided in this application and the information submitted in support of this application is true and accurate. I agree to provide any further information which may be required and I am aware of the penalties against providing false information.

Dated _____, at _____
Date Location

Signature of Applicant or duly Authorized Agent _____ Seal/Stamp

Full names _____ Title or Relationship_____

OFFICIAL SECTION

Reception date _____ day of_____ 20_____

Full names _____ Title/Position _____

Signature of Ministry Official_____

CHECKLIST (Part B)

NOTE: Information requested hereunder must be provided through attachments submitted with the Application form

WATER USE AND DEMAND

IRRIGATION							
Type of Crop			Type of Production System (out door, Green House, hydroponics)	Type of irrigation technology/method (overhead, micro-sprinkler, drip)	Expected Rate of Water Use (m^3/ha/day)	Total irrigated area (ha)	Total Expected Water demand at the harvesting time (assuming no rainfall)
Type	Growing season (months)						
	From	To					
TOTAL							

Storage facilities, if proposed (Reservoirs, tanks, etc)	
Facility	**Capacity (m^3)**
Attach plans/drawings of water diversion relative to fields to be irrigated	
What percentage of water flow will be diverted for agricultural use?	
Describe what diversion/withdrawal/drainage works will be constructed on the irrigated land.	
How will you dispose of unused water? Name the water source to which it will be returned.	

WATER SUPPLY		
	Number	Volume of water required (m^2)
Population to be served (number of people/number of dwellings)		
Estimated use per capita (m^3/day)		
Water Demand per day (number of person*m^3/day)		

How much water will be abstracted? (m^3/day)									
Type and number of storage facilities									
How much storage capacity (m^3)									
Total of volume (m^3)									

Aquaculture										
Species										
Ponds	IS THE POND CONSTRUCTED IN THE WATER SOURCE CHANNEL OR OFF WATER SOURCE?					Yes		No		
	Length m	Width m	Surface (m^2/ha)	Storage Capacity (m^3)	Amount of water to be diverted (m^3)		Amount of water Returned (m^3/day) Returned to(Name of Stream)			
In water source aquaculture	Total area (m^2/ha)	Estimated dry season losses due to evaporation (m^3/day)					(Calculation)			

INDUSTRIAL	
Type of Industry (tick whichever is appropriate)	
Food Processing	
Horticultural Packaging	
Chemical Manufacturing	
Mineral water	
Brewing/Beverage manufacturing	
Fruit and vegetable canning or pickling	
Others (explain)	
Water Requirements	
Water required for Plant /Processing (m^3/day)	
Water required for Sanitation Facilities (m^3/day)	
Water required for other purposes (m^3/day)	
Total Water Requirements (m^3/day)	

ELECTRICITY GENERATION		
1. Capacity of Power Plant (output)		
2. Gross fall or head available for power production at the following river stage (Altitude)	At low stage (meters)	At high stage (meters)
3. The net fall or head to be used in 1 above	Meters	
4. The water needed to be used in 1 above	m^3/s	
5. Amount of water to be diverted	(m^3)	
6. How will water be returned to its sources after use?		
7. State length of any return channel	meters	
8. Distance between dam and Power Plant	m or km	
9. Is there any water user along this distance?		

MINING	
Water required for Physical separation (m^3/day)	
Water required for washing equipment (m^3/day)	
Total Water Requirements (m^3/day)	

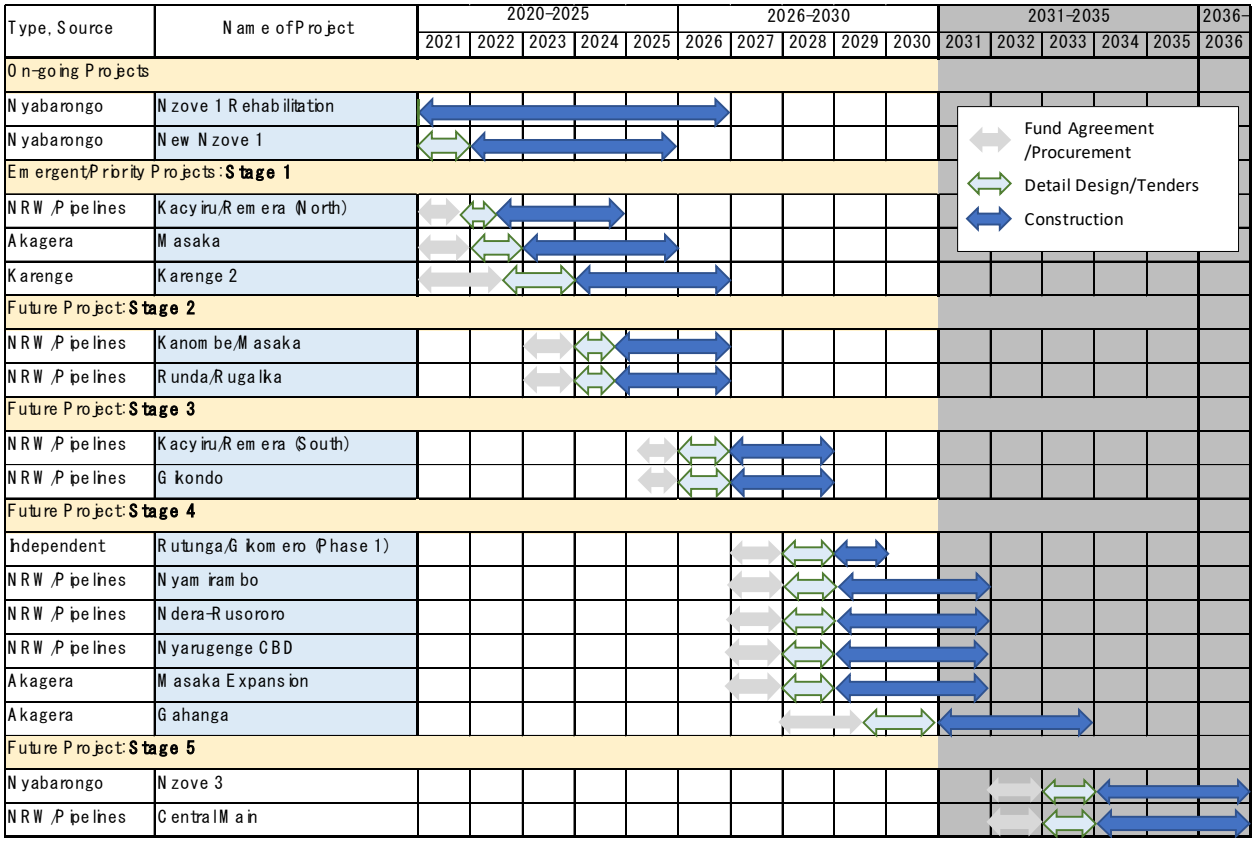
CONSTRUCTION OF WORKS FOR THE USE OF WATER **(Water flow alteration and construction of Diversion works structures in water flow)**	
Purpose of construction (objectives)	
Description of the construction project (Materials, quantities, excavation, construction methods, temporary facilities, etc)	
Expected period of time required for construction within water flow	
Liability during construction	

Topographic site Map (show boundaries of the site and existing conditions						
Plans or maps showing proposed alterations and/or constructions at the end of construction works						
Required for water flow diversion only						
Maps showing location of intake and discharges						
Submit drawings/plans including sizes, materials, pipes and fixtures (valves, backflow control devices, meters, etc). Include pump capacity and water storage facilities. Clearly indicate all existing conditions and proposed alteration.						
Submit drawings/plans showing configuration of the intake structure, indicating the stream level at different seasonal flows. Show direction, velocities, detailed sizes and configuration of diversion structures.						
Location of point (s) of diversion	Intake	Flow (m^3/s)	Latitude	Longitude	Elevation (m)	
Location points of discharge	Discharge	Flow (m^3/s)	Latitude	Longitude	Elevation (m)	

Appendix 12 : 10-Year Investment Plan

1. SCHEDULE

The ten-year investment plan (10YIP) is an extracted version of the fifteen-year investment plan which was described in the Kigali City Water Supply Masterplan. The schedule and project overview are as show in **Figure 1**.



Source: JST

Figure 1 Implementation Schedule for 10-Year Investment Plan

2. INVESTMENT PLAN

10YIP was presented by annualized disbursement basis as shown in **Table 1**.

This Page is closed due to the confidentiality.

Table 1 Ten-year Investment Plan

3. PROJECT DESCRIPTIONS

Stage 1 (Procurement from 2021, Completion in 2026): Emergency Project (NRW reduction project phase 1: the Ntora-Remera), the rehabilitation and expansion of the Karenge WTP and the Construction of the Masaka WTP.

(1) NRW/Pipelines (Phase 1) Kacyiru/Remera (North)

The area includes the Gisozi, Kinyinya, and a part of the Remera (the Nyarutarama), which is the supply area of the Ntora-Remera transmission pipeline. The topography is relatively simple, and the system is not very old. The areas can be portrayed as a model for good practices on pressure control and can be disseminated to the other areas.

(2) Masaka New Water Treatment Plant (Phase 1: 20,000 m^3/day, Phase 2: 20,000 m^3/day, Phase 3: 40,000 m^3/day Phase 4: 40,000 m^3/day)

Water demand growth on the eastern side of the city is urgent and large (i.e., Masaka, Ndera, Rusororo). The construction during Phase 1 is aimed at the first phase (Approx. 20,000 m^3/day, to be reviewed during F/S) to meet the emerging demand in this area. Due to the insufficiency of the current supply capacity, residents in this area are facing difficulties to access safe and steady water supply service. It is more efficient to utilize water source at Masaka near the demand area instead of conveying water from other existing WTPs. New transmission pipes and distribution reservoirs and reinforcement of the distribution network are required for the water supply expansion.

a) 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)
b) 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)
c) Construction of distribution network in Masaka Area

(3) Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities

- The intake pumps are damaged, overloaded and vulnerable to the flooding risk. The intake pumps are below the flood level of Mugesera Lake and can be affected by water during the rainy season. An old raw water intake pipe (ND300) is damaged and is not working properly.
- The existing WTP in under over-load operation; being forced to operate 18,000 m^3/day while its capacity is only 15,000 m^3/day. Incidental maintenances of pumps and resulting water supply interruption is a serious problem since they are fully operated with no standby.
- Demand in the eastern area is as large as 52,000 m^3/day in 2025, and 89,000m^3/day in 2035 only for Ndera, Rusororo, Masaka and upcountry three sectors. It is necessary to make the most of the already acquired water rights for 48,000 m^3/day as permitted by RWFA.

a) Rehabilitation of intake facility

- Rehabilitation of Raw Water Transmission pipes (ND300)
- Relocation of the pump house and upgrading the capacity of pumps and motors
- Expansion of WTP capacity from 15,000m^3/d to 18,000 m^3/d

(Filtration Basins, Clear Water Reservoirs)

b) Expansion of Karenge WTP and forwarding infrastructures

- Expansion of Intake and WTP for 30,000 m^3/d

(Intake pumps, Treatment facilities, Clearwater reservoirs and pumps

- Construction of New Transmission Pipelines (ND700, L= 33 km)

Stage 2 (Procurement in 2022, Completion in 2025): Investment on the NRW reduction by reconstruction of the distribution systems (construction of distribution reservoirs and pressure/flow monitoring systems and replacement of pipelines) in the prioritized zones (Phase2: the Kacyiru/South, the Runda Rugarika, the Masaka Kanombe).

(1) NRW/Pipelines (Phase 2) Kanombe/Masaka

Reconstruction of the Masaka existing systems through the Karenge 1 system. Major system construction should be done in the Masaka WTP F/S in order that the system design is along with the Masaka New Water Source.

(2) NRW/Pipelines (Phase 2) Runda Rugarika

The area includes existing and newly developing areas in the Runda and the Rugarika sectors. Setting small reservoirs, reconstruction of incapably small diameters and replacement of the supply pipes along with their expansion are the key considerations for the system.

Stage 3 (Procurement in 2024, Completion in 2027): Investment on the NRW reduction mainly by reconstruction of the distribution systems in the prioritized zones (Phase3: the Ndera Rusororo, the Kicukiro).

(1) NRW/Pipelines (Phase 3) Kacyiru/Remera (South)

The area includes the Kacyiru, the Remera, the Kimironko and the Kimihurura. An old and complicated system where the pipelines from the Ntora, the Remera, the Kimihurura, Kicukiro is tangled. The system's reconstruction should focus on hydraulic separation and NRW reduction rather than the new reservoir construction.

As an improvement measures for the energy, re-arrangement of pumps from the Kimisagara WTP should be also included under this rehabilitation project.

(2) NRW/Pipelines (Phase 3) Gikondo

The area includes the distribution systems from the Kicukiro reservoir and the Nyanza reservoir. Hydraulic separation considering the elevation, is the key consideration.

Stage 4 (Procurement from 2026, Completion in 2032): Last phase of NRW reduction project to transform the distribution system to NRW 23%. Two WTP expansions, the Masaka expansion, and the New Gahanga WTP should be developed to meet the additional demand in the east. New WTP development should also be considered to meet the growing demand in the remote. The water demand in the Target year 2035 will be met following development under this stage.

(1) Independent water supply (Rutunga/Gikomero)

Remote sectors (the Rutunga and the Gikomero) need independent Water Supply Schemes (WSS) by this target year. Each capacity is total of the sector estimated from the CoK M/P and needs to be examined according to the actual development in those sectors. The existing supply capacities in those sectors are neglected in this statement because they are rather small when compared to the demands.

Feasibility Study is necessary to compare the water supply from a. Masaka WTP, b. New water sources from the wells and c. Muhazi Lake. It is also necessary to transit and integrate the new system with the district-based water supply operated by the private operator.

(2) NRW/Pipelines (Phase 4) Nyamirambo, Ndera-Rusororo, Nyarugenge CBD

Nyamirambo: The area includes the Kimisagara-Rwezamenyo-Nyakabanda to the Mount-Kigali, where pipes are not capable and possibly suffering from high NRW ratio. This should also include the reconstruction of existing small-scale water sources (the Mburabuturo).

Ndera-Rusororo: Mainly focus on the reconstruction of the FTZ and the FTZII supplying system and strategic construction of main distribution systems through a new road from the Masoro to the Kabuga.

CBD: The CBD and adjacent areas include the Nyarugenge, the Muhima, and the Gitega sectors, where the pipes are aged and tangled. Extensive replacement of water supply pipes (e.g., Galvanized pipes and fittings) along with the PVC distribution mains and distribution sub-mains with small diameters. The Kimisagara: Small reservoirs and pressure control through the block system are necessary to be constructed.

(3) Masaka Expansion (Phase 2: Approx. 20,000 m^3/day)

Expansion of the Masaka Water Treatment Plant (Phase 2: Approx. 20,000 m^3/day) should be considered in line with the development in the vicinity area (Masaka, Nyarugunga, Ndera and Rusororo Sectors). The development under this phase 2 is considered as a simple expansion of the wells, treatment facilities and transmission pump capacity.

(4) Gahanga (Phase 1: 40,000 m^3/day)

Water supply facilities on the left side of the Nyabarongo River. Water source development (groundwater (subsurface water)) accompanied by its related RW transmission pipes and treatment facilities.

New water source and water supply facilities

- Water Well Field
- Water Treatment Plant

Forwarding infrastructures (Transmission and Distribution Pipes)

Stage 5 (Procurement in 2032, Completion in 2036): This stage is to meet further demand after 2035. The Nzove 3 and the Karenge 3 should be developed to meet the growing demand. The Central Main should be constructed to transmit the water from the Nzove to the eastern part of the City of Kigali.

The Stage 5 goes beyond the evaluation period until 2035 while it needs preparation for the demand right after the 2035.

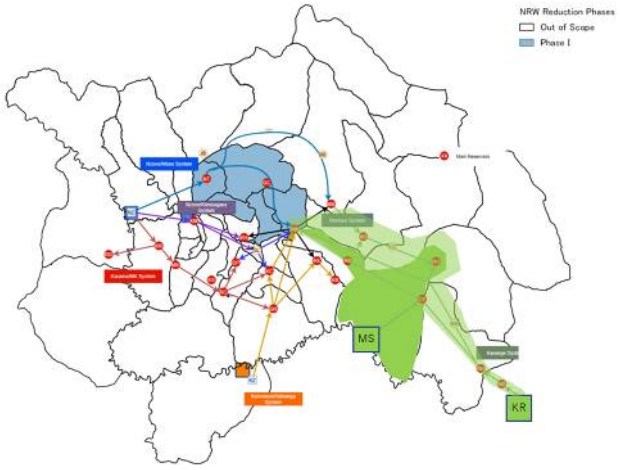
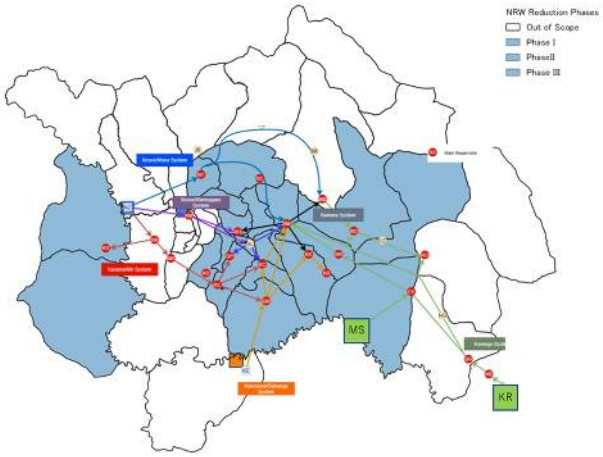
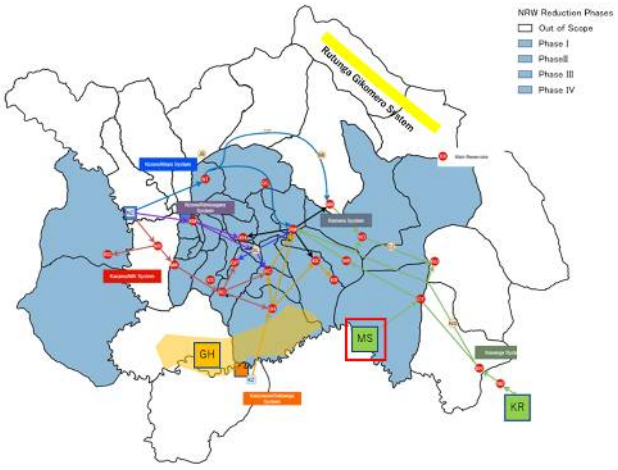
(1) Central Transmission Main

The availability of the potential water source in the middle- and down-stream of the Nyabarongo River is limited. Under this circumstance, transmission from Nzove to the eastern side of the city should be considered. The existing transmission route through Nzove and Mont-Kigali to Remera is inefficient. This is because they are transmitted from the high elevation mountain as well as the route is diverted from the city center and thus is a long way to the eastern area

- Transmission Pipeline (Nzove-Kimisagara-Remera) (18.4 km, ND 800-1,000 mm)
- Transmission Pumping Stations and Pumps (Nzove H=70m, Kimihurura H=125m)
- Distribution Reservoirs (Kimisagara, Kimihurura)

(2) Nzove 3

Expansion of the Nzove Water Treatment Plant (Approx. 40,000 m^3/day as was planned in the F/S of Nzove rehabilitation project) should be considered in line with the development of the Central Transmission Main because of the lack of current water conveyance capacity from the Nzove.

Stage 1 Investment 	Stage 1 (Procurement from 2021, Completion in 2026): Emergency Project (NRW reduction project phase 1: The Ntora-Remera), the rehabilitation and expansion of the Karenge WTP and the Construction of the Masaka WTP.
Stage 2 and 3 Investment 	Stage 2 (Procurement in 2022, Completion in 2025): Investment on the NRW reduction mainly by reconstruction of the distribution systems (Phase2: the Kacyiru/South, the Runda Rugarika, the Masaka Kanombe). Stage 3 (Procurement in 2024, Completion in 2027): Investment on the NRW reduction mainly of the replacement of pipelines in the prioritized zones (Phase3: the Ndera Rusororo, the Kicukiro).
Stage 4 Investment 	Stage 4 (Procurement from 2026, Completion in 2032): Last phase of NRW reduction project to transform the distribution system to NRW 23%. Two WTP expansions, the Masaka expansion, and the New Gahanga WTP should be developed to meet the additional demand in the east. New WTP development should also be considered to meet the growing demand in the remote. The water demand in the Target year 2035 will be met during the development under this stage.

APPENDIX 13: AfDB Projects for water and sanitation sector

Title	Commitment in UA	Status	Signature Date	Project Description
Rwanda - Sustainable Water Supply and Sanitation Program – Additional Financing	94,372,862	Implementation	16/Jan/2019	This project concerns the additional financing of the Sustainable Water Supply and Sanitation Program in Rwanda. The initial financing of the program targets the City of Kigali and the satellite cities of Rubavu, Rusizi, Nyagatare, Muhanga, Huye, Musanze and Karongi covering water supply and sanitation sub-projects. It will enable the Government of the Republic of Rwanda (GoR) to provide improved water supply services to an additional 1.5 million people bringing the total number of beneficiaries to 5.4 million. The program also complements Bank's private sector financed Kigali Bulk Water Supply Project by ensuring connection between the water treatment plant and the city's water supply network. The expanded reach will target additional areas including peri-urban and rural areas with low service coverage to help the country accelerate progress towards universal access to improved water and sanitation services by 2024 in line with the First National Strategy for Transformation (NST-1). Therefore, the additional financing will mainly support scaling up of component 1 in additional areas in Nyagatare, Gatsibo, Kayonza, Ngoma, Bugesera, Ruhango, Nyanza, Muhanga, Ngororero, Kamonyi, Musanze, Nyabihu, Rubavu, Karongi and Rutsiro districts. The program is being implemented over 6 years (including the implementation time of the ongoing initial financing). The total cost including additional activities, is estimated at EUR 379.689 million, net of taxes and duties.
Rwanda - Sustainable Water Supply and Sanitation Program	87,099,418	Implementation	29/Nov/2017	The program supports infrastructure investments as well as institutional capacity development. It involves multiple water supply and sanitation sub-projects or interventions to be implemented in the City of Kigali and in the satellite cities of Rubavu, Rusizi, Nyagatare, Muhanga, Huye, Musanze and Karongi. The program focuses on the urban water and sanitation subsector to promote development in the identified key satellite cities and in the city of Kigali. Its benefits include: (a) improved reliability and sustainability of the water supply and sanitation services;

Title	Commitment in UA	Status	Signature Date	Project Description
				(b) overall improvement of the public health situation in the target cities and their surrounding areas, as a result of more reliable improved water supply and sanitation services, and (c) an enhanced operation & maintenance (O&M) capacity of Water & Sanitation Corporation Limited (WASAC). The program is expected to be implemented over 48 months starting in January 2018, while European Investment Bank (EIB) and the Government of the Republic of Rwanda (GoR) will contribute 19.25% (EUR 45.000m) and 15.51% (USD 40.687m) respectively.
Rwanda - Kigali Bulk Water Supply Project	13,625,349	Implementation	24/Nov/2017	Kigali Bulk Water Supply (KBWS) Project is Public Private Partnership (PPP) between the Government of Rwanda (GoR), represented by the Ministry of Infrastructure, Water, Sanitation Corporation (WASAC), the government water utility company and Kigali Water Limited (KWL). This is the country's first Independent Water Producer project on a large scale in the continent. The project scope involves the development, design, financing, construction and operation of 40,000m3/day Bulk Water Facility (BWF) south of Kigali in Rwanda. The scope of the BWF shall comprise of; a water treatment plant, a well field with 38 wells, three pumping stations, pipelines and three storage reservoirs. Under the PPP arrangement, Kigali Water Limited will supply bulk water to the Water and Sanitation Corporation, which WASAC then sells to the local consumers.
Rwanda - National water supply and sanitation master plans	1,606,679	Implementation	17/Feb/2017	National Integrated Water Supply and Sanitation Masterplans development follows the need to preserve gains and best practices in the national water and sanitation programs. The project is consistent with related national strategies in Rwanda and will allow Water and Sanitation Corporation (WASAC) to prioritize investments in water supply and sanitation to maximize effect and efficiency. Its outputs will allow Government of Rwanda to attract funds for sustainable infrastructure investments, which will ultimately help to achieve the projects impact. The project consists of three (3) project components as follows: Component 1 deals with the Development of the National Water Supply and Sanitation investment plans for a 10 year horizon, and the preparation of

Title	Commitment in UA	Status	Signature Date	Project Description
				feasibility and detailed designs for small selected prioritized projects. Component 2 focuses on capacity building activities for main stakeholders, WASAC, district staff and private sector staff on previously identified topics. Component 3 comprises project management, stakeholder consultation and community participation and also includes the establishment of a Project Implementation Unit (PIU) within WASAC to coordinate project implementation. The total project duration is 24 months. Its cost amounts to Euro 2,250,614 of which Euro 1,950,894 (87%) will be funded by AWF, Euro 299,720 (13%) by Government of Rwanda.
Rwanda - National Rural Drinking Water Supply and Sanitation Program (Phase II)	16,208,742	Completion	10/Sep/2009	Unlike the agricultural, education and health sectors, there was not as yet a sector budget support (SWAP) as financing instrument for the water and sanitation sector in Rwanda. However, the Government has commissioned a World Bank-funded study to explore ways and means of gaining access to a sector SWAP. Once the study is completed, the findings will be discussed by the Government and all the technical and financial partners for ultimate validation and definition of their conditions of implementation. Consequently, the financing mechanism jointly adopted could be applied for the next financing phases of the national programme (PNEAR). This present sub-programme will use the mechanisms already existing in the country that were also used for PNEAR Phase I.
Projet pilote à l'introduction des techniques de collecte et d'utilisation des eaux de pluie au Bugesera	396,147	Completion	22/May/2007	The present intervention is about a pilot project to introduce the techniques of collecting and using rainwater in Bugesera. It aims to help improve the living conditions of the target groups through the protection and sustainable management of natural resources for food security in the country. The results of this pilot project should also popularize and generalize water collection techniques throughout the country. The components of the project are: (i) promotion of rainwater harvesting techniques; (ii) promotion of soil conservation and improvement techniques; (iii) capacity building; (iv) evaluation and impact studies; and (v) project management.

Title	Commitment in UA	Status	Signature Date	Project Description
Rural Drinking Water Supply and Sanitation Programme - PNEAR (First Sub-programme)	12,796,204	Completion	13/May/2004	The present intervention concerns the Rural Drinking Water Supply and Sanitation Programme - PNEAR (First Sub-programme). Based on the Communities' demands in its different phases of implementation, it has remained in keeping with the Water and Sanitation sector policy. This program aims to improve the living conditions of rural populations in its area of influence. It should contribute to the realization of the sector water and sanitation policy objectives in the intervention zones, namely: (i) providing families with drinking water that is accessible in adequate quantities, (ii) providing families access to an adequate system of sanitation, (ii) Community management and involvement and in all sector activities, (iii) the protection, preservation, rehabilitation and development of all water resources; and (iv) development of the sector through a process geared toward high community involvement in projects that propose viable financial and technological options for sustainable development of the sector. The four (04) main components of the program are: A) studies and Planning Tools; B) capacity building; C) development of DWSS infrastructure; and D) program management.
Etude Alimentation en Eau de Kigali III	779,781	Completion	7/Mar/1991	Not available
Projet d'adduction d'eau dans la ville de Kigali, phase 2	10,441,718	Completion	14/Aug/1986	Not available
Etude: alimentation en eau potable à Kigali	1,344,735	Completion	23/Jul/1984	Not available
Projet d'extension des réseaux d'adduction d'eau à Butare	2,357,893	Completion	18/Feb/1977	Not available

*source:
https://projectsportal.afdb.org/dataportal/VTopCountry/show/RW?query=&hi5Id=&offset=105&max=15&sort=actualStartDate&order=desc

* UA1 = SDR1= USD1.38 (as of 17/Jun/2019)

APPENDIX 14: Summary of USAID's aids related to water supply, sanitation in Rwanda

Purpose name	Activity name	Start date	End date	Current amount (USD)	Activity description
Basic drinking water supply and basic sanitation	YAL - Ishimwe - Iriba Clean Water	2016/12/21	2017/6/30	10,000	Sector: Water/Services .Beneficiaries: YALI Youth 803 of which 402 are women. 2 volunteer staff, 1 intern/trainee, 200 households will gain access to clean water (avg. household - 4 x 200 = 800). The grant will be used to pump underground water in form of boreholes. Then the water will be treated and purified to safe drinking standards for usage in household activities. After the production and purification process, the treated clean water will be delivered to people's homes in all possible means via bicycles, delivering truck, and pipes dependent on what a customer prefers to use and can afford. The grant funds will be used to: (a) drill an additional borehole; (b) the purchase of a water storage tank; and (c) the construction of a piping system directly connected to the water storage tank.
Basic sanitation	Rwandan Rural Sanitation Activity (Isuku Iwacu)	2016/9/2	2020/11/9	2,355,327	Isuku Iwacu will improve access to and encourage correct, consistent use of household sanitation and hygiene facilities in order to decrease childhood stunting, with an emphasis on reaching the lowest poverty quintile and complementing the activities undertaken by Gikuriro and within the CBEHPP curriculum. Three intermediate results (IRs) will contribute directly to achieving this objective: a. IR 1 Demand for sanitation and hygiene products and services increased b. IR 2 Supply and availability of sanitation products and services in the private sector improved c. IR 3 Governance for sustained access to sanitation and hygiene products and services improved
Basic sanitation	Rwandan Rural Sanitation Activity (Isuku Iwacu)	2016/9/2	2020/11/9	1,947,225	Isuku Iwacu will improve access to and encourage correct, consistent use of household sanitation and hygiene facilities in order to decrease childhood stunting, with an emphasis on reaching the lowest poverty quintile and complementing the activities undertaken by Gikuriro and within the CBEHPP curriculum. Three intermediate results (IRs) will contribute directly to achieving this objective: a. IR 1 Demand for sanitation and hygiene products and services increased b. IR 2 Supply and availability of sanitation products and services in the private sector improved c. IR 3 Governance for sustained access to sanitation and hygiene products and services improved
Basic sanitation	Rwandan Rural Sanitation Activity (Isuku Iwacu)	2016/9/2	2020/11/9	1,222,821	Isuku Iwacu will improve access to and encourage correct, consistent use of household sanitation and hygiene facilities in order to decrease childhood stunting, with an emphasis on reaching the lowest poverty quintile and complementing the activities undertaken by Gikuriro and within the CBEHPP curriculum. Three intermediate results (IRs) will contribute directly to achieving this objective: a. IR 1 Demand for sanitation and hygiene products and services increased b. IR 2 Supply and availability of sanitation products and services in the private sector improved c. IR 3 Governance for sustained access to sanitation and hygiene products and services improved

Purpose name	Activity name	Start date	End date	Current amount (USD)	Activity description
Basic drinking water supply and basic sanitation	Gikuriro Activity	2015/11/10	2020/11/9	3,072,358	The primary purpose of the USAID-supported Gikuriro (Good Growth) integrated nutrition and WASH project is to improve the nutritional status of women of reproductive age and children under five years of age, with an emphasis on the 1,000 day window of opportunity from pregnancy until a child's second birthday. In addition, Gikuriro will promote WASH activities, including handwashing practices, safe water use to prevent diarrheal infections. Through Gikuriro, USAID is expected to reach an estimated 324,000 children under five years of age and their mothers with nutrition and hygiene interventions in eight districts of Rwanda. In support of the Government of Rwanda's efforts, Gikuriro will contribute to priority nutrition and hygiene outcomes.
Basic drinking water supply and basic sanitation	Gikuriro Activity	2015/11/10	2020/11/9	1,702,982	The primary purpose of the USAID-supported Gikuriro (Good Growth) integrated nutrition and WASH project is to improve the nutritional status of women of reproductive age and children under five years of age, with an emphasis on the 1,000 day window of opportunity from pregnancy until a child's second birthday. In addition, Gikuriro will promote WASH activities, including handwashing practices, safe water use to prevent diarrheal infections. Through Gikuriro, USAID is expected to reach an estimated 324,000 children under five years of age and their mothers with nutrition and hygiene interventions in eight districts of Rwanda. In support of the Government of Rwanda's efforts, Gikuriro will contribute to priority nutrition and hygiene outcomes.
Basic drinking water supply and basic sanitation	Gikuriro Activity	2015/11/10	2020/11/9	1,174,660	The primary purpose of the USAID-supported Gikuriro (Good Growth) integrated nutrition and WASH project is to improve the nutritional status of women of reproductive age and children under five years of age, with an emphasis on the 1,000 day window of opportunity from pregnancy until a child's second birthday. In addition, Gikuriro will promote WASH activities, including handwashing practices, safe water use to prevent diarrheal infections. Through Gikuriro, USAID is expected to reach an estimated 324,000 children under five years of age and their mothers with nutrition and hygiene interventions in eight districts of Rwanda. In support of the Government of Rwanda's efforts, Gikuriro will contribute to priority nutrition and hygiene outcomes.
Basic drinking water supply and basic sanitation	Twiyubake - Integrated Strengthening for Vulnerable Populations (ISVP)	2015/2/23	2020/2/22	333,135	The Improved Services for Vulnerable Populations (ISVP) Activity aims to improve the protection of vulnerable populations against adverse circumstances. Global Communities is implementing the Improved Services for Vulnerable Populations (ISVP) Program, which aims to assist 50,000 vulnerable households in 12 districts. Locally known as USAID Twiyubake, the program is designed to build and enhance lasting self-reliance in a way that promotes mutual support. The program objectives include increasing capacity of families and communities to provide better care for vulnerable individuals; improving household and community care and support practices for vulnerable populations, especially children; and increasing access to education and social services for vulnerable populations.

Purpose name	Activity name	Start date	End date	Current amount (USD)	Activity description
Basic drinking water supply and basic sanitation	Twiyubake - Integrated Strengthening for Vulnerable Populations (ISVP)	2015/2/23	2020/2/22	105,531	The Improved Services for Vulnerable Populations (ISVP) Activity aims to improve the protection of vulnerable populations against adverse circumstances. Global Communities is implementing the Improved Services for Vulnerable Populations (ISVP) Program, which aims to assist 50,000 vulnerable households in 12 districts. Locally known as USAID Twiyubake, the program is designed to build and enhance lasting self-reliance in a way that promotes mutual support. The program objectives include increasing capacity of families and communities to provide better care for vulnerable individuals; improving household and community care and support practices for vulnerable populations, especially children; and increasing access to education and social services for vulnerable populations.
Basic drinking water supply and basic sanitation	Twiyubake - Integrated Strengthening for Vulnerable Populations (ISVP)	2015/2/23	2020/2/22	16,865	The Improved Services for Vulnerable Populations (ISVP) Activity aims to improve the protection of vulnerable populations against adverse circumstances. Global Communities is implementing the Improved Services for Vulnerable Populations (ISVP) Program, which aims to assist 50,000 vulnerable households in 12 districts. Locally known as USAID Twiyubake, the program is designed to build and enhance lasting self-reliance in a way that promotes mutual support. The program objectives include increasing capacity of families and communities to provide better care for vulnerable individuals; improving household and community care and support practices for vulnerable populations, especially children; and increasing access to education and social services for vulnerable populations.
Water sector policy and administrative management	Rwanda Health Systems Strengthening Activity	2014/11/17	2019/7/1	300,000	The Rwanda Health System Strengthening (RHSS) Activity aims to support the delivery of high-quality health services at sustainable cost for all Rwandans.
Basic drinking water supply and basic sanitation	Demographic and Health Surveys Phase 7 (DHS-7)	2013/9/9	2020/3/8	100,000	The DHS-7 contract will continue to be USAID's primary implementation mechanism for demographic and health data collection. The purpose of this contract is to improve the collection, analysis, and presentation of population, health, and nutrition data and to facilitate use of these data for planning, policy-making, and program management.
Basic drinking water supply and basic sanitation	Small Project Assistance (SPA) Program with Peace Corps	2012/9/30	2019/9/30	50,000	New Small Project Assistance program award with Peace Corps. The SPA Program enables USAID to have direct development investments and impact in selected priority areas, while supporting U.S. Peace Corps volunteers to engage community members in participatory processes that contribute to capacity building and sustainable development.
Basic drinking water supply and basic sanitation	Small Project Assistance (SPA) Program with Peace Corps	2012/9/30	2019/9/30	50,000	New Small Project Assistance program award with Peace Corps. The SPA Program enables USAID to have direct development investments and impact in selected priority areas, while supporting U.S. Peace Corps volunteers to engage community members in participatory processes that contribute to capacity building and sustainable development.

Purpose name	Activity name	Start date	End date	Current amount (USD)	Activity description
Basic drinking water supply and basic sanitation	Small Project Assistance (SPA) Program with Peace Corps	2012/9/30	2019/9/30	25,000	New Small Project Assistance program award with Peace Corps. The SPA Program enables USAID to have direct development investments and impact in selected priority areas, while supporting U.S. Peace Corps volunteers to engage community members in participatory processes that contribute to capacity building and sustainable development.
Basic drinking water supply and basic sanitation	Small Project Assistance (SPA) Program with Peace Corps	2012/9/30	2019/9/30	24,259 (= 25,000 - 741)	New Small Project Assistance program award with Peace Corps. The SPA Program enables USAID to have direct development investments and impact in selected priority areas, while supporting U.S. Peace Corps volunteers to engage community members in participatory processes that contribute to capacity building and sustainable development.
Basic drinking water supply and basic sanitation	Ubaka Ejo	2012/9/12	2020/9/11	217,175	Through the Ubaka Ejo activity, USAID aims to improve the well-being of orphans and vulnerable children (OVC) and their families, especially those affected by HIV/AIDS, in 9 districts. Ubaka Ejo supports vulnerable households' access to quality health and social services; provides education support to OVC in primary, secondary, and Technical and Vocational Education Training schools; improves household economic strengthening and HIV awareness and prevention; and implements community-based nutrition programs and water, sanitation and hygiene (WASH).
Basic drinking water supply and basic sanitation	Ubaka Ejo	2012/9/12	2020/9/11	182,825	Through the Ubaka Ejo activity, USAID aims to improve the well-being of orphans and vulnerable children (OVC) and their families, especially those affected by HIV/AIDS, in 9 districts. Ubaka Ejo supports vulnerable households' access to quality health and social services; provides education support to OVC in primary, secondary, and Technical and Vocational Education Training schools; improves household economic strengthening and HIV awareness and prevention; and implements community-based nutrition programs and water, sanitation and hygiene (WASH).
Basic drinking water supply and basic sanitation	Ubaka Ejo	2012/9/12	2020/9/11	132,271	Through the Ubaka Ejo activity, USAID aims to improve the well-being of orphans and vulnerable children (OVC) and their families, especially those affected by HIV/AIDS, in 9 districts. Ubaka Ejo supports vulnerable households' access to quality health and social services; provides education support to OVC in primary, secondary, and Technical and Vocational Education Training schools; improves household economic strengthening and HIV awareness and prevention; and implements community-based nutrition programs and water, sanitation and hygiene (WASH).
Basic drinking water supply and basic sanitation	Turengere Abana	2012/9/12	2020/9/11	100,000	USAID through Turengere Abana supports an integrated approach to improve the well-being of orphans and vulnerable children (OVC) and their families, especially those affected by HIV/AIDS, in seven districts. The project supports vulnerable households' access to quality health and social services; education support for OVC, including Technical and Vocational Education Training; Early Childhood Development (ECD); household economic strengthening; HIV awareness and prevention; child protection; community-based nutrition programs; and water, sanitation, and hygiene (WASH).

Purpose name	Activity name	Start date	End date	Current amount (USD)	Activity description
Basic drinking water supply and basic sanitation	Ubaka Ejo	2012/9/12	2020/9/11	50,000	Through the Ubaka Ejo activity, USAID aims to improve the well-being of orphans and vulnerable children (OVC) and their families, especially those affected by HIV/AIDS, in 9 districts. Ubaka Ejo supports vulnerable households' access to quality health and social services; provides education support to OVC in primary, secondary, and Technical and Vocational Education Training schools; improves household economic strengthening and HIV awareness and prevention; and implements community-based nutrition programs and water, sanitation and hygiene (WASH).
Basic sanitation	GIMBUKA	2012/9/12	2020/9/11	50,000	Caritas-Rwanda will continue to improve the nutritional status of mothers and children (especially those under 2 years of age) through community-based interventions in nine districts. The project will seek to improve the well-being of HIV/AIDS-affected orphans and vulnerable children (OVC) and improve the nutritional status of adults living with HIV through cooking demonstrations, nutrition assessments (anthropometric measurements) and nutrition counseling. Of the 73,482 people supported under this program, 14,416 are OVCs, 36,000 are children under five years, and 7,200 are pregnant and lactating women. The project uses cost effective community-based solutions like internal savings and loan groups, farmers field schools and the positive deviance hearth model to address nutritional and financial needs of beneficiaries, with emphasis on resilience and empowerment through economic strengthening, food security, nutrition and hygiene, and increased access to health services.
Basic drinking water supply and basic sanitation	Turengere Abana	2012/9/12	2020/9/11	50,000	USAID through Turengere Abana supports an integrated approach to improve the well-being of orphans and vulnerable children (OVC) and their families, especially those affected by HIV/AIDS, in seven districts. The project supports vulnerable households' access to quality health and social services; education support for OVC, including Technical and Vocational Education Training; Early Childhood Development (ECD); household economic strengthening; HIV awareness and prevention; child protection; community-based nutrition programs; and water, sanitation, and hygiene (WASH).
Water supply and sanitation - large systems	Family Health Project	2012/2/3	2017/2/2	400,005	To increase the use of district-level facility and community based family health (FH) services in Rwanda.
Water supply and sanitation - large systems	Family Health Project	2012/2/3	2017/2/2	56,000	To increase the use of district-level facility and community based family health (FH) services in Rwanda.
Water supply - large systems	Rwanda Integrated Water Security Program	2011/5/18	2016/9/30	1,401,083	The Authorized Agent is requested to negotiate under LWA a cooperative agreement for the Rwanda Integrated Water Security Program

Purpose name	Activity name	Start date	End date	Current amount (USD)	Activity description
Water supply - large systems	Rwanda Integrated Water Security Program	2011/5/18	2016/9/30	1,293,802	The Authorized Agent is requested to negotiate under LWA a cooperative agreement for the Rwanda Integrated Water Security Program
Water supply - large systems	Rwanda Integrated Water Security Program	2011/5/18	2016/9/30	1,069,551	The Authorized Agent is requested to negotiate under LWA a cooperative agreement for the Rwanda Integrated Water Security Program
Water supply - large systems	Rwanda Integrated Water Security Program	2011/5/18	2016/9/30	698,231	The Authorized Agent is requested to negotiate under LWA a cooperative agreement for the Rwanda Integrated Water Security Program
Water supply - large systems	Rwanda Integrated Water Security Program	2011/5/18	2016/9/30	305,115	The Authorized Agent is requested to negotiate under LWA a cooperative agreement for the Rwanda Integrated Water Security Program
Water supply - large systems	Rwanda Integrated Water Security Program	2011/5/18	2016/9/30	32,218	The Authorized Agent is requested to negotiate under LWA a cooperative agreement for the Rwanda Integrated Water Security Program
Water supply - large systems	Rwanda Integrated Water Security Program	2011/5/18	2016/9/30	2,005	The Authorized Agent is requested to negotiate under LWA a cooperative agreement for the Rwanda Integrated Water Security Program
Water supply and sanitation - large systems	Strengthening Sustainable Ecotourism in and around Nyungwe National Park - Nyungwe Ecotourism II (SSENNP)	2010/3/24	2015/3/22	150,000	The project's aim is to transform Nyungwe National Park into a viable ecotourism destination that can generate sustainable and equitable income for local communities and as many other stakeholders as possible (including private investors). Creating employment for surrounding communities provides economic incentives to conserve the rich biodiversity of the Park.
Basic drinking water supply and basic sanitation	Rwanda Dairy Sector Competitiveness (RDSC)	2007/11/15	2011/9/30	193,928 = (193,995 -20 - 47)	The Rwanda Dairy Sector Competitiveness (RDSC) project will expand economic opportunities in the Rwandan dairy sector by enhancing value-added production, processing, and increasing market-driven private sector growth development. Within the context of integrating rural development activities focused on the dairy sector with health-related activities, USAID may also support HIV/AIDS prevention and palliative care services.
Water supply and sanitation - large systems	HIV/AIDS Clinical Services program in Rwanda	2007/6/6	2014/6/2	100,000	USAID HIV/AIDS Clinical Services Program (HCSP) is working to reinforce Rwanda's health care system and expand access to HIV/AIDS clinical services
Water supply and sanitation	Program Research for Strengthening Services	2007/6/1	2012/12/31	100,000	USAID HIV/AIDS Clinical Services Program (HCSP) is working to reinforce Rwanda's health care system and expand access to HIV/AIDS clinical services

Purpose name	Activity name	Start date	End date	Current amount (USD)	Activity description
- large systems	(PROGRESS)				
Basic drinking water supply and basic sanitation	Water Supply and Sanitation	-	-	9,127	Ensure broadly accessible, reliable and economically sustainable water and sanitation services for health, security, and prosperity. (Note that this element does not include the household behavior aspects found in sub-element 1.6.7 or water issues directly relating to Agriculture found in the EG Objective.)
Basic drinking water supply and basic sanitation	Water Supply and Sanitation	-	-	6,585	Ensure broadly accessible, reliable and economically sustainable water and sanitation services for health, security, and prosperity. (Note that this element does not include the household behavior aspects found in sub-element 1.6.7 or water issues directly relating to Agriculture found in the EG Objective.)
Basic drinking water supply and basic sanitation	Water Supply and Sanitation	-	-	6,025	Ensure broadly accessible, reliable and economically sustainable water and sanitation services for health, security, and prosperity. (Note that this element does not include the household behavior aspects found in sub-element 1.6.7 or water issues directly relating to Agriculture found in the EG Objective.)
Basic drinking water supply and basic sanitation	Water Supply and Sanitation	-	-	339	Ensure broadly accessible, reliable and economically sustainable water and sanitation services for health, security, and prosperity. (Note that this element does not include the household behavior aspects found in sub-element 1.6.7 or water issues directly relating to Agriculture found in the EG Objective.)

* Source: https://explorer.usaid.gov/query, https://www.usaid.gov/rwanda/water

APPENDIX 15: Summary of WB's aids related to water supply project in Rwanda

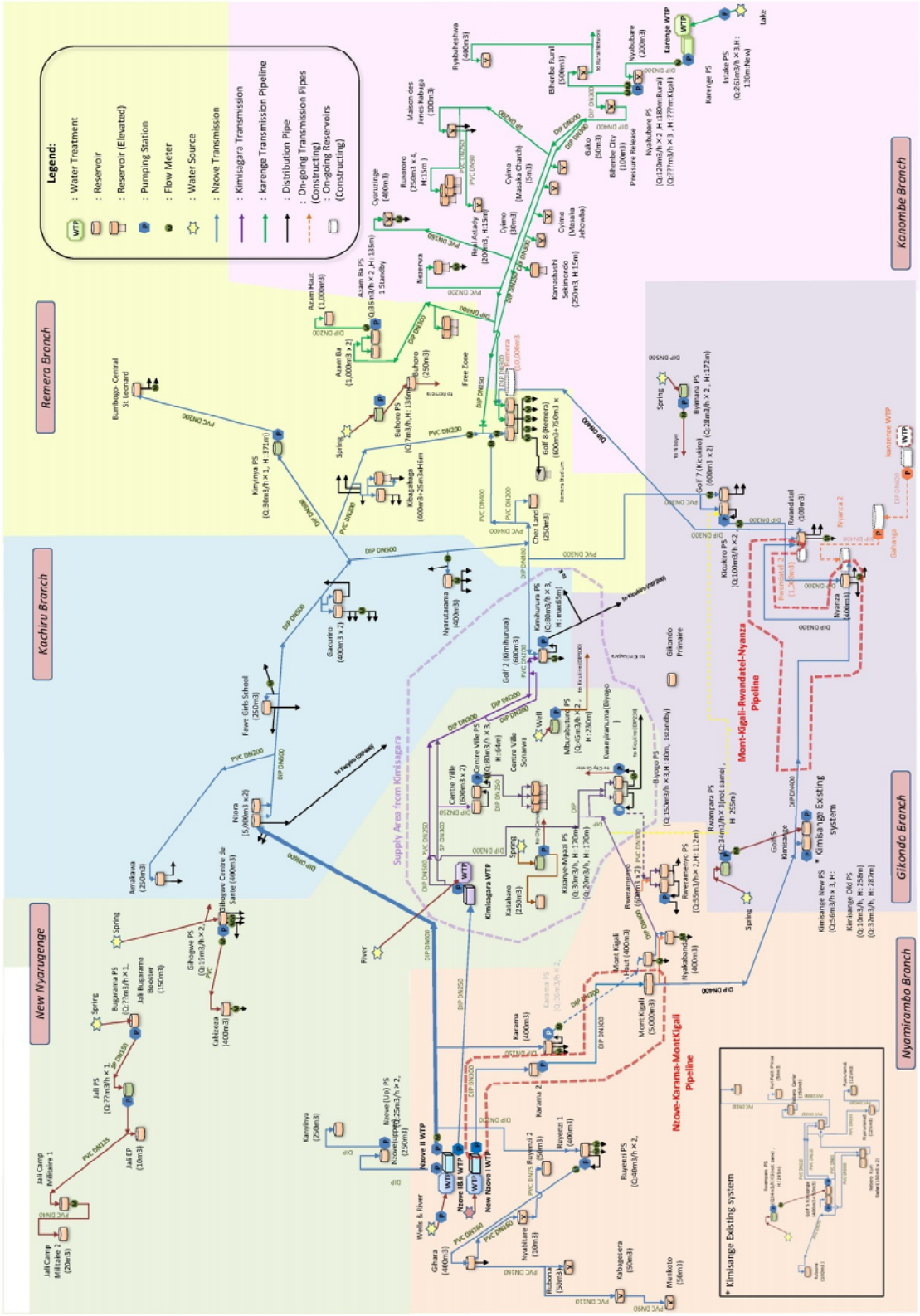
Project Title	Project Description	Commitment Amount (Mil.USD)	Status	Approval Date
Poverty Reduction Support Credit 1 (Health, water, Energy, Education)	The Poverty Reduction Strategy Paper (PRSP) provides a comprehensive diagnosis of the causes of poverty, and outlines the key objectives and actions required for reducing it. The surveys, and the national rapid poverty assessments (NPAs) carried out at the grassroots level, confirm that living conditions in Rwanda, while slowly improving since 1994, continue to be very poor, particularly in rural areas. Development partners strongly supported Rwanda's PRSP process, and have universally commended the Government of Rwanda (GoR) for the consultative manner through which it was developed. The PRSP was endorsed by the Boards of the Bank and Fund on August 12, 2002. The strategy was complemented by the development of an Medium-Term Expenditure Framework (MTEF). The PRSP identifies the private sector as the main engine of growth, with the transformation of agriculture and the rural economy as the leading source of growth in the near to medium term. To deal with the legacies of genocide and structural impediments to economic transformation, the PRSP outlines five basic building blocks for economic growth and poverty reduction-macroeconomic stability, human development, good governance, partnership, and the prioritization of public actions-and six priority action areas (a) rural development and agricultural transformation; (b) human development; (c) economic infrastructure; (d) good governance; (e) private sector development; and (f) institutional capacity building (see Box 2). The PRSP stresses the importance of defining sectoral strategies and associated (MTEFs) to guide public actions for implementation.	65.00	Closed	2004/10/21
Rural water Supply and Sanitation Project	The Rural Water Supply and Sanitation Project aims at increasing availability of water supply, and sanitation services in rural areas in Rwanda. The four main components call for: 1) provision of grants to communities, for the construction of water, and sanitation facilities. Furthermore, technical assistance, training, and outreach activities will be financed to strengthen community capacity in the operation and maintenance of those facilities; 2) demand-responsiveness in the rehabilitation of major water supply systems, and establish sustainable management of these systems; 3) strengthening stakeholder capacity to perform the tasks required within the rural water supply, and sanitation strategy, and ensure appropriate services to the community. Thus, the component will support private sector, and non-governmental organizations' in the provision of computer services, and, the public sector will facilitate the sub-sector development, and management process; and, 4) inclusion of incremental project management costs, and technical assistance to community development committees.	20.00	Closed	2000/6/6

Water Supply Project (02)	This second project within the water supply sector aims to provide Rwandans with safe water within reasonable distances from their homes. Specifically, it aims to strengthen institutions involved in the water supply subsector, establish cost recovery mechanisms for safe water and support a program to rehabilitate rural water supply systems. To this end, the project intends to provide (a) an institutional component with technical assistance and training, to reinforce the General Directorate of Water (GDW), as well as the communes and the users associations. It also includes (b) a national program utilizing "line of credit financing" for rehabilitation, operation and maintenance of existing rural water supply systems throughout the country. The first-year work program is expected to be ready about the time of credit effectiveness. The communes will carry out the sub-projects pertaining to their communities, with assistance from local non-governmental organizations. Lastly, the project involves (c) specific investments for the rehabilitation and expansion of seven water supply systems in the Lava Region (North-West Rwanda). Benefits under the proposed project are expected to result in improvements in the productivity and well-being of the rural population throughout Rwanda.	15.00	Closed	1987/4/28
Water Supply Project (01)	The main objectives of the project are to: (i) strengthen the capability of Electrogaz in the planning, administrative, financial and technical areas; (ii) improve the efficiency of Electrogaz operations and maintenance; and (iii) expand access to potable water in rural areas. The project components are: (i) improvement and expansion of water supply facilities in the five secondary centers of Cyangugu, Kibungo, Kibuye Ruhengeri and Rwamagana; (ii) improvement of the organization and management of Electrogaz, including the establishment of a system for the management of inventories and of cost accounting, construction and equipping of a training center (including the supply of training equipment), and the carrying out of a training program for Electrogaz personnel; (iii) acquisition and distribution to primary and secondary schools of text books on hygiene and training of primary school teachers to teach courses in hygiene; (iv) a study on tariffs (for water, gas and electricity) covering policies and tariff structure, a detailed engineering study for water supply in the northern (lava) regions and an organizational and management study for rural water supply operations on the national level, including cost-recovery mechanisms.	13.00	Closed	1983/4/12

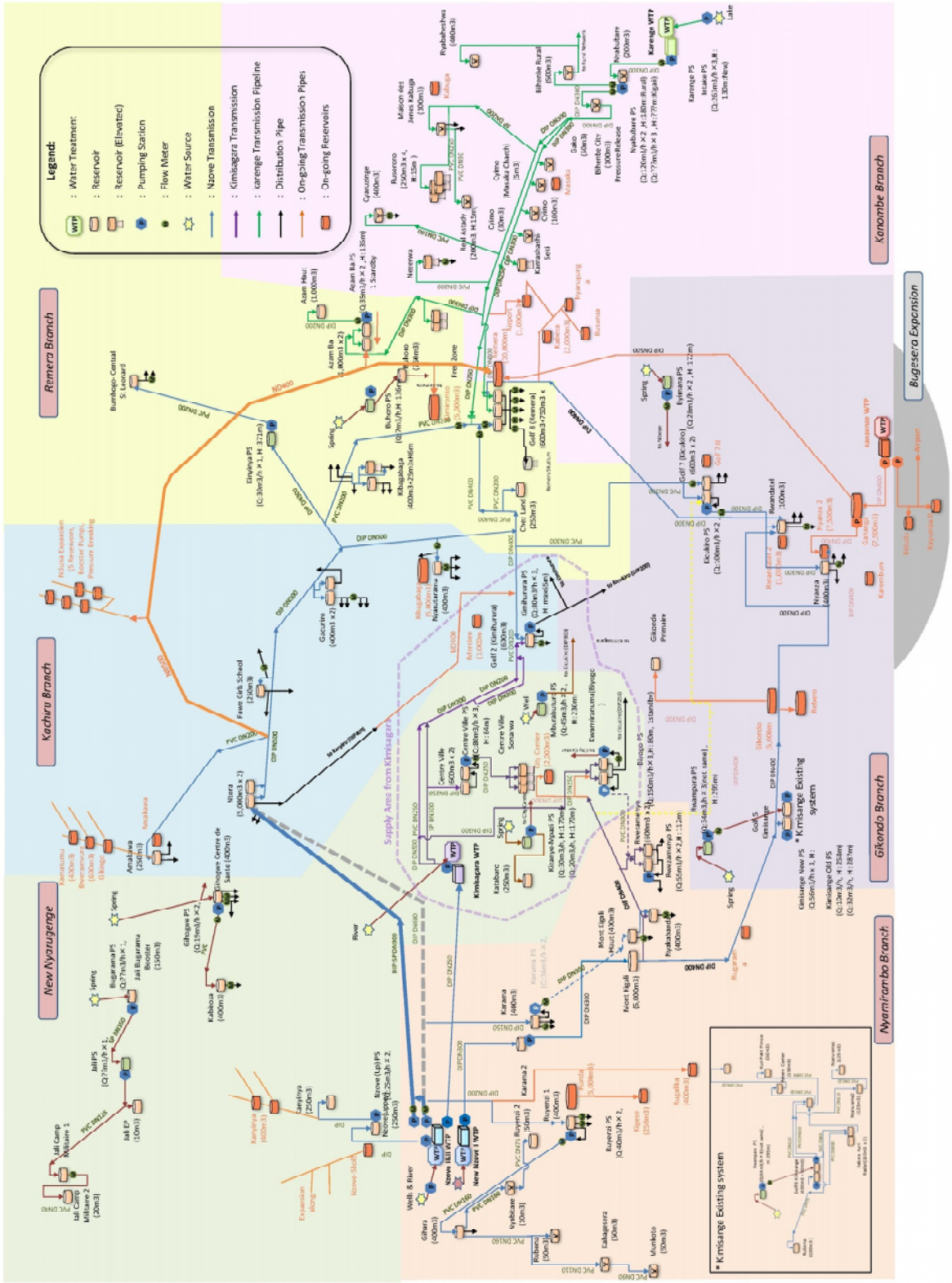
Source: http://projects.worldbank.org/search?lang=en&searchTerm=&countrycode_exact=RW

APPENDIX 16: Existing and on-going water supply system

(1) Existing water supply system



(2) On-going water supply system



APPENDIX 17: List of Reservoirs

Location_Name	Capacity_m3	Altitude	Reservoir_Function	Reservoir_Position	Presence_of_Float_valve_Regulator	Type_of_the_inlet_pipe	Material	Latitude	Longitude	Provide_comment_if_necessary
Kivugiza	30	1,638	Storage	Ground	No	Top	Stainless steel	-1.980434	30.04034	
Mont Kigali haut	400	1,790	Storage	Ground	No	Top	Concrete	-1.974988	30.03556	
Nyakabanda	400	1,680	Storage	Ground	No	Top	Concrete	-1.976791	30.03975	
Mumena	200	1,439	Break_Pressure	Underground	No	Bottom	Concrete	-1.98159	30.05905	
Rubona	100	1,623	Storage	Semiground	No	Top	Stones	-1.992128	30.03924	
Rwezamenyo	600	1,573	Storage	Ground	No	Top	Concrete	-1.975627	30.04853	
Rwezamenyo	10	1,519	Kiosk_Reservoir	Ground	No	Top	Steel	-1.971238	30.05394	Plastic material
Rwezamenyo	600	1,572	Storage	Ground	No	Top	Concrete	-1.975459	30.04851	
Nyakabanda	10	1,531	Kiosk_Reservoir	Semiground	No	Top	Stainless steel	-1.96767	30.04977	
Nyakabanda	4	1,531	Storage	Semiground	Yes	Top	Stainless steel	-1.963792	30.05072	
Kigali	50	1,595	Unbalanced_Reservoir	Semiground	No		Concrete	-1.983639	30.02417	The reservoir construction works still operating
Gacuriro	400	1,495	Storage	Ground	Yes	Top	Concrete	-1.923208	30.0939	Initial, maximum and minimum level are not known *
Gacuriro	400	1,495	Storage	Ground	Yes	Top	Concrete	-1.923486	30.09373	Initial, maximum and minimum level are not known *
Ntora	5000	1,365	Storage	Ground	No	Top	Concrete	-1.915331	30.05616	
Amajyambere	1000	1,465	Storage	Ground	Yes	Top	Concrete	-1.956961	30.08418	No,convincing answer
Fawe Girls School	250	1,471	Storage	Ground	Yes	Top	Concrete	-1.913842	30.07225	
Ntora	5000	1,365	Storage	Ground	No	Top	Concrete	-1.915021	30.05606	
UTEXRWA	150	1,385	Storage	Ground	No	Top		-1.928194	30.07861	This Reservoire is useless
Kabiziza	250	1,662	Storage	Ground	Yes	Top	Concrete	-1.907194	30.03453	
Yanze	750	1,457	Storage	Semiground	No	Bottom	Concrete	-1.919047	30.0222	
Yanze	750	1,457	Storage	Semiground	No	Bottom	Concrete	-1.919123	30.02223	
Yanze	750	1,457	Storage	Semiground	No	Bottom	Concrete	-1.919224	30.02227	
Yanze	750	1,455	Storage	Semiground	No	Bottom	Concrete	-1.919317	30.0223	
Kamuhoza	10	1,574	Storage	Ground	Yes	Top	Concrete	-1.905811	29.94872	
Kinyambi	10	1,657	Storage	Ground	Yes	Top	Concrete	-2.007556	29.92928	
Amakawe reservoir	400	1,512	Storage	Semiground	No	Top	Concrete	-1.894242	30.05136	
Jali bugarama	150	1,608	Storage	Semiground	No	Top	Concrete	-1.896104	30.03179	
Jabana	8	1,429	Kiosk_Reservoir	Ground	No	Top	Stones	-1.898211	30.05624	
Kwa nyiranuma	1200	1,518	Storage	Ground	No	Bottom	Concrete	-1.966691	30.05991	They are two combined tanks and it have octagon f*
Kizanye mpazi	300	1,424	Storage	Underground	No	Bottom	Concrete	-1.954563	30.05403	
Gihogwe		1,495	Storage	Semiground	No	Bottom	Stones	-1.907305	30.04417	Ntabwo bakigkoresha kuko nta mazi akigeramo. nta*
Gihogwe		1,462	Storage	Semiground	No	Top	Concrete	-1.905917	30.04648	
Jali	400	2,071	Storage	Elevated	No	Top	Concrete	-1.882975	30.0153	
Jali	10	2,014	Unbalanced_Reservoir	Semiground	No	Bottom	Stones	-1.876315	30.01249	
Jali	6	1,848	Storage	Underground	No	Top	Concrete	-1.89867	30.02598	
Jali	6	1,932	Kiosk_Reservoir	Underground	No	Bottom	Stones	-1.900852	30.02331	
Plateau	70	1,559	Unbalanced_Reservoir	Elevated	No	Top	Steel	-1.955095	30.06144	
Centre ville	400	1,517	Storage	Semiground	Yes	Top	Concrete	-1.94455	30.05781	
Centre ville	600	1,515	Storage	Ground	No	Bottom	Concrete	-1.944561	30.05769	
Plateau	70	1,559	Unbalanced_Reservoir	Elevated	No	Top	Steel	-1.955134	30.06144	
Plateau	70	1,559	Unbalanced_Reservoir	Elevated	No	Top	Steel	-1.955072	30.06143	
Katabero		1,523	Storage	Semiground	No	Top	Concrete	-1.955524	30.04749	
Mburabuturo	10	1,392	Storage	Underground	No	Bottom	Concrete	-1.955717	30.07244	Pumpist don't have information on reservoir.
Mburabuturo	10	1,391	Storage	Underground	No	Bottom	Concrete	-1.955776	30.07244	
Kimisagara	600	1,430	Storage	Semiground	No	Top	Concrete	-1.944514	30.046	
Kimisagara	600	1,431	Storage	Semiground	No	Top	Concrete	-1.944562	30.04619	

Location_Name	Capacity_m3	Altitude	Reservoir_Function	Reservoir_Position	Presence_of_float_valve_Regulator	Type_of_the_inlet_pipe	Material	Latitude	Longitude	Provide_comment_if_necessary
Kimisagara	600	1,429	Storage	Semiground	No	Top	Concrete	-1.944505	30.04655	
Kimisagara	600	1,429	Storage	Semiground	No	Top	Concrete	-1.944505	30.04673	
Kimisagara	2400	1,433	Storage	Semiground	No	Bottom	Concrete	-1.94471	30.04612	
Nzove	2000	1,365	Storage	Semiground	No	Top	Concrete	-1.942431	30.00134	
Nzove	36	1,364	Storage	Semiground	No	Top	Concrete	-1.942021	30.00058	
Ikanama	400	1,519	Storage	Ground	No	Top	Concrete	-1.950132	30.01967	
Ruyenzi	400	1,508	Storage	Semiground	No	Top	Concrete	-1.950488	29.98565	
Ruyenzi	50	1,576	Storage	Ground	No	Top	Stones	-1.953911	29.99489	
Nzove	250	1,512	Storage	Ground	No	Top	Concrete	-1.935032	30.00693	
Nzove	250	1,527	Storage	Semiground	No	Top	Concrete	-1.928457	30.01463	
Kanyinya	10	1,614	Storage	Ground	Yes	Top	Stones	-1.949965	29.97114	
Nyabitare	50	1,690	Storage	Ground	Yes	Top	Stones	-1.951292	29.96491	
Rubona	400	1,730	Storage	Ground	No	Top	Concrete	-1.937084	29.96573	
Gihara	10	1,550	Storage	Ground	Yes	Top	Concrete	-1.954798	29.97464	
Musebeya	10	1,674	Unbalanced_Reservoir	Ground	Yes	Top	Concrete	-1.951177	29.94268	
Kabagesera	50	1,605	Storage	Ground	Yes	Top	Stones	-1.990849	29.93368	
Munkoto	10	1,559	Unbalanced_Reservoir	Ground	Yes	Top	Concrete	-1.991988	29.94841	
Sheli	2	1,468	Storage	Ground	Yes	Top	Concrete	-1.98708	29.95072	
Sheli	400	1,479	Storage	Ground	Yes	Top	Concrete	-1.944969	30.1038	
Nyarutarama	200	1,508	Storage	Ground	No	Top	Concrete	-1.958752	30.11003	
Chez Lando	400	1,520	Storage	Ground	No	Top	Steel	-1.954136	30.11531	
Remera	600	1,527	Storage	Ground	No	Top	Concrete	-1.951217	30.11953	
Golf 8	1500	1,527	Storage	Ground	No	Top	Concrete	-1.951441	30.11936	
Golf 8	100	1,508	Storage	Ground	No	Top	Stones	-1.928964	30.13413	
Buhoro	30	1,508	Storage	Elevated	No	Top	Concrete	-1.929035	30.13421	
Buhoro	30	1,485	Storage	Underground	No	Top	Concrete	-1.908096	30.12602	
Kinyinya	800	1,524	Storage	Ground	No	Top	Concrete	-1.933368	30.14714	
Mascro bas	800	1,524	Storage	Ground	No	Top	Concrete	-1.933353	30.14734	
Mascro bas	100	1,417	Storage	Underground	No	Bottom	Concrete	-1.918954	30.12857	
Masizi	250	1,469	Storage	Elevated	Yes	Top	Steel	-1.949635	30.15503	
Free zone	250	1,469	Storage	Elevated	Yes	Top	Steel	-1.949778	30.15472	
Free zone	200	1,496	Storage	Ground	No	Top	Concrete	-1.931619	30.11246	
Kibagabaga	27	1,496	Storage	Elevated	Yes	Top	Steel	-1.931302	30.11337	
Kibagabaga	400	1,542	Storage	Ground	No	Top	Concrete	-1.892886	30.15089	
Bumbogo Central st Leonard	800	1,594	Storage	Ground	No	Top	Concrete	-1.928016	30.15534	
Mascro free zone phase 2	150	1,386	Storage	Underground	No	Top	Concrete	-1.988865	30.1188	
Byimana	40	1,386	Storage	Underground	No	Bottom	Concrete	-1.988865	30.1188	
Byimana	600	1,510	Storage	Ground	No	Top	Concrete	-1.985361	30.1021	
Golf seven	600	1,510	Storage	Ground	No	Top	Concrete	-1.985352	30.10224	
Golf seven	75	1,650	Storage	Ground	Yes	Top	Stones	-1.998404	30.09948	
Rwandatel	35	1,625		Ground	No		Stones	-1.996978	30.08842	
Murambi	200	1,531	Storage	Semiground	No	Top	Concrete	-1.980201	30.0767	
Gikondo primaire	400	1,700	Storage	Elevated	Yes		Concrete	-2.003365	30.09739	
Nyenze	100	1,616	Storage	Ground	No		Concrete	-1.987856	30.07194	
Kuri petit prince	5	1,560	Kiosk_Reservoir	Ground	No	Top		-1.984685	30.07233	
Indatwa village	50	1,630	Storage	Semiground	No	Top	Stones	-1.988955	30.06905	
Rebero carrier										

Location_Name	Capacity_m3	Altitude	Reservoir_Function	Reservoir_Position	Presence_of_float_valve_Regulator	Type_of_the_Inlet_pipe	Meterial	Latitude	Longitude	Provide_comment_if_necessary
Rebero	200	1,758	Storage	Semiground	No	Top	Concrete	-1.995583	30.06872	
Golf five	150	1,628	Storage	Semiground	No	Top	Stores	-2.001327	30.05996	
Golf five kimisange	250	1,628	Storage	Underground	No	Top	Concrete	-2.001327	30.05996	
Kmisenge	5	1,544	Kiosk_Reservoir	Ground	No	Top		-1.99534	30.05632	
Nyarurama ku kigega	125	1,658		Elevated	Yes	Top	Concrete	-2.013425	30.06893	
Rebero kuri radari	20	1,809	Storage	Elevated	No	Top	Concrete	-2.007727	30.06436	
Nyarurama	125	1,625	Storage	Ground			Concrete	-2.009556	30.07335	
Umudugudu wa bwiza	10	1,469	Kiosk_Reservoir	Ground	No	Top		-1.991049	30.11329	Tank not reservoir
kumunyinya	5	1,437	Kiosk_Reservoir	Ground	No	Top		-1.977501	30.0916	Material of tank is plastic
Master steel	3	1,448	Kiosk_Reservoir	Ground	No	Top		-1.978484	30.10029	Material of tank is plastic
Nyaruembo	30	1,430	Storage	Ground	Yes	Top	Concrete	-1.969933	30.11876	
Intwari	50	1,471	Kiosk_Reservoir	Ground	No	Top	Stores	-1.975074	30.13642	
Abarezi Samuduha	50	1,476	Kiosk_Reservoir	Ground	No	Top	Stores	-1.9761	30.13545	
Kabeza	20	1,470	Storage	Ground	No	Top	Stores	-1.970691	30.12602	
Beninka	25	1,434	Storage	Ground	Yes	Top	Stores	-1.989079	30.13193	
Rugari	5	1,480	Kiosk_Reservoir	Ground	No	Top	Stores	-1.976475	30.15137	
Kamashashi	100	1,421	Storage	Elevated	Yes	Top	Steel	-1.975249	30.17475	
Rwinyange	10	1,456	Kiosk_Reservoir	Ground	Yes	Top	Stores	-1.959012	30.14031	
Karema	10	1,422	Storage	Ground	No	Top	Stores	-1.991744	30.15955	
Antene	45	1,560	Storage	Ground	Yes	Top	Stores	-1.983566	30.14852	
Antene	50	1,561	Storage	Ground	Yes	Top	Stores	-1.98346	30.1436	
Nezerwa	150	1,468	Storage	Elevated	Yes	Top	Steel	-1.957089	30.16901	
Karema	20	1,470	Storage	Ground	No	Top	Stores	-1.992376	30.14958	
Eymana	20	1,490	Storage	Ground	No	Top	Stores	-1.996659	30.14552	
Radari	20	1,459	Kiosk_Reservoir	Semiground	No	Top	Stores	-1.995619	30.1454	
Cymc	50	1,416	Storage	Semiground	Yes	Top	Concrete	-1.996025	30.19256	
Kigarama	250	1,463	Storage	Elevated	Yes	Top	Steel	-1.977384	30.19917	
Kigarama	250	1,464	Storage	Elevated	Yes	Top	Steel	-1.977397	30.19934	
Kigarama	250	1,463	Storage	Elevated	Yes	Top	Steel	-1.977485	30.19917	
Kigarama	250	1,463	Storage	Elevated	Yes	Top	Steel	-1.977496	30.19934	
Real estate	100	1,442	Storage	Elevated	Yes	Top	Steel	-1.980636	30.20027	
Cymc	150	1,473	Storage	Semiground	Yes	Top	Stores	-1.999979	30.19997	
Ngarama	40	1,350	Kiosk_Reservoir	Ground	Yes	Top	Stores	-2.022517	30.18031	
Kanyetabi	10	1,404	Kiosk_Reservoir	Ground	No	Top	Concrete	-2.024548	30.1954	
Rusheshe	10	1,404	Kiosk_Reservoir	Ground	No	Top	Concrete	-2.032717	30.19288	
Maison des jeune kabuga	100	1,468	Storage	Ground	Yes	Top	Stores	-1.974363	30.22173	
Rebero	15	1,443	Break_Pressure	Ground	No	Top	Stores	-1.997947	30.21678	
Cymc	50	1,563	Break_Pressure	Semiground	Yes	Top	Concrete	-2.001774	30.2112	
Gako	250	1,475	Storage	Semiground	Yes	Top	Concrete	-2.00546	30.22085	
Kagese	30	1,374	Kiosk_Reservoir	Ground	No	Top	Stores	-2.036988	30.20735	
Murambi	3	1,499	Break_Pressure	Ground	Yes	Top	Stores	-2.030841	30.21431	
Cyeru	10	1,421	Break_Pressure	Semiground	Yes	Top	Stores	-2.05745	30.20683	
Cyaruzinge	400	1,564	Storage	Semiground	Yes	Top	Concrete	-1.95116	30.19654	
Ryabahesha	400	1,608	Storage	Ground	Yes	Top	Concrete	-1.967497	30.25747	
Gatsata	10	1,525	Break_Pressure	Ground	No	Top	Stores	-1.969952	30.25136	
Kanyinya	3	1,560	Break_Pressure	Ground	No	Top	Stores	-1.96847	30.27491	

Location_Name	Capacity_m3	Altitude	Reservoir_Function	Reservoir_Position	Presence_of_float_valve_Regulator	Type_of_the_inlet_pipe	Material	Latitude	Longitude	Provide_comment_if_necessary
Kanyinya	10	1.539	Break_Pressure	Semiground	No	Top	Stones	-1.973687	30.27354	
Maremba	10	1.429	Break_Pressure	Ground	Yes	Top	Stones	-1.969151	30.23766	
Gihuke	10	1.403	Storage	Ground	No		Stones	-1.995604	30.22393	The connection pipes have been removed
Golf 10	50	1.505	Storage	Underground	No	Top	Concrete	-1.92987	30.13482	
	125	1.936								
Jali Haut	140	2.055	Storage	Ground		Top				
Karema	2000	1.562	Storage	Underground		Top	Concrete			
Mont Kigali	5000	1.800	Storage	Underground		Bottom	Concrete			
Nzove I	1000	1.370	Storage			Top	Stainless-steel			
	50	1.558								
	150	1.555	Storage	Ground			Concrete			
	250	1.473								
	250	1.711	Storage	Ground						
Ntungamo	200	1.638		Ground						
Kavumu	100	1.532		Ground						
	100	1.459	Storage	Ground	Yes	Top	Concrete			
		1.509								
Nzove I New	2000	1.363		Ground						
Kacyiru Public Library	150	1.430								
	250	1.628								

APPENDIX 18: Water Demand Calculation

(1) Sector-wise population for CoK used in water demand projection

	Sector	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Nyarugenge	Gitega	28,728	28,309	27,889	27,470	27,051	26,631	26,212	25,792	25,373	24,954	24,534	24,115	23,696
	Kanyinya	21,859	22,130	22,401	22,672	22,942	23,213	23,484	23,755	24,026	24,297	24,568	24,839	25,109
	Kigali	30,023	31,548	33,073	34,597	36,122	37,647	39,172	40,696	42,221	43,746	45,271	46,795	48,320
Gasabo	Kimisagara	46,753	45,893	45,033	44,174	43,314	42,454	41,594	40,734	39,874	39,015	38,155	37,295	36,435
	Mageregere	23,407	25,431	27,455	29,479	31,502	33,657	35,670	37,662	39,598	41,486	43,385	45,090	47,032
	Muhima	29,768	29,991	30,214	30,437	30,660	30,934	31,153	31,360	31,552	31,718	31,866	32,029	32,136
	Nyakabanda	25,666	25,486	25,307	25,127	24,947	24,768	24,588	24,409	24,229	24,049	23,870	23,690	23,510
	Nyamirambo	40,292	42,529	44,766	47,004	49,241	51,982	54,178	56,256	58,190	59,846	61,335	62,969	64,043
	Nyarugenge	21,302	22,050	22,797	23,545	24,292	25,208	25,942	26,636	27,282	27,836	28,333	28,879	29,238
	Rwezamenyo	16,763	16,971	17,178	17,386	17,594	17,848	18,052	18,245	18,425	18,579	18,717	18,869	18,968
	Bumbogo	35,381	38,936	42,491	46,046	49,601	53,156	56,711	60,266	63,821	67,376	70,931	74,486	78,041
	Gatsata	37,110	36,563	36,015	35,468	34,921	34,373	33,826	33,279	32,731	32,184	31,637	31,090	30,542
	Gikomero	16,625	16,613	16,602	16,590	16,578	16,566	16,555	16,543	16,531	16,520	16,508	16,496	16,484
	Gisozi	44,003	44,629	45,256	45,882	46,508	47,175	47,798	48,414	49,013	49,598	50,185	50,713	51,314
	Jabana	33,577	34,491	35,404	36,318	37,231	38,145	39,058	39,972	40,885	41,799	42,713	43,626	44,540
	Jali	25,057	25,363	25,669	25,974	26,280	26,586	26,892	27,197	27,503	27,809	28,115	28,420	28,726
	Kacyiru	37,088	37,609	38,129	38,650	39,170	39,752	40,268	40,770	41,252	41,704	42,142	42,566	42,975
	Kimihurura	21,672	22,144	22,617	23,089	23,561	24,140	24,603	25,042	25,450	25,800	26,114	26,459	26,686
	Kimironko	57,430	62,509	67,588	72,667	77,746	83,970	88,955	93,673	98,063	101,824	105,205	108,913	111,351
	Kinyinya	57,846	63,458	69,071	74,683	80,295	86,574	92,132	97,548	102,745	107,613	112,342	116,910	121,325
	Ndera	41,764	48,780	55,796	62,812	69,828	78,411	85,077	91,550	97,893	103,089	108,697	113,833	120,286
	Nduba	25,370	26,234	27,099	27,963	28,828	29,692	30,557	31,421	32,286	33,150	34,015	34,879	35,744
	Remera	43,279	45,862	48,444	51,027	53,610	56,775	59,310	61,709	63,941	65,853	67,572	69,458	70,698
	Rusororo	35,453	45,247	55,041	64,835	74,629	85,586	95,284	104,736	113,804	122,300	130,553	138,524	146,228
	Rutunga	17,906	18,275	18,644	19,012	19,381	19,750	20,119	20,488	20,856	21,225	21,594	21,963	22,331
Kicukiro	Gahanga	27,808	34,011	40,214	46,416	52,619	60,207	66,101	71,824	77,431	82,025	86,983	91,523	97,229
	Gatenga	48,640	49,272	49,904	50,536	51,168	51,841	52,470	53,092	53,696	54,286	54,879	55,411	56,018
	Gikondo	17,146	17,935	18,725	19,514	20,303	21,270	22,045	22,778	23,460	24,045	24,570	25,146	25,525
	Kagarama	14,385	19,665	24,945	30,224	35,504	41,974	47,156	52,060	56,623	60,533	64,047	67,903	70,437
	Kanombe	44,426	50,369	56,311	62,254	68,196	74,845	80,729	86,464	91,966	97,121	102,128	106,965	111,639
	Kicukiro	16,450	17,014	17,579	18,143	18,708	19,400	19,954	20,478	20,966	21,384	21,759	22,172	22,443
	Kigarama	43,907	44,592	45,278	45,963	46,648	47,488	48,160	48,797	49,389	49,897	50,353	50,853	51,182
	Masaka	39,548	43,562	47,576	51,590	55,603	60,267	64,105	67,886	71,659	74,935	78,534	81,724	85,991
	Niboye	26,197	27,402	28,606	29,811	31,016	32,364	33,556	34,719	35,834	36,879	37,894	38,875	39,823
	Nyarugunga	40,057	42,561	45,066	47,570	50,075	52,877	55,357	57,774	60,093	62,265	64,376	66,414	68,384
	Total	1,132,686	1,203,433	1,274,180	1,344,927	1,415,675	1,497,528	1,566,821	1,634,025	1,698,663	1,756,739	1,813,880	1,869,894	1,924,429

	Sector	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Nyarugenge	Gitega	23,276	22,857	22,437	22,018	21,599	21,179	20,760	20,341	19,921	19,502	19,083	18,663	18,244
	Kanyinya	25,380	25,651	25,922	26,193	26,464	26,735	27,006	27,276	27,547	27,818	28,089	28,360	28,631
	Kigali	49,845	51,370	52,894	54,419	55,944	57,469	58,994	60,518	62,043	63,568	65,093	66,617	68,142
	Kimisagara	35,575	34,716	33,856	32,996	32,136	31,276	30,417	29,557	28,697	27,837	26,977	26,117	25,258
	Mageregere	49,115	51,343	53,721	56,251	58,934	61,769	64,754	67,886	71,160	74,566	78,096	81,738	85,478
	Muhima	32,242	32,346	32,449	32,549	32,646	32,740	32,830	32,917	32,999	33,078	33,153	33,223	33,289
	Nyakabanda	23,331	23,151	22,972	22,792	22,612	22,433	22,253	22,073	21,894	21,714	21,534	21,355	21,175
	Nyamirambo	65,106	66,153	67,180	68,182	69,155	70,096	71,002	71,871	72,700	73,489	74,237	74,943	75,608
	Nyarugenge	29,593	29,943	30,286	30,621	30,946	31,261	31,563	31,854	32,131	32,394	32,644	32,880	33,102
	Rwezamenyo	19,067	19,164	19,260	19,353	19,443	19,530	19,615	19,695	19,772	19,845	19,915	19,980	20,042
Gasabo	Bumbogo	81,596	85,151	88,706	92,261	95,816	99,371	102,927	106,482	110,037	113,592	117,147	120,702	124,257
	Gatsata	29,995	29,448	28,900	28,353	27,806	27,258	26,711	26,164	25,616	25,069	24,522	23,974	23,427
	Gikomero	16,473	16,461	16,449	16,438	16,426	16,414	16,403	16,391	16,379	16,367	16,356	16,344	16,332
	Gisozi	51,958	52,648	53,384	54,167	54,997	55,874	56,798	57,767	58,780	59,834	60,927	62,054	63,211
	Jabana	45,453	46,367	47,280	48,194	49,107	50,021	50,935	51,848	52,762	53,675	54,589	55,502	56,416
	Jali	29,032	29,338	29,643	29,949	30,255	30,561	30,867	31,172	31,478	31,784	32,090	32,395	32,701
	Kacyiru	43,402	43,846	44,304	44,777	45,260	45,754	46,255	46,760	47,269	47,777	48,283	48,783	49,276
	Kimihurura	26,910	27,131	27,348	27,560	27,765	27,964	28,155	28,338	28,513	28,680	28,838	28,987	29,127
	Kimironko	113,764	116,142	118,473	120,748	122,958	125,094	127,151	129,123	131,006	132,797	134,495	136,098	137,608
	Kinyinya	125,929	130,712	135,657	140,748	145,965	151,286	156,686	162,139	167,620	173,100	178,552	183,950	189,268
	Ndera	127,209	134,617	142,521	150,929	159,845	169,268	179,191	189,601	200,481	211,803	223,536	235,640	248,072
	Nduba	36,608	37,473	38,337	39,202	40,066	40,931	41,795	42,659	43,524	44,388	45,253	46,117	46,982
	Remera	71,925	73,134	74,320	75,476	76,600	77,686	78,732	79,735	80,693	81,604	82,467	83,282	84,049
	Rusororo	154,263	162,609	171,239	180,123	189,227	198,512	207,935	217,452	227,016	236,579	246,094	255,514	264,794
	Rutunga	22,700	23,069	23,438	23,807	24,175	24,544	24,913	25,282	25,651	26,019	26,388	26,757	27,126
Kicukiro	Gahanga	103,349	109,898	116,886	124,319	132,202	140,533	149,305	158,509	168,128	178,137	188,510	199,212	210,202
	Gatenga	56,668	57,364	58,107	58,897	59,734	60,620	61,552	62,530	63,552	64,616	65,718	66,856	68,024
	Gikondo	25,900	26,270	26,632	26,986	27,329	27,661	27,981	28,287	28,580	28,858	29,122	29,371	29,606
	Kagarama	72,945	75,417	77,840	80,205	82,502	84,723	86,861	88,911	90,869	92,731	94,495	96,162	97,731
	Kanombe	116,515	121,578	126,815	132,205	137,729	143,363	149,081	154,855	160,658	166,460	172,234	177,949	183,580
	Kicukiro	22,711	22,975	23,234	23,487	23,732	23,970	24,198	24,418	24,627	24,826	25,015	25,193	25,361
	Kigarama	51,508	51,829	52,143	52,450	52,748	53,036	53,314	53,580	53,834	54,076	54,305	54,521	54,725
	Masaka	90,672	95,802	101,419	107,565	114,282	121,616	129,612	138,321	147,791	158,074	169,220	181,280	194,303
	Niboye	40,811	41,837	42,899	43,992	45,112	46,254	47,413	48,583	49,760	50,936	52,106	53,265	54,406
	Nyarugunga	70,439	72,573	74,780	77,052	79,380	81,754	84,164	86,597	89,043	91,488	93,922	96,330	98,704
	Total	1,981,267	2,040,382	2,101,732	2,165,262	2,230,898	2,298,554	2,368,125	2,439,494	2,512,529	2,587,083	2,663,001	2,740,117	2,818,257

	Sector	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Nyarugenge	Gitega	17,824	17,405	16,986	16,566	16,147	15,728	15,308	14,889	14,469	14,050	13,631	13,211	12,792
	Kanyinya	28,902	29,172	29,443	29,714	29,985	30,256	30,527	30,798	31,069	31,339	31,610	31,881	32,152
	Kigali	69,667	71,192	72,716	74,241	75,766	77,291	78,815	80,340	81,865	83,390	84,914	86,439	87,964
	Kimisagara	24,398	23,538	22,678	21,818	20,959	20,099	19,239	18,379	17,519	16,659	15,800	14,940	14,080
	Mageregere	89,301	93,190	97,127	101,093	105,067	109,031	112,965	116,849	120,666	124,398	128,032	131,552	134,948
	Muhima	33,351	33,410	33,464	33,515	33,561	33,605	33,645	33,682	33,717	33,748	33,777	33,804	33,828
	Nyakabanda	20,996	20,816	20,636	20,457	20,277	20,097	19,918	19,738	19,559	19,379	19,199	19,020	18,840
	Nyamirambo	76,232	76,816	77,361	77,868	78,339	78,776	79,179	79,552	79,895	80,211	80,502	80,768	81,012
	Nyarugenge	33,311	33,506	33,688	33,857	34,015	34,161	34,296	34,420	34,535	34,640	34,737	34,826	34,908
	Rwezamenyo	20,100	20,154	20,205	20,252	20,296	20,336	20,374	20,408	20,440	20,470	20,497	20,521	20,544
Gasabo	Bumbogo	127,812	131,367	134,922	138,477	142,032	145,587	149,142	152,697	156,252	159,807	163,362	166,917	170,472
	Gatsata	22,880	22,332	21,785	21,238	20,691	20,143	19,596	19,049	18,501	17,954	17,407	16,859	16,312
	Gikomero	16,321	16,309	16,297	16,285	16,274	16,262	16,250	16,239	16,227	16,215	16,203	16,192	16,180
	Gisozi	64,394	65,598	66,816	68,043	69,273	70,500	71,717	72,919	74,100	75,255	76,380	77,469	78,520
	Jabana	57,329	58,243	59,156	60,070	60,984	61,897	62,811	63,724	64,638	65,551	66,465	67,378	68,292
	Jali	33,007	33,313	33,618	33,924	34,230	34,536	34,841	35,147	35,453	35,759	36,064	36,370	36,676
	Kacyiru	49,760	50,232	50,690	51,133	51,560	51,969	52,359	52,730	53,082	53,415	53,728	54,021	54,296
	Kimihurura	29,259	29,382	29,497	29,604	29,704	29,796	29,881	29,960	30,032	30,099	30,160	30,216	30,268
	Kimironko	139,024	140,350	141,587	142,738	143,808	144,799	145,715	146,561	147,341	148,058	148,717	149,322	149,876
	Kinyinya	194,482	199,570	204,511	209,288	213,887	218,297	222,506	226,511	230,306	233,890	237,263	240,429	243,392
	Ndera	260,778	273,704	286,789	299,970	313,180	326,355	339,430	352,340	365,026	377,432	389,508	401,209	412,496
	Nduba	47,846	48,711	49,575	50,440	51,304	52,169	53,033	53,898	54,762	55,627	56,491	57,356	58,220
	Remera	84,770	85,444	86,073	86,658	87,202	87,706	88,172	88,603	88,999	89,364	89,699	90,006	90,288
	Rusororo	273,893	282,771	291,393	299,730	307,756	315,451	322,797	329,785	336,407	342,662	348,549	354,074	359,244
	Rutunga	27,495	27,863	28,232	28,601	28,970	29,338	29,707	30,076	30,445	30,814	31,182	31,551	31,920
Kicukiro	Gahanga	221,436	232,864	244,432	256,085	267,764	279,412	290,971	302,385	313,600	324,569	335,245	345,589	355,568
	Gatenga	69,217	70,432	71,661	72,900	74,141	75,379	76,607	77,820	79,012	80,178	81,312	82,412	83,472
	Gikondo	29,826	30,032	30,224	30,403	30,569	30,723	30,865	30,997	31,118	31,230	31,332	31,426	31,512
	Kagarama	99,203	100,581	101,867	103,064	104,176	105,206	106,159	107,038	107,849	108,595	109,280	109,908	110,484
	Kanombe	189,101	194,487	199,719	204,778	209,648	214,316	218,774	223,014	227,032	230,827	234,399	237,751	240,888
	Kicukiro	25,518	25,665	25,803	25,931	26,050	26,160	26,262	26,356	26,442	26,522	26,595	26,662	26,724
	Kigarama	54,916	55,095	55,262	55,417	55,561	55,695	55,819	55,933	56,038	56,135	56,224	56,305	56,380
	Masaka	208,337	223,424	239,605	256,913	275,373	295,004	315,812	337,794	360,933	385,198	410,543	436,906	464,212
	Niboye	55,526	56,618	57,678	58,704	59,691	60,637	61,541	62,400	63,215	63,984	64,708	65,388	66,024
	Nyarugunga	101,030	103,300	105,505	107,637	109,690	111,657	113,536	115,323	117,016	118,616	120,121	121,534	122,856
	Total	2,897,240	2,976,884	3,057,003	3,137,412	3,217,928	3,298,372	3,378,570	3,458,354	3,537,562	3,616,038	3,693,637	3,770,215	3,845,640

Source: JST (based on Census 2012 for population in 2012 and Information shared by CoK M/P side through WASAC for population in 2050)

(2). Sector-wise population for City of Kigali (total with urban vs rural)

Population (Urban)

	Sector	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Nyarugenge	Gitega	28,728	28,309	27,889	27,470	27,051	26,631	26,212	25,792	25,373	24,954	24,534	24,115	23,696
	Kanyinya	0	582	1,179	1,790	2,415	3,054	3,708	4,376	5,058	5,755	6,465	7,190	7,929
	Kigali	4,748	5,688	6,696	7,771	8,914	10,124	11,402	12,747	14,160	15,641	17,189	18,804	20,487
	Kimisagara	46,753	45,893	45,033	44,174	43,314	42,454	41,594	40,734	39,874	39,015	38,155	37,295	36,435
	Mageregere	0	669	1,445	2,327	3,316	4,429	5,632	6,938	8,336	9,826	11,417	13,052	14,852
	Muhima	29,768	29,991	30,214	30,437	30,660	30,934	31,153	31,360	31,552	31,718	31,866	32,029	32,136
	Nyakabanda	25,666	25,486	25,307	25,127	24,947	24,768	24,588	24,409	24,229	24,049	23,870	23,690	23,510
	Nyamirambo	40,292	42,529	44,766	47,004	49,241	51,982	54,178	56,256	58,190	59,846	61,335	62,969	64,043
	Nyarugenge	21,302	22,050	22,797	23,545	24,292	25,208	25,942	26,636	27,282	27,836	28,333	28,879	29,238
	Rwezamenyo	16,763	16,971	17,178	17,386	17,594	17,848	18,052	18,245	18,425	18,579	18,717	18,869	18,968
Gasabo	Bumbogo	4,246	5,574	7,067	8,725	10,547	12,534	14,686	17,002	19,483	22,128	24,938	27,913	31,053
	Gatsata	37,110	36,563	36,015	35,468	34,921	34,373	33,826	33,279	32,731	32,184	31,637	31,090	30,542
	Gikomero	0	437	874	1,310	1,745	2,180	2,614	3,047	3,480	3,913	4,344	4,775	5,206
	Gisozi	44,003	44,629	45,256	45,882	46,508	47,175	47,798	48,414	49,013	49,598	50,185	50,713	51,314
	Jabana	9,271	10,180	11,124	12,103	13,117	14,165	15,249	16,367	17,520	18,708	19,930	21,187	22,480
	Jali	3,808	4,420	5,047	5,686	6,340	7,007	7,688	8,382	9,090	9,812	10,547	11,296	12,058
	Kacyiru	37,088	37,609	38,129	38,650	39,170	39,752	40,268	40,770	41,252	41,704	42,142	42,566	42,975
	Kimihurura	21,672	22,144	22,617	23,089	23,561	24,140	24,603	25,042	25,450	25,800	26,114	26,459	26,686
	Kimironko	57,430	62,509	67,588	72,667	77,746	83,970	88,955	93,673	98,063	101,824	105,205	108,913	111,351
	Kinyinya	53,162	58,455	63,772	69,113	74,478	80,487	85,849	91,104	96,177	100,963	105,639	110,184	114,603
	Ndera	33,469	39,347	45,297	51,322	57,419	64,886	70,847	76,717	82,543	87,464	92,790	97,768	103,940
	Nduba	0	690	1,426	2,208	3,035	3,907	4,825	5,788	6,797	7,851	8,951	10,097	11,287
	Remera	43,279	45,862	48,444	51,027	53,610	56,775	59,310	61,709	63,941	65,853	67,572	69,458	70,698
	Rusororo	20,833	27,079	33,538	40,209	47,093	54,936	62,195	69,501	76,754	83,811	90,883	97,936	104,969
	Rutunga	0	481	981	1,501	2,040	2,599	3,177	3,774	4,391	5,027	5,683	6,358	7,052
Kicukiro	Gahanga	11,698	14,826	18,143	21,649	25,344	29,917	33,853	37,879	42,017	45,760	49,852	53,850	58,689
	Gatenga	46,306	46,970	47,635	48,302	48,971	49,681	50,349	51,013	51,662	52,298	52,938	53,522	54,178
	Gikondo	17,146	17,935	18,725	19,514	20,303	21,270	22,045	22,778	23,460	24,045	24,570	25,146	25,525
	Kagarama	14,385	19,665	24,945	30,224	35,504	41,974	47,156	52,060	56,623	60,533	64,047	67,903	70,437
	Kanombe	44,426	50,369	56,311	62,254	68,196	74,845	80,729	86,464	91,966	97,121	102,128	106,965	111,639
	Kicukiro	16,450	17,014	17,579	18,143	18,708	19,400	19,954	20,478	20,966	21,384	21,759	22,172	22,443
	Kigarama	43,907	44,592	45,278	45,963	46,648	47,488	48,160	48,797	49,389	49,897	50,353	50,853	51,182
	Masaka	19,369	21,920	24,578	27,345	30,219	33,562	36,561	39,628	42,793	45,756	49,008	52,096	55,971
	Niboye	26,197	27,402	28,606	29,811	31,016	32,364	33,556	34,719	35,834	36,879	37,894	38,875	39,823
	Nyarugunga	40,057	42,561	45,066	47,570	50,075	52,877	55,357	57,774	60,093	62,265	64,376	66,414	68,384
	Total (Urban)	859,332	917,402	976,547	1,036,765	1,098,057	1,169,696	1,232,070	1,293,652	1,353,968	1,409,794	1,465,369	1,521,402	1,575,780

Population (Urban)

	Sector	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Nyarugenge	Gitega	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kanyinya	21,859	21,548	21,222	20,882	20,527	20,159	19,776	19,379	18,968	18,542	18,103	17,648	17,180
	Kigali	25,275	25,860	26,377	26,826	27,209	27,523	27,770	27,949	28,061	28,105	28,082	27,991	27,833
	Kimisagara	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mageregere	23,407	24,762	26,010	27,151	28,186	29,229	30,038	30,724	31,261	31,660	31,968	32,038	32,180
	Muhima	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyakabanda	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyamirambo	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyarugenge	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rwezamenyo	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasabo	Bumbogo	31,135	33,362	35,424	37,321	39,054	40,622	42,026	43,264	44,339	45,248	45,993	46,573	46,989
	Gatsata	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gikomero	16,625	16,176	15,728	15,280	14,833	14,387	13,941	13,496	13,051	12,607	12,164	11,721	11,279
	Gisozi	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jabana	24,306	24,310	24,280	24,214	24,114	23,979	23,810	23,605	23,366	23,091	22,782	22,439	22,060
	Jali	21,249	20,942	20,622	20,288	19,940	19,579	19,204	18,815	18,413	17,997	17,568	17,125	16,668
	Kacyiru	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kimihurura	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kimironko	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kinyinya	4,684	5,003	5,299	5,570	5,817	6,088	6,282	6,444	6,568	6,650	6,703	6,726	6,722
	Ndera	8,295	9,434	10,499	11,491	12,409	13,524	14,230	14,834	15,350	15,626	15,908	16,064	16,346
	Nduba	25,370	25,544	25,673	25,756	25,793	25,785	25,732	25,633	25,489	25,299	25,063	24,783	24,456
	Remera	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusororo	14,620	18,168	21,503	24,626	27,536	30,650	33,089	35,234	37,050	38,489	39,669	40,588	41,259
	Rutunga	17,906	17,794	17,662	17,511	17,341	17,151	16,942	16,714	16,466	16,198	15,911	15,605	15,279
Kicukiro	Gahanga	16,110	19,185	22,071	24,768	27,275	30,290	32,248	33,945	35,414	36,265	37,131	37,674	38,540
	Gatenga	2,334	2,302	2,269	2,234	2,197	2,160	2,120	2,078	2,034	1,988	1,940	1,889	1,839
	Gikondo	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kagarama	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kanombe	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kicukiro	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kigarama	0	0	0	0	0	0	0	0	0	0	0	0	0
	Masaka	20,179	21,642	22,997	24,245	25,385	26,704	27,544	28,257	28,866	29,179	29,526	29,628	30,021
	Niboye	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyarugunga	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (Rural)	273,354	286,031	297,634	308,163	317,617	327,832	334,751	340,372	344,695	346,946	348,511	348,492	348,650

(Continued)

Population (Urban)

	Sector	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Nyarugenge	Gitega	23,276	22,857	22,437	22,018	21,599	21,179	20,760	20,341	19,921	19,502	19,083	18,663	18,244
	Kanyinya	8,683	9,450	10,232	11,029	11,839	12,664	13,503	14,356	15,223	16,105	17,001	17,911	18,836
	Kigali	22,238	24,057	25,942	27,896	29,917	32,005	34,162	36,385	38,676	41,035	43,462	45,955	48,517
	Kimisagara	35,575	34,716	33,856	32,996	32,136	31,276	30,417	29,557	28,697	27,837	26,977	26,117	25,258
	Mageregere	16,802	18,916	21,206	23,685	26,365	29,259	32,377	35,730	39,325	43,170	47,269	51,624	56,236
	Muhima	32,242	32,346	32,449	32,549	32,646	32,740	32,830	32,917	32,999	33,078	33,153	33,223	33,289
	Nyakabanda	23,331	23,151	22,972	22,792	22,612	22,433	22,253	22,073	21,894	21,714	21,534	21,355	21,175
	Nyamirambo	65,106	66,153	67,180	68,182	69,155	70,096	71,002	71,871	72,700	73,489	74,237	74,943	75,608
	Nyarugenge	29,593	29,943	30,286	30,621	30,946	31,261	31,563	31,854	32,131	32,394	32,644	32,880	33,102
	Rwezamenyo	19,067	19,164	19,260	19,353	19,443	19,530	19,615	19,695	19,772	19,845	19,915	19,980	20,042
Gasabo	Bumbogo	34,357	37,826	41,459	45,257	49,220	53,347	57,639	62,096	66,717	71,503	76,454	81,569	86,849
	Gatsata	29,995	29,448	28,900	28,353	27,806	27,258	26,711	26,164	25,616	25,069	24,522	23,974	23,427
	Gikomero	5,635	6,065	6,493	6,921	7,348	7,775	8,201	8,627	9,052	9,476	9,899	10,322	10,745
	Gisozi	51,958	52,648	53,384	54,167	54,997	55,874	56,798	57,767	58,780	59,834	60,927	62,054	63,211
	Jabana	23,806	25,168	26,565	27,996	29,462	30,963	32,499	34,070	35,675	37,315	38,990	40,700	42,445
	Jali	12,835	13,625	14,428	15,245	16,076	16,921	17,779	18,650	19,536	20,435	21,348	22,274	23,214
	Kacyiru	43,402	43,846	44,304	44,777	45,260	45,754	46,255	46,760	47,269	47,777	48,283	48,783	49,276
	Kimihurura	26,910	27,131	27,348	27,560	27,765	27,964	28,155	28,338	28,513	28,680	28,838	28,987	29,127
	Kimironko	113,764	116,142	118,473	120,748	122,958	125,094	127,151	129,123	131,006	132,797	134,495	136,098	137,608
	Kinyinya	119,221	124,027	129,008	134,150	139,433	144,838	150,342	155,920	161,548	167,198	172,845	178,463	184,025
	Ndera	110,587	117,730	125,388	133,574	142,300	151,573	161,396	171,763	182,667	194,090	206,010	218,398	231,216
	Nduba	12,524	13,806	15,133	16,506	17,924	19,388	20,898	22,452	24,053	25,699	27,390	29,127	30,909
	Remera	71,925	73,134	74,320	75,476	76,600	77,686	78,732	79,735	80,693	81,604	82,467	83,282	84,049
	Rusororo	112,411	120,257	128,498	137,120	146,104	155,427	165,061	174,976	185,135	195,501	206,035	216,694	227,438
	Rutunga	7,766	8,499	9,252	10,024	10,815	11,626	12,457	13,306	14,175	15,064	15,972	16,899	17,846
Kicukiro	Gahanga	63,959	69,687	75,900	82,623	89,877	97,683	106,057	115,011	124,553	134,685	145,401	156,693	168,542
	Gatenga	54,879	55,625	56,419	57,260	58,150	59,089	60,075	61,109	62,188	63,310	64,473	65,674	66,907
	Gikondo	25,900	26,270	26,632	26,986	27,329	27,661	27,981	28,287	28,580	28,858	29,122	29,371	29,606
	Kagarama	72,945	75,417	77,840	80,205	82,502	84,723	86,861	88,911	90,869	92,731	94,495	96,162	97,731
	Kanombe	116,515	121,578	126,815	132,205	137,729	143,363	149,081	154,855	160,658	166,460	172,234	177,949	183,580
	Kicukiro	22,711	22,975	23,234	23,487	23,732	23,970	24,198	24,418	24,627	24,826	25,015	25,193	25,361
	Kigarama	51,508	51,829	52,143	52,450	52,748	53,036	53,314	53,580	53,834	54,076	54,305	54,521	54,725
	Masaka	60,235	64,929	70,098	75,790	82,057	88,956	96,546	104,890	114,055	124,113	135,137	147,202	160,386
	Niboye	40,811	41,837	42,899	43,992	45,112	46,254	47,413	48,583	49,760	50,936	52,106	53,265	54,406
	Nyarugunga	70,439	72,573	74,780	77,052	79,380	81,754	84,164	86,597	89,043	91,488	93,922	96,330	98,704
	Total (Urban)	1,632,912	1,692,825	1,755,533	1,821,042	1,889,344	1,960,421	2,034,243	2,110,768	2,189,941	2,271,697	2,355,958	2,442,638	2,531,640

Population (Urban)

	Sector	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Nyarugenge	Gitega	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kanyinya	16,698	16,201	15,690	15,164	14,625	14,071	13,503	12,920	12,324	11,713	11,088	10,448	9,795
	Kigali	27,607	27,313	26,952	26,523	26,027	25,463	24,832	24,133	23,367	22,533	21,631	20,662	19,625
	Kimisagara	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mageregere	32,312	32,427	32,516	32,566	32,569	32,510	32,377	32,157	31,835	31,396	30,827	30,114	29,243
	Muhima	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyakabanda	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyamirambo	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyarugenge	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rwezamenyo	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasabo	Bumbogo	47,240	47,326	47,247	47,004	46,597	46,024	45,287	44,386	43,319	42,088	40,693	39,132	37,407
	Gatsata	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gikomero	10,837	10,396	9,956	9,517	9,077	8,639	8,201	7,764	7,327	6,892	6,456	6,021	5,587
	Gisozi	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jabana	21,647	21,199	20,716	20,198	19,645	19,058	18,435	17,778	17,087	16,360	15,598	14,802	13,971
	Jali	16,197	15,713	15,215	14,704	14,179	13,640	13,088	12,522	11,942	11,349	10,742	10,121	9,487
	Kacyiru	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kimihurura	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kimironko	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kinyinya	6,709	6,685	6,649	6,598	6,532	6,447	6,344	6,219	6,072	5,902	5,707	5,488	5,243
	Ndera	16,622	16,887	17,133	17,355	17,545	17,694	17,795	17,838	17,814	17,713	17,525	17,243	16,856
	Nduba	24,084	23,667	23,204	22,696	22,142	21,542	20,898	20,207	19,471	18,690	17,863	16,991	16,073
	Remera	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusororo	41,852	42,351	42,741	43,003	43,123	43,085	42,874	42,476	41,881	41,078	40,059	38,820	37,356
	Rutunga	14,934	14,570	14,186	13,783	13,360	12,918	12,457	11,976	11,475	10,956	10,416	9,858	9,280
Kicukiro	Gahanga	39,390	40,211	40,986	41,697	42,325	42,850	43,249	43,498	43,574	43,453	43,109	42,519	41,660
	Gatenga	1,789	1,738	1,688	1,636	1,584	1,531	1,477	1,421	1,364	1,306	1,245	1,182	1,117
	Gikondo	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kagarama	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kanombe	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kicukiro	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kigarama	0	0	0	0	0	0	0	0	0	0	0	0	0
	Masaka	30,437	30,873	31,321	31,775	32,225	32,660	33,067	33,431	33,736	33,960	34,083	34,078	33,917
	Niboye	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyarugunga	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (Rural)	348,355	347,557	346,199	344,220	341,554	338,133	333,882	328,726	322,588	315,386	307,043	297,479	286,617

(Continued)

Population (Urban)

	Sector	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Nyarugenge	Gitega	17,824	17,405	16,986	16,566	16,147	15,728	15,308	14,889	14,469	14,050	13,631	13,211	12,792
	Kanyinya	19,775	20,728	21,695	22,677	23,672	24,682	25,707	26,745	27,798	28,865	29,947	31,042	32,152
	Kigali	51,146	53,843	56,607	59,438	62,338	65,305	68,339	71,441	74,610	77,847	81,152	84,524	87,964
	Kimisagara	24,398	23,538	22,678	21,818	20,959	20,099	19,239	18,379	17,519	16,659	15,800	14,940	14,080
	Mageregere	61,101	66,214	71,567	77,150	82,948	88,946	95,128	101,474	107,964	114,578	121,293	128,090	134,948
	Muhima	33,351	33,410	33,464	33,515	33,561	33,605	33,645	33,682	33,717	33,748	33,777	33,804	33,828
	Nyakabanda	20,996	20,816	20,636	20,457	20,277	20,097	19,918	19,738	19,559	19,379	19,199	19,020	18,840
	Nyamirambo	76,232	76,816	77,361	77,868	78,339	78,776	79,179	79,552	79,895	80,211	80,502	80,768	81,012
	Nyarugenge	33,311	33,506	33,688	33,857	34,015	34,161	34,296	34,420	34,535	34,640	34,737	34,826	34,908
	Rwezamenyo	20,100	20,154	20,205	20,252	20,296	20,336	20,374	20,408	20,440	20,470	20,497	20,521	20,544
Gasabo	Bumbogo	92,294	97,903	103,677	109,616	115,719	121,987	128,419	135,016	141,778	148,705	155,796	163,052	170,472
	Gatsata	22,880	22,332	21,785	21,238	20,691	20,143	19,596	19,049	18,501	17,954	17,407	16,859	16,312
	Gikomero	11,167	11,588	12,008	12,428	12,848	13,266	13,684	14,102	14,519	14,935	15,351	15,766	16,180
	Gisozi	64,394	65,598	66,816	68,043	69,273	70,500	71,717	72,919	74,100	75,255	76,380	77,469	78,520
	Jabana	44,224	46,038	47,887	49,771	51,690	53,643	55,632	57,655	59,712	61,805	63,933	66,095	68,292
	Jali	24,168	25,135	26,116	27,111	28,119	29,141	30,176	31,225	32,288	33,365	34,455	35,559	36,676
	Kacyiru	49,760	50,232	50,690	51,133	51,560	51,969	52,359	52,730	53,082	53,415	53,728	54,021	54,296
	Kimihurura	29,259	29,382	29,497	29,604	29,704	29,796	29,881	29,960	30,032	30,099	30,160	30,216	30,268
	Kimironko	139,024	140,350	141,587	142,738	143,808	144,799	145,715	146,561	147,341	148,058	148,717	149,322	149,876
	Kinyinya	189,509	194,892	200,153	205,274	210,241	215,040	219,662	224,097	228,343	232,394	236,252	239,917	243,392
	Ndera	244,422	257,968	271,799	285,859	300,085	314,415	328,785	343,132	357,394	371,514	385,436	399,112	412,496
	Nduba	32,737	34,610	36,529	38,493	40,503	42,559	44,660	46,806	48,998	51,235	53,518	55,846	58,220
	Remera	84,770	85,444	86,073	86,658	87,202	87,706	88,172	88,603	88,999	89,364	89,699	90,006	90,288
	Rusororo	238,225	249,016	259,771	270,456	281,038	291,488	301,779	311,891	321,805	331,506	340,984	350,232	359,244
	Rutunga	18,812	19,798	20,803	21,827	22,871	23,934	25,017	26,119	27,240	28,381	29,541	30,721	31,920
Kicukiro	Gahanga	180,925	193,812	207,167	220,947	235,106	249,594	264,355	279,335	294,476	309,724	325,023	340,321	355,568
	Gatenga	68,169	69,454	70,756	72,071	73,392	74,712	76,027	77,329	78,613	79,874	81,107	82,307	83,472
	Gikondo	29,826	30,032	30,224	30,403	30,569	30,723	30,865	30,997	31,118	31,230	31,332	31,426	31,512
	Kagarama	99,203	100,581	101,867	103,064	104,176	105,206	106,159	107,038	107,849	108,595	109,280	109,908	110,484
	Kanombe	189,101	194,487	199,719	204,778	209,648	214,316	218,774	223,014	227,032	230,827	234,399	237,751	240,888
	Kicukiro	25,518	25,665	25,803	25,931	26,050	26,160	26,262	26,356	26,442	26,522	26,595	26,662	26,724
	Kigarama	54,916	55,095	55,262	55,417	55,561	55,695	55,819	55,933	56,038	56,135	56,224	56,305	56,380
	Masaka	174,768	190,424	207,432	225,866	245,793	267,276	290,369	315,116	341,548	369,681	399,518	431,040	464,212
	Niboye	55,526	56,618	57,678	58,704	59,691	60,637	61,541	62,400	63,215	63,984	64,708	65,388	66,024
	Nyarugunga	101,030	103,300	105,505	107,637	109,690	111,657	113,536	115,323	117,016	118,616	120,121	121,534	122,856
	Total (Urban)	2,622,859	2,716,182	2,811,492	2,908,666	3,007,577	3,108,096	3,210,093	3,313,434	3,417,988	3,523,620	3,630,197	3,737,582	3,845,640

Population (Urban)

	Sector	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Nyarugenge	Gitega	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kanyinya	9,127	8,445	7,748	7,038	6,313	5,573	4,820	4,052	3,270	2,474	1,664	839	0
	Kigali	18,521	17,349	16,110	14,803	13,428	11,986	10,476	8,899	7,255	5,542	3,762	1,915	0
	Kimisagara	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mageregere	28,200	26,976	25,560	23,943	22,119	20,085	17,837	15,375	12,702	9,821	6,739	3,462	0
	Muhima	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyakabanda	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyamirambo	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyarugenge	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rwezamenyo	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasabo	Bumbogo	35,518	33,464	31,245	28,861	26,313	23,600	20,723	17,681	14,474	11,102	7,566	3,865	0
	Gatsata	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gikomero	5,154	4,721	4,289	3,857	3,426	2,996	2,566	2,137	1,708	1,280	853	426	0
	Gisozi	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jabana	13,105	12,205	11,269	10,299	9,294	8,254	7,179	6,070	4,925	3,746	2,532	1,284	0
	Jali	8,839	8,178	7,502	6,814	6,111	5,395	4,665	3,922	3,165	2,394	1,610	812	0
	Kacyiru	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kimihurura	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kimironko	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kinyinya	4,973	4,678	4,358	4,014	3,646	3,256	2,845	2,413	1,963	1,495	1,011	512	0
	Ndera	16,356	15,736	14,990	14,111	13,095	11,940	10,645	9,208	7,632	5,918	4,072	2,097	0
	Nduba	15,109	14,100	13,046	11,946	10,801	9,610	8,374	7,092	5,764	4,392	2,973	1,509	0
	Remera	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusororo	35,667	33,755	31,622	29,274	26,718	23,963	21,018	17,894	14,603	11,156	7,565	3,842	0
	Rutunga	8,682	8,066	7,430	6,774	6,099	5,404	4,691	3,957	3,205	2,433	1,641	830	0
Kicukiro	Gahanga	40,511	39,051	37,265	35,137	32,658	29,818	26,616	23,050	19,124	14,845	10,222	5,269	0
	Gatenga	1,049	978	905	828	749	666	580	491	399	304	205	104	0
	Gikondo	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kagarama	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kanombe	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kicukiro	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kigarama	0	0	0	0	0	0	0	0	0	0	0	0	0
	Masaka	33,569	33,000	32,173	31,047	29,580	27,728	25,443	22,678	19,386	15,517	11,025	5,867	0
	Niboye	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyarugunga	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (Rural)	274,382	260,702	245,510	228,745	210,351	190,276	168,477	144,920	119,574	92,418	63,440	32,633	0

(3). Sector-wise population for 7 adjacent sectors used in water demand projection

Sector	*Sector*	*2012*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*	*2029*	*2030*	*2031*	*2032*	*2033*
Shyorongi	Shyorongi	23,545	28,522	28,835	29,152	29,473	29,797	30,125	30,456	30,791	31,130	31,473	31,945	32,424	32,910	33,404	33,905
Runda	Runda	34,389	44,650	45,548	46,447	47,345	48,243	49,142	50,040	51,543	53,047	54,550	56,054	57,557	58,863	60,169	61,476
Rugalika	Rugalika	34,860	42,654	43,468	44,283	45,097	45,911	46,726	47,540	48,645	49,751	50,856	51,962	53,067	54,078	55,090	56,101
Ntarama	Ntarama	17,978	22,335	23,169	24,004	24,838	25,672	26,507	27,341	28,176	29,010	29,844	30,679	31,513	32,347	33,182	34,016
Muyumbu	Muyumbu	24,242	26,073	28,048	30,024	31,999	33,975	35,950	37,926	39,901	41,877	43,852	45,827	47,803	49,778	51,754	53,729
Gahengeri	Gahengeri	23,517	28,836	31,021	33,206	35,390	37,575	39,760	41,945	44,130	46,314	48,499	50,684	52,869	55,053	57,238	59,423
Nyakariro	Nyakariro	20,196	24,938	26,926	28,913	30,901	32,889	34,876	36,864	38,851	40,839	42,827	44,814	46,802	48,790	50,777	52,765
	Total for 7 sectors	**178,727**	**218,008**	**227,016**	**236,028**	**245,044**	**254,063**	**263,086**	**272,112**	**282,038**	**291,968**	**301,901**	**311,964**	**322,035**	**331,821**	**341,614**	**351,415**

Sector	*Sector*	*2034*	*2035*	*2036*	*2037*	*2038*	*2039*	*2040*	*2041*	*2042*	*2043*	*2044*	*2045*	*2046*	*2047*	*2048*	*2049*
Shyorongi	Shyorongi	34,414	34,930	35,454	35,985	36,525	37,073	37,629	38,194	38,767	39,348	39,938	40,537	41,145	41,763	42,389	43,025
Runda	Runda	62,782	64,088	65,248	66,408	67,568	68,728	69,888	71,295	72,702	74,110	75,517	76,924	78,158	79,392	80,626	81,860
Rugalika	Rugalika	57,113	58,124	59,060	59,996	60,931	61,867	62,803	63,861	64,920	65,978	67,037	68,095	69,069	70,043	71,018	71,992
Ntarama	Ntarama	34,851	35,685	36,519	37,354	38,188	39,022	39,857	40,691	41,526	42,360	43,194	44,029	44,863	45,697	46,532	47,366
Muyumbu	Muyumbu	55,705	57,680	59,656	61,631	63,607	65,582	67,557	69,533	71,508	73,484	75,459	77,435	79,410	81,386	83,361	85,336
Gahengeri	Gahengeri	61,608	63,793	65,977	68,162	70,347	72,532	74,717	76,901	79,086	81,271	83,456	85,641	87,825	90,010	92,195	94,380
Nyakariro	Nyakariro	54,753	56,740	58,728	60,715	62,703	64,691	66,678	68,666	70,654	72,641	74,629	76,617	78,604	80,592	82,579	84,567
	Total for 7 sectors	**361,224**	**371,040**	**380,642**	**390,251**	**399,869**	**409,495**	**419,129**	**429,142**	**439,162**	**449,192**	**459,230**	**469,277**	**479,075**	**488,883**	**498,700**	**508,526**

(4). Sector-wise population for 7 adjacent sectors (total with urban vs rural)

Population (Urban)

S.sector	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Shyorongi	6,791	7,075	7,365	7,661	7,961	8,268	8,580	8,899	9,223	9,553	9,929	10,313	10,707	11,111	11,524	11,947	12,380	12,823	13,277	13,742	14,218	14,705	15,203	15,713	16,234	16,768	17,314	17,873	18,445	19,030	19,628	20,240
Rusida	21,182	22,067	23,379	24,517	25,681	26,871	28,082	29,678	31,312	32,989	34,710	36,475	38,155	39,874	41,630	43,423	45,255	47,019	44,817	50,649	52,514	54,412	56,540	58,709	60,919	63,170	65,461	67,643	69,861	72,115	74,404	76,729
Rugalika	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nzuruma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mayumba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahengeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyakarire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total for 7 sectors (Urban)	**27,973**	**29,143**	**30,745**	**32,178**	**33,643**	**35,139**	**36,668**	**38,576**	**40,535**	**42,542**	**44,639**	**46,788**	**48,862**	**50,984**	**53,153**	**55,370**	**57,635**	**59,843**	**62,094**	**64,391**	**66,731**	**69,117**	**71,743**	**74,422**	**77,154**	**79,938**	**82,776**	**85,517**	**88,306**	**91,145**	**94,032**	**96,969**

Population (Rural)

S.sector	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Shyorongi	21,730	21,760	21,787	21,813	21,836	21,857	21,876	21,893	21,907	21,920	22,016	22,111	22,203	22,293	22,381	22,467	22,550	22,630	22,708	22,783	22,855	22,925	22,991	23,054	23,114	23,170	23,223	23,272	23,318	23,359	23,397	23,430
Rusida	23,468	23,281	23,067	22,828	22,562	22,270	21,953	21,866	21,735	21,561	21,343	21,082	20,708	20,296	19,846	19,358	18,833	18,229	17,591	16,919	16,214	15,476	14,755	13,993	13,190	12,347	11,463	10,515	9,531	8,511	7,456	6,365
Rugalika	42,654	43,468	44,283	45,097	45,911	46,726	47,540	48,645	49,751	50,856	51,962	53,067	54,078	55,090	56,101	57,113	58,124	59,060	59,996	60,931	61,867	62,803	63,861	64,920	65,978	67,037	68,095	69,069	70,043	71,018	71,992	72,966
Nzuruma	22,335	23,169	24,004	24,838	25,672	26,507	27,341	28,176	29,010	29,844	30,679	31,513	32,347	33,182	34,016	34,851	35,685	36,519	37,354	38,188	39,022	39,857	40,691	41,526	42,360	43,194	44,029	44,863	45,697	46,532	47,366	48,201
Mayumba	26,073	28,048	30,024	31,999	33,975	35,950	37,926	39,901	41,877	43,852	45,827	47,803	49,778	51,754	53,729	55,705	57,680	59,656	61,631	63,607	65,582	67,557	69,533	71,508	73,484	75,459	77,435	79,410	81,386	83,361	85,336	87,312
Gahengeri	28,836	31,021	33,206	35,390	37,575	39,760	41,945	44,130	46,314	48,499	50,684	52,869	55,053	57,238	59,423	61,608	63,793	65,977	68,162	70,347	72,532	74,717	76,901	79,086	81,271	83,456	85,641	87,825	90,010	92,195	94,380	96,564
Nyakarire	24,938	26,926	28,913	30,901	32,889	34,876	36,864	38,851	40,839	42,827	44,814	46,802	48,790	50,777	52,765	54,753	56,740	58,728	60,715	62,703	64,691	66,678	68,666	70,654	72,641	74,629	76,617	78,604	80,592	82,579	84,567	86,555
Total for 7 sectors (Rural)	**190,035**	**197,673**	**205,284**	**212,866**	**220,420**	**227,946**	**235,444**	**243,462**	**251,433**	**259,359**	**267,325**	**275,246**	**282,958**	**290,630**	**298,262**	**305,853**	**313,405**	**320,799**	**328,157**	**335,479**	**342,764**	**350,013**	**357,399**	**364,740**	**372,038**	**379,292**	**386,501**	**393,559**	**400,577**	**407,555**	**414,494**	**421,392**

(5). Calculation basis for non-domestic demand in CoK M/P

Sector-wise land use in 2018

	Sector	*Commercial*	*Industries*	*Open Space*	*Public Facilities*	*Total*
Nyarugenge	Gitega	195.2	82.1	7.6	62.3	347.3
	Kanyinya	0.0	536.5	0.0	149.2	685.7
	Kigali	23.8	154.7	16.3	205.5	400.2
	Kimisagara	308.5	16.2	6.6	98.0	429.4
	Mageregere	7.8	0.0	0.0	301.6	309.3
	Muhima	919.1	445.0	90.0	291.0	1,745.1
	Nyakabanda	75.9	0.0	3.1	218.6	297.7
	Nyamirambo	245.7	7.3	15.4	447.8	716.3
	Nyarugenge	2,160.8	0.0	16.0	1,217.5	3,394.4
	Rwezamenyo	250.2	5.9	1.7	64.5	322.2
Gasabo	Bumbogo	0.0	0.0	40.2	199.5	239.7
	Gatsata	18.6	567.4	31.2	57.0	674.2
	Gikomero	0.0	98.5	1.9	168.7	269.1
	Gisozi	376.0	0.0	146.2	497.7	1,019.8
	Jabana	78.0	255.5	65.0	262.4	660.9
	Jali	102.4	121.1	12.7	197.7	433.8
	Kacyiru	560.6	133.1	63.3	1,566.4	2,323.4
	Kimihurura	804.1	445.1	104.2	1,161.3	2,514.8
	Kimironko	548.7	0.0	556.9	624.2	1,729.7
	Kinyinya	241.2	210.2	287.6	1,158.3	1,897.4
	Ndera	155.9	1,408.9	15.8	829.9	2,410.4
	Nduba	0.0	0.0	2.5	102.1	104.6
	Remera	598.2	145.7	164.5	1,651.9	2,560.3
	Rusororo	59.2	451.6	56.1	573.5	1,140.4
	Rutunga	22.9	0.7	0.0	111.8	135.4
Kicukiro	Gahanga	57.4	579.7	23.5	248.4	909.0
	Gatenga	174.5	499.6	175.0	222.8	1,071.9
	Gikondo	66.4	2,084.3	65.2	514.5	2,730.4
	Kagarama	7.1	0.0	67.0	364.3	438.4
	Kanombe	184.4	20.1	93.5	428.8	726.8
	Kicukiro	438.6	1,022.7	23.0	143.1	1,627.4
	Kigarama	34.9	0.0	192.0	397.9	624.8
	Masaka	68.3	745.8	63.7	844.0	1,721.9
	Niboye	41.6	43.5	42.9	734.4	862.4
	Nyarugunga	63.0	217.7	177.7	3,025.3	3,483.6
		8,889.3	**10,298.8**	**2,628.3**	**19,141.9**	**40,958.2**

(Continued)

Sector-wise land use in 2050

Area (ha)

	Sector	Commercial	Industries	Open Space	Public Facilities	Total
Nyarugenge	Gitega	6.568	2.009	10.549	1.890	21.016
	Kanyinya	3.741	86.478	164.932	0.000	255.151
	Kigali	10.168	17.153	230.605	0.000	257.926
	Kimisagara	15.462	0.000	22.784	4.225	42.472
	Mageregere	39.023	20.090	523.091	2.692	584.896
	Muhima	136.694	1.223	10.687	3.570	152.175
	Nyakabanda	4.105	0.000	10.031	0.000	14.136
	Nyamirambo	8.699	4.961	50.622	22.725	87.008
	Nyarugenge	102.162	0.000	11.189	84.076	197.427
	Rwezamenyo	11.549	0.000	6.576	1.457	19.582
Gasabo	Bumbogo	0.101	253.543	132.242	0.000	385.886
	Gatsata	0.000	11.095	25.167	0.000	36.261
	Gikomero	0.969	1.170	77.348	0.000	79.486
	Gisozi	3.946	0.000	46.229	33.418	83.592
	Jabana	0.275	21.164	45.322	0.000	66.761
	Jali	0.000	0.000	27.790	0.000	27.790
	Kacyiru	62.786	0.000	31.956	68.232	162.974
	Kimihurura	68.414	0.000	41.182	25.105	134.702
	Kimironko	87.897	0.000	63.018	26.624	177.539
	Kinyinya	27.773	0.092	163.160	6.392	197.417
	Ndera	140.203	265.635	209.548	45.022	660.410
	Nduba	0.000	0.000	116.493	0.000	116.493
	Remera	87.788	0.000	102.966	45.365	236.119
	Rusororo	47.960	332.419	284.042	10.985	675.406
	Rutunga	1.448	0.000	224.330	89.120	314.898
Kicukiro	Gahanga	103.314	178.481	301.164	120.563	703.522
	Gatenga	51.183	0.000	74.647	5.287	131.118
	Gikondo	59.492	2.400	6.619	17.251	85.761
	Kagarama	19.917	0.000	25.536	20.912	66.365
	Kanombe	95.739	20.873	142.134	12.707	271.453
	Kicukiro	133.046	0.000	10.665	4.197	147.909
	Kigarama	2.294	9.061	26.618	0.000	37.974
	Masaka	235.468	294.906	179.566	20.379	730.320
	Niboye	54.829	0.000	23.665	39.630	118.125
	Nyarugunga	71.268	50.519	83.791	110.584	316.163
		1,694.283	**1,573.271**	**3,506.266**	**822.411**	**7,596.231**

(Continued)

Unit consumption rate for non-domestic use

Unit consumption rates for non-domestic use according to type of use per unit area per day with reference to South African Guidelines,

- 32 m^3/ha/d for commercial,
- 24 m^3/ha/d for industrial,
- 4 m^3/ha/d for public/admin,
- 10 m^3/ha/d for open space.

(Continued)

Demand in 2018

Demand (m3/d)

	Sector	Commercial	Industries	Open Space	Public Facilities	Total
Nyarugenge	Gitega	195.2	82.1	7.6	62.3	347.3
	Kanyinya	0.0	536.5	0.0	149.2	685.7
	Kigali	23.8	154.7	16.3	205.5	400.2
	Kimisagara	308.5	16.2	6.6	98.0	429.4
	Mageregere	7.8	0.0	0.0	301.6	309.3
	Muhima	919.1	445.0	90.0	291.0	1,745.1
	Nyakabanda	75.9	0.0	3.1	218.6	297.7
	Nyamirambo	245.7	7.3	15.4	447.8	716.3
	Nyarugenge	2,160.8	0.0	16.0	1,217.5	3,394.4
	Rwezamenyo	250.2	5.9	1.7	64.5	322.2
Gasabo	Bumbogo	0.0	0.0	40.2	199.5	239.7
	Gatsata	18.6	567.4	31.2	57.0	674.2
	Gikomero	0.0	98.5	1.9	168.7	269.1
	Gisozi	376.0	0.0	146.2	497.7	1,019.8
	Jabana	78.0	255.5	65.0	262.4	660.9
	Jali	102.4	121.1	12.7	197.7	433.8
	Kacyiru	560.6	133.1	63.3	1,566.4	2,323.4
	Kimihurura	804.1	445.1	104.2	1,161.3	2,514.8
	Kimironko	548.7	0.0	556.9	624.2	1,729.7
	Kinyinya	241.2	210.2	287.6	1,158.3	1,897.4
	Ndera	155.9	1,408.9	15.8	829.9	2,410.4
	Nduba	0.0	0.0	2.5	102.1	104.6
	Remera	598.2	145.7	164.5	1,651.9	2,560.3
	Rusororo	59.2	451.6	56.1	573.5	1,140.4
	Rutunga	22.9	0.7	0.0	111.8	135.4
Kicukiro	Gahanga	57.4	579.7	23.5	248.4	909.0
	Gatenga	174.5	499.6	175.0	222.8	1,071.9
	Gikondo	66.4	2,084.3	65.2	514.5	2,730.4
	Kagarama	7.1	0.0	67.0	364.3	438.4
	Kanombe	184.4	20.1	93.5	428.8	726.8
	Kicukiro	438.6	1,022.7	23.0	143.1	1,627.4
	Kigarama	34.9	0.0	192.0	397.9	624.8
	Masaka	68.3	745.8	63.7	844.0	1,721.9
	Niboye	41.6	43.5	42.9	734.4	862.4
	Nyarugunga	63.0	217.7	177.7	3,025.3	3,483.6
		8,889.3	**10,298.8**	**2,628.3**	**19,141.9**	**40,958.2**

(Continued)

Demand in 2050

Demand (m3/d)

	Sector	Commercial	Industries	Open Space	Public Facilities	Total
Nyarugenge	Gitega	210.2	48.2	42.2	18.9	319.5
	Kanyinya	119.7	2,075.5	659.7	0.0	2,854.9
	Kigali	325.4	411.7	922.4	0.0	1,659.5
	Kimisagara	494.8	0.0	91.1	42.3	628.2
	Mageregere	1,248.7	482.2	2,092.4	26.9	3,850.2
	Muhima	4,374.2	29.4	42.7	35.7	4,482.0
	Nyakabanda	131.4	0.0	40.1	0.0	171.5
	Nyamirambo	278.4	119.1	202.5	227.3	827.2
	Nyarugenge	3,269.2	0.0	44.8	840.8	4,154.7
	Rwezamenyo	369.6	0.0	26.3	14.6	410.5
Gasabo	Bumbogo	3.2	6,085.0	529.0	0.0	6,617.2
	Gatsata	0.0	266.3	100.7	0.0	366.9
	Gikomero	31.0	28.1	309.4	0.0	368.5
	Gisozi	126.3	0.0	184.9	334.2	645.4
	Jabana	8.8	507.9	181.3	0.0	698.0
	Jali	0.0	0.0	111.2	0.0	111.2
	Kacyiru	2,009.2	0.0	127.8	682.3	2,819.3
	Kimihurura	2,189.3	0.0	164.7	251.1	2,605.0
	Kimironko	2,812.7	0.0	252.1	266.2	3,331.0
	Kinyinya	888.7	2.2	652.6	63.9	1,607.5
	Ndera	4,486.5	6,375.3	838.2	450.2	12,150.2
	Nduba	0.0	0.0	466.0	0.0	466.0
	Remera	2,809.2	0.0	411.9	453.7	3,674.7
	Rusororo	1,534.7	7,978.0	1,136.2	109.9	10,758.8
	Rutunga	46.3	0.0	897.3	891.2	1,834.8
Kicukiro	Gahanga	3,306.0	4,283.5	1,204.7	1,205.6	9,999.9
	Gatenga	1,637.9	0.0	298.6	52.9	1,989.3
	Gikondo	1,903.7	57.6	26.5	172.5	2,160.3
	Kagarama	637.4	0.0	102.1	209.1	948.6
	Kanombe	3,063.6	501.0	568.5	127.1	4,260.2
	Kicukiro	4,257.5	0.0	42.7	42.0	4,342.1
	Kigarama	73.4	217.5	106.5	0.0	397.4
	Masaka	7,535.0	7,077.7	718.3	203.8	15,534.8
	Niboye	1,754.5	0.0	94.7	396.3	2,245.5
	Nyarugunga	2,280.6	1,212.5	335.2	1,105.8	4,934.1
		54,217.1	**37,758.5**	**14,025.1**	**8,224.1**	**114,224.7**

APPENDIX 19: CANDIDATE ACTIVITIES FOR ORGANIZAITONAL DEVELOPMENT

WASAC Organizational Structure and Challenges			Proposal Activity			
No.	Target Sector / Organization	Challenges toward Sustainable Utility	Organization structure/ function	Human resource development	Equipment / Information system	Points related to implementation
Development and facility management						
1	Maintenance of water resources and wells	-Water resource is at a risk of sustainable use as the department of water resources and well maintenance does not exist. -Lack of the WASAC engineers and experts in charge of groundwater; Operation management for sustainable water sources and water intake facilities to protect the production capacity has not been implemented due to the lack of the WASAC engineers and experts in charge of groundwater. Strong coordination with the RWFA for resource management is also needed. - The permission for water resources need to be reviewed and acquired in a planned manner in order to meet the future water demand increase.	-Establish a department in charge of water source and water intake. -Establish a license management department for water resource development.	-Attend training seminars to acquire skills related to water source maintenance. -In cooperation with the RWFA, provide training for water source development. Also, provide management engineer training with support of the RWFA. -Acquire technology to improve the ability to maintain and manage water sources for the Surface water / groundwater monitoring and maintenance of well facilities (calculation of well efficiency, grasp of well interference, well rehabilitation method).	-Introduce water source monitoring equipment. -Build a water source ledger and update system on a regular basis.	-Decision making by top management of the WASAC to create a new organizational structure. -It is effective for the organization that the WASAC strategically manages water use, sorting out business demarcation with the RWFA. -In order to improve the operation of water intake permits, it is first necessary to establish and improve the the RWFA permit / management system.
2	Service connection work (Target organization: Branch / UWSSD)	-Customers purchase service pipe materials under the current system. Since the standard of pipe material is not specified, inexpensive and low-quality pipes are installed. Moreover, during service pipe installation, activities such as location and earth cover are not always appropriate. (It is assumed that the leakage from service connection accounts for a large proportion of the total amount of leakage. Therefore, improvement of service connection will greatly contribute to leakage reduction.) -Considering that the number of service connection is expected to increase dramatically in the future, it will become much difficult to deal with the increase of water leakage without improving pipe material and installation of service connection significantly. Therefore, current organization or system for procurement and installation shall be revised. (In order to avoid above, it is necessary to take drastic measures at the earliest possible stage during implementation of the MP. In particular, usage of appropriate pipe material and proper installation of service connections are must.) -Records pertaining to status of service connection are not available. (It is necessary to maintain a record such as water ledger sheet. It is useful to keep records of meter readings and water leak repairs and to create a mechanism that can be easily used.)	-Specify the standard of service connection material to eliminate low quality materials. -Introduce the Plumber qualification system in the WASAC and maintain a record on connection with the name of the Plumber in charge. It is useful to set up Plumber awards. -In order to respond to the dramatic increase in the number of service connection, consider outsourcing of service connection by creating a system for designated/ registered contractors for water service connection. . -Establish monitoring system of outsourced contractors using records of service connections.	-Provide training for human resources with the following knowledge and skills. ・ Basic knowledge to be able to select / review standards for service connection pipe material . ・ Basic knowledge for designing and reviewing Plumber's qualification system and designing and reviewing the system of designated/registered contractors ・ Training of Plumbers meeting the desired qualifications including contractors ・ Training leaders who can provide education and training (training, etc.) for fostering Plumber, and can also provide continuous education for renewal of qualifications. ・ Knowledge of appointing designated /registered contractors	-Establish standards for service connection material and compliance methods. -Maintain the format of service connection records (pipe laying position, depth, materials used, etc.) and keep records for application / completion. Link the records to the GIS data and assign engineers to maintain the system so that it can be used as a water ledger. -Examine the methods for recording service connections and establish a GIS / water ledger * for storing and utilizing the records. -Establish Plumber's education and testing methods and system to maintain qualification. -Establish a registration / renewal system that defines the requirements of designated/registered contactors.	-It is necessary to implement the methods step by step. It is efficient to establish a qualification for “qualified material supplier” at the initial stage before introduction of designated/registered contractor system. -It is a priority issue to increase the number of Plumbers through education and training. -Establish a Plumber qualification system and a system for awards and disqualification to ensure the desired quality. -Investigate the reasons why the WASAC previously outsourced and was not successful. After that, consider the system design and management method / system for the designated/ registered contractor. - Keep in mind that the WASAC is responsible for supervision and management of service connection. It shall not be leaved to the customer.

WASAC Organizational Structure and Challenges			**Proposal Activity**			
No.	Target Sector / Organization	Challenges toward Sustainable Utility	Organization structure/ function	Human resource development	Equipment / Information system	Points related to implementation
3	Water quality control	- At the water treatment plant (WTP) level, quality assurance and quality control (QA / QC) under water quality test procedure is not sufficiently implemented (e.g.: QC with reference to standard reference material is not properly performed. Duplicate test and/or testing by other third-party institutions/laboratories are not conducted). - Regarding small-scale water sources, water quality test is not conducted properly even though there are some places having potential risk of pollution. Properly speaking, appropriate measures should be considered depending on the results of water quality tests, but this is not always the case. - Water quality testing results in a distribution system including user's taps are not always reflected in its operation and maintenance. - Management of water quality testing results and maintenance of equipment are not properly implemented. - Units of sophisticated analytical equipment (e.g. HPLC and AAS) are installed at the central laboratory, but the technicians are not well trained. Therefore, these devices are left unused without being maintained due to lack of maintenance and reagents. -The WASAC Central Laboratory conducts regular water sampling and analysis (once every 3 months) at each water treatment plant, but the inspection timing is not consistent and the results cannot be compared. In addition, big differences are observed on results obtained of some parameters of the same sample between the central laboratory and the WTP's laboratory.	-Establish a system with the WASAC's Central Laboratory controlling each WTP's lab in terms of QA/QC (Since the Central Lab has acquired ISO 17025, it is considered that QA/QC is properly being implemented). -Establish a sampling and testing implementation system for the purpose of water quality control for small-scale water sources. -Establish a system for collecting, analyzing, and feeding back the water quality testing results pertaining to raw water, treated water, and distribution network including user's tap. -Prepare a regular purchasing system for required consumables including chemical reagents.	-Conduct training to draw the WASAC's executives' attention to the issues on water quality control (e.g. for the WTP's managers / managers and their superior executives). -Conduct a capacity development training on water quality control for the concerned staff.	- Purchase standard reference material for water quality control. - Prepare IT equipment (including PC, software, network equipment, etc.) with an eye on effective utilization including organizing, analyzing, and sharing water quality analysis data.	-It is recommended that when the central laboratory side conducts sampling at each WTP, same sample should be also analyzed by the laboratory of each WTP side in order to compare the results of both laboratories. -Water quality analysis data is recorded on a proper basis at each WTP. There are some cases where it is difficult to refer to the analysis data or share the results. The water quality control capacity will be improved by combining equipment for data collection and storage, and implementation of activities to draw staff's attention to data analysis and utilization methods.
4	Meter reading by Branch	-The meter readers do not come to the branch office on a daily basis, therefore, the status of work carried out by the meter readers are not properly managed. -The results of meter reading are not thoroughly scrutinized. -Facility to transport meter readers to move around the customer sites for meter reading are not secured.	-Require regular meter reading attendance at branch. - Establish a system to check the results of meter reading for improvement.	-Provide training and work incentives to improve the accuracy of meter checkups. -Performance review of the meter reading accuracy will be added in addition to the number of meter readings, as an evaluation item.	-Introduce smart meter system such as automatic meter reader (AMR). -Supply cars and motorcycles to meter readers.	-In some cases, meter checkers estimate and enter the meter readings without looking at the actual site. In addition, the meter is broken and often unreadable. -There is a possibility to collect charges incorrectly because the meter is not read correctly due to the inappropriate practice between the examiner and the customer.
5	Maintenance and management of customer water meters	-The accuracy of customer meters are not confirmed on-site, and charges to customers are not properly billed. -There is no role defined for the responsible department which manages the customer meters in the branch office, the commercial affairs section and the water distribution section. -It is necessary to clarify the business structure of the branch office; which department consistently manages the customer meter replacement / maintenance responsibility.	-Separate the organizational structure of the branch office into customer department, meter connection department, billing department, and water distribution department.			-The roles of CACRO and Manpower, who are short-term employees, are limited to mining and water leakage repair . -New working assignment for CACRO is necessary as their tasks do not cover meter maintenance.

WASAC Organizational Structure and Challenges			Proposal Activity			
No.	Target Sector / Organization	Challenges toward Sustainable Utility	Organization structure/ function	Human resource development	Equipment / Information system	Points related to implementation
Project management, organizational cooperation						
6	Project management/ Supervision	- Supervision on the design and construction of the large scale projects are facing challenges due to an enormous burden on design confirmation. - The contractors always lack incentives and capacities to prioritize the quality and efficiency of the water supply system as a whole. The number of personnel and technical capabilities involved in specific projects are insufficient to lead them in those aspects. In particular, subprojects implemented by other development partners lack professional supervision and supervision systems compared to the scale of the project. -Strong leadership to avoid delay gives precedence to fast construction over quality facilities (Respecting construction period tend to be given first priority over pursuing quality of construction).	-The WASAC to conduct F/S and D/D by itself and supervise the contractor based on the design. -Clarify the project approval procedure and create a manual. - Establish a system to use consultants for large scale construction supervision and to supervise the consultants	-Strengthen the project implementation procedure through SPIU human resource development. -Deploy long-term experts to strengthen the capacity of construction management. -Hire WASAC in-house consultants from the outside entity. Or increase the number of employees.	- Utilize Japanese technical cooperation projects to introduce /establish D/D and construction supervision system -Improve the quality of material and equipment for project implementation.	-The WASAC, as a basic idea, states that the contractor is responsible for the construction facility, However, the contractor tends to build in its own way and complete the work without full responsibility and necessary procedure with the objective to avoid construction delay. Proper construction supervision by professionals with knowledge and experience will be required.
7	Overall business planning and strategy	-Lack of facilities to plan and maintain the long-term investment plan. For example; -There is no department responsible for overall planning of the business entity as the UWSSD is specialized in operation and maintenance of existing facilities, and the SPIU is specialized in project implementation -The long-term and short-term plans, including both finance and technology should be linked to the facility needs of the business strategy department under the CEO. -(A water sector challenge beyond the WASAC) The water tariff guidelines and the process/stakeholders associated with the tariff revision are not disclosed/ not clear. In order to avoid the politically motivated unreasonably low tariff, the tariff revision process needs to be clarified. Such a tariff revision system is essential to the implementation of the 15-year investment plan.	-Set up the following for implementation of the 15-year investment plan created under the MP ① Set up a committee comprising of regular members of the WASAC, the MININFRA and the RURA for preparing the WASAC's long-term investment (management) plan, facility development plan, and budget measures. ② Create a water tariff guideline in cooperation with the RURA to make the tariff revision process transparent. -Organize concession contracts with the government. -Involve managers of the Water and Sanitation Development department who were involved as the JICA MP members.	-Develop staff (belonging to the development / general affairs / finance department) who can formulate, monitor and evaluate long-term management plans. -Develop human resources by formulating a team to establish a better supervisory system when implementing large-scale investment projects, especially design build projects.	-Utilize Japanese technical cooperation projects to carry out "human resource development".	-In order to implement item nos. ① and ② as mentioned under "Organizational structure and functions" , a long-term expert will be assigned to the MININFRA, which is an organization that supervises the management of the WASAC, to facilitate coordination between water supply policy and operation. -In addition to the UWSSD, the MP is difficult to implement without the formal involvement and coordination of the Development, the SPIU, and the strategic department of the head office. -The WASAC business independence needs to be increased to formulate important items and long-term plans for business operation. It is necessary to strengthen budget preparation and execution capabilities with a view to reinforcing long-term planning capabilities.

WASAC Organizational Structure and Challenges			Proposal Activity			
No.	Target Sector / Organization	Challenges toward Sustainable Utility	Organization structure/ function	Human resource development	Equipment / Information system	Points related to implementation
Data management and utilization						
8	Management and utilization of pipeline GIS data	-Data read from customer meters are not properly entered to GIS. -Insufficient number of staff are allocated and pipeline GIS data is not updated regularly. In addition, the data is underutilized and there are no rules to ensure regular updates.	-Provide incentives such as a higher salary for persons having GIS qualification.	-Increase the number of staff in the GIS department. -Register GIS skill training regularly.	-Set up the data update procedure. -Establish an application process for construction approval and management.	-It is necessary for the management to understand how to use GIS and its value. -It is necessary to keep the water distribution pipe in a new state by not only increasing the number of personnel but also by efficiently creating a network diagram.
9	Customer data survey / analysis	-Research and analysis of customer data are not sufficient because the responsibilities and roles of the Commercial Service Officer and Billing Supervisor are not clear.	-Restructure branch department into customer department, meter connection department, billing department, and water distribution department. -Clarify the survey and analysis of customer data in the role of the customer department.		-Introduce a data management system for customer data.	
10	Document management	-Document material such as water purification plants, distribution reservoirs, pump stations, and completion drawings for water transmission and distribution pipelines, etc. are lost, and equipment drawings and documents are not sufficiently managed. -Appropriate management systems such as departments that manage drawings, human resources for staff, and archive registration systems are not built.	-Create a department that specializes in data management.		-Establish a book / drawing registration system and an information management center for basic information/ future maintenance of infrastructure facilities.	
Environment and Social Considerations						
11	Environmental and social considerations/ Public relations	-It is necessary for the overall WASAC staff to enhance an understanding on the necessity of environmental and social considerations. - It is important to conduct business with environmental and social considerationst, even when competing with private companies for profits.	-Create a setting policy and manual for environmental and social consideration, and manage and monitor the execution as a public utility organization. -Increase budget allocation for environmental and social considerations.	-Increase the number of WASAC PR staff for environmental and social considerations. -Conduct training on environmental and social consideration.		-Environmental and social considerations need to be implemented on a global basis in order to obtain financing from development partners. -Promote PR with corporate commitment and to the SDGs for continuous efforts toward environmental and social considerations.
12	Finance support for customers	-The financial support such as subsidy system does not exist for low income people.	-Support the loan / subsidy system for connection; The subsidy will be examined by the government and city and implemented with the WASAC. Obtaining private funds for support is another option.			-In the process of increasing the connection rate to future water supply services, it is essential to promote connection to low-income groups. Therefore, it is necessary to establish a support loan / subsidy system.

WASAC Organizational Structure and Challenges			Proposal Activity			
No.	Target Sector / Organization	Challenges toward Sustainable Utility	Organization structure/ function	Human resource development	Equipment / Information system	Points related to implementation
Financial / accounting management						
13	Entire water cost recognition/ Management	-It is important for the top management and each departmental staff to recognize and undesrand the entire costs related to water supply: separately at the water resource level, at the production level, at the distribution level, at the commercial level and at the administration level.	-Introduce a cost management system for monitoring the cost reduction and financial performance.	-Establish a cost management section to provide information to the top management as needed, and provide guidance and support to the related departments.	-Make a full use on an Oracle based system for the cost management.	- It will be necessary for the WASAC to actively work on the tariff revision by reflecting these cost data.
14	Financial data Accuracy	-Financial information should be provided timely to the top management. -Budget execution data should be provided to the top management and the elated departments in a timely manner. (External audit pointed out: Oracle system does not meet the budgetary management reuirements). -Past financial statements have been revised several times, and accurate financial data were not available (External audit pointed out: the data of each department and of financial department is not collated with each other to a considerable extent). -Assets are necessary to be managed properly. (External audit pointed out: There is a mismatch between the asset register book and the financial ledger).	-Produce a monthly financial management tool -Appropriate explanations and guidance are conducted by the Finance Department to each department on a regular basis. -Recognize the importance of the reconcilaiation between the register book and the ledger, which is a fundamental management.		-Interface the Oracle system (finance) with the CMS (customer management system). -Re-engineer Oracle system to support budget execution management. -Distribute a ledger that enables each department to obtain common financial data.	-Providing an appropriate information to finaicial institutions, investors, and international donors is important -As for assets data, an external consultant need to be hired to scrutinize and sort out the register book.. -It is necessary to consider the financial and accounting issues as pointed out by the external audit (OAG).
Human resources and organizational culture						
15	Human Resource policy	-The departmental head level is mostly selected from government ministries and agencies that are supervisory bodies of the WASAC. Internal promotions of the WASAC staff/manager to management level is limited.	-Appoint human resources from within the WASAC to the management level.	-Build a human resource development system that enables a promotion to the department manager or higher level.		It is necessary to have a system that promotes talented people to the management level for ensuring staff motivation.
16	Organizational culture	-Empowering the staff of field team to autonomously deal with problems in operation and maintenance is not clearly recommended by the management. -There is no organizational culture that encourage staffs to propose/report problems and issues actively all times to the management . -The flow of communication between departments and even among managers is limited for implementing the MP.	-Adopt a management system that enables decision making on a team-by-site basis. -Deploying the ombudsperson as the contact point for employees who have various problems in the workplace, and set up a section to handle complaints and solve problems.	-Organize a seminar for empowerment regularly. -Monitor implementation of employee empowerment.		-The WASAC has a bureaucratic organizational structure to operate its business as part of a government agency. However, it is possible to transfer the operational authority to the field staff in order to improve work efficiency.

Note: Serial number of this table does not represent priority order.

APPENDIX 20: Methodology of unit cost for WTP construction

This Page is closed due to the confidentiality.

APPENDIX 21: Methodology of unit cost for pipeline construction

This Page is closed due to the confidentiality.

APPENDIX 22: Hydraulic Review and Preliminary Quantity Estimation for Transmission and Distribution System

List of Calculation Sheets

1. Basic Assumption

2-1. Comparison of the routes for Central Transmission main
2-2. Calculation of Optimum Diameter for the Central Transmission Main
2-3. Profiles of Selected Route for Central Main

3-1. Summary of the transmission energy and OM costs
3-2. Proposed Gikondo-Low (Kimihurura) Transmission Reservoir and energy cost comparison
3-3. Breakdown calculation of energy cost for each route
3-4. Summary of Operational Cost calculation for each Water Supply Scenario

4. Capital Cost Estimate for Transmission Pipelines in 2035 and 2050

5. Summary of Capital and O&M cost for the Cases in 2035 and 2050

6. Hydraulic Profiles and Comparison of Transmission Line from Remera to the Eastern Areas

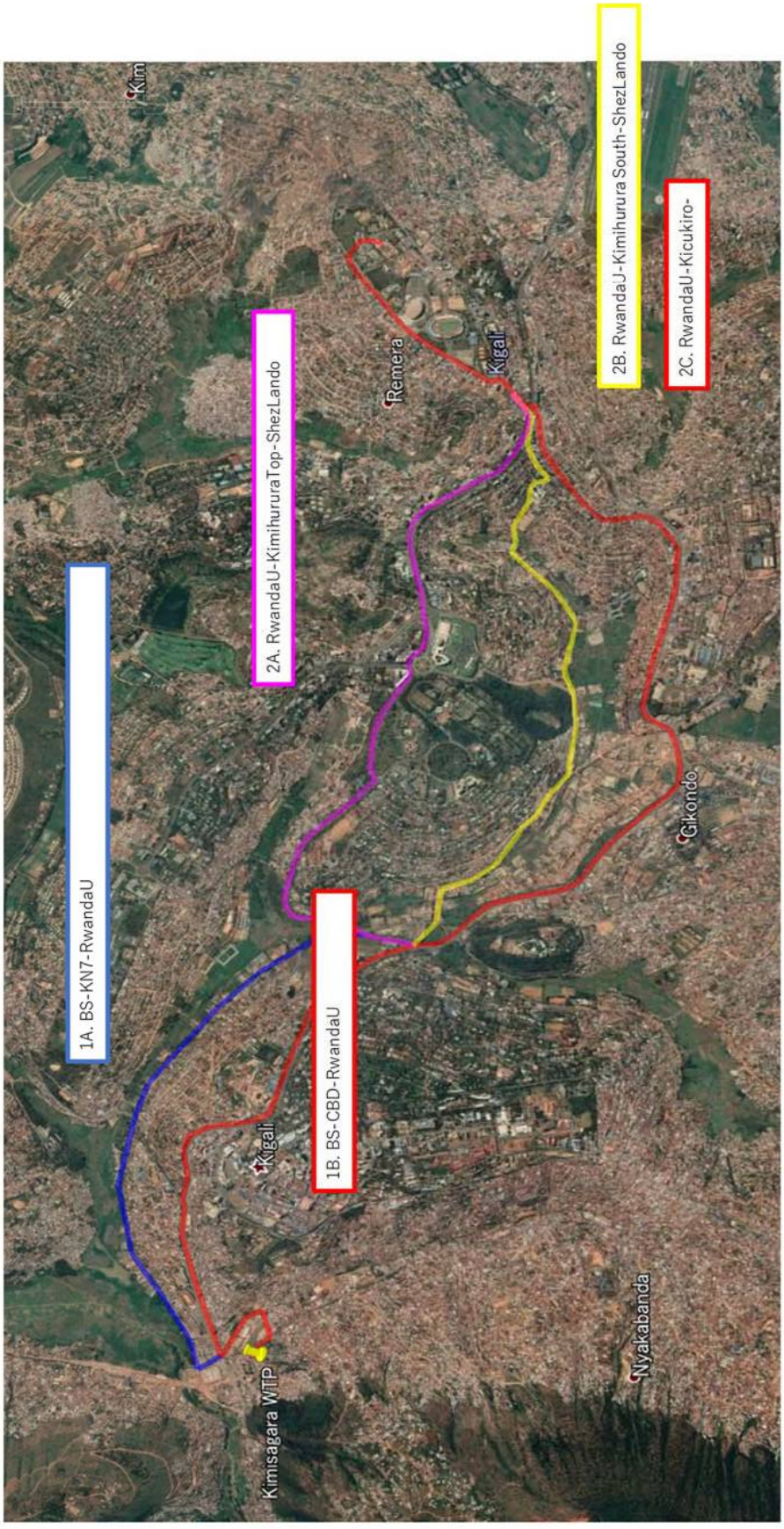
7. Quantity Estimate of Pipeline Length for 2035 and 2050

8. Water Supply Scenario (2025, 2035 and 2050)

Hydraulic Review and Preliminary Quantity Estimation for Transmission and Distribution System

1. Basic Assumption

Hydraulic Calculation		
Formula	Hazen-Williams	
Coefficients	C=130 (for Transmission Mains)	
	C=110 (for Distribution Pipes)	
Pump efficiency (ηp)	0.8 (Transmission pumps) 0.7 (Well pumps)	
Motor efficiency (ηm)	0.9	
Cost Calculation		
Unit electricity tariff	148.68	Rwf/kW
Benchmark Year of Cost	2019	
Evaluation Period for lifetime cost	20	years
Social Discount Rate (SDR)	6%	
Others		
Elevation	From WASAC GIS point data or estimated from Google Earth.	


Kim
Remera
Kigali
2B. RwandaU-Kimihurura South-ShezLando
2C. RwandaU-Kicukiro-
2A. RwandaU-KimihururaTop-ShezLando
1A. BS-KN7-RwandaU
1B. BS-CBD-RwandaU
Gikondo
Kigali
Nyakabanda
Kimisagara WTP

2-1. Comparison of the routes for Central Transmission main

R= 6,378,137 m

Kimisagara-RwandaU-Kucukiro-Remera											
type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude	**Location**
T	-1.943378319	30.045884	1406.5	-0.033918	0.5243996	1.168E-06	9.232E-06		0	1406.5	
T	-1.943311406	30.046413	1404.2	-0.033917	0.5244088	-1.97E-05	1.76E-05	59	59	1404.2	
T	-1.944437944	30.047421	1420.7	-0.033937	0.5244264	9.109E-06	2.852E-05	168	228	1420.7	
T	-1.943916028	30.049055	1392	-0.033928	0.524455	1.785E-05	-9.35E-06	191	419	1392	
T	-1.942893584	30.048519	1388.5	-0.03391	0.5244456	2.66E-05	-4.95E-05	129	547	1388.5	
T	-1.941369276	30.045686	1376.5	-0.033883	0.5243961	0.0338833	-0.524396	358	905	1376.5	**BS**
1A. BS-KN7-RwandaU											
type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude	
T	-1.941413536	30.045815	1376.7	-0.033884	0.5243984	2.534E-05	-1.69E-05		0	1376.7	**BS**
T	-1.939961946	30.044846	1371.3	-0.033859	0.5243815	7.99E-06	3.316E-05	194	194	1371.3	
T	-1.939504131	30.046746	1373.1	-0.033851	0.5244146	3.495E-05	6.36E-05	218	412	1373.1	
T	-1.937501671	30.05039	1377.8	-0.033816	0.5244782	2.745E-05	4.255E-05	463	875	1377.8	
T	-1.935928694	30.052828	1380.5	-0.033788	0.5245208	1.459E-05	8.134E-05	323	1,198	1380.5	
T	-1.93509296	30.057488	1375.3	-0.033774	0.5246021	-1.87E-05	8.179E-05	527	1,725	1375.3	
T	-1.936165433	30.062174	1383.2	-0.033792	0.5246839	-1.38E-05	3.872E-05	535	2,260	1383.2	
T	-1.9369585	30.064393	1381.5	-0.033806	0.5247226	-7.21E-05	8.819E-05	262	2,522	1381.5	
T	-1.941087285	30.069446	1385.3	-0.033878	0.5248108	-4.71E-05	4.429E-05	726	3,249	1385.3	
T	-1.94378388	30.071983	1383	-0.033925	0.5248551	-6.58E-05	4.292E-05	412	3,661	1383	
T	-1.947556109	30.074442	1381.2	-0.033991	0.524898	-2.55E-05	2.917E-06	501	4,162	1381.2	
T	-1.949015525	30.07461	1386.1	-0.034017	0.524901	-2.06E-05	-2.21E-06	164	4,326	1386.1	
T	-1.950197735	30.074483	1392	-0.034037	0.5248988	2.233E-06	5.602E-07	132	4,458	1392	***Confluent with Pink**
T	-1.950069815	30.074515	1391.1	-0.034035	0.5248993	-2.31E-05	-5.89E-06	15	4,473	1391.1	

T	-1.951394387	30.074178	1401.2	-0.034058	0.5248934	-2.28E-05	-3.6E-06	152	4,625	1407.9	
T	-1.952698915	30.073971	1404.3	-0.034081	0.5248898	-7.48E-06	-3.99E-06	147	4,772	1404.3	
T	-1.95312754	30.073743	1407.9	-0.034089	0.5248858	0.0340885	-0.524886	54	4,826	1401.2	**RwandaU**
1B. BS-CBD-RwandaU											
T	-1.941369276	30.045686	1376.5	-0.033883	0.5243961	2.783E-05	0.0001009	358	905	1376.5	**BS**
T	-1.939774922	30.051469	1416.8	-0.033855	0.5244971	1.11E-05	5.03E-05	668	1,573	1416.8	
T	-1.939138926	30.054351	1430.9	-0.033844	0.5245474	-3.16E-06	3.493E-05	329	1,902	1430.9	
T	-1.939320188	30.056352	1443.3	-0.033848	0.5245823	2.564E-06	8.998E-06	224	2,125	1443.3	
T	-1.939173253	30.056867	1442.3	-0.033845	0.5245913	-6.28E-06	2.713E-05	60	2,185	1442.3	
T	-1.939533219	30.058422	1456.2	-0.033851	0.5246184	4.484E-06	3.07E-05	178	2,363	1456.2	
T	-1.939276279	30.060181	1466.7	-0.033847	0.5246491	-7.41E-06	1.901E-05	198	2,560	1466.7	
T	-1.939700656	30.06127	1473.4	-0.033854	0.5246681	-2.18E-05	1.081E-05	130	2,691	1473.4	
T	-1.940948569	30.06189	1484.8	-0.033876	0.524679	-3.76E-05	6.828E-06	155	2,846	1484.8	
T	-1.943104122	30.062281	1502.4	-0.033914	0.5246858	-1.13E-05	3.466E-06	244	3,090	1502.4	
T	-1.943753096	30.06248	1506.7	-0.033925	0.5246892	-1.27E-05	7.036E-06	76	3,165	1506.7	
T	-1.944482343	30.062883	1507.9	-0.033938	0.5246963	-1.74E-05	5.201E-05	93	3,258	1507.9	
T	-1.945479442	30.065862	1480.4	-0.033955	0.5247483	-2.46E-05	6.305E-05	350	3,608	1480.4	
T	-1.946890919	30.069475	1451.2	-0.03398	0.5248113	-1.32E-05	2.81E-05	432	4,039	1451.2	
T	-1.947648742	30.071084	1439.7	-0.033993	0.5248394	-5.52E-05	3.367E-05	198	4,237	1439.7	
T	-1.95081142	30.073014	1424.7	-0.034048	0.5248731	-5.02E-06	2.508E-06	412	4,650	1424.7	
T	-1.951099288	30.073157	1423.7	-0.034053	0.5248756	-3.63E-05	1.099E-05	36	4,686	1423.7	
T	-1.953178486	30.073787	1406.5	-0.034089	0.5248866	#REF!	#REF!	242	4,927	1406.5	**Rwanda U**
2A. RwandaU-KimihururaTop-ShezLando											
type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude	
T	-1.95312754	30.073743	1407.9	-0.034089	0.5248858	7.481E-06	3.994E-06		0	1407.9	**Rwanda U**
T	-1.952698915	30.073971	1404.3	-0.034081	0.5248898	2.277E-05	3.6E-06	54	54	1404.3	
T	-1.951394387	30.074178	1401.2	-0.034058	0.5248934	2.312E-05	5.892E-06	147	201	1401.2	

T	-1.950069815	30.074515	1391.1	-0.034035	0.5248993	8.057E-06	7.514E-06	152	353	1391.1	*Confluent with Blue
T	-1.949608205	30.074946	1384.6	-0.034027	0.5249068	9.089E-06	7.058E-06	70	424	1384.6	
T	-1.949087463	30.07535	1383.5	-0.034018	0.5249139	1.184E-05	5.737E-06	73	497	1383.5	
T	-1.948409324	30.075679	1385.9	-0.034006	0.5249196	1.198E-05	1.116E-06	84	581	1385.9	
T	-1.947722642	30.075743	1390.3	-0.033994	0.5249207	4.749E-07	-6.25E-08	77	658	1390.3	
T	-1.947695432	30.075739	1390.4	-0.033994	0.5249207	2.129E-05	-2.7E-06	3	661	1390.4	
T	-1.946475665	30.075584	1393.6	-0.033972	0.524918	1.319E-05	2.991E-06	137	798	1393.6	
T	-1.945719679	30.075756	1396	-0.033959	0.524921	7.567E-06	1.546E-05	86	884	1396	
T	-1.945286103	30.076641	1401.9	-0.033952	0.5249364	-6.49E-07	1.495E-05	110	994	1401.9	
T	-1.945323297	30.077498	1409.4	-0.033952	0.5249514	-8.12E-06	2.398E-05	95	1,089	1409.4	
T	-1.945788465	30.078872	1423.4	-0.03396	0.5249753	-7.34E-06	2.474E-05	161	1,251	1423.4	
T	-1.946209201	30.080289	1429.5	-0.033968	0.5250001	-1.13E-05	1.65E-05	165	1,415	1429.5	
T	-1.946854264	30.081235	1435.1	-0.033979	0.5250166	-4.8E-05	4.169E-05	127	1,543	1435.1	
T	-1.949603276	30.083623	1453	-0.034027	0.5250583	-1.21E-05	1.33E-05	405	1,948	1453	
T	-1.950296195	30.084385	1461.2	-0.034039	0.5250716	-8.15E-06	7.574E-06	115	2,063	1461.2	
T	-1.950763359	30.084819	1464.9	-0.034047	0.5250791	2.166E-06	6.14E-06	71	2,134	1464.9	
T	-1.950639236	30.085171	1461	-0.034045	0.5250853	2.571E-06	8.894E-06	42	2,175	1461	
T	-1.950491922	30.08568	1454.7	-0.034043	0.5250942	-2.98E-06	3.891E-05	59	2,234	1454.7	
T	-1.950662834	30.08791	1454.6	-0.034045	0.5251331	-8.87E-06	2.47E-05	249	2,483	1454.6	
T	-1.951170878	30.089325	1461.8	-0.034054	0.5251578	-2.07E-05	2.958E-05	167	2,650	1461.8	
T	-1.952356214	30.09102	1487	-0.034075	0.5251874	-9.32E-06	1.263E-05	230	2,881	1487	
T	-1.952890156	30.091743	1493.1	-0.034084	0.5252	2.279E-06	8.304E-06	100	2,981	1493.1	
T	-1.952759551	30.092219	1494.4	-0.034082	0.5252083	4.064E-07	7.754E-06	55	3,036	1494.4	
T	-1.952736266	30.092664	1495.3	-0.034082	0.5252161	-5.71E-06	7.184E-06	50	3,085	1495.3	
T	-1.953063703	30.093075	1495.1	-0.034087	0.5252232	-8.22E-06	4.199E-06	59	3,144	1495.1	
T	-1.953534899	30.093316	1496.2	-0.034096	0.5252274	-5.52E-06	1.705E-05	59	3,203	1496.2	
T	-1.953851047	30.094293	1497.4	-0.034101	0.5252445	2.158E-06	1.642E-05	114	3,317	1497.4	
T	-1.953727381	30.095234	1495.9	-0.034099	0.5252609	8.569E-07	4.564E-06	106	3,423	1495.9	

T	-1.953678286	30.095495	1495.1	-0.034098	0.5252655	1.197E-06	8.86E-06	30	3,452	1495.1	
T	-1.953609712	30.096003	1494.6	-0.034097	0.5252743	9.099E-07	1.713E-05	57	3,509	1494.6	
T	-1.953557578	30.096985	1497.9	-0.034096	0.5252915	5.63E-06	2.137E-05	109	3,619	1497.9	
T	-1.953234992	30.098209	1498.4	-0.03409	0.5253128	7.992E-06	4.258E-05	141	3,760	1498.4	
T	-1.952777102	30.100649	1487.4	-0.034082	0.5253554	-3.76E-06	2.089E-05	276	4,036	1487.4	
T	-1.952992291	30.101846	1479.2	-0.034086	0.5253763	-1.15E-05	1.53E-05	135	4,171	1479.2	**RDB**
T	-1.953651915	30.102722	1478	-0.034098	0.5253916	-5.46E-05	3.123E-05	122	4,293	1478	
T	-1.956780205	30.104511	1490.8	-0.034152	0.5254228	-2.34E-05	1.126E-05	401	4,695	1490.8	
T	-1.958118744	30.105157	1499.6	-0.034176	0.5254341	-1.68E-05	2.219E-05	165	4,860	1499.6	
T	-1.959081228	30.106428	1506.5	-0.034192	0.5254563	-9.92E-06	2.138E-05	178	5,038	1506.5	
T	-1.959649383	30.107653	1513.3	-0.034202	0.5254777	-2.23E-06	1.7E-05	150	5,188	1513.3	
T	-1.959777259	30.108627	1512.1	-0.034205	0.5254947	4.804E-06	9.716E-06	109	5,297	1512.1	
T	-1.959502014	30.109184	1511.6	-0.0342	0.5255044	1.299E-05	1.693E-05	69	5,366	1511.6	
T	-1.95875798	30.110154	1507.7	-0.034187	0.5255213	0.0341868	-0.525521	136	5,502	1507.7	**Shez Lando**
2B. RwandaU-Kimihurura south-RDB											
type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude	
T	-1.953097802	30.073754	1407.8	-0.034088	0.524886	-2.59E-05	2.654E-05		0	1407.8	**Rwanda U**
T	-1.954581811	30.075274	1385.8	-0.034114	0.5249126	-5.63E-06	4.07E-05	237	237	1385.8	
T	-1.954904374	30.077607	1391.3	-0.03412	0.5249533	-3.42E-05	1.175E-05	262	499	1391.3	
T	-1.956866616	30.07828	1394.8	-0.034154	0.524965	-2.2E-05	1.712E-05	231	730	1394.8	
T	-1.958125539	30.07926	1400.8	-0.034176	0.5249821	-1.69E-05	2.524E-05	178	907	1400.8	
T	-1.959096261	30.080706	1409.1	-0.034193	0.5250074	-6.97E-06	1.173E-05	194	1,101	1409.1	
T	-1.959495459	30.081378	1416.8	-0.0342	0.5250191	-9.46E-07	4.365E-06	87	1,188	1416.8	
T	-1.959549674	30.081628	1421.7	-0.034201	0.5250235	-1.78E-05	1.658E-05	28	1,217	1421.7	
T	-1.960567718	30.082578	1419.1	-0.034218	0.52504	-1.04E-05	2.066E-05	155	1,372	1419.1	
T	-1.961164141	30.083762	1417.9	-0.034229	0.5250607	-2.39E-05	2.786E-05	148	1,519	1417.9	
T	-1.962533716	30.085358	1404.6	-0.034253	0.5250886	-4.31E-07	1.588E-05	234	1,753	1404.6	

T	-1.962558412	30.086268	1412.5	-0.034253	0.5251044	-5.14E-06	2.559E-05	101	1,855	1412.5	
T	-1.962853024	30.087734	1411.8	-0.034258	0.52513	-2.62E-06	1.415E-05	166	2,021	1411.8	
T	-1.963003285	30.088544	1407.4	-0.034261	0.5251442	2.346E-06	3.745E-05	92	2,113	1407.4	
T	-1.962868886	30.09069	1406	-0.034259	0.5251816	8.829E-06	2.259E-05	239	2,352	1406	
T	-1.962363034	30.091984	1407	-0.03425	0.5252042	1.929E-06	8.882E-06	155	2,507	1407	
T	-1.962252498	30.092493	1410	-0.034248	0.5252131	-1.18E-05	4.529E-05	58	2,565	1410	
T	-1.962930005	30.095088	1407	-0.03426	0.5252584	-5.15E-07	1.094E-05	299	2,863	1407	
T	-1.962959534	30.095715	1408.1	-0.03426	0.5252693	2.23E-05	3.466E-05	70	2,933	1408.1	
T	-1.961681905	30.097701	1414.7	-0.034238	0.525304	4.726E-05	4.257E-05	263	3,196	1414.7	
T	-1.958974116	30.10014	1429.4	-0.034191	0.5253465	-5.56E-06	1.189E-05	406	3,602	1429.4	
T	-1.959292856	30.100821	1421.9	-0.034196	0.5253584	3.557E-06	1.865E-05	84	3,685	1421.9	
T	-1.959089069	30.10189	1435.7	-0.034193	0.5253771	-1.62E-05	2.734E-05	121	3,807	1435.7	
T	-1.960018668	30.103457	1447.5	-0.034209	0.5254044	3.948E-07	1.41E-05	203	4,009	1447.5	
T	-1.959996047	30.104264	1462.8	-0.034208	0.5254185	-3.55E-06	4.297E-06	90	4,099	1462.8	
T	-1.960199534	30.104511	1468.3	-0.034212	0.5254228	-4.72E-06	1.718E-06	36	4,135	1468.3	
T	-1.960469791	30.104609	1471.5	-0.034217	0.5254245	-7.51E-06	3.367E-07	32	4,167	1471.5	
T	-1.960900151	30.104628	1474.6	-0.034224	0.5254249	-2.75E-06	3.123E-06	48	4,215	1474.6	
T	-1.961057778	30.104807	1479.8	-0.034227	0.525428	7.471E-06	6.587E-06	27	4,241	1479.8	
T	-1.96062974	30.105185	1482.3	-0.034219	0.5254346	9.585E-06	1.293E-05	64	4,305	1482.3	
T	-1.960080553	30.105925	1492.6	-0.03421	0.5254475	5.261E-06	1.237E-05	103	4,408	1492.6	
T	-1.959779119	30.106634	1503.7	-0.034205	0.5254599	1.276E-06	9.175E-06	86	4,493	1503.7	
T	-1.959706003	30.10716	1509.9	-0.034203	0.5254691	-4.78E-06	2.681E-05	59	4,552	1509.9	
T	-1.959979739	30.108696	1511.6	-0.034208	0.5254959	3.031E-06	7.365E-07	174	4,726	1511.6	
T	-1.959806098	30.108738	1511.9	-0.034205	0.5254966	4.483E-06	7.56E-06	20	4,746	1511.9	
T	-1.959549222	30.109171	1511.5	-0.034201	0.5255042	1.292E-05	1.678E-05	56	4,802	1511.5	
T	-1.958808929	30.110133	1507.9	-0.034188	0.525521	0.0341877	-0.525521	135	4,937	1507.9	**Shez Lando**

2C. RwandaU-Kicukiro-ShezLando											
T	-1.953178486	30.073787	1406.5	-0.034089	0.5248866	-2.78E-05	2.074E-06	0	0	1406.5	**Rwanda U (1) North**
T	-1.954768553	30.073906	1393.1	-0.034117	0.5248887	-1.32E-05	8.641E-06	177	177	1393.1	
T	-1.955522439	30.074401	1391.6	-0.03413	0.5248973	-9.86E-06	9.895E-06	100	278	1391.6	
T	-1.956087394	30.074968	1394.8	-0.03414	0.5249072	-7.18E-06	8.217E-06	89	367	1394.8	**Rwanda U (2) South**
T	-1.956499004	30.075438	1395	-0.034147	0.5249154	-2.51E-05	2.085E-05	70	437	1395	
T	-1.957936838	30.076633	1392	-0.034172	0.5249363	-4.21E-05	1.048E-05	208	645	1392	
T	-1.96035009	30.077234	1398.5	-0.034215	0.5249468	-2.84E-05	3.991E-06	277	922	1398.5	
T	-1.961975349	30.077462	1401.3	-0.034243	0.5249507	-2.01E-05	9.664E-06	183	1,104	1401.3	
T	-1.963125155	30.078016	1406.3	-0.034263	0.5249604	-3.41E-05	4.678E-05	142	1,246	1406.3	
T	-1.965078108	30.080696	1407.5	-0.034297	0.5250072	-4.01E-05	3.885E-05	369	1,615	1407.5	
T	-1.967373009	30.082922	1410.2	-0.034337	0.525046	-2.3E-05	1.978E-05	356	1,971	1410.2	
T	-1.968689489	30.084055	1412.2	-0.03436	0.5250658	-8.37E-06	1.339E-05	193	2,165	1412.2	
T	-1.969168825	30.084822	1414.9	-0.034368	0.5250792	-1.37E-06	1.649E-05	101	2,265	1414.9	
T	-1.969247286	30.085767	1414.5	-0.03437	0.5250957	1.108E-06	8.638E-06	106	2,371	1414.5	
T	-1.969183827	30.086261	1413.5	-0.034369	0.5251043	3.719E-06	2.169E-05	56	2,426	1413.5	
T	-1.968970749	30.087504	1408.8	-0.034365	0.525126	6.142E-06	1.503E-05	140	2,567	1408.8	
T	-1.968618834	30.088365	1407.7	-0.034359	0.525141	2.248E-05	1.168E-05	104	2,670	1407.7	
T	-1.967330559	30.089035	1412.3	-0.034336	0.5251527	6.936E-06	1.12E-05	162	2,832	1412.3	
T	-1.966933152	30.089677	1416.1	-0.034329	0.5251639	-1.08E-05	5.654E-05	84	2,916	1416.1	
T	-1.967552563	30.092916	1424.9	-0.03434	0.5252205	-2.18E-05	8.189E-05	367	3,283	1424.9	
T	-1.968803797	30.097608	1443.1	-0.034362	0.5253024	-7.4E-07	4.769E-05	541	3,824	1443.1	
T	-1.968846188	30.10034	1453	-0.034363	0.52535	2.118E-05	2.89E-05	304	4,128	1453	
T	-1.967632874	30.101996	1461.8	-0.034342	0.5253789	1.009E-05	4.175E-06	229	4,356	1461.8	

T	-1.967054963	30.102235	1462.2	-0.034332	0.5253831	5.701E-06	2.707E-06	70	4,426	1462.2	
T	-1.966728293	30.10239	1462.4	-0.034326	0.5253858	3.55E-05	-6.41E-06	40	4,466	1462.4	
T	-1.964694261	30.102023	1470.8	-0.03429	0.5253794	9.024E-06	2.723E-06	230	4,696	1470.8	
T	-1.96417721	30.102179	1472.6	-0.034281	0.5253821	2.661E-05	2.669E-05	60	4,757	1472.6	
T	-1.962652368	30.103708	1482.5	-0.034255	0.5254088	1.9E-05	2.527E-05	240	4,997	1482.5	
T	-1.961563659	30.105156	1492.3	-0.034236	0.5254341	1.563E-05	2.285E-05	202	5,199	1492.3	
T	-1.960667851	30.106465	1502.5	-0.03422	0.5254569	4.424E-06	2.101E-05	177	5,375	1502.5	
T	-1.960414357	30.107669	1511.4	-0.034216	0.525478	6.063E-08	1.635E-05	137	5,512	1511.4	
T	-1.960410883	30.108606	1510.4	-0.034216	0.5254943	4.527E-06	5.899E-06	104	5,616	1510.4	
T	-1.960151483	30.108944	1510.6	-0.034211	0.5255002	-7.77E-07	6.527E-06	47	5,664	1510.6	
T	-1.960195993	30.109318	1509.8	-0.034212	0.5255067	5.853E-06	8.024E-07	42	5,706	1509.8	
T	-1.959860654	30.109364	1510.9	-0.034206	0.5255075	4.115E-06	-2.01E-06	38	5,743	1510.9	
T	-1.95962487	30.109249	1511.3	-0.034202	0.5255055	1.309E-05	1.672E-05	29	5,773	1511.3	
T	-1.958875001	30.110207	1508.4	-0.034189	0.5255223	6.147E-06	6.375E-06	135	5,908	1508.4	
T	-1.95852278	30.110572	1509.5	-0.034183	0.5255286	5.624E-06	9.341E-06	56	5,965	1509.5	**Shez Lando**
3. ShezLando-Remera											
T	-1.95820057	30.111108	1511.4	-0.034177	0.525538	1.146E-05	-4.09E-06		0	1511.4	
T	-1.957543808	30.110873	1511.1	-0.034166	0.5255339	4.537E-05	2.834E-05	78	78	1511.1	
T	-1.954944075	30.112496	1516.8	-0.03412	0.5255622	4.444E-05	3.372E-05	341	419	1516.8	
T	-1.952397959	30.114429	1515.7	-0.034076	0.5255959	4.918E-05	6.214E-05	356	775	1515.7	
T	-1.949580338	30.117989	1518.1	-0.034027	0.5256581	8.264E-06	1.832E-05	505	1,280	1518.1	
T	-1.949106835	30.119038	1511.9	-0.034018	0.5256764	-1.28E-05	1.768E-05	128	1,408	1511.9	
T	-1.9498386	30.120051	1519.7	-0.034031	0.5256941	-1.84E-05	-1.85E-06	139	1,547	1519.7	
T	-1.95089471	30.119945	1525.3	-0.03405	0.5256922	-5.39E-06	-5.97E-06	118	1,665	1525.3	
T	-1.951203446	30.119603	1526.7	-0.034055	0.5256862	0.0340549	-0.525686	51	1,717	1526.7	**Remera**

2-2. Calculation of Optimum Diamter for the Central Transmission Main

Parameters

C=	130					
L(A)=	18,400 m	Sta. Head	155.0	Elevation	Nzove	1,369 m
L(B1)=	5,800 m	Sta. Head	60.0		Kimisagar	1,429 m
L(B2)=	6,900 m	Sta. Head	-17.0		Gikondo L	1,412 m
L(B3)=	5,700 m	Sta. Head	112.0		Remera	1,524 m
Pump Efficiency		etaP	0.8			
Motor Efficiency		etaM	0.9			
Evaluation Period	20 years					
Social Discount Rate	6%					
Unit electr	148.68 Rwf/kW					
	0.1643 USD/kW					
Exchange	905 Rwf/USD					

A	Q=	82,000 m3/day
B(1)	Q=	82,000 m3/day
B(2)	Q=	79,000 m3/day
B(3)	Q=	56,600 m3/day

A

D (mm)	Q (m3/day)	A (m2)	Q (m3/sec)	V (m/sec)	I (‰)	C	L	USD/m	MUSD /Pipe Section	Total Head	Nos. Pumps	Pump kW	Pump Price, MUSD	**Total Initial, MUSD**	Electricity, kWh/year	Electricity, MUSD/year	O&M MUSD/year	**O&M cost in Evaluation Period**	**Total Cost**
300	82,000	0.071	0.949	13.43	418.44	130	18,400	753	13.86	7,854	5	20,293			888,833,400	146.02			
350	82,000	0.096	0.949	9.86	197.52	130	18,400	879	16.17	3,789	5	9,790			428,802,000	70.45			
400	82,000	0.126	0.949	7.55	103.08	130	18,400	902	16.60	2,052	5	5,301			232,183,800	38.14			
450	82,000	0.159	0.949	5.97	58.09	130	18,400	1,025	18.86	1,224	5	3,162			138,495,600	22.75			
500	82,000	0.196	0.949	4.83	34.77	130	18,400	1,130	20.79	795	5	2,054			89,965,200	14.78			
600	82,000	0.283	0.949	3.36	14.31	130	18,400	1,441	26.51	418	5	1,081			47,347,800	7.78			
700	82,000	0.385	0.949	2.47	6.75	130	18,400	1,717	31.59	279	5	722			31,623,600	5.20			
800	82,000	0.503	0.949	1.89	3.53	130	18,400	1,960	36.06	220	5	569			24,922,200	4.09			
900	82,000	0.636	0.949	1.49	1.99	130	18,400	2,470	45.45	192	5	495	1.40	**46.8**	21,681,000	3.56	0.093	**43.2**	**90.1**
1000	82,000	0.785	0.949	1.21	1.19	130	18,400	2,640	48.58	177	5	457	1.36	**49.9**	20,016,600	3.29	0.091	**40.0**	**89.9**
1100	82,000	0.950	0.949	1.00	0.75	130	18,400	3,410	62.74	169	5	436	1.34	**64.1**	19,096,800	3.14	0.089	**38.2**	**102.3**
1200	82,000	1.131	0.949	0.84	0.49	130	18,400	3,663	67.40	164	5	424	1.32	**68.7**	18,571,200	3.05	0.088	**37.1**	**105.9**

B1

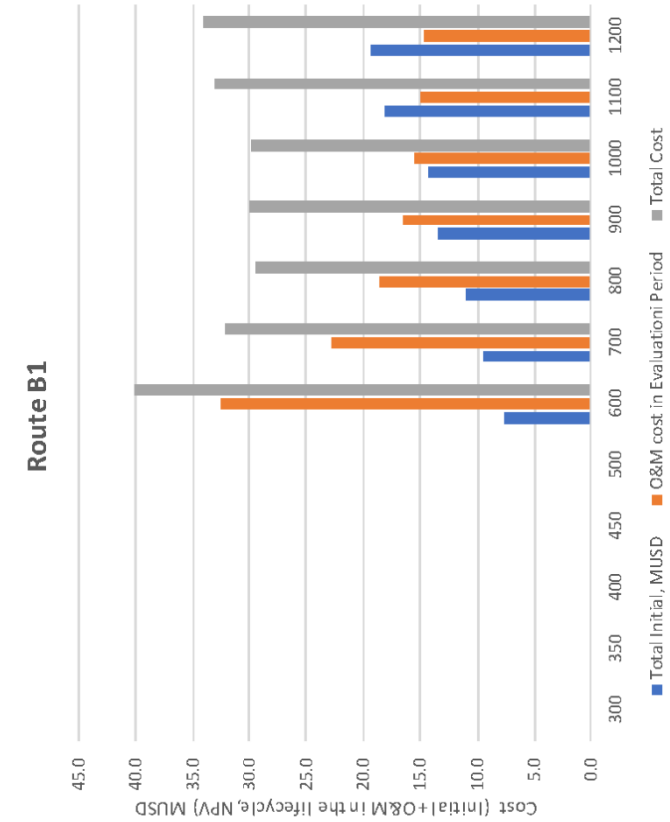
D (mm)	Q (m3/day)	A (m2)	Q (m3/sec)	V (m/sec)	I (‰)	C	L	USD/m	MUSD /Pipe Section	Total Head	Nos. Pumps	Pump kW	Pump Price, USD	Total Initial, MUSD	Electricity, kWh/year	Electricity, MUSD/year	O&M MUSD/year	**O&M cost in Evaluation Period**	**Total Cost**
300	82,000	0.071	0.949	13.43	418.44	130	5,800	579	3.36	2,487	5	6,426			281,458,800	46.24			
350	82,000	0.096	0.949	9.86	197.52	130	5,800	676	3.92	1,206	5	3,115			136,437,000	22.41			
400	82,000	0.126	0.949	7.55	103.08	130	5,800	694	4.02	658	5	1,700			74,460,000	12.23			
450	82,000	0.159	0.949	5.97	58.09	130	5,800	788	4.57	397	5	1,026			44,938,800	7.38			
500	82,000	0.196	0.949	4.83	34.77	130	5,800	869	5.04	262	5	677			29,652,600	4.87			
600	82,000	0.283	0.949	3.36	14.31	130	5,800	1,108	6.43	143	5	370	1.26	**7.7**	16,206,000	2.66	0.084	**32.5**	**40.2**
700	82,000	0.385	0.949	2.47	6.75	130	5,800	1,431	8.30	99	5	257	1.10	**9.4**	11,256,600	1.85	0.073	**22.7**	**32.1**
800	82,000	0.503	0.949	1.89	3.53	130	5,800	1,704	9.89	80	5	208	1.02	**10.9**	9,110,400	1.50	0.068	**18.5**	**29.4**
900	82,000	0.636	0.949	1.49	1.99	130	5,800	2,148	12.46	72	5	185	0.98	**13.4**	8,103,000	1.33	0.065	**16.5**	**30.0**
1000	82,000	0.785	0.949	1.21	1.19	130	5,800	2,296	13.31	67	5	173	0.95	**14.3**	7,577,400	1.24	0.064	**15.5**	**29.8**
1100	82,000	0.950	0.949	1.00	0.75	130	5,800	2,965	17.20	64	5	167	0.94	**18.1**	7,314,600	1.20	0.063	**15.0**	**33.1**
1200	82,000	1.131	0.949	0.84	0.49	130	5,800	3,185	18.47	63	5	163	0.93	**19.4**	7,139,400	1.17	0.062	**14.6**	**34.0**

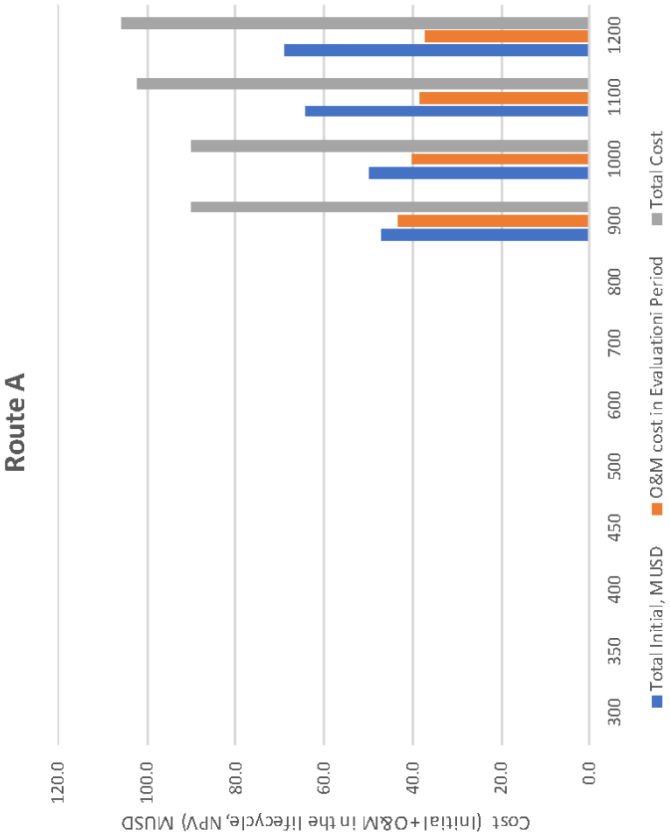
B2

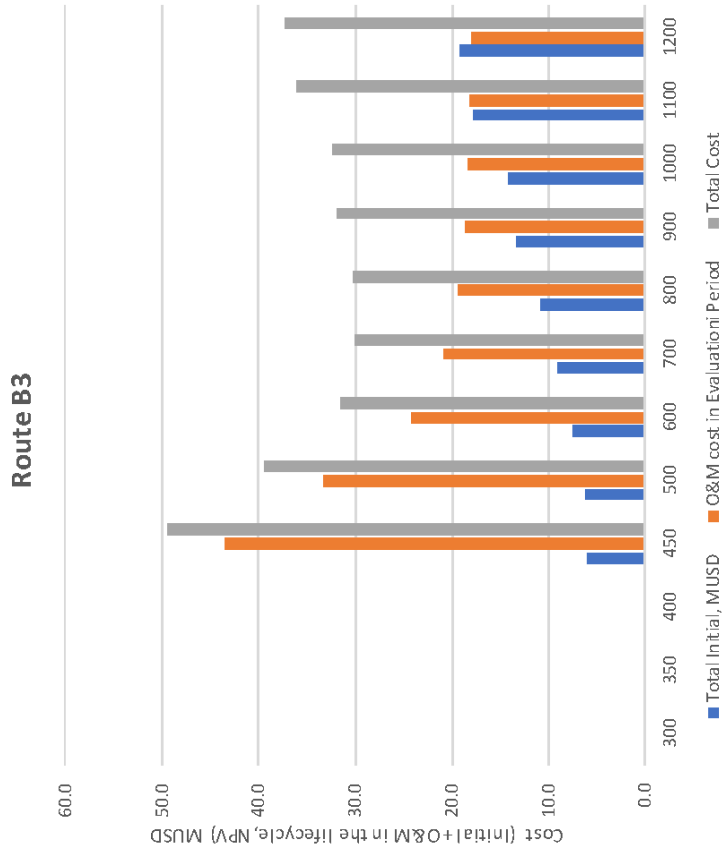
D (mm)	Q (m3/day)	A (m2)	Q (m3/sec)	V (m/sec)	I (‰)	C	L	USD/m	MUSD /Pipe Section	Total Head	Nos. Pumps	Pump kW	Pump Price, USD	Total Initial, MUSD	Electricity, kWh/year	Electricity, MUSD/year	O&M MUSD/year	O&M cost in Evaluation Period	Total Cost
300	79,000	0.071	0.914	12.94	390.56	130	6,900	579	4.00	2,678				**4.0**					**4.0**
350	79,000	0.096	0.914	9.50	184.35	130	6,900	676	4.67	1,255				**4.7**					**4.7**
400	79,000	0.126	0.914	7.28	96.21	130	6,900	694	4.79	647				**4.8**					**4.8**
450	79,000	0.159	0.914	5.75	54.22	130	6,900	788	5.44	357				**5.4**					**5.4**
500	79,000	0.196	0.914	4.66	32.46	130	6,900	869	6.00	207				**6.0**					**6.0**
600	79,000	0.283	0.914	3.23	13.36	130	6,900	1,108	7.65	75				**7.6**					**7.6**
700	79,000	0.385	0.914	2.38	6.30	130	6,900	1,431	9.87	26				**9.9**					**9.9**
800	79,000	0.503	0.914	1.82	3.29	130	6,900	1,704	11.76	6				**11.8**					**11.8**
900	79,000	0.636	0.914	1.44	1.85	130	6,900	2,148	14.82	-4				**14.8**					**14.8**
1000	79,000	0.785	0.914	1.16	1.11	130	6,900	2,296	15.84	-9				**15.8**					**15.8**
1100	79,000	0.950	0.914	0.96	0.70	130	6,900	2,965	20.46	-12				**20.5**					**20.5**
1200	79,000	1.131	0.914	0.81	0.46	130	6,900	3,185	21.98	-14				**22.0**					**22.0**

B3

D (mm)	Q (m3/day)	A (m2)	Q (m3/sec)	V (m/sec)	I (‰)	C	L	USD/m	ID/Pipe Se	Total Head	Nos. Pumps	Pump kW	Pump Price, USD	Total Initial, MUSD	Electricity, kWh/year	Electricity, MUSD/year	O&M MUSD/year	O&M cost in Evaluation Period	Total Cost
300	56,600	0.071	0.655	9.27	210.76	130	5,700	579	3.30	1,313	5	2,343			102,623,400	16.86			
350	56,600	0.096	0.655	6.81	99.48	130	5,700	676	3.85	679	5	1,211			53,041,800	8.71			
400	56,600	0.126	0.655	5.21	51.92	130	5,700	694	3.95	408	5	728			31,886,400	5.24			
450	56,600	0.159	0.655	4.12	29.26	130	5,700	788	4.49	279	5	498	1.40	**5.9**	21,812,400	3.58	0.093	**43.5**	**49.4**
500	56,600	0.196	0.655	3.34	17.51	130	5,700	869	4.95	212	5	378	1.27	**6.2**	16,556,400	2.72	0.085	**33.2**	**39.4**
600	56,600	0.283	0.655	2.32	7.21	130	5,700	1,108	6.32	153	5	273	1.13	**7.4**	11,957,400	1.96	0.075	**24.1**	**31.6**
700	56,600	0.385	0.655	1.70	3.40	130	5,700	1,431	8.16	131	5	235	1.07	**9.2**	10,293,000	1.69	0.071	**20.8**	**30.1**
800	56,600	0.503	0.655	1.30	1.78	130	5,700	1,704	9.71	122	5	218	1.04	**10.8**	9,548,400	1.57	0.069	**19.4**	**30.1**
900	56,600	0.636	0.655	1.03	1.00	130	5,700	2,148	12.24	118	5	210	1.02	**13.3**	9,198,000	1.51	0.068	**18.7**	**32.0**
1000	56,600	0.785	0.655	0.83	0.60	130	5,700	2,296	13.09	115	5	206	1.02	**14.1**	9,022,800	1.48	0.068	**18.3**	**32.4**
1100	56,600	0.950	0.655	0.69	0.38	130	5,700	2,965	16.90	114	5	204	1.01	**17.9**	8,935,200	1.47	0.068	**18.2**	**36.1**
1200	56,600	1.131	0.655	0.58	0.25	130	5,700	3,185	18.16	113	5	203	1.01	**19.2**	8,891,400	1.46	0.067	**18.1**	**37.2**

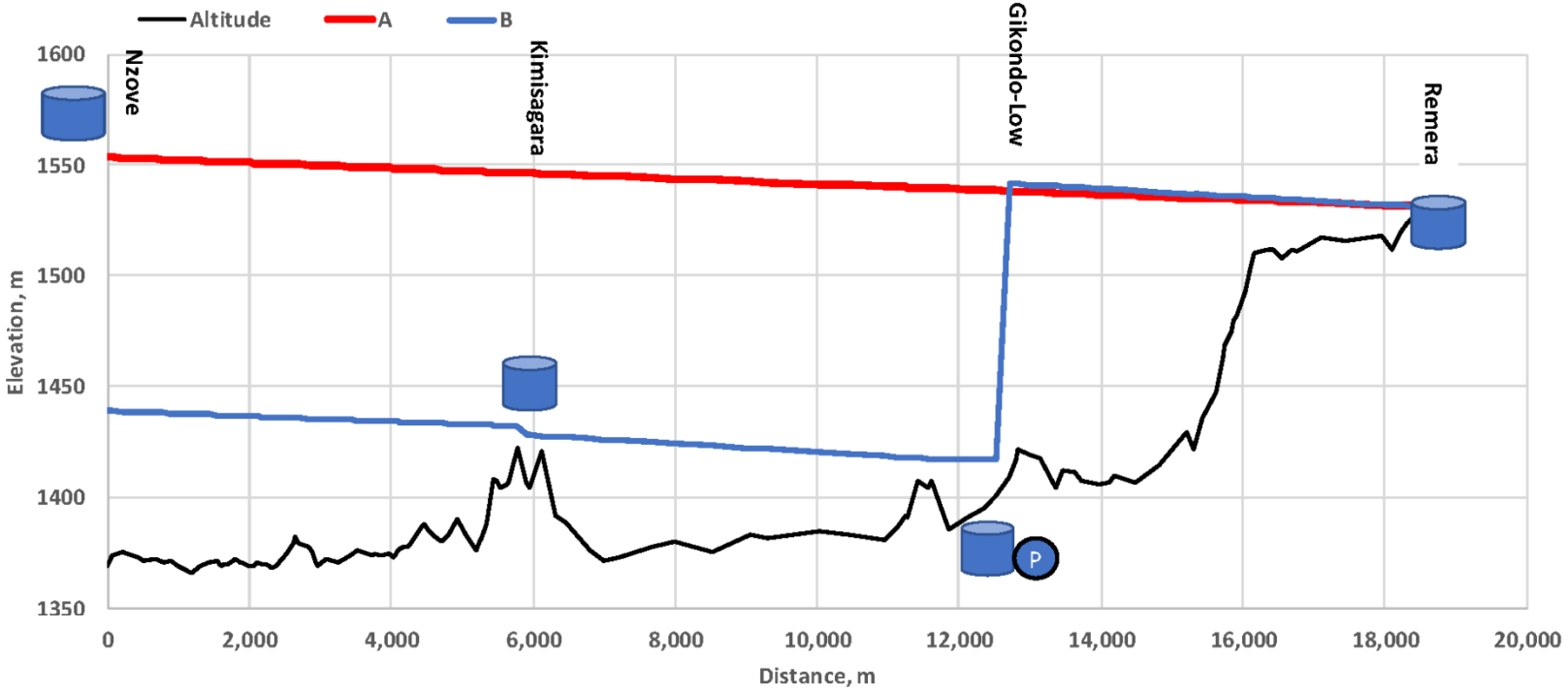

Route B1
Cost (Initial+O&M in the lifecycle, NPV) MUSD
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
300
350
400
450
500
600
700
800
900
1000
1100
1200
Total Initial, MUSD
O&M cost in Evaluationi Period
Total Cost


Route A
Cost (Initial+O&M in the lifecycle, NPV) MUSD
120.0
100.0
80.0
60.0
40.0
20.0
0.0
300
350
400
450
500
600
700
800
900
1000
1100
1200
Total Initial, MUSD
O&M cost in Evaluationi Period
Total Cost


Route B3
Cost (Initial+O&M in the lifecycle, NPV) MUSD
60.0
50.0
40.0
30.0
20.0
10.0
0.0
300
350
400
450
500
600
700
800
900
1000
1100
1200
Total Initial, MUSD
O&M cost in Evaluationi Period
Total Cost

2-3. Profiles of Selected Route for Central Main

Selected Route Nzove-0-1A-2 18.4km



Kimisagara-RwandaU-Kucukiro-Remera

type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude	**Location**	A	permil	B	permil
T	-1.9424	30.001	1369	-0.0339	0.5236	9E-06	6E-06		0	1369	**Nzove**	1,554	1.2	1,439	1.2
T	-1.9419	30.002	1373.6	-0.0339	0.5236	-1E-05	2E-05	65	65	1373.6		1,553	1.2	1,439	1.2
T	-1.9427	30.003	1375.8	-0.0339	0.5236	-2E-05	3E-05	159	224	1375.8		1,553	1.2	1,439	1.2
T	-1.9436	30.004	1373.5	-0.0339	0.5237	-1E-07	2E-07	205	430	1373.5		1,553	1.2	1,439	1.2
T	-1.9436	30.004	1373.4	-0.0339	0.5237	-3E-06	1E-05	1	431	1373.4		1,553	1.2	1,439	1.2
T	-1.9438	30.005	1371.9	-0.0339	0.5237	-5E-06	2E-05	76	507	1371.9		1,553	1.2	1,438	1.2
T	-1.9441	30.006	1372.6	-0.0339	0.5237	-7E-06	2E-05	161	669	1372.6		1,553	1.2	1,438	1.2
T	-1.9445	30.007	1371.1	-0.0339	0.5237	-6E-06	2E-05	120	788	1371.1		1,553	1.2	1,438	1.2
T	-1.9448	30.008	1371.3	-0.0339	0.5237	-6E-06	1E-05	108	896	1371.3		1,553	1.2	1,438	1.2
T	-1.9452	30.009	1369.5	-0.0339	0.5238	-8E-06	3E-05	100	996	1369.5		1,552	1.2	1,438	1.2
T	-1.9457	30.011	1366.4	-0.034	0.5238	-7E-06	2E-05	191	1,187	1366.4		1,552	1.2	1,438	1.2
T	-1.9461	30.012	1369.5	-0.034	0.5238	-5E-06	2E-05	118	1,305	1369.5		1,552	1.2	1,438	1.2
T	-1.9463	30.013	1371	-0.034	0.5238	-8E-07	2E-05	134	1,439	1371		1,552	1.2	1,437	1.2
T	-1.9464	30.014	1371.3	-0.034	0.5238	-3E-06	1E-05	105	1,544	1371.3		1,552	1.2	1,437	1.2
T	-1.9465	30.014	1368.9	-0.034	0.5239	-1E-06	6E-06	67	1,611	1368.9		1,552	1.2	1,437	1.2
T	-1.9466	30.015	1369.8	-0.034	0.5239	-5E-06	8E-06	39	1,650	1369.8		1,552	1.2	1,437	1.2
T	-1.9469	30.015	1370.3	-0.034	0.5239	-1E-06	1E-05	59	1,709	1370.3		1,552	1.2	1,437	1.2
T	-1.947	30.016	1371.6	-0.034	0.5239	-6E-07	4E-06	66	1,775	1371.6		1,551	1.2	1,437	1.2
T	-1.947	30.016	1372.3	-0.034	0.5239	-2E-06	6E-06	27	1,803	1372.3		1,551	1.2	1,437	1.2
T	-1.9472	30.016	1371.4	-0.034	0.5239	-1E-06	4E-06	41	1,843	1371.4		1,551	1.2	1,437	1.2
T	-1.9472	30.017	1370.8	-0.034	0.5239	-2E-06	5E-06	23	1,867	1370.8		1,551	1.2	1,437	1.2
T	-1.9473	30.017	1370.7	-0.034	0.5239	-6E-06	1E-05	33	1,899	1370.7		1,551	1.2	1,437	1.2
T	-1.9476	30.018	1369.2	-0.034	0.5239	-1E-06	5E-06	85	1,984	1369.2		1,551	1.2	1,437	1.2
T	-1.9477	30.018	1369	-0.034	0.5239	3E-09	6E-06	34	2,018	1369		1,551	1.2	1,437	1.2
T	-1.9477	30.018	1369.5	-0.034	0.5239	8E-07	9E-06	39	2,057	1369.5		1,551	1.2	1,437	1.2
T	-1.9477	30.019	1371.2	-0.034	0.5239	-4E-06	9E-06	55	2,112	1371.2		1,551	1.2	1,437	1.2
T	-1.9479	30.019	1370.3	-0.034	0.5239	-4E-06	9E-06	66	2,178	1370.3		1,551	1.2	1,436	1.2

T	-1.9482	30.02	1370.1	-0.034	0.5239	-2E-06	7E-06	62	2,240	1370.1		1,551	1.2	1,436	1.2
T	-1.9483	30.02	1369.1	-0.034	0.524	1E-06	4E-06	47	2,287	1369.1		1,551	1.2	1,436	1.2
T	-1.9482	30.02	1368.6	-0.034	0.524	2E-06	3E-06	29	2,316	1368.6		1,551	1.2	1,436	1.2
T	-1.9481	30.021	1368.7	-0.034	0.524	6E-06	4E-06	24	2,341	1368.7		1,551	1.2	1,436	1.2
T	-1.9477	30.021	1369.5	-0.034	0.524	1E-05	2E-05	47	2,387	1369.5		1,551	1.2	1,436	1.2
T	-1.947	30.022	1374.4	-0.034	0.524	8E-06	1E-05	129	2,517	1374.4		1,551	1.2	1,436	1.2
T	-1.9465	30.022	1379.8	-0.034	0.524	9E-07	4E-06	93	2,610	1379.8		1,550	1.2	1,436	1.2
T	-1.9465	30.023	1382.6	-0.034	0.524	-2E-06	7E-06	26	2,636	1382.6		1,550	1.2	1,436	1.2
T	-1.9466	30.023	1379.2	-0.034	0.524	-8E-06	2E-05	47	2,683	1379.2		1,550	1.2	1,436	1.2
T	-1.9471	30.024	1378	-0.034	0.524	-4E-06	9E-06	146	2,829	1378		1,550	1.2	1,436	1.2
T	-1.9473	30.025	1375.3	-0.034	0.524	-3E-06	7E-06	62	2,890	1375.3		1,550	1.2	1,436	1.2
T	-1.9474	30.025	1371.1	-0.034	0.524	-5E-07	4E-06	48	2,938	1371.1		1,550	1.2	1,436	1.2
T	-1.9475	30.025	1369.5	-0.034	0.524	1E-05	1E-05	27	2,965	1369.5		1,550	1.2	1,436	1.2
T	-1.9469	30.026	1372.2	-0.034	0.5241	2E-05	2E-05	110	3,075	1372.2		1,550	1.2	1,435	1.2
T	-1.9459	30.027	1370.9	-0.034	0.5241	2E-05	2E-05	177	3,252	1370.9		1,550	1.2	1,435	1.2
T	-1.9449	30.029	1373.9	-0.0339	0.5241	6E-06	1E-05	177	3,429	1373.9		1,549	1.2	1,435	1.2
T	-1.9445	30.029	1376.3	-0.0339	0.5241	5E-06	3E-05	91	3,519	1376.3		1,549	1.2	1,435	1.2
T	-1.9442	30.031	1374.2	-0.0339	0.5241	1E-06	6E-06	208	3,727	1374.2		1,549	1.2	1,435	1.2
T	-1.9441	30.032	1374.7	-0.0339	0.5242	8E-06	1E-05	40	3,767	1374.7		1,549	1.2	1,435	1.2
T	-1.9437	30.032	1373.8	-0.0339	0.5242	8E-06	9E-06	101	3,868	1373.8		1,549	1.2	1,434	1.2
T	-1.9432	30.033	1374.8	-0.0339	0.5242	4E-06	6E-06	81	3,949	1374.8		1,549	1.2	1,434	1.2
T	-1.943	30.033	1375	-0.0339	0.5242	-2E-06	3E-06	45	3,994	1375		1,549	1.2	1,434	1.2
T	-1.9431	30.033	1373.1	-0.0339	0.5242	-2E-06	5E-06	25	4,019	1373.1		1,549	1.2	1,434	1.2
T	-1.9432	30.034	1373.9	-0.0339	0.5242	-6E-07	4E-06	37	4,057	1373.9		1,549	1.2	1,434	1.2
T	-1.9433	30.034	1375.5	-0.0339	0.5242	3E-06	6E-06	25	4,082	1375.5		1,549	1.2	1,434	1.2
T	-1.9431	30.034	1377.1	-0.0339	0.5242	3E-06	9E-06	44	4,125	1377.1		1,549	1.2	1,434	1.2
T	-1.9429	30.035	1377.5	-0.0339	0.5242	7E-07	5E-06	61	4,186	1377.5		1,549	1.2	1,434	1.2
T	-1.9429	30.035	1377.7	-0.0339	0.5242	-1E-06	7E-06	35	4,221	1377.7		1,549	1.2	1,434	1.2
T	-1.943	30.036	1379.3	-0.0339	0.5242	-5E-06	2E-05	46	4,267	1379.3		1,549	1.2	1,434	1.2
T	-1.9433	30.037	1384.5	-0.0339	0.5242	-1E-06	5E-06	106	4,373	1384.5		1,548	1.2	1,434	1.2

T	-1.9433	30.037	1386.7	-0.0339	0.5242	-6E-07	8E-06	35	4,408	1386.7		1,548	1.2	1,434	1.2
T	-1.9434	30.037	1388.4	-0.0339	0.5242	1E-06	7E-06	53	4,461	1388.4		1,548	1.2	1,434	1.2
T	-1.9433	30.038	1385.6	-0.0339	0.5243	4E-06	2E-05	46	4,507	1385.6		1,548	1.2	1,434	1.2
T	-1.9431	30.039	1382.5	-0.0339	0.5243	3E-06	2E-05	103	4,610	1382.5		1,548	1.2	1,434	1.2
T	-1.9429	30.04	1380	-0.0339	0.5243	-5E-07	1E-05	112	4,722	1380		1,548	1.2	1,433	1.2
T	-1.9429	30.04	1383	-0.0339	0.5243	2E-06	2E-05	91	4,813	1383		1,548	1.2	1,433	1.2
T	-1.9428	30.041	1390.2	-0.0339	0.5243	3E-06	2E-05	123	4,936	1390.2		1,548	1.2	1,433	1.2
T	-1.9426	30.042	1383.1	-0.0339	0.5243	9E-06	2E-05	112	5,048	1383.1		1,548	1.2	1,433	1.2
T	-1.9421	30.044	1376.7	-0.0339	0.5244	-3E-06	8E-06	149	5,197	1376.7		1,547	1.2	1,433	1.2
T	-1.9423	30.044	1380.2	-0.0339	0.5244	-3E-06	1E-06	54	5,251	1380.2		1,547	1.2	1,433	1.2
T	-1.9425	30.044	1382.1	-0.0339	0.5244	-8E-06	-5E-06	21	5,272	1382.1		1,547	1.2	1,433	1.2
T	-1.9429	30.044	1387.7	-0.0339	0.5244	-9E-06	-2E-06	62	5,334	1387.7		1,547	1.2	1,433	1.2
T	-1.9435	30.044	1398.3	-0.0339	0.5244	-7E-06	3E-06	59	5,393	1398.3		1,547	1.2	1,433	1.2
T	-1.9439	30.044	1408	-0.0339	0.5244	-2E-06	5E-06	48	5,441	1408		1,547	1.2	1,433	1.2
T	-1.944	30.044	1407.3	-0.0339	0.5244	2E-06	9E-06	37	5,477	1407.3		1,547	1.2	1,433	1.2
T	-1.9439	30.045	1404.1	-0.0339	0.5244	6E-06	1E-05	59	5,536	1404.1		1,547	1.2	1,432	1.2
T	-1.9435	30.046	1406.4	-0.0339	0.5244	1E-06	4E-06	101	5,637	1406.4		1,547	1.2	1,432	1.2
T	-1.9434	30.046	1407.3	-0.0339	0.5244	-2E-05	2E-06	24	5,661	1407.3		1,547	1.2	1,432	1.2
T	-1.9445	30.046	1422.2	-0.0339	0.5244	2E-05	-2E-06	118	5,778	1422.2	**Kimisagara**	1,547	1.2	1,432	1.2
T	-1.9434	30.046	1406.5	-0.0339	0.5244	1E-06	9E-06	124	5,902	1406.5		1,547	1.2	1,428	1.9
T	-1.9433	30.046	1404.2	-0.0339	0.5244	-2E-05	2E-05	59	5,962	1404.2		1,546	1.2	1,428	1.9
T	-1.9444	30.047	1420.7	-0.0339	0.5244	9E-06	3E-05	168	6,130	1420.7		1,546	1.2	1,428	1.9
T	-1.9439	30.049	1392	-0.0339	0.5245	2E-05	-9E-06	191	6,321	1392		1,546	1.2	1,427	1.9
T	-1.9429	30.049	1388.5	-0.0339	0.5244	3E-05	-5E-05	129	6,450	1388.5		1,546	1.2	1,427	1.9
T	-1.9414	30.046	1376.7	-0.0339	0.5244	3E-05	-2E-05	343	6,793	1376.7	**BS**	1,545	1.2	1,427	1.9
T	-1.94	30.045	1371.3	-0.0339	0.5244	8E-06	3E-05	194	6,987	1371.3		1,545	1.2	1,426	1.9
T	-1.9395	30.047	1373.1	-0.0339	0.5244	3E-05	6E-05	218	7,205	1373.1		1,545	1.2	1,426	1.9
T	-1.9375	30.05	1377.8	-0.0338	0.5245	3E-05	4E-05	463	7,667	1377.8		1,544	1.2	1,425	1.9
T	-1.9359	30.053	1380.5	-0.0338	0.5245	1E-05	8E-05	323	7,990	1380.5		1,544	1.2	1,424	1.9
T	-1.9351	30.057	1375.3	-0.0338	0.5246	-2E-05	8E-05	527	8,517	1375.3		1,543	1.2	1,423	1.9

T	-1.9362	30.062	1383.2	-0.0338	0.5247	-1E-05	4E-05	535	9,053	1383.2		1,543	1.2	1,422	1.9
T	-1.937	30.064	1381.5	-0.0338	0.5247	-7E-05	9E-05	262	9,315	1381.5		1,542	1.2	1,422	1.9
T	-1.9411	30.069	1385.3	-0.0339	0.5248	-5E-05	4E-05	726	10,041	1385.3		1,542	1.2	1,421	1.9
T	-1.9438	30.072	1383	-0.0339	0.5249	-7E-05	4E-05	412	10,453	1383		1,541	1.2	1,420	1.9
T	-1.9476	30.074	1381.2	-0.034	0.5249	-3E-05	3E-06	501	10,955	1381.2		1,541	1.2	1,419	1.9
T	-1.949	30.075	1386.1	-0.034	0.5249	-2E-05	-2E-06	164	11,118	1386.1		1,540	1.2	1,419	1.9
T	-1.9502	30.074	1392	-0.034	0.5249	2E-06	6E-07	132	11,251	1392	***Confluent with Pink**	1,540	1.2	1,418	1.9
T	-1.9501	30.075	1391.1	-0.034	0.5249	-2E-05	-6E-06	15	11,265	1391.1		1,540	1.2	1,418	1.9
T	-1.9514	30.074	1401.2	-0.0341	0.5249	-2E-05	-4E-06	152	11,417	1407.8		1,540	1.2	1,418	1.9
T	-1.9527	30.074	1404.3	-0.0341	0.5249	-7E-06	-4E-06	147	11,564	1404.3		1,540	1.2	1,418	1.9
T	-1.9531	30.074	1407.8	-0.0341	0.5249	-3E-05	3E-05	51	11,615	1407.8	**Rwanda U**	1,540	1.2	1,418	1.9
T	-1.9546	30.075	1385.8	-0.0341	0.5249	-6E-06	4E-05	237	11,852	1385.8		1,539	1.2	1,418	1.9
T	-1.9549	30.078	1391.3	-0.0341	0.525	-3E-05	1E-05	262	12,114	1391.3		1,539	1.2	1,418	1.9
T	-1.9569	30.078	1394.8	-0.0342	0.525	-2E-05	2E-05	231	12,345	1394.8		1,539	1.2	1,418	1.9
T	-1.9581	30.079	1400.8	-0.0342	0.525	-2E-05	3E-05	178	12,522	1400.8		1,539	1.2	1,418	1.9
T	-1.9591	30.081	1409.1	-0.0342	0.525	-7E-06	1E-05	194	12,716	1409.1		1,538	1.2	1,542	1.8
T	-1.9595	30.081	1416.8	-0.0342	0.525	-9E-07	4E-06	87	12,803	1416.8		1,538	1.2	1,542	1.8
T	-1.9595	30.082	1421.7	-0.0342	0.525	-2E-05	2E-05	28	12,832	1421.7		1,538	1.2	1,542	1.8
T	-1.9606	30.083	1419.1	-0.0342	0.525	-1E-05	2E-05	155	12,987	1419.1		1,538	1.2	1,541	1.8
T	-1.9612	30.084	1417.9	-0.0342	0.5251	-2E-05	3E-05	148	13,134	1417.9		1,538	1.2	1,541	1.8
T	-1.9625	30.085	1404.6	-0.0343	0.5251	-4E-07	2E-05	234	13,368	1404.6		1,538	1.2	1,541	1.8
T	-1.9626	30.086	1412.5	-0.0343	0.5251	-5E-06	3E-05	101	13,470	1412.5		1,538	1.2	1,540	1.8
T	-1.9629	30.088	1411.8	-0.0343	0.5251	-3E-06	1E-05	166	13,636	1411.8		1,537	1.2	1,540	1.8
T	-1.963	30.089	1407.4	-0.0343	0.5251	2E-06	4E-05	92	13,728	1407.4		1,537	1.2	1,540	1.8
T	-1.9629	30.091	1406	-0.0343	0.5252	9E-06	2E-05	239	13,967	1406		1,537	1.2	1,540	1.8
T	-1.9624	30.092	1407	-0.0342	0.5252	2E-06	9E-06	155	14,122	1407		1,537	1.2	1,539	1.8
T	-1.9623	30.092	1410	-0.0342	0.5252	-1E-05	5E-05	58	14,180	1410		1,537	1.2	1,539	1.8
T	-1.9629	30.095	1407	-0.0343	0.5253	-5E-07	1E-05	299	14,478	1407		1,536	1.2	1,539	1.8
T	-1.963	30.096	1408.1	-0.0343	0.5253	2E-05	3E-05	70	14,548	1408.1		1,536	1.2	1,539	1.8

T	-1.9617	30.098	1414.7	-0.0342	0.5253	5E-05	4E-05	263	14,811	1414.7		1,536	1.2	1,538	1.8
T	-1.959	30.1	1429.4	-0.0342	0.5253	-6E-06	1E-05	406	15,217	1429.4		1,535	1.2	1,537	1.8
T	-1.9593	30.101	1421.9	-0.0342	0.5254	4E-06	2E-05	84	15,301	1421.9		1,535	1.2	1,537	1.8
T	-1.9591	30.102	1435.7	-0.0342	0.5254	-2E-05	3E-05	121	15,422	1435.7		1,535	1.2	1,537	1.8
T	-1.96	30.103	1447.5	-0.0342	0.5254	4E-07	1E-05	203	15,624	1447.5		1,535	1.2	1,537	1.8
T	-1.96	30.104	1462.8	-0.0342	0.5254	-4E-06	4E-06	90	15,714	1462.8		1,535	1.2	1,536	1.8
T	-1.9602	30.105	1468.3	-0.0342	0.5254	-5E-06	2E-06	36	15,750	1468.3		1,535	1.2	1,536	1.8
T	-1.9605	30.105	1471.5	-0.0342	0.5254	-8E-06	3E-07	32	15,782	1471.5		1,535	1.2	1,536	1.8
T	-1.9609	30.105	1474.6	-0.0342	0.5254	-3E-06	3E-06	48	15,830	1474.6		1,535	1.2	1,536	1.8
T	-1.9611	30.105	1479.8	-0.0342	0.5254	7E-06	7E-06	27	15,856	1479.8		1,535	1.2	1,536	1.8
T	-1.9606	30.105	1482.3	-0.0342	0.5254	1E-05	1E-05	64	15,920	1482.3		1,535	1.2	1,536	1.8
T	-1.9601	30.106	1492.6	-0.0342	0.5254	5E-06	1E-05	103	16,023	1492.6		1,535	1.2	1,536	1.8
T	-1.9598	30.107	1503.7	-0.0342	0.5255	1E-06	9E-06	86	16,108	1503.7		1,534	1.2	1,536	1.8
T	-1.9597	30.107	1509.9	-0.0342	0.5255	-5E-06	3E-05	59	16,167	1509.9		1,534	1.2	1,536	1.8
T	-1.96	30.109	1511.6	-0.0342	0.5255	3E-06	7E-07	174	16,341	1511.6		1,534	1.2	1,535	1.8
T	-1.9598	30.109	1511.9	-0.0342	0.5255	4E-06	8E-06	20	16,361	1511.9		1,534	1.2	1,535	1.8
T	-1.9595	30.109	1511.5	-0.0342	0.5255	1E-05	2E-05	56	16,417	1511.5		1,534	1.2	1,535	1.8
T	-1.9588	30.11	1507.9	-0.0342	0.5255	1E-05	2E-05	135	16,552	1507.9	**Shez Lando**	1,534	1.2	1,535	1.8
T	-1.9582	30.111	1511.4	-0.0342	0.5255	1E-05	-4E-06	128	16,680	1511.4		1,534	1.2	1,535	1.8
T	-1.9575	30.111	1511.1	-0.0342	0.5255	5E-05	3E-05	78	16,758	1511.1		1,534	1.2	1,535	1.8
T	-1.9549	30.112	1516.8	-0.0341	0.5256	4E-05	3E-05	341	17,099	1516.8		1,533	1.2	1,534	1.8
T	-1.9524	30.114	1515.7	-0.0341	0.5256	5E-05	6E-05	356	17,455	1515.7		1,533	1.2	1,533	1.8
T	-1.9496	30.118	1518.1	-0.034	0.5257	8E-06	2E-05	505	17,960	1518.1		1,532	1.2	1,532	1.8
T	-1.9491	30.119	1511.9	-0.034	0.5257	-1E-05	2E-05	128	18,088	1511.9		1,532	1.2	1,532	1.8
T	-1.9498	30.12	1519.7	-0.034	0.5257	-2E-05	-2E-06	139	18,227	1519.7		1,532	1.2	1,532	1.8
T	-1.9509	30.12	1525.3	-0.034	0.5257	-5E-06	-6E-06	118	18,346	1525.3		1,532	1.2	1,532	1.8
T	-1.9512	30.12	1526.7	-0.0341	0.5257	0.0341	-0.5257	51	18,397	1526.7	**Remera**	1,532	1.2	1,532	1.8

3-1 Summary of the transmission energy and OM costs

Comparison of Trasmission Energy	kWh/m3	Electricity cost, RWF/m3	OM Cost Reference	Chemical Cost, RWF/m3	Maintenance+Salary, RWF/m3	Total OM Cost RWF/m3
To Remera						
(1) Nzove-Ntora-Remera	0.91	135	Nzove	50	11	196
(2) Karenge-Remera	1.40	208	Karenge	54	23	285
(3) Nzove-MontKigali (-Remera)	2.00	298	Nzove	50	11	359
(4) Kanzenze-Gahanga(-Remera)	0.92	137	Nzove	50	11	198
(5) Central Main (Nzove-Kimisga	0.77	114	Nzove	50	11	175
To Kicukiro						
(1) Nzove-MontKigali-(Nyanza)-	2.00	298	Nzove	50	11	359
(2) Kanzenze-Gahanga-Kicukiro	0.92	137	Nzove	50	11	198
(3) Central Main (Nzove-Kimisag	0.70	105	Nzove	50	11	165
To Gikondo Premier						
(1) Nzove-MontKigali	2.00	298	Nzove	50	11	359
(2) Central Main (Nzove-Kimisag	0.77	114	Nzove	50	11	175
To Lower Gikondo Sector						
(1) Nzove-Ntora-Remera	0.91	135	Nzove	50	11	196
(2) Nzove-MontKigali (-Remera)	2.00	298	Nzove	50	11	359
(3) Central Main (Nzove-Kimisag	0.29	43	Nzove	50	11	104

*Direct Cost, overhead not included

3-2. Proposed Gikondo-Low (Kimihururra) Transmission Reservoir and energy cost comparison

Reservoirs	Allocated Water Demand			Unit Energy		Yearly Cost in 2035		Yearly Cost in 2050		Comparison
	2035 Day Average	2050 Day Average	2050 Day Max	Case A, kWh/m3	Case B, kWh/m3	Case A, MUSD	Case B, MUSD	Case A, MUSD	Case B MUSD	Case B/A
Remera (RM)	41,400	77,200	100,400	0.77	0.91	1.90	2.25	3.54	4.20	84%
Rebero Carrier (RC)	6,100	6,100	7,900	2.00	2.00	0.73	0.73	0.73	0.73	100%
Gikondo Premier (GP)	6,100	11,200	14,600	0.77	2.00	0.28	0.73	0.51	1.35	38%
Gikondo Low (GL) *Proposed	4,600	9,000	11,700	0.29	0.91	0.08	0.25	0.16	0.49	32%
Kicukiro Golf 7 (KC)	11,700	22,100	28,700	0.70	0.92	0.49	0.65	0.93	1.22	76%
Gahanga (GH)				0.92	0.92					
total	69,900	125,600	163,300	-	-	3.5	4.6	5.9	8.0	76%

3-3. Breakdown calculation of energy cost for each route

Nzove-Ntora-Remera		Distance	In	Out	Static Head	Headloss	Pump Head Estimated, m	Pump Head acutal, m	kWh/m3	kW/(m3/day	kWh/month as 12,000 m3/day (500m3/hr)	Electricity Cost RWF/year	Electricity Cost USD/year	Relative cost (Nzove-Ntora=1)	2035 Case 1	2035 Case 2
NZ	NT	9,400	1,364	1,572.5	209	19	227	240	0.91	0.03581	309,381	551,984,412			86,000	86,000
NT	RM	12,300	1,568	1,526	-42										10,000	10,000
Total								**240**	0.91	**0.036**	**309,381**	**551,984,412**	**609,928**	**100%**		
Nzove-MontKigali (-Remera)																
NZ	KR	3,800	1,364	1,565	201	8	209	250	0.95	0.03286	283,928	506,572,584				
KR	MK	2,400	1,561	1,792	231	5	236	280	1.06	0.03715	320,950	572,626,152				
Total								**530**	2.00	**0.070**	**604,878**	**1,079,198,736**	**1,192,485**	**196%**		
Nzove-Kimisgara-Remera																
NZ	KM	5,800	1,364	1,429	65	12	77	77	0.29	0.01207	104,261	186,018,504			37,000	66,000
KM	GL	6,700	1,429	1,412	-17										34,000	63,000
GL	RM	5,900	1,412	1,526	114	12	126	126	0.48	0.01982	171,228	305,497,752			9,500	36,500
Total								**202**	0.77	**0.032**	**275,489**	**491,516,256**	**543,112**	**89%**		
Nzove-Kimisagara-Gikondo Low-Gikondo Premierre																
NZ	KM	5,800	1,364	1,429	65	12	77	77	0.29	0.01207	104,261	186,018,504				
KM	GL	6,700	1,429	1,412	-17											
GL	GP	3,000	1,412	1,532	120	6	126	126	0.48	0.01985	171,500	305,983,440			3500	3500
Total								**203**	0.77	**0.032**	**275,761**	**492,001,944**	**543,649**	**89%**		
Nzove-MontKigali-Gikondo Premierre																
NZ	KR	3,800	1,364	1,565	201	8	209	209	0.79	0.03286	283,928	506,572,584				
KR	MK	2,400	1,561	1,792	231	5	236	236	0.89	0.03715	320,950	572,626,152				
MK	RC	7,800	1,788	1,650	-138											
RC	GP	1,500	1,646	1,532	-114											
Total								**444**	1.68	**0.070**	**604,878**	**1,079,198,736**	**1,192,485**	**196%**		
Nzove-MontKigali-Kicukiro																
NZ	KR	3,800	1,364	1,565	201	8	209	250	0.95	0.03286	283,928	506,572,584				
KR	MK	2,400	1,561	1,792	231	5	236	280	1.06	0.03715	320,950	572,626,152				
MK	RC	7,800	1,788	1,650	-138											
RC	KC	-	1,646	1,514	-132											
Total								**530**	2.00	**0.070**	**604,878**	**1,079,198,736**	**1,192,485**	**196%**		
Nzove-Kimisagara-Gikondo Low-Kicukiro																
NZ	KM	5,800	1,364	1,429	65	12	77	77	0.29	0.01207	104,261	186,018,504				
KM	GL	6,700	1,429	1,412	-17											
GL	KC	3,700	1,412	1,514	102	7	109	109	0.41	0.01723	148,906	265,671,336			12000	12000
Total								**186**	0.70	**0.029**	**253,167**	**451,689,840**	**499,105**	**82%**		
Kanzenze-Gahanga-Kicukiro																
KZ	GH	7600	1,352	1,581	229	15	244	244	0.92	0.03847	332,383	593,025,048				
GH	KC	5000	1,581	1,514	-67											
Total								**244**	0.92	**0.038**	**332,383**	**593,025,048**	**655,276**	**107%**		
Karenge-Bihimbe-Remera																
Mugesera	BH	4000	1,340	1,645	305	8	313	370	1.40							
		26500	1,645	1,526	-119											
								370	1.40							

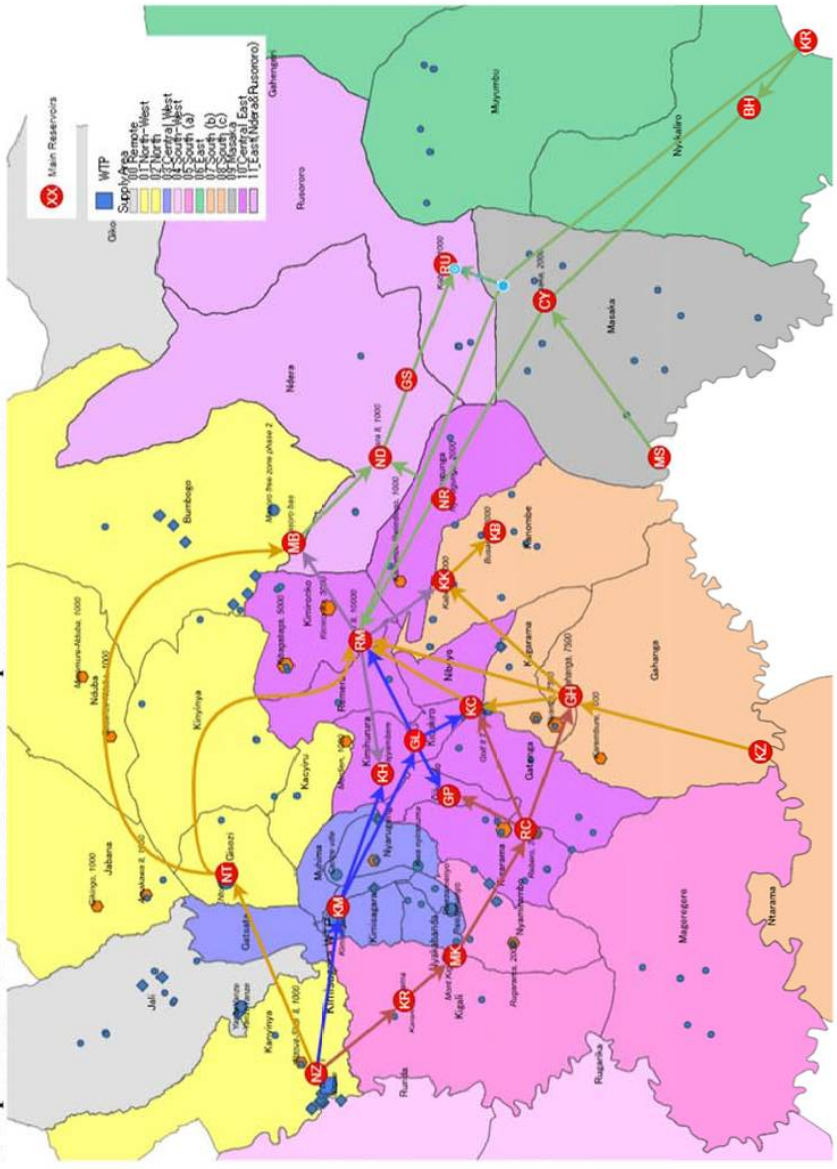
3-4. Summary of Operational Cost calculation for each Water Supply Scenario

Transmission Line	Base Assumption for Estimate							Produced&Transmitted Water Amount					
	Electricity by Transmissio	OM Cost Reference	Electricity by WTP	Electricity cost	Chemical Cost	Maintenance+Salary	Total OM Cost	2035 Case 1	2035 Case 2	2035 Case 3	2050 Case 1	2050 Case 2	2050 Case 3
	kWh/m3		kWh/m3	RWF/m3	RWF/m3	RWF/m3	RWF/m3	m3/day	m3/day	m3/day	m3/day	m3/day	m3/day
Nzove (Nzove-Ntora, North-east area)	0.91	Nzove	0.12	152	50	11	213	93,000	93,000	93,000	161,538	161,538	161,538
Nzove-Karama	0.95	Nzove	0.12	158	50	11	219	13,000	13,000	13,000	29,231	29,231	29,231
Nzove-Mont-Kigali	2.00	Nzove	0.12	315	50	11	376	27,000	27,000	27,000	53,846	53,846	53,846
Kimisagara	0.78	Kimisagara	0.09	129	36	39	204	22,000	22,000	22,000	16,923	16,923	16,923
Nzove-Kimisagara (Central Main)	0.29	Nzove	0.12	60	50	11	121	52,000	82,000	52,000	265,385	45,385	45,385
Kimisagara Area	0.78			116			116	3,000	3,000	3,000	23,136	23,136	23,136
Kimisagara-Central West (Ref. Kicukiro)	0.41			61			61	39,000	39,000	39,000	101,538	26,154	26,154
Kimisagara-East (Remera)	0.48			71			71	10,000	40,000	10,000	144,615	0	0
Karenge	1.57	Karenge	0.13	252	47	24	323	48,000	18,000	18,000	50,769	50,769	270,769
Kanzenze	0.92	Average	0.13	156	47	24	227	48,000	48,000	58,000	125,385	345,385	125,385
Masaka	0.59	Average	0.13	106	47	24	177	20,000	20,000	40,000	89,231	89,231	89,231
Total								**323,000**	**323,000**	**323,000**	**796,213**	**796,213**	**796,213**

Transmission Line	O&M Cost/year (RWF)						Cost/year (USD)					
	2035 Case 1	2035 Case 2	2035 Case 3	2050 Case 1	2050 Case 2	2050 Case 3	2035 Case 1	2035 Case 2	2035 Case 3	2050 Case 1	2050 Case 2	2050 Case 3
	MRWF/year	MRWF/year	MRWF/year	MRWF/year	MRWF/year	MRWF/year	MUSD/year	MUSD/year	MUSD/year	MUSD/year	MUSD/year	MUSD/year
Nzove (Nzove-Ntora, North-east area)	7,232	7,232	7,232	12,562	12,562	12,562	7.94	7.94	7.94	13.79	13.79	13.79
Nzove-Karama	1,038	1,038	1,038	2,333	2,333	2,333	1.14	1.14	1.14	2.56	2.56	2.56
Nzove-Mont-Kigali	3,706	3,706	3,706	7,391	7,391	7,391	4.07	4.07	4.07	8.11	8.11	8.11
Kimisagara	1,640	1,640	1,640	1,262	1,262	1,262	1.80	1.80	1.80	1.38	1.38	1.38
Nzove-Kimisagara (Central Main)	2,300	3,627	2,300	11,740	2,008	2,008	2.53	3.98	2.53	12.89	2.20	2.20
Kimisagara Area	127	127	127	981	981	981	0.14	0.14	0.14	1.08	1.08	1.08
Kimisagara-Central West (Ref. Kicukiro)	875	875	875	2,279	587	587	0.96	0.96	0.96	2.50	0.64	0.64
Kimisagara-East (Remera)	259	1,034	259	3,739	0	0	0.28	1.14	0.28	4.10	0.00	0.00
Karenge	5,653	2,120	2,120	5,980	5,980	31,891	6.21	2.33	2.33	6.56	6.56	35.01
Kanzenze	3,976	3,976	4,804	10,386	28,608	10,386	4.36	4.36	5.27	11.40	31.40	11.40
Masaka	1,291	1,291	2,581	5,758	5,758	5,758	1.42	1.42	2.83	6.32	6.32	6.32
Total	**28,097**	**26,666**	**26,682**	**64,409**	**67,469**	**75,158**	**30.8**	**29.3**	**29.3**	**70.7**	**74.1**	**82.5**

ID	Name	GL
NZ	Nzove	1,364
NT	Ntora	1,570
KM	Kimisagara	1,429
KR	Karama	1,563
MK	Mont Kigali	1,790
GL	Gikondo Low (Proposed)	1,412
GP	Gikondo Premiere	1,530
RC	Rebero Carrier	1,648
KC	Kicukiro (Golf 7)	1,510
RM	Remera (Golf 8)	1,524
GH	Gahanga	1,579
KZ	Kanzenze	1,352
BH	Bihimbe (from Karenge)	1,643
MB	Masoro-bas,	1,524
ND	Ndera,	1,466
RU	Rusororo (Kabuga)	1,468
MS	Masaka,	1,340
CY	Cyimo (Middle)	1,474
NR	Nyarugunga,	1,464
KK	Kanombe Kabeza	1,486
KB	Kanombe Busanza	1,500
GS	Gasogi	1,500

4. Capital Cost Estimate for Transmission Pipelines in 2035 and 2050



Nodes		Description	L, m	Existing Dia, mm	2035												2050															
					Case1				Case2				Case3				Case 1						Case 2						Case 3					
Start	End				Dave_2035, m3/day	Flow, m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2035, m3/day	Flow, m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2035, m3/day	Flow, m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2050, m3/day	Flow, m3/day	Optimum Dia, for total flow mm	Differential flow, (2050-2035) m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2050, m3/day	Flow, m3/day	Optimum Dia, for total flow mm	Differential flow, (2050-2035) m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2050, m3/day	Flow, m3/day	Optimum Dia, for total flow mm	Differential flow, (2050-2035) m3/day	Optimum Dia, mm	Expansion/Rehabilitation
1. Nzove-Ntora System																																
NZ	NT		9,400	900	6,100	91,700	1000	No	6,100	91,700	1000	No	6,100	91,700	1000	No	16,400	208,100	1600	116,400	1200	Yes	16,400	208,100	1600	116,400	1200	Yes	16,400	208,100	1600	116,400	1200	Yes
NT	02_1	Branch to North Ring	1,300	500	0	72,200	900	Yes	0	72,200	900	Yes	0	72,200	900	Yes	0	146,800	1400	74,600	900	Yes	0	146,800	1400	74,600	900	Yes	0	146,800	1400	74,600	900	Yes
02_1	02_4	Kibagabaga Branch	4,500	500	8,700	47,000	700	Yes	8,700	47,000	700	Yes	8,700	47,000	700	Yes	25,100	98,300	1000	51,300	800	Yes	25,100	98,300	1000	51,300	800	Yes	25,100	98,300	1000	51,300	800	Yes
02_4	02_6	RDB junction	3,300	500	4,600	29,600	600	Yes	4,600	29,600	600	Yes	4,600	29,600	600	Yes	10,100	48,100	700	18,500	500	Yes	10,100	48,100	700	18,500	500	Yes	10,100	48,100	700	18,500	500	Yes
02_6	RM		2,700	400	25,000	25,000	600	Yes	25,000	25,000	600	Yes	25,000	25,000	600	Yes	38,000	38,000	700	13,000	500	Yes	38,000	38,000	700	13,000	500	Yes	38,000	38,000	700	13,000	500	Yes
(Ntora-Kibagabaga)																																		
02_4	02_4_K2	Branch to Kibagabaga	2,400	400	8,700	8,700	400	No	8,700	8,700	400	No	8,700	8,700	400	No	25,100	25,100	600	16,400	500	Yes	25,100	25,100	600	16,400	500	Yes	25,100	25,100	600	16,400	500	Yes
(Ntora-Kacyiru-Kicukiro Golf 7)																																		
NT	02_S1		4,200	400	6,400	6,400	400	No	6,400	6,400	400	No	6,400	6,400	400	No	15,200	25,300	600	13,300	500	Yes	15,200	25,300	600	18,900	500	Yes	15,200	25,300	600	18,900	500	Yes
02_S1	02_6	RDB junction	8,000	200		0	200	No	0	0	200	No	0	0	200	No	10,100	10,100	400	10,100	400	Yes	10,100	10,100	400	10,100	400	Yes	10,100	10,100	400	10,100	400	Yes
(Nzove-Kanyinya)																																		
NZ	KAN		8,000	150	3,900	3,900	300	Yes	3,900	3,900	300	Yes	3,900	3,900	300	Yes	10,900	10,900	400	7,000	400	Yes	10,900	10,900	400	7,000	400	Yes	10,900	10,900	400	7,000	400	Yes
(Nzove-Shyolongi)																																		
NZ	SHY		10,000	150	3,100	3,100	300	Yes	3,100	3,100	300	Yes	3,100	3,100	300	Yes	8,700	8,700	400			No	8,700	8,700	400			No	8,700	8,700	400			No
(North Ring)																																		
02_1	02_1N_1		5,400	400	3,900	20,200	500	No	3,900	20,200	500	No	3,900	20,200	500	No	12,100	34,100	600	8,200	400	Yes	12,100	34,100	600	8,200	400	Yes	12,100	34,100	600	8,200	400	Yes
02_1N_1	02_1N_2		5,900	400	6,300	16,300	500	No	6,300	16,300	500	No	6,300	16,300	500	No	22,000	22,000	600	4,300	300	Yes	22,000	22,000	600	4,300	300	Yes	22,000	22,000	600	4,300	300	Yes
02_1N_2	MB		5,100	400	10,000	10,000	400	No	10,000	10,000	400	No	10,000	10,000	400	No		0	200			No		0				No		0				No
(Jabana)																																		
02_1	AM	Amakawa reservoir	6,000	200	5,000	5,000	300	Yes	5,000	5,000	300	Yes	5,000	5,000	300	Yes	14,400	14,400	500	9,400	400	Yes	14,400	14,400	500	9,400	400	Yes	14,400	14,400	500	9,400	400	Yes
2. Kimisagara System																																		
KM	03_1	Gatsata	5,800	200	2,700	2,700	300	No	2,700	2,700	300	No	2,700	2,700	300	No	3,800	3,800	300		200	Yes	3,800	3,800	300		200	Yes	3,800	3,800	300		200	Yes
	KM		5,800	300	9,900	20,200	500	Yes	9,900	20,200	500	Yes	9,900	20,200	500	Yes	17,700	38,900	700	18,700	500	Yes	17,700	38,900	700	18,700	500	Yes	17,700	38,900	700	18,700	500	Yes
KM	CV		1,600	300	8,100	8,100	400	Yes	8,100	8,100	400	Yes	8,100	8,100	400	Yes	16,500	16,500	500	8,400	400	Yes	16,500	16,500	500	8,400	400	Yes	16,500	16,500	500	8,400	400	Yes
	CV		10,000						0				0																					
KM	08_E	To Rwezamenyo	4,500	300	2,200	2,200	300	No	2,200	2,200	300	No	2,200	2,200	300	No	4,700	4,700	300	2,500	300	Yes	4,700	4,700	300	2,500	300	Yes	4,700	4,700	300	2,500	300	Yes
3. Nzove-Karama-MontKigali System																																		
NZ	KR		4,000	600	6,200	40,000	700	No	6,200	40,000	700	No	6,200	38,400	700	No	19,900	111,200	1200	71,200	900	Yes	19,900	159,400	1400	119,400	1200	Yes	19,900	159,400	1400	119,400	1200	Yes
KR	01_1R	To Runda, Rugalika	5,400	400	12,500	12,500	500	No	12,500	12,500	500	No	12,500	12,500	500	No	37,600	37,600	700	25,100	600	Yes	37,600	37,600	700	25,100	600	Yes	37,600	37,600	700	25,100	600	Yes
KR	MK		2,400	400	9,700	21,300	500	No	9,700	21,300	500	No	9,700	19,700	500	No	21,100	53,700	800	32,400	600	Yes	21,100	101,900	1200	80,600	900	Yes	21,100	101,900	1200	80,600	900	Yes
MK	08_E		1,900	400	2,200	2,200	300	No	2,200	2,200	300	No	2,200	2,200	300	No	4,700		200			No	4,700					No	4,700					No
MK	KS		4,900	400	7,800	9,400	400	No	7,800	9,400	400	No	7,800	7,800	400	No	32,600	32,600	600	23,200	600	Yes	32,600	80,800	900	71,400	900	Yes	32,600	80,800	900	71,400	900	Yes
KS	GC		2,000	400	0	1,600	200	No	0	1,600	200	No	0	0	200	No	0	0	200			No	0	48,200	700	46,600	700	Yes	0	48,200	700	46,600	700	Yes
GC	NY		4,200	400	0	1,600	200	No	0	1,600	200	No	0	0	200	No	0	0	200			No	0	48,200	700	46,600	700	Yes	0	48,200	700	46,600	700	Yes
NY	KC		2,500	400	1,600	1,600	200	No	1,600	1,600	200	No		0	200	No		0	200			No	48,200	48,200	700	46,600	700	Yes	48,200	48,200	700	46,600	700	Yes
4. Central Main (Nzove-Kimisagara-Remera) System																																		
NZ	KM		5800			45,200	700	Yes		75,200	900	Yes		45,200	700	Yes		421,000	2000	375,800	2000	Yes	17,700	40,500	700			No	17,700	40,500	700			No
KM	GL		6900	-	4,300	45,200	700	Yes	4,300	75,200	900	Yes	4,300	45,200	700	Yes	9,600	396,000	2000	350,800	2000	Yes	9,600	40,500	700			No	9,600	40,500	700			No
GL	GP		3000	-	5,300	5,300	300	Yes	5,300	5,300	300	Yes	5,300	5,300	300	Yes	11,700	11,700	400	6,400	400	Yes	11,700	11,700	400	6,400	400	Yes	11,700	11,700	400	6,400	400	Yes
GL	KC		3700	-	17,000	17,000	500	Yes	17,000	17,000	500	Yes	17,000	17,000	500	Yes	48,200	48,200	700	31,200	600	Yes		0	200			No		0	200			No
GL	RM		5700	-	10,000	10,000	400	Yes	40,000	40,000	700	Yes	10,000	10,000	400	Yes	264,000	264,000	1800	254,000	1600	Yes		0	200			No		0	200			No

Nodes		Description	L, m	Existing Dia, mm	2035												2050											
					Case1				Case2				Case3				Case 1						Case 2						Case 3					
Start	End				Dave_2035, m3/day	Flow, m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2035, m3/day	Flow, m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2035, m3/day	Flow, m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2050, m3/day	Flow, m3/day	Optimum Dia, for total flow mm	Differential flow, (2050-2035) m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2050, m3/day	Flow, m3/day	Optimum Dia, for total flow mm	Differential flow, (2050-2035) m3/day	Optimum Dia, mm	Expansion/Rehabilitation	Dave_2050, m3/day	Flow, m3/day	Optimum Dia, for total flow mm	Differential flow, (2050-2035) m3/day	Optimum Dia, mm	Expansion/Rehabilitation
5. Kanzenze System																																		
KZ	GH		7,600	600	47,700	48,100	700	No	47,700	48,100	700	No	47,700	76,700	900	Yes	162,600	162,600	1400	114,500	1200	Yes	162,600	291,300	1800	243,200	1600	Yes	162,600	162,600	1400	114,500	1200	Yes
GH	KC		4,800	400	400	400	200	No	400	400	200	No	19,000	19,000	500	Yes		0				No	48,200	48,200	700	47,800	700	Yes						No
GH	RM		9,200	500	0	0	200	No	0	0	200	No	10,000	10,000	400	Yes		0				No	80,500	80,500	900	80,500	900	Yes						No
6. Karenge System																																		
KR	NB	Karenge-Nyabubare	2,000	300x2	0	51,000	800	Yes	0	17,900	500	Yes	0	17,900	500	Yes	0	65,900	900	14,900	500	Yes	0	65,900	900	14,900	500	Yes	0	549,800	2000	498,800	2000	Yes
NB	09_2		9,300	400	5,700	45,200	700	Yes	5,700	12,100	400	Yes	5,700	12,100	400	Yes	21,100	44,600	700			No	21,100	44,600	700			No	21,100	528,500	2000	483,300	2000	Yes
6-1. North (Ndera-Rusororo)																									200						200			
09_2	09_2N1		3,500	300	0	36,000	700	Yes	0	6,400	400	Yes	0	6,400	400	Yes	0	23,500	600			No	0	23,500	600			No	0	507,400	2000	471,400	2000	Yes
09_2N1	09_2N1_1		5,200	300	17,000	17,000	500	Yes		0	200	No		0	200	No		0	200			No		0	200			No	87,500	87,500	1000	70,500	900	Yes
0_2N1	09_2N2	Cyaruzinge branch	5,000	300	0	12,600	500	Yes	0	0	200	No	0	0	200	No	0	0	200			No	0	0	200			No	0	396,400	2000	383,800	2000	Yes
09_2N2	09_2N2_1		2,200	300	12,600	12,600	500	Yes		0	200	No		0	200	No	50,100		200			No	50,100		200			No	50,100	248,300	1600	235,700	1600	Yes
09_2N2	09_2N3	Ndera2	2,300	300	0	0	200	No	0	0	200	No	0	0	200	No	0	0	200			No	0	0	200			No	0	148,100	1400	148,100	1400	Yes
09_2N3	09_2N3_2		3,600	300		0	200	No	0	0	200	No	0	0	200	No		0	200			No		0	200			No	50,100	50,100	800	50,100	800	Yes
09_2N3	09_2N4		1,500	300	0	0	200	No	0	0	200	No	0	0	200	No	0	0	200			No	0	0	200			No	0	98,000	1000	98,000	1000	No
09_2N4	RM		4,500	300	0	0	200	No	0	0	200	No	0	0	200	No		0	200			No		0	200			No	98,000	98,000	1000	98,000	1000	No
(To Muyumbu)					0																				200						200			
NB	MUY		16,000	200	5,800	5,800	400	Yes	5,800	5,800	400	Yes	5,800	5,800	400	Yes	21,300	21,300	500	15,500	500	Yes	21,300	21,300	500	15,500	500	Yes	21,300	21,300	500	15,500	500	Yes
(To Gahengeri)					0																				200						200			
09_2N1	GG		7,000	200	6,400	6,400	400	Yes	6,400	6,400	400	Yes	6,400	6,400	400	Yes	23,500	23,500	600	17,100	500	Yes	23,500	23,500	600	17,100	500	Yes	23,500	23,500	600	17,100	500	Yes
6-2. South (Masaka, Nyarugunga)																									200						200			
09_2	17_2		3,500	300	0	3,500	300	No	0	0	200	No	0		200	No	76,000	85,600	1000	82,100	900	Yes	0	9,600	400	6,100	400	Yes		0	200			Yes
17_2	09_2S1	CymoHigh-Middle	1,300	300		3,500	300	No	0	0	200	No	0		200	No		9,600	400	6,100	400	Yes		9,600	400	6,100	400	Yes		0	200			Yes
09_2S1	09_2S2	CymoMiddle-Kanombe	5,200	300	3,500	3,500	300	No		0	200	No	21,000	21,000	500	No	9,600	9,600	400	6,100	400	Yes	9,600	9,600	400	6,100	400	Yes		0	200			Yes
09_2S2	RM		7,600	300	0	0	200	No	0	0	200	No	0	0	200	No		0	200	0	200	Yes		0	200	0	200	Yes		0	200	0	200	Yes
8. Remera-Rusororo System																																		
RM	09_2N1_1	Remera-Rusororo	11,300	-	10,000	10,000	400	Yes	10,000	10,000	400	Yes	20,000	20,000	500	Yes	94,000	94,000	1000	84,000	1000	Yes	94,000	94,000	1000	84,000	1000	Yes		0	200			No
8. Remera-MasoroBas-Ndera System																																		
RM	MB		5,000	400		10,000	400	No	0	40,000	700	Yes	0	40,000	700	Yes	22,000	116,000	1200	106,000	1200	Yes	22,000	116,000	1200	106,000	1200	Yes		50,100	800	40,100	700	Yes
MB	09_2N3_2		3,600	-	10,000	10,000	400	Yes	40,000	40,000	700	Yes	40,000	40,000	700	Yes	94,000	94,000	1000	84,000	1000	Yes	94,000	94,000	1000	84,000	1000	Yes	50,100	50,100	800	40,100	700	Yes
8. Masaka																																		
Masaka	09_2S1			-	18,700	18,700	500	Yes	18,700	18,700	500	Yes	18,700	18,700	500	Yes	40,000	40,000	700	21,300	500	Yes	115,800	115,800	1200	97,100	1000	Yes	115,800	115,800	1200	97,100	1000	Yes

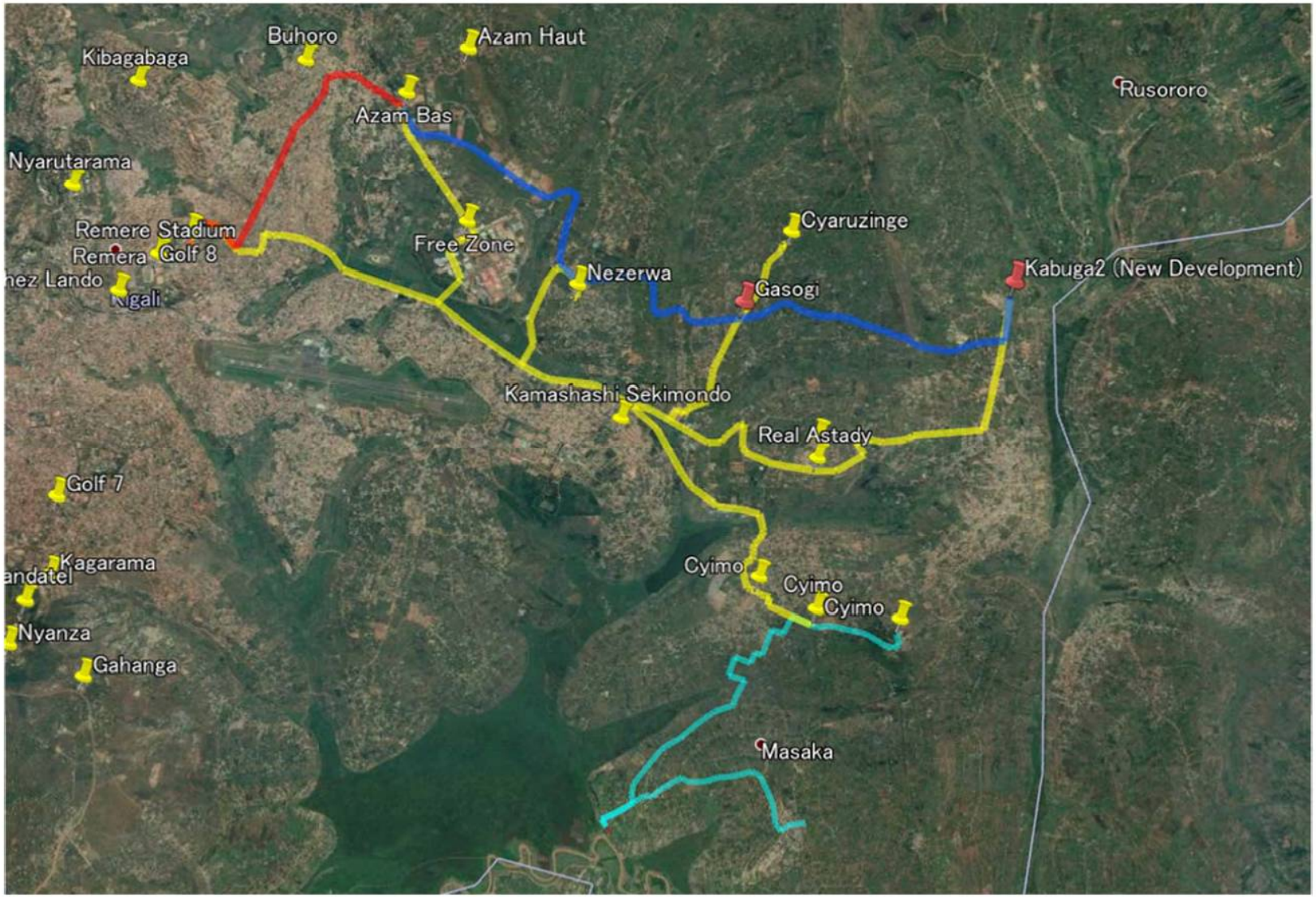
5. Summary of Capital and O&M cost for the Cases in 2035 and 2050

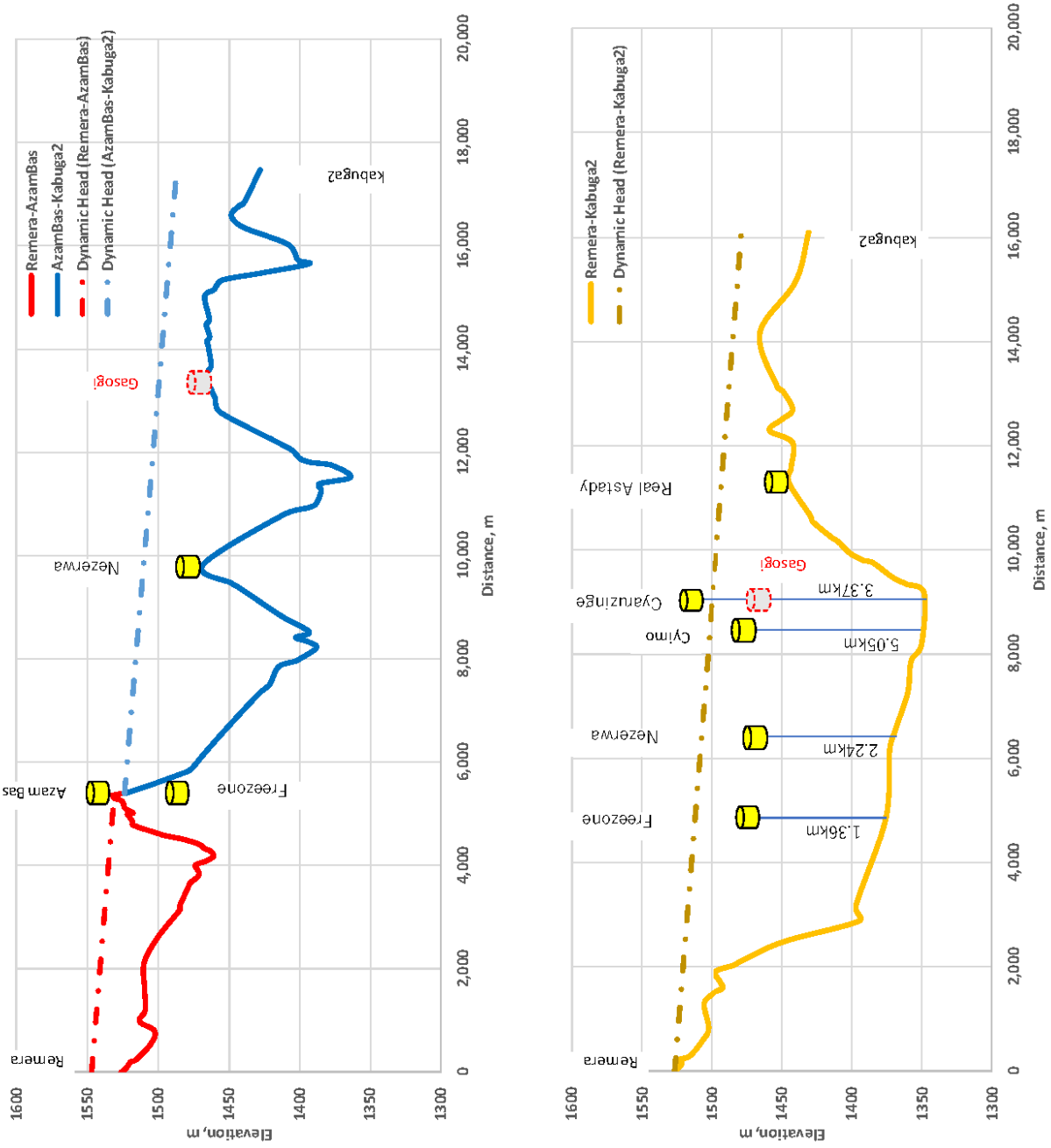
Capital Cost		2035 Case 1	2035 Case 2	2035 Case 3	2050 Case 1	2050 Case 2	2050 Case 3
		MUSD	MUSD	MUSD	MUSD	MUSD	MUSD
1. Water Source Development and Treatment Plant		124.3	125.4	120.1	348.9	348.9	348.9
2. Transmission and Distribution		326.9	337.4	373.5	728.6	650.9	716.2
(1) Transmission Mains (ND300-2000)		130.5	138.4	163.7	402.9	324.9	387.3
(2) Transmission Sub-mains (ND200-300)		49.8	52.0	61.4	82.5	82.7	85.2
(3) Distribution Mains for Subsystem (ND 110-160)		7.8	8.2	9.6	13.0	13.0	13.4
(4) Distribution Sub-mains and Meters (ND25-110)		112.1	112.1	112.1	178.1	178.1	178.1
(5) Reservoirs		26.7	26.7	26.7	52.1	52.1	52.1
Total direct costs (1+2)		**451.3**	**462.8**	**493.6**	**1,077.5**	**999.7**	**1,065.1**
Construction overhead	15%	67.7	69.4	74.0	161.6	150.0	159.8
Design and Consultancy	9%	46.7	47.9	51.1	111.5	103.5	110.2
Contingencies	10%	56.6	58.0	61.9	135.1	125.3	133.5
Total capital cost during the benchmark years		**622.2**	**638.1**	**680.6**	**1,485.7**	**1,378.5**	**1,468.6**
		(2019 to 2035)			(2035 to 2050)		
Incremental Served Population		1,185,275	1,185,275	1,185,275	1,354,501	1,354,501	1,354,501
Cost per capita for capital investment		525	538	574	1,097	1,018	1,084

Yearly Averaged Cost		2035 Case 1	2035 Case 2	2035 Case 3	2050 Case 1	2050 Case 2	2050 Case 3
		MUSD/year	MUSD/year	MUSD/year	MUSD/year	MUSD/year	MUSD/year
Capital Expenditure (Yearly averaged cost)	MUSD/year	41.5	42.5	45.4	99.0	91.9	97.9
Reccurent Expenditure (O&M wo/Overhead)	MUSD/year	30.8	29.3	29.3	70.7	74.1	82.5
Estimated Total Expenditure/year (Capex+Opex)	MUSD/year	**72.3**	**71.8**	**74.7**	**169.7**	**166.0**	**180.4**
Supply Amount*		323,000	323,000	323,000	796,213	796,213	796,213
Cost per m3 (Opex)	USD/m3	0.262	0.248	0.248	0.243	0.255	0.284
Cost per m3 (Opex+ Overhead)	USD/m3	0.340	0.323	0.323	0.316	0.331	0.369
Cost per m3 (Capex+Opex)	USD/m3	0.613	0.609	0.633	0.584	0.571	0.621

* Demands in remote areas are excluded from the calculation
Cost in 2050: Cost difference from the base case in 2035 (Case 1)
Tax, Administration cost for projects, and Financial cost not included

6. Hydraulic Profiles and Comparison of Transmission Line from Remera to the Eastern Areas




Remera-AzamBas
AzamBas-Kabuga2
Dynamic Head (Remera-AzamBas)
Dynamic Head (AzamBas-Kabuga2)
Remera
Azam Bas
Freezone
Nezerwa
Gasogi
Kabuga2
Elevation, m
Distance, m
Remera-Kabuga2
Dynamic Head (Remera-Kabuga2)
Remera
Freezone
Nezerwa
Cyimo
Cyanuzinge
Real Astady
Gasogi
Kabuga2
1.36km
2.24km
5.05km
3.37km
Elevation, m
Distance, m

Remera-AzamBas												i	0.003
type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude	**Location**		
T	-1.9510063	30.119609	1526.5	-0.0340515	0.5256863	1.03423E-05	7.212E-06		0	1526.5	**Remera**		1547.1617
T	-1.9504138	30.120022	1523	-0.0340411	0.5256936	5.98044E-06	-3.515E-06	80	80	1523			1546.9205
T	-1.9500711	30.119821	1521.8	-0.0340352	0.52569	5.37762E-06	-1.016E-05	44	125	1521.8			1546.7877
T	-1.949763	30.119238	1519.8	-0.0340298	0.5256799	6.36438E-06	-5.548E-06	73	198	1519.8			1546.5677
T	-1.9493983	30.11892	1515.6	-0.0340234	0.5256743	2.24526E-05	3.82E-05	54	252	1515.6			1546.4062
T	-1.9481119	30.121109	1505.9	-0.034001	0.5257125	-8.17774E-06	3.982E-05	283	534	1505.9			1545.5584
T	-1.9485804	30.12339	1502.8	-0.0340091	0.5257523	-2.30776E-05	1.947E-05	259	794	1502.8			1544.7806
T	-1.9499027	30.124506	1513.5	-0.0340322	0.5257718	-2.74106E-05	1.992E-05	193	986	1513.5			1544.2029
T	-1.9514732	30.125647	1509.5	-0.0340596	0.5257917	6.12093E-05	3.316E-05	216	1,202	1509.5			1543.5545
T	-1.9479662	30.127547	1510	-0.0339984	0.5258249	6.58069E-05	3.303E-05	444	1,646	1510			1542.2224
T	-1.9441957	30.12944	1510.2	-0.0339326	0.5258579	6.96597E-05	3.231E-05	470	2,116	1510.2			1540.8135
T	-1.9402045	30.131291	1500.6	-0.033863	0.5258902	7.65404E-05	3.39E-05	490	2,606	1500.6			1539.3442
T	-1.9358191	30.133234	1484.9	-0.0337864	0.5259241	7.37171E-06	5.968E-06	534	3,140	1484.9			1537.7424
T	-1.9353967	30.133576	1485.3	-0.033779	0.5259301	4.13977E-05	3.839E-05	60	3,200	1485.3			1537.561
T	-1.9330248	30.135775	1479.3	-0.0337376	0.5259685	1.42634E-05	5.312E-06	360	3,560	1479.3			1536.4806
T	-1.9322075	30.136079	1477.7	-0.0337234	0.5259738	1.30227E-05	1.266E-05	97	3,657	1477.7			1536.1894
T	-1.9314614	30.136805	1472.6	-0.0337104	0.5259865	1.27586E-05	4.118E-06	116	3,773	1472.6			1535.8419
T	-1.9307304	30.137041	1471.5	-0.0336976	0.5259906	2.05543E-05	6.941E-07	86	3,859	1471.5			1535.5854
T	-1.9295527	30.137081	1474.2	-0.033677	0.5259913	5.037E-06	2.402E-06	131	3,990	1474.2			1535.1918
T	-1.9292641	30.137218	1472.6	-0.033672	0.5259937	4.23654E-06	1.028E-05	36	4,026	1472.6			1535.0851
T	-1.9290214	30.137807	1465.2	-0.0336678	0.526004	3.11367E-06	1.093E-05	71	4,096	1465.2			1534.8723
T	-1.928843	30.138433	1461.3	-0.0336647	0.5260149	1.3312E-06	7.27E-06	72	4,169	1461.3			1534.6549
T	-1.9287667	30.13885	1461.4	-0.0336633	0.5260222	-2.32684E-06	9.773E-06	47	4,216	1461.4			1534.5134
T	-1.9289	30.13941	1463.7	-0.0336657	0.5260319	-3.07061E-06	5.745E-06	64	4,280	1463.7			1534.3212
T	-1.9290759	30.139739	1467.3	-0.0336687	0.5260377	2.10729E-06	2.891E-06	42	4,322	1467.3			1534.1965
T	-1.9289552	30.139905	1468.6	-0.0336666	0.5260406	4.60245E-06	4.184E-06	23	4,345	1468.6			1534.1281

T	-1.9286915	30.140144	1469.8	-0.033662	0.5260448	-4.02283E-06	6.95E-06	40	4,384	1469.8			1534.0091
T	-1.928922	30.140543	1474.1	-0.033666	0.5260517	-2.96249E-06	1.118E-05	51	4,435	1474.1			1533.8554
T	-1.9290917	30.141183	1483.9	-0.033669	0.5260629	-5.74974E-06	7.998E-06	74	4,509	1483.9			1533.6341
T	-1.9294212	30.141641	1495.3	-0.0336748	0.5260709	-4.94546E-06	3.627E-06	63	4,572	1495.3			1533.4456
T	-1.9297045	30.141849	1500	-0.0336797	0.5260745	-4.2142E-06	7.098E-06	39	4,611	1500			1533.3283
T	-1.929946	30.142256	1506.2	-0.0336839	0.5260816	-7.62571E-06	1.044E-05	53	4,664	1506.2			1533.1703
T	-1.9303829	30.142854	1515.3	-0.0336915	0.526092	-2.99629E-06	5.826E-06	82	4,746	1515.3			1532.923
T	-1.9305546	30.143188	1518.5	-0.0336945	0.5260979	-5.43038E-06	1.643E-06	42	4,788	1518.5			1532.7977
T	-1.9308657	30.143282	1518.3	-0.0337	0.5260995	-5.90244E-06	1.63E-05	36	4,824	1518.3			1532.6891
T	-1.9312039	30.144216	1520.5	-0.0337059	0.5261158	-3.02397E-06	4.976E-06	111	4,935	1520.5			1532.3574
T	-1.9313772	30.144501	1521.7	-0.0337089	0.5261208	-1.68487E-06	2.71E-06	37	4,972	1521.7			1532.246
T	-1.9314737	30.144656	1522.1	-0.0337106	0.5261235	-2.86066E-06	-1.147E-06	20	4,992	1522.1			1532.1849
T	-1.9316376	30.14459	1518.1	-0.0337134	0.5261224	-5.41499E-06	1.299E-05	20	5,012	1518.1			1532.1259
T	-1.9319479	30.145335	1523.8	-0.0337189	0.5261354	-1.0287E-05	1.188E-05	90	5,102	1523.8			1531.8566
T	-1.9325373	30.146015	1525	-0.0337291	0.5261472	-5.73623E-06	6.297E-06	100	5,202	1525			1531.5559
T	-1.9328659	30.146376	1526.9	-0.0337349	0.5261535	-9.44555E-07	5.669E-06	54	5,256	1526.9			1531.3929
T	-1.93292	30.146701	1531.1	-0.0337358	0.5261592	-1.83731E-07	6.32E-06	37	5,293	1531.1			1531.283
T	-1.9329306	30.147063	1532.2	-0.033736	0.5261655	-5.31802E-08	2.585E-06	40	5,333	1532.2			1531.162
T	-1.9329336	30.147211	1532.6	-0.0337361	0.5261681	-5.83418E-06	7.407E-07	16	5,350	1532.6			1531.1125
T	1.9332679	30.147254	1526	0.0337419	0.5261688	0.03374189	0.5261688	38	5,387	1526	**AzamBas**	5	1531
												i	0.003
AzamBas-Kabuga2													
type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude			
T	-1.9333944	30.147044	1523.5	-0.0337441	0.5261652	-2.00661E-05	1.352E-05		5,387	1523.5	**AzamBas**	0	1523.5
T	-1.9345441	30.147819	1506.1	-0.0337642	0.5261787	-3.05067E-05	1.316E-05	154	5,542	1506.1			1523.037
T	-1.936292	30.148573	1485.2	-0.0337947	0.5261919	-9.07308E-06	1.245E-05	212	5,753	1485.2			1522.4013
T	-1.9368119	30.149286	1477.1	-0.0338037	0.5262043	1.57493E-06	4.454E-05	98	5,852	1477.1			1522.1066

T	-1.9367216	30.151838	1468.2	-0.0338022	0.5262488	-2.35543E-05	6.765E-05	284	6,136	1468.2			1521.2538
T	-1.9380712	30.155714	1453.6	-0.0338257	0.5263165	-6.29251E-05	9.154E-05	457	6,593	1453.6			1519.8832
T	-1.9416765	30.160959	1429.7	-0.0338886	0.526408	-1.97009E-05	2.441E-05	708	7,301	1429.7			1517.7578
T	-1.9428053	30.162357	1421.5	-0.0339083	0.5264324	-2.60051E-05	4.603E-05	200	7,501	1421.5			1517.1575
T	-1.9442953	30.164994	1415.4	-0.0339344	0.5264785	-4.66881E-06	1.513E-05	337	7,839	1415.4			1516.146
T	-1.9445628	30.165861	1405.1	-0.033939	0.5264936	2.62218E-07	2.131E-06	101	7,940	1405.1			1515.8431
T	-1.9445478	30.165983	1403.1	-0.0339388	0.5264957	1.65594E-05	3.658E-05	14	7,953	1403.1			1515.802
T	-1.943599	30.168079	1388.7	-0.0339222	0.5265323	-2.24322E-06	1.973E-05	256	8,209	1388.7			1515.0337
T	-1.9437275	30.169209	1395.2	-0.0339244	0.526552	-8.75646E-06	7.806E-06	127	8,336	1395.2			1514.6538
T	-1.9442292	30.169656	1403.3	-0.0339332	0.5265598	-1.58993E-05	-5.945E-06	75	8,411	1403.3			1514.4294
T	-1.9451402	30.169316	1393.8	-0.0339491	0.5265539	-4.3236E-05	-1.679E-05	108	8,519	1393.8			1514.1046
T	-1.9476174	30.168353	1412.6	-0.0339923	0.5265371	-8.17913E-05	-1.803E-05	296	8,815	1412.6			1513.2171
T	-1.9523037	30.16732	1441.5	-0.0340741	0.5265191	-1.85265E-05	7.276E-07	534	9,349	1441.5			1511.6145
T	-1.9533652	30.167362	1448.6	-0.0340927	0.5265198	-3.74751E-05	3.985E-05	118	9,467	1448.6			1511.2597
T	-1.9555124	30.169645	1468.4	-0.0341301	0.5265596	1.24934E-05	0.0001494	349	9,816	1468.4	Nezerwa		1510.213
T	-1.9547966	30.178206	1413	-0.0341176	0.5267091	-1.14235E-05	2.127E-05	956	10,773	1413			1507.344
T	-1.9554511	30.179425	1394.4	-0.0341291	0.5267303	-1.09027E-05	2.142E-06	154	10,927	1394.4			1506.882
T	-1.9560757	30.179548	1389	-0.03414	0.5267325	-4.09278E-05	1.06E-07	71	10,997	1389			1506.6694
T	-1.9584207	30.179554	1385.2	-0.0341809	0.5267326	-2.04541E-05	8.03E-08	261	11,258	1385.2			1505.8863
T	-1.9595927	30.179559	1386.6	-0.0342013	0.5267327	-2.4483E-06	1.981E-05	130	11,389	1386.6			1505.4949
T	-1.9597329	30.180694	1364.1	-0.0342038	0.5267525	1.21621E-05	3.289E-05	127	11,516	1364.1			1505.1129
T	-1.9590361	30.182578	1376.7	-0.0341916	0.5267854	-1.6551E-07	1.063E-05	224	11,740	1376.7			1504.442
T	-1.9590456	30.183187	1393.3	-0.0341918	0.526796	-1.18108E-05	4.659E-06	68	11,808	1393.3			1504.2386
T	-1.9597223	30.183454	1400.7	-0.0342036	0.5268006	-2.06289E-05	1.91E-05	81	11,889	1400.7			1503.9957
T	-1.9609043	30.184548	1407.4	-0.0342242	0.5268198	8.62297E-06	0.0001098	179	12,068	1407.4			1503.4577
T	-1.9604102	30.190841	1456	-0.0342156	0.5269296	7.03732E-06	4.466E-05	703	12,771	1456	Gasozi		1501.3496
T	-1.960007	30.1934	1459.9	-0.0342086	0.5269742	2.2284E-05	4.034E-05	288	13,059	1459.9			1500.4846
T	-1.9587302	30.195711	1465.4	-0.0341863	0.5270146	6.04015E-06	1.02E-05	294	13,353	1465.4			1499.6028
T	-1.9583841	30.196296	1469.3	-0.0341803	0.5270248	-4.1176E-06	2.132E-05	76	13,429	1469.3			1499.376

T	-1.9586201	30.197517	1465	-0.0341844	0.5270461	-1.36053E-05	1.336E-05	138	13,567	1465			1498.9605
T	-1.9593996	30.198283	1462.7	-0.034198	0.5270595	-1.42184E-05	5.631E-05	122	13,689	1462.7			1498.5956
T	-1.9602142	30.201509	1464.7	-0.0342122	0.5271158	1.08109E-06	1.472E-05	370	14,059	1464.7			1497.4844
T	-1.9601523	30.202352	1465.6	-0.0342111	0.5271305	1.09982E-06	1.404E-05	94	14,153	1465.6			1497.2021
T	-1.9600893	30.203157	1463.6	-0.03421	0.5271445	-8.35585E-06	3.343E-05	90	14,243	1463.6			1496.9326
T	-1.960568	30.205072	1466	-0.0342184	0.527178	-3.94151E-06	1.373E-05	220	14,463	1466			1496.2732
T	-1.9607939	30.205859	1463.9	-0.0342223	0.5271917	-6.90627E-06	1.138E-05	91	14,554	1463.9			1495.9999
T	-1.9611896	30.20651	1464.2	-0.0342292	0.5272031	-1.76585E-05	5.842E-05	85	14,639	1464.2			1495.7452
T	-1.9622013	30.209858	1467.1	-0.0342469	0.5272615	-9.54308E-06	1.745E-05	389	15,028	1467.1			1494.5775
T	-1.9627481	30.210858	1460.5	-0.0342564	0.5272789	-4.93309E-06	2.807E-05	127	15,155	1460.5			1494.1969
T	-1.9630307	30.212466	1454.6	-0.0342613	0.527307	-1.31116E-05	1.774E-05	182	15,337	1454.6			1493.6515
T	-1.963782	30.213482	1426.4	-0.0342745	0.5273247	-7.5763E-06	2.632E-05	141	15,477	1426.4			1493.2294
T	-1.9642161	30.21499	1394	-0.034282	0.5273511	-1.30797E-06	1.198E-05	175	15,652	1394			1492.7053
T	-1.964291	30.215677	1401.7	-0.0342833	0.527363	-7.99528E-06	4.593E-05	77	15,729	1401.7			1492.4748
T	-1.9647491	30.218308	1408.6	-0.0342913	0.527409	1.78009E-05	5.051E-05	297	16,026	1408.6			1491.5827
T	-1.9637292	30.221202	1440.6	-0.0342735	0.5274595	4.88471E-06	3.455E-05	342	16,368	1440.6			1490.5579
T	-1.9634493	30.223182	1448.5	-0.0342687	0.527494	9.38917E-07	3.094E-05	223	16,590	1448.5			1489.8903
T	-1.9633955	30.224955	1442.3	-0.0342677	0.527525	-2.05321E-07	4.926E-06	197	16,788	1442.3			1489.298
T	-1.9634073	30.225237	1439.9	-0.0342679	0.5275299	0.000101458	1.244E-05	31	16,819	1439.9			1489.2037
T	-1.9575942	30.22595	1428.1	-0.0341665	0.5275423	0.034166463	-0.5275423	652	17,471	1428.1	**Kabuga2**		1487.2478
												i	0.003
Remera-Kabuga2													
type	latitude	longitude	altitude	Θ	ϕ	Δ Θ	Δ ϕ	Single Distance	Accumulated Distance	Altitude			
T	-1.951049	30.119613	1526.5	-0.0340522	0.5256864	8.75234E-06	1.018E-05		0	1526.5	**Remera**	0	1526.5
T	-1.9505475	30.120197	1523.3	-0.0340435	0.5256966	9.6198E-06	-5.676E-06	86	86	1523.3			1526.2431
T	-1.9499964	30.119872	1521.3	-0.0340339	0.5256909	1.14895E-07	-1.12E-05	71	157	1521.3			1526.0293

T	-1.9499898	30.11923	1522.7	-0.0340337	0.5256797	1.01468E-05	-4.957E-06	71	228	1522.7			1525.8151
T	-1.9494084	30.118946	1515.6	-0.0340236	0.5256748	2.07101E-05	3.732E-05	72	300	1515.6			1525.599
T	-1.9482218	30.121085	1507.2	-0.0340029	0.5257121	-5.48786E-06	3.974E-05	272	573	1507.2			1524.7823
T	-1.9485363	30.123362	1502.3	-0.0340084	0.5257518	-5.84377E-05	4.355E-05	256	828	1502.3			1524.0146
T	-1.9518845	30.125857	1505.5	-0.0340668	0.5257954	8.38526E-07	3.231E-05	465	1,293	1505.5			1522.6201
T	-1.9518364	30.127708	1498.6	-0.034066	0.5258277	-4.15552E-06	1.439E-05	206	1,499	1498.6			1522.0017
T	-1.9520745	30.128532	1491.9	-0.0340701	0.5258421	1.54467E-05	8.592E-06	96	1,595	1491.9			1521.7151
T	-1.9511895	30.129025	1493.3	-0.0340547	0.5258507	3.1601E-05	3.353E-06	113	1,708	1493.3			1521.3769
T	-1.9493789	30.129217	1496.8	-0.0340231	0.525854	-7.91657E-06	1.872E-05	203	1,910	1496.8			1520.7688
T	1.9498325	30.130289	1483.5	0.034031	0.5258728	4.226E 06	1.331E 05	130	2,040	1483.5			1520.3799
T	-1.9495904	30.131052	1477.6	-0.0340268	0.5258861	-9.46127E-06	5.523E-05	89	2,129	1477.6			1520.1128
T	-1.9501325	30.134216	1448.3	-0.0340362	0.5259413	-2.97635E-05	5.537E-05	357	2,486	1448.3			1519.0406
T	-1.9518378	30.137389	1394.6	-0.034066	0.5259967	-3.69092E-05	2.633E-05	401	2,887	1394.6			1517.8378
T	-1.9539525	30.138897	1396.8	-0.0341029	0.526023	-7.45835E-05	0.0002155	289	3,177	1396.8			1516.9703
T	-1.9582258	30.151244	1377.6	-0.0341775	0.5262385	-7.13186E-05	8.893E-05	1,454	4,631	1377.6	**Branch to Freezone**		1512.607
T	-1.9623121	30.156339	1373.2	-0.0342488	0.5263274	-7.23303E-05	0.000102	727	5,358	1373.2			1510.4257
T	-1.9664563	30.162183	1372.8	-0.0343211	0.5264294	-3.27896E-05	6.172E-05	797	6,156	1372.8	**Branch to Nezerwa**		1508.0333
T	-1.968335	30.165719	1368	-0.0343539	0.5264911	-1.19039E-05	0.000105	446	6,601	1368			1506.696
T	-1.9690171	30.171733	1359.8	-0.0343658	0.5265961	-4.26755E-05	8.189E-05	674	7,275	1359.8			1504.6747
T	-1.9714622	30.176425	1357.5	-0.0344085	0.526678	-1.26159E-05	4.865E-05	589	7,864	1357.5	**Branch to Cyimo**		1502.9079
T	-1.972185	30.179212	1350.1	-0.0344211	0.5267266	-7.79966E-05	0.0001312	321	8,185	1350.1			1501.9461
T	-1.9766539	30.186728	1348.2	-0.0344991	0.5268578	1.30332E-06	2.973E-05	973	9,158	1348.2	**Branch to Cyaruzinge**		1499.0261
T	-1.9765792	30.188431	1361.7	-0.0344978	0.5268875	1.66934E-05	1.22E-05	190	9,348	1361.7			1498.4568
T	-1.9756228	30.18913	1371.2	-0.0344811	0.5268997	2.60086E-05	3.145E-05	132	9,480	1371.2			1498.0612
T	-1.9741326	30.190932	1384.1	-0.0344551	0.5269312	-3.68509E-07	8.592E-06	260	9,740	1384.1			1497.2802
T	-1.9741537	30.191424	1391.4	-0.0344555	0.5269398	-1.04563E-07	2.226E-07	55	9,795	1391.4			1497.1157

T	-1.9741597	30.191437	1391.6	-0.0344556	0.52694	-1.8889E-05	-3.533E-06	2	9,796	1391.6			1497.111
T	-1.975242	30.191235	1400.3	-0.0344745	0.5269364	-3.60823E-05	-1.775E-06	123	9,919	1400.3			1496.7433
T	-1.9773093	30.191133	1409.2	-0.0345106	0.5269347	-1.19858E-05	6.698E-06	230	10,149	1409.2			1496.052
T	-1.9779961	30.191517	1414.2	-0.0345225	0.5269414	-1.85325E-05	4.349E-05	88	10,237	1414.2			1495.7893
T	-1.9790579	30.194008	1427.7	-0.0345411	0.5269849	-7.13035E-06	1.614E-05	302	10,538	1427.7			1494.8847
T	-1.9794664	30.194933	1429.3	-0.0345482	0.527001	-1.68614E-05	9.84E-05	113	10,651	1429.3			1494.5472
T	-1.9804325	30.200571	1444.6	-0.0345651	0.5270994	9.1752E-08	4.657E-05	637	11,288	1444.6	**RealAstady**		1492.637
T	-1.9804273	30.203239	1442.9	-0.034565	0.527146	3.78826E-05	6.412E-05	297	11,585	1442.9			1491.7459
T	-1.9782567	30.206912	1442.1	-0.0345271	0.5272101	2.93202E-05	-2.019E-05	475	12,060	1442.1			1490.3209
T	-1.9765768	30.205756	1458.5	-0.0344978	0.5271899	6.78631E-06	3.428E-05	227	12,287	1458.5			1489.6398
T	-1.976188	30.20772	1448.9	-0.034491	0.5272242	-6.17941E-06	2.727E-05	223	12,510	1448.9			1488.9711
T	-1.976542	30.209283	1441.9	-0.0344972	0.5272514	6.42644E-06	5.38E-05	178	12,688	1441.9			1488.436
T	-1.9761738	30.212365	1448.7	-0.0344907	0.5273052	9.84313E-06	1.37E-05	346	13,034	1448.7			1487.3993
T	-1.9756099	30.21315	1453.1	-0.0344809	0.5273189	1.21216E-05	0.0001582	108	13,141	1453.1			1487.0765
T	-1.9749154	30.222212	1465.3	-0.0344688	0.5274771	0.000149524	3.882E-05	1,012	14,153	1465.3			1484.0412
T	-1.9663482	30.224436	1439.8	-0.0343193	0.5275159	0.000145516	2.628E-05	985	15,138	1439.8			1481.0853
T	-1.9580108	30.225942	1430.5	-0.0341737	0.5275422	0.034173735	-0.5275422	943	16,081	1430.5	**Kabuga2**		1478.2559

7. Quantity Estimate of Pipeline Length for 2035 and 2050

Grand Total Estimated Cost

By WASAC

	Transmission Pipes	Distribution Pipes and Meters	Average cost, MUSD/year
2019-2035	231.4	112.1	21.5
2036-2050	395.0	178.1	38.2

By Customer	Connection Fee	Average cost, MUSD/year
2019-2035	34.778	2.2
2036-2050	55.264	3.5

Transmission Pipes	Total cost until the benchmark year			Average cost, MUSD/year			Remarks
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	
2019-2035	188.1	198.6	234.7	11.8	12.4	14.7	
2036-2050	497.9	406.8	358.7	33.2	27.1	23.9	*1

*1: Cost difference from the base case in 2035 (Case 1)

Transmission Pipes

Assumption
+1Dia +2Dia

Pipe Length (Existing + On-going Project)								Unit Cost, USD/m	Estimated Total Length for 2035, m	Estimated Total Length for 2050, m	Estimated Total Costs for 2035, MUSD	Estimated Total Costs for 2050, MUSD
Existing		Existing (minor dia.)		On-going		Total (Existing+Ongoing)						
Dia	Length	Dia	Length	Dia	Length	Dia	Length					
200	92,289	225	1,604	200	32,517	200	126,400	75				
250	51,517			250	18,311	250	69,800	117	126,400		14.8	
300	83,804			300	23,490	300	107,300	186	69,800	126,400	13.0	23.5
400	10,391	350	40	400	32,459	400	42,900	902	107,300	69,800	96.8	63.0
500	9,683			500	11,339	500	21,000	1,130	42,900	107,300	48.5	121.2
600	14,281					600	14,300	1,441	21,000	42,900	30.3	61.8
800								1,960	14,300	21,000	28.0	41.2
1000								2,640	12700	14,300		37.8
1200								3,663		12,700	0.0	46.5
Total											**231.4**	**395.0**

Distribution Pipes: Pipe Length per capita (<300)

911 RWF/USD

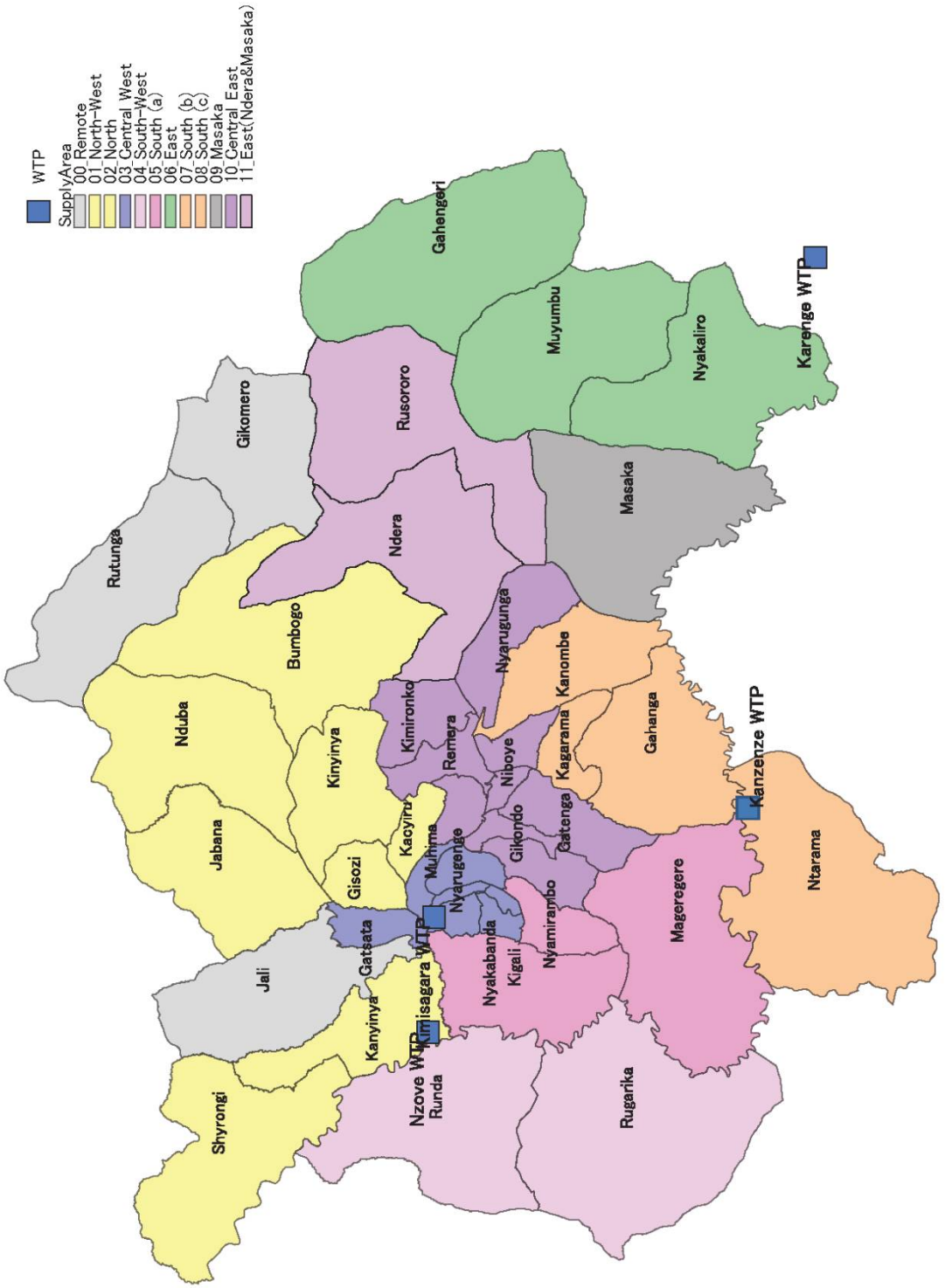
Dia	Length, m/connection	Unit Cost, RWF/m	Ref. Dia	Sub-total cost/capita, RWF	Sub-total, cost/capita Usd
25	21.994	1,200	25	26,393	
32-40	9.595	3,000	40	28,785	
50-63	4.248	7,500	63	31,860	
75-90	4.421	15,200	90	67,199	
100-110	2.843	22,700	110	64,536	
Total	43.101			218,773	**240.15**

Estimated Cost per capita

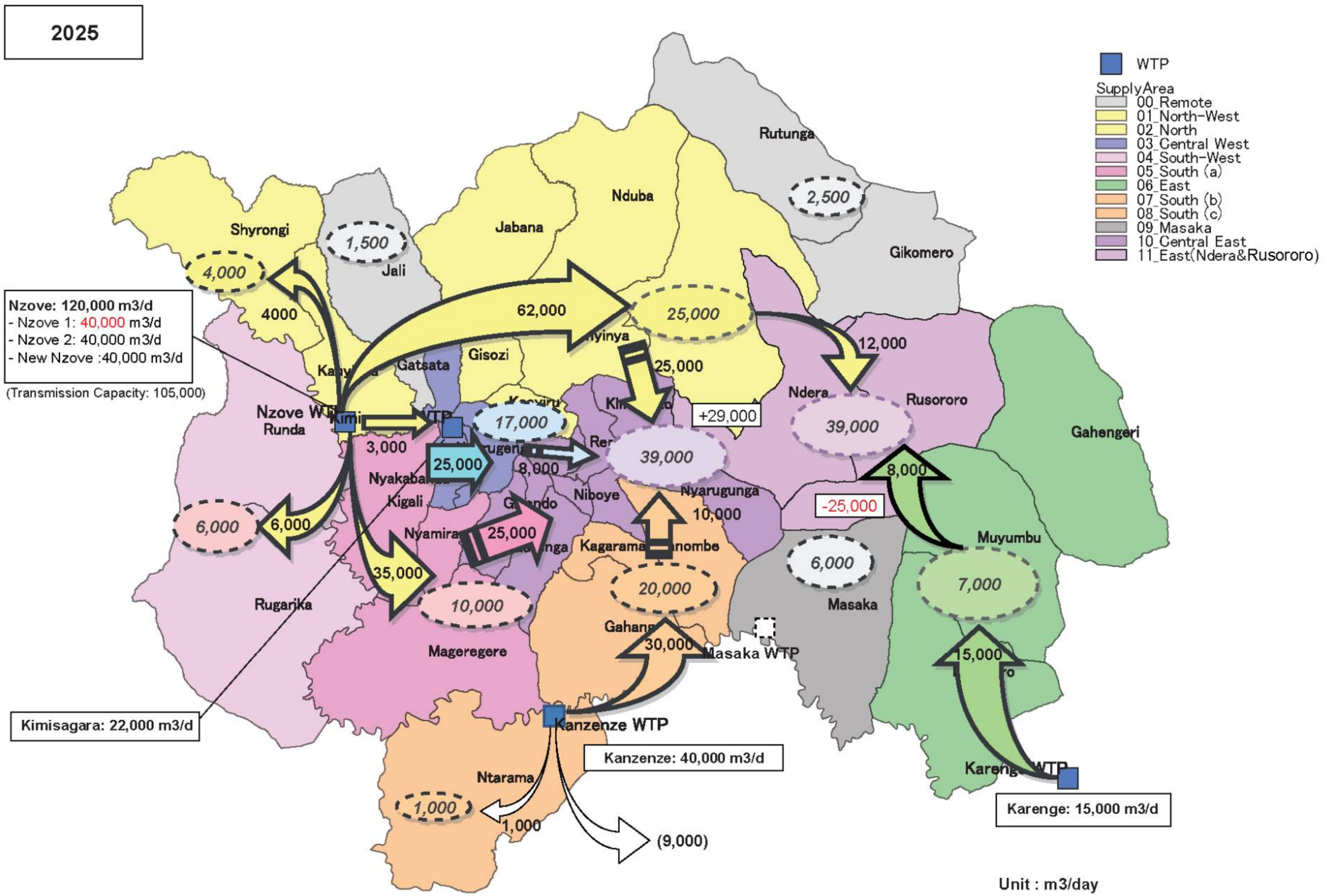
(a) Distribution Pipes (25-160)	**240.15**
(b) Meters	**50**
(c) Customer Connection (borne by customers)	**90.01**

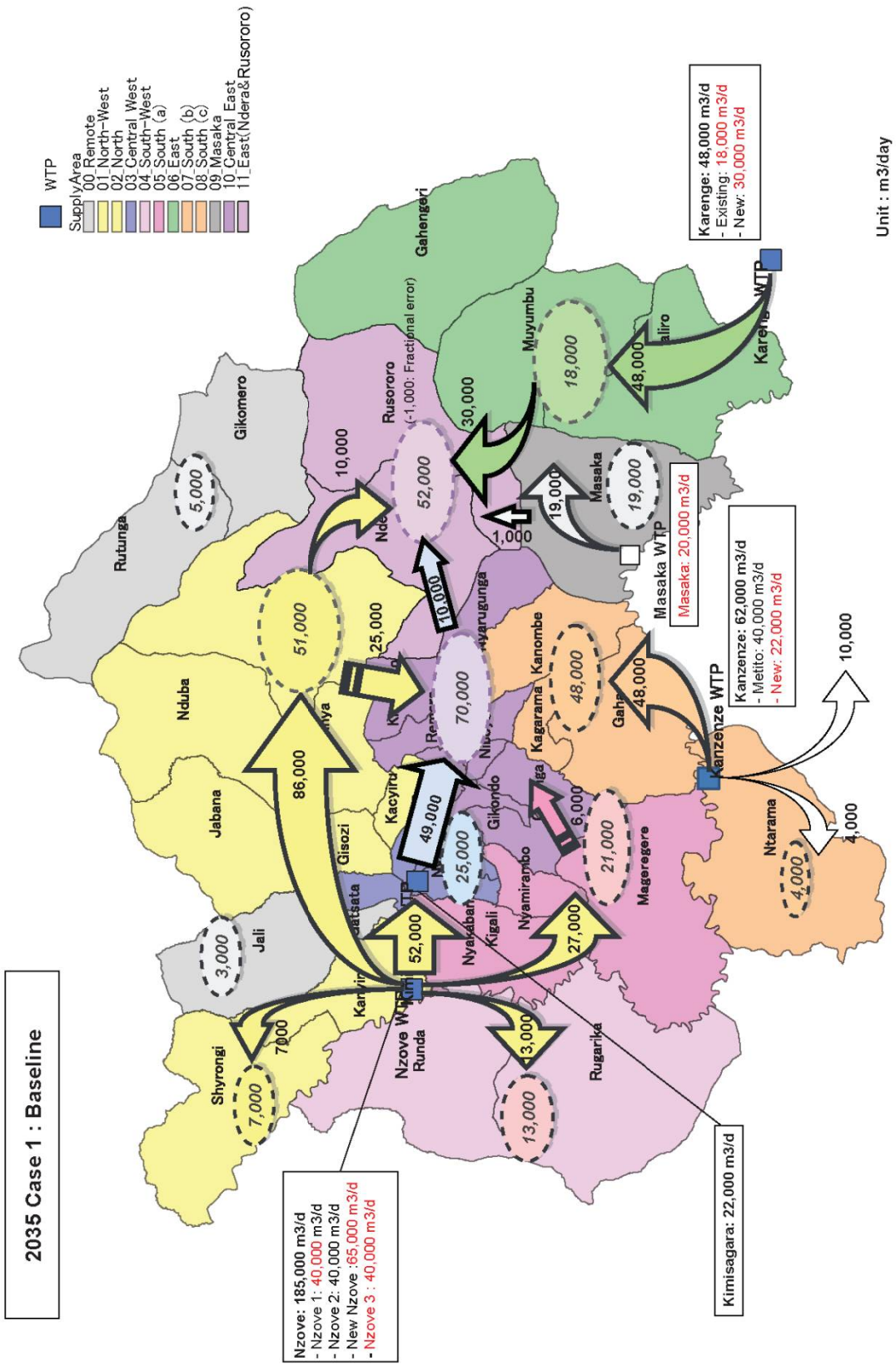
Year	Estimated Cost, MUSD			By Actor		By Benchmark Year	
	(a)	(b)	(c)	by WASAC	by Customer	by WASAC	by Custome
2019	4.465	0.930	1.673	5.395	1.673		
2020	3.891	0.810	1.458	4.701	1.458		
2021	3.986	0.830	1.494	4.816	1.494		
2022	4.161	0.866	1.560	5.027	1.560		
2023	4.329	0.901	1.622	5.230	1.622		
2024	4.483	0.933	1.680	5.416	1.680		
2025	4.746	0.988	1.779	5.734	1.779		
2026	5.018	1.045	1.881	6.063	1.881		
2027	5.280	1.099	1.979	6.379	1.979		
2028	5.550	1.156	2.080	6.706	2.080		
2029	5.831	1.214	2.186	7.045	2.186		
2030	6.115	1.273	2.292	7.388	2.292		
2031	6.396	1.332	2.397	7.728	2.397		
2032	6.689	1.393	2.507	8.082	2.507		
2033	6.985	1.454	2.618	8.439	2.618		
2034	7.284	1.516	2.730	8.800	2.730		
2035	7.583	1.579	2.842	9.162	2.842	112.111	34.778
2036	7.900	1.645	2.961	9.545	2.961		
2037	8.198	1.707	3.073	9.905	3.073		
2038	8.493	1.768	3.183	10.261	3.183		
2039	8.784	1.829	3.292	10.613	3.292		
2040	9.069	1.888	3.399	10.957	3.399		
2041	9.364	1.950	3.510	11.314	3.510		
2042	9.636	2.006	3.612	11.642	3.612		
2043	9.900	2.061	3.710	11.961	3.710		
2044	10.198	2.123	3.822	12.321	3.822		
2045	10.445	2.175	3.915	12.620	3.915		
2046	10.667	2.221	3.998	12.888	3.998		
2047	10.892	2.268	4.082	13.160	4.082		
2048	11.104	2.312	4.162	13.416	4.162		
2049	11.305	2.354	4.237	13.659	4.237		
2050	11.494	2.393	4.308	13.887	4.308	178.149	55.264
Total	**240.241**	**50.019**	**90.042**	**290.260**	**90.042**	**290.260**	**90.042**

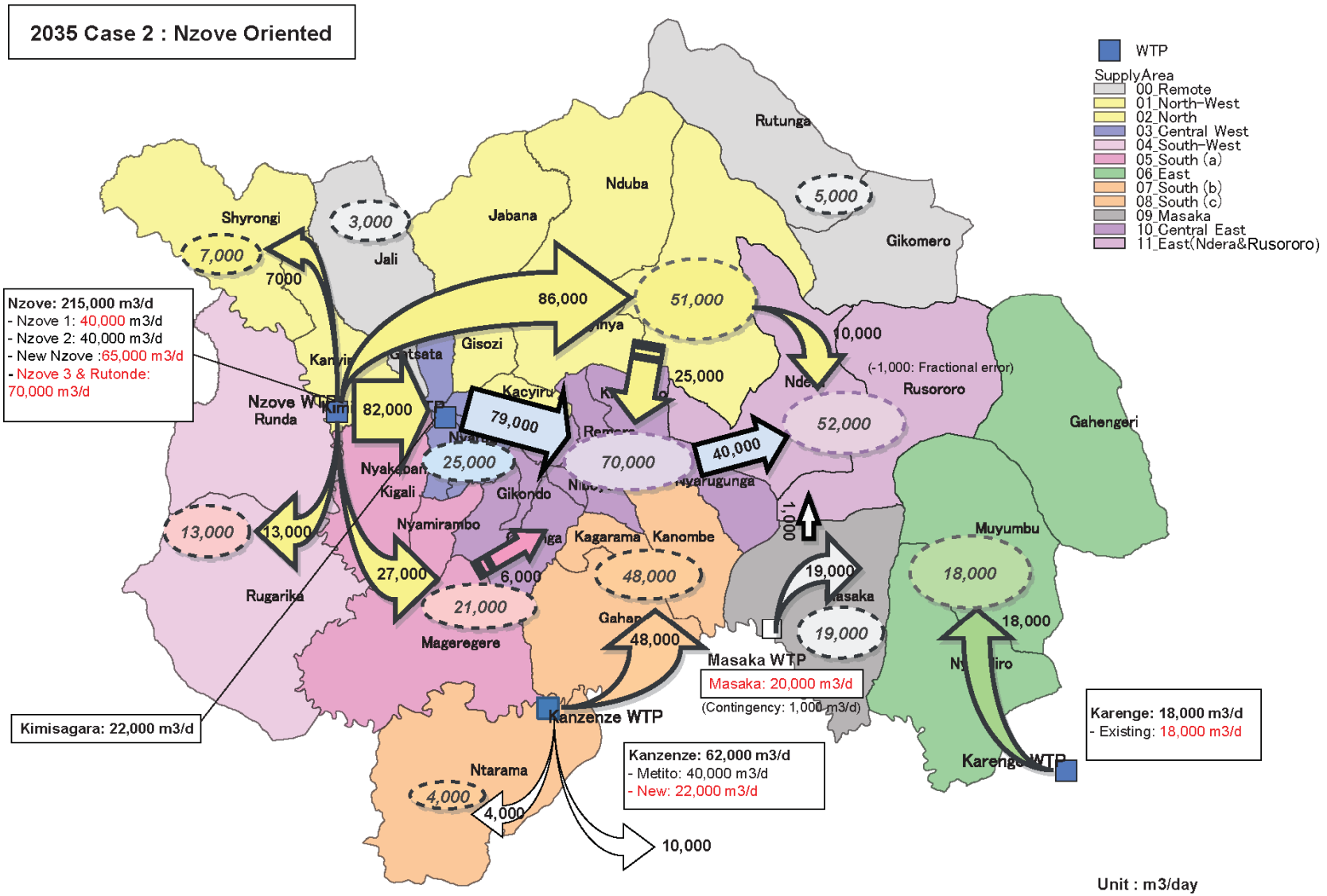
8. Water Supply Scenario (2019, 2025, 2035 and 2050)

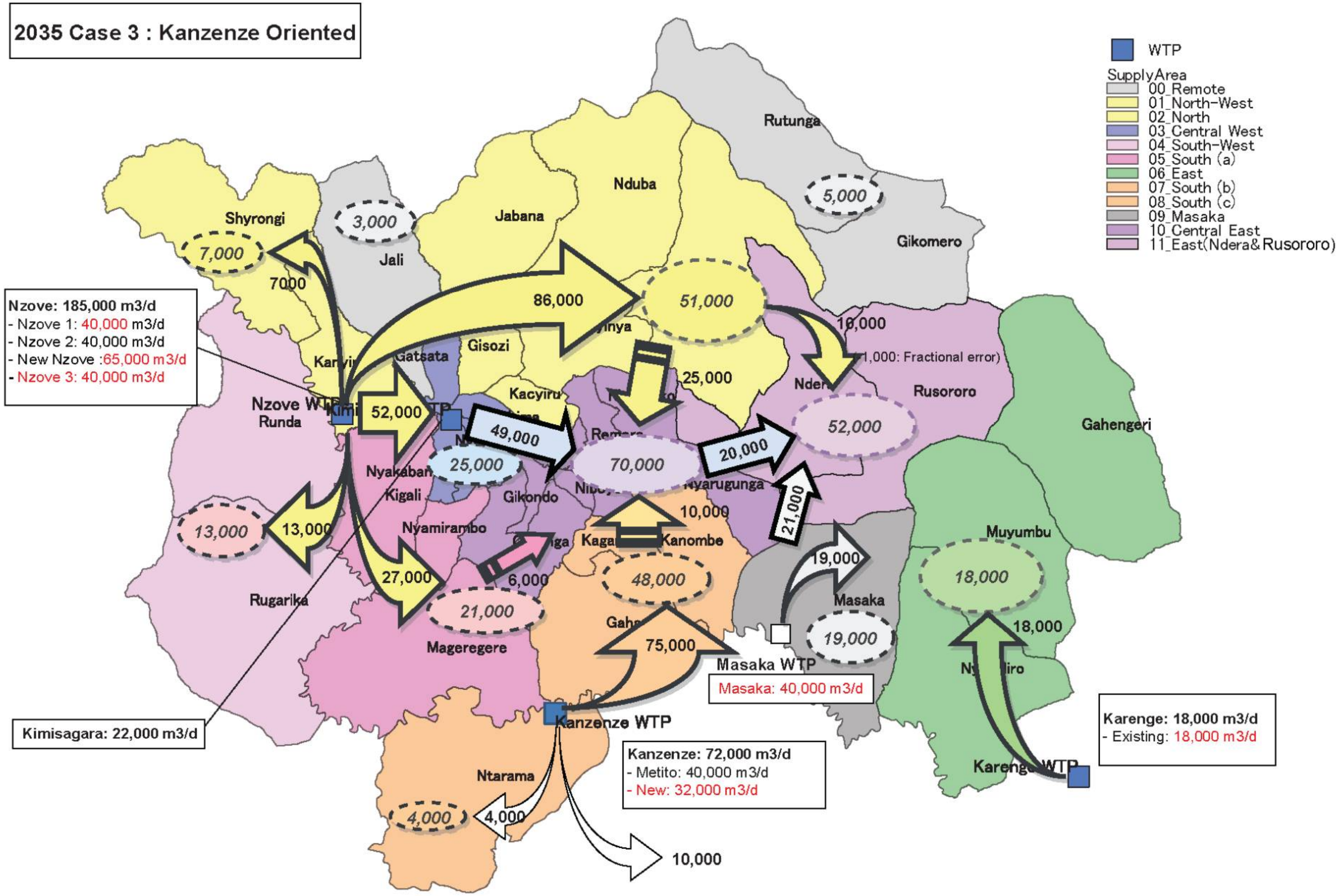


Schematic of Water Supply Area


2025
WTP
SupplyArea
00_Remote
01_North-West
02_North
03_Central West
04_South-West
05_South (a)
06_East
07_South (b)
08_South (c)
09_Masaka
10_Central East
11_East(Ndera&Rusororo)
Nzove: 120,000 m3/d
- Nzove 1: 40,000 m3/d
- Nzove 2: 40,000 m3/d
- New Nzove :40,000 m3/d
(Transmission Capacity: 105,000)
Kimisagara: 22,000 m3/d
Kanzenze: 40,000 m3/d
Karenge: 15,000 m3/d
Nzove WTP
Kanzenze WTP
Masaka WTP
Rutunga
Gikomero
Nduba
Jabana
Shyrongi
Jali
Gatsata
Gisozi
Runda
Rugarika
Nyakabanda
Kigali
Nyamirambo
Mageregere
Ntarama
Niboye
Nyarugunga
Ndera
Rusororo
Gahengeri
Muyumbu
Masaka
2,500
1,500
4,000
4000
62,000
25,000
12,000
25,000
17,000
+29,000
39,000
39,000
3,000
25,000
8,000
8,000
-25,000
6,000
6,000
10,000
25,000
35,000
10,000
20,000
6,000
7,000
30,000
15,000
1,000
1,000
(9,000)
Unit : m3/day


2035 Case 1 : Baseline
WTP
SupplyArea
00_Remote
01_North-West
02_North
03_Central West
04_South-West
05_South (a)
06_East
07_South (b)
08_South (c)
09_Masaka
10_Central East
11_East(Ndera&Rusororo)
Unit : m3/day
Gahengeri
Muyumbu
Rusororo
(-1,000: Fractional error)
Gikomero
Rutunga
Nduba
Jabana
Gisozi
Jali
Kacyiru
Kagarama
Kanombe
Gikondo
Nyamirambo
Mageregere
Ntarama
Rugarika
Runda
Shyrongi
Masaka
Karenge WTP
Masaka WTP
Kanzenze WTP
Nzove WTP
18,000
48,000
30,000
10,000
52,000
5,000
19,000
1,000
51,000
25,000
70,000
48,000
86,000
49,000
25,000
6,000
21,000
27,000
52,000
3,000
7,000
13,000
4,000
10,000
Karenge: 48,000 m3/d
- Existing: 18,000 m3/d
- New: 30,000 m3/d
Masaka: 20,000 m3/d
Kanzenze: 62,000 m3/d
- Metito: 40,000 m3/d
- New: 22,000 m3/d
Nzove: 185,000 m3/d
- Nzove 1: 40,000 m3/d
- Nzove 2: 40,000 m3/d
- New Nzove :65,000 m3/d
- Nzove 3 : 40,000 m3/d
Kimisagara: 22,000 m3/d


2035 Case 2 : Nzove Oriented
WTP
SupplyArea
00_Remote
01_North-West
02_North
03_Central West
04_South-West
05_South (a)
06_East
07_South (b)
08_South (c)
09_Masaka
10_Central East
11_East(Ndera&Rusororo)
Nzove: 215,000 m3/d
- Nzove 1: 40,000 m3/d
- Nzove 2: 40,000 m3/d
- New Nzove :65,000 m3/d
- Nzove 3 & Rutonde: 70,000 m3/d
Kimisagara: 22,000 m3/d
Kanzenze: 62,000 m3/d
- Metito: 40,000 m3/d
- New: 22,000 m3/d
Masaka: 20,000 m3/d
(Contingency: 1,000 m3/d)
Karenge: 18,000 m3/d
- Existing: 18,000 m3/d
(-1,000: Fractional error)
Unit : m3/day
Rutunga
Nduba
Jabana
Shyrongi
Jali
Gikomero
Gisozi
Kacyiru
Rusororo
Gahengeri
Nyarugunga
Kigali
Gikondo
Nyamirambo
Kagarama
Kanombe
Muyumbu
Rugarika
Mageregere
Masaka WTP
Kanzenze WTP
Karenge WTP
Ntarama
7,000
7000
3,000
86,000
51,000
5,000
10,000
25,000
82,000
79,000
52,000
40,000
25,000
70,000
13,000
13,000
27,000
6,000
21,000
48,000
19,000
19,000
18,000
18,000
48,000
4,000
4,000
10,000


2035 Case 3 : Kanzenze Oriented
WTP
SupplyArea
00_Remote
01_North-West
02_North
03_Central West
04_South-West
05_South (a)
06_East
07_South (b)
08_South (c)
09_Masaka
10_Central East
11_East(Ndera&Rusororo)
Nzove: 185,000 m3/d
- Nzove 1: 40,000 m3/d
- Nzove 2: 40,000 m3/d
- New Nzove :65,000 m3/d
- Nzove 3: 40,000 m3/d
Kimisagara: 22,000 m3/d
Kanzenze: 72,000 m3/d
- Metito: 40,000 m3/d
- New: 32,000 m3/d
Masaka WTP
Masaka: 40,000 m3/d
Karenge: 18,000 m3/d
- Existing: 18,000 m3/d
Nzove WTP
Kanzenze WTP
Rutunga
Gikomero
Nduba
Jabana
Shyrongi
Jali
Gisozi
Gatsata
Kacyiru
Runda
Nyakabanda
Kigali
Nyamirambo
Gikondo
Rugarika
Mageregere
Ntarama
Masaka
Rusororo
Gahengeri
Muyumbu
Nyarugunga
Kanombe
(1,000: Fractional error)
7,000
7000
3,000
5,000
86,000
51,000
10,000
25,000
52,000
52,000
49,000
25,000
70,000
20,000
21,000
19,000
19,000
10,000
13,000
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6,000
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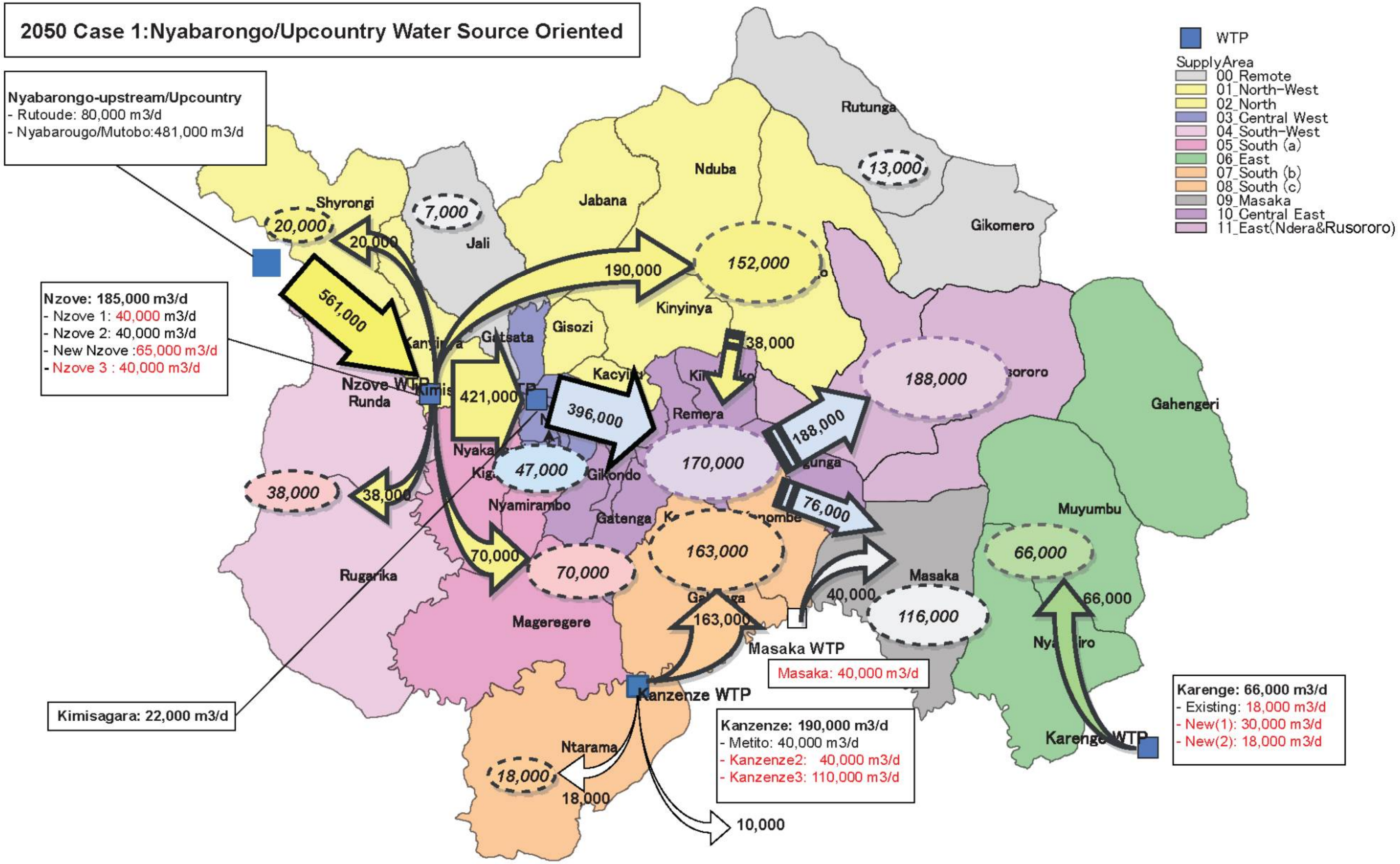
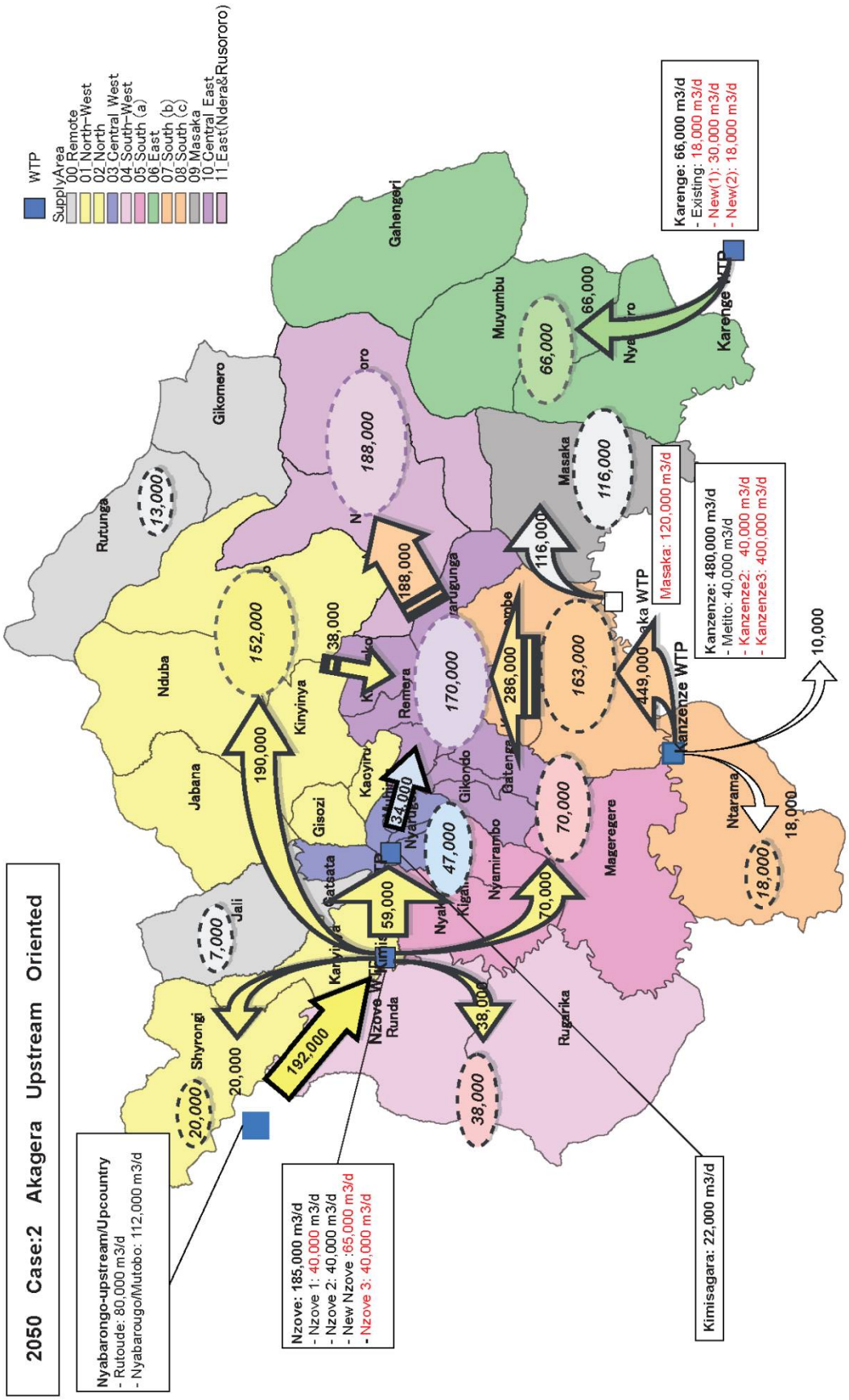
75,000
18,000
18,000
4,000
4,000
10,000


2050 Case 1:Nyabarongo/Upcountry Water Source Oriented
Nyabarongo-upstream/Upcountry
- Rutoude: 80,000 m3/d
- Nyabarougo/Mutobo:481,000 m3/d
Nzove: 185,000 m3/d
- Nzove 1: 40,000 m3/d
- Nzove 2: 40,000 m3/d
- New Nzove :65,000 m3/d
- Nzove 3 : 40,000 m3/d
Kimisagara: 22,000 m3/d
Kanzenze: 190,000 m3/d
- Metito: 40,000 m3/d
- Kanzenze2: 40,000 m3/d
- Kanzenze3: 110,000 m3/d
Masaka: 40,000 m3/d
Karenge: 66,000 m3/d
- Existing: 18,000 m3/d
- New(1): 30,000 m3/d
- New(2): 18,000 m3/d
WTP
SupplyArea
00_Remote
01_North-West
02_North
03_Central West
04_South-West
05_South (a)
06_East
07_South (b)
08_South (c)
09_Masaka
10_Central East
11_East(Ndera&Rusororo)
Nzove WTP
Masaka WTP
Kanzenze WTP
Karenge WTP
Shyrongi
Jali
Jabana
Nduba
Rutunga
Gikomero
Kinyinya
Gisozi
Gatsata
Kacyiru
Remera
Runda
Nyakabanda
Gikondo
Nyamirambo
Gatenga
Rugarika
Mageregere
Masaka
Muyumbu
Gahengeri
Ntarama
561,000
20,000
190,000
152,000
13,000
7,000
421,000
396,000
38,000
188,000
170,000
76,000
47,000
70,000
163,000
40,000
116,000
66,000
18,000
10,000


2050 Case:2 Akagera Upstream Oriented
WTP
SupplyArea
00_Remote
01_North-West
02_North
03_Central_West
04_South-West
05_South (a)
06_East
07_South (b)
08_South (c)
09_Masaka
10_Central_East
11_East(Ndera&Rusororo)
Nyabarongo-upstream/Upcountry
- Rutoude: 80,000 m3/d
- Nyabarougo/Mutobo: 112,000 m3/d
Nzove: 185,000 m3/d
- Nzove 1: 40,000 m3/d
- Nzove 2: 40,000 m3/d
- New Nzove :65,000 m3/d
- Nzove 3: 40,000 m3/d
Kimisagara: 22,000 m3/d
Karenge: 66,000 m3/d
- Existing: 18,000 m3/d
- New(1): 30,000 m3/d
- New(2): 18,000 m3/d
Masaka: 120,000 m3/d
Kanzenze: 480,000 m3/d
- Metito: 40,000 m3/d
- Kanzenze2: 40,000 m3/d
- Kanzenze3: 400,000 m3/d
Gahengeri
Muyumbu
Gikomero
Rutunga
Nduba
Jabana
Kinyinya
Gisozi
Jali
Shyorongi
Runda
Remera
Gikondo
Nyarugenge
Kigali
Nyamirambo
Gatenga
Mageregere
Rugarika
Ntarama
Masaka
Karenge WTP
Kanzenze WTP
Nzove WTP
Kimisagara WTP
66,000
66,000
188,000
188,000
116,000
116,000
13,000
152,000
38,000
190,000
170,000
286,000
163,000
449,000
10,000
34,000
47,000
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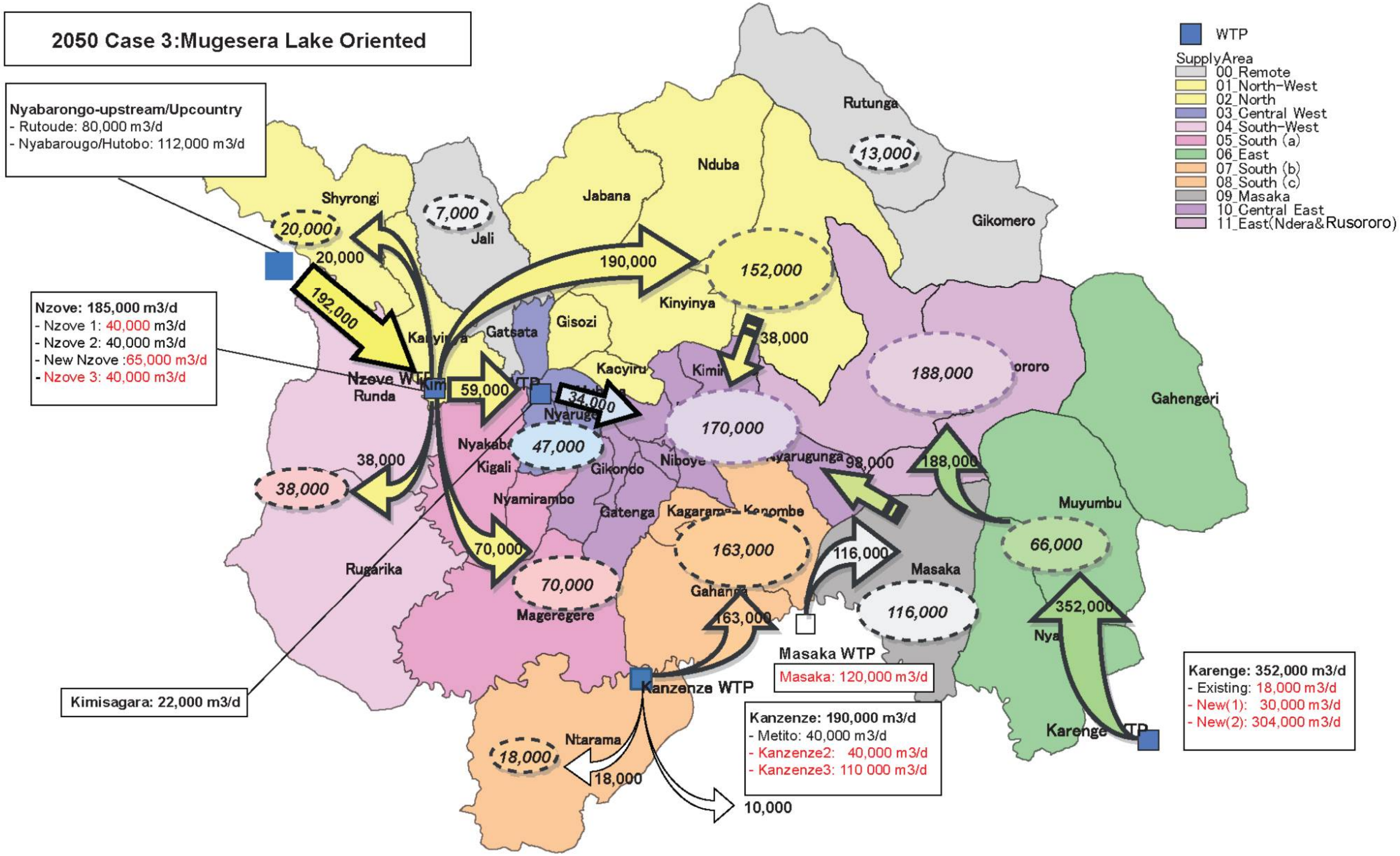
59,000
7,000
20,000
20,000
192,000
38,000
38,000
18,000
18,000


2050 Case 3:Mugesera Lake Oriented
Nyabarongo-upstream/Upcountry
- Rutoude: 80,000 m3/d
- Nyabarougo/Hutobo: 112,000 m3/d
Nzove: 185,000 m3/d
- Nzove 1: 40,000 m3/d
- Nzove 2: 40,000 m3/d
- New Nzove :65,000 m3/d
- Nzove 3: 40,000 m3/d
Kimisagara: 22,000 m3/d
Masaka WTP
Masaka: 120,000 m3/d
Kanzenze: 190,000 m3/d
- Metito: 40,000 m3/d
- Kanzenze2: 40,000 m3/d
- Kanzenze3: 110 000 m3/d
Karenge: 352,000 m3/d
- Existing: 18,000 m3/d
- New(1): 30,000 m3/d
- New(2): 304,000 m3/d
WTP
SupplyArea
00_Remote
01_North-West
02_North
03_Central West
04_South-West
05_South (a)
06_East
07_South (b)
08_South (c)
09_Masaka
10_Central East
11_East(Ndera&Rusororo)
Rutunga
13,000
Nduba
Jabana
Shyrongi
7,000
Jali
20,000
20,000
192,000
190,000
152,000
Gikomero
Kinyinya
Gisozi
Gatsata
38,000
188,000
Kacyiru
Nzove WTP
Runda
59,000
34,000
170,000
Gahengeri
47,000
Nyakabanda
Kigali
38,000
38,000
Gikondo
Niboye
98,000
188,000
Nyamirambo
Gatenga
Muyumbu
Rugarika
70,000
70,000
163,000
116,000
Masaka
66,000
116,000
Mageregere
163,000
352,000
Kanzenze WTP
Ntarama
18,000
18,000
10,000

APPENDIX 23: LIST OF DEVELOPMENT PROJECTS

Project title		Component	Background	Possible project content in brief	Remarks
A1	**Construction of Masaka WTP and Clear Water Transmission & Distribution Facilities**	Construction of well field and WTP in Masaka **(Phase 1: 20,000 m^3/day,** **Phase 2: 20,000 m^3/day** **Phase 3: 40,000 m^3/day)** **Phase 4: 40,000 m^3/day)**	- Water demand growth on the eastern side of the city is urgent and large (i.e., Masaka, Ndera, Rusororo). Due to the insufficiency of the current supply capacity residents in this area is hard to access safe and steady water supply service. - It is more efficient to utilize water source at Masaka near the demand area instead of conveying water from other existing WTPs. - New transmission pipes and distribution reservoirs and reinforcement of the distribution network are required for the water supply expansion.	**(1)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) **(2)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) **(3)Construction of distribution network in Masaka Area**	* Land acquisition is required for water wells and a treatment plant * Demand is yet to be high in the Masaka sector in 2019. Expansion in the phased manner should be considered. In addition, the water transmission to the other area (Ndera, Rusororo, Nyarugunga) should be considered (Additional cost is required). * (3) Construction of distribution network may be omitted (Existing distribution networks can be utilities for the moment).
A2	**Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities**	Rehabilitation of intake facility and Expansion of Karenge WTP **(Phase 1)**	- The intake pumps are damaged, overloaded and vulnerable to the flooding risk. The intake pumps are below the flood level of Mugesera Lake and can be affected by water during the rainy season. An old raw water intake pipe (ND300) is damaged and not working properly. - The existing WTP in over-load operation; forced to operate 18,000 m^3/day while the capacity is only 15,000 m^3/day. Incidental maintenances of pumps and resulting water supply interruption are a serious problem since they are fully operated with no standby. - Demand in the eastern area is as large as 52,000 m^3/day in 2025, and 89,00 0m^3/day in 2035 only for Ndera, Rusororo, Masaka and upcountry three sectors. It is necessary to make the most of the already acquired water right of 48,000 m^3/day permitted by RWFA.	**(1)Rehabilitation of intake facility** - Rehabilitation of Raw Water Transmission pipes (ND300) - Relocation of the pump house and upgrading the capacity of pumps and motors **(2)Expansion of Karenge WTP** Expansion of WTP capacity from 15,000m^3/d to 18,000 m^3/d (Filtration Basins, Clear Water Reservoirs)	* Land acquisition for the next step (for approx. 40,000 m^3/d) is required. * Without increasing capacity of CW transmission pipes, additional head with approx. 40 m is required (i.e., energy efficiency goes down).
		Expansion of Karenge WTP and forwarding infrastructures **(Phase 2: 30,000 m^3/day)** **(Phase 3: 50,000 m^3/day)**		**(3)Expansion of Karenge WTP and forwarding infrastructures** - Expansion of Intake and WTP for 30,000 m^3/d (Intake pumps, Treatment facilities, Clearwater reservoirs and pumps - Construction of New Transmission Pipelines (ND700, L= 33 km)	* Eutrophication of Mugesera lake is concerned because of the development of the surrounding area. Further monitoring, water safety planning, coordination with the stakeholders, and additional treatment facilities may be necessary.
A3	**Expansion & renewal of Nzove 1 WTP**	Expansion/ renewal of well fields of Nzove 1 **(40,000 m^3/day)**	- Nzove well fields and treatment facilities are the largest and the most important existing water sources for the City of Kigali. However, the yield capacity for the existing wells for Nzove 1 is declining (40,000 m^3/d to 17,000 m^3/d). Because of the declination of its production capacity, the on-going transmission pumps and pipes to Ntora may not be fully utilized. - The procurement process for upgrading existing WTP is on-going, however, it may be unsuccessful because the current condition of the structure is poor thus the technical difficulty on the rehabilitation of existing facilities is high. - The current treatment system is not efficient in terms of O&M because it uses intermediate pumps which can be omitted in an appropriate treatment system.	**(1)Expansion and renewal of well field of Nzove 1** □Expansion of well field for Nzove 1 (23,000m^3/d). **(2)Expansion/renewal of Nzove 1 Treatment Facilities** □Scrap & build of Nzove 1 (40,000 m^3/d) □Water source: wells (sub-surface water).	* This component is not necessary if on-going procurement for the rehabilitation of Nzove 1 is successful. * This rehabilitation of the Capacity of Nzove (up to 25,000 m^3/day) was described as "borne by WASAC" as a precondition of the Nzove-Ntora transmission project by Japan's Grant Aid. * Land acquisition for expansion (western side of the existing area is one of the most probable options but it may involve small-scale relocation).
A4&5	**NRW reduction project through pipe renewal and pressure control**	Comprehensive NRW reduction investment	- The reduction of the high NRW ratio (38% in 2019) is the most important challenge in WASAC. Major causes of high NRW ratio are attributable to the leakages from the aged pipes, poor pipe materials and construction. difficulty in controlling regional high pressure due to hilly geographical characteristics, poor quality of pipe material as well as poor workmanship of its installation works, and leakage from aged existing pipes. Accordingly, pressure control in the transmission and distribution system as well as the renewal of aged distribution pipes and service connection facility is necessary. - WASAC is currently focusing on the expansion of the new service area due to the rapid growth of water demand. Therefore, it does not have sufficient resources to allocate for the renewal of facilities.	**(1) Block zonings, metering and identifying pipelines to be replaced (e.g., deterioration diagnosis of aged pipes)** **(2) Renewal of service pipes and meter replacement for leakage reduction** Performance-based contract, Procurement of material plus installation work, or Procurement of material only **(3) Maintenance services for NRW reduction** Establishment of the preventive maintenance system	* Design-Build (DB) or Performance-Based Contract (PBC) scheme may be applicable for constructing distribution blocks, identifying pipes to be replaced and implement the replacement. * It is not clear whether potential contractors show interest in this project. * Justification of the project effect would be difficult ("Improvement of business management"" and/or ""increasing available volume of water resource" could be itemized as one of the project effects but those are not necessarily well-explained to the public)
	Part 1: Kacyiru/Remera (North))	Improvement of the high-pressure area through distribution blocks	- Clearwater transmission capacity from Nzove to Ntora is being upgraded by Japan's Grant Aid. However the water is	**(1) Construction of Service Reservoirs** □Service reservoirs (V=100-500m^3, 7 nos.)	* Land acquisition required for reservoirs.

Project title		Component	Background	Possible project content in brief	Remarks
		constructions	not effectively utilized because of the poor distribution facilities from Ntora to the Remera sector. - A pilot area of Japan's technical cooperation project on NRW reduction is in the midst of the distribution main. Additional investment in the facility will accelerate disseminating the successful experience on the NRW reduction. - Many leakage cases were observed in the southern side of the Ntora area due to high pressure. The introduction of appropriate zoning of the distribution system will contribute to solving this issue.	□Elevated Tanks (V=50-100m^3, 6 Nos) □Flow meters (ND150, 13 nos.)) □Appurtenant facilities (Pipes, Valves and miscellaneous) **(2) Modification of existing/on-going SCADA system** **(3)Construction of Transmission Pipeline** □ DIP ND600 L=3.5km **(4) Construction of Distribution Pipelines** □Distribution Mains (ND150-200: 20 km)	* Procurement of service pipes presumes the construction capacity development and monitoring by the Japanese Technical Cooperation project for NRW.
		Procurement of service pipes for replacement		**(5) Procurement of secondary distribution and service pipe equipment** Secondary distribution pipes (ND 63-110: 90km) Service pipes (ND13-25: 200 km)	
A6	**Capacity development for Sustainable Use of Water Resources and Water Supply Facilities**	Technical Assistance	- The on-going Japanese cooperation (TC) project on NRW management demonstrated successful achievement in the pilot areas. It is necessary to scale-up and disseminate the experience to the entire CoK and surrounding area. - On the other hand, the challenges of WASAC are diversifying in line with the rapid expansion and development (e.g., development of water source including wells and its proper O&M, NRW reduction measures, facilitating financial independence, organization reform.). - Improvement of financial situation is one of the urgent issues considering the fact that the business profit is negative. Improvement of efficiency is the key to the sustainable management of the utility.	Technical Assistance from international donors - Water resource development and its O&M (O&M for wells) - NRW reduction - Planning/ design/ construction supervision - Strengthening capacity of water quality monitoring - Improvement of financial status and facilitate self-reliance - Organization reform	- Broader involvement and engagement of other stakeholders (e.g. MININFRA, RWFA, RURA) are expected.
A7	**Kigali Central Transmission Main**	Kigali City central trunk main (Nzove WTP to city west)	- The availability of the potential water source in the middle- and down-stream of the Nyabarongo River is limited. Under this circumstance, transmission from Nzove to the eastern side of the city should be considered. - The existing transmission route through Nzove and Mont-Kigali to Remera is inefficient. This is because they are transmitted from the high elevation mountain as well as the route is diverted from the city center and thus is a long way to the eastern area	- Transmission Pipeline (Nzove-Kimisagara-Remera) (18.4 km, ND 800-1,000 mm) - Transmission Pumping Stations and Pumps - (Nzove H=70m, Kimihurura H=125m) - Distribution Reservoirs(Kimisagara, Kimihurura)	- Land Acquisition is required for reservoirs and pumping stations
B2	**Nzove 3 Water Treatment Plant**	New water source and water supply facilities in order to cover demand in 2050. **(40,000 m^3/day)**	Construction of new facilities at the right bank (the opposite side) of the existing WTPs in Nzove including the followings: New intake facility in case of taking river water, or new well-field in case of taking groundwater (sub-surface water).RW transmission facilities.	- Water Well Field - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	Feasibility Study including water sources survey and a large area of land acquisition
B3	**Rutonde Water Treatment plant**	New water source and water supply facilities in the upstream of Nyabarongo from Nzove. **(Phase 1: 40,000 m^3/day, Phase 2: 40,000 m^3/day)**	Water supply facilities at both sides of the riverbanks in the Rutonde Area (7 km upstream of the Nzove WTP) in Nyabarongo River by 2050. Water source development (groundwater (subsurface water)) accompanied by its related RW transmission pipes and treatment facilities. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Well Field - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	- Feasibility Study including water sources survey and a large area of land acquisition
B4	**Nyabarongo WTP (Water supply facilities related to Nyabarongo II Dam)**	New water source and water supply facilities in order to cover demand in 2050. **Phase 1: 120,000 m^3/day** **Phase 2: 120,000 m^3/day**	To develop new water source and water supply facilities in order to cover demand in 2050. Nyabarongo II Dam that is for the purpose of hydropower generation and flood control is planned at the 20 km upstream of the existing Nzove WTP. De-sludging of accumulated bottom sediment would impact the O&M of WTPs at the downstream of Nyabarongo River. Intake, RW transmission pipes, WTP would be considered if the part of water can be used for drinking water	- Surface Water Intake - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes) - The primary sedimentation pond would be considered in case intake suspension is inevitable at the WTPs in the downstream during the discharging period of the bottom sludge from the Nyabarongo II Dam (by 2050?).	- This is subject to change of the Nyabarongo II Dam implementation.
B5	**Dam construction at the downstream of Yanze River**	New water source and water supply facilities in order to cover demand in 2050.	The dam at the downstream of Yanze River Intake, RW transmission pipes, WTP	- Dam (Single Purpose) - Surface Water Intake - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	- Resettlement, Environmental and social impact is large
B6	**Construction of small-scale water supply facilities**	New water source and water supply facilities in order to cover demand	Construction of new well fields accompanied by its related RW transmission pipes and treatment facilities.	- Construction of wells - Pumping Stations	- Currently no candidate new sources are listed or nominated. Need a comprehensive water resources survey in the City of

Project title		Component	Background	Possible project content in brief	Remarks
	including related water sources (e.g., springs and small rivers and/or creeks)	in 2050.		- Pipelines	Kigali and adjacent sectors.
B7	**Gahanga Water Treatment Plant**	New water source and water supply facilities in order to cover demand in 2050. (Phase 1: 40,000 m^3/day) (Phase 2: 120,000 m^3/day) (Phase 3: 120,000 m^3/day)	Water supply facilities on the left side of the Nyabarongo River. Water source development (groundwater (subsurface water)) accompanied by its related RW transmission pipes and treatment facilities. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Well Field - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	- Feasibility Study including water sources survey and a large area of land acquisition
B8	**Construction of new water supply facilities taking raw water from Akanyaru River**	New water source and water supply facilities in order to cover demand in 2050.	Water supply facilities with taking water from Akanyaru River. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Intake - Water Transmission Pipeline - Distribution Reservoir and Pipelines	<Not listed in the water resources utilization plan since this may not be feasible because of the location>
B9	**Construction of new water supply facilities taking raw water from Mutobo Spring**	New water source and water supply facilities in order to cover demand in 2050.	Water supply facilities with taking water from Mutobo Spring in Musanze District. Water source development (spring) accompanied by its related intake facility (in Musanze District), RW transmission pipes (tens of kilometers), treatment facilities (in Musanze or in Kigali).	- Water Intake - Water Transmission Pipeline - Distribution Reservoir and Pipelines	The Mutobo source is the main source of the Musanze District. The right to take the water to Kigali should be clarified.
B10	**Construction of new water supply facilities taking raw water from Kivu Lake**	New water source and water supply facilities in order to cover demand in 2050.	Water supply facilities with taking water from Kivu Lake. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Intake - Water Transmission Pipeline - Distribution Reservoir and Pipelines	Maybe Technically not feasible.
C1	**Others (combining with other projects can be considered)**	Installing additional valves for emergency response and redundancy of transmission & distribution system	Under the on-going TC project, flow meters are installed to monitor the inlet flow volumes for 6 (six) branches in and around Kigali City. However, the necessary valves to segregate each zone to facilitate proper operation (e.g., mutual transfer of water from zone to zone) are still lacking and this hinders WASAC from addressing incidents of leakage and/or pipe replacement works properly and timely.	- Adding shut-off valves to minimize the risk of supply failure attributed to major leakage and/or accident in WTP.	To be implemented combining with 1, 2, 3, 4, and 5 (Project cost scale: ranging from a few millions of Yen to tens of millions of Yen).
C2		Introduction of smart meter	Meter reading is difficult in some areas due to geographical restrictions. It may be solved by introducing smart meters in a new service area and/or replacing the existing meter with the smart meters. This could contribute to reducing NRW.	- Procurement of smart meters (pilot project, procurement of material) - Implementing along with NRW reduction measures and/or renewal of pipes.	WASAC has already initiated the procurement of smart-meters for 50,000 nos.
C3		Introduction of small-scale in-line hydropower generation	On the whole, WASAC's transmission and distribution system is not necessarily an efficient system in terms of energy consumption. Introducing in-line small-scale hydropower generation could be an option for improving the energy efficiency of the system.	- Introduction of the in-line small-scale hydro generator. - Construction of new WTP or combined with pipe renewal.	- Whether there is sufficient Q (flow) and ΔH (head) - Project cost scale: ranging from tens of millions of Yen to hundreds of millions of yen.
C4		Rehabilitation of small-scale WTPs the wells	Production capacities in some small-scale WTPs and/or wells are decreasing due to pipe breakage attribute to landslide near the site. In general, these kinds of small-scale water sources are close to their supply areas and those can take a role for the back-up source in case of emergencies. Therefore, considering those advantages, it is recommended for WASAC to continue keeping those small-scale sources to secure steady supply in future	- Rehabilitation of wells and pipes	- Supply capacity is at most several thousand m^3/d however cost would be low and taking effect instantaneously. - O&M cost for the small-scale WTPs (opinion of WASAC to be confirmed) - Most of the small-scale water sources are at risk of t the contamination by human activities. It is necessary to assess the possibility of sustainable use of water sources as well as water safety planning.
C5		Integrated SCADA system for entire Kigali City	SCADA system, furnished with monitoring devices such as the level gauge of reservoirs and flow meters for transmission and distribution system integrally, is not available. The content of the SCADA system component to be developed by the AfDB's assistance is not clear.	- Integrated SCADA system for monitoring the entire transmission and distribution system.	* SCADA is already furnished under AfDB's assistance. (present actual status to be confirmed)

APPENDIX 24: PROJECT IDENTIFICATION SHEET

This Page is closed due to the confidentiality.

APPENDIX 25: ECONOMIC EVALUATION

This Page is closed due to the confidentiality.

APPENDIX 26: FINANCIAL EVALUATION

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APPENDIX 27: PRROJECTIONS OF COUNTRY-WIDE RECURRENT COSTS

(Million RWF)

Sources	Cost Items	1st Period 2020/21 – 2025/26	2nd Period 2026/27 - 2030/31	3rd Period 2031/32 - 2035/36
WASAC (1)	1.Chemical products	15,238	12,698	12,698
	2.Electricity cost (VAT exclusive)	48,954	40,795	40,795
	3.Salaries, Wages & Benefits (Casual)	9,288	8,485	9,425
	4.Salaries, Wages & Benefits (Permanent)	34,202	31,243	34,704
	5.Repair & Maintenance Production	1,937	1,614	1,614
	6.Distribution network	13,496	11,247	11,247
	7.Commercial expenses	9,334	8,527	9,471
	8.Administrative Expenses	17,236	15,745	17,489
	9.Depreciation & Amortization Expenses	-	-	-
	10.inance costs	3,377	2,814	2,814
	11.External Water Quality Analysis	291	243	243
	12.Abstraction permit (2frw/m3)	795	663	663
	13. Repayment of existing loans	21,177	12,353	0
	Total	175,326	146,426	141,163
JST	1.Kanzanze: Bulk water purchase	49,833	45,302	45,302
	2.Depreciation of existing assets (2)	20,118	16,765	16,765
	3.Depreciation of new assets: on-going works	3,089	3,162	3,162
	4.Depreciation of new WTP	3,379	7,765	11,863
	5.Depreciation of new NRW/Pipelines	10,637	28,620	39,622
	6.Depreciation of new DSM&PR(3)	1,039	2,148	3,767
	7.Depreciation of new assets: water meters	929	2,148	3,767
	8.O&M of the Projects	1,919	26,490	42,490
	Total	90,943	132,401	166,737
Grand Total		266,269	278,827	307,900

Note: (1) “Final Costing Model, 2019” of WASAC, (2) FY 2018/19 Financial Statement of WASAC, (3) Distribution sub-mains and pipe for replacement

Source: JST

APPENDIX 28: LIST OF ARTICLES REGARDING THE PROJECT FOR KIGALI WATER SUPPLY MASTERPLAN

English

No	*Newspaper*	*Website*	*Tittle*	*Date*	*Pictures*
1	Top Africa News	https://www.topafricannews.com/2019/03/15/wasac-jica-launch-the-development-of-water-supply-master-plan-for-city-of-kigali/	WASAC, JICA launch the development of Water Supply Master Plan for City of Kigali	14th February 2019	
2	IGIHE NETWORK	https://en.igihe.com/news/kigali-city-water-supply-master-plan-to-be	Kigali City Water Supply Master Plan to be revised	15th March 2019	
3	All Africa/The New Times	https://allafrica.com/stories/202003020250.html	Rwanda: Water Demand in Kigali to Increase Fivefold By 2050, Report	28th February 2020	
4	New Times	https://www.newtimes.co.rw/featured/wasac-introduces-mobile-water-tanks-tackle-shortage	FEATURED: WASAC tackles water shortage in Kigali with 26 mobile tanks	1st December 2020	
5	MININFRA	https://www.mininfra.gov.rw/updates/news-details/minister-gatete-receives-jica-team-working-on-kigali-water-supply-master-plan-with-2050-horizon	Minister Gatete receives JICA team working on Kigali Water Supply Master Plan with 2050 horizon	27th May 2021	 

Kinyarwanda

No	*Newspaper*	*Website*	*Tittle*	*Date*	*Pictures*
1	Umurabyo.rw	https://umurabyo.rw/2019/08/06/kigali-hamuritswe-igenamigambi-irambye-rigamije-kureba-uko-amazi-agera-kubaturage-bose/	Kigali: hamuritswe igenamigambi rirambye rigamije kureba uko amazi agera kubaturage bose	6th August 2019	 
2	RBA (Rwanda Broadcasting Agency)	https://www.rba.co.rw/post/WASAC-ivuga-ko-mu-2024-buri-muturage-muri-Kigali-azaba-ashobora-kubona-amazi-muri-metero-200	WASAC ivuga ko mu 2024 buri muturage muri Kigali azaba ashobora kubona amazi muri metero 200	27th August 2021	
3	Kigalitoday.com	https://www.kigalitoday.com/amakuru/amakuru-mu-rwanda/article/muri-2050-abatuye-umujyi-wa-kigali-bose-bazaba-bafite-amazi-mu-nzu	Muri 2050 abatuye Umujyi wa Kigali bose bazaba bafite amazi mu nzu	27th August 2021	
4	Isango Star	https://www.isangostar.rw/amakuru/mu-rwanda/article/wasac-muri-2035-buri-rugo-muri	WASAC: Muri 2035 buri rugo muri Kigali ruzaba rufite amazi	28th August 2021	
5	Bwiza.com	http://bwiza.com/?Buri-rugo-mu-Mujyi-wa-Kigali-ruzaba-rufite-amazi-mu-2035-WASAC	Buri rugo mu Mujyi wa Kigali ruzaba rufite amazi mu 2035 - WASAC	29th August 2021	

Japan International Cooperation Agency

FINAL REPORT

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

FOR THE

KIGALI WATER SUPPLY MASTER PLAN INCLUDING 15-YEARS INVESTMENT PLAN

Prepaid by
BUREAU FOR ENGINEERING AND ENVIRONMENTAL STUDIES
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Consulting Engineers & Architects

September, 2021

ACRONYMS/ABBREVIATIONS

AIDS : Acquired Immune Deficiency Syndrome
ARAP : Abbreviated Resettlement Action Plan
CBOs : Community Based Organizations
CITES : Convention of International Trade of Endangered Species
CBD : Convention of Biological Diversity
ESIA : Environmental and Social Impact Assessment
ESMP : Environmental and Social Management Plan
GIS : Geographic Information System
GoR : Government
GPS : Global Positioning System
HH : Households
IPAR : Institute of Policy Analysis and Research
IUCN : International Union for the Conservation of Nature
IWRMP : Integrated Water Resources Master Plan
JICA : Japan International Cooperation Agency
KCC : Kigali City Council
Ltd : Limited
MININFRA : Ministry of Infrastructure
MoE : Ministry of Environment
MP : Master Plan
NGO : Non-Government Organization
NISR : National Institute of Statistics of Rwanda
NNYL : Nile Nyabarongo Lower
OHS : Occupational, Health and Safety
RDB : Rwanda Development Board
REMA : Rwanda Environment Management Authority
RLMUA : Rwanda Land Management and Use Authority
RURA : Rwanda Utilities Regulatory Agency
RWAF : Rwanda Water and Forestry Authority
ToRs : Terms of Reference
WASAC : Water and Sanitation Corporation
WHO : World Health Organization

TABLE OFCONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

1. INTRODUCTION

1.1. Background

Government of Rwanda has made sustainable water supply one of priorities of the National Development Agenda and is establishing supportive policies and legislation. The government also acknowledges that access to safe and clean water plays a vital role in social and economic development, poverty reduction and public health.

To achieve national objective in water supply, the Ministry of Infrastructure has developed the National Water Supply Policy to provide clear direction for the implementation of activities in the water supply sub-sector. 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). Urbanization is widely associated with economic transformation, in particular increasing off-farm activity, which would alleviate some of the pressures on the land from rising population density. While the urbanization rate is currently still low compared with other countries, rapid urbanization will occur in Rwanda in the coming years, with 35 per cent of the population envisaged to live in urban areas by 2020 (Vision 2020). At present, the urban water supply sub-sector still struggles with a number of challenges, including slow progress towards 100 per cent urban water supply coverage, high levels of non-revenue water, and insufficiency of production capacities leading to persistent water shortages and dry zones in urban areas.

From above background, the Government of Rwanda (GoR) through Water and Sanitation Corporation (WASAC) with the support from Government of Japan through, Japan International Cooperation Agency (JICA) is preparing a Water Supply Master Plan for City of Kigali referred in this document as Master Plan (MP). The objective of the Project 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. Though the proposed Master Plan aims at contributing to urban and human development, some of the anticipated programs and projects may results in environmental and social Impacts and need to be assessed in order to have a comprehensive environmental and Social framework that ensure sustainable development.

In addition to Master Plan, a 15 Years Investment Plan and feasibility study for two selected projects namely: (i) Construction of the Masaka WTP and Clear Water Transmission & Distribution Facilities and Rehabilitation and Expansion of the Karenge WTP and Transmission & Distribution Facilities, and, (ii) Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities. Therefore, this Strategic Environmental Assessment covers the oveall Master Plan,15-Years Investment Plan and information provided in Feasibility Study for the two projects.

1.2. Rationale of Strategic Environmental Assessment(SEA)

While SEA has a wide variety of definitions and interpretations depending on the countries or institutions concerned, "in general, SEA refers to a formal, systematic process to analyses and address the environmental effects of policies, plans and programmes and other strategic initiative" (UNEP, 2004). The New Guidelines clearly states, "JICA applies a Strategic Environmental Assessment (SEA) when conducting Master Plan Studies etc. Further, in Rwanda SEA is embedded in the Environment law approved in 2005 and amended in 2018. Article 31 of this law state that "every policy, strategy, plan and programme must undergo a strategic environmental assessment. Procedures for conducting strategic environmental assessment are determined by an Order of the Minister". Guidelines for SEA preparation were prepared and published in June 2011 and provide guidance on SEA procedures in Rwanda.

From the above reasons, SEA is the right instrument that meet for both Environmental and Social Considerations and National Environmental regulations.

1.3. Objectives and scope of SEA for Kigali Water Supply Master Plan

1.3.1. Objective of SEA study

This SEA is prepared in compliance with Environmental and Social Considerations (hereinafter referred to as ""), World Bank's Safeguard Policy OP 4.01 as well as Rwandan regulations. Therefore, the aim of the Study is to achieve the following objectives:

- To identify and assess potential environmental and social impacts of the Master Scenario used for Master Plan,
- To identify all potential significant adverse environmental and social impacts of the development Projects included in Master Plan.

1.3.2. Scope of SEA

1.3.2.1. Evaluation Water Supply Master Plan and 15-Years Investment Plan

Through review of all available documents related to the Master Plan including 15 Years Investment Plan and Feasibility Study for two selected projects, policy paper, and development plans (development projects), the Consultant provided a description of the development policy, the projects, and surrounding environment specifying any information necessary to identify and assess the environmental and social effects by the Master Plan. This includes background and objectives of the Master Plan, concise description of each facility assessed in the Study, geographic, ecological, general layout of facilities including maps at appropriate scale where necessary information on size and capacity of facilities should also be provided. If lack of information necessary for the Study is identified, the additional study may be conducted. The evaluation considered additional information provided in 15-Years Investment Plan and Feasibility Study of two selected projects.

1.3.2.2. Review of policy, legal and regulatory framework

The SEA includes identification and description of pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. Thereafter, the Consultant shall identify the project activities that should comply with the identified regulations. It shall be including but not limited to:

- Details of the regulations and standards governing social environmental consideration (EIA, involuntary resettlement, public participation, information disclosure) and water supply;
- Details of the Counterpart organization and specifics regarding the Master Plan;
- Analyse gaps between JICA guidelines and national regulations;

1.3.2.3. Development of baseline information

The SEA also include baseline information on the environmental and social characteristics of the existing situation around target area. The baseline information includes but not limited to:

- Physical environment (topography, land cover, geology, climate and meteorology, air quality, hydrology, etc.)
- Biological environment (flora and fauna, migratory species, endangered species, sensitive habitats, etc.)
- Social and cultural environment (present and planned land use, planned development activities, community/social structure, employment and labour market, sources and distribution of income, cultural/religious sites and properties, vulnerable groups and indigenous populations, etc.)
- Economic activities (agriculture, livestock, fisheries, small-scale industries, etc.)

1.3.2.4. Assessment and comparison of project alternatives

The Consultant examined proposed alternative Master scenario firstly to avoid and prevent, or secondly to reduce or minimize adverse or improve beneficial environmental or socio-economic impacts. The alternatives to the projects include a "no action" alternative, indicating what would happen in the absence of the proposed project.

1.3.2.5. Identification and assessment/analysis of potential impacts

From the detailed field survey, the Consultant analysed and described all significant changes brought about by each scenario. These encompass environmental, ecological social impacts, both positive and negative, because of proposed facility that are likely to bring about changes in the baseline environmental and social conditions. The SEA presents a prioritization of all concerns identified and differentiate between short, medium, long-term and cumulative impacts during construction, operation and decommissioning.

1.3.2.6. Development of mitigation measures

The SEA provide strategic and policy actions and scenarios that may help in avoiding or reducing, as far as possible, any adverse impacts due to proposed usage of the sites and utilizing of existing environmental attributes for optimum development.

1.3.2.7. Development of monitoring plan

The SEA include specific description, and technical details, of monitoring measures for developed Mitigation Measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, definition of thresholds that will signal the need for corrective actions as well as deliver a monitoring and reporting procedure. The Monitoring plan provides a period and implementation mechanism, staffing requirements, training and a reliable cost estimate for the all proposed actions in Mitigation Measures.

1.3.2.8. Public participation/consultation program

The SEA also include implementation program for conducting public presentation(s) on the findings of the SEA in consultation with stakeholders. The program consists of public participation program, and implementing program during the SEA study and implementation.

1.3.2.9. Preparation of filing documents

Filing documents of the Master Plan, which will be available to the public through public participation program and reviewed by Ministry of Infrastructure (hereinafter referred to as "MININFRA"), shall be prepared in consultation with the project proponent (WASAC). Drafts of scoping and TOR for the IEE study shall be developed for various projects identified during Master plan development.

1.4. SEA methodology

The SEA is conducted in accordance with the Rwandan Guidelines and Procedures for Developing a Strategic Environment Assessment as well as JICA guidelines for Environmental and Social Considerations. The following guidance materials have also been considered:

- UNEP (2004), EIA and SEA: Towards an Integrated Approach;
- World Bank (2011), SEA in Policy and Sector Reform: Conceptual Model and Operational Guidance; and

The methodology for the conduct of the SEA include the Following:

1.4.1. Situational and stakeholder analysis

The initial phase of the SEA includes an initial situational analysis and stakeholder analysis of the water supply in Kigali, its surroundings and water supply in General. BESST LTD has initiated a series of initial consultations with, Kigali City Council (KCC), Water and Sanitation Corporation (WASAC), the Rwanda Environment Management Authority (REMA) and the Ministry of Environment (former MINIRENA) and a selected number of key informants to discuss current water supply sector situation, confirm the scope and objectives of the SEA, and discuss the proposed methodology and work plan for the conduct of this work. The Initial consultation also helped to identify stakeholders for Kigali Water Supply Master Plan. Further, additional consultation was undertaken during Environmental Impact Assessment for two selected projects.

1.4.2. Literature review

A literature review of documents relevant to water supply in Kigali City and surrounding areas is also ongoing and will continue during the preparation of SEA. This shall legal / policy documents, strategic for water supply sector and Kigali City, and master Plans. This work included:

- Review of national legislation and policy and information water supply,
- Review and identification environmental Policies and Regulations relevant to the master Plan
- Assessment of the current environmental and social challenges facing the water supply in Kigali City;
- Review of Statistical data such as EICV 3,4, and 5 to have A document repository was established and shared with UNDP, REMA and MoE to facilitate information gathering and review during the conduct of the SEA.
- Review of Strategic Documents such as Kigali Urban Development Master Plan 2050 (2020), water sector Policy (2016) district strategic Plans (2019-2024), Environment and natural Resources Sector Strategic Plan (2019-2024), National strategy for transformation Strategy((NST1), Water and sanitation sector working Group reports etc.

1.4.3. Stakeholder analysis and participation

1.4.3.1. 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. 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.

1.4.3.2. Purpose

- To prepare stakeholders on potential scenarios that could be caused by the proposed investment and get feedback from them,
- To build a trusting relationship with stakeholders based on a transparent and timely supply of information and open dialogue.
- To ensure effective engagement with key stakeholders throughout all phases of this Master Plan.
- To actively build and maintain productive working relationships, based on principles of transparency, accountability, accuracy, trust, respect and mutual interests with stakeholders.

1.4.3.3. Public consultations and participation

Public participation consultation is an integral part of environmental and social assessment process of the project. Consultation is a tool to inform project-affected people, beneficiaries and stakeholders about the proposed activities both before and after the development decisions are made. For this SEA the affected community are not yet identified and public consultation focused on stakeholders and provide mechanism of consulting communities and affected people at later stage of Master plan.

1.4.4. Baseline information

The national Guidelines for Strategic Environmental Assessment provides guidance on information to be collected to document baseline information the area covered by PPP. Therefore, in reference to these guidelines and terms of reference of SEA, the consultant collected and presented environmental and social baseline information on Kigali and seven sectors covered by master Plan outside Kigali City. The coverage of environmental and socio-economic baseline information include:

- **Socio-economic economic characteristics:** both secondary and Primary data are used in this SEA including results of socio-economic survey conducted during Master Plan development and different surveys conducted by Rwanda National Institute of Statistics. Those surveys include the fourth national Population Census (2012), Integrated Living Condition Survey (EICV 3, 4 and 5). Other statistics available in Kigali City and district was also used and the assessment focused on Economic activities (agriculture, livestock, fisheries, small-scale industries, etc.).
- **Social and cultural environment** focused on present and planned land use, planned development activities community/social structure, employment and labour market, sources and distribution of income, cultural/religious sites and properties, vulnerable groups and marginalized populations, Resettlement, livelihood, cultural heritage, minority, labour environment, safety requirements.
- **Physical environment:** The baseline information includes but not limited to physical environment (topography, land cover, geology, climate and meteorology, air quality, hydrology, water quality, waste, noise &vibration, land subsidence, soil contamination, odour etc.
- **Biological environment** (flora and fauna, migratory species, endangered species, sensitive habitats, ecosystem etc.).

For Physical and Biological baseline information, the consultant used different methodology and approach including literature review, field visit and observations, field Measurement as well as analysis aerial, topographic Maps, Geological maps, Meteorological data etc. Checks list and matrix were used to record information.

1.4.5. Determining the nature and extent of impacts

At SEA level, risk assessment approach is used to identify and assess potential Impacts associated with proposed development options. This task consisted at analysing and describing all significant changes that are likely to be brought by each facility/activity proposed. These would encompass environmental, ecological and social impacts, both positive and negative, because of each facility/activity intervention that are likely to bring about changes in the baseline environmental and social conditions. Potential positive and negative impacts maybe identified into different categories, including:

- Direct impacts associated with alternative options within the Master Plan that initiate and locate specific project activities;
- Indirect impacts that are associated more with policies that may have fiscal or legislative implications;
- Cumulative impacts that involve large-scale schemes, such as infrastructure development; and
- Large-scale impacts that that have regional and global effects; and,
- Impacts also may be permanent, temporary, or synergistic.

Scoping matrix is provided in Annex 4.

1.4.6. Alternative options analysis

Prior to embarking on analysing the nature and extent of impacts, options for the Master Plan was developed by Study team including "status quo" or "do nothing" option being the point of reference. Under this section, the Consultant examined different option identified at Master Plan level firstly to avoid and prevent, or secondly to reduce or minimize adverse or improve beneficial environmental or socio-economic impacts. The alternatives to the projects include a "no action" alternative, indicating what would happen in the absence of the proposed project/program. The alternative analysis approach considered the following:

- Take into account the geographical scope, hierarchy and objectives of the plan –be realistic;
- Be based on socio-economic and environmental evidence – be reasonable;
- Be capable of being delivered within the plan timeframe and resources –be implementable
- Be technically and institutionally feasible – be viable

The following matrix shows how alternatives are assessed in terms of environmental and Social considerations. During the assessment three scenarios were compared including

- Ground water prioritized scenario
- Surface water prioritized scenario and,
- Without projects scenario

Matrix for alternative assessment is presented in Annex 5

1.4.7. Development of mitigation measures

At SEA level mitigation measures focuses on proposed strategic decision and policy options or development option based on alternatives or option proposed in the Master Plan. Therefore, the consultant assessed options presented in Master plan and came up with the best options in terms of environmental and social perspectives but also and considerations needed during details formulations of projects. This includes terms of references and checklist for specific investment proposed in the Master Plan were prepared and are part of this SEA.

1.4.8. Monitoring plan

At this stage specific Monitoring indicator are not yet established. However, investments proposed under the master Plan are known. Therefore, the monitoring will provide the monitoring indicator for SEA level but also indicative indicator for impacts anticipated from proposed investments.

2. WATER SUPPLY MASTER PLAN AND ITS COMPONENTS

The Kigali Water Master Plan including 15-Years Investment Plan is prepared by Government of Rwanda (GoR) through Water and Sanitation Corporation Limited (WASAC Ltd) with funds from Japanese International Cooperation Agency (JICA). This section briefly describes the Master Plan and provide its objective, coverage and key components.

2.1. Objective Master Plan and coverage

2.1.1. Objective of Master Plan

The objective of the Master Plan is to provide a blueprint of the future water supply system by 2050 and steps to be taken by the Rwandan side for achieving the same. The Master Plan consists of the Master Scenario until 2050 and the 15-Years Investment Plan. Based on the Master Plan, feasibility studies on the priority projects was conducted. In addition, technology transfer to the counterpart staff from WASAC is also being pursued during the course of preparation of the Masterplan and the feasibility studies.

2.1.2. Coverage

The Master Plan will covers the City of Kigali and surrounding seven (7) sectors (Shyorongi sector, Runda sector, Rugarika sector, Ntarama sector, Muyumbu sector, Gahengeri sector, and Nyakaliro sector) until year 2050.

Figure 1: Study area
Source: JST, 2020

2.2. Strategic option for the Master Plan

The strategies which are the basic principles incorporated in the Master Plan can be associated with the three keywords namely, 'inclusiveness', 'efficiency', and 'sustainability'. The inclusiveness is the strategy to supply water to everyone leaving no one left behind in line with the basic discipline of the Sustainable Development Goals. The 'efficiency' is in line with the most important keyword emphasized in WASAC's vision. The sustainability is also an important view in implementing the projects and measures itemized in the Masterplan to expand quality water supply services in the long run. Key strategic options for the Master Plan are:

1) **Manage water resource, intake and WTP issues**

In order for effective and sustainable use of water resources, measures for improving operation and maintenance of water resource, intake and WTP facilities shall be considered in the Masterplan. Coordination measures for dealing with water resource development license, protecting intake facilities from flooding, and ensuring sustainability of existing infrastructures up to 2050 shall also be considered in the Masterplan.

2) Reduce water shortage area

In order to cope with the water shortage, increasing intake volume and capacities of the WTPs in the Study Area shall be considered in the facility planning of the Masterplan. In addition, construction and rehabilitation of well shall be conducted. Further, additional transmission and distribution facilities shall be constructed in line with the new water source development and the WTPs. Those aspects shall be incorporated in the Masterplan.

3) Realize 24/7 water supply everywhere

There are emerging and persistent needs for pipe replacement and pressure management, which needs large investment. Strong policy enhancement for ensuring 24/7 (twenty-four-hours-seven-days -a-week) water supply everywhere shall be incorporated in the Masterplan.

4) Realize resilient and stable water supply, minimizing the effect by accident

Minimizing the water supply interruption by accidents has to be addressed in order to minimize the effect of pipe breaks. Highlighting the resiliency will enhance the formulation of secondary pipe network and reservoir capacity. Those aspects shall be incorporated in the facility planning of the Masterplan.

5) Implement appropriate distribution block systems and pressure control

The strategy for dividing the present distribution system area-wise with seeing ranges of elevation and locations will be more effective if the distribution block system concept is introduced for enhancing efficiency. This concept shall be incorporated in the facility planning of the Masterplan.

6) Accelerate NRW reduction activities and continue sustainably

Dissemination of the experience and continuous implementation are the keys to the NRW reduction under the current WASAC. To achieve this, “continuous sustainably” is the most important strategy for accelerating the activities. Those aspects shall be incorporated in the Masterplan

7) Reinforcing organizational and institutional aspects

Approaches for ‘Strengthening the Operational and Maintenance (O&M) capacity’ and ‘Improving comprehensive organizational system’ shall be undertaken in order for the Masterplan to be on its track.

8) Improving financial status of WASAC

Approaches for the financial improvement including setting out an appropriate water tariff and undertaking maximum efforts in cost-cutting for achieving the profit sustainably in terms of both ‘Profit and Loss’ and ‘Cash Flow’ shall also be required for the Masterplan, so that WASAC/MININFRA can attract development partners and private investors.

Table 1: Summary for Strategies and Major Actions

Strategies			*Actions*
Sustainability	Manage intake & water resource issues		- Adding new personnel in charge of O&M of water resource & intake - Establish a license management department for water resource development
Inclusiveness	Reduce water shortage area.		Expand water supply capacities (water sources and plants) such as: - Construct more wells (after verifying yield capacity) and conduct rehabilitation of existing wells - Improve pre-treatment process and expansion of transmission pipe - Protection of intake facilities from inundation - Coordinate with authorities in charge of dam operation
Inclusiveness	Realize 24/7 water supply everywhere.		Increase reservoir capacities for water stability and pressure control such as: - Increase capacities where not sufficient. - Control pressure to maximum allowable - Construct a model Zone for 24/7 supply - Optimize energy efficiency
Inclusiveness	Realize resilient and stable water supply minimizing the effect by accident.		Implement Intensive pipe replacement and measures to enhance stability and resiliency, for example: - Target leakage susceptible pipes to replace - Install shut-off valves - Install Pressure Reducing Valves - Plan pipes considering 40 to 60-year O&M cost
Efficiency	Implement appropriate block systems and Pressure control.		Establish SCADA system for monitoring and control of flow rate and pressure.
Efficiency	Integrate O&M cost into facility planning.		Enhance Implementation of policy and guidelines for NRW reduction, such as: - Staff and Budget allocation for NRW activity
Efficiency	Install service connections in a proper manner, using high quality material.		- Specify the standard of service connection material to eliminate low quality material and introduce qualification system to WASAC's plumbers - Consider outsourcing to respond drastic increase of connections and creating system to registered contractors to secure quality installation works
Efficiency	Accelerate Non-Revenue Water reduction and continue sustainably.		- Continue the measure against NRW in line with the lessons learned from the techical cooperation project under JICA's assistance. - Conduct measures including pressure management and improve quality of material & work for service connections
Efficiency	- Re-organizing transmission and distribution system for existing ones - Consider best-efficient way for new transmission & distribution system		Identify appropriate transmission method including route/ diameter/ location of reservoirs & pumping stations, with seeing initial vs running costs, clear separation of roles (transmission vs distribution),
Sustainability	Identify suitable funding sources according to nature/type of project(s), with seeing combination of funding sources including PPP		- Establish transparency in tariff system determination process - Draw interests of private investors and/or international development partners - Prepare a long-term budget planning, with clear division of responsibilities with MININFRA & WASAC
Sustainability	Establish pro-poor measures to encourage low-income group having WASAC's water supply services		Establish support measures (e.g., loan and/or subsidy, by public and/or private funds)
Sustainability	Implement approaches for reinforcing organizational and institutional aspects		Implement the organizationa and institutional aspects including adding new personnel and conducting capacity development project as specifically itemized in Appendix 4

Source: JST, 2020

2.3. Master Plan components and facilities

2.3.1. New Water Sources for Water Supply in the Study Area by 2050

Present permitted amount of water used by water supply is 237,350 m^3/day (the RWFA registered record in 2020). Apparently, this amount can't satisfy the future demand of water supply in the Study Area. Therefore, extra water sources are needed for future water supply investment plan. Estimated additional water sources are shown in **Table 2**. These amounts were decided by considering the result of water balance study and characteristics of each water source as described in the Master Plan. At the moment, only limited data is available, especially for floodplain development through boreholes. Therefore, the plan has to be revised if new data such as long-term groundwater level measurement data is available.

Table 2: New Water Sources to be developed by 2050

Category at Hydrologic al Cycle	Source	Location	Water Supply m^3/day	Raw Water Intake m^3/day	Period (m^3/day)		Remarks
					2035	2050	
Surface Water	River	Nyabarongo	25,000	25,000	25,000		Intake place is Nzove *
		Nyabarongo or Akagera (by 2035)	100,000	110,000	110,000		Contingency plan**
		Nyabarongo or Akagera (by 2050)	380,000	418,000		418,000	Intake points has not decided yet**
	(Dam)	Nyabarongo, Akanyaru	(200,000)				Sites has not decided yet, need further study**
		Nyabarongo (Butamwa)	(130,000)				Site was recommended by the Nyabarongo II Multi-purpose study***
	Lake	Mugesera	(33,000)	(36,000)			Intake facilities shall be expanded. Not included for water source development
		Mugesera	50,000	55,000		55,000	
Groundwat er (sub-surface water) at floodplain)	Boreholes in the river flood plains	Floodplain (Akagera)	80,000	88,000	88,000		Assumed Masaka and Gahanga
		Floodplain (Nyabarongo)	40,000	44,000		44,000	Near Nzove
		Floodplain (Nyabarongo and Akagera)	160,000	176,000		176,000	Rutonde, Kanzenze and Gahanga
Groundwat er except floodplain	Borehole and springs	Small scale WSS for remote area	5,000	5,000	5,000		Jali, Rutunga, Gikomero****
		Small scale WSS for remote area	10,000	10,000		10,000	
		Allocated amount(m^3/day)	850,000	931,000	228,000	703,000	

Source: JST, 2020

The F/S for the Nyabarongo II Multipurpose Development Project, conducted by the EDCL (Energy Development Corporation Limited) refers to a plan of the Butamwa Dam that involves abstraction of 1.5 m3/d for the Butamwa WTP. However, the Butamwa WTP is purposely excluded from the Master Scenario 2050 due to its geographical disadvantage for transmission and distribution and concerns over uncertain r isk on future water quality. For this reason, this amount is being considered only as a provisional water source under this Water Resource Developmen t Plan.

* Amount based on the hearing from the RWFA (Permitted amount for abstraction).

** Contingency plan in case the water sources from sub-surface water are not capable. The amount shall be transferred to 2050 development if not used.

*** The amounts shown in the "Dam" are included in the amount shown in "Nyabarongo or Akagera (by 2050)" of "River" and deemed as possible sites of "Nyabarongo or Akagera (by 2050)".

*** Location of these area is explained in the Master Scenario of Chapter 7.

2.3.2. Water Production Facilities

The facilities to be constructed towards 2050 are listed in **Table 3** as per the production facility basis.

Table 3: Facilities to be constructed towards 2050

Name of Facilities	Descriptions
Existing Facilities: 162,000 m^3/day*1	
On-going Facilities: +65,000 m^3/day (Total: 227,000 m^3/day) *2	
Additional Facilities for 2025: +20,000 m^3/day (Total: 247,000 m^3/day) *3	

Name of Facilities	Descriptions
Additional Facilities for 2035: +98,000 m^3/day [*4]	
Gahanga WTP	+40,000 m^3/day (New)
Masaka WTP	+20,000 m^3/day (Total: 40,000 m^3/day)
Karenge WTP	+33,000 m^3/day (Expansion plus Rehabilitation)
Small Scale WSS	+5,000 m^3/day (For remote areas: Rutunga, Gikomero)
Transmission and Distribution Pipelines for the abovementioned facilities	
Additional Facilities for Long Term (2050) +754,000 m^3/day	
Nzove 3	+40,000 m^3/day (New)
Rutonde	+80,000 m^3/day (New)
Nyabarongo	+240,000 m^3/day (New)
Gahanga2	+240,000 m^3/day (New)
Masaka2	+80,000 m^3/day
Karenge	+50,000 m^3/day
Small Scale WSS	+10,000 m^3/day (For remote areas)
Transmission and Distribution Pipelines for the abovementioned facilities	

[*1]: Nzove 120,000 m^3/day, including the rehabilitation, Kimisagara 22,000 m^3/day, Karenge 15,000 m^3/day, and Small-Scale Water Sources 5,000 m^3/day.
[*2]: Kanzenze (Kigali Bulk Water Supply) 40,000 m^3/day, including the demand for Bugesera Airport (10,000m^3/day), which is out of the study area and New Nzove 1 expansion of 25,000 m^3/day.
[*3]: Masaka WTP 20,000 m^3/day
Source: JST

2.3.3. Transmission Pipelines: Grand Design

The transmission pipelines to deliver the clear water from the WTP to the Key Reservoirs are shown in **Table 4**. There are six (6) major clear water transmission systems considering the long-term planning perspective, namely the Nzove/Ntora, the Karama/MK (Mont-Kigali), the Nzove/Kimisagara, the Kanzenze/Gahanga, the Karenge/Masaka and the Remera.

Table 4: Transmission Routes and Construction Framework

Transmission Scheme	Descriptions	Construction Framework
The Nzove/Ntora	The Nzove WTP (Source: the Nyabarongo) is a single water source. All treated water is transferred to the Ntora Reservoir except the minor transmission to the Mount-Jali, the Kanyinya and the Shyolongi. The line covers the northern area of the entire Kacyiru branch, the Nyarutarama, Remera, and a part of the Kimironko. The branch of the line covers the future north-ring line to the Nduba and the Bumbogo.	On-going Expansion: The North-ring (On-going) and the Ntora-reconstruction (Priority project) Future Expansion: After 2040 along with the Nyabarongo WTP (240,000 m^3/day two phases)
Karama/MK	The Nzove WTP is a single water source. The water is pumped up to the Mont Kigali (MK) reservoir through the Karama Pumping Station. The major portion of water goes to the Kimisange, the Nyanza, and reaches the Kicukiro. This is a back-up line to supply water to the Rwezamenyo and the CBD, while it is not the mainline due to its low energy efficiency. A part of water goes from the Karama to the Runda and the Rugarika areas and will be the major transmission line after the on-going pipeline expansion.	On-going Expansion: The Karama to the Runda-Rugarika (On-going) Future Expansion: After 2040 along with the Nyabarongo WTP
Nzove/Kimisagara	The primary water source is the Kimisagara WTP (Source: the Yanze) and minor source from the Nzove as on 2020. The major source will be switched to the Nzove after the alternative transmission line (Central Mains) is constructed.	Future Expansion: Towards 2036 for the Nzove 3 and the Rutonde as "the Central Main."
Kanzenze/Gahanga	The new transmission pipelines are constructed from the Kanzenze WTP (Bulk water supply) to the Kicukiro, the Remera, the Kanombe-Kabeza, and the Busanza. The systems will be expanded to the southern part of the lower Gahanga in order to meet the new demand for the gateway city to the new airport.	On-going Expansion: Along the completion of the Kanzenze WTP. Future Expansion: By 2032 along with the Gahanga WTP, After 2040 under the Gahanga 2 and 3 (240,000 m^3/day 2 phases)
Karenge/Masaka	The Old Karenge I and II systems from the Karenge WTP (Source: the Mugesera Lake) to the Remera need expansion and rehabilitation. The northern line (the Karenge II) should be reconstructed with the expansion of the Karenege WTP to supply water to the Upcountry areas (the Nyakaliro, the Muyumbu, and the Gahengeri) and the Rusororo, the Ndera to the Remera. The southern line (the Karenge I) will be reconstructed for and along with the new Masaka Water Sources to feed water to the Masaka, the Nyarugunga, a part of the Rusororo.	Future Expansion: By 202,5the Karenge II along with the Karenge 2 WTP Expansion and by 2036 the Karenge I for the Karenge 3 WTP Expansion.

Transmission Scheme	Descriptions	Construction Framework
Remera	The system needs to allocate water from the Remera reservoir to the key reservoirs, namely; the Kicukiro, the Kimihurura, the Kimironko, the Masoro-bas, and the eastern area (the Ndera).	Future Expansion: By 2025 along with the NRW reduction (the Kacyiru/South and the Kicukiro)

Source: JST

2.3.4. Distribution Systems: Focusing on NRW Reduction

NRW reduction through reconstruction of distribution systems is the top priority issue to be tackled within the early stage of the Masterplan implementation. The impact of water loss on supply capacity is estimated to be 34,400 m^3/day in 2025, 82,700 m^3/day in 2035 (Day Average), and 310,000 m^3/day in 2050 (Day max). The reconstruction of distribution systems is phased in 8 target areas, as shown in **Table 5**.

Table 5: Target and Phasing of NRW Reduction

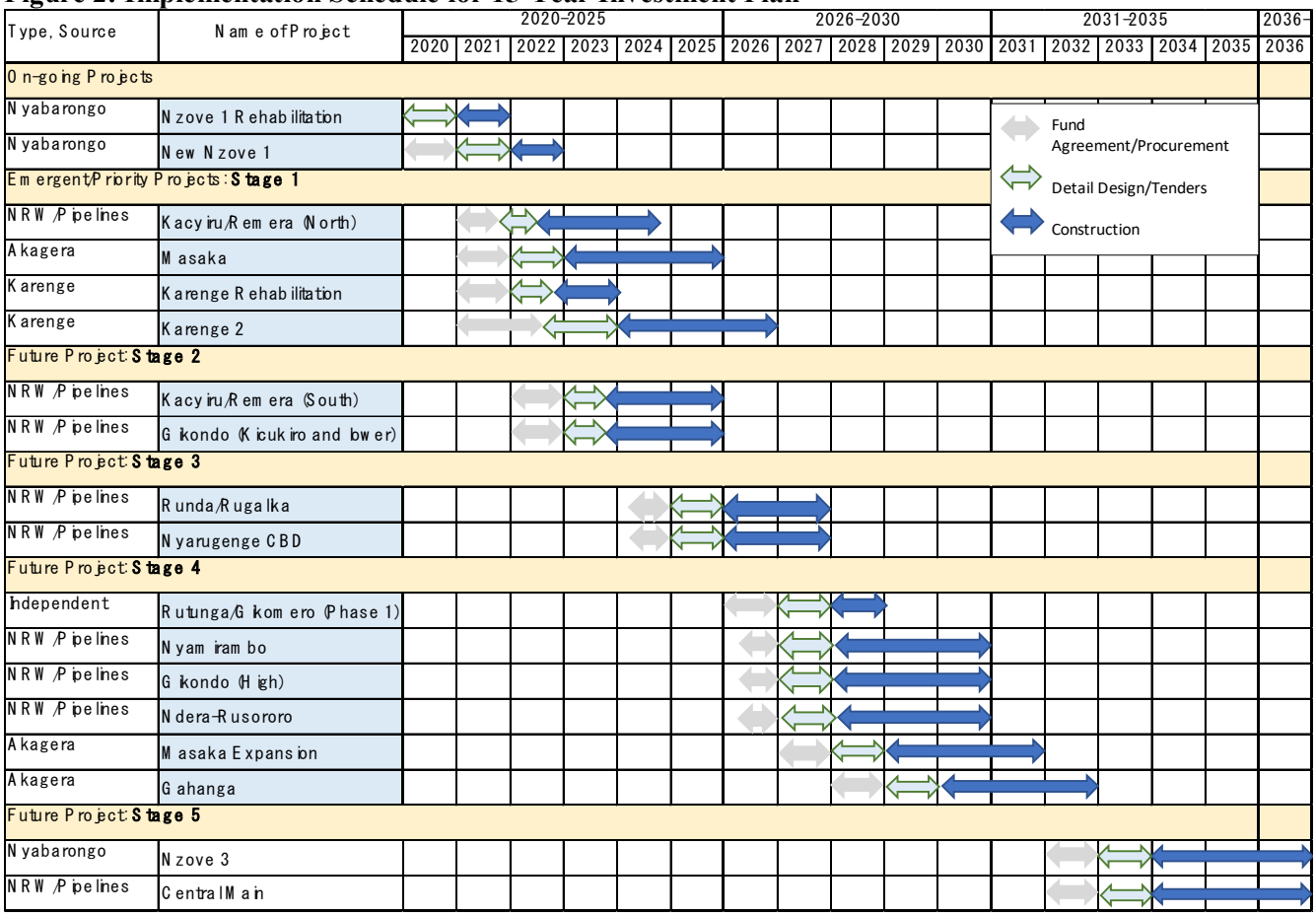
Target Areas	Reconstruction framework	Priority/Phase
Nyarugenge/CBD	The CBD and adjacent areas include the Nyarugenge, the Muhima, and the Gitega sectors, where the pipes are aged and tangled. Extensive replacement of water supply pipes (e.g., Galvanized pipes and fittings) along with the PVC distribution mains and distribution sub-mains with small diameters. The Kimisagara: Small reservoirs and pressure control through the block system are necessary to be constructed.	Phase IV
Nyamirambo	The area includes the Kimisagara-Rwezamenyo-Nyakabanda to the Mount-Kigali, where pipes are not capable and possibly suffering from high NRW ratio. This should also include the reconstruction of existing small-scale water sources (the Mburabuturo).	Phase IV
Kacyiru/North	The area includes the Gisozi, Kinyinya, and a part of the Remera (the Nyarutarama), which is the supply area of the Ntora-Remera transmission pipeline. The topography is relatively simple, and the system is not very old. The areas can be portrayed as a model for good practices on pressure control and can be disseminated to the other areas.	Phase I
Kacyiru/South	The area includes the Kacyiru, the Remera, the Kimironko and the Kimihurura. An old and complicated system where the pipelines from the Ntora, the Remera, the Kimihurura, Kicukiro are tangled. The system's reconstruction should focus on hydraulic separation and NRW reduction rather than the new reservoir construction.	Phase II
Ndera Rusororo	Mainly focus on the reconstruction of the FTZ and the FTZII supplying system and strategic construction of main distribution systems through a new road from the Masoro to the Kabuga.	Phase III
Gikondo (Kicukiro and lower)	The area includes the distribution systems from the Kicukiro reservoir and the Nyanza reservoir. Hydraulic separation considering the elevation, is the key consideration.	Phase III
Runda Rugarika	The area includes existing and newly developling areas in the Runda and the Rugarika sectors. Setting small reservoirs, reconstruction of incapably small diameters and replacement of the supply pipes along with their expansion are the key considerations for the system.	Phase II
Kanombe/Masaka	Reconstruction of the Masaka existing systems through the Karenge 1 system. Major system construction should be done in the Masaka WTP F/S in order that the system design is along with the Masaka New Water Source.	Phase II

Source: JST

2.4. 15-Years Investment Plan

The 15-Year Investment Plan is the investment plan to achieve the master scenario. The Plan is divided into five (5) stages apart from the On-going projects. The stage 5 is aimed at the target after the year 2035 and is not included in the evaluation of 15-Year Investment Plan.

Figure 2: Implementation Schedule for 15-Year Investment Plan



Source: JST, 2020

2.4.1. Stage 1(Procurement from 2021, Completion in 2026)

Stage 1 includes Emergency Project (NRW reduction project phase 1: the Ntora-Remera), the rehabilitation and expansion of the Karenge WTP and the Construction of the Masaka WTP.

(1) NRW/Pipelines (Phase 1) Kacyiru/Remera (North)

The area includes the Gisozi, Kinyinya, and a part of the Remera (the Nyarutarama), which is the supply area of the Ntora-Remera transmission pipeline. The topography is relatively simple, and the system is not very old. The areas can be portrayed as a model for good practices on pressure control and can be disseminated to the other areas.

(2) Masaka New Water Treatment Plant (Phase 1: 20,000 m^3/day, Phase 2: 20,000 m^3/day, Phase 3: 40,000 m^3/day Phase 4: 40,000 m^3/day)

Water demand growth on the eastern side of the city is urgent and large (i.e., Masaka, Ndera, Rusororo). The construction during Stage 1 is aimed at the first stage (Approx. 20,000 m^3/day, to be reviewed during F/S) to meet the emerging demand in this area. Due to the insufficiency of the current supply capacity, residents in this area are facing difficulties to access safe and steady water supply service. It is more efficient to utilize water source at Masaka near the demand area instead of conveying water from other existing WTPs. New transmission pipes and distribution reservoirs and reinforcement of the distribution network are required for the water supply expansion.

a) 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)
b) 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)
c) Construction of distribution network in Masaka Area

(3) Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities

- The intake pumps are damaged, overloaded and vulnerable to the flooding risk. The intake pumps are below the flood level of Mugesera Lake and can be affected by water during the rainy season. An old raw water intake pipe (ND300) is damaged and is not working properly.
- The existing WTP in under over-load operation; being forced to operate 18,000 m^3/day while its capacity is only 15,000 m^3/day. Incidental maintenances of pumps and resulting water supply interruption is a serious problem since they are fully operated with no standby.
- Demand in the eastern area is as large as 52,000 m^3/day in 2025, and 89,000m^3/day in 2035 only for Ndera, Rusororo, Masaka and upcountry three sectors. It is necessary to make the most of the already acquired water rights for 48,000 m^3/day as permitted by RWFA.

a) Rehabilitation of intake facility

- Rehabilitation of Raw Water Transmission pipes (ND300)
- Relocation of the pump house and upgrading the capacity of pumps and motors
- Expansion of WTP capacity from 15,000m^3/d to 18,000 m^3/d

(Filtration Basins, Clear Water Reservoirs)

b) Expansion of Karenge WTP and forwarding infrastructures

- Expansion of Intake and WTP for 30,000 m^3/d

(Intake pumps, Treatment facilities, Clearwater reservoirs and pumps

- Construction of New Transmission Pipelines (ND700, L= 33 km)

2.4.2. Stage 2(Procurement in 2022, Completion in 2025)

Stage 2 includes Investment on the NRW reduction by reconstruction of the distribution systems (construction of distribution reservoirs and pressure/flow monitoring systems and replacement of pipelines) in the prioritized zones (Phase2: the Kacyiru/South, the Runda Rugarika, the Masaka Kanombe).

(1) NRW/Pipelines (Phase 2) Kanombe/Masaka

Reconstruction of the Masaka existing systems through the Karenge 1 system. Major system construction should be done in the Masaka WTP F/S in order that the system design is along with the Masaka New Water Source.

(2) NRW/Pipelines (Phase 2) Runda Rugarika

The area includes existing and newly developing areas in the Runda and the Rugarika sectors. Setting small reservoirs, reconstruction of incapably small diameters and replacement of the supply pipes along with their expansion are the key considerations for the system.

2.4.3. Stage 3(Procurement in 2024, Completion in 2027)

Stage 3 consists of Investment on the NRW reduction mainly by reconstruction of the distribution systems in the prioritized zones (Phase3: the Ndera Rusororo, the Kicukiro).

(1) NRW/Pipelines (Phase 3) Kacyiru/Remera (South)

The area includes the Kacyiru, the Remera, the Kimironko and the Kimihurura. An old and complicated system where the pipelines from the Ntora, the Remera, the Kimihurura, Kicukiro is tangled. The system's reconstruction should focus on hydraulic separation and NRW reduction rather than the new reservoir construction. As an improvement measures for the energy, re-arrangement of pumps form the Kimisagara should be also included under this rehabilitation project.

(2) NRW/Pipelines (Phase 3) Gikondo

The area includes the distribution systems from the Kicukiro reservoir and the Nyanza reservoir. Hydraulic separation considering the elevation, is the key consideration.

2.4.4. Stage 4 (Procurement from 2026, Completion in 2032)

Stage 4 is the last phase of NRW reduction project to transform the distribution system to NRW 23%. Two WTP expansions, the Masaka expansion, and the New Gahanga WTP should be developed to meet the additional demand in the east. New WTP development should also be considered to meet the growing demand in the remote. The water demand in the Target year 2035 will be met following development under this stage.

(1) Independent water supply (Rutunga/Gikomero)

Remote sectors (the Rutunga and the Gikomero) need independent Water Supply Schemes (WSS) by this target year. Each capacity is total of the sector estimated from the CoK M/P and needs to be examined

according to the actual development in those sectors. The existing supply capacities in those sectors are neglected in this statement because they are rather small when compared to the demands.
Feasibility Study is necessary to compare the water supply from a. Masaka WTP, b. New water sources from the wells and c. Muhazi Lake. It is also necessary to transit and integrate the new system with the district-based water supply operated by the private operator.

(2) NRW/Pipelines (Phase 4) Nyamirambo, Ndera-Rusororo, Nyarugenge CBD

Nyamirambo: The area includes the Kimisagara-Rwezamenyo-Nyakabanda to the Mount-Kigali, where pipes are not capable and possibly suffering from high NRW ratio. This should also include the reconstruction of existing small-scale water sources (the Mburabuturo).

Ndera-Rusororo: Mainly focus on the reconstruction of the FTZ and the FTZII supplying system and strategic construction of main distribution systems through a new road from the Masoro to the Kabuga.
CBD: The CBD and adjacent areas include the Nyarugenge, the Muhima, and the Gitega sectors, where the pipes are aged and tangled. Extensive replacement of water supply pipes (e.g., Galvanized pipes and fittings) along with the PVC distribution mains and distribution sub-mains with small diameters. The Kimisagara: Small reservoirs and pressure control through the block system are necessary to be constructed.

(3) Masaka Expansion (Phase 2: Approx. 20,000 m^3/day)

Expansion of the Masaka Water Treatment Plant (Phase 2: Approx. 20,000 m^3/day) should be considered in line with the development in the vicinity area (Masaka, Nyarugunga, Ndera and Rusororo Sectors). The development under this phase 2 is considered as a simple expansion of the wells, treatment facilities and transmission pump capacity.

(4) Gahanga (Phase 1: 40,000 m^3/day)

Water supply facilities on the left side of the Nyabarongo River. Water source development (groundwater (subsurface water)) accompanied by its related RW transmission pipes and treatment facilities. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.
New water source and water supply facilities
- Water Well Field
- Water Treatment Plant

Forwarding infrastructures (Transmission and Distribution Pipes)

2.4.5. Stage 5 (Procurement in 2032, Completion in 2036)

This stage is to meet further demand after 2035. The Nzove 3 and the Karenge 3 should be developed to meet the growing demand. The Central Main should be constructed to transmit the water from the Nzove to the eastern part of the City of Kigali. The Stage 5 goes beyond the evaluation period until 2035 while it needs preparation for the demand right after the 2035.

(1) Central Transmission Main

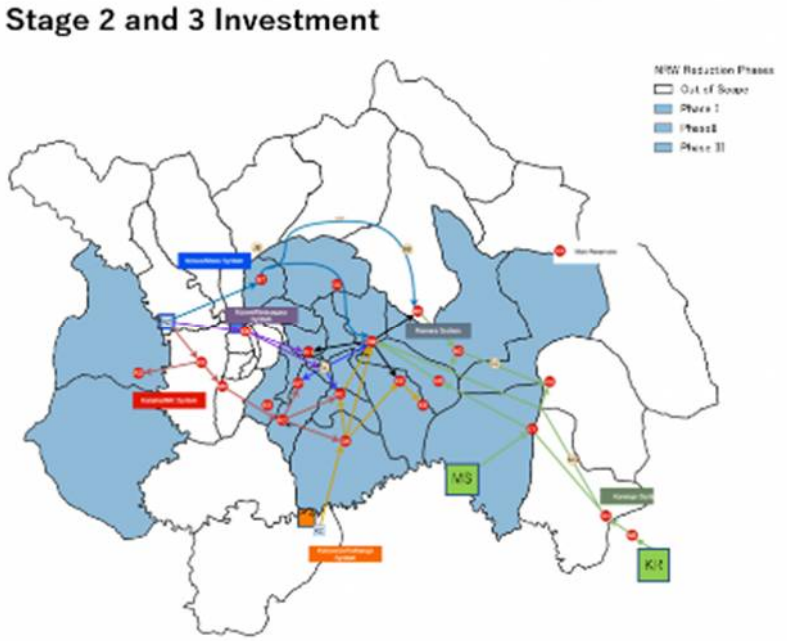
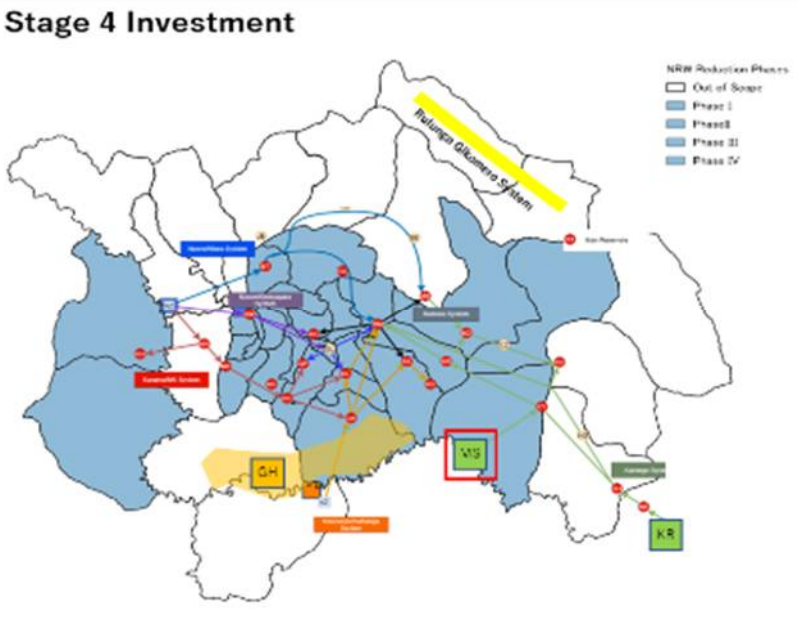
The availability of the potential water source in the middle- and down-stream of the Nyabarongo River is limited. Under this circumstance, transmission from Nzove to the eastern side of the city should be considered. The existing transmission route through Nzove and Mont-Kigali to Remera is inefficient. This is because they are transmitted from the high elevation mountain as well as the route is diverted from the city centre and thus is a long way to the eastern area

- Transmission Pipeline (Nzove-Kimisagara-Remera) (18.4 km, ND 800-1,000 mm)
- Transmission Pumping Stations and Pumps (Nzove H=70m, Kimihurura H=125m)
- Distribution Reservoirs (Kimisagara, Kimihurura)

(2) Nzove 3

Expansion of the Nzove Water Treatment Plant (Approx. 40,000 m^3/day as was planned in the F/S of Nzove rehabilitation project) should be considered in line with the development of the Central Transmission Main because of the lack of current water conveyance capacity from the Nzove.

Figure 3: Coverage of four stages of 15-Years Investment Plan

	Stage 1 (Procurement from 2021, Completion in 2026): Emergency Project (NRW reduction project phase 1: The Ntora-Remera), the rehabilitation and expansion of the Karenge WTP and the Construction of the Masaka WTP.
	Stage 2 (Procurement in 2022, Completion in 2025): Investment on the NRW reduction mainly by reconstruction of the distribution systems (Phase2: the Kacyiru/South, the Runda Rugarika, the Masaka Kanombe). Stage 3 (Procurement in 2024, Completion in 2027): Investment on the NRW reduction mainly of the replacement of pipelines in the prioritized zones (Phase3: the Ndera Rusororo, the Kicukiro).
	Stage 4 (Procurement from 2026, Completion in 2032): Last phase of NRW reduction project to transform the distribution system to NRW 23%. Two WTP expansions, the Masaka expansion, and the New Gahanga WTP should be developed to meet the additional demand in the east. New WTP development should also be considered to meet the growing demand in the remote. The water demand in the Target year 2035 will be met during the development under this stage.

Source: JST, 2020

2.5. Priority projects and projects selected for Feasibility study

Various options were considered before the selection of the master scenario with clear evaluation criteria, namely stability, flexibility, resiliency, and efficiency: life cycle cost, which includes the capital and O&M costs. The evaluation criteria were prepared to clarify the ideas and presumptions for selecting the Master Scenario. The efficiency problem is attributed mainly to the energy cost issue which is currently over 50% of the production cost in the Study Area.

Table 6: Evaluation Criteria for the Master Scenario

Evaluation Criteria	Explanation
Stability; of water sources in terms of quality and quantity	This criterion is to clarify the risks of the variations of the water quantity and quality for the major water source under each scenario and to examine whether the water supply will be stable.
Flexibility; to the Change of Demand and Development	Water demand is based on the water demand projection based on the city's development plan (the CoK M/P in 2019 and the physical plans obtained from sector/district offices). However, the actual city's development may change from time to time; the water demand is sensitive to the change of development location and timing. This criterion intends to clarify the ability to respond to the change in the water demand; e.g. water supply can be used in the other regions.
Resiliency; for the preparedness to disasters and Climate Change	The major direct risks on the Climate Change is the change of rainfall pattern, temperature rising, change of migration pattern. As a result, the water quality and availability affected by urbanization may also affect the water quality of the sources and may accelerate the drawdown of the sources. The risks and possible mitigation measures will be clarified in the statement under this criterion.
Cost	Capital and O&M costs for water supply expansions according to the cases. Total costs are presented in the yearly averaged costs.
Recommendation	Recommendation based on the criteria.

Source: JST

2.5.1. Priority projects

The priority projects are the projects to be prepared under this Master Plan. NRW reduction project through pipe renewal and pressure control is the priority project which should be implemented in a phased manner as shown in the Master Scenario. Its first phase (Phase I) NRW Reduction for the Ntora-Remera Area: Pressure control and pipe renewal is to be proposed under the Japan's Grant Aid (Unsolicited proposal).

Construction of the Masaka WTP and Clear Water Transmission & Distribution Facilities and Rehabilitation and Expansion of the Karenge WTP and Transmission & Distribution Facilities are selected to be further studied under the Feasibility Study (F/S) of WASAC/JICA Masterplan Project.

Table 7: Shortlist and Priority of Development Projects

Priority	Project Name	Status	Remarks
-	NRW reduction project through pressure control and pipe renewal	Under Preparation of Proposal for Basic Design for Phase I (Ntora-Remera)	Phase I project will be proposed to Japan's Grant Aid (Basic Design is not included in WASAC/JICA Masterplan Project)
1	Construction of Masaka WTP and Clear Water Transmission & Distribution Facilities	Under F/S Financing: To be proposed.	Subject to F/S in WASAC/JICA Masterplan Project
2	Rehabilitation of Karenge WTP	Under F/S Financing: To be proposed	
3	Expansion of Karenge WTP and Transmission & Distribution Facilities	Under F/S Financing: To be proposed.	

Source: JST,2020

2.5.2. Selected projects for Feasibility Study

As part of the preparation of Master Plan, two project were selected for feasibility studies including Environmental Impacts Assessment (EIA). The two selected projects are (i) **Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities in Rwamagana District, and (ii) construction of Masaka New Water Treatment Plant (Phase 1: 20,000 m^3/day, Phase 2: 20,000 m^3/day, Phase 3: 40,000 m^3/day Phase 4: 40,000 m^3/day) in Kicukiro district, City of Kigali.**

(1) Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities

Karenge Water Treatment Plant is located in Eastern Province of Rwanda, Rwamagana District, Karenge Sector, Byimana Cell, Rukori village. The Plant was constructed was constructed in 1978 and expanded in 1985 and 2000. Currently, the plant produces 16,000 m^3/d, which is much larger than the designed water treatment amount of 13,000 m^3/d with a distribution system extended to approximatively on 69,5km. The main source of water for the plant is Lake Mugesera. The plant supplies treated water in different areas of Rwamagana District and City of Kigali (Gasabo and Kicukiro District).

The key activities to be undertaken under rehabilitation and extension include: (a) Rehabilitation of intake facility(rehabilitation of Raw Water Transmission pipes (ND300), relocation of the pump house and upgrading the capacity of pumps and motors), (b) Expansion of Karenge WTP and forwarding infrastructures(expansion of WTP capacity from 15,000m3/d to 18,000 m3/d (Filtration Basins, Clear Water Reservoirs)in phase one and expansion of Intake and WTP for 30,000 m3/d (Intake pumps, Treatment facilities, Clearwater reservoirs and pumps in Phase two) and, (c) Construction of new Transmission Pipelines (ND700, L= 33 km) and Rehabilitation and construction of treated water reservoirs.

Currently the draft feasibility study is available and Environmental impact assessment report was prepared and approved by Rwanda Development Board (RDB)/EIA department.

(2) Construction of Maska Water Treatment Plant

The Construction of Masaka Water Treatment Plant is one of the critical components of the Water Supply Masterplan to serve essential water to the people, especially those living in the growing east in the City of Kigali (CoK) and the Rwamagana District. The Project intends to construct a new WTP sourcing groundwater along Akagera River with a capacity of 20,000 m3/day (Phase 1) and 40,000 m3/day (Phase 2). In addition to the WTP, the project include:

- ✓ Well fields and WTP: Construction of new water source and WTP (Phase 1: 20,000 m3/d, Phase 2: 20,000 m3/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 Area

3. INSTITUTIONAL, LEGISLATIVE AND REGULATORY FRAMEWORK

One of the objectives of SEA, is to ensure that the proposed Water Supply Master Plan is aligned with and contributes national development objectives. Further, the SEA process includes identification and description of pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels.

In Rwanda, the national development and environmental management are well established in both long term and short-term strategic plans. The Vision 2050 aspiration provide national targets by 2050 in terms of developments and environmental sustainability. Similarly, the National Transformation Strategy (NST1, 2018-2024) breaks down the long-term targets into short-term targets. The short term targets are, achieve by sectoral policies, sector strategic Plans as well as regulations implemented by various institutions. This section presents national development objectives and targets, pertinent policies and regulations and how the proposed complies or will comply with them.

3.1. National development targets to be achieved by 2050

3.1.1. Rwanda vision 2050 aspirations

The national vision 2050 aspires to take Rwanda beyond high income to high living standards. Its income targets are to attain upper middle-income country status by 2035 and high-income status by 2050 with an objective of providing high quality livelihoods and living standards to a Rwandan. This will be done through key development priority:

- **Developing modern infrastructure and livelihoods:** Modernisation with smart and green cities, towns and rural settlements, well-designed transport facilities and services, efficient public and private services.
- **Transformation for prosperity (developing high value and competitive off-farm green jobs and sectors):** Improved productivity and competitiveness through diversified tourism, manufacturing driven by competitive local industries, business and financial services, Internet of things and technology, logistics and aviation, agro-processing, science and technology innovation, construction and extractive industries. All these will be underpinned by high-quality services in public and private sectors.

The Proposed Master Plan falls under the first priority as one of the expected result of this Master Plan is to provide a road map that will enable Kigali City and its surroundings to meet water supply needs for its growing population up to 2050.

3.1.2. Short term development strategy (NST 1, 2024)

Development targets of NST1 include:

- Create 1,500,000 (214,000 annually) decent and productive jobs through a dual approach supporting private sector businesses and entrepreneurs;
- Accelerate sustainable urbanisation from 17.3% (2013/14) to 35% by 2024. Smart, green cities and towns supporting thriving, sustainable urban economies will be developed in partnership with the private sector;
- Establish Rwanda as a globally competitive knowledge-based economy. A strong private sector will be built through the promotion of "Anchor" firms, innovative entrepreneurs and resilient SMEs.
- Promote industrialisation and attain a structural shift in the export base to high-value goods and services with the aim of growing exports by 25.3% annually. A rising import bill and foreign exchange dependency will be reduced through strengthening the local industrial base.
- Increase domestic savings and position Rwanda as a hub for financial services to promote investments. Increasing domestic savings and broadening investment offerings will provide innovative and affordable financing to public and private sectors, and attract and convert high impact investments.
- Modernise and increase the productivity of agriculture and livestock. Agriculture and livestock production can benefit from Rwanda's favourable growing conditions and from access to regional markets.

In terms of water supply, NST1's water supply priority is be to ensure universal access 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.

3.1.3. Sectoral policies and strategic plans

Development priorities included in NST 1 are implemented at sector level through sectoral policies and sector strategic plans. This section presents the development policies that are relevant to the present Water Supply Master Plan.

- **Water supply policy, 2016**

National water supply 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 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 Master Plan is aligned with this Policy in essence that it is providing the roadmap for achieving policy objectives in City of Kigali and its surroundings.

- ✓ **Urbanization Policy,2015**

Approved in 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. Rwanda's urban agenda encourages multi-institutional cooperation, for the development of safe public space, quality education, medical and transport facilities, and a friendly city ambiance offering public services and infrastructure. As part of this vision, the government seeks to prevent unplanned growth in support of the urban development system and an increasing quality of life. Given that water supply is a major component in urban development the Master Plan considered development scenarios included in the Kigali Urban Master Plan especially in terms of meeting the need of growing population in the city and its surroundings.

- **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.

3.2. National environmental targets by 2050

National long-term environmental and climate change targets are included in both Vision 2050 aspirations and National Strategy for Climate Change and Low Carbon Development (2011-2050). These long term vision are translated into short-term strategies in NST1 and into strategic actions included sectoral Policies and sector strategic Plans.

3.2.1. National Environment aspirations in Vision 2050

Environmental and climate change considerations are reflected in key priority areas named High Quality and Standards of Life. That is moving beyond meeting basic needs to ensuring a high standard of living to transform the lives of households and individuals. The focus is on:

- Sustained food security and quality nutrition,
- Universal access to water and modern sanitation,
- Affordable, reliable and clean energy,
- Quality education and health care,
- Modern housing and settlements with environment-friendly and climate resilient surroundings,
- Inclusive financial services,
- Adequate social security and safety nets,
- National and regional peace and security.

The above Environment Vision is supplemented by climate change vision which is for Rwanda to be a developed climate-resilient, low-carbon economy by 2050 (National Strategy for Climate change and Low Carbon development). This vision is to be achieved through the following strategic objectives:

- To achieve Energy Security and a Low Carbon Energy Supply that supports the development of Green Industry and Services
- To achieve Sustainable Land Use and Water Resource Management that results in Food Security, appropriate Urban
- Development and preservation of Biodiversity and Ecosystem Services
- To achieve Social Protection, Improved Health and Disaster Risk Reduction that reduces vulnerability to climate change.

This long term vision are were translated into short term targets in NST1 as cross cutting issues but also in sectoral policies and sector strategic Plans(SSPs, 2018-2024).

3.2.2. Environmental and climate change targets by 2024

In the medium-term, the National Strategy for Transformation, NST-1/Seven Years Government Program (2017-2024) sets the priority for a Green Economy approach in its Economic Transformation Pillar that promote "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.

3.2.3. Environmental policies and regulations

The above long term vision and medium term targets and objectives are achieved through the implementation of sectoral policies and regulations. This section presents both Policies and regulations relevant to the above vision/objectives but also to the proposed Kigali Master Plan.

- ✓ **Policies**
- **The National policy on environment and climate change, 2019**

The first environmental policy was adopted by the cabinet in November 2003 and was recently revised (June 2019) to include climate change and other emerging issues and opportunities. The policy goal is Rwanda to be a nation that has a clean and healthy environment, resilient to climate variability and change that supports a high quality of life for its society.

The Policy objective are:

- Greening economic transformation;
- Enhancing functional natural ecosystems and managing biosafety;
- Strengthening meteorological and early warning services;
- Promote climate change adaptation, mitigation and response;
- Improve environmental well-being for Rwandans;
- Strengthen environment and climate change governance; and,
- Promote green foreign and domestic direct investment and other capital inflows.

This Policy is relevant to the Master Plan given that the proposed options may have impacts on environment and natural resources. Further, the Master Plan is contributing to the above policy objectives and has complied with this policy with the preparation of this SEA, consideration of environment and climate change in selecting options and

- **National Biodiversity Strategy (NBS), 2015**

The revised and updated Rwanda National Biodiversity Strategy (NBS) of 2015 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 Master Plan will comply with this policy given that the proposed infrastructure may have both negative and positive impacts on biodiversity.

- **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 and Forestry Authority (RWFA) 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 mobilisation, human resource development and institutional capacity building.

The Water Resources Policy is very relevant to the proposed Master Plan given that is the one providing guidance on water source management and allocation of water to various users. Further, water abstraction permit will be required for selected projects.

- ✓ **Land policy, 2019**

The Rwanda land policy calls for rational use and sound management of national land resources, and that land use be based on established master plans. The policy also provides development of land use plans based on suitability of the areas/lands thus distinguishing the different categories of land and their purpose.

Project activities are not expected to acquire the land as trenches will be traced in road reserve, but this can happen through the proper alignment and the choice of the project engineers which can involve the small land acquisition. This will require WASAC to observe the procedures of the national land policy that stipulates that land must be used for productive and development purposes without compromising its use by future generations.

The Land Policy is relevant to the Master Plan, given that the proposed infrastructure will need land and hence may change land tenure and may requires expropriation. Further, the Water supply should be aligned with other land use Master Plan such as Kigali Urban Development Master Plan. The proposed land for wells (Conservation Area) and Water Treatment Plant (R3-Medium Density Residential Area) is not allocated to industrial development under the National Land Use Master Plan and Kigali Urban Master Plan. Therefore, before construction, WASAC will request change in land use to meet land use requirements. This also applies for Karenge Water Treatment Plant and other development under this Master Plan.

- ✓ **Relevant regulations**

To comply with this constitutional statement and to ensure that the country development is done in sustainable manner, the government has adopted different regulations. These regulations are aligned or complemented Multilateral Environmental Agreements (MEAs) ratified Rwanda including the United Nations Framework Convention on Climate Change (UNFCCC); the Kyoto Protocol, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Basel Convention, the Montreal Protocol on Substances that Deplete the Ozone Layer, the Rotterdam Convention, among others. The development of present Master Plan and its implementation has and will comply with these regulations.

- **Constitution of the Republic of Rwanda of 2003 revised in 2015**

The Constitution of the Republic of Rwanda of 2003 revised in 2015 clearly provides the binding legal framework which shall guide the Master Plan and this SEA:

- Article 22 on "Right to a clean environment": Everyone has the right to live in a clean and healthy environment.
- Article 53 on "Protection of the environment": 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 determines modalities for protecting, conserving and promoting the environment.

- **Law n°48/2018 of 13/08/2018 on environment**

The new environmental law approved No 48/2018 of 13/08/2018 determines modalities of protection, conservation and promotion of environment in Rwanda and regulates the Environmental Impact Assessment. Article 33 on Consideration and approval of environmental studies, states that the environmental impact assessment, environmental audit and strategic environmental assessment must be approved by the Authority or another State organ authorized in writing to do so by the Authority. If the approval is made by an authorized organ, such an organ does so on behalf of the Authority which is also responsible for its audit. Currently the EIA approval process is done on line via RDB one stop centre and is done as follows**:**

- Project proponent /developer request EIA terms of reference by submission of project brief;
- RDB review the project brief and conduct field visit before issuance of terms of reference;
- Once terms of reference are approved and sent to the project developer, this one is allowed to hire one of the certified expert based on the list approved by Ministry of Environment;
- The hired consultant conducts the EIA study and submit the EIA report to the developer and this one send the report to RDB if is satisfied with the report;
- RDB review the report and issues the EIA clearance letter with approval condition if is satisfied with the report. Once the conditions of approval are signed by the developer, then RDB issue the original certificate and the developer is allowed to start the project;
- If RDB is not satisfied with the report, the report is reject and the developer together with the consultant addresses comments issues by RDB;
- If the developer is not satisfied with RDB decision, he/she can appeal to the Minister of natural resources having environment in his attribution.

Article 30 states projects that must undergo an environmental impact assessment and its procedure. The list of projects that must undergo an environmental impact assessment before they obtain authorization for their implementation is established by an Order of the Minister. An Order of the Minister also issues instructions and procedures for conducting environmental impact assessment.

Article 31 of this law state that "every policy, strategy, plan and programme must undergo a strategic environmental assessment. Procedures for conducting strategic environmental assessment are determined by an Order of the Minister". Guidelines for SEA preparation were prepared and published in June 2011. While EIA studies are approved by RDB, Terms of Reference and SEA report as well as Environmental audit report are approved by REMA.

Article 32 on Environmental Audit requires every project that may have significant impact on the environment to undergo an environmental audit during and after its implementation. The list of projects that must undergo environmental audit is established by an Order of the Minister. An Order of the Minister also issues instructions and procedures for conducting environmental impact assessment.

- **Law N° 37 /2008 of 11/08/2008 on mining and quarry exploitation**

Though proposed investments under the Master Plan are not yet confirmed, it anticipated that water supply infrastructure requires construction material including stones and sand. Therefore, the mining and quarry exploitation laws 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 ESIA Certificate is required for each quarry to be exploited. Thus, the contractor will be requested to acquire material from a certified mines and quarry and in respect to environmental requirements.

- **Law N° 70/2013 of 02/09/2013 governing biodiversity in Rwanda**

This Law determines modalities for management and conservation of biological diversity within Rwanda and provide guidance on biodiversity planning and monitoring, management of ecosystems, endangered and invasive species, bioprospecting-access and benefit sharing as well as permitting provisions. The law indicates a number of ministerial order that facilitated the implementation of the law. These include: (i) Ministerial order determining a geographic region as a bioregion if that region contains whole or several nested ecosystems and is characterized by its landforms, vegetation cover, human culture or history;(ii) An Order of the Minister that l set out a national list of ecosystems that are threatened and in need of protection and their location; (iii) An Order of the Minister that set out a list of activities prohibited in an ecosystem(including critically endangered species, endangered species and vulnerable species;(iv) An Order of the Minister that set out a list of invasive species and the list shall be subject to review every two (2) years and whenever necessary; and (v) an Order of the Minister that determines the time limits within which the person applying for a permit must be notified of the issuance, suspension and cancellation of the permit.

- **Ministerial Order N°007/2008 of 15/08/2008 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 Lemoroids, 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: Ficusthonningii, Prunus Africana, Pentadesmareindersii, Myrianthusholstii, Thonningia sanguine, Hypoestestrifolia,Aloesp.,Syzygiumguineense,Erythrinaabyssinica, Fagarachalybea, Kigelia, Africana, Orchidaceae, Eulophiastreptopetala, Eulophiahorsafalli, Diaphananthebilosa, Disaemili,Disperiskilimanjarica,Euggelingialigulifolia,Polystachyiahastate,Tridactyleanthomaniaca, Entandopheragmasp, Podocarpususambarensis, Albizziasasa, Piptadenia Africana, Podocarpusmilinjianus, grandiflora, Strombosia, Scheffleri.

The ministerial order specifies that the listed animals and plant species shall not be destroyed without permission of the competent authorities. Although none of these species were observed in the project area,

this project will endeavour to respect and protect these organisms, their habitats and the regulation enforcing the measures of their protection where they are present.

- **Environmental impact assessment general guidelines, 2007**

REMA has now developed the ESIA regulations, which provide a guide and requirements for ESIA in Rwanda. According to these new regulations, Article 1 makes it mandatory for all the projects listed under schedule I to be subjected to a full scale ESIA. The Article further states that no environmental authorization shall be granted by the Authority for any project in Schedule I to these Regulations if no Environmental Impact Assessment has been submitted to the Authority in accordance with the provisions of these Regulations.

The Article states that any project listed under Impact Level III of Schedule I to these Regulations shall require a full environmental impact assessment by preparation of an environmental impact report, unless the Authority refuses permission. The construction and rehabilitation of mass graves of victims of 1994 Genocide, falls in this category II and thus must be subjected to full scale ESIA.

Public Hearing Process: Article 47: The Authority shall on receipt of the developer's environmental impact report, arrange for a public hearing to take place within twenty (20) working days from the first day of public notification, at which relevant Lead Agencies, local governments, civil societies and concerned members of the public may comment on the environmental impact report and express views on impacts of the proposed development. The Authority shall cover all costs incidental to the public hearing. Article 48: All projects classified under Impact Level III shall be subjected to a public hearing prior to the decision-making process.

- **General guidelines on SEA in Rwanda (2011)**

The purpose of the SEA guidelines is to provide step-by-step procedures that will enable policy-making, macro or strategic planning, and program formulation processes to assess and integrate environmental considerations using participatory methods based on quantitative and qualitative evidence. The SEA guidelines also are intended to facilitate the building of a "culture" of analytical assessment that will strengthen the institutional capacity for considering and addressing environmental issues over the longer term while developing and revising development strategies and plans at the national, sectoral, and district levels.

The guidelines describe procedures and processes that are designed to enhance the potential for Policy, Program and Plans (PPPs) to achieve effective and sustainable development by integrating considerations of environmental sustainability with economic growth and social well-being. As the guidelines establish a common understanding of the concept, objectives, and methodology of SEA, they help ensure that the conduct and practice of SEA promotes the effectiveness of PPPs to meet their development goals while supporting environmental sustainability.

- **Ministerial order establishing the list of works that requires EIA studies (2019)**

The Ministerial order No 001/ 2019 of 15/04/2019 establishes the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment. Article 3 of this ministerial order states that No public institution is authorized to take a decision, to warrant a certificate, approve or authorize the commencement of a project mentioned in the annexes of this Order without prior environmental impact assessment. The list of works, activities and projects that must undergo a full environmental impact assessment before being granted authorization for their implementation is in Annex I of this Order. Article 4 provides the List of works, activities and projects that must undergo a partial environmental impact assessment The list of works, activities and projects that must undergo a partial environmental impact assessment before being granted authorization for their implementation is in Annex II of this Order.

Annex I of this ministerial order provide the list of works that shall undergo a full EIA study and those include all buildings classified as residential, commercial, administrative or institutional sports facilities, social, cultural, and assembly and religious buildings, hotels, health facilities, educational buildings, or other publicly accessible facilities fulfilling at least two of the following conditions:

a) having capacity to host more than five hundred (500) people;
b) having a total floor area exceeding one thousand and five hundred square meters (1500 sqm);
c) built in plot size exceeding one thousand square meters (1000 sqm).

Annex 2 of this ministerial order provides the list of projects that shall undergo a partial Environmental Impact assessment and those include:

1) towers and antennas;
2) all types of buildings, except those qualified for full environmental impact assessment fulfilling at least two of the following conditions:
    a. with a capacity to host more than two hundred (200) people but not exceeding five hundred (500) people,
    b. with a total floor area exceeding one thousand and five hundred square meters (1500 sqm);
    c. built in a plot size exceeding one thousand square meters (1000sqm).
3) micro hydroelectric power plants

At Master Plan level, this SEA meet the environmental requirement but when specific investments are confirmed a screening process will be undertaken to determine the level of environmental and Social instruments required during Phase two of the proposed Master Plan.

- **Law n° 27/2021 of 10/06/2021 governing land**

The recent approved law n° 27/2021 of 10/06/2021, (replacing the 2013 law), determines modalities of allocating, acquisition, transfer and management of land in Rwanda. It also establishes the principles applicable to rights recognized over all lands situated on Rwanda's national territory and all rights united or incorporated with land, whether naturally or artificially.

According to article 9, a person who acquired land through inheritance, succession, purchase, donation, exchange, land sharing or legal grant by competent authorities, owns it in accordance with one of the following tenure modalities: (i) emphyteutic lease and (ii) freehold. Article 41 states that a holder of land rights enjoys full rights in exploiting his or her land in accordance with legal provisions. The State grants the right to free ownership of land and protects the land rights holder from being dispossessed of the land whether totally or partially, except in case of expropriation in the public interest in accordance with relevant laws. Project activities shall respect the land use plans of the area where the land is located and if any private land is affected then the person will be compensated in accordance with this law and funding agency requirements.

- **Organic law n° 32/2015 of 11/06/2015 law relating to expropriation in the public interest**

This law determines the procedures relating to expropriation of land in the interest of the 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.

Eligibility for compensation is enshrined under the Rwandan constitution (article 29) and the expropriation law. The two laws regulate and give entitlement to those affected, whether or not they have written customary or formal tenure rights. The person to be expropriated is defined under article 2(7) of the expropriation law to mean any person or legal entity who is to have his or her private property transferred due to public interest, in which case they shall be legally entitled to payment of compensation.

During Phase 2 of Master Plan, land requirement will be assessed and as appropriate resettlement action plan prepared and implemented.

- **Water law, 2018 and Regulations No 002/of 23/09/2015 governing water supply services in Rwanda**

The law No49/2018 of 13/08/2018 determines the use and management of water resources in Rwanda (N° 49/2018 of 13/08/2018) place strict regulations governing the protection and use of Rwanda's wetlands and water resources. Specifically, according to Article 21, the use of water resources that may modify the flow rates, reduce water levels, degrade water quality, or threaten related ecosystems, wetlands, and the environment, are subject to water use permits. Water users must pay a fee for permits, which is to be deposited in the National Fund for Environment.

The law is completed by various regulations and under these regulations, Rwanda Utilities Regulatory Authority (RURA) does the licensing of water supply operators. Currently, there are three category 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 is constructing 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.

3.2.4. Institutional arrangement for Master Plan and SEA

The institutional framework for environmental management is currently enshrined in the Organic Law determining the modalities of protection, conservation and promotion of the environment in Rwanda, published in the Official Gazette RWA Nº 9 of the 1st May 2005, particularly in its chapter III relating to the establishment of the institutions.

3.2.4.1. Ministry of Infrastructure (MININFRA)

The mission of Ministry of Infrastructure includes:

- 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.

- ✓ **Water and Sanitation Corporation Limited (WASAC Ltd)**

WASAC Ltd is the entity setup to manage the water and sanitation services in Rwanda and was created by 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.

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.

For this SEA, WASAC in collaboration with Kigali City is the institution responsible for formulating and implementing a PPP. The legal responsibility for conducting a SEA of the PPP, therefore, lies with the lead agency, while REMA provides the necessary oversight.

- ✓ **Ministry of Environment (MoE)**

The Ministry of Environment is responsible for the development of environmental policies and procedures (including impact assessments), protection of natural resources (water, land, flora, and fauna), environmental legislation, biodiversity, and other environmental aspects. The Chapter IV of the organic law on environmental protection, conservation and management, article 65, clearly calls for the need to subject projects to mandatory EIA. The Article 65 further specifies that every project shall be subjected to environmental assessment prior to its commencement. It shall be the same for programs, plans and policies likely to affect the environment. Specific details of projects referred to in this Article shall be spelt out by the order of the Minister in charge of environment. MoE is one of the lead Agencies / Line Ministry as provided by the General Guidelines and Procedure for EIA.

- ✓ **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 the 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.

In terms of strategic Environmental Assessment, REMA is required by law to oversee environmental assessment requirements in policies, plans, and development programmes. REMA also is required by law to advise the Government on policies, strategies, and legislation related to the management of the environment. Under this mandate, REMA develops facilitative and legal instruments in the form of guidelines and regulations for implementing its oversight functions. Environmental assessment guidelines for Rwanda, including general guidelines for EIA and several sector-specific EIA guidelines as well as for Environmental Auditing have been developed and mainstreamed.

- ✓ **Rwanda Water Resource Board**

The Rwanda Water Resource Body was recently formed after splitting Rwanda Water and Forestry Authority. The Body is responsible:

- To implement policies, laws, strategies and Government decisions related to the management of natural water resources;
- To advise Government, monitor and coordinate the implementation of strategies related to the management of natural water resources;
- To assist public and private institutions in charge of management of natural water resources in a bid to fight erosion;
- To prepare appropriate management and support districts in the management natural water resources;
- To assist in the establishment of standards and regulations relating to the management of natural water resources.

During the implementation of Master Plan, the body will be responsible to issue water abstraction permit and allocation of water resources for various users.

- ✓ **Rwanda Land Management and Use Authority (RLMUA)**

RLMUA is responsible for putting in place and operational zing 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 of 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 protects 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.

✓ **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 in Rwanda. Initially the responsibility for reviewing and approving EIA reports was entrusted to REMA, this duty has now been transferred to the newly created 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 they are approved for implementation. At later stage, EIA will be developed and implemented for selected investments/projects in this Master Plan. At this stage RDB will play a critical role including to:

- Receive and register EIA Applications (Project Briefs) submitted by developers;
- Identify relevant Lead Agencies to review Project Briefs and provide necessary input during screening,
- Review Project Briefs and determine project classification at screening stage,
- Transmit Project Briefs to relevant Lead Agencies and concerned Local Governments to provide input on Terms of Reference (ToR),
- Publicize Project Briefs and collect public comments during development of ToR,
- Receive EIA documents submitted by a developer and verify that they are complete,
- Transmit copy of EIA Reports to relevant Lead Agencies, Local Governments and Communities to review and make comments,
- Review EIA reports 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 Documents (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.

✓ **Rwanda Standards Board (RSB)**

- RSB was established by the law N°50/2013 of 28/06/2013.Chapter II of that law gives the main mission of RSB which is very relevant to this project:
- to establish and publish national standard;
- to disseminate information on standards, technical regulations relating to standards and conformity assessment;

- to raise awareness and promote the importance of standards and quality service as tools to improve market access, technology transfer and sustainable development;
- to participate in monitoring standardization at national, regional and international level;
- to provide products and quality service certifications and monitor conformity for issued certifications;
- to provide legal, scientific and industrial metrology services;
- to represent the country at the regional and international standardization organizations;
- to establish laboratories capable of conducting tests and offering testing services;
- to act as reference laboratory in the quality domain;
- to carry out measurement and comparison of proficiency with same level regional and international institutions;
- to organize training programs in the area of standardization, metrology and conformity assessment. Requirements for potable water are presented in standards RS 435:2009.

✓ **Rwanda Utility Regulatory Authority (RURA)**

Rwanda Utilities Regulatory Authority (RURA) was initially created by the Law n° 39/2001 of 13 September 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, organization 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.

✓ **Local governments**

Generally, decentralized entities are responsible for the implementation of laws, policies, strategies, objectives and programmes relating 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 Local Governments including Kigali City, districts and sectors.

3.3. International guidelines and procedures

The SEA for Kigali Master Plan is prepared in compliance with JIC guidelines for environmental and Social consideration and will comply with both regulations. Further, WASAC Ltd works with other partners such as ADB and World Bank who have their own Environmental and Social standards. Therefore, this section provides key international requirements relevant to this SEA as well as investments to be implemented under this Master Plan.

3.3.1. JICA guidelines for environmental and social consideration (2010)

Japan International Cooperation Agency (JICA), which is a bilateral development aid agency of Japan, introduced JICA's Guidelines for Environmental and Social Considerations in 2004 and JICA officially started to integrate the concept of SEA to its operations. According to these guidelines, SEA is used when conducting Master Plan studies, program and Policies etc., and works with the recipient governments to address a wide range of environmental and social factors from an early stage. JICA makes an effort to include an analysis of alternatives on such occasions". In April 2010, new for Environmental and Social

Considerations, hereinafter referred as "the New Guidelines", were formulated following establishment of new JICA in 2008.

✓ **Objective of guidelines**

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

✓ **Social considerations**

The key principle of JICA's policy on involuntary resettlement is summarized below:

- Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
- When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.
- People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently 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.
- Compensation must be based on the full replacement cost as much as possible.
- Compensation and other kinds of assistance must be provided prior to displacement.
- For projects that entail large-scale involuntary resettlement, RAPs must be prepared and made available to the public. It is desirable that the RAP include elements laid out in the WB, OP 4.12 Annex A.

During the preparation of RAP, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner and language that are understandable to the affected people. Appropriate participation of affected people must be promoted in planning, implementation and monitoring of RAPs. Furthermore, appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

✓ **Environmental considerations**

- **Categorization of projects**

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. An illustrative list of sensitive sectors, characteristics, and areas is provided in annex 3.

- **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.

- **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.

When necessary, JICA can change a category even after screening. This might occur such as when a new significant impact has come to light as a result of the cooperation project process, or in other specific situations.

It's worth to note that in Rwanda, according to the Ministerial order establishing the list of works that requires EIA studies (2019) projects that should undergo environmental studies are into two categories: (i) Projects that should have a full environmental impacts assessment (Annex 1), and (ii) projects that should have a partial Environmental assessment (annex 2).

- **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 and indigenous peoples, 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.

- **Responsibility of JICA**

While project proponents etc. 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 that project proponents etc. implement in accordance with Sections 2 and 3 of the guidelines, depending on the nature of cooperation projects.

- **Requirements of project proponents etc.**

Project proponents etc. 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, as mentioned in Appendix 1 of JICA guidelines. In addition, JICA examines the items shown in Appendix 2 in order to satisfy the environmental impact assessment reports required for Category A projects.

3.3.2. AfDB Integrated Safeguards System (ISS).

Approved in 2013, the AfDB's ISS is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects. The safeguards aim to:

- Avoid adverse impacts of projects on the environment and affected people, while maximizing potential development benefits to the extent possible;
- Minimized, mitigate, and/ or compensate for adverse impacts on the environment and affected people when avoidance is not possible; and help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

The 'Environmental and Social Safeguard Policies' of the African Development Bank (AfDB) consist of Environment Policy, Operations Manual and Guidelines; Policy on Involuntary Resettlement. The preparation of the environmental and social impact assessment for the proposed project has also followed the AfDB Environmental and Social Assessment Procedure (ESAP).

The ESAP gives the steps to be undertaken when undertaking an EIA including the generic terms of reference of an EIA; typical contents of an EIA and the minimum contents of an Environmental and Social Management Plan (ESMP). It defines EIA as an Instrument whose purpose is to identify and assess the potential environmental and social impacts of a proposed project, evaluate alternatives, and design

appropriate mitigation/enhancement, monitoring, consultative and institutional strengthening measures. The ESAP divides projects into four categories: -

- **Category 1**: projects are those that are likely to have significant and irreversible environmental and social impacts, widespread in extent and require a full EIA.
- **Category 2:** projects are likely to have detrimental and site-specific environmental and social impacts that can be minimized by the application of mitigation measures included in an EMP.
- **Category 3:** shall not induce any adverse environmental and social impacts and do not need further action.
- **Category 4:** projects involve investment of Bank's funds through Financial Intermediaries (FIs) in subprojects that may result in adverse environmental or social impacts. Specific requirements for this type of project include an assessment of FI capacities to handle environmental and social considerations.

3.3.3. 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 technically2 and financially3 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) is being prepared to guide the implementation of proposed project.

- **ESS2: Labor 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 labour and child labour;
- 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.

- **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 SEA 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.

- **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.

Table 8: Comparative analysis between JICA guidelines (JG) and national regulations

Principles	JICA guidelines	Rwanda Regulations	Gaps	Measures to bridge the gap
Categorization of Projects for EIA studies	JICA guidelines provide four categorization of projects (A, B, C, FI) in terms of Environmental and Social Considerations.	National Regulations classify projects under two categories 1 and 2	While the JICA categorization of projects is mainly based on potential impacts and sensitivity of hosting environment, the national categorization is mainly based on size of project.	Project/investment under Kigali Master Plan will be categorized based on JICA guidelines and will follow the most equivalent category in national Regulations.
Environmental and Social instruments	JICA guidelines recognizes various safeguards instruments including SEA, ESIA and RAP	In Rwanda only EIA, SEA and Environment audit well regulated	Though national regulations recognize social safeguards aspects, but there is not provision to prepare Resettlement Action Plan. Resettlement impacts are handled by expropriation process regulated by expropriation	For investments involving land acquisition, Resettlement Plan will be prepared and implemented
Concern about Social Environment and Human Rights	JICA integrates local human rights situations into decision-making processes that relate to environmental and social considerations.	Environmental Regulations are silent on Human Rights when desi	Though Rwanda has ratified Human right treats Human rights concern are not well articulated in Environmental regulations.	Investment included in Kigali water supply Master Plan shall comply with human rights provisions included in JICA guidelines and other national Laws such as the Constitution.
Eligibility criteria for Compensation	JICA Guidelines apply World Bank Polices that recognizes Affected persons who: Have formal legal rights to land or assets; Do not have formal legal rights to land or assets, but have a claim to land or assets that is recognized or recognizable under national law; or Have no recognizable legal right or claim to the land or assets they occupy or use.	National regulations recognize Affected people: - who have land titles and documentary evidence that he/she is the owner of property incorporated on land. A person dispossessed of land or unlawfully occupying land or having developed activities on land on which such activities are prohibited after the enactment of relevant laws shall receive no compensation.	The JICA diverges with the Rwanda Law whereas the law in Rwanda refuses to recognize illegal land owners and does not provide any Compensation	The compensation and resettlement measures should be provided to all affected person including those with no land title and tenants. Those who don't have legal right on the land will be compensated for assets and properties established on the land
Assessment of alternatives	The JICA Guidelines requires borrower to consider feasible alternative project designs to avoid or minimize land acquisition or restrictions on land use, especially where this would result in physical or economic displacement, while balancing environmental, social, and financial costs and benefits, and paying particular attention to gender impacts and impacts on the poor and vulnerable.	The national law on environment and ESIA procedures requires the developer to explorer project alternatives but is silent about avoiding, minimizing involuntary resettlement.	While JICA Guidelines requires the borrower to explore alternatives that avoid or minimize resettlement impacts, the national regulations only requires the provision of compensation	For investment proposed under Kigali Master Plan, alternatives should be assessed to avoid or minimize involuntary resettlement and other sensitive areas.
Compensation and Benefits for Affected Persons	JICA applies World bank Policies and When land acquisition or restrictions on land use (whether permanent or temporary) cannot be avoided, JICA requires Borrower to offer affected persons compensation at replacement cost, and other assistance as may be necessary to help them improve or at least restore their standards of living or livelihoods.	The national Regulations (expropriation law, art 27) defines properties subject to valuation for the payment of fair compensation due to expropriation in the public interest are: 1° land; 2° activities carried out on land for its efficient management or rational use; 3° compensations for disruption caused by expropriation.	Loss of income is not covered under national regulations and regulations are silent on livelihood measures or assistance to vulnerable people	(i)During the preparation of resettlement plan, livelihood restoration measures will be considered for where physical relocation is expected. (ii) Vulnerable people will be identified and special attention provided to them to ensure that all affected people improve or restore livelihood

Timeframe for Compensation and provision of resettlement measures	JICA Guidelines requires that the Borrower takes possession of acquired land and related assets only after compensation in accordance with World Bank Policies.	Article 36 of the Expropriation law (2015) state that approved fair compensation shall be paid within a period not exceeding one hundred and twenty (120) days from the day of its approval. Subsequent to receiving fair compensation, the expropriated person shall have a period not exceeding one hundred and twenty (120) days to relocate.	National Regulations allows the project developer to take the land even before the compensation as long as the compensation is made in 120days.	Compensation and provision of resettlement measures will be given prior land take and any construction works.
Community engagement	JICA Guidelines requires the Borrower In principle, project proponents etc. consult with local stakeholders through means that induce broad public participation to a reasonable extent, in order to take into consideration the environmental and social factors in a way that is most suitable to local situations, and in order to reach an appropriate consensus	Article 24 of expropriation law requires the District or City of Kigali administration or the relevant Ministry to inform the persons to be expropriated in the public interest of the expected start date of measurement of land and inventory of property incorporated thereon.	While the JICA Guidelines requires consultation with affected communities and other stakeholders, the national regulations requires only communication to the affected people.	This SEA provides process and guidance for Public consultation and community engagement. Public consultation and information disclosure will be part of preparation and implementation of resettlement instruments.
	Disclosure of relevant information and meaningful participation of affected communities and persons will take place during the consideration of alternative project designs and thereafter throughout the planning, implementation, monitoring, and evaluation of the compensation process and livelihood restoration activities.	Such a communication shall be made through an announcement posted on the office of the Cell of the place designated for the implementation of the project. The communication shall also be made through at least one radio station with a wide audience in Rwanda and at least one of Rwanda-based newspapers with a wide readership.		
Grievance Mechanism	In JICA Guidelines complies with World bank and other international standards that requires project proponents/borrowers to ensure that a grievance mechanism for the project is in place, as early as possible in project development to address specific concerns about compensation, relocation or livelihood restoration measures raised by displaced persons (or others) in a timely fashion. Where possible, such grievance mechanisms will utilize existing formal or informal grievance mechanisms suitable for project purposes, supplemented as needed with project-specific arrangements designed to resolve disputes in an impartial manner.	Article 33 of expropriation law state that Within seven (7) days after the approval of the valuation report by the expropriator, any person to be expropriated who is not satisfied with the assessed value of his/her land and property incorporated thereon shall indicate in writing grounds for his/her dissatisfaction with the valuation report. Any person contesting the assessed value shall, at his/her own expense, engage the services of a Valuer or a valuation firm recognized by the Institute of Real Property Valuers in Rwanda to carry out a counter-assessment of the value.	National regulations provides only steps and timeframe for contesting valuation report	Grievance redress mechanism will be established at project level, district level and site level
Planning and Implementation	Where land acquisition or restrictions on land use are unavoidable, the Borrower will, as part of the environmental and social assessment, conduct a census to identify the persons who will be affected by the project, to establish an inventory of land and assets to be affected, to determine who will be eligible for compensation and assistance, and to discourage ineligible persons, such as opportunistic settlers, from claiming benefits.	Article 10 of expropriation law requires the project developer to prepare application that shall indicate: 1° the nature of the project; 2° the indication that the project aims at the public interest; 3° the master plan of land where the project will be carried out; 4° the document indicating that the project has no detrimental effect on the environment; 5° the document confirming the availability of funds for fair compensation;	The measures gap in terms of planning and implementation is the absence of socio-economic assessment of project affected and inventory of affected assists in the application report. during decision making about a	The socio-economic survey is part of Master Plan preparation and detailed Socio-economic survey for t affected people and inventory of affected assets will be part of Resettlement Plan

		6° the explanatory note detailing that such land or place suits the project; 7° the minutes indicating that the concerned population was sensitized about the project and its importance;		
Social assessment	The social assessment is part of Environmental studies and addresses the claims of communities or groups who, for valid reasons, may not be present in the project area during the time of the census, such as seasonal resource users.	The social assessment is part of Environmental Impact assessment.	Regulations on land acquisition does not require social assessment.	Social assessment will be part of Resettlement Plan.
Cut-off date	JICA applies world bank provision whereby the project proponent/ the Borrower shall establish a cut-off date for eligibility. Information regarding the cut-off date will be well documented and will be disseminated throughout the project area at regular intervals in written and (as appropriate) non-written forms and in relevant local languages. This will include posted warnings that persons settling in the project area after the cut-off date may be subject to removal.	The national Regulations requires the District or City of Kigali administration or the relevant Ministry to inform the persons to be expropriated in the public interest of the expected start date of measurement of land and inventory of property incorporated thereon. Such a communication shall be made through an announcement posted on the office of the Cell of the place designated for the implementation of the project. The communication shall also be made through at least one radio station with a wide audience in Rwanda and at least one of Rwanda-based newspapers with a wide readership for the relevant parties to be informed thereof.	The only gap identified is that the national regulations does not include warnings to the persons settling in the project area after the cut-off date may be subject to removal.	The cut-off date will be established and communicated to all affected people
Economic Displacement	In the case of projects affecting livelihoods or income generation, the Borrower's plan will include measures to allow affected persons to improve, or at least restore, their incomes or livelihoods. The plan will establish the entitlements of affected persons and/or communities, paying particular attention to gender aspects and the needs of vulnerable segments of communities, and will ensure that these are provided in a transparent, consistent, and equitable manner. The plan will incorporate arrangements to monitor the effectiveness of livelihood measures during implementation, as well as evaluation once implementation is completed.	National Regulation are silent about economic displacement and does not provide any livelihood restoration program	Livelihood restoration and economic displacement are not considered under national regulations	Both Physical and Economic displacement will be considered and livelihood plan prepared as appropriate

Source: World Bank ESF, JICA Guidelines, Rwanda Expropriation law (2015) and Rwanda Environment Law (2019)

4. ENVIRONMENTAL AND SOCIAL BASELINE DATA

This chapter presents the existing condition in the area covered by Master Plan and potential project sites. It covers social and cultural environment (present and planned land use, planned development activities community/social structure, employment and labour market, sources and distribution of income, cultural/religious sites and properties, vulnerable groups and marginalized populations, Resettlement, livelihood, cultural heritage, minority, labour environment, safety requirements.). It also covers physical environment (topography, land cover, geology, climate and meteorology, air quality, hydrology, water quality, waste, noise &vibration, land subsidence, soil contamination, odour etc. Further, the chapters presents the baseline information on biological environment (flora and fauna, migratory species, endangered species, sensitive habitats, ecosystem etc.).

4.1. Socio-economic baseline

4.1.1. Population projection in Kigali City and surrounding sectors

The total population of Rwanda is estimated to be 11.8 million in 2016/17, an increase of 0.4 million people since the EICV4 estimate of 11.4 million in 2013/14. Over the three-year period, this implies an average annual population growth rate of around 1.4%. The population of Rwanda is young: 51.5% of the population is aged 19 or younger; and age group of 0-4 years is 14.5% of the total population in EICV5. Around 82% of the population is under 40 years old, 3.5% of the population is aged 65 years, and above, among which females markedly outnumber males. Again, the percentage of women is estimated at 52% of the total population. Kigali City has a slightly lower percentage of females compared to other Provinces (50%) while the percentage of females in the Northern Province is the highest of all the other Provinces (53%).

Around 82% of the Rwandan populations live in rural areas. At the national level, the percentage of the population living in urban areas increased from 17% to 18% between the two surveys. In all provinces, the majority of the population lives in rural areas, except in Kigali City where rural population accounts for 26% of its total population. Western Province has the second highest percentage of the population living in urban areas (13%).

According to IPAR, under "high growth scenario", it is estimated that in 2018 Kigali has a population of 1.5million, which is projected to grow to 3.8million in 2050. In the "medium growth scenario", Kigali will grow from a population of 1.5million in 2018, to 3.5million in 2050. In the "low growth scenario", Kigali population will grow from 1.5million in 2018 to 3.1miliion in 2050. Table 2 indicates the projected population growth scenarios from IPAR study

Table 9: Projected population growth scenarios in Kigali City

Year	IPAR-NISR adjusted projections		
	Low growth Scenario	Medium growth Scenario	High growth Scenario
2012 (Cesus Year)	1,132,686	1,132,686	1,132,686
2018	1,569,579	1,582,659	1,582,659
2028	1,960,047	2,044,282	2,084,897
2038	2,431,149	2,603,307	2,728,598
2048	3,040,986	3,349,960	3,575,300
2050	3,199,857	3,545,015	3,824,708

Source: New Kigali Urban Development Master Plan Interim Report, 2019

4.1.2. Present and planned land use in Kigali City and its surroundings

The share of urban area in Kigali City is around 17% (124.27 km^2), whereas the rural portion dominates with 83% coverage (606.73 km^2). The city surroundings has a mix of land uses, including built up residential, commercial, recreational, industrial as well as areas for transport facilitation. Other identified land uses include agricultural (cropland), forest land, open land and wetlands. Some areas especially in the outskirts and neighbouring districts are still dominated by agriculture whereas Kigali City Centre is dominated by built up areas. The city is provided with many growth opportunities in terms of available undeveloped land and low-density areas with the potential to be developed. In general the city's current land use is dominated by agriculture (63.1%), natural areas (19.4%), and residential areas (9.2%). The projected future land use distributions by the Kigali Land Use Master Plan for 2040 will be dominated by residential (43%), open and natural areas (26 %), industry (5%), and commercial and mixed use (3%).

Table 10: Changes in land use in Kigali between 2013-2018

Broad Land Use	Existing Land Use 2013 (sqkm)	Existing Land Use 2018 (sqkm)	% Change
Agriculture	477.55	457.95	- 4.1
Commercial	3.00	3.32	10.6
Industries	4.14	4.25	2.7
Infrastructure	21.25	27.99	32.3
Mixed Use	0.19	0.26	36.5

Broad Land Use	Existing Land Use 2013 (sqkm)	Existing Land Use 2018 (sqkm)	% Change
Nature Area	124.78	123.61	- 0.9
Open Space	1.91	1.81	- 5.5
Public Administrative, Institutional and services	14.07	15.17	7.8
Residential	67.07	80.87	20.6
Special Use	13.26	9.51	- 28.3
Water Bodies	2.73	5.13	87.6
TOTAL	729.86	729.86	

Source: New Kigali City Urban Development Master Plan, Interim report, 2019

Table 11: Proposed land use in Kigali City in 2040

#	Item	Description	Surface area
1	Residential land use projections	Law density and single family houses	13,000 ha
		medium density housing	3,565 ha
		high density housing	170 ha
2	Public facilities projections	Community space	690 ha
		Schools and education institutions	436
		Hospitals and health center	141
3	Commercial and industrial land use projections	Offices and commercial developments	1,330 ha
		Light industries	1,110 ha
		Heavy industries	1,790 ha
4	Green land use projections	Public parks and open spaces	3,575 ha
		Plantations and agricultural farmland	19,100
		Protected forests and wetlands	20,160 ha

Source: New Kigali City Urban Development Master Plan, Interim report, 2019

4.1.3. Occupation and source of income

The Socio-economic survey results show that 47.6% of surveyed households reported farming activities as main income generating activity, followed by 17.9% odd job, 16.99% employed full time, 9.5% own business, 5.1% other activities,2.4% livestock, 0.5% employed part time.

In rural area, the main income generating activity is farming which occupy 59.7% of rural sampled households and this occupy 10.8% in urban area. In Urban area, the main income generating activity is full time employment at 34.3% while this takes 11.3% in rural area. Further, results shows that in Kigali 38.4% households has farming as main income generating activities compared to 56.5% in peri-urban area. Results shows that 22.2% has full employment as main source of income in Kigali City while it is to 11.9% in per-urban.

Table 12: Percentage of households by main source of income (%)

	Main Income generating activity								Count total Sample
	Employed (full time)	Employed (part time)	Farming Activities (Rice, fruits, vegetables, ...)	Livestock	Odd job	Others	Own business	Total	
All area	**17.0**	**0.5**	**47.6**	**2.4**	**18.0**	**5.1**	**9.5**	**100**	**412**
Urban/rural									
Rural	11.3	0.0	59.7	3.2	16.8	1.9	7.1	100	310
Urban	34.3	2.0	10.8	0.0	21.6	14.7	16.7	100	102
Sex HH Head									
Female	3.3	1.1	54.4	1.1	20.7	7.6	12.0	100	92
Male	20.9	0.3	45.6	2.8	17.2	4.4	8.8	100	320
Kigali City/peri-urban area (Sectors)									
City of Kigali sectors	22.2	0.5	38.4	2.5	19.2	6.9	10.3	100	203
Peri-urban Area sectors	12.0	0.5	56.5	2.4	16.8	3.4	8.6	100	209
Quantiles									
Q1	4.6	0.0	70.1	1.2	17.2	2.3	4.6	100	87
Q2	3.8	0.0	63.8	5.0	21.3	2.5	3.8	100	80
Q3	14.9	0.0	50.6	1.2	24.1	2.3	6.9	100	87
Q4	19.4	2.0	34.7	4.1	15.3	9.2	15.3	100	98
Q5	51.7	0.0	10.0	0.0	10.0	10.0	18.3	100	60
Source of Water (Drink)									
Improved	17.9	0.6	44.5	1.5	19.1	6.3	10.2	100	335
Not Improved	13.0	0.0	61.0	6.5	13.0	0.0	6.5	100	77

Source: BESST Ltd, Socio-economic survey, July 2019

4.1.4. Household monthly expenditures on households needs

This survey results show that the average monthly expenses on households needs consumption in surveyed households is 46,474 Rwfs per month per household, which makes 557,688 per year. From all these households 42.2% has consumption capacity ranged between 0-30,000 Rwfs per month per household, 28.4% in range of 30,000-50,000 Rwfs, 16.5% in range of 50,000-80,000 Rwfs, 8.7% in range between 80,000-160,000 Rwfs and 3.40% has consumption equal or greater 160,000 Rwfs per month per household.

In rural area, average households consumption is 31,335 Rwfs per month compared to 93,255 Rwfs in urban sampled households. By consumption quantiles households in Q1 has an average consumption of 6,199 Rwfs per month per household compared to 16,928 Rwfs for households in Q2, 29,609 Rwfs in Q3, 50,888 Rwfs in Q4 and 159,500 Rwfs in Q5.

Table 13: Monthly expenditures of households

	Average HH Monthly Expenses	Monthly Expenses on households needs							Count Total Sample
		0 - 30000	30000 - 50000	50000 - 80000	80000 - 160000	>=160000	Not Specified	Total	
All area	46,474	42.2	28.4	16.5	8.7	3.4	0.5	99.8	412
Urban/rural									
Rural	31,335	49.7	28.7	15.5	5.9	0.3	0.3	100	310
Urban	93,255	19.6	27.5	19.6	18.6	12.7	1.0	100	102
Sex HH Head									
Female	37,707	50.0	28.3	14.1	5.4	2.2	0.00	100	92
Male	49,019	40.0	28.4	17.2	9.7	3.7	0.63	99.7	320
Kigali City/peri-urban area (Sectors)									
City of Kigali sectors	62,748	38.4	25.6	18.7	11.8	3.9	1.0	100	203
Peri-urban Area sectors	39,853	45.9	31.1	14.3	5.7	2.8	0.0	100	209
Quantiles									
Q1	6,199	96.5	0.0	0.00	0.00	0.0	2.30	98.8	87
Q2	16,928	100.0	0.0	0.0	0.0	0.0	0.0	100	80
Q3	29,609	11.5	88.5	0.0	0.0	0.0	0.0	100	87
Q4	50,888	0.0	40.8	59.2	0.0	0.0	0.0	100	98
Q5	159,500	0.0	0.00	16.7	60.0	23.3	0.0	100	60
Source of Water (Drink)									
Improved	52,403	34.9	31.0	18.5	10.4	4.2	0.6	99.7	335
Not Improved	20,073	74.0	16.9	7.8	1.3	0.0	0.0	100	77

Source: BESST Ltd, Socio-economic survey, July 2019

The socio-economic survey assessed also household's expenditure on water services from WASAC. Survey results show that 14.56% of respondents pay a bill equal or less 10,000 Rwfs for last month (counting before the day of interview) and only 3.6% paid between 10,001-43,000 Rwfs. Urban households pay more money where by 35.3% paid less or equal 10,000 Rwfs compared to 7.7% of households in rural area. It is recommended that during the establishment of water tariffs, especially in rural areas, the regulatory agency should consider economic situation of residents to ensure that established prices are affordable to poor households.

Table 14: Payment of water for a month preceding the period of the study

	0-10,000	10,001-43,000	Not paying WASAC Bill	Total	Count Total Sample
All area	14.6	3.64	81.8	100	412
Urban/rural					
Rural	7.7	1.29	91.0	100	310
Urban	35.3	10.78	53.9	100	102
Sex HH Head					
Female	11.9	4.35	83.7	100	92
Male	15.3	3.44	81.2	100	320
Kigali City/peri-urban area					
City of Kigali	23.2	6.40	70.4	100	203
Peri-urban Area	6.2	0.96	92.8	100	209
Quantiles					
Q1	6.9	1.15	91.9	100	87
Q2	11.3	0.00	88.7	100	80

	0-10,000	10,001-43,000	Not paying WASAC Bill	Total	Count Total Sample
Q3	14.9	2.30	82.7	100	87
Q4	19.4	3.06	77.5	100	98
Q5	21.7	15.00	63.3	100	60
Source of Water (Drink)					
Improved	17.9	4.9	77.6	100	335
Not Improved	0.00	0.0	100.0	100	77

Source: BESST Ltd, Socio-economic survey, July 2019

4.1.5. Water prices in urban areas

Recently, water tariff was revised and increase by Rwanda Utilities regulatory Authority (RURA) and the **Table 15** shows the current prices.

Table 15: Applicable tariff for WASAC customers by consumption block (VAT exclusive)

Customer category	Monthly consumption block	Previous tariff (Frw/m3)	Current tariff (Frw/m3)	Variation (%)
Public taps	N/A	323	323	0.0
Residential	0-5m3	323	340	5.3
	6-20m3	331	720	117.5
	21-50m3	413	845	104.6
	> 50 m3	736	877	19.2
Non Residential	0-50m3	736	877	19.2
	> 50 m3	847	895	5.7
Industries	N/A	736	736	0.0

Source: RURA, 2019

This increase may have a considerable impact on customers who are already struggling to meet water bills and whose the monthly expenditure remain low as shown in table 8. To cover water bills some house holds may need subsidies especially household in category 1 and 2 of ubudehe.

4.1.6. Water quality for water source in areas without improved water

In addition to water quality in major water body in and around Kigali City, the study team assessed water quality in sampled water source especially in areas, which do not have improved water. Results of water quality survey at sites indicates that, except C-2, all samples don't meet Rwanda Drinking Water Quality Standard. Main issues are turbidity (C-4 and C-6), pH (C-3), ammonia (C-4), iron (C-4, C-5, C-6) and manganese (C-1, C-4, C-5, C-7). Therefore, additional treatment processes (such as filtration with aeration to removal turbidity, ammonia, iron and manganese) will be necessary for these water sources**.**

Table 16: Parameters for water quality survey

No.	Parameter	No.	Parameter
1	Turbidity	8	Nitrite nitrogen (NO_2^--N)
2	Color	9	Nitrate nitrogen (NO_3^--N)
3	pH	10	Ammonia nitrogen (NH_4-N)
4	Electric conductivity (EC)	11	Sulphate (SO_4^{2-})
5	Total dissolved solids (TDS)	12	Iron (Fe)
6	Dissolved oxygen (DO)	13	Manganese (Mn)
7	COD_{Cr}	14	E. coli

Source: JST, Kigali Water Supply Master Plan, 2020

Table 17: Sampling locations of water quality survey for water sources in the area without public water supply

No	Sector	Cell	Village	Name of Water Source	X	Y	Z	Current Status
C-1	Runda	Ruyenzi	Nyagacaca	Kadobogo	497425	4783339	1454	Damaged ground spring (it needs rehabilitation and extension)
C-2	Runda	Kabagesera	Bwirabo	Gashubi	494249	4781624	1455	Old ground spring (it needs rehabilitation and extension)
C-3	Bumbogo	Nyabikenke	Masizi	Masizi	514457	4788030	1421	Old ground spring (it needs rehabilitation and extension)
C-4	Bumbogo	Nyabikenke	Kiriza	Kiliza	516765	4789768	1508	Old ground spring (it needs rehabilitation and extension)
C-5	Gahengeri	Mutamwa	Ryasenteteri	Kamugasa	531443	4787059	1388	Ground water (hand pump)
C-6	Muyumbu	Nyarukombe	Marembo	Marembo	526005	4782240	1351	Ground water near marshland which can be obtained by forage
C-7	Nyakariro	Munini	Nyiramitemeri	Nyiramitemere	526066	4773924	1350	Ground water near marshland which can be obtained by forage

Source: JST, Kigali Water Supply Master Plan, 2020

Table 18: Result of water quality survey for water source in the area without public water supply

No.	Sampling No.	C-1	C-2	C-3	C-4	C-5	C-6	C-7	RDWQS [1)]	WHO Guideline (2017)	Analysis Method
	Sampling Date	2019/09/04	2019/09/04	2019/09/04	2019/09/05	2019/09/05	2019/09/05	2019/09/05			
1	Turbidity (NTU)	3.08	2.36	0.65	11.00	1.17	6.83	2.16	5	5	Turbidity meter
2	Colour (TCU)	<15	<15	<15	<15	<15	<15	<15	15	15	APHA
3	pH	6.77	6.17	6.09	6.95	5.99	7.32	6.56	6.5-8.5	-	Electrochemistry
4	Electric Conductivity (EC) (µs/cm)	439	243	300	374	240	456	597	1,500	-	Electrochemistry
5	Total dissolved solids (TDS) (mg/l)	205.5	116.8	144.0	163.8	117.7	229.0	267.0	700	-	Electrochemistry
6	DO (mg/l)	7.11	1.52	2.74	5.60	1.48	11.29	3.56	-	-	Electrochemistry
7	Chemical Oxygen Demand (COD_{Cr}) (mg/l)	<2	<2	<2	<2	<2	<2	<2	-	-	Digestion with Potassium Dichromate in closed reflux
8	Nitrate Nitrogen (NO_3^-,as N) (mg/l)	3.50	3.50	4.50	4.40	5.20	0.40	0.30	10	11.3	Cadmium reduction
9	Nitrite Nitrogen (NO_2^-, as N) (mg/l)	<0.002	<0.002	<0.002	0.010	<0.002	<0.002	<0.002	0.001	0.9	Diatization
10	Ammonia Nitrogen (NH_4^-,as N) (mg/l)	<0.02	<0.02	<0.02	0.80	<0.02	0.37	0.25	0.5	-	Nessler
11	Sulphate (SO_4^{2-}) (mg/l)	62	54	32	49	41	31	31	300	-	Turbid metric
12	Iron (Fe) (mg/l)	0.27	0.24	0.08	1.05	0.65	0.50	0.30	0.3	0.3	Phenanthroline
13	Manganese (Mn) (mg/l)	0.257	0.084	0.002	2.100	0.187	0.002	0.253	0.1	-	PAN indicator
14	E. Coli (cfu/100ml)	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not be detectable	Not be detectable	Spreading

Source: JST, Kigali Water Supply Master Plan, 2020

4.1.7. Habitat and housing

- **Type of habitat**

Type of habitat is an important aspect in terms of water supply given that the type of habitat may facilitate or not the provision and accessibility of water infrastructures. Results from the survey shows that 25.9% are living in isolated settlement, 3.40% in model village, 0.5% in modern planned area, 3.88% in umudugudu/ small settlement, 42.96% in unplanned clusted rural housing and 23.3% are living in unplanned urban housing. In urban area, most households are living in unplanned urban housing (70.6% while in rural areas most of household are living in unplanned clusted rural housing (53.5%). A big share of households in Kigali City sectors is living in unplanned urban housing (43.3%) compared to household in per-urban sectors where a big share is living in unplanned clusted rural settlement.

For households headed by females a big share is living in unplanned clusted rural housing (38.04%) compared to theses headed by males where a big share is living also in the same type of habitat (44.38%). Further results show that households in Q1 has a big percentage of households living in unplanned clusted rural housing (57.5%). The same category of habitat for household in Q2 is 57.5% while household in Q3 big share is in isolated housing (39.1%), households in Q4 big share is living in unplanned urban housing (32.6%) and households in Q5 a big share is living in unplanned urban housing (41.7%).

In terms of access to improved water, more households with access to improved water source are living in unplanned clusted rural housing (39.7%) and household without access to improved water more of them are living in unplanned clusted rural housing (57.1%).

Table 19: Distribution (%) of households by type of habitat

	Isolated rural housing	Model Village	Modern planned area	Umudugudu/ Small Settlement	Unplanned clusted rural housing	Unplanned urban housing	Total	Total Sample
All area	**26.0**	**3.4**	**0.5**	**3.9**	**43.0**	**23.3**	**100**	**412**
Urban/rural								
Rural	34.5	0.0	0.3	3.9	53.6	7.7	100	310
Urban	0.0	13.7	1.0	3.9	10.8	70.6	100	102
Sex HH Head								
Female	26.1	1.1	0.0	7.6	38.0	27.2	100	92
Male	25.9	4.1	0.6	2.8	44.4	22.2	100	320
Kigali City/peri-urban area (Sectors)								
City of Kigali sectors	22.7	5.9	1.0	3.9	23.2	43.4	100	203
Peri-urban Area sectors	29.2	1.0	0.0	3.8	62.2	3.8	100	209
Quantiles								
Q1	23.0	0.0	1.2	1.2	57.5	17.2	100	87
Q2	28.8	0.0	0.0	3.8	57.5	10.0	100	80
Q3	39.1	1.2	0.0	3.5	37.9	18.4	100	87
Q4	23.5	2.0	0.0	4.1	37.8	32.7	100	98
Q5	11.7	18.3	1.7	8.3	18.3	41.7	100	60
Source of Water (Drink)								
Improved	23.9	4.2	0.6	4.5	39.7	27.2	100	335
Not Improved	35.1	0.0	0.0	1.3	57.1	6.5	100	77

Source: BESST Ltd, Socio-economic survey, July 2019

- **Composition and occupancy of dwelling**

According to EICV5 results, single house dwelling has decreased slightly by one percentage point since 2013-14 (from 90% in EICV4 to 89% in EICV5) and this type of dwelling is more common in rural areas (96%) than urban areas (59%). Results from this survey shows that 14.3% of assessed households are living in shared dwelling and 85.7% are living in single occupied by one household dwelling.

Household in rural area are living in single occupied house with 89.3% and only 10.6% in shared house compared to 74.5% of households in urban area living in single occupied house and 25.5% in shared house. The survey results also show that 16.7% of households in Kigali City sectors are living in shared house, 11.9% for peri-urban area sectors.

Table 20: Dwelling stand-alone/shared and number of HH shared

	% of Single house occupied by one household dwelling	A house occupied by multiple households						Single house occupied by one household dwelling	Total Sample
		% of households living in a house occupied by multiple HHs	Less than 4	4-7	>7	Total	Count Total multiple HHs		
All area	**85.7**	**14.3**	**78.0**	**15.3**	**6.8**	**100**	**59**	**353**	**412**
Urban/rural									
Rural	89.4	10.7	90.9	6.1	3.0	100	33	277	310
Urban	74.5	25.5	61.5	26.9	11.5	100	26	76	102
Sex HH Head									
Female	82.6	17.4	75.0	18.8	6.3	100	16	76	92
Male	86.6	13.4	79.1	14.0	7.0	100	43	277	320
Kigali City/peri-urban area (Sectors)									
City of Kigali sectors	83.3	16.8	73.5	20.6	5.9	100	34	169	203
Peri-urban Area sectors	88.0	12.0	84.0	8.0	8.0	100	25	184	209
Quantiles									
Q1	96.6	3.5	100.0	0.0	0.0	100	3	84	87
Q2	81.3	18.8	86.7	0.0	13.3	100	15	65	80
Q3	86.2	13.8	75.0	25.0	0.0	100	12	75	87
Q4	81.6	18.4	61.1	27.8	11.1	100	18	80	98
Q5	81.7	18.3	90.9	9.1	0.0	100	11	49	60
Source of Water (Drink)									
Improved	78.5	21.5	55.6	12.5	4.2	100	72	263	335
Not Improved	84.4	15.6	50.0	0.0	8.3	100	12	65	77
Settlement									
Isolated rural housing	90.7	9.4	100.0	0.0	0.0	100	10	97	107
Model Village	92.9	7.1	100.0	0.0	0.0	100	1	13	14
Modern planned area	100.0	0.0	0.0	0.0	0.0	0	0	2	2
Umudugudu/ Small Settlement	81.3	18.8	100.0	0.0	0.0	100	3	13	16
Unplanned clusted rural housing	90.4	9.6	88.2	5.9	5.9	100	17	160	177
Unplanned urban housing	70.8	29.2	60.7	28.6	10.7	100	28	68	96

Source: BESST Ltd, Socio-economic study, July 2019

- **Construction material for houses**

EICV5 presents data on material used for constructing walls. Over all, the majority of the households in the country use mud bricks 35%. In rural areas, the use of tree trunks with mud has significantly decreased by around eight percentage points from 33% in EICV4 to 25.5% in EICV5. The study shows that from 412 assessed households' mud bricks with cement (stucco) construct 55.1% of their house exterior wall.

The study shows that 50% and above of all house in urban and rural area and at all areas exterior wall are constructed in Mud bricks with cement (stucco) except for house of household in Q1 (where this wall constructed materials occupy 41.38%), Q2 (47.50%) and for households without access to improved drinking water source which where mud bricks with cement (stucco) occupy 41.56% of total houses.

Table 21: Distribution of HH according to main construction material of wall

	Construction material exterior wall							Total Sample
	Cement blocks	Mud bricks	Mud bricks with cement (stucco)	Oven fired bricks	Tree trunks with mud and cement	Tree trunks with mud	Total	
All area	**3.4**	**12.9**	**55.1**	**5.6**	**14.6**	**8.5**	**100**	**412**
Urban/rural								
Rural	1.6	15.8	52.6	1.0	18.1	11.0	100	310
Urban	8.8	3.9	62.8	19.6	3.9	1.0	100	102
Sex HH Head								
Female	4.4	13.0	57.6	2.2	14.1	8.7	100	92
Male	3.1	12.8	54.4	6.6	14.7	8.4	100	320

	Construction material exterior wall							Total Sample
	Cement blocks	Mud bricks	Mud bricks with cement (stucco)	Oven fired bricks	Tree trunks with mud and cement	Tree trunks with mud	Total	
Kigali City/peri-urban area (Sectors)								
City of Kigali sectors	3.9	7.9	57.1	7.9	15.8	7.4	100	203
Peri-urban Area sectors	2.9	17.7	53.1	3.4	13.4	9.6	100	209
Quantiles								
Q1	0.0	23.0	41.4	0.0	20.7	14.9	100	87
Q2	2.5	18.8	47.5	2.5	15.0	13.8	100	80
Q3	0.0	12.6	63.2	4.6	11.5	8.1	100	87
Q4	5.1	6.1	66.3	2.0	17.4	3.1	100	98
Q5	11.7	1.7	55.0	25.0	5.0	1.7	100	60
Source of Water (Drink)								
Improved	4.2	9.9	58.2	6.3	14.0	7.5	100	335
Not Improved	0.0	26.0	41.6	2.6	16.9	13.0	100	77

Source: BESST Ltd, Socio-economic study, July 2019

4.1.8. Employment and labour market

According to EICV5, the proportion of workers among the working age population in EICV4 and EICV5 was almost the same in urban (76%) as well as in rural areas (89%). While the activity rate in Kigali City was 77% in EICV5, it ranges from 87% to 89% in other provinces. Most people in Rwanda work in more than one job, particularly in rural areas. Overall 42% of employed population had two jobs and 16% had 3 jobs or more within 12 months before the survey (NISR, 2016/17).

The employment forecast for Kigali City indicates creation of a total of 1,760,285 jobs in agro- processing, agriculture, forestry and fishing; mining; manufacturing; services; construction; trade; and transport sectors. Majority of these jobs are distributed within mixed use commercial districts (CBD, Fringe Centres and Regional Centres) and industrial parks with some employment in residential zones.

Table 22: Employment project and distribution in Kigali up to 2050

Sector	2014	2024	2034	2044	2050
Agro-processing, Agriculture, Forestry & Fishing	143,136	173,931	202,219	205,690	204,114
Mining	7,656	10,937	16,106	21,335	24,195
Manufacturing	22,387	40,909	70,389	108,107	132,021
Services	188,780	280,522	412,788	557,769	635,463
Construction	62,463	98,159	152,708	216,214	246,440
Trade	131,769	192,024	277,976	369,757	415,603
Transport	23,779	38,405	60,845	87,896	102,449
Total	**579,969**	**834,887**	**1,193,030**	**1,566,768**	**1,760,285**

Source: IPAR study, 2018

4.1.9. Poverty level and vulnerability

- **Poverty level**

As stated in EICV5 report, with the new ubudehe categorization framework created in 2014, households are ranked on a scale of 1 to 4, based on their social-economic status, and property ownership in terms of land and other belongings, and what the household members do to earn a living. For the ubudehe categories relevant for VUP participation, 25% of households in ubudehe category 1 and 18% of households in ubudehe category 2 are in the lowest quintile (EICV5, 2016/2017).

Overall from 412 assessed households, 53.6% are in Ubudehe category 3, 34.9% in category 2, 8.2% in category 1, 1.5% in category 4 and 1.21% do not have category. In rural area, the dominant category is category 3 with 51.9% of total household of rural area compared to 58.8% in urban area. Category 3 of Ubudehe remain dominant to all household category except for households headed by females where category 2 dominate at 42.4%. Ubudehe category are under revision after many complaints from households and the new categorization will have 6 categories.

Table 23: Distribution of household according to category of Ubudehe

	Category 1	Category 2	Category 3	Category 4	Don't know	Not found on list	Total	Total Sample
All area	**8.3**	**35.0**	**53.6**	**1.5**	**1.2**	**0.5**	**100**	**412**
Urban/rural								
Rural	8.7	38.4	51.9	0.0	0.3	0.7	100	310
Urban	6.9	24.5	58.8	5.9	3.9	0.0	100	102
Sex HH Head								
Female	16.3	42.4	38.0	0.0	2.2	1.1	100	92
Male	5.9	32.8	58.1	1.9	0.9	0.3	100	320
Kigali City/peri-urban area (Sectors)								
City of Kigali sectors	10.8	38.4	46.3	3.0	1.0	0.5	100	203
Peri-urban Area sectors	5.7	31.6	60.8	0.0	1.4	0.5	100	209
Quantiles								
Q1	10.3	47.1	41.4	0.0	1.2	0.0	100	87
Q2	12.5	36.3	51.3	0.0	0.0	0.0	100	80
Q3	10.3	26.4	62.1	0.0	0.0	1.2	100	87
Q4	6.1	39.8	53.1	0.0	0.0	1.0	100	98
Q5	0.0	20.0	63.3	10.0	6.7	0.0	100	60
Source of Water (Drink)								
Improved	8.7	34.6	52.8	1.8	1.5	0.6	100	335

Source: BESST Ltd, Socio-economic study, July 2019

Categorization plays an important role in planning given that some services and subsidies are provided based on ubudehe category. EICV5 shows that household in Ubudehe category 1, 14.1% are direct support beneficiaries; about 10% are beneficiaries of Public works and 0.4% are beneficiaries of financial services. Currently household in category 1 of Ubudehe are used to receive support from government or different partners for improving their living conditions. The important support there are getting is health insurance (64.7%).

- **Vulnerability**

Around 4% of the Rwandan population aged 5 years and above reported having a disability in EICV5 and the rate has fallen very slightly over time. The percentage of persons with a disability is larger in rural areas than in urban areas (4.3% and 3.6% respectively in EICV5), and there is no difference by sex (4.2% for both male and female) with little difference between consumption quintiles. The percentage of the population with disability among people aged 65 and above has decreased from 37% in EICV4 to 30% in EICV5. The most common disability types are disability of the, accounting for a quarter of the population with disability, followed by mental disability (19%) and old age (14%). The survey results presented in the next table shows that 17.5% of assessed households has reported an adult household member with disability and the dominant disability type (that identified by respondent) is disability of legs.

Table 24: Percentage (%) of sample reporting vulnerability of adult in household

	% 0f HHs with any adult with Disability	Deaf and/or mute	Disability	Disability in the arms	Disability in the legs	Mental disability	Other, specify.	Very old	Visual disability	Total	Total HHs with any adult with Disability	Total Sample
All area	**17.5**	**4.2**	**34.7**	**8.3**	**20.8**	**11.1**	**4.2**	9.7	**6.9**	**100**	**72**	**412**
Urban/rural												
Rural	16.5	2.0	29.4	9.8	21.6	15.7	5.9	9.8	5.9	100	51	310
Urban	20.6	9.5	47.6	4.8	19.1	0.0	0.0	9.5	9.5	100	21	102
Sex HH Head												
Female	21.7	10.0	30.0	10.0	25.0	0.0	10.0	10.0	5.0	100	20	92
Male	16.3	1.9	36.5	7.7	19.2	15.4	1.9	9.6	7.7	100	52	320
Kigali City/peri-urban area (sectors)												
City of Kigali sectors	18.2	5.4	37.8	5.4	16.2	13.5	5.4	8.1	8.1	100	37	203

	% 0f HHs with any adult with Disability	Deaf and/or mute	Disability	Disability in the arms	Disability in the legs	Mental disability	Other, specify.	Very old	Visual disability	Total	Total HHs with any adult with Disability	Total Sample
Peri-urban Area sectors	16.8	2.9	31.4	11.4	25.7	8.6	2.9	11.4	5.7	100	35	209
Quantiles												
Q1	21.8	0.0	26.3	10.5	36.8	10.5	0.0	5.3	10.5	100	19	87
Q2	20.0	6.3	18.8	6.3	18.8	18.8	12.5	6.3	12.5	100	16	80
Q3	16.1	0.0	28.6	21.4	7.1	14.3	7.1	21.4	0.0	100	14	87
Q4	11.2	9.1	63.6	0.0	27.3	0.0	0.0	0.0	0.0	100	11	98
Q5	20.0	8.3	50.0	0.0	8.3	8.3	0.0	16.7	8.3	100	12	60
Source of Water (Drink)												
Improved	17.6	5.1	37.3	5.1	20.3	10.2	5.1	11.9	5.1	100	59	335
Not Improved	16.9	0.0	23.1	23.1	23.1	15.4	0.0	0.0	15.4	100	13	77

Source: BESST Ltd, Socio-economic study, July 2019

From this survey only 3.9% of 412 sampled households reported having a child suffering physical, mental problems. From them, 50% has some difficulty in working and 31.2% cannot do any activity at all.

4.1.10. Socio-economic activities

- **Urban agriculture and livestock**

Although Kigali is an urban centre occupied by urban infrastructure, agriculture is still the most common land use in Kigali, covering 60.5 per cent of the land use. Wetlands cover 12.5 per cent of the land and are frequently used for agriculture also most of the arable land is found in or adjacent to wetlands and in lowland areas. There are three levels of agriculture. The first occurs at the level of household plot, where vegetables, fruits, medicinal plants and small livestock are tended to provide food for the family. At the next level, wetlands, mainly in the urban areas of Nyabugogo, Kicukiro, Muhima and Kimihurura, are cultivated at a larger scale, such as market gardening of high-value crops including sugarcane, rice sericulture and fish farming. The third level involves farming along the slopes, which is dominated by agroforestry, fruit and vegetable growing, mainly banana, beans, potatoes, cassava and maize, among other crops. 20 per cent. It proposes conserving arable land on slopes below 15 per cent, limiting mechanized agriculture on steep slopes, promoting forestry on slopes above 25 per cent and supporting sustainable irrigation and fertilization methods (Surbana, 2012). In surrounding sectors and rural part of the city, agriculture remain the main income generating activity is farming which occupy 59.7% of rural sampled households and this occupy 10.8% in urban area.

Livestock, mainly goat, poultry and cattle, graze on some 23.7 ha within the city. Urban agriculture is important for food security and when practiced locally, reduces the transport impacts of importing food, including greenhouse gas emissions from vehicles transporting produce into the city.

Some of the environmental impacts of urban agriculture are the potential for excess fertilizers to run off into wetlands and water bodies and when practiced on steep slopes without terracing, erosion and landslides. The Kigali City Master Plan proposes to continue allowing agriculture in arable lands along wetlands and unbuildable zones and it promotes high value-added agriculture and agro- based industries and the creation of innovative types of urban agriculture suitable for slopes of over

- **Trade and industry**

In 2012, industry and quarries covered only 0.4 per cent of the land area of Kigali City. Kigali has set aside designated, serviced land for small- and large-scale industrial development. The Kigali Special Economic Zone (KSEZ) was created through the merger of the former Kigali Free Trade Zone and the Kigali Industrial Park projects. The key goal of the KSEZ is to attract investments and strengthen the country's economy (RDB, 2017) The KSEZ is located on the outskirts of the city, in Masoro-Munini, and Kagarama-Musave, several kilometres from the Kigali International Airport along the Central Transport Corridor (Kagera, 2014)

The KSEZ will occupy 276 ha of land and is being developed in two phases: Phase I covers 98 ha of land and was completed in 2013 and Phase II, still under construction, uses 178 ha of land. Both areas will be serviced with roads, electricity, water, firefighting systems and sewage, while Phase I will also have fiber

optic cable provision (RDB, 2017). About 65 per cent of Phase 1 investment is in manufacturing and 30 per cent in services while in Phase 2, 58 per cent of investment is expected to be in manufacturing and 37 per cent in services (including warehousing and ICT).

As highlighted in the 2013 SEOR that focused on Kigali City, some industries are relocating from the former Gikondo Industrial Park to the KSEZ. An important reason is to cease the pollution of the Nyabarongo River via the Rugenge and Nyabugogo Rivers by industrial effluent and waste. News reports indicate that by 2014, 7 companies had relocated and construction of the remaining 5 big industries is expected to be completed by end of 2017 (Kagera, 2014).

The Rwanda Development Board (RDB) cites the availability of environment protection as one of the zone's advantages (RDB, 2017) The RBD's one- stop centres (OSC), which facilitate the issuance of various permits and authorizations, is housed within the RDB Investment Promotion Department. It offers Environmental Impact Assessment (EIA) Services that provide investors with EIA and mitigation plan approvals through powers delegated directly to the RDB by the Rwandan Environmental Management Authority (REMA). REMA itself maintains a strictly ex-post facto audit function (UNIDO, 2016).

- **Transport**

A good road network is important for the economy and is a key communication tool, increasing access to markets and supporting off-farm activities such as trade, tourism and education. In 2013, asphalt paving covered 34.5 km in Nyarugenge district, 10 km in Gasabo and 29 km in Kicukiro (RoR, 2013a); (RoR, 2013b); (RoR, 2013c). In Nyarugenge, 98.1 per cent of people walked less than 20 minutes to reach an all-weather road; in Kicukiro the percentage was 98.2 of people. On average, it took 41.7 per cent ofthe people between 20 and 59 minutes to reach the nearest public transport stage. Gasabo's usage rate of all-weather roads was 86.2 per cent compared to Kicukiro and Nyarugenge at rates of 97.4 and 95.9 per cent, respectively.

In addition to the low access to roads in informal areas, the state of roads can also be quite poor with access to houses almost impossible at times. For instance, in Agatare settlement in Nyarugenge district, only 5 per cent of the houses are located along the main tarmac road. About 70 per cent of the houses have no vehicular access and the footpaths are also dilapidated and eroded (MININFRA, 2016b). About 20 per cent of houses are located along the internal motorable earth roads, which are in a poor state. In total, there is only 7 km of asphalt road, 1 km cobblestone road and 23 km of earthen roads in this area (MININFRA, 2016b) (Figure 11). Accessing the area with service vehicles such as ambulance, fire trucks or even personal cars is difficult and the situation is made worse during the rainy season (MININFRA, 2016b). The results can be erosion and the formation of gullies and the potential for landslides.

The hilly topography means that attention must be paid to drainage and gullies throughout the city. Nyarugenge district in particular faces challenges constructing roads due to the extremely hilly nature of the district. Maintaining and repairing damage caused by floods is financially challenging and the problem is likely to worsen as floods potentially occur more frequently with climate change.

However, although quantitative data on road quality has not yet been updated for public access satellite data show that asphalt paving of access and neighbourhood roads in different locations of Kigali increased over the last 5 years in high-density areas to ease traffic congestion. One example is the Remera-Kimironko area showing unpaved roads in 2010 that were paved with asphalt by 2017. Similar efforts are evident all over Kigali.

- **Energy**

In Kigali City as a whole, electricity is the primary fuel used for lighting (73.3per cent) while charcoal is most commonly used for cooking (70.8 per cent), followed by firewood (25.6 per cent). By district, access to electricity is highest in Kicukiro followed by Nyarugenge and Gasabo, as follows: 80.6, 75.7 and 68.3 per cent, respectively (Table 5) (UN-Habitat, 2011). With 96.4 per cent of Kigali City residents depending on biomass fuel for cooking, the pressure on the country's forests is very high.

Rwanda is committed to developing a low carbon economy that avoids deforestation. It is reflected in Priority 7 of the National Strategy for Transformation (NST 1) 2017-2024, "Sustainable Management of Natural Resources and Environment to Transition Rwanda towards a Carbon Neutral Economy", which aims to halve the number of households depending on firewood as a source of energy for cooking from 25 per cent in 2014 to 42 per cent by 2024.

It aims to achieve this by focusing on alternative fuels such as cooking gas and biogas. Currently, the uptake of alternative cooking fuels (gas, peat and biogas) as well as improved cooking stoves in Kigali has been slow, thought to be due to the high cost of fuels for low-income households (Kanamugire, 2016). The Government of Rwanda also supports increasing the planting of commercially viable tree species to support the wood industry (RoR, 2017a). The Food and Agriculture Organization of the United Nations (FAO) supports MININFRA and key stakeholders through the Bioenergy and Food Security Approach (BEFS) to assess sustainable bioenergy options in Rwanda and to boost the small but vibrant private sector biomass and bioenergy projects (FAO, 2017).

4.2. Physical environment of study area

This section presents the existing physical condition of Kigali City and its surroundings including topography, geological formation and soil, hydrology and water resources, climate and weather conditions and land use set up in project area.

4.2.1. Topography

The topography of Kigali city and its surroundings is made of transitions between mountain ridges and valleys in between with altitude is ranging from 1,300 to 1,600 masl and this terrain has implications on the works for water supply systems as well as for the sewerage infrastructures and eventual discharge of effluents. The City centre area is surrounded by a series of hills, the highest of which is Mount Kigali at 1,850 m. The slope of Kigali city varies in gradient from inclinations of up to 45 or 50 %, to those in wetland valley areas with slopes of less than 2 %. In the broader geographical context, Kigali is located within the Lake Victoria basin and the larger Nile river basin.

The Nyarugenge District is dominated by strong linear ridge running north-south with a maximum altitude of 1900m and softens towards the flat alluvial planes of the Nyabarongo River on the west. The Gasabo District constitutes of more aggressive relief due to the tight rectilinear ridges oriented northwest with a maximum altitude of 2100m to 1900m and gentle relief along the Nyabugogo River and southern part of the district. The Kicukiro District is composed of gentle slope plateaus, averaging less than 1700m of altitude and the slopes gently settle into the alluvial plains of the Nyabarongo River.

As per Organic Law, the slopes more than 20% are not suitable for urbanization. In Nyarugenge District 37%, Gasabo District 37.5%, Kicukiro District 6.8% area occupied by steep slopes. The slopes of Kicukiro District are relatively gentle compared to other two districts with 15,562 ha land below 20% slope available for development compared to Gasabo District (26891 ha) and Nyarugenge District (8401.4 ha).

The surrounding region ranges in altitude from 787 m to over 4,000 m. In the east of Kigali City (Bugesera and Rwamagana as well in the south(Kamonyi) the topography is characterized with low land with moderate slop. In the north towards Rulindo district, the topography is made of succession of mountain with steep slope. The next figure presents the topographic configuration and slopes of Kigali City and its surroundings.

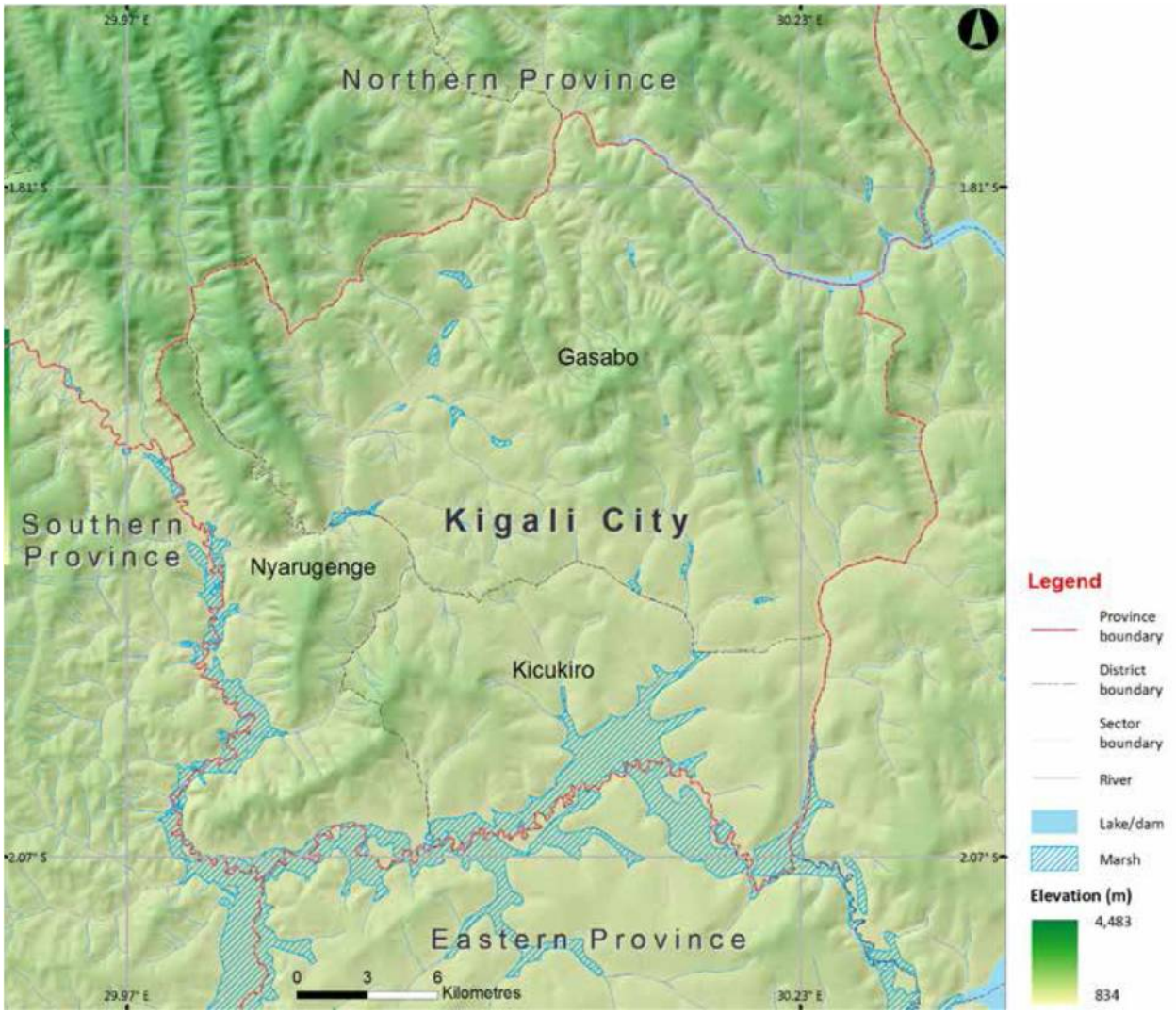


Figure 4: Elevation of Kigali City and its surroundings
Source: BESST LTD, 2020

4.2.2. Soil and geological formation in the study area

Data on soil and geological formation was obtained from secondary data available in Rwanda Mines, Petroleum and Gas Board (RMPGB). In general, Granitic and meta-sedimentary rocks underlie the City of Kigali; these include schists, sandstones and siltstones (Surbana 2012). Lateritic soils, rich in iron and aluminium, dominate the city's hillside surfaces while alluvial soils (fertile soil deposited in river valleys) and organic soils are found in the lowlands and wetlands.

- **Soil**

Soil in Kigali and its surroundings are mainly made of Dystric Humic and Ferralic Cambisols, Umbric Glycols, Dystric Regosols, Dystric Leptosols, Ferric Lixisols, and Humic Sombric Acrisols (WRB, 2006). Colluvium found at the bottom of hills near the valley indicate soil erosion taking place in the northern side of Nyabarongo and Nyabugogo rivers. Leptosols with a shallow entic horizon on shale point to high erosion happening on steep slopes at the southern part of Nyabugogo River. The table below outlines the soil groups, their capability and erodibility classes is presented below. The occurrence of wetland soils is also underlined. The current land uses and the ones applicable to the soils established in the study area are discussed in the **Table 25**.

Table 25: Characteristics of soils to be disturbed at project area

Position in the landscape	Soil types to be disturbed, their fertility and depth	Land Capability classes	Soil erodibility classes	Presence of wetland soils
Valley	Umbric Gleysols: Fertile, deep soil (>1.5 m)	-Class 5	Low	Yes
Bottom slope	Dystric Regosols (moderately deep: <1 m)/ Dystric Leptosols (shallow: <0.5 m): Low fertility	-Class 4	-Moderate to High	No
	Dystric (Humic) Cambisols, Fertile, Moderately deep soil (<1m)	-Class 2	-Moderate	No

Position in the landscape	Soil types to be disturbed, their fertility and depth	Land Capability classes	Soil erodibility classes	Presence of wetland soils
Middle slope	Ferric Lixisols: low fertility, Shallow soil (< 1 m)	-Class 3	-Moderate to High	No
Hill plateau	Humic Acrisols (Sombric), medium fertility, relatively shallow (<1m)	-Class 3	- Moderate	No
Uphill	Ferralic Cambisols: Very low fertility, Shallow soil (< 1m)	-Class 6	- High	No

Source: MINAGRI, Soil map, 2014

- **Umbric gleysols**

These are wetland soils that, unless drained, are saturated with ground water for long enough periods to develop a characteristic gleyic color pattern. This pattern is essentially made up of reddish, brownish or yellowish colours at ped surfaces and/or in the upper soil layer or layers, in combination with greyish colours inside the peds and/or deeper in the soil. These soils had a thick, dark-colored, base-depleted surface horizon rich in organic matter and therefore called umbric. Nyabarongo and Nyabugogo rivers cross the valley with gleysols and deposit sandy materials on their river banks. This valley with Gleysols that will be affected by the project is used for vegetables and sweet potatoes farming during the dry season (season C). Shallow water are used for irrigation while in parcels with stagnating water, seasonal drains are made by farmers to lower the ground water table. However, farmers are challenged by frequent flooding during rainy seasons. Small wet patches still sustains wetland vegetation such as papyrus.

- **Dystric (Humic) cambisols**

This young soils developing on colluvium brought by erosion on hillside are established near the valley. Despite the shallow cambic horizon with less base saturation of these soils, they present higher agricultural potential than their associated Regosols and mostly due to the accumulation of nutrients from hillsides. Cambisols that will be affected by the project are used for construction near the existing Nzove plant and for upland agriculture along the valley.

- **Dystric leptosols**

These are very shallow soils over continuous shale rock with a very shallow entic horizon (<0.5 m). They are zonal soils particularly common in Rwandan mountainous regions. The shallowness of these soils shows high erosion that has kept pace with soil formation, or has removed the top of the soil profile. These soils were found on foothills in the southern part of Nyabugogo River. They were developed on shale with few cross cutting quartzite mineralization where communities living around attempt to mine stones for construction. These soils have poor agricultural potential mainly due to its shallowness, low chemical fertility and steep slope and were hence kept under eucalyptus woodlots.

- **Dystric regosols**

These are very weakly developed mineral soils in unconsolidated materials that do not have a mollic or umbric horizon. They are not very shallow or very rich in gravels. The parent material is the unconsolidated, finely grained material. The dystric characteristic indicates a base saturation of less than 50% in the major part of the soil surface. The low soil moisture holding capacity and the compactness of its subsoil reduce the agricultural potential of these soils to be affected by the project

- **Ferric lixisols**

These soils have a higher clay content in the subsoil than in the topsoil as a result of pedogenetic processes (especially clay migration) leading to an argic subsoil horizon. These soils are developed on shale in the investigated site. They have a high base saturation and low-activity clays at certain depths and have a ferric horizon starting within 100 cm of the soil surface.The Ferric Lixisols that will be affected by the project are used for residential and for upland agriculture that suits a wide range of crops. However, the low absolute level of plant nutrients and low cation retention makes recurrent inputs of fertilizers and lime a precondition for continuous cultivation. Since these soils are also prone to erosion, measures to protect soils should be applied and perennial crops preferred to annual crops.

- **Humic acrisols (Sombric)**

These soils have a low base saturation at certain depths and high-activity clays throughout the argic horizon. They lack the albeluvic tonguing as in Albeluvisols and have an advanced degree of weathering. They are developed on shale and occur predominantly on hilly topography in the study area. The generally unstable surface of these soils makes them susceptible to erosion. Preservation of the surface soil with its all-important

organic matter and preventing erosion are preconditions for farming on these Acrisols. The current land use involves perennials such as bananas and cassava which favor the preservation of the surface soil. Annual crops farmed are sorghum, beans and maize.

- **Ferralic cambisols**

These soils have an incipient subsurface soil formation. Transformation of parent material is evident from structure formation and mostly brownish discoloration and increasing clay percentage. These cambisols are characterized by slight weathering of parent material and by absence of appreciable quantities of illuviated clay, organic matter, Al and/or Fe compounds. They have a ferralic horizon starting within 30 cm of the soil surface. Erosion on the steep slope of Mount Kigali where these soils were found explains the occurrence of Ferralic Cambisols. These soils are used for eucalyptus forest and presents very low agricultural potential. This is mainly due to its shallowness, steep slope and shallow oxic hardpan that impedes root penetration. In addition, these soils are excessively drained. It worsens their low water holding capacity and confer to this type of soil a poor physical and chemical soil fertility status.

- **Geological formation**

In terms of geological formation, Kigali City and its surrounding is situated at 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 incolour, 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.
- **Quaternary:** represented by undifferentiated Holocene and Pleistocene with several tens of meters of recent alluvial sediments deposited by rivers and/or erosion.

4.2.3. Climate patterns

Kigali has a tropical wet and dry climate, which is modified by its high elevation. The average temperature is 20ºC with monthly variations of about 1.5ºC. However the temperature trend for the urban area of Kigali in three meteorological stations between 1971 and 2008 showed an increasing annual mean temperature of 0.2^0C for a period of nearly 40 years. Mainly, for the last 10 years a warming in Kigali is evident. In the first instance, this development could be attributed to global warming, because more or less rising temperatures could be recognized all over Rwanda during the last decades. But it could also be related to the ongoing urbanization, because the temperature trend of Kigali is much higher and faster than in other parts of the country. Total average annual rainfall is around 1,028 mm and it follows the typical bimodal pattern found in other parts of Africa. The rainfall pattern is influenced by the Inter Tropical Convergence Zone (ITCZ).

- **Rainfall and temperature**

The city of Kigali has an altitude of 1,567m and experiences a long rainy season that extends from mid-February to mid-May with another rainy season from mid-September to mid-December. However, the rainy season may extend for some weeks into the dry season and vice versa. In general, the average precipitations range from 65 mm to 200 mm per month. In times of extreme storms and rainfall, there can be a danger of flooding in the city, especially where urban developments have created impervious surfaces or changed

hydrological conditions in rivers. Kigali, is one of the major flood prone areas in the country, where almost every year flood events are recorded.

The average temperature in Kigali, Rwanda is at 20.5 degrees Celsius (68.9 degrees Fahrenheit). The variation of mean monthly temperatures is 1.5 °C (2.7°F) which is an extremely low range. The average diurnal temperature variation/ range is 11 °C (19.8 °F). The warmest month (August) having a mean temperature of 21.5 degrees Celsius (70.7 degrees Fahrenheit) while April is the coldest month (warm) having an average temperature of 20 degrees Celsius (68 degrees Fahrenheit).

Figure 4-5: Rainfall and temperature

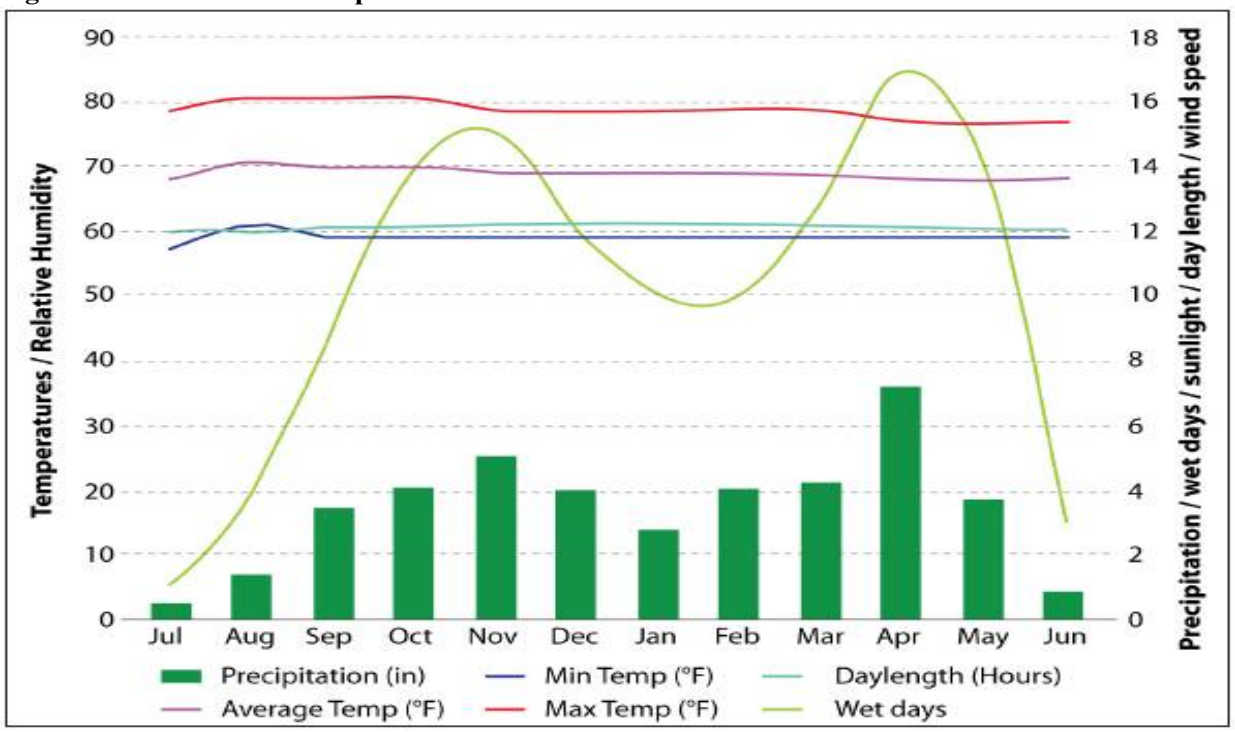


Figure 6: Rainfall and temperature
Source: Meteo rwanda , 2017

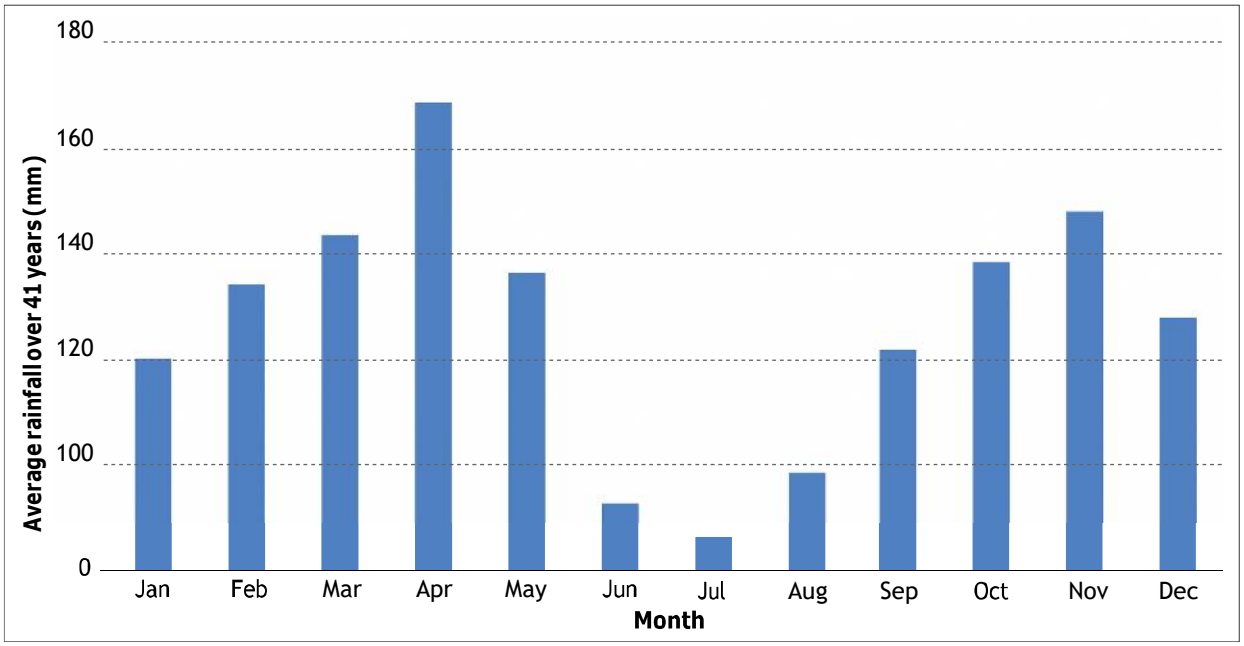


Figure 7: Average monthly rainfall measured at Kigali station over a period of 41 years
Source: Meteo Rwanda , 2019

4.2.4. Climate change and natural disasters

- **Overview**

Climate studies forecast an increase in Rwanda's average temperatures by 2.5oC between 1970 and 2050 and annual rainfall increases of up to 20% over the same period.19 Climate change impacts in Rwanda include more extreme rainfall events, flooding, landslides, more extreme temperatures, heat waves, and

periods of drought. Kigali has areas at risk of and experiencing natural disasters such as flooding and landslides, including areas which have been encroached upon by industries informal settlements, cultivation. The frequency and extent of flooding in the city would be expected to increase with climate change, in the absence of environmental management. actions to limit the flooding and its impacts. Kigali similarly has high risk steep sloped areas susceptible to landslides, which could have a higher risk of occurring under the conditions of increased rainfall and storm water runoff expected in Kigali. Climate change and disaster resiliency measures are essential to minimizing the scale and impact of flooding on infrastructure, services, economic activities, and households.

- **Climate change and disaster resiliency strategies**

Rwanda's National Strategy for Climate Change and Low Carbon Development was published in October 2011 with the aim of providing strategies for green growth and climate resilience in Rwanda. Actions are proposed in that document for low carbon development/ mitigation (promoting: geothermal power generation, integrated soil fertility management, and high-density walkable cities) and climate resilience/ adaptation (promoting: irrigation infrastructure, robust road network centre for climate knowledge for development and agroforestry).

- A citywide climate change management plan with projects and guidelines;
- Include tax exemption and climate financing opportunities as incentives for all energy efficient development;
- Integrating climate and disaster resiliency into planning and design of buildings, infrastructure, and urban services to adapt to and minimize negative impacts from and contribution to climate change and natural disasters;
- Identification and mapping of natural disaster risk and hazard areas (e.g. Flooding, erosion, landslides, earthquakes, and lightning strikes);
- Restriction of development and activities in high risk areas;
- Relocation of households from high risk/hazardous areas;
- Preparation of early warning system;
- Preparation of disaster response plans; and
- Design of resilient infrastructure and services to minimize the impacts and disruptions from common natural disasters.

4.2.5. Air pollution level in Master Plan area

Kigali City is subject to outdoor air pollution from a number of sources, including vehicle exhaust and industrial emissions, and indoor pollution from smoking cook stoves. This pollution has impacts on the ambient environment and especially on human health.

- **Outdoor air pollution**

A study conducted by REMA in 2012 identified vehicular emissions as the main source of increasing pollution, exacerbated by the mainly very old vehicles that do not meet air emissions requirements (MININFRA, 2015c). Another study conducted between 2012 and 2013 reported that emissions from vehicles burning petrol contained higher levels of carbon monoxide (CO) because of incomplete fuel combustion or partially oxidized fuel compared to diesel-driven vehicles that also produce less GHGs, have a better fuel economy and higher engine efficiency. The study found that every year, petrol and diesel vehicles release a total of 526,327.1 tonnes of carbon dioxide (CO2), 18,405.5 tonnes of carbon monoxide (CO) and 354,967.0 m3 of unburned hydrocarbons (HC) into the atmosphere of Kigali City (Nduwayezu, Ishimwe, Niyibizi, & Ngirabakunzi, 2015). A 2011 report on air pollution in Kigali also found high levels of ozone, which is a major ground-level pollutant associated with traffic exhaust (Nsengimana, Bizimana, & Sezirahiga, 2011). The former study concluded that the rise in emissions from fossil fuels would result in increased human health risks, environmental degradation, lower human work productivity and a slowdown in economic growth in Rwanda (Nduwayezu, Ishimwe, Niyibizi, & Ngirabakunzi, 2015).

Industries are also the sources of air pollution, contributing sulphur dioxide from the combustion of fossil fuels. Sulphur dioxide emissions have been increasing in Kigali, where about 63 per cent of the country's industries are located. Air pollution levels in Kigali City exceed standards recommended by the World Health Organization (WHO) and the East African Community. For example, the level of presence of small-suspended particulates (PM10) in the city's air is over the WHO allowable limit of 50 μg m (MININFRA, 2015c). The National Energy Policy stipulates that industries, especially energy- intensive ones, carry out energy audits to enhance energy efficiency, which reduces polluting emissions (UNEP, 2015).

The air quality of the project area shows that sulphur dioxide, Nitrogen Oxides, Carbon Monoxides and Hydrocarbons may be below detectable limits. The suspended particulate matter (SPM) is in the range of 120- 140µg/m^3. The air quality of the project area is within permissible limit. The following table shows the average of different data on gases CO, SO2, NO2... that have been collected on the station IO104-1-204 near the project within Kigali City during the period September 2015. The data were collected on the interval of 30 min one after another.

Table 26: Average of different data on gases

No.	Pollutant	Measurement results	Test Methods
1.	Sulphur oxides (SOx);	60µg/m3	ISO 4221-1980
2.	Oxides of Nitrogen (NOx)	60ug/m3	ISO 4221-1980
3	Suspended particulate matter(SPM)	140µg/m3	ISO 9835:1993
4	Respirable particulate matter(<10um)(RPM)	50µg/m3	ISO 9835;1993
5	Carbon monoxide(CO)/carbon dioxide(CO_2)	2.0mg/m3	ISO 4224:2000

Source: REMA, 2015.

Table 27: Main Gas emissions in Kigali City

Gas emissions per each type of vehicle and fuel				
Vehicle & Fuel type	**Chemical component**	**Vehicles from Kigali City**	**Vehicles from outside Kigali**	**Total emissions (tons/year or m 3 /year)**
Petrol vehicles	CO2 (tons/year)	146,500.0	3,767.1	150,267.1
	(tons/year)	13,163.0	338.5	13,501.5
	HC (m3)	346,068.0	8,899.0	354,967.0
Diesel vehicles	CO2 (tons/year)	366,632.0	9428.0	376,060.0
	CO (tons/year)	4,781.0	123.0	4,904.0
Overall total gas emission	CO2 (tons/year)			526,327.1
	CO (tons/year			18,405.5
	HC (m3 /year			354,967.0

Source: REMA, 2015.

- **Indoor air pollution**

There is a very high rate of biomass burning in Kigali City, especially for cooking (96.4 per cent of Kigali City residents use biomass fuel for cooking), which is largely done indoors by women in unventilated kitchens. They, and their children, thus inhale smoke and are exposed to the risk of respiratory disease.

Data from Rwanda's air quality monitoring station at the observatory on Mount Mugogo reveal that black carbon concentrations, primarily from biomass burning, are as high as in major US cities. The World Health Organization (WHO) reports that annual mean PM2.5 concentration in Rwanda are 17 g m-3, which exceed the US Environmental Protection Agency's limit of 10 g m-3 annual exposure (FONERWA, 2017).

Small particulates from both indoor and outdoor air pollutants lodge in human lungs and can cause respiratory illnesses. Indeed, the aforementioned study listed the following risks of exposure to even relatively low concentrations of air pollutants: "premature mortality or morbidity and diseases such as cardiovascular and respiratory diseases, lung cancer, bladder cancer, aggravation of asthma, acute and chronic bronchitis, TB, chronic obstructive pulmonary disease, chronic inflammation and irreversible structural changes in the lungs, brain damage, impaired cognitive skills and difficulty in speaking and hearing" (Nduwayezu, Ishimwe, Niyibizi, & Ngirabakunzi, 2015).

Table 28: Recommended ambient air quality standards for Rwanda (REMA 2018)

Pollutant	Averaging period	National standard (µg/m3)	Justification
Sulphur Dioxide SO2	10 minute	500	In line with WHO guideline
	24 hour	125	In line with WHO Interim Target 1 and the most common national standards
Nitrogen Dioxide NO2	1 hour	200	In line with WHO guideline and the most common national standards
	Annual	40	
PM10	24 hour	100	In line with WHO Interim Target 2, the existing Rwandan standards and other national standards
	Annual	50	
PM2.5	24 hour	75	In line with WHO Interim Target 1
	Annual	35	
Ozone 03	1 hour	200	In line with the most common national standards
	8-hour daily maximum	120	In line with WHO Interim Target 1 and the most common national standards
Carbon Monoxide CO	1 hour	30,000	In line with WHO guideline and the most common national Standards
	8 hours	10,000	

Source: REMA, 2018

4.2.6. Hydrology and water resources

- **Water bodies**

Reference to National Water Resource Master Plan, the targeted area has 25 water catchment basins . Major water bodies (lakes and rivers) in the project area are, Lake Muhazi which borders the city along northeast of Gasabo District and Nyabarongo(which becomes Akagera after meeting Akanyaru) River bordering Nyarugenge and Kicukiro Districts along the south west. The City contain also other rivers and streams, such as Yanze, Kibumba, Rwazangoro and Ruganwa which flow into the Nyabarongo River to the west. The River Nyabarongo (with source in Nyungwe Forest) flows along the south-western boundary of the city, forming the border with the Southern and Eastern Provinces and becomes Akagera when it meets Akanyaru. Nyabarongo River is a key part of Kigali's urban hydrological network.

- **Nyabarongo river**

Nyabarongo River is the main source of water resources supplied in Kigali with both Nzove and the ongoing Kigali bulk water supply project getting water from Nyabarongo ground water. The Nyabarongo river basin is within the Rwandan Nile catchments that occupies 67% of Rwanda and drains most of the Rwandan waters into the Nile through Akagera River. Nyabarongo river basin has a catchment area of 8,900 km^2, an annual rainfall of about 1,350 m and its altitude varies between 3000 m upstream and 1,350 m downstream, with an average altitude of 2,176 m. The Nyabarongo River has a slope of about 0.8% with an annual average discharge of 83% m3 /s. The basin runoff coefficient is about 22% and the specific discharge 9.31/s/km. The river basin does not experience cold season, except in the Northwest part of the country where the sub catchments of the river (Mukungwa River) are situated in the volcanoes area with altitudes higher than 2,500 m. There are no marked differences in rainy and dry seasons while the special variation of rain is heterogeneous and precipitation pattern are characterized by thunderstorms, due to slowly moving humid air masses climbing against the hilly terrain. Major Nyabarongo river tributaries are Akanyaru River from North West and Mukungwa River from North in the volcanoes.

- **Nyabugogo river and its tributaries**

So far, Nyabugogo is not used as source of water supply especially due to its high pollution level but it remain one of the important hydrological component in the project area. The Nyabugogo River is 45.97 km long, measured from the outflow of Lake Muhazi to its confluence with the lower Nyabarongo River near Ruliba Clays at an altitude of about 1,360 m above sea level. The highest point of the catchment is at 2,280 m in the northern part of the catchment. The main tributaries of the Nyabugogo River are Mwange, Muyanza, Rusine, Kajevuba and Yanze rivers.

- **Lake Muhazi**

This Lake is situated at 1,444 above mean average sea level (masl) and it is 37 km long with. It occupies the floor of a system of valleys, with 13 narrow branches. Muhazi lake presents a total surface area of 3, 290 ha (including the marshes). The lake is 37 km long with a maximum width of 0.6 km with a digitated shape. The western part close to the outlet is narrow, less than 100 m in some places. The lake's average depth is 2.5 m near the outlet and increases towards the east, often reaching a depth of 15 m in the centre and the eastern part of the lake. The eastern part is wider and has numerous branches, which end up in marshes. The maximum observed depth (bathymetric recording) is 16.8 m.

The variations in the lake's shores do not change its physiognomy fundamentally in view of the steep slopes of the surrounding reliefs. In view of the lake's configuration and its bathymetry, the lake beds are on average accessible only when less than 5 meters away from the shore. The lakeshores measure approx. 180 km due to its diverticular shape. The construction of a dyke to the west of the lake has amputated a part of the lake's surface area so that it is now emerged from the water and used for stock farming. Lake Muhazi is one of the potential source of water that might be used to supply Kigli City and its surroundings.

Table 29: Characteristics of Lake Muhazi

Item	Measures
Maximum length	37 km
Maximum width	0.6 km
Surface area	33 km^2
Average depth	10 m
Maximum depth	14 m
Water volume	0.33 km^3
Surface elevation	1,443 m

Source: MINIRENA, Water Resource Master Plan, 2015

According to the geo-topographical classification, the Muhazi region belongs to the "intermediate zone" which comprises the low hills of Muhazi and Bugesera and constitutes the middle part of the Akagera-Akanyaru-Nyabarongo fluvial complex and is characterized mainly by soils of metamorphic origin (black schists and micaschists) and magmatic acid (granite). The alluvial and colluvial soils are not well developed and that is why there is very little physical degradation of the soils in this area.

Water quality analyses show that there are very high sediment loads and turbidity, due to mining and traditional farming methods, high loads of Escherichia coli and coliform bacteria from untreated sewage, and high organic loads and high biological and chemical oxygen demands (BOD and COD), resulting in low concentrations of dissolved oxygen (mg/L). Concentrations of Cadmium, Iron and Lead in Lake Muhazi are found to exceed recommended levels for aquatic life. These high levels of heavy metals are attributed to riparian land use practices such as agriculture, urban runoff, and mining activities in the vicinities of the lake.

4.2.7. Wetlands

Wetlands cover approximately 10.6% (compared to 14% in 2013) of the land area of the City of Kigali, occurring primarily along the low-lying valleys and floodplains of the rivers flowing through the city landscape. Wetlands in Kigali are classified as Central Plateau Swamps (based on REMA's 2008 wetland inventory and classification system). The wetlands have mineralized soil substrate with dominant vegetation, when not cultivated, being Polygonum pulchrum, Cyperus papyrus, Commelina diffusa, Cynodon dactylon, Eicchornia crasipes, and Pennisetum purpureum. The wetland play an important role in improving water quality, flood attenuation, reducing soil erosion, providing habitat for diverse species of flora and fauna, moderating climate conditions, contributing to the City's aesthetics, and providing opportunities for economic, recreational, educational and research activities.

In Kigali wetlands are used extensively for agriculture and in some sites for extraction of sand and clay which are important building materials. The wetlands in Kigali, however,are threatened and impacted by urbanization, agricultural and industrial activities including cultivation in wetlands, pollution from fertilizers and pesticides, grazing by livestock, mining of clay and sand, encroachment and pollutionfromindustries, encroachment and pollution from human settlements. Over half of the wetlands in Kigali are degraded and have lost ecological functions and over 2078 establishments are identified as encroaching on the city's wetlands.

Through Prime Ministers Order No.006 of 13/02/2017 12 four wetlands within Kigali City are to be designated as wetlands of international importance under the RAMSAR Convention. The Ramsar Site wetlands would include: Kitagurizwa Wetland (Within Gasabo and Kicukiro districts), Rugende- Isumo Wetland (Within Gasabo and Kicukiro districts), Nyabarongo- Aval Wetland (Within Nyarugenge and Kicukiro districts) and Nyabarongo- Amont Wetland (Within Nyarugenge district).

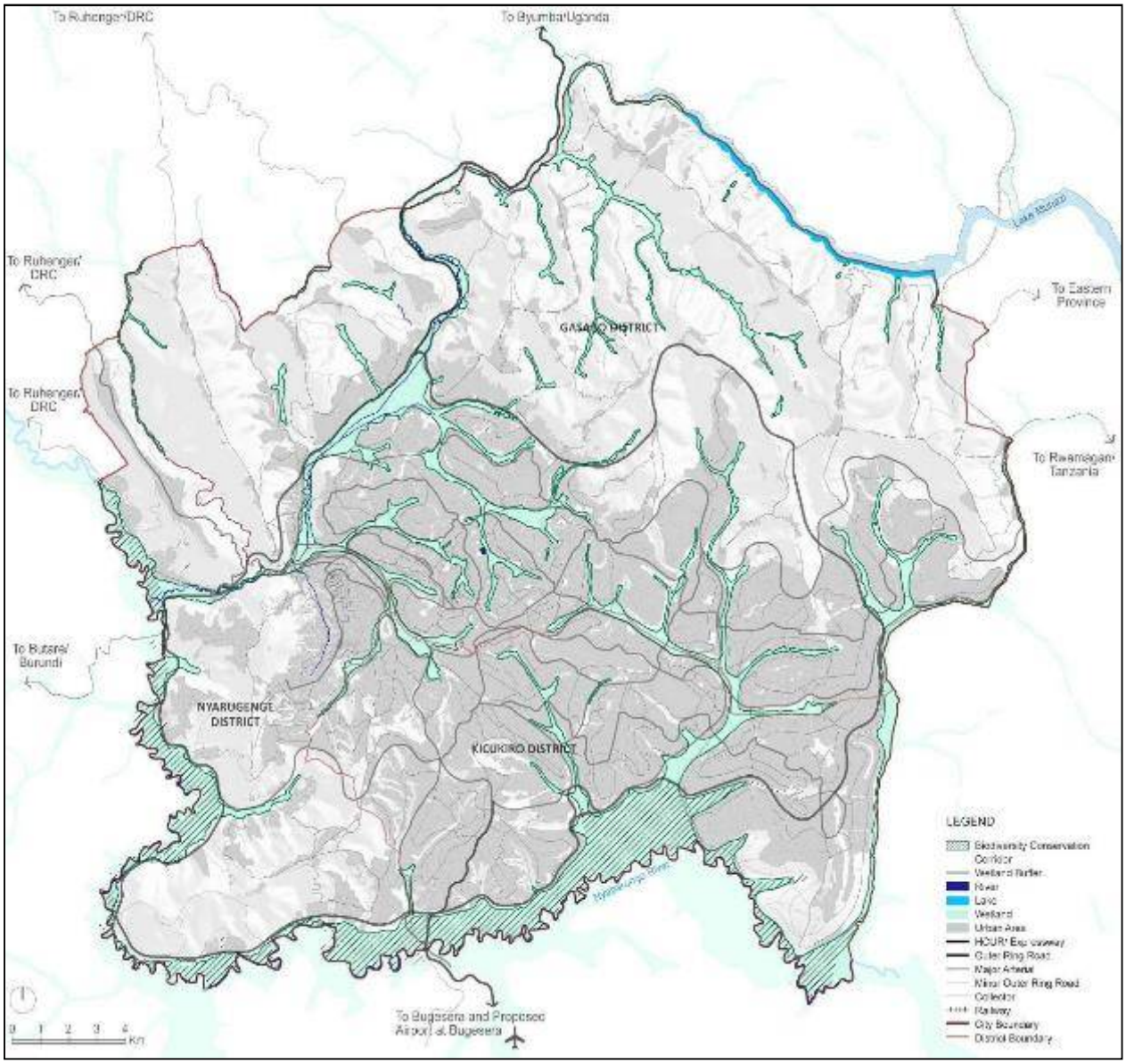


Figure 8: wetlands and major water bodies in Kigali and its surroundings
Source: Rwanda Water Board maps customised, BESST LTD, 2020

4.2.8. Water quality and source of water pollution

- **Water quality for key parameters in sampled areas**

The water pollution poses a direct threat to the environment and the public health. However, efforts are being made within the city to avoid water bodies' pollution according the water quality monitoring report conducted by the IWRM program in April 2019, the results revealed that some measured water quality parameters are generally within the acceptable range within Kigali city and others are out of the acceptable range for natural potable water. These results clearly illustrate that the main concerns in terms of surface water quality are mostly related to the sedimentation /siltation of water bodies mainly due to soil erosion as well as the microbiological contamination that can be linked to poor sanitation systems and practices. The table below illustrates the mean level of water parameters measured on different sampling points within Kigali City.

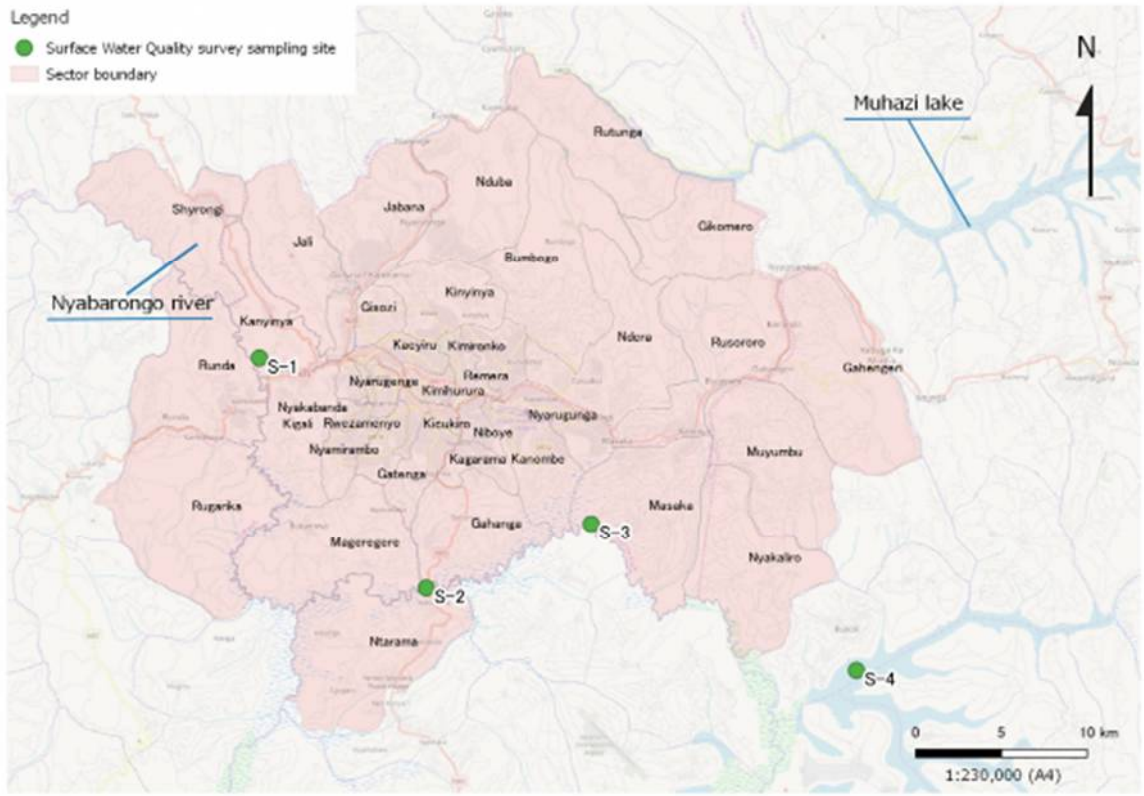
In order to confirm the suitability as drinking water sources and to decide the water treatment process, a surface water quality survey will be conducted both in the wet season and dry season. The sampling method and sampling locations are shown in **tables 24**

Table 30: Sampling for the Surface Water Quality Survey

Sampling Site		Sample ID	Coordinates	Number of Sample
1	Nyabarongo River at Nzove (up-stream)	S-1	1˚56.431' S 29˚59.934' E	2 (1 in wet and 1 in dry season)
2	Nyabarongo River at Kanzenze (middle-stream)	S-2	2˚3.742' S 30˚5.170' E	2 (1 in wet and 1 in dry season)

Sampling Site		Sample ID	Coordinates	Number of Sample
3	Nyabarongo River at Masaka (down-stream)	S-3	2°1.691' S 30°10.366' E	2 (1 in wet and 1 in dry season)
4	Mugesera Lake	S-4	2°6.378' S 30°18.707' E	2 (1 in wet and 1 in dry season)
Total number of sample				8
Sample type: grap sample				

Source: JST



Source: JST

Figure 9: Sampling Locations of Surface Water Quality Survey

- **Water Quality Analysis Parameters**

Water quality analysis parameters for the surface water quality survey are shown in **Table 31**:

Table 31: Analysis Parameters

No.	Parameter	No.	Parameter
1	pH	11	Calcium (Ca)
2	Turbidity	12	Magnesium (Mg)
3	BOD_5	13	Standard plate count bacteria
4	Ammonia nitrogen (NH_4-N)	14	E. coli
5	Nitrate nitrogen (NO_3^--N)	15	Cyanide (CN^-) 1)
6	Nitrite nitrogen (NO_2^--N)	16	Chromium (Cr^{6+}) 1)
7	Fluoride (F^-)	17	Cadmium (Cd) 1)
8	Manganese (Mn)	18	Lead (Pb) 1)
9	Iron (Fe)	19	Mercury (Hg) 1)
10	Zinc (Zn)		

Source: JST

1) Items analyzed in Japan

- **Results of Water Quality Survey**

The results of the surface water quality survey during the dry season are summarized as bellow

Table 32: Results of Water Quality Survey on Surface Water (Dry Season)

No.	Sampling No. / Sampling Date	Unit	S-1	S-2	S-3	S-4	RDWQS 1)	WHO Guideline (2017)
			2019/09/12	2019/09/12	2019/09/12	2019/09/12		
1	pH	-	7.55	7.35	7.09	8.93	6.5-8.5	-
2	Turbidity	NTU	477	474	512	10.5	5	5
3	BOD_5	mg/L	9.0	8.7	10.8	12.0	-	-

No.	Sampling No.	Unit	S-1	S-2	S-3	S-4	RDWQS [1]	WHO Guideline (2017)
	Sampling Date		2019/09/12	2019/09/12	2019/09/12	2019/09/12		
4	Ammonia nitrogen (NH_4-N)	mg/L	0.19	0.17	0.23	0.05	0.5	-
5	Nitrate nitrogen (NO_3^--N)	mg/L	0.42	0.20	0.16	<0.01	10	11.3
6	Nitrite nitrogen (NO_2^--N)	mg/L	<0.002	<0.002	<0.002	0.016	0.001	0.9
7	Fluoride (F^-)	mg/L	0.41	0.59	0.32	0.49	1	1.5
8	Manganese (Mn)	mg/L	0.100	0.023	0.015	0.254	0.1	0.4
9	Iron (Fe)	mg/L	0.13	0.18	0.16	0.41	0.3	0.3
10	Zinc (Zn)	mg/L	0.43	0.43	0.18	0.21	-	-
11	Calcium (Ca)	mg/L	8.0	8.4	5.6	17.8	150	-
12	Magnesium (Mg)	mg/L	9.0	6.3	8.3	13.3	100	-
13	Standard plate count bacteria	cfu/ml	5×10^4	8×10^4	5×10^4	1×10^4	100	-
14	E. coli	cfu/100 ml	5×10^1	9×10^1	4×10^1	1×10^1	-	-
15	Cyanide (CN^-) [1]	mg/L	<0.001	<0.001	<0.001	<0.001	0.01	0.5
16	Chromium (Cr^{6+}) [1]	mg/L	<0.005	<0.005	<0.005	<0.005	0.05	0.05
17	Cadmium (Cd) [1]	mg/L	<0.0003	<0.0003	<0.0003	<0.0003	0.003	0.003
18	Lead (Pb) [1]	mg/L	0.007	0.007	0.007	<0.001	0.01	0.01
19	Mercury (Hg) [1]	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	0.001	0.006

Source: JST

1) RDWQS: Rwanda Drinking Water Quality Standard
2) 0.016 means the value exceeding Rwanda Drinking Water Quality Standard

- **Water quality in water source for the two selected projects**

Table 33: 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

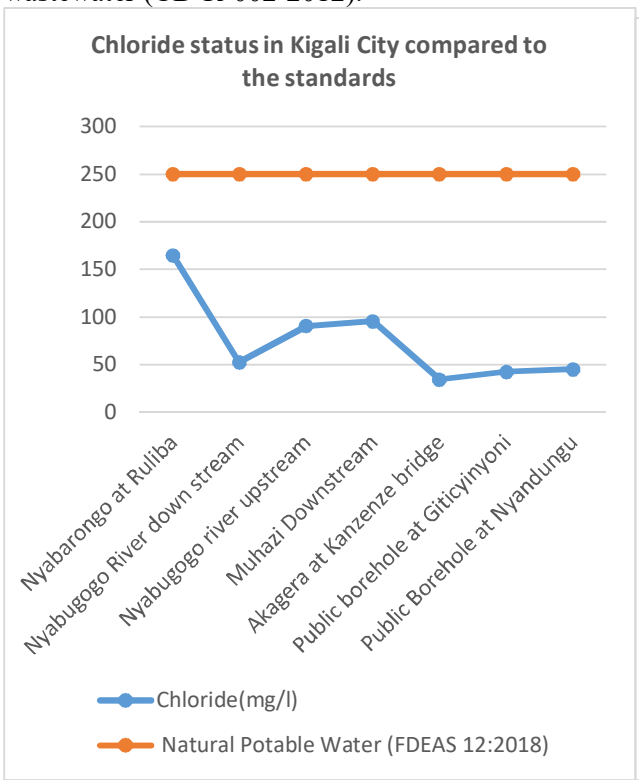
Table 34: Raw water and treated water quality for Karenge water treatment Plant

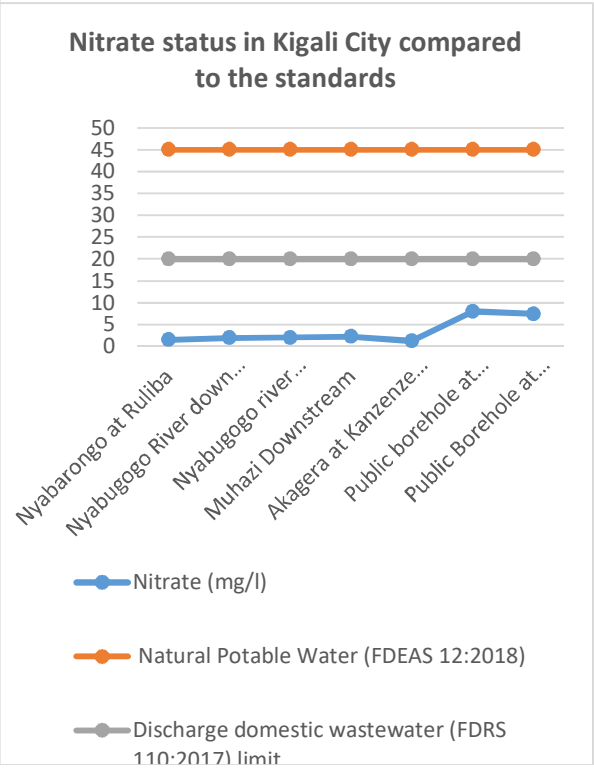
Parameters	Unit	Raw water	Treated water	RSB & EAST AFRICAN STANDARD
Total Coliforms	<1 MPN/100ml	10253	0	**0 cfu/100 ml**
Fecal coliforms	<1 MPN/100ml	245	0	**0 cfu/100 ml**
E. Coli	<1 MPN/100ml	44	0	**0 cfu/100 ml**
Fecal Streptococcus	Cfu/100ml	452	0	**0 cfu/100 ml**
pH		8.5	7.5	**6.5-8.5**
Color	APHA	284	9	**15 APHA**
Turbidity	NTU	10.8	0.75	**< 5 NTU**
Suspended matter	mg/L	42	0	**0 mg/l**
Residual free Chlorine	mg/L		1.25	**0.2 - 0.5mg/l**
T-N	mg/L	5.96	-	
T-P	mg/L	0.99	-	
Calcium	mg/L	8	15.2	**150mg/L**
Magnesium	mg/L	9.24	8.36	**100mg/l**
Dissolved Oxygen	mg/L	14.5	7.5	
Organic matter	mg/L	5.4	1	**2 mg/l**
Iron	mg/L	0.85	0.05	**0.3 mg/l**
Manganese	mg/L	0.62	0.009	**0.1 mg/l**
Nitrites	mg/L	0.35	0.002	**0.9 mg/l**
Nitrates	mg/L	12.2	0.5	**45mg/l**
Ammoniacal Nitrogen	mg/L	0.3	0.003	**0.5 mg/l**
Phosphates	mg/L	1.2	0.1	**2.2mg/l**
Copper	mg/L	0.5	0.035	**1mg/l**
Zinc	mg/L	0.72	0.04	**5mg/l**
Silica	mg/L	0.5	0.03	**IND**
Fluoride	mg/L	1.5	0.3	**1.5mg/l**
Cyanide	mg/L	0.2	0	**0.01 mg/l**
Chromium	mg/L	0.2	0.003	**0.05mg/l**
Sulphates	mg/L	4	0	**400 mg/l**
Aluminium	mg/L	0.4	0.004	**0.2 mg/l**
Temperature	°C	24.6	24.2	**25°C**

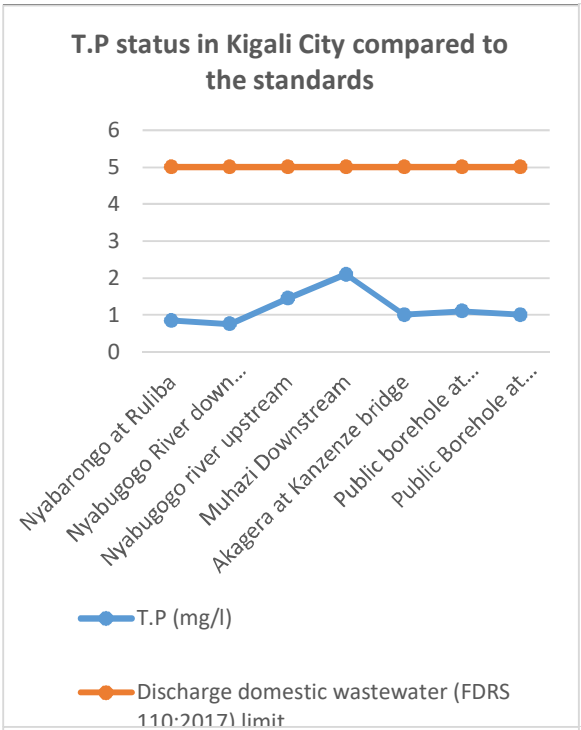
Source: WASAC, Karenge water treatment Plant,2020

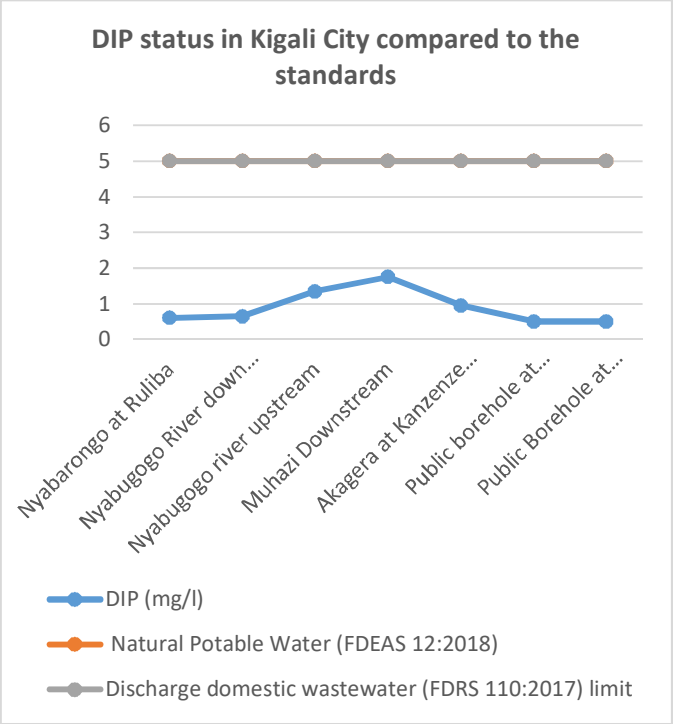
- **Water quality for key parameters in other locations covered in Master Plan**

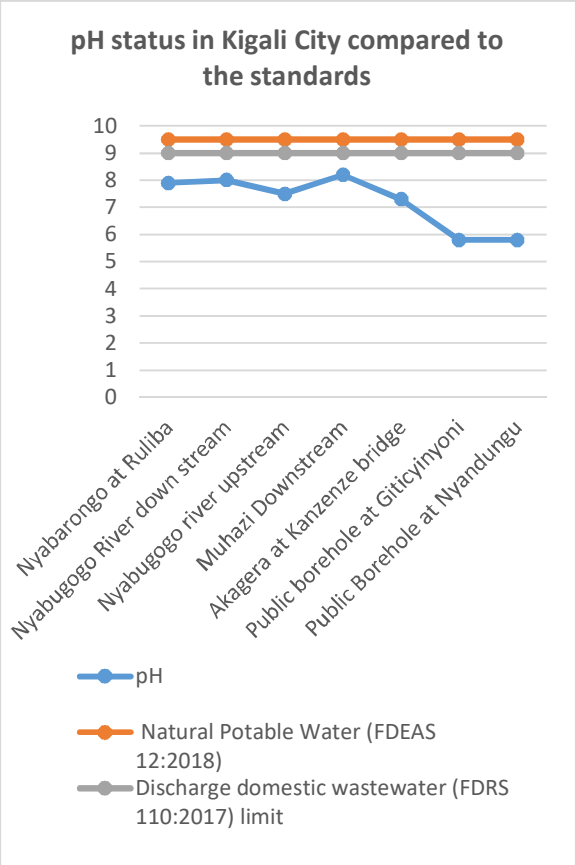
The figures below provides a brief description of each parameters following the standards for potable water (FDEAS 12:2018), the discharged domestic wastewater (FDRS 110:2017) and the discharged industrial wastewater (CD-R-002-2012).

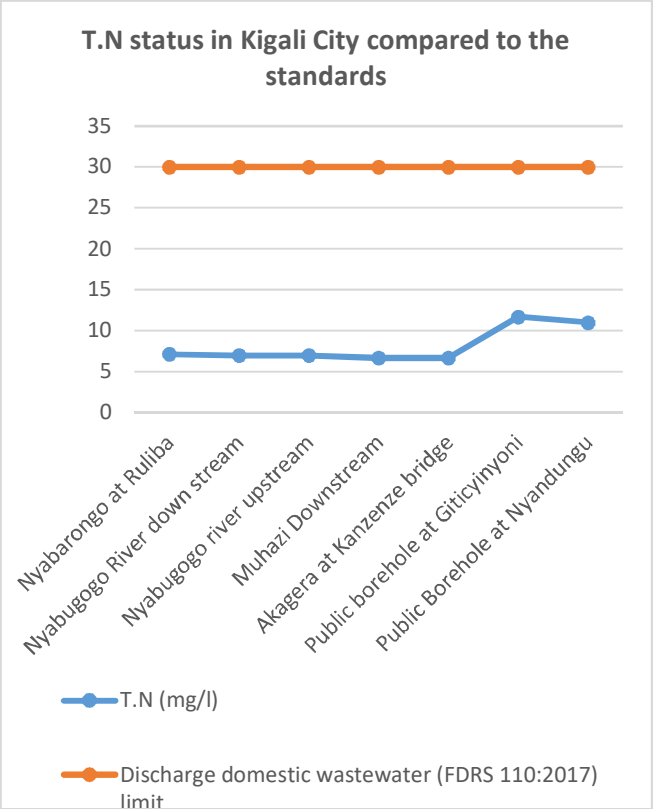





T.P status in Kigali City compared to the standards
6
5
4
3
2
1
0
Nyabarongo at Ruliba
Nyabugogo River down...
Nyabugogo river upstream
Muhazi Downstream
Akagera at Kanzenze bridge
Public borehole at...
Public Borehole at...
T.P (mg/l)
Discharge domestic wastewater (FDRS 110:2017) limit


DIP status in Kigali City compared to the standards
6
5
4
3
2
1
0
Nyabarongo at Ruliba
Nyabugogo River down...
Nyabugogo river upstream
Muhazi Downstream
Akagera at Kanzenze...
Public borehole at...
Public Borehole at...
DIP (mg/l)
Natural Potable Water (FDEAS 12:2018)
Discharge domestic wastewater (FDRS 110:2017) limit


pH status in Kigali City compared to the standards
10
9
8
7
6
5
4
3
2
1
0
Nyabarongo at Ruliba
Nyabugogo River down stream
Nyabugogo river upstream
Muhazi Downstream
Akagera at Kanzenze bridge
Public borehole at Giticyinyoni
Public Borehole at Nyandungu
pH
Natural Potable Water (FDEAS 12:2018)
Discharge domestic wastewater (FDRS 110:2017) limit


T.N status in Kigali City compared to the standards
35
30
25
20
15
10
5
0
Nyabarongo at Ruliba
Nyabugogo River down stream
Nyabugogo river upstream
Muhazi Downstream
Akagera at Kanzenze bridge
Public borehole at Giticyinyoni
Public Borehole at Nyandungu
T.N (mg/l)
Discharge domestic wastewater (FDRS 110:2017) limit

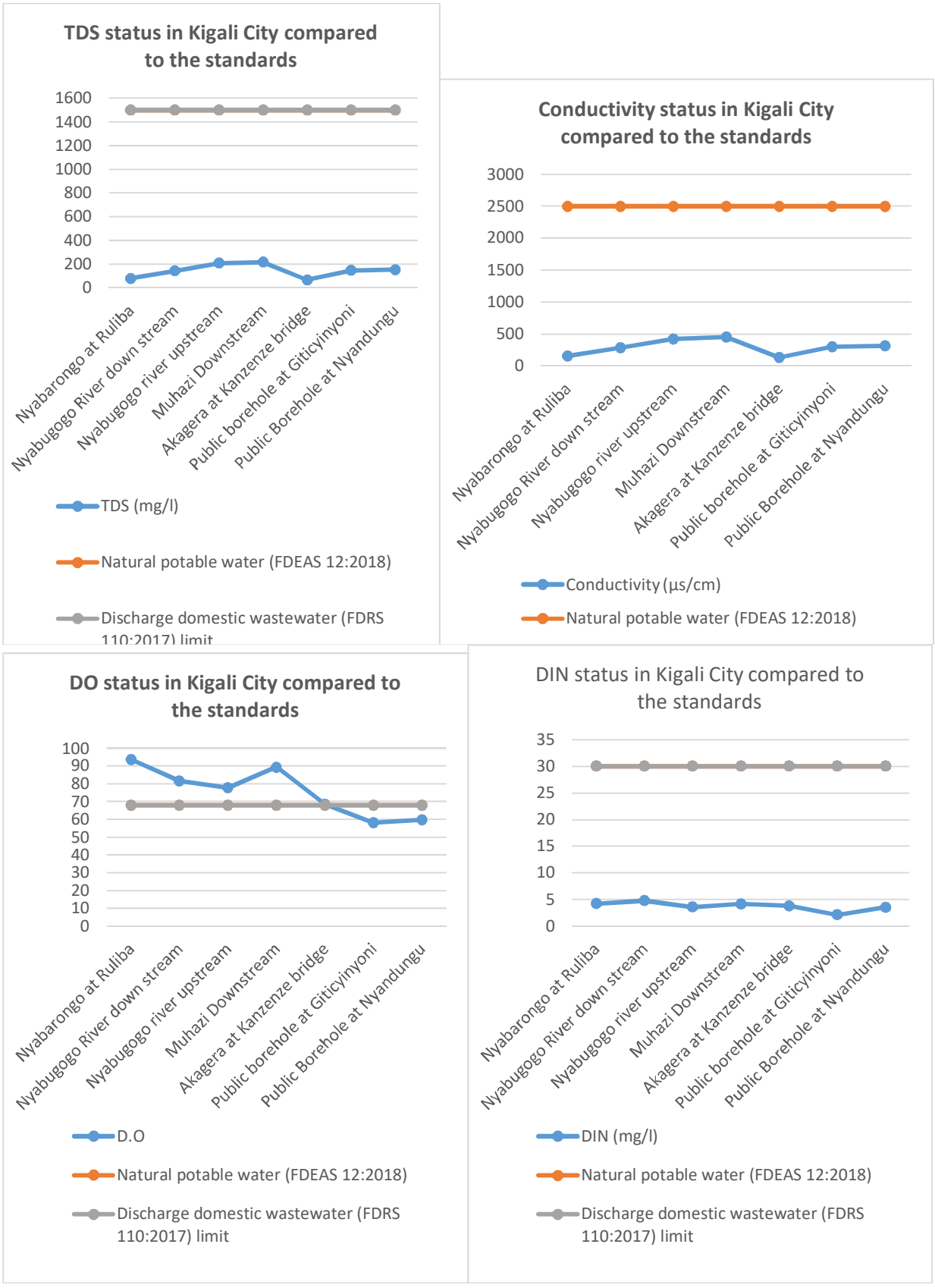


Figure 10: Water quality in and around Kigali compared to standards
Source: Rwanda water Resource Board, 2018

Based on the results of surface water quality survey during dry season, it is considered that basically the water of surface water is treatable with conventional treatment processes to achieve Rwanda standard and WHO guideline values for drinking water supply even some of parameters slightly exceed the standard. However, BOD concentration in all sampling locations presents a higher level, which indicates that surface water is contaminated by organic pollutants. In addition, the higher pH value in Mugesera Lake implies a higher level of eutrophication. Therefore, the risk of river water pollution should be considered during surface water source development.

4.2.9. Potential source of water pollution and ongoing mitigation measures

Water quality in Kigali and around Kigali is mainly affected by human induced factors like soil erosion from agriculture and mining activities upstream Kigali city, and lack of wastewater treatment facilities as well as the application of pesticides and fertilizers. The industrial activities are currently less contributing to water pollution within Kigali City as most of them have been relocated to KSEZ and where the waste treatment technologies and techniques are being adequately implemented.

The major source of water supplied in Kigali are from Nyabarongo river and the assessment done during water quality assessment identified Municipal waste, industrial waste and domestic water as the main source of pollution of Nyabarongo river. The 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, those are Rwanzekuma, Ruganwa, Mpazi and Yanze and join Nyabarongo river with all pollution.

Other main activity practiced in the Nyabugogo catchment especially on its upstream are agriculture and sugar cane are the crops that are mostly cultivated but there is also other plantation like Legumes plantation and Rice plantation. The Kabuye Sugar Works are not the only industry located into the Nyabugogo catchment, there are other many industries such as the Textile industry known as «UTEXRWA» which discharge its wastewater into the Rwanzekuma stream, the water from the Rwanzekuma and Ruganwa before being discharged into the Nyabugogo River, pass through a marshland which is a natural marshland composed with papyrus vegetation, where they leave the marshland as one water body and then enter into the Nyabugogo River, among other activities carried on the Nyabugogo catchment there is garage car, a main taxi park, restaurant and a lot petrol gas station. Rwanda has taken the water pollution and environmental pollution seriously and many initiatives were conducted to mitigate these impacts. Those initiatives include:

- **Relocation of Gikondo industrial park**

Pursuing the environmental law and decision of government official retreat that considered Gikondo Industrial Park as the most environmental concern in Kigali environment, the Minister of trade and industry approved instruction no 15/2012 of 23/04/2012 related to the relocation of factories and other facilities located in the Gikondo Industrial Park. The relocation started in May 2012 and according the Ministry of Trade and Industry once completed the relocation will see about 14 heavy and light factories shifted to the Kigali Special Economic Zone (KSEZ) in Nyandungu sector, Gasabo district.

The Kigali Special Economic Zone (KSEZ) was created through the merger of the former Kigali Free Trade Zone and the Kigali Industrial Park projects. The key goal of the KSEZ is to attract investments and strengthen the country's economy (RDB, 2017) The KSEZ is located on the outskirts of the city, in Masoro-Munini, and Kagarama-Musave, several kilometers from the Kigali International Airport along the Central Transport Corridor (Kagera, 2014)

The KSEZ will occupy 276 ha of land and is being developed in two phases: Phase 1 covers 98 ha of land and was completed in 2013 and Phase 2, still under construction, uses 178 ha of land. Both areas will be serviced with roads, electricity, water, firefighting systems and sewage, while Phase 1 will also have fiber optic cable provision (RDB, 2017). About 65 per cent of Phase 1 investment is in manufacturing and 30 per cent in services while in Phase 2, 58 per cent of investment is expected to be in manufacturing and 37 per cent in services (including warehousing and ICT).

- **Relocation of Nyabugogo garages**

Four years ago, the Rwanda Environmental Management Authority (REMA) recommended they leave the wetland but the mechanics and suppliers of motor vehicle spare parts were opposed saying they have nowhere to relocate. After the bickering between the garage owners pitted against Kigali City Council (KCC) and REMA, finally the garage owners have agreed to relocate from Nyabugogo swamp.

They have been allocated a large piece of land above Gatsata where a three level building with modern garages and spare parts shops were build. As for now, Garages cooperative have completed their own complexes and the relocation was completed. Ikerekezo Cooperative, bringing together 500 garage owners, workers and car parts sellers at Gatsata and around Nyabugogo. REMA has mobilized resources, through Lake Victoria Environmental Management Project (LIVEMP II), for the rehabilitation of the wetland and 20 m buffer zones were demarcated and rehabilitation has started.

- **Relocation of all structure in wetlands**

The last move for wetland and protection of water resources is to remove all structures in wetland and high slop areas. This was initiated to not only protect wetlands and water resources but also to save the life of people threatened by floods and landslides. The relocation of all structures in Kigali wetlands is expected to be completed by the end of 2019.

4.2.10. Waste Management in Kigali City

It worth to note that the current master plan covers only water supply. Different plans for sanitation, waste management, storm water or waste water management will be developed separately. This section provide on overview of waste management in Kigali City in view of the New Kigali Master Plan (2050).

- **Waste Water Management in Kigali City**

The provision of adequate sanitation systems in conjunction with the safe supply of water, is essential for social and economic development and the overall health of a city. Sanitation systems are also very difficult and costly to retrofit into urban environments if space has not been allocated for this infrastructure in the land use planning and the identification of servitudes. Some of the key issues to be addressed by the City relating to waste water include:

- **Direct discharge of sewage into the existing water bodies -** This not only contaminates the water quality of the resource, but also poses a threat to public health. The City needs to progressively phase out septic tanks in urban areas and provide adequate sewer connections and treatment plants to curb the problem of sewer discharge into water sources.
- **Contamination of ground water by pit latrines** - As the sewage infiltrates the soil, it needs time to be treated by the organisms and cations in the ground. Most of the contamination cases occur at areas with high water tables or near water bodies when the sewage has shorter retention time in the soil. Due to the density of development, this is more of a concern in urban areas. Phasing out of pit latrines in these areas will assist in significantly improving the current water quality. In rural areas, careful consideration needs to be given for the placement of pit latrines in order to minimise the associated risks.
- **Semi-centralised sewerage systems efficiency** - Many of these systems have functional problems such as; clogging and broken aerators. In addition to this the quality of the effluent discharge does not complying with national standards.
- **Sludge waste** - The new WWTP should make provision for receiving sludge from exhauster trucks. The City should encourage converting the sludge into biofuels, as done at the Pivot Plant.
- **Faecal sludge management** - Removal services should be improved in unplanned settlements by upscaling the eVac services and regulating manual emptiers to avoid illegal dumping of sludge. Standards should be established for containment, emptying and transportation of sludge.
- **Technical experience** - A capacity development programme will need to be put in place to train CoK staff in terms of managing, operating and maintaining sewerage systems and waste water treatment plants.
- **Tariffs -** There is no tariff structure currently in place for sanitation services.
- **Environmental concerns of location of the centralised STPs** - The sites that is currently being considered are susceptible to flooding and are an environmental concern due to being placed in wetlands. Detailed environmental studies will need to be done in order to propose mitigation methods to limit the negative impact on the environment and water quality.
- **Bylaws and regulations** – Waste water treatment to ensure that developers apply the City By-laws and regulations to be prepared for the correct technical standards to their developments

- **Solid waste Management In Kigali city**

Solid waste management in the City of Kigali is undertaken by the Infrastructure Department of the City. Even though Kigali is known to be one of the cleanest cities in Africa, there is currently no Solid Waste Master Plan / Management Plan for the city. Some of the key issues to be addressed by the City relating to solid waste management are discussed below. Recommendations to address these issues have been made by the project team and are presented later in this report.

- **Implementation of regional landfill and recycling facility** - As raised in the 2013 Master Plan, the site that is currently being considered by the City has several limitations such as its proximity to the City Centre and Nyabarongo River, one of City's main water sources. Higher priority needs to be given to this project. Ideally the landfill site should be located away from the population. It should be properly lined to prevent the leachate from infiltrating and contaminating the ground, with a monitoring protocol.

- To increase the life span of the landfill, waste recycling should be encouraged at various stages before disposal at the landfill.
- **Close Nduba landfill** - The current Nduba landfill, which was only for temporary use should be closed and the appropriate rehabilitation steps taken.
- **Waste management plan** - CoK to develop a waste management plan.
- **Waste unit** - A waste unit department to be established in CoK to manage, monitor and implement the waste management plan.
- **Separation at source** - A "separation- at-source" programme should be developed with supporting infrastructure.

Household collection issues includes:

- **Frequency of removal** is not in-line with the rate of waste generation. Transfer stations are required to reduce the collection time and increase frequency of collection. The types and sizes of collection vehicles are not always appropriate for the areas in which they operate. CoK does **not have sufficient capacity to monitor vehicles in terms of trips/ movement and weight.**
- **Transfer of Waste** – The travel time between the collection points and the dumpsite can take up to 1.5 hours per trip (one-way), to cover 25-30 km. This results in the need for more trucks / collection vehicles

Table 35: Estimation of solid waste in Kigali City

Sector	2018 Waste Generation (t/day)	2050 Waste Generation (t/day)
Gitega	39.003	7.675
Kanyinya	16.592	19.291
Kigali	30.913	52.778
Kimisagara	37.741	8.448
Mageregere	28.606	80.969
Muhima	23.077	20.297
Nyakabanda	23.407	11.304
Nyamirambo	29.369	48.607
Nyarugenge	20.269	20.945
Rwezamenyo	12.387	12.326
Bumbogo	33.518	102.283
Gatsata	30.968	9.787
Gikomero	22.072	9.708
Gisozi	13.883	47.112
Jabana	39.039	40.975
Jali	29.736	22.006
Kacyiru	27.433	32.578
Kimihurura	16.412	18.161
Kimironko	33.094	89.926
Kinyinya	19.917	146.035
Ndera	36.875	247.498
Rutunga	25.807	19.152
Kanombe	37.283	144.533
Nduba	33.110	34.932
Remera	22.145	54.173
Rusororo	38.570	215.546
Gahanga	28.737	213.341
Gatenga	29.837	50.083
Gikondo	15.081	18.907
Kagarama	12.653	66.290
Kicukiro	16.718	16.034
Kigarama	35.846	33.282
Masaka	36.620	278.527
Niboye	30.482	39.614
Nyarugunga	26.978	73.714
Total	**954.179**	**2307.384**

Source: Kigali Urban Development Master Plan (2050).

- **Storm Water Management**

The adequate management of storm water within a city is critical to reduce property damage, erosion, flooding, pollution and many other environmental and health and safety issues. The storm water drainage system in the City of Kigali is constructed and maintained by the Infrastructure Department of the City. This

City plays a reactive role by identifying flood- prone areas, but there is no existing Storm water Management Plan and no modelling is done. A need has been identified for a full scale storm water master planning study to be conducted by the city. The study should include the creation of a detailed hydrological model for the city, in order to obtain the information required to inform a storm water master plan. The Master Plan should consider the flood line results in order to inform land use around all natural watercourses.

Some of the key issues to be addressed by the City relating to storm water management are discussed below. Recommendations to address these issues have been made by the project team and are presented later in this report.

- **Storm water and wastewater not separated** – The water in the public drains is contaminated by the sewer, in turn affecting the quality of the receiving water bodies. To resolve this issue, close coordination with the implementation of the sanitation policy is required and proper sewage treatment system is necessary.
- **Maintenance and upgrading of the damaged channels** - Damaged channels will not function at their optimum design capacity, which may cause localised flooding in the event of heavy rains. The City has to conduct regular checks and maintenance of the existing drains to ensure that they are in good condition.
- **Lack of storm water management -** The City has a high rainfall annually generating large storm water volumes, this should be seen as a resource to be valued and utilised. With proper storm water management, it could be harvested for non-potable use such as landscape irrigation and general area washing. Besides, providing an additional water resource, proper storm water management (e.g. rainwater harvesting and storm water retention) would also help to reduce flood risks.
- **Lack of proper drainage design guideline** - Without a standard local design guideline, there is no common basis for designing drains in new developments or for verifying the adequacy of the drainage capacities of the receiving drains and canals. With the rapid urbanization process, and for proper development control; a local standard guideline with relevant rainfall data should be established.
- **Erosion at the areas with steep slopes** - The Gikondo Industrial Area is an example of a problematic area. The government has been relocating the industrial zone since 2013 to the newly established SEZ in Gasabo, however this is not complete due to lack of funding. The slopes result in the eroded soil ending up in the water courses and water bodies, thus reducing the drainage capacity and polluting the water environment. Earth control measures such as afforestation, soil terracing, contour farming, etc. should be implemented to minimise soil erosion.
- **Need for policy** - CoK should develop a policy to deal with on-site attenuation for short-duration, high-intensity storms. This policy should also deal with excess storm water runoff that cannot be viably contained and how this should be accommodated by downstream landowners.
- **Building plan approval -** The approval process should include a storm water management plan that addresses how storm water will be controlled on the site and points out the areas downstream of the site that could potentially be affected.
- **Relocation in high risk zones:** It should be reinforced that people settling in high risk zones such as wetlands, floodplains, and steep slopes (30% +) should be relocated

4.2.11. Water balance in area covered by Master Plan

Kigali City and its surrounding is located in Lower Nyabarongo Catchment (NNYL). Water resources in this catchment is being used by various sectors such as water supply, irrigation, coffee washing, mining, hydropower station and so on. However, quantified information of current water resources utilization by sector is limited due to unregulated water use and lack of the inventory of water use. The next table presents registered water users in the project area.

Table 36: Registered Water Users of three catchments in 2019

No	Water User	Amount allocated (m^3/day)
1	Irrigation	85,747
2	Hydropower station	51,840
3	**Water Supply**	**269,901**
4	Mining	1,242
5	Other(Coffee washing station, Fish ponds)	48,747
Total		**457,478**

Source: JST

From the above table it can be seen from the table that water supply is main water user and occupies nearly 60% of total registered water at the combined three catchments. Renewable water source in three catchments

is estimated as 3,988,521 m^3/day. This means that more than 11% of renewable water source at three catchments is already registered by users.

In addition to the present water use, water demand projection by the above sectors isn't studied well. In Kigali, there is no study regarding water use and water demand projection by sector has been done as well. Water balance and future water demand of Level 1 catchments was studied and described in National Water Resources Master Plan (NWRMP) (2014). A part of those of Level 2 catchments is studied by the Ministry of Environment (2018) and RWFA (2020 on going).

Thus, present and future water balance by all sectors in Project area will be explained by using those available data. Results of water balance of a scale of L1 catchments shown at NWRMP (2015) is different from that of a scale of L2 catchments carried out recently For example, water inventory by NWRMP was carried out in 2012. On the other hand, the studies of L2 catchments management are conducted recently (2019-on going). In addition, change of land use obviously affect water resource's generation and gives impact of amount of renewable water resource at the catchment. This also causes the discrepancy of the result between them. Moreover the water demand projection for Kigali water supply carried out by Project is not reflected in those studies.

- **Water Balance and Water Demand at Level 1 Catchment**

Water Balance (water availability minus water use) of Level 1 catchments is included in NWRMP. Project area is contained as a part of Nyabarongo Lower Catchment (NNYL) and Akagera Upper Catchment (NAKU).

Table 37: Water Balance of Two Level 1 Catchments (2012)

Name of the catchment	Code	Renewable water source(m^3/year)	Water supply use (m^3/year)	Irrigation water use (m^3/year)	Total water use (m^3/year)	% of total water use over resource
Nyabarongo Lower	NNYL	899,000,000	11,983,000	7,983,000	19,966,000	2.22%
Akagera Upper	NAKU	504,000,000	9,776,000	16,034,000	25,810,000	5.12%

Source: NWRMP, 2014. Renewable water source means average rainfall – evaporation and plant transpiration at catchment area

At NNYL, water use is just over 2% of the annually renewable sources. At NAKU, it is about 5%. This is higher than that of the other catchments in Rwanda. At NNYL, water supply use is higher than irrigation use due to the water use of Kigali.

Unadjusted and adjusted water demands in 2040 were also estimated at NWRMP. In unadjusted demand, projected demand is based on population and indicators (irrigation area, energy production, number of cattle etc.) which are applied uniformly for all catchments and no consideration is given to actual resource availability for this demand. On the other hand, water demand in each sector is reviewed and adjust when necessary in adjusted water demand.

Amount of irrigation water changes significantly after adjusting and reduced to avoid the over exploitation of water resources. At adjusted water demand, total water consumption by all sectors in 2040 becomes 51% at NNYL and 65% at NAKU. This means that water resources will be consumed widely in future due to the high water demand

Table 38 : Water Balance Projection in 2040 at NNYL

	Nyabarongo Lower (NNYL)			
	Unadjusted water demand (m^3/year)	**% of water use over renewable water source**	**Adjusted water demand (m^3/year)**	**% of water use over renewable water source**
Water supply (Urban and Rural)	170,810,000	19	170,810,000	19
Irrigation	368,590,000	41	215,760,000	24
Industry	53,940,000	6	35,960,000	4
Mining	17,980,000	2	17,980,000	2
Livestock			8,990,000	1
Fish ponds			8,990,000	1
		68		**51**

Source: NWRMP

Table 39 :Water Balance Projection in 2040 at NAKU

Water Use	Akagera Upper (NAKU)			
	Unadjusted water demand (m3/year)	% of water use over renewable water source	Adjusted water demand (m3/year)	% of water use over renewable water source
Water supply (Urban and Rural)	90,720,000	18	90,720,000	18
Irrigation	463,680,000	92	196,560,000	39
Industry	25,200,000	5	15,120,000	3
Mining	10,080,000	2	10,080,000	2
Livestock	5,040,000	1	5,040,000	1
Fish ponds	10,080,000	2	10,080,000	2
		120		**65**

Source: NWRMP

It is concluded in NWRMP that the catchment's own renewable resources are sufficient to water demand over the next thirty years or so at the scale of the Level 1. In addition it is recommend in the NWRMP that comprehensive monitoring of actual water use and renewable resources are needed. Water source inventory and water demand projection was conducted in 2012. Therefore this demand projection may not be valid at the present situation. It is obvious that water amount used by Kigali water supply is underestimated.

- **Water Balance and Future Water Demand at Level 2 Catchment**

Level I catchments can be divided into Level 2 Catchments (Sub-Catchments). Two level 1 catchments in Project area have the following four sub-catchments (Level 2 catchments).

Table 40 :Name of Level 2 Catchments under NNYL and NAKU

Name of the level 1catchment	Code	Name of the level 2 catchment	Code	Area (km^2)
Nyabarongo Lower	NNYL	Nyabugogo	NNYL_1	1,540
		Mambu/ Base	NNYL_2	1764
Akagera Upper	NAKU	Mugesera/Sake	NAKU_1	1,888
		Rweru	NAKU_2	

Source: JST, Project area is 1,129 km^2

Within the four catchments, three catchments, NNYL_1, NNYL_2, and NAKU_1 contain the Project area. At the moment, water balance study is carried out at only Nyabugogo catchment (NNYL_1) and Mugesera/ Sake catchment (NAKU_1).

- **Nyabugogo catchment (NNYL_1)**

Nyabugogo catchment management plan (2018) was formulated by the Ministry of Environment. Table 28 shows the water use of each sector. It shows that 8% of renewable water source is used at the catchment. This means Nyabugogo catchment currently provide enough water to satisfy the demand. It is higher usage than NNYL Level 1 catchment estimated in NWRMP. Irrigation has higher water consumption than other sectors and water supply comes second. Renewable water source is estimated 463 MCM/year. Catchment management plan mentioned that manageable water in surface water body and groundwater is very limited. Water balance projection in 2050 shows 45% of renewable water source at the catchment is used.

Table 41:Water Balance of Nyabugogo Catchment

Water use	2018		2035		2050	
	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source
Irrigation	18,493,500	4.0%	55,658,160	12.0%	117,795,032	25.4%
Domestic Water supply	9,276,360	2.0%	27,829,080	6.0%	51,395,886	11.1%
Industry	4,638,180	1.0%	13,914,540	3.0%	29,113,502	6.3%
Livestock	4,638,180	1.0%	6,493,452	1.4%	12,067,208	2.6%
		8.0%		**22.4%**		**45.4%**

Source: Nyabugogo catchment management plan, water balance projection in 2035 is not available in this study and estimated by JST using data of 2018 and 2050.

- **Mugesera / Sake catchment (NAKU_1)**

The catchment study is on-going by RWFA. Renewable water source of this catchment is estimated 557 MCM/year. Water balance study shows 8.8% of renewable water source in the catchment was used in 2019.

Table 42 : Water Balance of Mugesera / Sake Catchment

Water use	2019		2035		2050	
	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source	Water demand (m^3/year)	% of water use over renewable water source
Irrigation	22,203,300	4.0%	83,529,000	15.0%	144,192,200	25.9%
Water supply	17,716,200	3.2%	38,980,200	7.0%	56,740,900	10.2%
Industry	36,000	0.01%	278,430	0.05%	684,000	0.1%
Fish ponds	351,600	0.1%	556,860	0.1%	448,000	0.1%
Livestock	8,514,200	1.5%	11,137,200	2.0%	16,273,900	2.9%
Mining	178,600	0.03%	167,058	0.03%	237,700	0.04%
Coffee washing	10,100	0.002%	16,706	0.003%	22,400	0.004%
		8.8%		**24.2%**		**39.3%**

Source: RWFA, water balance projection in 2035 is not available in the study and estimated by JST using data of 2019 and 2050.

Proportion of water consumption by all sectors against renewable water source at this catchment is very similar to that of Nyabugogo catchment. This may indicate that these two catchments have similar natural and social environments of water consumption. Water use by sectors in 2050 is around 40% of renewable water source at the catchment. It is lower than that of Nyabugogo catchment. Moreover, this value (40%) is relatively small compared with that of Level 1catchment (NAKU) at the NWRMP. It also indicated that water consumption by irrigation will become very large portion of renewable water source in 2050 and it is more than 6 times than present use at a scale of Level 2 catchments.

- **Comparison with demand projection by Kigali Water Supply Master Plan**

Water balance studies at Level 2 catchment indicate that 22-24% of renewable water source at catchment is used by all sectors in 2035 and 40% to 45% in 2050. Water consumption by water supply (urban and rural) is 6% to 7% of renewable water source in 2035 and 10% to 11% of that in 2050. However these water demand prediction of water supply does not include the result of study of Kigali Water Supply MP. Water demand projection for water supply in Kigali indicated the amount of 335,000 m3/day will be needed by 2035 and 1,070,000 m3/day by 2050 to meet the water demand in Kigali.

Table 43 : Comparison of Water Supply Demand by Catchment Study and Master Plan Study

Category	2035	2050
Water demand by water supply (urban and rural) at three catchment (m^3/day)[1]	279,196	398,852
Water demand by water supply at Kigali estimated by Kigali Water Supply MP (m^3/day)	335,000	1,070,000
Proportion of amount of water needed in Kigali against total amount of water supply at three catchments	120%	268%

Source: JST, 2020

Water Resources Master Plan Table shows that amount of water supply estimated in three catchments is much smaller than that in Kigali. This means that water demand projection of water supply is obviously underestimated at the Level 2 catchment studies. In order to adjust this, water balance at three catchments in 2035 and 2050 is revised and shown in Table 34. It is assumed that 30% of total amount of water supply in three catchments is derived from Kigali. It can be seen that total water use in 2035 at three catchments is around 30% of renewable water source and water use in 2050 becomes 68%. Due to the high usage of water in Kigali, water demand by water supply (urban and rural) in three catchment becomes higher than irrigation in 2035 and 2050. Revised amount of total water demand in 2035 and 2050 is still within the limit of renewable water source. However in order to avoid the over exploitation of water resources in the catchments, efficiency of water use must be improved. Comprehensive monitoring of actual water use and renewable resources will be required.

Table 44: Estimated Water Balance at combined three L2 catchments (NNYL_1 and 2, NAKU_1)

	2035		2050	
	Water demand (m^3/day)	% of water use over renewable water source	Water demand (m^3/day)	% of water use over renewable water source
Irrigation	478,623	12.0%	1,037,015	26.0%
Water supply except Kigali	195,438	4.9%	279,196	7.0%

[1] It is assumed 7% of renewable water source at three catchment in 2035 and 10% in 2050.Renewable water source of three catchment is estimated as 1,456 MCM/year in total which 463 MCM/year at Nyabugogo, 557 MCM/year at Mugesera / Sake., 436 MCM/year at Mambu / Base, Renewable water source of Mambu/ Base is not available then used that of Nybarongo Lower (L1) minus Nyabugogo (L2).

	2035		2050	
	Water demand (m^3/day)	% of water use over renewable water source	Water demand (m^3/day)	% of water use over renewable water source
Kigali water supply(domestic use)	335,000	8.4%	1,070,000	26.8%
Industry	119,656	3.0%	239,311	6.0%
Livestock	39,885	1.0%	79,770	2.0%
Total	**1,168,601**	**29.3%**	**2,705,293**	**67.8%**

Source: JST, renewable water source in three catchments is estimated 1,456 MCM/year (3,988,521m^3/day)

This is very rough estimation since no study regarding WRM in Kigali is conducted. However this information is very useful and give degree of impact of Kigali water supply to renewable water resource at the catchment level.

4.2.12. Countermeasures against Climate Change

Climate change can cause reducing the availability of water resources and difficulty of water usages. The master Plan analysed the effect of climate change on water resources development scenario and the next tables summarizes vulnerability of water resources against climate change and countermeasures.

Table 45: Vulnerability of Water Resources against Climate Change

Water Source	Vulnerability against climate change	Reason	Countermeasures
Rivers	High	Reducing rainfall cause the change of river flow rate and river stage immediately, In addition, high rainfall cause the flood and damage of intake area	In case of low flow rate, water use efficiency must be increased. Also in order to avoid the damage from flood, intake point should be constructed at higher ground.
Springs	High	Reducing rainfall cause the change of spring flow rate immediately.	Use the alternative water sources such as groundwater or lake which are less vulnerable to the climate change. Since the total amount of spring water is smaller than the other water sources.
Groundwater	Middle	Reducing rainfall cause less yield. However it may take some time due to the storage capacity of aquifer. Well fields will be submerged in the water in case of heavy rainfall.	
Lakes	Middle	Reducing rainfall cause the lowering of lake water level, Due to the storage capacity of Lake, lake is thought to be less vulnerable than river and spring.	

Source: JST, 2020

4.3. Ecological and biological characteristics

The baseline data information on biological characteristics were primarily investigated through desk review, sites visits, photographic capture and direct public consultation interviews with the interested and involved stakeholders. We provided the description of fauna and flora that present birds, amphibians, insects, Reptiles, mammals, natural tress, crops, planted trees at the project area. The IUCN Red List of Threatened Species, version 2019-1 (IUCN, 2019) was used to assess the conservation status of identified species.

4.3.1. Key biological habitat in project area

Rwanda lies in the western part of a rift valley known as the Albertine Rift, one of the most biologically diverse regions in Africa. As of 2010, there were 402 species of mammals, 1,061 species of birds, 293 species of reptiles and amphibians and 5,793 plant species in this region (UNEP 2010).Deforestation, cultivation and urbanisation in and around Kigali, however, have led to the serious destruction of wildlife biodiversity and the city no longer enjoys the same magnitude of biodiversity as the nation as a whole. Where some natural habitat remains, there are species of birds and reptiles, hares, jackals and a few species of snakes and fishes and CoK greening efforts have brought more trees and flowers along the roadsides.

Wetlands along Nyabarongo River have been designated as an Important Bird Area (IBA) as it serves as a hotspot for diverse species of migratory and congregators birds annually. Four wetlands (Kitagurizwa, Rugende- Isumo, Nyabarongo- Aval and Nyabarongo- Amont) within Kigali City are to be designated as Ramsar Sites, and thus recognized and protected as wetlands of international importance. The next figure present key biological habitat in Kigali and its surroundings.

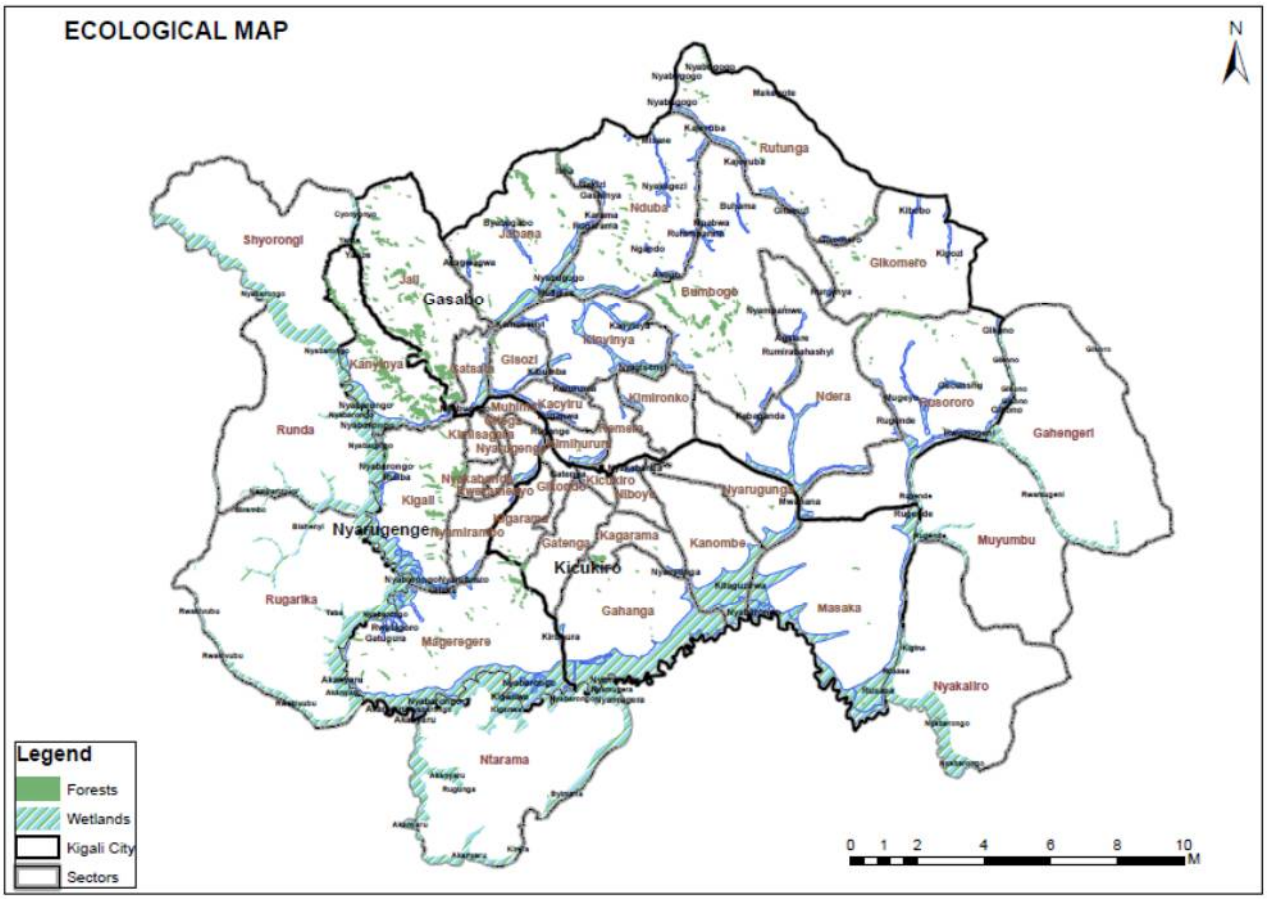


Figure 11: The ecological map of the study area
Source: BESST LTD, 2020

4.3.2. Fauna

Animal biodiversity in Kigali City and its surroundings includes amphibians, birds, fish, mammals, reptiles and insects. Lake Muhazi has three known endemics and nine introduced species, 47 species of phytoplankton and 11 orders of insects, as well as invertebrates and annelids, among others..

- **Amphibians**

Table 46: List of amphibians found at the site

№	Common name	Vernacular Name	Scientific name	Order	Family	IUCN Conservation Status	Type
1	Bocage's Tree Frog	Igikeri	Leptopelis bocagii	Anura	Arthroleptidae	Least Concern	Native
2			Hyperolius lateralis	Anura	Hyperoliidae	Least Concern	Native
3	Grandison's ridged frog	Igikeri	Ptychadena grandisonae	Anura	Ptychadenidae	Least Concern	Native
4	Secteur Munsenene Reed Frog	Umutubu	Hyperolius lateralis	Anura	Hyperoliidae	Least Concern	Native
5	Angola Toad	Igikeri	Sclerophrys funerea	Anura	_Bufonidae	Least Concern	Native
6	Eastern Flat-backed Toad	Umutubu	Sclerophrys pusilla	Anura	Bufonidae	Least Concern	Native
7	Kivu Reed Frog	Umutubu	Hyperolius kivuensis	Anura	Hyperoliidae	Least Concern	Native
8	Waterlily reed frog	Umutubu	Hyperolius microps		Hyperoliidae	Least Concern	Native
9	Senegal Kassina	Igikeri	Kassina senegalensis	Anura	Hyperoliidae	Least Concern	Native
10	Christy's Tree Frog	Igikeri	Leptopelis christyi	Anura	Phrynobatrachidae	Least Concern	Native
11	Bocage's Tree Frog	Igikeri	Leptopelis bocagii	Anura	Phrynobatrachidae	Least Concern	Native
12	Sharp-nosed Ridged Frog	Igikeri	Ptychadena oxyrhynchus		Ptychadenidae	Least Concern	Native
13	Mwanza Frog	Umutubu	Xenopus victorianus	Anura	Arthroleptidae/ Pipidae	Least Concern	Native

Source: BESST LTD Survey, 2019, IUCN Conservation Status list


Secteur Munsenene Reed Frog

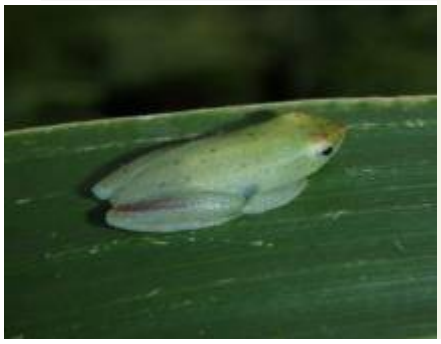

Bocage's Tree Frog


Grandison's ridged frog


Angola Toad


Eastern Flat-backed Toad


Kivu Reed Frog


Waterlily reed frog


Senegal Kassina


Sharp-nosed Ridged Frog

- **Birds**

The project area does not fall into critical habitat areas and the project is not located within a legally protected area however, has the Nyabarongo wetland, which is an Important Birds Area (IBA). The Nyabarongo Wetland receives an exceptionally large number of migratory and congretory birds every year, but rice and sugarcane plantations, which dominate the city's wetlands and low-lying areas in river floodplains, have contributed to biodiversity loss. Overall, 13 birds species were found. These are divided in 5 orders and 9 Families. Detailed bird species identified in the project area is presented in annex 6.

Table 47: Dominant birds' species identified in the study area with their IUCN conservation status.

No	Order	Family	Common Name	Vernacular Name	Scientific Name	IUCN status
1	Gruiformes	Gruidae	Grey-crowned Crane	Umusambi	Balearica regulorum	Endegered
2	Passeriformes	Ploceidae	Black-Headed Weaver		Ploceus melanocephalus	Least Concern
3	Charadriiformes	Charadriidae	Black-Headed Heron	Uruyongoyongo	Ardea melanocephala	Least Concern
4	Passeriformes	Motacillidae	African-Pied Wagtail	Inyamanza	Motacilla aguimp	Least Concern
5	Passeriformes	Ploceidae	Slender-Billed Weaver	Isandi	Ploceus pelzelni	Not assessed
6	Passeriformes	Nectariniidae	Olive-Bellied Sunbird		Cinnyris chloropygia	Least Concern
7	Pelecaniformes	Ardeidae	Cattle Egret	Inyange	Bubulcus ibis	Least Concern
8	Pelecaniformes	Threskiornithidae	Hadada Ibis	Nyirabarazana y'inkara	Bostrychia Hagedash	Least Concern
9	Accipitriformes	Accipitridae,	Black Kite	Sakabaka	Milvus migrans	Least Concern
10	Columbiformes	Columbidae	Red-eyed Dove	Inuma	Streptopelia semitorquata	Least Concern
11	Passeriformes	Viduidae	Pin-tailed Whydah		Vidua macroura	Least Concern

No	Order	Family	Common Name	Vernacular Name	Scientific Name	IUCN status
12	Passerine	Pycnonotidae	Common Bulbul		Pycnonotus barbatus	Least Concern
13	Galliformes	Phasianidae	Domestic Chicken	Inkoko	Gallus gallus domesticus	Least concern
14	Passeriformes	Passeridae	Grey-headed Sparrow	Igishwi	Passer griseus	Least Concern
15	Passeriformes	Fringillidae	Yellow-fronted Canary		Serinus mozambicus	Least Concern

Source: BESST LTD Survey, 2019, IUCN Conservation Status list

Grey-crowned Crane

Black Kite

Black-headed Heron

Hadada Ibis

Cattle Egret

Red-eyed Dove

Pin-tailed Whydah

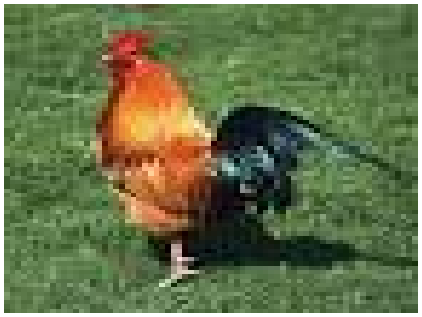
Black-headed Weaver

Common Bulbul

African-Pied Wagtail

Slender-Billed Weaver

Olive-Bellied Sunbird



Domestic chicken

Grey-headed Sparrow

- **Fish**

Fish species were found identified in Nyabarongo and Muhazi lake and fish farming ponds. Key species reported by fishermen include smooth-head Catfish (Clarias liocephalus) locally known as **Inshonzi**, Lungfish (Protopterus aethiopicus) which are locally known as **Imamba** and Tilapia (Oreochromis niloticus).

Table 48: Fish species identified in the project area

No	Species	Type	IUCN Red list category
1	Oreochromis niloticus	Indigenous in East Africa (Exotic, introduced from Lake Edward)	LC (Least Concern)
2	Tilapia rendalli	Indigenous	LC (Least Concern)
3	Haplochromis vittatus	Indigenous	LC (Least Concern)
4	Haplochromis crebidens	indigenous	LC (Least Concern)
5	Haplochromis insidiae	Indigenous	LC (Leas Concern)
6	Haplochromis erythromaculatus	Indigenous	EN (Endangered)
7	Pseudocrenilabrus multicolor	Indigenous	LC (Least Concern)
8	Clarias gariepinus	indigenous (potential pest)	LC (Least Concern)
9	Clarias liocephalus	Indigenous	LC (Least Concern)
10	Shilbe intermedius	Indigenous of Lake Ihema	LC (Least Concern)
11	Barbus cercops	Indigenous	LC (Least Concern)
12	Protopterus aethiopicus	Indigenous in East Africa, (Exotic, introduced from L. Edward), invasive	LC (Least Concern)

Source: BESST Ltd Survey, 2019, IUCN Conservation Status list

Protopterus aethiopicus

Oreochromis niloticus (Tilapia)

Clarias gariepinus (Inkube)

- **Mammals**

There are two endangered mammals under 2019 IUCN Red list Common Hippopotamus Hippopotamus amphibious and Sitatunga Tragelaphus spekii due to poaching, habitat degradation and poor quality of the habitat. And some small mammals exist such as hares (Oryctolagus cuniculus), hedgehogs, Civettictis civetta (impimbi), crocodile Crocodylus niloticus.

Hippopotamus amphibious

Tragelaphus spekii (Sitatunga)

Table 49: Domestic mammal species

No	Common name	Vernacular Name	Scientific name	Order	Family	Type
1	Cow	Inka	Bos Taurus	Artiodactyla	Bovidae	Livestock
2	Goat	Ihene	Capra aegagrus hircus	Artiodactyla	Bovidae	Livestock
3	Sheep	Intama	Ovis aries	Artiodactyla	Bovidae	Livestock

Source: BESST Ltd survey, 2019, IUCN Conservation Status list

- **Reptiles**

The following table presents few reptiles identified in the projects area and are mainly founds in wetlands and residual forest found in Kigali and its surroundings.

Table 50: List of reptiles found in the area

№	Common name	Scientific name	Family	Order
1	Egg-eating Snake	Dasypeltis scabra	Colubridae	Squamata
2	Angolan Shovel-snout	Prosymna ambigua	Lamprophiidae	Squamata
3	Olive Marsh Snake	Natriciteres olivacea	Colubridae	Squamata
4	Common Slug-eater	Duberria lutrix	Lamprophiidae	Squamata
5	Black Mamba	Dendroaspis polylepis	Elapidae	Squamata
6	Mwanza Flat-headed Rock Agama	Agama mwanzae	Agamidae	Squamata
7	Sparse-scaled Forest Lizard	Congolacerta vauereselli	Lacertidae	Squamata
8	Cape File Snake	Limaformosa capensis	Lamprophiidae	Squamata
9	Common Bush Snake	Philothamnus irregularis	Colubridae	Squamata

Source: BESST Ltd survey, 2019, IUCN Conservation status list

Kivu Blue-headed Tree Agama

Montane Side-striped Chameleon

African Striped Skink

Jackson's Forest Lizard

Tropical House Gecko

Olive Marsh Snake

- **Insects**

Table 51: List of insect found in the area

No	Common name	Vernacular Name	Scientific name	Order	Family	IUCN Conservation Status
Butterflies						
1	African swallowtail	Ikinyugunyugu	Papilio dardanus	Lepidoptera	Papilionidae	-
2	Mackinnon's swallowtail	Ikinyugunyugu	Papilio mackinnoni	Lepidoptera	Papilionidae	-
3	African Migrant	Ikinyugunyugu	Catopsilia florella	Lepidoptera	Pieridae	-
4	Sulphur Orange Tip	Ikinyugunyugu	Colotis aurora	Lepidoptera	Pieridae	-
5	Regular Grass Yellow	Ikinyugunyugu	Eurema regularis	Lepidoptera	Pieridae	-
6	Eastern Swamp Dotted Border	Ikinyugunyugu	Mylothris rubricosta	Lepidoptera	Pieridae	-
7	Friar	Ikinyugunyugu	Amauris niavius	Lepidoptera	Nymphalidae	-
8	Anal-patch Bush Brown	Ikinyugunyugu	Bicyclus analis	Lepidoptera	Nymphalidae	-
9	Danaid Eggfly	Ikinyugunyugu	Hypolimnas misippus	Lepidoptera	Nymphalidae	-
10	Dancing Acraea	Ikinyugunyugu	Acrea serena	Lepidoptera	Nymphalidae	-
Damesflies and Dragonflies						
1	Banded Groundling	Helicopteri	Brachythemis leucosticte	Odonata	Libellulidae	Least Concern
2	Banded Groundling	Helicopteri	Brachythemis impartita	Odonata	Libellulidae	Least Concern
3			Ceriagrion glabrum	Odonata	Coenagrionidae	Least Concern
Criquets						

No	Common name	Vernacular Name	Scientific name	Order	Family	IUCN Conservation Status
1	Migratory locust	Injereri	Locusta migratoria	Orthoptera	Acrididae	Least Concern
2	Red locust	Injereri	Nomadacris septemfasciata	Orthoptera	Acrididae	
3	Tree locust		Anacridium wemerelium	Orthoptera	Acrididae	
4	Tree locust		Anacridium melanorhodon	Orthoptera	Acrididae	
5	Tree locust		Anacridium moestum	Orthoptera	Acrididae	
Bees and wasp						
1	Honey Bee	Uruyuki	Apis sp	Hymenoptera	Apidae	
2	Wasp	ivubi		Hymenoptera	Vespidae	

Source: BESST Ltd survey, 2019, IUCN Conservation status list

Papilio dardanus

Catopsilia florella (male)

Catopsilia florella

Amauris naivius

Anal-patch Bush Brown

Locusta migratoria

Ceriagrion glabrum

Palpopleura lucia

Brachythemis leucostica

4.3.3. Flora

Forest and natural vegetation are disappearing in Kigali City and its surroundings dure to the urban development and agro pastoral activities (e.g. burning of forest and vegetation). In areas where forests have been reforested, native forests have been replaced by planted forests of non-native Eucalyptus and Pine species, grown for agro-forestry or for slope protection and erosion control. Other commonly planted tree species in Kigali include timber species such as Grevillea robusta, Vernonia amygdalina, Euphorbia tirucalli, Cupressus, Acanthus Pubescens, and Ficus thonningii and horticultural species such as Persea gratissima, Psidiumguajava, Capsicum frutescens, Caric, Coffee, Banana and Papaya trees. Most natural forests in the City are owned and managed by the central government, while forest plantations are either privately owned or under district government land.

Native tree species and flora remain only in small patches in the city. Natural vegetation of Kigali's wetlands has similarly been cleared to make way for cultivated species, while remaining areas of natural vegetation transition to fewer species with the changes in hydrology and the inflow of polluted, sediment and nutrient rich waters draining from the catchment.

The plant diversity at the project site is made by crop, shrubs, native and planted trees. Crop land is dominated by large scale rice, maize fields with bean, cassava, banana and perennial species on hills and wetland. Residual species are found in various places, with some exotic plant species including timber trees such as Grevillea robusta (Gereveriya) and Eucalyptus sp (Inturusu), shrubs like Senna, spectabilis (Gasiya),

Lantana camara (Umuhengeri), Ricinus communis and fruit trees like Mangifera indica (Imyembe) and Persea americana (Avoka). Following photos present some plant species in the project area and the list of key flora species identified in the study area are presented in annex 7.


Bamboo spp


Ficus spp


Markhamia spp


Maesopsis eminii


Erythrina abyssinica


Brachychiton acerifolius


Senna spectabilis


Delonix regia


Jacaranda mimosefolia


Araucariria heterophylla


Syzigium sp


Prunus africana


Manguier


Tuja orientaris


Azadiracta indica


Cedrela Serrata


Grevielle Robusta


Alnus Acuminate


Mimosa Scabrella

Invasive spicies


Lantana camara


Eichhornia


Mimosa pigra


Pistia stratoites

4.3.4. Important ecosystem services

Water source development for Kigali water supply master plan include abstraction of water from Nyabarongo/Akagera rivers, groundwater from Akagera/Nyabarongo wetlands and lakes such as Mugesera and Muhazi. These ecosystems provide important ecosystem services for environmental conservation but also to the local communities. It is therefore important that water services development considers these ecosystem services and environmental flow is determined during feasibility studies and environmental impacts assessments.

Wetlands are mainly contributing to food provision, nutrient cycling and water balance regulation. Big wetlands such as Nyabugogo and Nyabarongo are occupied by sugar cane that is used for sugar production. Irrigated rice and vegetable patches are also extended to wetlands and the production is contributing in food provision for the city. Rivers and lakes direct valued uses include water supply, transportation, recreation, and fishing. Indirect valued uses include flood protection, nutrient recycling, genetic material, and wetlands. Existence services are river services that provide the needed habitat to allow current biological ecosystems and their species to thrive.

Key ecosystem services offered by targeted ecosystems in Kigali water Supply Master Plan include:

- **Regulating services**:
  - **Climate regulation**: Microclimate temperature, precipitation, temperature, and precipitation.
  - **Water purification and waste treatment**: Removal of nutrients, industrial pollution
  - **Flood control:** Holding of soil and sediments from surrounding hills;
  - **Pollination:** Habitat of pollinators such as bees and others insects
  - **Carbon sequestration**: absorb the carbon through photosynthesis and store it.

- **Provisioning services:**
  - **Food:** Production of fish and meats, vegetables, fruits, mushrooms, honey
  - **Fresh water:** For domestic use, irrigation, industries and construction
  - **Energy:** Firewood, peat, biomass, and hydropower and;
  - **Medicine:** Traditional from plants and animals.
  - **Transport::** Especially for lakes and river

- **Supporting services**:
  - **Soil formation**: Sediment retention and retention of organic matter
  - **Nutrient cycling**: Storage, recycling, processing, and acquisition of nutrients

- **Recreational area:**
  - **Opportunities for eco-tourism activities**.
  - **Educational:** Opportunities for education, training and research.

5. NATURE AND EXTENT OF IMPACTS ASSOCIATED WITH MASTER PLAN AND 15-YEARS INVESTMENT PLAN

This section presents the nature and extent of environmental and social impacts associated with priority development scenario identified with Water Supply Master Plan. It include scoping issues, presentation of water supply scenario as well as environmental and social impacts associated with each scenario.

5.1. Scoping issues

In general, water supply project is considered as relatively environmentally acceptable project. However, there are still possibilities of negative impact from water supply projects. Following table shows possible impacts by water supply project in the City of Kigali and adjacent 7 sectors and considerations for such project. The next table present the summary of the environmental issues associated with the proposed facilities based on the evaluation of proposed scenario.

Table 52: Scoping matrix for potential impacts of City of Kigali Water Supply Master Plan

SEA Issues/issue		Ground water Priority	Surface water Priority	Without Project	Remark
Socio-economic	Land availability/ land tenure	-	--	0	
	Economy	+/-	+/-	-	
	Livelihoods	+/-	+/-	-	
	Aesthetics	+/-	+/-	0	
	Health/safety	+/-	+/-	-	
	Archeological Resources	-	-	0	
	Historical/culture Resources	-	-	0	
	Crop & Livestock productivity	-	--	0	
	Resettlement	-	--	0	
	Infrastructures	+/-	+/-	0	
Atmosphere	Climate Change Risks	-	--	0	
	Adaptation/Mitigation to Climate Change	+/-	-	0	
	Air quality	-	--	0	
Biodiversity	Sensitive habitat	-	--	0	
	Protected areas	-	--	0	
	Fauna	-	--	0	
	Flora	-	--	0	
Water Resources	Endegered species	0	0	0	So far there is no endangered species identified.
	Water quality	-	--	0	
	Water quantity	-	-	0	
	Ground water	--	-	0	
	Flood damage mitigation	+/-	--	0	
	Climate change adaptation	+	-	0	
	Surface water	-	--	0	
Soil	Soil erosion	-	--	0	
	Soil pollution	-	--	0	
	Wetland degradation	-	--	0	
Transboundary	Water resources	-	-	0	
	Protected Ecosystem	0	0	0	No transboundary protected ecosystem to be affected
	People movement	+/-	+/-	0	
	Natural disaster	-	-	0	No transboundary natural disaster anticipated
Waste management	Solid waste	-	--	0	
	Liquid waste	-	--	0	
	Hazardous waste/Chemical waste	-	--	0	
Occupational health and Safety	Workers health and safety	-	-	0	
	Community health and safety	-	-	-	

+	Positive environmental and Social Impacts
0	No foreseen effects(Positive or Negative)
+/-	Potential positive and Negative impacts(Mixed Effect
-	Negative impacts/effects

Source: BESST LTD (prepared based on RWANDA SEA guidelines), 2019

5.2. Evaluation criteria for SEA

The performance of both the Kigali Master Plan is based on how both plans comply and meet National Development Policies, Financial Requirement and Operation Requirement and Environmental Policy Adaptation and Regulation Compliance and how they bridge gaps between Local Regulation and JICA's Guideline as well as international best practices. Therefore, the strategic Environmental Assessment ensures that the preparation and implementation of proposed investments under Master Plan is done in compliance with policy and environmental requirements.

5.2.1. National development policy requirement

The proposed Water Supply Master Plan falls under national development policy framework including vision 2050 aspiration , first national strategy for transformation, national water supply policy, national Integrated water resources Policy and Environmental Policy. Therefore, SEA evaluation ensures that the proposed investments under the Master Plan are in line with the objectives of the above development policies and meets their requirement in terms of water supply services, water resources management and environmental Protection.

These requirements include (i) priority to basic water services were each person and community has equal right to access basic water services, (ii) social inclusion where by all population groups, including vulnerable households, children, elderly and disabled persons benefit from water interventions, (iii) support the urbanization process by adequate service delivery, in a way that is well harmonized with urbanization planning and keeps pace with the rate of urbanization, (iv) ensure universal access to improved drinking water on premises as well as availability of safe water when needed, and (v) Environment and water resources protection by development water supply programs in close coordination with water resources management, based on an integrated approach and in compliance with environmental regulations and safeguards.

5.2.2. Environmental policy adaptation and regulations compliance

Water abstraction, treatment and distribution may cause environmental and social impacts and depends itself on environmental factors. The extent of impacts and related risks varies considerably with the scope and type of intervention. The strategic Environmental assessment ensures that the proposed Master Plan comply with relevant water resources and environmental laws of Rwanda as well as JICA guidelines for Environmental and Social Consideration. It sets up procedures and safeguards to make sure that all measures comply with the standards, permits and regulations defined by Ministry of Environment (MoE), and Rwanda Environmental management Authority (REMA) with respect to: (i) the rational and sustainable utilization of water resources; and (ii) environmental protection and conservation of water resources.

For medium to large-size projects, REMA requires an Environmental Impact Assessment (EIA). For smaller projects, the water sector will develop guidelines defining environmental safeguards, to be approved by REMA. For larger interventions, collaboration with REMA will also include monitoring of real impact during work and operations. Water-quality monitoring needs to be strengthened and the development of water safety plans should be promoted.

5.2.3. Gap analysis between JICA's guidelines and local regulations

Gap analysis between JICA's guidelines and National regulation indicated that there are no many gaps between them. Gaps identified include public consultation and information disclosure, eligibility criteria for affected people where the national regulations recognize only affected people with legal rights. In terms of resettlement, While JICA Guidelines requires the project proponents to explore alternatives that avoid or minimize resettlement impacts, the national regulations only require the provision of compensation. For environmental Categorization, while the JICA's categorization of projects is mainly based on potential impacts and sensitivity of hosting environment, the national categorization is mainly based on size of project. The SEA report provides mechanism to bridge these gaps during the implementation of Master Plan and proposed investments.

5.3. Assessment and comparison of Master Scenarios

In SEA (Strategic Environmental Assessment), it is important to evaluate "No Project" option as an alternative option of water supply scenario. In evaluation, each water supply scenarios were evaluated by following process.

- Evaluate "Without Project" option which is leave current situation as it is
- Compare alternative water supply scenario accordance with compliance to criteria

5.3.1. Brief presentation of Master Scenio

The "Master Scenario" developed by design team gives an overall scenario for water supply in the Study Area up to 2050, considering the water resources development plan, and appropriate transmission and distribution of water system to meet the future water demand. The Master Scenario is the basis of the 15-Year Investment Plan.

✓ **Master Scenario: The year 2025**

The Master Scenario in the year 2025 is determined as shown in the following figure. The master scenario simulation is planned based on the Contingency Scenario with the NRW 38.8% as well as the projected water demand under NRW 25%. The policy for the investment toward the year 2025 is as follows;

1) Accelerate NRW reduction measures to achieve WASAC's target (25%) progressively
2) Meeting the demand in the east: To construct a new WTP near the high demand area (the Sectors of Masaka, and Karenge) or transmit water from the Remera to the east

The on-going and additional facilities for 2025 is as shown in the following table.

Table 53: On-going Project and Additional Facilities for 2025

On-going Projects	
Rehabilitation of Nzove 1	+23,000 m^3/day (from 17,000 to 40,000 m^3/day)
Expansion of New Nzove:	+25,000 m^3/day (from 40,000 to 65,000 m^3/day)
Rehabilitation of Karenge WTP	+3,000 m^3/day (from 15,000 to 18,000 m^3/day)
Additional Facilities for 2025: +20,000 m^3/day (Total: 247,000 m^3/day)	
Masaka WTP and forwarding infrastructures	+20,000 m^3/day
NRW Reduction Measures	Phase 1 to 2

Source: JST. 2020

✓ **Master Scenario: The year 2035**

For Master Scenario 2035, additional facilities considred are presented in Table 54 below:

Table 54: Additional Facilities for 2035

Additional Facilities for 2035: +98,000 m^3/day	
Gahanga WTP	+40,000 m^3/day (New)
Masaka WTP	+20,000 m^3/day (Total: 40,000 m^3/day)
Karenge WTP	+33,000 m^3/day (Expansion plus Rehabilitation)
Small Scale WSS	+5,000 m^3/day (For remote areas: Rutunga, Gikomero)
Transmission and Distribution Pipelines for the abovementioned facilities: NRW Project: Phase 3 to 5	

Source: JST, 2020

✓ **Master Scenario: The year 2050**

The Master Scenario planning in 2050 is aimed at the determination of the mix of the water source by the given conditions as specified in the City of Kigali Masterplan. as show in the following figure. Additional facilities for the long term are shown in the following table.

Table 55: Additional Facilities for the Long Term (2050)

Additional Facilities for Long Term (2050) +754,000 m^3/day	
Nzove 3	+40,000 m^3/day (New)
Rutonde	+80,000 m^3/day (New)
Nyabarongo	+240,000 m^3/day (New)

Gahanga2	+240,000 m^3/day (New)
Masaka2	+80,000 m^3/day
Karenge	+50,000 m^3/day
Small Scale WSS	+10,000 m^3/day (For remote areas)
Transmission and Distribution Pipelines for the abovementioned facilities.	

Source: JST

Water Production Facilities The facilities to be constructed towards 2050 are listed in the following table.

Table 56: Water production Facilities to be constructed towards 2050

Name of Facilities	Descriptions
Existing Facilities: 162,000 m^3/day[*1]	
On-going Facilities: +65,000 m^3/day (Total: 227,000 m^3/day) [*2]	
Additional Facilities for 2025: +20,000 m^3/day (Total: 247,000 m^3/day) [*3]	
Additional Facilities for 2035: +98,000 m^3/day [*4]	
Gahanga WTP	+40,000 m^3/day (New)
Masaka WTP	+20,000 m^3/day (Total: 40,000 m^3/day)
Karenge WTP	+33,000 m^3/day (Expansion plus Rehabilitation)
Small Scale WSS	+5,000 m^3/day (For remote areas: Rutunga, Gikomero)
Transmission and Distribution Pipelines for the abovementioned facilities	
Additional Facilities for Long Term (2050) +754,000 m^3/day	
Nzove 3	+40,000 m^3/day (New)
Rutonde	+80,000 m^3/day (New)
Nyabarongo	+240,000 m^3/day (New)
Gahanga2	+240,000 m^3/day (New)
Masaka2	+80,000 m^3/day
Karenge	+50,000 m^3/day
Small Scale WSS	+10,000 m^3/day (For remote areas)
Transmission and Distribution Pipelines for the abovementioned facilities	

Source: JST

[*1]: Nzove 120,000 m^3/day, including the rehabilitation, Kimisagara 22,000 m^3/day, Karenge 15,000 m^3/day, and Small-Scale Water Sources 5,000 m^3/day.
[*2]: Kanzenze (Kigali Bulk Water Supply) 40,000 m^3/day, including the demand for Bugesera Airport (10,000m^3/day), which is out of the study area and New Nzove 1 expansion of 25,000 m^3/day.
[*3]: Masaka WTP 20,000 m^3/day

5.3.2. Process used to select Best master Scenario

To come up with the above Master Scenario, the Master Plan team evaluated multiple cases to adopt appropriate scenario towards 2050. This was done with the objective of determining the Master Scenario which gives the blueprint of the water supply area, water sources, treatment processes and water transmission methods, as the basis of the 15 years investment plan.

The method used consisted at:

- Plan the technical basis including efficient transmission method, water treatment processes and distribution areas and;
- Water balance model: Simulate transmission method.

Key Criteria used for scenario comparison are:

- ✓ **Stability;** of water sources in terms of quality and quantities.
  - Is there a significant risk of water interruption?
- ✓ **Flexibility**; to the Change of Demand and Development
  - Is the system capable to respond to the city's development change?
- ✓ **Resiliency;** for the preparedness to disasters and Climate Change
  - Does the system have a significant risks on disasters and Climate Change?
  - Is there a possible mitigation measure?

✓ **Cost**: Both capital and O&M cost

The following table summarizes key scenario compare

Table 57: Master Scenario cases Compared-2025, 2035 and 2050

Year	Simulated Scenario(s)			Demand	Note
2019	Existing Status			Day Average	Models to show the number of shortages by the regions.
2025	Ongoing Project				
2035	Case 1	Case 2	Case 3		Models to compare the possible future scenario of water transmission.
	Baseline (Near demand principle)	Nzove Oriented	Kanzenze Oriented		
2050	Case 1	Case 2	Case 3	Day Max	
	Nyabarongo/ Upcountry water source-oriented	Akagera River upstream oriented	Mugesera Lake oriented		

Source: JST, 2020

For 2025, the assessment indicated that the total water supply capacity of existing on-going projects (197,000 m^3/day) will be sufficient to the daily average demand in 2025 (159,000 m^3/day) if NRW achieves and kept in 25% as planned. However, it will locally have a deficiency in the east (approx. 25,000 m^3/day) because of the lack of transmission route based on the existing facilities. It was concluded that Supply capacity can meet the average water demand if **NRW reduction is successful.** Prioritized issues are:

(1) NRW reduction along with pipeline expansions
(2) Meet the Emerging Demands:
   - Eastern demand: Masaka WTP (Described later in detail)
   - Unserved populations

For 2035, cases assessed are presented in the next table.

Table 58: 2035 Master Scenario cases

		Case 1: Baseline	**Case 2: Nzove/Rutonde Oriented**	**Case 3: Gahanga/Masaka Oriented**
Principle		Make most of existing water permission	**Prioritize development at Nzove**	Prioritize development at Gahanga/Masaka
Common Components		Reduce and Maintain NRW at 25% Additional Water Supply: + 118,000 m3/day		
Key Differences		Karenge +30,000 m3/d	**Nzove 3 +30,000 m3/d**	Masaka +20,000 m3/d Gahanga +10,000 m3/d
Evaluation	Stability	Low/Intermediate	**Intermediate**	Intermediate
	Flexibility	Intermediate	**High**	Low/Intermediate
	Resiliency	Intermediate	**Intermediate**	Intermediate
Average Cost (Capital*/O&M)		69.7 MUSD/year (Capex; 38.9, Opex; 30.8)	**69.2 MUSD/year (Capex; 39.9, Opex; 29.3)**	71.8 MUSD/year (Capex; 42.5, Opex; 29.3)
Recommend			✓	

Source: JST, 2020

For the Master Scenario-2050, cases compared are presented in the next table,

Table 59: Compared cases for 2050 master Scenario

		Case 1: Upctry/Nyabarongo	Case 2: Akagera River	Case 3: Mugesera Lake
Principle		Prioritize Nyabarongo and upstream dam sources	Prioritize Akagera River Source	Prioritize Mugesera Lake Source
Key Differences*		Additional Capacity at Nyabarongo River/Dam	Additional Capacity at Gahanga/Masaka	Additional Capacity at Karenge
Evaluati	Stability	Intermediate/High	Low/Intermediate	Intermediate
	Flexibility	High	High	Low/Intermediate
	Resiliency	Intermediate	Intermediate	Intermediate/High
Average Cost (Capital*/O&M)		169.7 MUSD/year (Capex; 99.0, Opex; 70.7)	166.0 MUSD/year (Capex; 91.9, Opex;74.1)	180.4 MUSD/year (Capex; 97.9, Opex; 82.5)
Recommend		**✓ (temporary)**	**✓ (temporary)**	

5.3.3. Envionmental and social alternative analysis

In terms of environmental and social alternative evaluation, three pbtions were considred:

- Ground water as source of water development
- Surface water as source of water development and
- No-option

1) Ground water prioritized development option

Summary of the ground water prioritized water source development scenario is shown in following table.

Table 60: Summary of water supply option (1)

Water supply scenario	Ground water prioritized water source development option
Overview	- Water source development shall be prioritized on ground water (underflow water) that is advantageous on relatively better water quality. In the medium to long term, lake water from Mugesera Lake, or Muhazi Lake, and surface water from Nyabarongo River and Nyabugogo River shall be sequentially developed and meet future demand. - In principal, the main development sites will be the expansion / renovation of the existing water treatment plant along the Nyabarongo River. New development sites are only planned in two locations (Masaka, and Rurindo) in which the eastern and northern part of Kigali City where the future demand is expected according to Kigali City Master Plan.
Merit	- Underflow water has low-turbidity compared with intake directly from Nyabarongo River (it shall reduce treatment cost and reduce environmental load). - In near future, along with population increase of Kigali City, contamination of the surface water is expected. By minimizing use of surface water (minimize use of surface water until development of sewerage system in Kigali City) it shall also minimize treatment cost. - It is also considered as effective measures for mitigating effect of climate change (preventing damage to intake facilities by flooding)
Demerit	- Utilizing ground water as water source is technically challenging. It is rather difficult works even for normal operation. - Compared with surface water, potential capacity of ground water is smaller than surface water. In addition, it is still under examination. - It is yet certain when the pollutant become eminent. It is also same for sewerage system function. - Main source is depending on Akagera River and it may say it is lack of redundancy
Short term (Priority) Project Component	- Construction of Masaka WTP and its related clear water (CW) transmission & distribution facilities - Expansion of Karenge WTP and its related transmission & distribution facilities - Expansion & renewal of Nzove 1 WTP and its related transmission and distribution facilities - Kigali City central trunk main (Nzove WTP to city west) - Strengthening the function of Nzove-Ntora Distribution System - Technical cooperation scheme under JICA assistance
Long term Project Component	- Construction of reservoir and distribution network and renewal - Expansion of Nzove water treatment plant

Water supply scenario	Ground water prioritized water source development option
	- Development of water intake and water treatment plant development attached to Nyabarongo 2 dam construction - Yanze river dam development - Small scale water treatment plant development for spring and small stream - Development of water source and treatment plant in Kanzenze - Development of water source and treatment plant in Akanyaru River - Development of water source and construction of water treatment plant near Muhazi Lake

Source: JST 2020

2) Surface water prioritized development option

Summary of the surface water prioritized water source development scenario is shown in following table.

Table 61 Summary of water supply Option (2)

Water Supply option	Surface water prioritized water source development option
Overview	- Water source development shall be prioritized on surface water of Akagera River. Take advantages of available development capacity of Akagera River as much as possible. In the medium to long term, lake water from Mugesera Lake, and surface water from Akagera River shall be sequentially developed and meet future demand in eastern and northern region. - In principal, the main development sites will be the expansion / renovation of the existing water treatment plant along the Akagera River. New development sites are only planned in two locations (Masaka, and Rurindo) in which the eastern and northern part of Kigali City where the future demand is expected according to Kigali City Urban Development Master Plan.
Merit	- Maximize use of available water resource development capacity of Akagera River. - Simplify technology apply for treatment.
Demerit	- Treatment cost for turbid water may be higher than ground water (underflow water) - Due to heavy contamination of the surface water by expected urbanization of this region shall increase treatment cost - It is also required to consider effective measures for mitigating climate change (risk of suffering damage to intake facilities by flooding) - Main source is depending on Nyabarongo River and it may say it is lack of redundancy for draught
Short term (Priority) Project Component	- NRW reduction project through pressure control and pipe renewal - Construction of Masaka WTP - and Clear Water Transmission & Distribution Facilities - Rehabilitation of Karenge WTP - Expansion of Karenge WTP and Transmission & Distribution Facilities
Long term Project Component	- Construction of reservoir and distribution network and renewal - Expansion of Nzove water treatment plant - Development of water source and construction of water treatment plant in Rutonde - Development of water intake and water treatment plant development attached to Nyabarongo 2 dam construction - Yanze river dam development - Development of water source and treatment plant in Kanzenze - Development of water source and treatment plant in Akanyaru River - Development of water source and construction of water treatment plant near Muhazi Lake

Source: JST, 2020

3) Evaluation and comparison of water source developments options

Following table summarized merit and demerit of the possible water source development options

Table 62: Comparison of alternative options (water source development)

S/N	Alternative Options			Merit	Demerit
1	Ground water prioritized water source development option	Water Source Development Near-by Kigali City and Adjacent 7 sectors	Utilize relatively better-quality water for water source	- Relatively lower treatment cost - Lower impact on environment - Better climate change adaptation	- Increase system complexity

2	Surface water prioritized water source development option		Utilize accessible water for water source	- Simplified and consolidated facility management - Quicker development - Lower social impact	- High treatment cost - More environmental impact
3	Without projects	No impact		- No adverse impact on Environment	- Socio-economically no benefit for society. It may limit development of Region; - Existing shortage of improved water shortage will increase; - People with no access to improved will continue to suffer waterborne diseases;

Source: JST, 2020

In case of without project case, there is no development of water treatment plant and distribution and transmission network development. This won't cause any environmentally adverse impact. However, it also will bring no socio-economic benefits to the community of Kigali City and adjacent 6 Sectors in the future. It may become a bottleneck for the development effort of improvement of socio-economic status of Rwandans which until now Rwanda Government has set out in target (Rwanda Vision 2020 (2012) and series of Development Plans).

In terms of ESC point of view, groundwater prioritized water source development option is considered as most suitable since it has a wide range of benefit. Especially it is not only complying with environmental requirements aspect (environmental and social impacts by the component projects are managed to be avoiding adverse impact) but also has advantages in adaptation to climate change and economic efficiency. Only concern is it requires capacity development of project proponent during its implementation. The Next table summarizes the results of comparison of options considered.

Table 63: Characteristics of each water source development options (alternative plans)

Characteristics	Ground water Prioritized	Surface Water Prioritized	Without Projects	Remark
Archive Development Goal	◎	◎	×	
Development Capacity	○	◎	-	
Construction Cost	○	◎	-	
Treatment cost	◎	○	-	
Operation Requirement	○	◎	-	
Climate Change Adaptation	○	△	-	
Environmental Impact	○	△	-	
Social impact	○	○	-	
Overall	1	2	3	

Source: JST, 2020

5.4. Identification of environmental and social impacts

Potential positive and negative impacts need to be identified which may fall into different categories, including:

- Direct impacts associated with alternative options within the PPP that initiate and locate specific project activities;
- Indirect impacts that are associated more with policies that may have fiscal or legislative implications;
- Cumulative impacts that involve large-scale schemes, such as infrastructure development; and
- Large-scale impacts that have regional and global effects. Impacts also may be permanent, temporary, or synergistic.

Impact assessment methods commonly applied to SEA include the following: scenario development, risk assessment Policy impact matrix, predictive and simulation models, significance thresholds, GIS capacity/habitat analysis, cost/benefit analysis, least cost analysis, multi-criteria analysis. Each of the above methodology is used depending on available information but also the instruments that requires SEA (policy,

Plan or program). Based on the available information and given that the proposed Master Plan has identified specific projects; risk assessment approach is used in impacts assessment.

Table 64: Determination of potential environmental Impacts within alternative options

SEA Issues		Ground water priority	Surface water priority	Without project
Socio-economic	Loss of land or access to land	Construction of water treatment plants, water reservoir and water intake as well as water pipelines identified for the investments will result in loss of farm land, grazing land, business and structures among others by the local communities owning the land mainly during construction of WTP, Water Reservoirs, Water Intake and water pipelines	Construction of water treatment plants, water reservoir and water intake as well as water pipelines identified for the investments will result in loss of farm land, grazing land, business and structures among others by the local communities owning the land mainly during construction of WTP, Water Reservoirs, Water intake and water pipelines	No Impacts
	Livelihoods and loss of income	It is anticipated that the proposed infrastructures will affected farmland, grazing land, business and structures, which are used by communities for their livelihoods. These impacts will be permanent where water intake, WTP and reservoirs will be constructed and temporary for transmission pipelines.	It is anticipated that the proposed infrastructures will affected farmland, grazing land, business and structures, which are used by communities for their livelihoods. These impacts will be permanent where water intake, WTP and reservoirs will be constructed and temporary for transmission pipelines.	-Existing shortage of improved water shortage will increase; - People with no access to improved will continue to suffer waterborne diseases; - Country objective will not achieved and cost of water may remain high
	Physical Resettlement	Among proposed sites none of them requires physical resettlement given that are free of human settlement.	Among proposed sites none of them requires physical resettlement given that are free of human settlement	No impacts
	Crop & Livestock productivity	The land expected to be affected include crops, trees and pastures. These assets will be affected during site clearance	The land expected to be affected include crops, trees and pastures. These assets will be affected during site clearance	No impacts
		Increased water usage for water supply may affect other users like irrigation and livestock and hence loss of income	Increased water usage for water supply may affect other users like irrigation and livestock and hence loss of income	No Impacts
	Archaeological Resources/Cultural resources	No archaeological or cultural resources expected in the proposed sites. However, this may happen during excavation of constructions of various proposed structures	No archaeological or cultural resources expected in the proposed sites. However, this may happen during excavation of constructions of various proposed structures	No Impacts
	Employment opportunity and source of income	At this stage is not ease to estimate how many direct and indirect employment opportunity will be generated but construction works requires both skilled and unskilled people. This will generated income to workers.	At this stage is not ease to estimate how many direct and indirect employment opportunity will be generated but construction works requires both skilled and unskilled people. This will generated income to workers.	Employment opportunity will be missed
	Livelihoods, Health and safety improvement,	Provision of water to communities will improve the livelihood of population in Kigali and its surroundings and improve the health and safety conditions	Provision of water to communities will improve the livelihood of population in Kigali and its surroundings and improve the health and safety conditions	Shortage of water will remain and no improvement of existing conditions
	Labour influx and Community health and safety	Construction activities may lead to influx of workers but the scale is likely to be low including significance. The influx of workers and followers can lead to adverse social and environmental impacts on local communities. Therefore, there is a potential risk (minimal) that the construction process for most of the investment projects could increase HIV/AIDS and other STI prevalence in the project areas especially through interactions of the locals with the labour forces. Increase in risk of sexually	Construction activities may lead to influx of workers but the scale is likely to be low including significance. The influx of workers and followers can lead to adverse social and environmental impacts on local communities. Therefore, there is a potential risk (minimal) that the construction process for most of the investment projects could increase HIV/AIDS and other STI prevalence in the project areas especially through interactions of the locals	Lack of water in community will remain and cause health and hygienic issues.

SEA Issues		Ground water priority	Surface water priority	Without project
		transmitted diseases, such as HIV/AIDS etc. due to influx of migrant workers; solid waste and effluent discharge from construction camps; risk of increase in vectors of schistosomiasis, river blindness, Lymphatic filariasis (elephantiasis) and malaria due to stagnant water associated with construction works/borrow pits etc.	with the labour forces. Increase in risk of sexually transmitted diseases, such as HIV/AIDS etc. due to influx of migrant workers; solid waste and effluent discharge from construction camps; risk of increase in vectors of schistosomiasis, river blindness, Lymphatic filariasis (elephantiasis) and malaria due to stagnant water associated with construction works/borrow pits etc.	
	Occupation health and safety of workers	Occupation health and safety of the workers during the construction phase is likely to be a concern due to the accidents that normally occur in construction sites that could cause loss of life, limbs among others. Construction activities may also endanger the health and safety of the local community around the construction sites as a result of construction related hazards. The construction of WTP, Water Reservoirs, Water Intake and water pipelines are likely to lead to occupational safety and health impacts. Communities near generation and transmission facilities remain at risk with respect to safety	Occupation health and safety of the workers during the construction phase is likely to be a concern due to the accidents that normally occur in construction sites that could cause loss of life, limbs among others. Construction activities may also endanger the health and safety of the local community around the construction sites as a result of construction related hazards. The construction of WTP, Water Reservoirs, Water Intake and water pipelines are likely to lead to occupational safety and health impacts. Communities near generation and transmission facilities remain at risk with respect to safety	No Impacts
Atmosphere	Air pollution and air quality	Airborne dust will be caused by excavation, vehicle movement hence engine combustion and materials handling, particularly downwind from the construction sites during the construction phase of the identified investments. Uncovered stock piles and asphalt mixing plant operations are another source of dust. Air pollution will be further caused by emissions from vehicles and construction machinery. There will be decreased air quality due to dust, suspended particles, hydrocarbon vapours, oxides of nitrogen and sulphur (NOx and SOx) and Volatile Organic Compounds (VOC) among other emissions	Airborne dust will be caused by excavation, vehicle movement hence engine combustion and materials handling, particularly downwind from the construction sites during the construction phase of the identified investments. Uncovered stock piles and asphalt mixing plant operations are another source of dust. Air pollution will be further caused by emissions from vehicles and construction machinery. There will be decreased air quality due to dust, suspended particles, hydrocarbon vapours, oxides of nitrogen and sulphur (NOx and SOx) and Volatile Organic Compounds (VOC) among other emissions	No Impacts
Biodiversity	Sensitive habitat/protected area	None of proposed site is found in protected areas, however, water abstraction, construction of well, MMC rooms and raw water pipeline may will be done in wetlands and near rivers or lakes. This can lead to the degradation of these fragile ecosystems.	In case of surface water, only water intake and raw water pipeline are expected in wetlands near rivers and lakes and construction works may affect these ecosystem	No Impacts
	Fauna	During operational phase, over-abstraction of ground water has a negative impact on living organisms including flora and fauna. When the ground water withdrawals exceed recharge, there is a falling of water table and living organism does not have enough water.	Reptiles and birds maybe affected during site clearance and fauna living in rivers and lake may be affected with excessive water abstraction	No Impacts
	Flora	There will be vegetation loss (site specific) during the construction phase for WTP, intake, reservoirs and pipelines either to pave way for actual project construction among others. The vegetation will be cleared so that the area where the construction work is to take place is clear for the construction work to be performed.	There will be vegetation loss (site specific) during the construction phase for WTP, intake, reservoirs and pipelines either to pave way for actual project construction among others. The vegetation will be cleared so that the area where the construction work is to take place is clear for the construction work to be performed	No impacts
	Impacts on Water table	Ground water abstraction may have impacts in aquifer water table. Even if, proposed areas for ground water abstractions	The same as ground water, surface water abstraction may affect the amount of water available in rivers and lakes	Pre-existing status will remain

SEA Issues		Ground water priority	Surface water priority	Without project
Water Resources		have enough quantity of ground water, water abstraction will contribute to the variation of the ground water 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 ground water abstraction will be limited to the fixed rate and regular monitoring is recommended.	especially when is combined with seasonal or climate variation and other water use. This may have an impacts on downstream users but also on the amounts of raw water expected for treatment	
	Climate change impacts	Apart from dust, suspended particles, hydrocarbon vapours, oxides of nitrogen and sulphur (NOx and SOx) and Volatile Organic Compounds (VOC) among other emissions, the proposed option will not much have impacts on climate and will not be affected by climatic conditions	In addition to minor emissions as it is in the first option, this option more affected by climatic conditions including reduction of amount of water but also heavy sedimentation due to floods	Pre-existing status will remain
	Sedimentation	Excavation works shall involve earth moving within the river flood plains and sections of the adjoining riverbanks and lands. This loosening of the soil and the steep slope terrain will create a situation where any heavy rains will freely wash down the silt into the downstream areas. The silt when washed down may contain high levels of organic matter and deposition of this may lead to anoxic conditions in the lower water levels with potential risks to the associated aquatic life. However, abstraction of ground water is not much affected by sedimentation and water treatment is much easier compared to surface water	Excavation works involve earth moving within the river flood plains and sections of the adjoining riverbanks and lands. This loosening of the soil and the steep slope terrain will create a situation where any heavy rains will freely wash down the silt into the downstream areas. The silt when washed down may contain high levels of organic matter and deposition of this may lead to anoxic conditions in the lower water levels with potential risks to the associated aquatic life. Surface water is much affected by sedimentation and the cost of water treatment is high. Sometimes the treatment is even impossible after heavy rains and floods	Where the project is implemented or not, sedimentation may be caused by other events such as heavy rains and soil erosion
	Pollution of ground water	Ground water may be contaminated from hydrocarbons mainly from the contractor's machineries especially during drilling of wells	It is only expected when there is oil spillage when operating heavy equipment's/ machineries near water bodies	No impacts
	Conflicts about water usage	Inceased amount of water supply may affect other users such as agriculture and affect production and hence income	Inceased amount of water supply may affect other users such as agriculture and affect production and hence income	The current usage will remain
	Soil erosion	Soil erosion involves transport of the soil down slope by running water or, more rarely but still a significant factor, away from the site by wind. Soil compaction and disturbance, usually accompanied by vegetation and litter layer damage, are preconditions for accelerated soil erosion. Most soil damage occurs as the result of movement of machine, trucking, and to some extent through felling of trees during excavation works.	Soil erosion involves transport of the soil down slope by running water or, more rarely but still a significant factor, away from the site by wind. Soil compaction and disturbance, usually accompanied by vegetation and litter layer damage, are preconditions for accelerated soil erosion. Most soil damage occurs as the result of movement of machine, trucking, and to some extent through felling of trees during excavation works	Even without projects soil erosion will happen due to other activities such as farming
Soil	Soil pollution	The only anticipated soil pollution will be from oil spillage during construction works	The only anticipated soil pollution will be from oil spillage during construction works	No Impacts
	Wetland degradation	Ground water abstraction, installation of raw water pipe, drilling of wells will alter the features of the wetland and therefore alter their hydrology (flow and water turbidity). Temporary loss of habitat and component species within the construction corridor. Further, the construction phase will involve the use of heavy machines and vehicles and increase of circulation of people. For different purposes laydown yards will be needed, as for storage	Construction of water intake and installation of raw water pipe will alter the features of the wetland and therefore alter their hydrology. Construction phase will involve the use of heavy machines and vehicles and increase of circulation of people. For different purposes laydown yards will be needed, as for storage of parts and construction material, storage of pipes, parking of trucks	No impacts

SEA Issues		Ground water priority	Surface water priority	Without project
		of parts and construction material, storage of pipes, parking of trucks and construction machines etc. and work camps have to be installed. You should add wells digging impacts on the wetland (immediate and in long term)…	and construction machines etc. and work camps have to be installed.	
Waste management	Wastewater	Wastewater from water projects include filter backwash, reject streams from membrane filtration processes, and brine streams from ion exchange or demineralization processes. These waste streams may contain suspended solids and organics from the raw water, high levels of dissolved solids, high or low pH, heavy metals, etc.	Wastewater from water projects include filter backwash, reject streams from membrane filtration processes, and brine streams from ion exchange or demineralization processes. These waste streams may contain suspended solids and organics from the raw water, high levels of dissolved solids, high or low pH, heavy metals, etc.	No Impacts
	Solid waste	Solid waste residuals generated by water treatment include process residuals, used filtration membranes, spent media and miscellaneous wastes. Process residuals primarily consist of settled suspended solids from source water and chemicals added in the treatment process, such as lime and coagulants. Pre-sedimentation, coagulation (e.g. with aluminum hydroxide [alum] or ferric hydroxide), lime softening, iron and manganese removal, and slow sand and diatomaceous earth filtration all produce sludge. Composition of the sludge depends on the treatment process and the characteristics of the source water, and may include arsenic and other metals, radionuclides, lime, polymers and other organic compounds, microorganisms, etc.	Solid waste residuals generated by water treatment include process residuals, used filtration membranes, spent media and miscellaneous wastes. Process residuals primarily consist of settled suspended solids from source water and chemicals added in the treatment process, such as lime and coagulants. Pre-sedimentation, coagulation (e.g. with aluminum hydroxide [alum] or ferric hydroxide), lime softening, iron and manganese removal, and slow sand and diatomaceous earth filtration all produce sludge. Composition of the sludge depends on the treatment process and the characteristics of the source water, and may include arsenic and other metals, radionuclides, lime, polymers and other organic compounds, microorganisms, etc.	No impacts
	Sludge	One of the important waste during the operational phase will be sludge from water treatment. If not well handled, this waste may contribute to water pollution and environmental degradation.	The surface water has more sludge given the high level of turbidity and sedimentation identified in various water sources especially Akagera river.	No impacts
	Hazardous chemicals	Water treatment may involve the use of chemicals for coagulation, disinfection and water conditioning. In general, potential impacts and mitigation measures associated with storage and use of hazardous chemicals are similar to those for other industrial projects	Water treatment may involve the use of chemicals for coagulation, disinfection and water conditioning. In general, potential impacts and mitigation measures associated with storage and use of hazardous chemicals are similar to those for other industrial projects	No Impacts

Source: BESST Ltd, expert's assessment, 2021

The conclusion of Master Scenario and Enviromental and social alteratative assessment is that ***without-project Option can't be considered and the team recommends to implement better ranked options with the implementation od strategic option an d mitigation measures.***

6. STRATEGIC MITIGATION MEASURES

The section provides strategic actions that avoids or reduces as far as possible, any adverse impacts due to proposed scenarios in the Master Plan and usage of proposed the sites and utilizing of existing environmental attributes for optimum development.

6.1. Environmental and social strategic options

6.1.1. Screening and classification of environment studies required

Both national regulations and JICA guidelines for environmental and social consideration requires screening of projects and classification in one of environmental Category. JICA guidelines classifies each project into one of four environmental categories (A, B, C, and FI) depending on the level of ESC required. Classification of the project is based on reports and documents prepared by the project proponents such as the Screening Format prepared by JICA. The project may be reclassified into a different category when there is a change in the scope or when an unanticipated impact has been identified. In Rwanda, the new environmental law classified projects into category 1 and category 2 categories mainly due to projects size. A list of typical projects classified in category 1 and two are provided as annex to the ministerial order establishing the list of projects that requires EIA

Table 65: Classification of environmental category in JICA guideline and regulation in Rwanda

Type of the Project	JICA guideline	Rwanda Guideline	Remarks
The project is likely to have significantly adverse impacts on the environment or society.	Category A	Cat 1	Require full-scale EIA
The project may have adverse impacts on the environment or society, but these impacts are less significant than those of Category A projects. These impacts are site-specific; few, if any, of them are irreversible; in most cases, they can be mitigated more readily than Category A projects.	Category B	Cat 2	Depends on scale of adverse impact full-scale EIA is not necessary
The project is likely to have minimal or no adverse impact on the environment or society.	Category C	Cat 2	Full scale EIA is not necessary
JICA provides funds to a Financial Intermediary, which in turn implements sub-projects that may have adverse impacts on the environment or society, but these impacts cannot be identified in detail prior to JICA's approval. If there is a sub-project that can be categorized as Category A, it needs to go through the same procedure as a Category A project including JICA's environmental review and information disclosure prior to its implementation.	Category FI	N/A	After categorized apply review

Source: JST

In terms of MP study, it is considered as Category B in JICA's guideline. It is almost same in Rwanda's guideline. However, Rwanda's Guideline is basically applied to each project bases, and construction of the water treatment plant and urban water supply facility are subject to EIA except rehabilitation or some other cases. Therefore, when actual EIA application, it is better to follow Guideline prepared by the Rwanda Government.

6.1.2. Preparation of Environmental Impacts Assessment (EIA) for each subprojects

This SEA contains potential mitigation measures and monitoring indicators through which the adverse impacts for specific sub project investments may be managed. However, each sub project will have to prepare an EIA/EMP. The EIA/EMP for each sub project should at a very minimum contains among others;-

- Description of the possible adverse effects that the EIA/EMP is intended to address;
- Identification of project design alternatives that would meet similar objectives, and a description of why these projects are not viable, especially if they have a lesser environmental or social impact;
- Description of planned mitigation measures, and how and when they will be implemented
- Program for monitoring the environmental and social impacts of the project, both positive and negative;
- Description of who will be responsible for implementing the EMP; and
- Cost estimate and source of funds.

6.1.3. Climate change adaptation and mitigation measures

Rwanda is one of the most densely populated country in Africa. In this regard, rising temperatures and variable rainfall now-days threatens the country. Especially, in the rapidly growing urban areas like the City of Kigali, competition increases between urban water supply and agriculture water. There are increasing concerns about water shortages during longer dry spells, and the impact of flooding and landslides (increase of sediment and turbidity) on the water-intake of the water treatment plant along the Nyabarongo River.

To cope up with the climate change in this region and to ensure sustainability of the 15-Year Investment Plan, following aspects are considered to be applied.

- Reducing greenhouse gas emission
- Enhancing adaptive capacity, strengthening resilience and reducing vulnerability

Specifically, measures for reduction of greenhouse gas emission are being studied under the Masterplan and the 15-Year Investment Plan in the following manner.

- Methods of energy saving is carefully studied during preparation of water supply system, especially minimization of pumping energy in water transmission system
- Water pressure control and usage of appropriate pipe material is planned for reduction of NRW, which will contribute to reduction of water intake, purification, transmission and distribution energy,
- Usage of energy and chemicals is reduced in water treatment system using underground water

Influence of drought during dry season and flooding during rainy season on water intake facilities will increase due to climate change. Following mitigation measures are planned to reduce the risks to the water supply system.

- Intake from groundwater is planned with high priority considering reliability against drought.
- Drawdown of water table in wells is also considered when designing intake facilities.
- In order to mitigate impact of drought, numerous intake locations are planned. Three main locations are planned to be developed at upstream, middle, and downstream along the Nyabarongo/Akagera River, namely the Nzove, the Gahanga, and the Masaka, in addition to the Karenge Intake at the Mugesera Lake.
- Clear water transmission pipelines are planned to interconnect all the above water sources to mitigate impact of drought.
- Upgrading of intake facilities in the Karenge and the Nzove are planned to mitigate influence of flooding
- Preventing measures are studied against clogging of transmission pipe from the Yanze River to the Kimisagara WTP during the rainy season.

6.1.4. Land and easements acquisitions

Proposed investment under both Master Plan and 15-Years Investment Plan including construction of intake, wellfields, Water Treatment Plant and forwarding infrastructures involve land acquisition or easements. The land used is either government lands or private land. Experience and research indicate that physical and economic displacement, if unmitigated, may give rise to severe economic, social and environmental risks: production systems may be dismantled; people face impoverishment if their productive resources or other income sources are lost; people may be relocated to environments where their productive skills are less applicable and the competition for resources greater; community institutions and social networks may be weakened; kin groups may be dispersed; and cultural identity, traditional authority, and the potential for mutual help may be diminished or lost. For these reasons, involuntary resettlement should be avoided. Where involuntary resettlement is unavoidable, it will be minimized and appropriate measures to mitigate adverse impacts on displaced persons (and on host communities receiving displaced persons) will be carefully planned and implemented. It is recommended that:

- Every project undergoes screening to determine whether a resettlement plan is required and if yes, the instruments will be prepared and compensation measures provided prior land acquisition;
- Alternative option be explored to avoid, minimize resettlement impacts;
- Where possible road reserves should be used to minimize land take on households

6.2. Mitigation considerations and options for specific environmental and social impacts

All moderate to major adverse impacts are considered for mitigation. Specific measures have been suggested in this regard where practicable. With regard to negligible and minor impacts where the project activity is not expected to cause any significant impact in such cases, best practice measures and mitigation have also been recommended where appropriate to improve the environmental and social performance of the Project. The mitigation options considered may include project modification, provision of alternatives, project timing,

pollution control, compensations and relocation assistance. In cases where the effectiveness of the mitigation is uncertain, monitoring programs are introduced.

6.2.1. Recommended mitigation measures for potential environmental and Social Impacts

The mitigation measures or guidelines have been designed in order to avoid, minimize and reduce negative environmental and social impacts at the project level. The mitigation measures are presented in the following tables in a descriptive format.

Table 66: Proposed mitigation measures

Impacts	Description of mitigation measures
Physical Environment	
Solid and Effluent Waste	**Solid nontoxic waste** - Adequate waste receptacles and facilities should be provided at project sites/camp sites - Training and awareness on Safe Waste Disposal in construction camps for all workers - Final disposal should be at dumpsites approved by the REMA **Waste oil /fuel** - Spent or waste oil from vehicles and equipment should be collected and temporarily stored in drums or containers at site; - Waste oil should be disposed of by oil marketing companies or agents approved or recognized and have the capacity to undertake oil disposal; - Prepare Waste Disposal Plan for every construction site; - Install waste disposal receptacles and signs in strategic places within the construction camps; - Provide training and awareness on need to avoid littering; - Ensure the construction camps have toilets and connected to the sewer system
Flood risk assessment and Management	**One of the water source considered under Master Plan is Nyabarongo/Akagera river. The river is prone to repetitive floods (MINEMA, 2015)[2].** The flood assessment conducted at Kanzenze area found the maximum water in extreme event for both 50year and 100 years return period is about 1,5m above the ground. Thought this happens rarely, the project design should consider this level during the construction of different project component especially wellfileds. Potential mitiation measures may include: - For protection of wells a concrete room at reasonale height based on highest foold level - Put water treatment plants outside the swamp area and, - Design and implement water monitoring programs in areas proposed for water abstractions
Sludge management	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. Options to be considered include: − 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 use will depend on sludge composition. The sludge may 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. If the composition is made of biological matter then the use of sludge for making fertilizers would be considered. − **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.

[2] National Risk Atlas of Rwanda, Ministry of Disaster Management and Refugee Affairs,2015

Impacts	Description of mitigation measures
Decreased Air Quality	- Proposed investments should require that construction contractors operate only well maintained engines, vehicles, trucks and equipment. A routine maintenance program for all equipment, vehicles, trucks and power generating engines should be in place; - The project should ensure the use of good quality fuel and lubricants only; - If dust generation at the project/construction site becomes a problem, limited wetting of sites and or unloading and reloading points should be done to reduce dust raising; - Construction traffic speed control measures should be enforced on unpaved roads (speed limits through communities should be ≤50km/hr on unpaved roads and near or at project site should be ≤30 km/hr); - Engines of vehicles/trucks and earth-moving equipment should be switched off when not in use.
Noise and vibration	- Proposed investments should require contractors to use equipment and vehicles that are in good working order, well maintained, and that have some noise suppression equipment (e.g. mufflers, noise baffles) intact and in working order. - This will be achieved by making it a component of contractual agreements with the construction contractors. - Contractors will be required to implement best driving practices when approaching and leaving the site (speed limit of ≤30 km/hr) to minimize noise generation created through activities such as unnecessary acceleration and breaking squeal. - Engines of vehicles/trucks and earth-moving equipment should be switched off when not in use.
Visual Impacts	- Landscaping of facilities after construction and restoration of disturbed areas e.g. borrow pits
Impact on traffic and public safety	- Only road worthy vehicles and trucks should be used to avoid frequent breakdowns on the roads; - Only experienced drivers should be employed; - Contractors must provide training for drivers; Establish speed limits; Enforce safe driving and take disciplinary action against repeat offenders
Water Abstraction	- Obtain water abstraction permits from the Water Resources Management Authority
Decreased Water Quality	- No garbage/refuse, oily wastes, fuels/waste oils should be discharged into drains or onto site grounds; - Fuel storage tanks/sites should be properly secured to contain any spillage; - Maintenance and cleaning of vehicles, trucks and equipment should take place offsite especially where project sites are close to water bodies; - Toilet facilities should be provided for construction workers to avoid indiscriminate defecation in nearby bush or local water bodies
Soil Erosion	- Minimize land clearing areas as much as possible to avoid unnecessary exposure of bare ground to the elements of the weather; - Re-vegetate cleared areas as early as possible using native plant species - As much as possible, avoid construction work in the rainy season
Impact on fauna and habitat	- Avoid unnecessary exposure and access to sensitive habitat areas; - For identified or suspected sensitive habitats (swamps/ wetlands), regular inspection or monitoring should be carried out in the area prior to start and during work.; - If sensitive habitats are encountered, Project activities should cease and the Project should consult wildlife agency to determine the appropriate course of action. - If the project site is discovered as a sensitive habitat area, the Project should engage the wildlife agency to develop a suitable plan. - Prohibition on hunting and consumption of bush meat by workforces - Proposed investments should require that contractors implement a hazardous materials management plan that includes specification for proper storage and handling of fuels, oil, wastes, and other potentially hazardous materials as well as a plan for containment and clean-up of accidental spills into the aquatic environment. - During pre-installation and installation of project facilities, spotting of sensitive aquatic mammals should form part of the project activities. Should these species be observed in the vicinity of the work area, the project should execute measures to avoid destruction or disturbance. - Ensure provision for water flow reserves and appropriate reservoir filling schedules - Project staff must report sightings of any injured or dead aquatic life (fishes)/ mammals immediately, regardless of whether the injury or death is caused by a Project activity. The report should include the date and location of the animal/strike,

Impacts	Description of mitigation measures
	and the species identification or a description of the animal. The report should be made to the wildlife agency in Rwanda. - The Project workforce and local communities should be educated to ensure that the importance of environmental protection and nature conservation are effectively communicated and that wider appreciation of environmental issues and construction best practice are fostered.
Downstream Impacts	- Maintain environmental flow reserves for the river, Do into retain water in reservoir during drought, ensure that water retention in dam is controlled to ensure that adequate reserve is left to flow downstream for users
Quarry Site Impacts	- Identify borrow and quarry sites away from sensitive environments and develop quarry management and rehabilitation plans
Hydrology Impacts/Changes	- Maintain environmental flow reserves for the river, Do into retain water in reservoir during drought, ensure that water retention in dam is controlled to ensure that adequate reserve is left to flow downstream for users; - Ensure water balance by monitoring and regulating water use through water abstraction parmit
Social environment	
Physical displacement	- All affected persons to be given relocation assistance (cash or kind) by the Project to enable them move their properties to new locations, i.e. in accordance with the Resettlement Action; - Resettlement Plans will be required. If a site is acquired, the State may relocate persons and their families as well as community facilities to be affected. The affected families should not be made to incur any cost during the relocation period. A resettlement plan should be prepared for this area;
Loss of employment and livelihoods	- Those whose livelihood is affected should be assisted to ensure they will not be worse off as a result of the project. This can include livelihood assistance, provision of new jobs immediately without any loss of income. The social assessments and socio-economic surveys, which will be undertaken for the preparation of individual investments/subprojects as well as the resettlement action plans, should assess these issues and provide measures in accordance with the Resettlement Action Plan. - Contractors should use local labour as much as possible and where available. As much as possible, all unskilled labour should be contracted or obtained from the local community.
Loss of land and other assets	– Due process should be followed to establish the true owner of any land, be it family or communal land. Once established, the project should acquire the site by paying appropriate compensation in accordance with the resettlement action plan.
Loss of structures/properties	– For a project site to be used, irrespective of the land ownership, appropriate compensation should be paid for any structures/ properties which are permanent structures at the site as well as investment made for any development on the land. - Depreciation should not be factored during valuation of these properties. The compensation process should satisfy the RPF developed for the project. - Appropriate compensation should be paid for any damaged or destroyed propriety that belongs to affected persons. No depreciation during valuation of these properties.
Impact on access among communities living in the project areas	- Measures will be considered in the projects' design to ensure that communities are not divided and if they are as a result of a project appropriate measures are taken to mitigate this impact.
Impacts on human health/ traffic safety and sanitation	- Trucks carrying construction materials such as sand, quarry dust, laterite etc. will have the buckets covered with tarpaulin or appropriate polythene material from or to project site - Except for areas secured by fencing, all active construction areas will be marked with high-visibility tape to reduce the risk accidents involving pedestrians and vehicles. - All open trenches and excavated areas will be backfilled as soon as possible after construction has been completed. Access to open trenches and excavated areas will be secured to prevent pedestrians or vehicles from falling in. - Adequate sanitary facilities will be available for workers and open range defecation will not be countenanced. - Construction workers will be provided with and educated to wear suitable Personal Protective Equipment (PPE) including hard hats, overalls, high-visibility vests, safety boots, earplugs, gloves etc.

Impacts	Description of mitigation measures
	- Enforce use of PPEs at all times for all staff and labourers and ensure supervision of the same to minimize accidents - Construction workers should be educated to adhere to basic rules with regard to protection of public health, including most importantly hygiene and disease (HIV/AIDS) prevention.
Impacts on cultural heritage / archaeological interest / existing ecologically sensitive areas	- The pre-construction surveys should identify cultural heritage resources and existing ecologically sensitive areas that the project should avoid and by-pass these resources. - The Project should implement a chance find procedure and reporting system to be used by contractors in the event that a cultural heritage feature or ecologically sensitive item/issue is encountered.
Impacts on human health and public safety	- The Project will require all contractors to implement an Environmental, Health and Safety (EHS) plan which will outline procedures for avoiding health and safety incidents and for emergency medical treatment. This will be achieved by making it a component of contractual agreement. - Contractors will be required to wear suitable Personal Protective Equipment (PPE) including hard hats, high-visibility vests, safety boots and gloves and life vests as appropriate in accordance with the EHS plan. - Enforce use of PPEs at all times for all staff and labourers and ensure supervision of the same to minimize accidents - All construction and other workers will be sufficiently trained in the safe methods pertaining to their area of work to avoid injuries.
Labor Influx Management	- Develop site-specific measures before the contractor starts work, and update them as necessary to reflect project developments. Overall, adequate monitoring and adaptive management of the potential impacts from labour influx are key to properly addressing them and mitigating risks. Recruit as many local workers from the areas as possible. Provide training for the local communities to acquire skills needed for work opportunities if there is reasonable time especially on monitoring and maintenance. - Develop a Labour Influx Management Plan and Workers Camp Management Plan for all projects. Outline the contractor's responsibilities on influx management in contracts.
Impact on gender access to water for household use and other usage	- The project will take into consideration the different needs for water and types of access which will be affected for each of these groups and provide relevant mitigation measures which will be decided with those affected. Some mitigation measures could include water points for household use and livestock; livelihood assistance to those whose whole or partial livelihood will be affected as a result of some of the possible investments such as dams. Specific impact and relevant measures will be covered by project specific social assessment.
HIV/AIDS Spread and other related public health diseases –Water borne diseases etc.	- Design HIV/AIDS awareness, sensitization and prevention program for each project that extends to the communities as a whole; - Design programs for reducing the spread of water borne diseases like Malaria, Bilharzia etc. in collaboration with the Ministry of Health
Labour and employment related impacts	- Ensure that the local communities are given priority in relation to employment and provided with training (skilled) to provide future labour in the project e.g. operation and maintenance. Ensure that workers are provided satisfactory working conditions and work environment including pay in accordance with the laws of the country - Ensure that child labour is not tolerated in the project; - The project to prepare redundancy plans and packages to be discussed with affected workers which will include re- training and re- tooling of affected workers and aim to avoid labour strife

Source: BESST Ltd, expert's assessment, 2019

7. PUBLIC PARTICIPATION AND CONSULTATION PROGRAM

7.1. Overview

JICA Guidelines requires the Borrower in principle, project proponents etc. to consult with local stakeholders through means that induce broad public participation to a reasonable extent, in order to take into consideration the environmental and social factors in a way that is most suitable to local situations, and in order to reach an appropriate consensus. At national level, public consultation and stakeholders engagement is recognized as important component of environmental studies and expropriation process.

The consultation and engagement process focuses on providing information on the proposed project in a manner that can be understood and interpreted by the relevant audience, seeking comment on key issues and concerns, sourcing accurate information, identifying potential impacts and offering the opportunity for alternatives or objections to be raised by the potentially affected parties; non-governmental organizations, members of the public and other stakeholders. Consultation has also been found to develop a sense of stakeholder ownership of the project and the realization that their concerns are taken seriously, and that the issues they raise, if relevant, are addressed.

Further, 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. 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.

7.2. Purpose public consultation and stakeholders engagement

- To prepare communities on potential emergency scenarios that could be caused by the project and can affect the community.
- To build a trusting relationship with the affected communities and other interested stakeholders based on a transparent and timely supply of information and open dialogue.
- To ensure effective engagement with local communities and other 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.

7.3. Stakeholders analysis and consultation approach

7.3.1. Stakeholders analysis and identification

The first step in public consultation and stakeholder's engagement is to identify and analyse key stakeholders involved in the projects, programs or plans. Stakeholders may include public institutions, private sector; Community based organization and civil society, development partners and affected communities.

For this Master Plan, key stakeholders were identified in public institutions dealing with water supply, water resources and environmental regulations at both local level and central level. Other stakeholders include development partners, private sector, NGO and community based organization. At this stage, affected are not yet identified and will be identified and consulted during the implementation of Master Plan. Key stakeholders and authorities with whom consultations made at the project study areas were:

- **Government institutions at central level:**
  - Ministry of Environment(MoE);
  - Ministry of Infrastructure(MININFRA)
  - Rwanda Water and Sanitation Corporation Limited (WASAC Ltd)
  - Rwanda Environment Management Authority (REMA)
  - Rwanda Development Board (RDB).
  - Rwanda Water and Forestry Authority(RWAF)
  - Rwanda Land Use and Management Authority
  - Kigali City Council(KCC)
  - Rwanda Energy Group(REG)
  - National Institute of Statistics in Rwanda(NISR)
  - Rwanda Utilities regulatory Authority (RURA)
  - Rwanda Transport Development Agency(RTDA)

- **Development partners and private operators in water supply**
  - United Nations Children Funds (UNICE;
  - Japan International Cooperation Agency (JICA)
  - Japan Embassy
  - Water for People;
  - World Vision;
  - African Development Bank(ADB)
  - Private Operators

At local level:

- Districts officials (Gasabo, Kicukiro, Nyarugenge, Bugesera, Kamonyi Rwamagana and Rulindo

7.3.2. Public participation – methods and process

During the Public consultation, the study team applied and shall apply different participatory methods, namely; one-to-one discussions and official meetings with stakeholders. One to one consultation were mainly used during data collection and focused on decision-making body, regulatory institutions, local administration and private operators. Official consultation meetings were organized and held through Joint Coordination Committee (JCC) and larger Stakeholders meetings. Stakeholders consulted was informed on the proposed Master Plan, SEA and feedback/ information obtained was be incorporated in Master Plan and in SEA.

7.3.3. Information disclosure

Information disclosure is key in Master Plan Development and Strategic Environmental Assessment. It is required that project proponent proactively release relevant information to the public. By sharing information with a wide range of stakeholders from the early stage, the project proponent can utilize their feedback to improve the plan/project. In addition, the project proponent can ensure that unnecessary concerns and misunderstandings among the stakeholders are improved.

In this regards, WASAC (as project proponent) held the first Stakeholder Meeting on July 2019 and informed public about overall objective of study and implementation plan for the Project. Here are the key public participation / consultation events during Master Plan development.

- 2019 July 1st Stakeholder Meeting
  - ✓ Announce kick-off of the study
  - ✓ Analysed stakeholders
  - ✓ Establish information flow via media
- 2020 February 20th thematic Working Group meeting
  - ✓ Hold preliminary meeting for major stakeholders (such as Sector Working Groups coordinated by MININFRA)
  - ✓ Present result of SEA

This meeting replaced the second stakeholder meeting that was planned as it was overlapping with Joint coordination committee meeting held on February13th, 2020.

7.4. Consultation during Master Plan and SEA preparation

During the preparation of Master Plan and strategic environmental assessment two Joint Coordination meetings and two stakeholders meeting were held. The following sections presents key objectives and outcomes of these meetings. List of participants are also attached to this strategic environmental assessment as annexes.

7.4.1. First JCC and stakeholders meeting

The Joint Coordination Committee (JCC) meeting on progress of the preparation of Kigali Water Supply Master Plan was held on July 26th, 2019 in Kalisimbi Hotel. The meeting was attended by WASAC official, JICA study team, Representative of JICA, Representative of Japan Embassy in Rwanda, Representative of Ministry of infrastructure(MININFRA), Rwanda Water and Forestry Authority(RWAF), Rwanda Utility Regulatory Authority(RURA), Rwanda Transport Development Agency (RTDA), Rwanda Energy Group(REG), City of Kigali. Representative of Kamonyi, Rwamagana, Bugesera and Rulindo District attended also the meeting. The objective of the meeting was to present the progress made on the preparation of Master Plan and the next steps.

Under the facilitation of Mr. Innocent Gashugi, Manager of Urban water and sanitation, two presentations were provided by JICA study team. The first presentation provided by chief consultant of JST focused on project background and objectives, project schedule and subcontracted works summary of progress report and existing status and issues. The second presentation was provided by deputy Chief consultant of JST and focused on water demand projection and way forward. After each presentation the audience was given opportunity to provide comments, ask questions or give suggestion. Response were provided by JICA study team and WASAC.

The JCC meeting was followed by stakeholders meeting held on On August 6th 2019, the Water & Sanitation Cooperation (hereinafter referred to as "WASAC"), leading Agency for the Project for Water Supply Master Plan for City of Kigali in the Republic of Rwanda (hereinafter referred to as "the WASAC/JICA M/P"), held first stakeholder meeting for explaining progress of the WASAC/JICA M/P under the scheme of technical cooperation supported by Japanese International Cooperation Agency (JICA).

Participants to the meeting include stakeholders from various institutions in Rwanda, Embassy of Japan in Rwanda, JICA Rwanda office, and the Working Team members that includes counterpart (C/P) of WASAC and JICA Study Team headed by Mr. Mamiya Takemasa, with the members from Nihon Suido Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd., from Japan to implement the WASAC/JICA M/P. Various national media were also invited to cover the meeting. The list of all participants is presented as annex 10.

The purpose of the stakeholder meeting was: (i) to inform stakeholders the progress made on study (future water demand and social-economic scenario), (ii) to invite local stakeholders for participation and provision of opinions into decision making process comments and inputs to the WASAC/JICA M/P and, (iii) to develop contacts list and communication channel for the WASAC/JICA M/P. Important comments, suggestions and opinions provided are summarized as follows:

1) **Linkage of Kigali Master Plan and other master Plans:** all Stakeholders confirmed the importance of aligning the other ongoing Master Plan such as City of Kigali Master Plan (CoK M/P), National Water Supply and Sanitation Master Plan (AfDB M/P) and existing integrated Water Resource Master Plan. The study team confirmed that the Water Supply Master Plan is being developed in considering other master plans.
2) **Spatial Coverage of study:** some stakeholders suggested to include more sectors which are outside of Kigali such as Kinzuzi and Ntarabana on the Kigali-Byumba Road. They are showing signs of development to be urbanized. It was clarified that the WASAC/JICA M/P will cover Kigali city and seven adjacent seven (7) sectors and other areas are covered under National Water and Sanitation Master Plan based on the Record of Discussion.

3) **Measures to reduce Non-revenue water:** It was confirmed that in addition to the proposed increased number of staffs, other technological measures should be considered in order to reduce non-revenue water. The study team and WASAC informed that practical measures will be studied in the Master plan.

4) **Definition and setting of service ratio:** All parties suggested that the way of explanation on service ratio should be revised. Especially, the service ratio for individual house connection, public tap, and sharing connection are considered as important indexes which targeted the total service coverage reaches 100% in 2024. In this regards, the given figure of those indexes by the study was inconsistent with the existing study such as EICV5 by NISR.

5) **Source of water:** Stakeholders suggested that all source of water, including surface water, ground water, and rainwater should be explored and identified. Further, stakeholders requested an assessment of the efficiency of ground water abstraction and surface water abstraction in current production, and then advise on future projects.

6) **Population and Water Demand Projection scenario:** Some stakeholders suggested that both low, medium, and high growth scenario should be assessed. Further, it was suggested that the target for service coverage of the intermediate target might be optimized. The study team took note of the suggestion. The current scenario was considered to be on the safer side to be aligned with other development plans such as the CoK M/P that considers high growth scenario.

7) **The production capacity of the private operators:** Some stakeholders indicated that the production capacity of the private operators is not covered in the study. Currently, there are several private operators

having a business in the area, and it should be considered in the project.
Minutes and list of participants are provided in annex 9 and were disclosed at WASAC website.

7.4.2. Thematic working group meeting held on February 20th, 2020

The second stakeholder meeting was held during the water sector technical working group (TWG) on 20th February, 2020. Presentations focused on Interim Report including master scenario and priority projects, the Project for Water Supply Master Plan for City of Kigali (WASAC/JICA M/P). During the meeting JST and WASAC team presented:

- General overview of Master Plan;
- Financial & organizational issues;
- Update of demand forecast;
- Water resource development plan;
- Socio economic survey & SEA;
- Master scenario & candidate projects; and
- Way forward .

Important comments, suggestions and opinions provided are summarized as follows:

- The aim of Master plan study (WASAC/JICA M/P) is for achieving SDGs and the national target that aims at 100% access to safe water (500 m distance from a sources for rural and 200 m in urban).
- Big challenges are being laid out ahead the years to come for Rwandan side including WASAC and MININFRA to approach the SDGs targets as well as future demand according to the Study.
- Interim result of the Study implies that the huge investment is inevitable to cover future water demand and in this context he added that today's meeting to share the Study progress among the concerned development partners would help Rwandan side including WASAC and MININFRA to seek future financial sources.
- The Master Plan is being prepared as a sort of "technical cooperation program" under which the Rwandan side including C/P are actively involved in the process of planning with the JICA Study Team (JST).

Minutes of the meeting, summary of the Q&A as well as comments raised during the meeting are attached as annex 11 and list of attendance is attached as annex 12.

7.4.3. Third stakeholder consultaion meeting

A third stakeholder meeting was orginised and held in august 27th, 2021 in Kigali. The objective of the the stakeholder meeting was to disclose the information related the Master Plan to stakeholders and general public. Specifically, the meeting aimed to:

- To share MP (business plan of the WASAC) ;
- To share current standing point of the water supply sector and necessity of support from public and relating agencies.

Participates to the stakeholder meeting included representative from the City of Kigali, WASAC, representative of districts officials (Rwamagana, Bugesera, Kamonyi and Rulindo, representative of NGos working in water sector, JICA study team and members of Media.

The meeting focused on key findings of the Master Plan 15-Years Investment Plan, progress on Feasibility study for selected projects as well as key conclusions of Strategic Environmental Assessment (SEA). Participants were also provided with time to ask questions and provide comments and inputs to the presentations and overall Master Plan. At the end of the meeting, partictipants were shared the link where they can find Master Plan Materials and were urged to convey the message to the general public and invite to visit WASAC website to consultant details material related to the Master Plan. Detailed minutes of the meeting including questions and answers as well as the list of participants is provided in annex 13.

It is worth to point out that in addition to the stakeholder meetings conducted, WASAC used other communication tools including media and its website to disclose informarion related to Master Plan to general public. WASAC and the Ministry of Infrastructure are committed to continue with stakeholder's engagement during the implementation of the Master Plan.

7.4.4. Result of stakeholder consultaion meeting

Important comments, suggestions and opinions provided thought the three (3) meetings are summarized as follows:

- The aim of Master Plan study (WASAC/JICA M/P) is for achieving SDGs and the national target that aims at 100% access to safe water (500 m distance from a sources for rural and 200 m in urban) in 2024 and by 2050 every household in the City of Kigali will have water in its premises.
- The Master Plan is being prepared as a sort of "technical cooperation program" under which the Rwandan side including C/P are actively involved in the process of planning with the JICA Study Team (JST). "
- Big challenges are being laid out ahead the years to come for Rwandan side including WASAC and MININFRA to approach the SDGs targets as well as future demand according to the Study;
- The result of the Study implies that the huge investment is required to cover future water demand;
- Stakeholder engagement was used to share findings and progress of study to different development partners who would help Rwanda to mobilize financial sources required for the implementation of the Master Plan;

8. IMPLEMENTATION AND MONITORING PLAN

This section gives specific description, and technical details, of monitoring measures for developed Mitigation Measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, and definition of thresholds that will signal the need for corrective actions as well as deliver a monitoring and reporting procedure. The monitoring of this SEA will be linked with the overall monitoring of the master Plan and at the first level, the monitoring focus on the preparation of specifics instruments such as EIA, and RAPs.

8.1. Monitoring plans and indicators

The goal of monitoring is to measure the success rate of the project, determine whether interventions have resulted in dealing with negative impacts, whether further interventions are needed or monitoring is to be extended in some areas. Monitoring indicators will be very much dependent on specific project contexts.

8.1.1. Monitoring levels-overall Master Plan level

WASAC will be responsible for overall monitoring and reporting on compliance with the SEA. WASAC will ensure that sub projects investments are screened, their safeguard instruments prepared, cleared and disclosed prior to sub project approval. Further, WASAC will ensure that contractors implement the specific sub project ESMP, and submit reports on ESMP implementation as required. Within WASAC , monitoring and surveillance of all the sub project investments will be undertaken by the Environmental and Social Safeguards Specialist within the WASAC.

Table 67 : Monitoring indicator

Monitoring Level	Monitoring Issue	Verifiable Indicators	Responsibility
SEA level	Adequate dissemination of SEA to stakeholders Capacity building and training programs	Record of consultations and meetings; Workshop reports	WASAC Ltd
	Preparation of environmental and social impact assessment report Environmental permitting Monitoring and evaluation	- Independent consultants hired to prepare EIA and/ RAP documents - Environmental Permits for sub projects - Environmental Management Plans, - Monitoring Reports, - Annual Environmental Reports	WASAC Ltd

Source: BESST Ltd analysis, 2020

8.1.2. Sub project level monitoring

The second level of monitoring will be at the sub project level where the safeguard instruments for the investments will and must include a monitoring plan for which the WASAC will be responsible for ensuring that monitoring is carried out. All sub project investments will be subject to mandatory annual environmental audit /supervision to ensure that they comply with the Organic Law. Specific monitoring indicator will be included in Environmental and Social Monitoring Plan during the preparation of ESIA of subprojects. The next table presents some of the monitoring indicator based on key environmental and Social Impacts anticipated from proposed investments.

Table 68: Project monitoring indicators and responsibilities

Impact issue	Proposed action/ measures	Implementation tool/criteria	Monitoring indicators (inputs)	Monitoring indicators (outcomes)	Verification	Project stage	Responsibility
Solid waste disposal	Provide adequate waste reception facilities at construction camp sites Dispose of waste at approved waste collection sites	Waste management plan/Construction site management plan	Number of waste bins at site bins Availability of waste disposal plan Final disposal records	Percentage of workers who follow the solid waste disposal plan including use of receptacles	Weekly checks by project engineer	Construction Operation	Contactor Project engineer
Waste oil/fuel disposal	Provide drums/containers for temporary storage on site of waste oil from equipment and vehicles.	Waste management plan/Construction site management plan	Waste oil drums/containers on site Availability of waste disposal plan (waste oil)	Number of workers familiar and aware of the waste disposal plan	Monthly checks by project engineer	Construction Operation	Contactor Project engineer

Impact issue	Proposed action/ measures	Implementation tool/criteria	Monitoring indicators (inputs)	Monitoring indicators (outcomes)	Verification	Project stage	Responsibility
Air pollution	Purchase sound equipment/machinery for project Operate well maintained vehicles, trucks and other equipment Use good quality fuel and lubricants Suppress dust generation at project sites	Part of contract agreement Routine maintenance plan for machinery Purchase of fuel at recognized stations Schedule of works is to limit site.	Number of sound machinery and equipment purchased Availability of equipment and machinery maintenance plan Frequency of watering of surfaces to reduce dust related impacts	Percentage of workers following the good practices for equipment and machinery maintenance	Independent check by project engineers Verification of maintenance record by project engineers Self-check by contractor	Construction	Contactor / Project engineer
Noise pollution	Schedule of works is to be limited to daylight hours; Compliance with the noise emission levels/standard Provision of PPE and train workers on the use of PPEs for noise mitigation and reprimand those not complying	Part of contract agreement for the contractors	Recorded grievances Number of PPE procured for noise mitigation	Number of workers correctly and frequently using PPEs	Self-check by contractor	Construction	Contactor / Project engineer
Traffic impacts	Use only road worthy vehicles and trucks; Use experienced drivers; Contractors must provide driver training; Establish speed limits,	Purchase sound vehicles and trucks /machinery for project Driver qualification recorded Traffic Safety Plan	Traffic incidence records Grievances Recorded	Number of drivers aware and familiar with the traffic safety plan Percentage of drivers who have not committed a traffic offence for the last 6 months	Project engineers to verify	Construction	Contactor / Project engineer
Water pollution	No garbage/refuse, oily wastes, fuels/waste oils should be discharged into drains or water bodies Fuel storage tanks/sites should be properly secured Maintenance and cleaning of vehicles, trucks and equipment should take place offsite. Provide toilet facilities for construction workers	Waste management plan Spill prevention and control plan Water Quality Plan to measure the quality of water including physical, chemical and biological. Implement an Integrated Pest Management Plan when using fertilizers and pesticides	Visibility of oil on water bodies Procurement and installation of water monitoring and measuring gauges On site erosion observed Proposed actions implemented Quality of water following periodic measurements	Increased water quality upstream and downstream shown by periodic measurements Water samples collected showing compliance to water pollution standards	Daily self-checks by contractors Periodic reports on performance by contractor to project engineers Spot checks/audits by project engineers	Construction Operation	Contractors /Project engineers Project engineers

Impact issue	Proposed action/ measures	Implementation tool/criteria	Monitoring indicators (inputs)	Monitoring indicators (outcomes)	Verification	Project stage	Responsibility
Water quality	Protection of watersheds and water catchment	Watershed Management Plans	Number of watershed protected	Improved Water quality	Results of water quality sampled	Annually	Rwanda Water Board
Water balance	Monitoring water balance through water abstraction permit	Water abstraction permit, Water Resource Management Plan	Water balance in Catchment	Balanced Water level maintained	Measured water level	Annually	Rwanda Water Board
Impact on fauna and flora	Avoid unnecessary exposure or access to sensitive habitat. Avoid protected areas, critical habitats or areas with significant biodiversity (wetlands)	If a sensitive habitat is discovered in the work area or vicinity, Project activities should cease.	Wildlife incidents recorded and reported	Number or percentage of terrestrial flora and fauna unaffected by the sub projects	Regular self-checks by contractor Spot checks and audit by contractor to the client	Construction Operation Maintenance	Contractors /Project engineers/

Table 69:Project monitoring indicators and responsibilities-social impacts

Impact issue	Proposed action/ measures	Implementation tool/criteria	Monitoring indicators (input)	Monitoring indicators (output)	Verification	Project stage	Responsibility
Impacts on downstream water users	Maintain Environmental Flows for river basins Ensure that abstraction of water complies with the water abstraction permits	Environmental Flows Plan	Presence of an Environmental Flows Plan calculated and approved by water abstraction agency Availability of Water Abstraction Permit from Water regulation agency	Impacts on water uses and livelihoods downstream	Regular spot checks by water regulation agency Periodic checks of the flows by environmental team	Construction Operation	Contractor WASAC REMA Water regulation agency
Impacts on recreation and public areas	Place notices and warning signs at working areas	ESMP	Grievance records	Recreational Facilities and areas restored/protected	Warning signs/notices in place	Construction	Contractors/Project engineers
Impacts on Human Health/ Safety and sanitation	Cover buckets of trucks carrying construction materials such as sand, quarry dust, etc. Use road worthy vehicles/trucks and experienced drivers/operators Active construction areas to be marked with high-visibility tape Provide adequate sanitary facilities Provide PPEs for construction workers. Educate construction workers on site rules/regulation and hygiene and disease (HIV/AIDS) prevention.	ESMP Vehicle maintenance programme /plan in place Construction site management plan ESMP	Health and safety incident register Grievance records	Reduced accidents and hazards in construction sites Reduced incidence of diseases spread e.g. HIV/AIDS, and other STDs Increased understanding of workers on measures to reduce STDs/HIV/ AIDS etc.	Health and safety plan under implementation Daily self-checks and verification by contractor Spot checks by project engineers Periodic reports by contractor to project engineers	Construction	Contractors

Impact issue	Proposed action/ measures	Implementation tool/criteria	Monitoring indicators (input)	Monitoring indicators (output)	Verification	Project stage	Responsibility
Impacts on cultural heritage/ archaeological interest /existing aquatic infrastructure and services	Identify cultural heritage resources and existing ecologically sensitive areas.	Pre-construction surveys / Chance Finds procedure Plan for accidental Cultural Finds	Cultural/ archaeological resources/ existing infrastructure encounter incidence register	Number of workers familiar with the chance find procedures	Chance finds procedure under implementation Daily self-checks and verification by contractor	Preconstruction and construction and repairs/ recovery	Contractors
Impacts on Human Health and Safety	Use suitable Personal Protective Equipment (PPE). Provide Training on use of PPE	ESMP	Health and safety incident register Grievance records	Reduction in or increase in accidents due to use of or lack of use of PPEs	ESMP under implementation Spot checks and observations by project engineers	Pre-construction and construction, and repairs/ recovery	Contractors
Labour related impacts (Employment)	Ensure that the local communities are given priority in relation to employment and provided with training (skilled) to provide future labour in the project e.g. operation and maintenance	Human Resource Management Plan	Number of local residents employed in sub projects	Number of local residents employed in sub projects	Employment Records	Pre-construction and construction, and repairs/ recovery	Contractors/EA

Source: BESST Ltd analysis, 2020

8.2. Monitoring Roles and Responsibilities

8.2.1. Water and Sanitation Corporation (WASAC)

WASAC will be solely responsible for the environmental and social monitoring of the activities under Kigali Water Master Plan. WASAC will be required to prepare periodic (monthly, quarterly and annual) monitoring reports for all sub projects subjected to further environmental analysis for submission to the JICA or other donors involved in projects under Master Plan and REMA. WASAC will be responsible for appraising and approving sub-projects, organizing the management and implementation of sub-projects, and supervising the implementation of sub-projects, including the implementation of safeguards activities.

8.2.2. Rwanda Environment Management Authority (REMA)

The Organic Law on environment places the responsibility of environmental protection on REMA as the coordinating agency. REMA is charged with the overall role of providing oversight in regard to monitoring for all project activities that have potential impacts on the environment in Rwanda. REMA will undertake periodic monitoring of the investment projects by making regular site inspection visits to determine compliance with the investment projects ESIAs approved and will further rely on the submitted annual audit reports submitted for each investment project annually as required by Organic Law as a way of monitoring.

8.2.3. Rwanda Water Board

Rwanda Water Board is responsible for sustainable water resources management in the country and it has the responsibility to issue water abstraction permit, monitor water quality and to ensure water balance. It will also ensure distribution of water resources among water users and advise on initiative aiming at ensuring water quality.

8.2.4. Rwanda Development Board (RDB)

RDB will provide approvals and ESIA license to all the investments based on the ESIA reports submitted, without RDB's approval implementation of the investment project will not move forward.

8.2.5. WASAC -Social and environmental specialist

WASAC has a strong team of environmental and social Specialists who will provide oversight, screening of sub projects, preparation of ToRs for EIAs, facilitation, coordination, review of EIAs, monitoring and evaluation of all the sub projects.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1.Conclusion

This study has included findings regarding baseline information on area targeted by the proposed Master Scenario for water supply in the City of Kigali and adjacent 7 Sectors. It is meant to incorporate ESC (Environmental social consideration) into water supply scenario derived from selection of optimal water source development scenario. Followings are major findings of this study.

- By developing ground water as a main source of water treatment plant, there shall be positive and negative environmental impact in each site. However, in each candidate site, it will not cause significant irreversible impacts on surrounding environment and community.
- Compared with surface water from Akagera River, utilization of ground water has advantage on water quality and climate change adaptation measure.
- Even this scenario expecting surface water development in later stage, it is expected to have low to moderate impact on environment
- Regulations for EIA in Rwanda have no much difference with JICA's guideline 2010 and World Bank Safeguards Policies. Major difference is procedure regarding information disclosure and public consultation etc. There are several minor differences between them. But they are basically consistent with JICA's guideline.
- The proposed water supply scenario is aligned with Vision 2020, NST1 and series of plans and policies set out by the Rwanda Government. The development following this scenario shall comply with plans and policies of Rwanda's development.
- Without-project Option can't be considered and the team recommends to implement better ranked options with the implementation and strategic options recommended as well as mitigation measures for identified impacts.

9.2.Recommendation

Basically construction of water treatment plant and urban water supply system is requiring full-scale EIA by REMA's Guideline for Environmental Impact Assessment for Water Resources Management in Rwanda 2009 March. Actual implementation of projects listed in Master Plan following Master Scenario may be subject of application of EIA Therefore, Project proponent should start application EIA for prioritized projects. Followings are points to consider.

- EIA shall be implemented based on procedures stipulated in Rwanda's Environmental Law
- EIA should carry out by project proponent at candidate sites following International Guidelines and/or Rwanda's Guideline such as "Guideline for Environmental Impact Assessment for Water Resources Management in Rwanda 2009 March"
- In case it requires to evaluate potential evaluation survey, EIA should carry out at candidate site before the survey and even after the survey.
- In Accordance with the result of the survey, EIA should revised (require additional study)
- It is required to earn approval for EIA before the application of operation license
- Resettlement implication will be assessed during EIA preparation and a decision should be made whether a RAP is required or not.

Other permits required prior construction and operation of proposed infrastructure include water abstraction permit and construction permit. Application of these permits shall be made upon the availability-required documents such as hydrological study, final designs and EIA studies.

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Annex 1: List of Development Projects

Project title		Component	Background	Possible project content in brief	Remarks
A1	**Construction of Masaka WTP and Clear Water Transmission & Distribution Facilities**	Construction of well field and WTP in Masaka **(Phase 1: 20,000 m^3/day,** **Phase 2: 20,000 m^3/day** **Phase 3: 40,000 m^3/day)** **Phase 4: 40,000 m^3/day)**	- Water demand growth on the eastern side of the city is urgent and large (i.e., Masaka, Ndera, Rusororo). Due to the insufficiency of the current supply capacity residents in this area is hard to access safe and steady water supply service. - It is more efficient to utilize water source at Masaka near the demand area instead of conveying water from other existing WTPs. - New transmission pipes and distribution reservoirs and reinforcement of the distribution network are required for the water supply expansion.	**(1)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) **(2)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) **(3)Construction of distribution network in Masaka Area**	* Land acquisition is required for water wells and a treatment plant * Demand is yet to be high in the Masaka sector in 2019. Expansion in the phased manner should be considered. In addition, the water transmission to the other area (Ndera, Rusororo, Nyarugunga) should be considered (Additional cost is required). * (3) Construction of distribution network may be omitted (Existing distribution networks can be utilities for the moment).
A2	**Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities**	Rehabilitation of intake facility and Expansion of Karenge WTP **(Phase 1)**	- The intake pumps are damaged, overloaded and vulnerable to the flooding risk. The intake pumps are below the flood level of Mugesera Lake and can be affected by water during the rainy season. An old raw water intake pipe (ND300) is damaged and not working properly. - The existing WTP in over-load operation; forced to operate 18,000 m^3/day while the capacity is only 15,000 m^3/day. Incidental maintenances of pumps and resulting water supply interruption are a serious problem since they are fully operated with no standby. - Demand in the eastern area is as large as 52,000 m^3/day in 2025, and 89,00 0m^3/day in 2035 only for Ndera, Rusororo, Masaka and upcountry three sectors. It is necessary to make the most of the already acquired water right of 48,000 m^3/day permitted by RWFA.	**(1)Rehabilitation of intake facility** - Rehabilitation of Raw Water Transmission pipes (ND300) - Relocation of the pump house and upgrading the capacity of pumps and motors **(2)Expansion of Karenge WTP** Expansion of WTP capacity from 15,000m^3/d to 18,000 m^3/d (Filtration Basins, Clear Water Reservoirs)	* Land acquisition for the next step (for approx. 40,000 m^3/d) is required. * Without increasing capacity of CW transmission pipes, additional head with approx. 40 m is required (i.e., energy efficiency goes down).
		Expansion of Karenge WTP and forwarding infrastructures **(Phase 2: 30,000 m^3/day)** **(Phase 3: 50,000 m^3/day)**		**(3)Expansion of Karenge WTP and forwarding infrastructures** - Expansion of Intake and WTP for 30,000 m^3/d (Intake pumps, Treatment facilities, Clearwater reservoirs and pumps - Construction of New Transmission Pipelines (ND700, L= 33 km)	* Eutrophication of Mugesera lake is concerned because of the development of the surrounding area. Further monitoring, water safety planning, coordination with the stakeholders, and additional treatment facilities may be necessary.
A3	**Expansion & renewal of Nzove 1 WTP**	Expansion/ renewal of well fields of Nzove 1 **(40,000 m^3/day)**	- Nzove well fields and treatment facilities are the largest and the most important existing water sources for the City of Kigali. However, the yield capacity for the existing wells for Nzove 1 is declining (40,000 m^3/d to 17,000 m^3/d). Because of the declination of its production capacity, the on-going transmission pumps and pipes to Ntora may not be fully utilized. - The procurement process for upgrading existing WTP is on-going, however, it may be unsuccessful because the current condition of the structure is poor thus the technical difficulty on the rehabilitation of existing facilities is high. - The current treatment system is not efficient in terms of O&M because it uses intermediate pumps which can be omitted in an appropriate treatment system.	**(1)Expansion and renewal of well field of Nzove 1** □Expansion of well field for Nzove 1 (23,000m^3/d). **(2)Expansion/renewal of Nzove 1 Treatment Facilities** □Scrap & build of Nzove 1 (40,000 m^3/d) □Water source: wells (sub-surface water).	* This component is not necessary if on-going procurement for the rehabilitation of Nzove 1 is successful. * This rehabilitation of the Capacity of Nzove (up to 25,000 m^3/day) was described as "borne by WASAC" as a precondition of the Nzove-Ntora transmission project by Japan's Grant Aid. * Land acquisition for expansion (western side of the existing area is one of the most probable options but it may involve small-scale relocation).

Project title		Component	Background	Possible project content in brief	Remarks
A4&5	**NRW reduction project through pipe renewal and pressure control**	Comprehensive NRW reduction investment	- The reduction of the high NRW ratio (38% in 2019) is the most important challenge in WASAC. Major causes of high NRW ratio are attributable to the leakages from the aged pipes, poor pipe materials and construction. Difficulty in controlling regional high pressure due to hilly geographical characteristics, poor quality of pipe material as well as poor workmanship of its installation works, and leakage from aged existing pipes. Accordingly, pressure control in the transmission and distribution system as well as the renewal of aged distribution pipes and service connection facility is necessary. - WASAC is currently focusing on the expansion of the new service area due to the rapid growth of water demand. Therefore, it does not have sufficient resources to allocate for the renewal of facilities.	**(1) Block zonings, metering and identifying pipelines to be replaced (e.g., deterioration diagnosis of aged pipes)** **(2) Renewal of service pipes and meter replacement for leakage reduction** Performance-based contract, Procurement of material plus installation work, or Procurement of material only **(3) Maintenance services for NRW reduction** Establishment of the preventive maintenance system	* Design-Build (DB) or Performance-Based Contract (PBC) scheme may be applicable for constructing distribution blocks, identifying pipes to be replaced and implement the replacement. * It is not clear whether potential contractors show interest in this project. * Justification of the project effect would be difficult ("Improvement of business management"" and/or ""increasing available volume of water resource" could be itemized as one of the project effects but those are not necessarily well-explained to the public)
	Part 1: Kacyiru/Remera (North))	Improvement of the high-pressure area through distribution blocks constructions	- Clearwater transmission capacity from Nzove to Ntora is being upgraded by Japan's Grant Aid. However the water is not effectively utilized because of the poor distribution facilities from Ntora to the Remera sector. - A pilot area of Japan's technical cooperation project on NRW reduction is in the midst of the distribution main. Additional investment in the facility will accelerate disseminating the successful experience on the NRW reduction. - Many leakage cases were observed in the southern side of the Ntora area due to high pressure. The introduction of appropriate zoning of the distribution system will contribute to solving this issue.	**(1) Construction of Service Reservoirs** □Service reservoirs (V=100-500m^3, 7 nos.) □Elevated Tanks (V=50-100m^3, 6 Nos) □Flow meters (ND150, 13 nos.)) □Appurtenant facilities (Pipes, Valves and miscellaneous) **(2) Modification of existing/on-going SCADA system** **(3)Construction of Transmission Pipeline** □ DIP ND600 L=3.5km **(4) Construction of Distribution Pipelines** □Distribution Mains (ND150-200: 20 km)	* Land acquisition required for reservoirs. * Procurement of service pipes presumes the construction capacity development and monitoring by the Japanese Technical Cooperation project for NRW.
		Procurement of service pipes for replacement		**(5) Procurement of secondary distribution and service pipe equipment** Secondary distribution pipes (ND 63-110: 90km) Service pipes (ND13-25: 200 km)	
A6	**Capacity development for Sustainable Use of Water Resources and Water Supply Facilities**	Technical Assistance	- The on-going Japanese cooperation (TC) project on NRW management demonstrated successful achievement in the pilot areas. It is necessary to scale-up and disseminate the experience to the entire CoK and surrounding area. - On the other hand, the challenges of WASAC are diversifying in line with the rapid expansion and development (e.g., development of water source including wells and its proper O&M, NRW reduction measures, facilitating financial independence, organization reform.). - Improvement of financial situation is one of the urgent issues considering the fact that the business profit is negative. Improvement of	Technical Assistance from international donors - Water resource development and its O&M (O&M for wells) - NRW reduction - Planning/ design/ construction supervision - Strengthening capacity of water quality monitoring - Improvement of financial status and facilitate self-reliance - Organization reform	- Broader involvement and engagement of other stakeholders (e.g. MININFRA, RWFA, RURA) are expected.

Project title		Component	Background	Possible project content in brief	Remarks
			efficiency is the key to the sustainable management of the utility.		
A7	**Kigali Central Transmission Main**	Kigali City central trunk main (Nzove WTP to city west)	- The availability of the potential water source in the middle- and down-stream of the Nyabarongo River is limited. Under this circumstance, transmission from Nzove to the eastern side of the city should be considered. - The existing transmission route through Nzove and Mont-Kigali to Remera is inefficient. This is because they are transmitted from the high elevation mountain as well as the route is diverted from the city center and thus is a long way to the eastern area	- Transmission Pipeline (Nzove-Kimisagara-Remera) (18.4 km, ND 800-1,000 mm) - Transmission Pumping Stations and Pumps - (Nzove H=70m, Kimihurura H=125m) - Distribution Reservoirs(Kimisagara, Kimihurura)	- Land Acquisition is required for reservoirs and pumping stations
B2	**Nzove 3 Water Treatment Plant**	New water source and water supply facilities in order to cover demand in 2050. **(40,000 m^3/day)**	Construction of new facilities at the right bank (the opposite side) of the existing WTPs in Nzove including the followings: New intake facility in case of taking river water, or new well-field in case of taking groundwater (sub-surface water).RW transmission facilities.	- Water Well Field - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	Feasibility Study including water sources survey and a large area of land acquisition
B3	**Rutonde Water Treatment plant**	New water source and water supply facilities in the upstream of Nyabarongo from Nzove. **(Phase 1: 40,000 m^3/day, Phase 2: 40,000 m^3/day)**	Water supply facilities at both sides of the riverbanks in the Rutonde Area (7 km upstream of the Nzove WTP) in Nyabarongo River by 2050. Water source development (groundwater (subsurface water)) accompanied by its related RW transmission pipes and treatment facilities. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Well Field - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	- Feasibility Study including water sources survey and a large area of land acquisition
B4	**Nyabarongo WTP (Water supply facilities related to Nyabarongo II Dam)**	New water source and water supply facilities in order to cover demand in 2050. **Phase 1: 120,000 m^3/day** **Phase 2: 120,000 m^3/day**	To develop new water source and water supply facilities in order to cover demand in 2050. Nyabarongo II Dam that is for the purpose of hydropower generation and flood control is planned at the 20 km upstream of the existing Nzove WTP. De-sludging of accumulated bottom sediment would impact the O&M of WTPs at the downstream of Nyabarongo River. Intake, RW transmission pipes, WTP would be considered if the part of water can be used for drinking water	- Surface Water Intake - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes) - The primary sedimentation pond would be considered in case intake suspension is inevitable at the WTPs in the downstream during the discharging period of the bottom sludge from the Nyabarongo II Dam (by 2050?).	- This is subject to change of the Nyabarongo II Dam implementation.
B5	**Dam construction at the downstream of Yanze River**	New water source and water supply facilities in order to cover demand in 2050.	The dam at the downstream of Yanze River Intake, RW transmission pipes, WTP	- Dam (Single Purpose) - Surface Water Intake - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	- Resettlement, Environmental and social impact is large
B6	**Construction of small-scale water supply facilities including related**	New water source and water supply facilities in order to cover demand in 2050.	Construction of new well fields accompanied by its related RW transmission pipes and treatment facilities.	- Construction of wells - Pumping Stations - Pipelines	- Currently no candidate new sources are listed or nominated. Need a comprehensive water resources

Project title		Component	Background	Possible project content in brief	Remarks
	water sources (e.g., springs and small rivers and/or creeks)				survey in the City of Kigali and adjacent sectors.
B7	**Gahanga Water Treatment Plant**	New water source and water supply facilities in order to cover demand in 2050. (Phase 1: 40,000 m^3/day) (Phase 2: 120,000 m^3/day) (Phase 3: 120,000 m^3/day)	Water supply facilities on the left side of the Nyabarongo River. Water source development (groundwater (subsurface water)) accompanied by its related RW transmission pipes and treatment facilities. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Well Field - Water Treatment Plant - Forwarding infrastructures (Transmission and Distribution Pipes)	- Feasibility Study including water sources survey and a large area of land acquisition
B8	**Construction of new water supply facilities taking raw water from Akanyaru River**	New water source and water supply facilities in order to cover demand in 2050.	Water supply facilities with taking water from Akanyaru River. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Intake - Water Transmission Pipeline - Distribution Reservoir and Pipelines	<Not listed in the water resources utilization plan since this may not be feasible because of the location>
B9	**Construction of new water supply facilities taking raw water from Mutobo Spring**	New water source and water supply facilities in order to cover demand in 2050.	Water supply facilities with taking water from Mutobo Spring in Musanze District. Water source development (spring) accompanied by its related intake facility (in Musanze District), RW transmission pipes (tens of kilometers), treatment facilities (in Musanze or in Kigali).	- Water Intake - Water Transmission Pipeline - Distribution Reservoir and Pipelines	The Mutobo source is the main source of the Musanze District. The right to take the water to Kigali should be clarified.
B10	**Construction of new water supply facilities taking raw water from Kivu Lake**	New water source and water supply facilities in order to cover demand in 2050.	Water supply facilities with taking water from Kivu Lake. Water source development (surface water) accompanied by its related intake facility, RW transmission pipes and treatment facilities.	- Water Intake - Water Transmission Pipeline - Distribution Reservoir and Pipelines	Maybe Technically not feasible.
C1	**Others (combining with other projects can be considered)**	Installing additional valves for emergency response and redundancy of transmission & distribution system	Under the on-going TC project, flow meters are installed to monitor the inlet flow volumes for 6 (six) branches in and around Kigali City. However, the necessary valves to segregate each zone to facilitate proper operation (e.g., mutual transfer of water from zone to zone) are still lacking and this hinders WASAC from addressing incidents of leakage and/or pipe replacement works properly and timely.	- Adding shut-off valves to minimize the risk of supply failure attributed to major leakage and/or accident in WTP.	To be implemented combining with 1, 2, 3, 4, and 5 (Project cost scale: ranging from a few millions of Yen to tens of millions of Yen).
C2		Introduction of smart meter	Meter reading is difficult in some areas due to geographical restrictions. It may be solved by introducing smart meters in a new service area and/or replacing the existing meter with the smart meters. This could contribute to reducing NRW.	- Procurement of smart meters (pilot project, procurement of material) - Implementing along with NRW reduction measures and/or renewal of pipes.	WASAC has already initiated the procurement of smart-meters for 50,000 nos.
C3		Introduction of small-scale in-line hydropower generation	On the whole, WASAC's transmission and distribution system is not necessarily an efficient system in terms of energy consumption. Introducing in-line small-scale hydropower generation could be an option for improving the energy efficiency of the system.	- Introduction of the in-line small-scale hydro generator. - Construction of new WTP or combined with pipe renewal.	- Whether there is sufficient Q (flow) and ΔH (head) - Project cost scale: ranging from tens of millions of Yen to hundreds of millions of yen.

Project title		Component	Background	Possible project content in brief	Remarks
C4		Rehabilitation of small-scale WTPs the wells	Production capacities in some small-scale WTPs and/or wells are decreasing due to pipe breakage attribute to landslide near the site. In general, these kinds of small-scale water sources are close to their supply areas and those can take a role for the back-up source in case of emergencies. Therefore, considering those advantages, it is recommended for WASAC to continue keeping those small-scale sources to secure steady supply in future	- Rehabilitation of wells and pipes	- Supply capacity is at most several thousand m^3/d however cost would be low and taking effect instantaneously. - O&M cost for the small-scale WTPs (opinion of WASAC to be confirmed) - Most of the small-scale water sources are at risk of t the contamination by human activities. It is necessary to assess the possibility of sustainable use of water sources as well as water safety planning.
C5		Integrated SCADA system for entire Kigali City	SCADA system, furnished with monitoring devices such as the level gauge of reservoirs and flow meters for transmission and distribution system integrally, is not available. The content of the SCADA system component to be developed by the AfDB's assistance is not clear.	- Integrated SCADA system for monitoring the entire transmission and distribution system.	* SCADA is already furnished under AfDB's assistance. (present actual status to be confirmed)

Source: JST, Kigali Water Supply Master Plan, 2020

Annex 2: Sample ToRs for ESIA/ESMP study for subprojects

1. Background Information:
Describe the pertinent background issues. This should include a brief description of the major components of the proposed project, a statement of the need for the project, the objectives it is intended to meet, the implementing agency, a brief history of the project (including alternatives considered), its status and timetable, and a list any associated projects. If there are other projects in progress or planned within the region that may compete for the same resources, they should also be identified here.

2. **Objectives:** Summarize the general scope of the environmental assessment and discuss its timing in relation to the project preparation, design, and execution processes.

3. Study Area: Specify the boundaries of the study area for the assessment (e.g., water catchment area and land use), as well as any adjacent or remote areas that should be considered with respect to specific impacts (temporary infrastructure). The project could have different study areas corresponding to the level of impact.

4. Scope of Work: Define the tasks. In some cases, the tasks to be carried out by a consultant will be known with sufficient certainty to be specified completely in the terms of reference. In other cases, specialized field studies or modeling activities will need to be performed to assess impacts. In that case, the consultant will define particular tasks in more detail after some period of assessment and will submit the detailed scope of work to the District for approval at a later date. Task 4 in the Scope of Work (below) is an example of the latter.
Task 1: Describe the Proposed Project: Provide a brief description of the relevant parts of the project using maps of appropriate scale where necessary and include the following information:

- Project justification;
- Location;General layout, size, and capacity;
- Pre-construction activities;
- Construction activities;
- Schedule of activities;
- Staffing and support;
- Facilities and services;
- Operation and maintenance activities;
- Required offsite investments;
- Life span.

[Note: specify any other type of information relevant to the description of the project category.]

Task 2: Describe the Environment
Assemble, evaluate, and present baseline data on the relevant environmental characteristics of the study area. Include information on any changes anticipated before the project commences. Modify the list below to show critical project information (e.g., information relevant to the project category and other project-specific information). Avoid compiling irrelevant data. Present environmental characteristics of the study area on a map to facilitate the understanding.
[a] Physical environment: geology; topography; soils; climate and meteorology; ambient air quality; surface and ground water hydrology; coastal and oceanic parameters; existing sources of air emissions; existing water pollution discharges; and receiving water quality.
[b]Biological environment: flora; fauna; rare or endangered species; ecologically important or sensitive habitats, including parks or reserves, and significant natural sites; species of commercial importance; and species with potential to become nuisances, vectors, or dangerous (of project site and potential area of influence of the project).
[c]Socio-cultural environment: population; land use; planned development activities; community structure; employment; distribution of income, goods and services; recreation; public health; cultural/ historic properties; tribal peoples; and customs, aspirations, and attitudes.

Task 3: Describe and analyse the legislative and regulatory framework and issues
Describe the pertinent regulations and standards at international, national, regional and local levels that govern environmental quality, health and safety, protection of sensitive areas, protection of endangered species, site, and land use control. ToRs should specify those that are known and should require the consultant to investigate for others.

Then review and analyse relevant laws, regulations and guidelines that govern the conduct of the assessment or specify the content of the report, including international treaties, national laws and/ or regulations and/ or guidelines on environmental reviews and impact assessments.

Task 4: Determination of the Potential Impacts of the Proposed Project
Distinguish between positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts. Identify impacts that are unavoidable or irreversible.
Wherever possible, describe impacts quantitatively, in terms of the affected environmental components (e.g., area, number) and environmental costs and benefits. Assign economic values when feasible. Characterise the extent and quality of available data, explaining significant information deficiencies and any uncertainties associated with the predicted impacts. If possible, develop ToRs to conduct research to obtain the missing information. Identify the types of special studies likely to be needed for this project category.

The engineering plans should reflect "best practice" in alignment and construction to ensure that potential negative environmental impacts are minimised (e.g., through measures to prevent soil erosion risk, ensure proper drainage, and provide for waste disposal, landfill material, and used oil.

Task 5: Analyse the Alternatives to the Proposed Project
Describe alternatives that were examined in the course of developing the proposed project and identify other alternatives, which would achieve the same objectives. The concept of alternatives extends to site, design, technology selection, construction techniques and phasing, and operating and maintenance procedures. Compare alternatives in terms of potential environmental impacts; capital and operating costs; suitability under local conditions; and institutional, training, and monitoring requirements. When describing the impacts, indicate which are irreversible or unavoidable and which can be mitigated. Try to quantify the costs and benefits of each alternative, incorporating the estimated costs of any associated mitigating measures. Include the 'no project' alternative to demonstrate environmental conditions without the project.

Task 6: Develop the Management Plan to Mitigate Negative Impacts
The Environmental Management Plan focuses on three generic areas: mitigation measures, institutional strengthening and training, and monitoring. The emphasis on each of these areas depends on the context-specific project needs.

Mitigation of environmental impact: Recommend feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels. Quantify the impacts and estimate the costs of the mitigation measures.
Consider compensation to affected parties for impacts that 'cannot be mitigated. The plan should include proposed work programs, budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigation measures. Summarize the environmental impacts and mitigation measures using a map at the same scale as that of the road design.

Institutional strengthening and training: Identify institutional needs to implement environmental assessment recommendations. Review the authority and capability of institutions at local, provincial, regional, and national levels and recommend how to strengthen the capacity to implement the environmental management and monitoring plans. The recommendations may cover such diverse topics as new laws and regulations, new agencies or agency functions, inter-sectoral arrangements, management procedures, training, staffing, operation and maintenance training, budgeting, and financial support.

Monitoring: Prepare detailed arrangements to monitor the implementation of mitigation measures and the impacts of the project during construction and operation. Include in the plan an estimate of capital and operating costs and a description of other required inputs (e.g., training and institutional strengthening).

Task 7: Organize and facilitate public consultations, in accordance with the provisions of the General ESIA guidelines and other attendant legislation.

Task 8: Prepare the ESIA Report: The ESIA report should be concise and limited to significant environmental issues. The main text should focus on findings, conclusions, and recommended actions supported by summaries of the data collected and citations for any references used in interpreting data. Detailed data should be presented in appendices or in a separate volume.

The ESIA report according to the outline below:

- Executive Summary;
- Introduction
- Policy, Legal, and Administrative Framework;
- Description of the Proposed Project; "
- Description of the existing Environment;
- Significant Environmental Impacts and Mitigation Measures;
- Analysis of the Alternatives;
- Environmental Management Plan (including Monitoring Plan);
- Conclusion and recommendation
- List of References;
- Appendices:
    - Terms of reference;
    - List of the ESIA team;
    - Records of Interagency and Public/ NGO Communications;
    - Data and Unpublished Reference Documents.

8. Consulting Team: Identify the expertise to include on the ESIA team. Environmental Assessment requires interdisciplinary analysis. Members of the team could consist of people with the following specializations: rural sociology (in the case of rural roads); human geography; and/or terrestrial ecology (e.g., wildlife, plant, and conservation ecology).

9. Other Information: List data sources, project background reports and studies, relevant publications, and other items to which the consultant's attention should be directed.

Annex 3: Content of Resettlement Action Plan if required

During the preparation of environmental and Social Impact Assessment, the consultant will confirm whether a resettlement Action Plan is required or Not. If the resettlement action Plan is required detailed terms of reference will be prepared and a consultant hired for the preparation of Resettlement action Plan. Therefore, this annex describes the elements of a Resettlement Plan and Requirements for voluntary land donation. Given that the project is not expected to have any physical or economic displacement, the Resettlement Plan will have the following Minimum elements:

1. **Description of the project.** General description of the project and identification of the project area.
2. **Potential impacts.** Identification of:

(a) the project components or activities that give rise to displacement, explaining why the selected land must be acquired for use within the timeframe of the project;
(b) the zone of impact of such components or activities;
(c) the scope and scale of land acquisition and impacts on structures and other fixed assets;
(d) any project-imposed restrictions on use of, or access to, land or natural resources;
(e) alternatives considered to avoid or minimize displacement and why those were rejected; and
(f) the mechanisms established to minimize displacement, to the extent possible, during project implementation.

3. **Objectives.** The main objectives of the resettlement program
4. **Census survey and baseline socio-economic studies**. The findings of a household-level census identifying and enumerating affected persons, and, with the involvement of affected persons, surveying land, structures and other fixed assets to be affected by the project. The census survey also serves other essential functions:
   a) identifying characteristics of displaced households, including a description of production systems, labour, and household organization; and baseline information on livelihoods (including, as relevant, production levels and income derived from both formal and informal economic activities) and standards of living (including health status) of the displaced population;
   b) information on vulnerable groups or persons for whom special provisions may have to be made;
   c) identifying public or community infrastructure, property or services that may be affected;
   d) providing a basis for the design of, and budgeting for, the resettlement program;
   e) in conjunction with establishment of a cut-off date, providing a basis for excluding ineligible people from compensation and resettlement assistance; and
   f) establishing baseline conditions for monitoring and evaluation purposes.
   g) As the Bank may deem relevant, additional studies on the following subjects may be required to supplement or inform the census survey:
   h) land tenure and transfer systems, including an inventory of common property natural resources from which people derive their livelihoods and sustenance, non-title-based usufruct systems (including fishing, grazing, or use of forest areas) governed by local recognized land allocation mechanisms, and any issues raised by different tenure systems in the project area;
   i) the patterns of social interaction in the affected communities, including social networks and social support systems, and how they will be affected by the project; and
   j) social and cultural characteristics of displaced communities, including a description of formal and informal institutions (e.g., community organizations, ritual groups, nongovernmental organizations (NGOs)) that may be relevant to the consultation strategy and to designing and implementing the resettlement activities.

5. **Legal framework.** The findings of an analysis of the legal framework, covering:
   a. the scope of the power of compulsory acquisition and imposition of land use restriction and the nature of compensation associated with it, in terms of both the valuation methodology and the timing of payment;
   b. (b) the applicable legal and administrative procedures, including a description of the remedies available to displaced persons in the judicial process and the normal timeframe for such procedures, and any available grievance redress mechanisms that may be relevant to the project;
   c. (c) laws and regulations relating to the agencies responsible for implementing resettlement activities; and
   d. (d) gaps, if any, between local laws and practices covering compulsory acquisition, imposition of land use restrictions and provision of resettlement measures and ESS 5, and the mechanisms to bridge such gaps.

6. **Institutional Framework.** The findings of an analysis of the institutional framework covering:
    a. the identification of agencies responsible for resettlement activities and NGOs/CSOs that may have a role in project implementation, including providing support for displaced persons;
    b. (b) an assessment of the institutional capacity of such agencies and NGOs/CSOs; and
    c. (c) any steps that are proposed to enhance the institutional capacity of agencies and NGOs/CSOs responsible for resettlement implementation.

7. **Eligibility.** Definition of displaced persons and criteria for determining their eligibility for compensation and other resettlement assistance, including relevant cut-off dates.

8. **Valuation of and compensation for losses.** The methodology to be used in valuing losses to determine their replacement cost; and a description of the proposed types and levels of compensation for land, natural resources and other assets under local law and such supplementary measures as are necessary to achieve replacement cost for them.

9. **Community participation.** Involvement of displaced persons (including host communities, where relevant);
    (a)a description of the strategy for consultation with, and participation of, displaced persons in the design and implementation of the resettlement activities;
    (b) a summary of the views expressed and how these views were taken into account in preparing the resettlement plan;
    (c) a review of the resettlement alternatives presented and the choices made by displaced persons regarding options available to them; and
    (d) institutionalized arrangements by which displaced people can communicate their concerns to project authorities throughout planning and implementation, and measures to ensure that such vulnerable groups as indigenous people, ethnic minorities, the landless, and women are adequately represented.

10. **Implementation schedule**. An implementation schedule providing anticipated dates for displacement, and estimated initiation and completion dates for all resettlement plan activities. The schedule should indicate how the resettlement activities are linked to the implementation of the overall project.

11. Costs and budget. Tables showing categorized cost estimates for all resettlement activities, including allowances for inflation, population growth, and other contingencies; timetables for expenditures; sources of funds; and arrangements for timely flow of funds, and funding for resettlement, if any, in areas outside the jurisdiction of the implementing agencies.

12. **Grievance redress mechanism**. The plan describes affordable and accessible procedures for third-party settlement of disputes arising from displacement or resettlement; such grievance mechanisms should take into account the availability of judicial recourse and community and traditional dispute settlement mechanisms.

13. **Monitoring and evaluation.** Arrangements for monitoring of displacement and resettlement activities by the implementing agency, supplemented by third-party monitors as considered appropriate by the Bank, to ensure complete and objective information; performance monitoring indicators to measure inputs, outputs, and outcomes for resettlement activities; involvement of the displaced persons in the monitoring process; evaluation of results for a reasonable period after all resettlement activities have been completed; using the results of resettlement monitoring to guide subsequent implementation.

14. **Arrangements for adaptive management**. The plan should include provisions for adapting resettlement implementation in response to unanticipated changes in project conditions, or unanticipated obstacles to achieving satisfactory resettlement outcomes.

Annex 4: Scoping Matrix for Environmental Impacts

SEA Issues		Ground water Priority	Surface water Priority	Without Project	Remark
Socio-economic	Land availability/ Land Tenure				
	Economy				
	Livelihoods				
	Aesthetics				
	Health/safety				
	Archeological Resources				
	Historical/culture Resources				
	Crop & Livestock productivity				
	Resettlement				
	Infrastructures				
Atmosphere	Climate Change Risks				
	Adaptation/Mitigation to Climate Change				
	Air quality				
Biodiversity	Sensitive habitat				
	Protected areas				
	Fauna				
	Flora				
Water Resources	Endegered species				
	Water quality				
	Water quantity				
	Ground water				
	Flood danage mitigation				
	Climate change adaptation				
	Surface water				
Soil	Soil erosion				
	Soil pollution				
	Wetland degradation				
Transboundary	Water resources				
	Protected Ecosystem				
	People movement				
	Natural disaster				

Source: Prepared by BESST Ltd based on SEA guidelines, REMA 2011

Annex 5: Matrix for alternatives assessment

SEA Topic \ Scenarios		Ground water Prioritized	Surface Water Prioritized	Without Projects
Socio-economic	Land/resource Economy Livelihoods Distributional Effects Existing Vulnerabilities Aesthetics Health/safety Archeological Historical/culture			
Atmosphere	Climate Change Trends Climate Change Risks Existing Vulnerabilities Adaptation/Mitigation to Climate Change Air quality			
Terrestrial	Biodiversity Fauna Flora Existing Vulnerabilities Physiographic			
Aquatic	Biodiversity Fauna Flora Existing Vulnerabilities Hydrology			

Source: Prepared by BESST Ltd based on SEA guidelines, REMA 2011

Annex 6: Full list of Birds identified in the Project area

Common name	Vernacular Name	Scientific name	Order	Family	IUCN Conservation Status	Type
African Black-headed Oriole		Oriolus larvatus	Passerine	Oriolidae	Least concern	Native

Common name	Vernacular Name	Scientific name	Order	Family	IUCN Conservation Status	Type
African Fish Eagle		Haliaeetus vocifer	Accipitriformes	Accipitridae	Least concern	Native
African Harrier-Hawk		Polyboroides typus	Accipitriformes	Accipitridae	Least concern	Native
African Jacana		Actophilornis africanus	Charadriiformes	Jacanidae	Least concern	Native
African Marsh Harrier		Circus ranivorus	Accipitriformes	Accipitridae	Least concern	Native
African Open-billed Stork		Anastomus lamelligerus	Ciconiiformes	Ciconiidae	Least concern	Native
African palm Swift		Cypsiurus parvus	Apodiformes	Apodidae	Least Concern	Native
African Paradise-flycatcher		Terpsiphone viridis	Passeriformes	Monarchidae	Least concern	Native
African Pied Wagtail	Inyamanza	Motacilla aguimp	Passeriformes	Motacillidae	Least Concern	Native
African Pygmy Kingfisher		Ispidina picta	Coraciiformes	Alcedinidae	Least concern	Intra-African migrant
African Spoonbill		Platalea alba	Pelecaniformes	Threskiornithidae	Least concern	
African Wattled Lapwing		Vanellus senegallus	Charadriiformes	Charadriidae	Least concern	
Angola Swallow		Hirundo angolensis	Passeriformes	Hirundinidae	Least concern	
Amur Falcon		Falco amurensis	Falconiformes	Falconidae	Least concern	
Arrow-marked Babbler		Turdoides jardineii	Passeriformes	Leiothrichidae	Least concern	
Baglafecht Weaver		Ploceus baglafecht	Passeriformes	Ploceidae	Least concern	
Barn Swallow		Hirundo rustica	Passeriformes	Hirundinidae	Least concern	
Black Crake		Amaurornis flavirostra	Gruiformes	Rallidae	Least concern	
Black Kite	Sakabaka	Milvus migrans	Accipitriformes	Accipitridae	Least Concer	Migratory and resident
Black-backed Cisticola						
Black-headed Gonolek		Laniarius erythrogaster	Passeriformes	Malaconotidae	Least concern	
Black-headed Heron	Ikiyongoyongo	Ardea melanocephala	Pelecaniformes	Ardeidae	Least Concern	Native
Black-headed Weaver		Ploceus melanocephalus	Passeriformes	Ploceidae	Least Concern	Native
Blue-headed Coucal		Centropus monachus	Cuculiformes	Cuculidae	Least concern	
Broad-tailed Warbler		Schoenicola brevirostris	Passeriformes	Locustellidae	Least concern	
Bronze Mannikin		Lonchura cucullata	Passeriformes	Estrildidae	Least concern	
Bronze Sunbird		Nectarinia kilimensis	Passeriformes	Nectariniidae	Least concern	
Brown Parrot		Poicephalus meyeri	Psittaciformes	Psittacidae	Least concern	
Cape Wagtail		Motacilla capensis	Passeriformes	Motacillidae	Least concern	
Cardinal Woodpecker		Dendropicos fuscescens	Piciformes	Picidae	Least concern	
Carruther's Cisticola		Cisticola carruthersi	Passeriformes	Cisticolidae	Least concern	
Cattle Egret	Inyange	Bubulcus ibis	Pelecaniformes	Ardeidae	Least Concern	Native
Chubb's Cisticola		Cisticola chubby	Passeriformes	Cisticolidae	Least concern	
Cinnamon Bee-eater		Merops oreobates	Coraciiformes	Meropidae	Least concern	
Common Bulbul		Pycnonotus barbatus	Passeriformes	Pycnonotidae	Least Concern	Native
Common Fiscal		Lanius collaris	Passeriformes	Laniidae	Least concern	
Common Sandpiper		Actitis hypoleucos	Charadriiformes	Scolopacidae	Least concern	Least concern
Common Stonechat		Saxicola rubicola	Passeriformes	Muscicapidae	Least concern	Resident & breeding record confirmed
Collared Sunbird		Hedydipna collaris	Passeriformes	Nectariniidae	Least concern	
Common Waxbill		Estrilda astrild	Passeriformes	Estrildidae	Least concern	
Croaking Cisticola		Cisticola natalensis	Passeriformes	Cisticolidae	Least concern	
Domestic Chicken	Inkoko	Gallus gallus domesticus	Galliformes	Phasianidae	Least concern	
Egyptian goose		Alopochen aegyptiacus	Anseriformes	Anatidae	Least concern	Resident & breeding record confirmed
Emerald-spotted Wood-Dove		Turtur chalcospilos	Columbiformes	Columbidae	Least concern	
Fan-tailed Widowbird		Euplectes axillaris	Passeriformes	Ploceidae	Least concern	Resident & breeding record confirmed
Fish Eagle		Haliaeetus vocifer	Accipitriformes	Accipitridae	Least concern	Resident & breeding record confirmed
Fork-tailed Drongo		Dicrurus adsimilis	Passeriformes	Dicruridae	Dicrurus adsimilis	
Garden Warbler		Sylvia borin	Passeriformes	Sylviidae	Least concern	
Giant kingfisher		Megaceryle mazima	Coraciiformes	Alcedinidae	Least concern	Resident & breeding record confirmed

Common name	Vernacular Name	Scientific name	Order	Family	IUCN Conservation Status	Type
Greater swamp warbler		Acrocephalus rufescens	Passeriformes	Sylviidae	Least concern	Resident & breeding record confirmed
Green-backed Heron		Butorides striatus	Pelecaniformes	Ardeidae	Least concern	Resident & breeding record confirmed
Green-winged Pytilia		Pytilia melba	Passeriformes	Estrildidae	Least concern	
Grey-backed Camaroptera		Camaroptera brevicaudata	Passeriformes	Cisticolidae		
Grey-backed Fiscal		Lanius excubitoroides	Passeriformes	Laniidae	Least concern	
Grey-crowned Crane	Umusambi	Balearica regulorum	Gruiformes	Gruidae	Endangered (EN)	Native
Grey-headed Kingfisher		Halcyon leucocephala	Coraciiformes	Alcedinidae	Least concern	
Grey-headed Sparrow		Passer griseus	Passeriformes	Passeridae	Least concern	
Grey Heron		Ardea cinerea	Pelecaniformes	Ardeidae	Least concern	
Grosbeak Weaver		Amblyospiza albifrons	Passeriformes	Ploceidae	Least concern	
Hadada Ibis	Nyirabarazana	Bostrychia hagedash	Pelecaniformes	Threskiornithidae	Least Concern	Native
Hamerkop		Scopus umbretta	Pelecaniformes	Scopidae	Least Concern	
Holub's Golden Weaver		Ploceus xanthops	Passeriformes	Ploceidae	Least Concern	
Hooded Vulture		Necrosyrtes monachus	Accipitriformes	Accipitridae	Critically Endangered	
Lesser Masked Weaver		Ploceus intermedius	Passeriformes	Ploceidae	Least Concern	
Lesser Striped Swallow	Intashya	Cecropis abyssinica	Passeriformes	Hirundinidae	Least Concern	Native
Lesser Swamp Warbler		Acrocephalus gracilirostris	Passeriformes	Acrocephalidae	Least Concern	
Little Bee-eater		Merops pusillus	Coraciiformes	Meropidae	Least Concern	
Little Egret		Egretta garzetta	Pelecaniformes	Ardeidae	Least Concern	
Little Greenbul		Eurillas virens	Passeriformes	Pycnonotidae	Least Concern	Native
Little Swift		Apus affinis	Apodiformes	Apodidae	Least Concern	
Long-crested Eagle		Lophaetus occipitalis	Accipitriformes	Accipitridae	Least Concern	
Long-toed Plover		Vanellus crassirostris	Charadriiformes	Charadriidae	Least Concern	
Madagascar Sqacco Heron		Ardeola idea	Pelecaniformes	Ardeidae	Edangered (EN)	Migrant species
Malachite Kingfisher		Corythornis cristatus	Coraciiformes	Alcedinidae	Least Concern	
Malachite Sunbird		Nectarinia famosa	Passeriformes	Nectariniidae	Least Concern	Native
Marsh Sandpiper		Tringa stagnatilis	Charadriiformes	Scolopacidae	Least Concern	
Marico Sunbird		Cinnyris mariquensis	Passeriformes	Nectariniidae	Least Concern	
Night heron		Nycticorax nycticorax	Pelecaniformes	Ardeidae	Least Concern	
Nothern Brown-throated Weaver		Ploceus castanops	Passeriformes	Ploceidae	Least Concern	
Northern Grey-headed Sparrow	Igishwi	Passer griseus	Passeriformes	Passeridae	Least Concern	Native
Olive Thrush		Turdus olivaceus	Passeriformes	Turdidae	Least Concern	
Opened-billed Stork		Anastomus oscitans	Ciconiiformes	Ciconiidae	Least Concern	
Palm-nut Vulture		Gypohierax angolensis	Accipitriformes	Accipitridae	Least Concern	
Papyrus Gonolek		Laniarius mufumbiri	Passeriformes	Malaconotidae	Least Concern	
Papyrus yellow Warbler		Calamonastides gracilirostris	Passeriformes	Acrocephalidae	Least Concern	
Pennant-winged nightjar		Caprimulgus vexillarius	Caprimulgiformes	Caprimulgidae	Least Concern	
Pink-backed pelican		Pelecanus rufescens	Pelecaniformes	Pelecanidae	Least Concern	
Pied Crow		Corvus albus	Passeriformes	Corvidae	Least Concern	
Pied kingfisher		Ceryle rudis	Coraciiformes	Alcedinidae	Least Concern	Native
Pin-tailed Whydah	Nyiramatene	Vidua macroura	Passeriformes	Viduidae	Least Concern	
Plain-backed Pipit		Anthus leucophrys	Passeriformes	Motacillidae	Least Concern	
Purple Heron		Ardea purpurea	Pelecaniformes	Ardeidae	Least Concern	
Red-billed Firefinch		Lagonosticta senegala	Passeriformes	Estrildidae	Least Concern	
Red-billed Teal		Anas erythrorhyncha	Anseriformes	Anatidae	Least Concern	
Red-cheeked Cordon-bleu		Uraeginthus bengalus	Passeriformes	Estrildidae	Least Concern	
Red-chested Sunbird		Cinnyris erythrocercus	Passeriformes	Nectariniidae	Least Concern	Native
Red-eyed Dove	Inuma	Streptopelia semitorquata	Columbiformes	Columbidae	Least Concern	
Red-faced Cisticola		Cisticola erythrops	Passeriformes	Cisticolidae	Least Concern	
Red-headed Quelea		Quelea erythrops	Passeriformes	Ploceidae	Least Concern	
Red-necked Spurfowl		Francolinus afer	Galliformes	Phasianidae	Least Concern	

Common name	Vernacular Name	Scientific name	Order	Family	IUCN Conservation Status	Type
Ring-necked Dove		Streptopelia capicola	Columbiformes	Columbidae	Least Concern	
Rüppell's Long-tailed Starling		Lamprotornis purpuroptera	Passeriformes	Sturnidae	Least Concern	
Sacred Ibis		Threskiornis aethiopicus	Pelecaniformes	Threskiornithidae	Least Concern	Resident & breeding record confirmed
Scarlet-chested Sunbird		Chalcomitra senegalensis	Passeriformes	Nectariniidae	Least Concern	
Singing Cisticola		Cisticola cantans	Passeriformes	Cisticolidae	Least Concern	
Slender billed-Weaver		Ploceus pelzelni	Passeriformes	Ploceidae	Least Concern	
Southern Red Bishop		Euplectes orix	Passeriformes	Ploceidae	Least Concern	
Speckled Mousebird		Colius striatus	Passeriformes	Ploceidae	Least Concern	
Spectacled Weaver		Ploceus ocularis	Passeriformes	Ploceidae	Least Concern	
Spot-flanked Barbet		Tricholaema lacrymosa	Piciformes	Lybiidae	Least Concern	
Spur-winged Goose		Plectropterus gambensis	Anseriformes	Ardeida	Least Concern	
Squacco heron		Ardeola ralloides	Pelecaniformes	Ardeidae	Least Concern	
Swamp Flycatcher		Muscicapa aquatica	Passeriformes	Muscicapidae	Least Concern	
Three-banded plover		Charadrius tricollaris	Charadriiformes	Charadriidae	Least Concern	
Tropical Boubou		Laniarius aethiopicus	Passeriformes	Malaconotidae	Least Concern	
Variable Sunbird		Cinnyris venustus	Passeriformes	Nectariniidae	Least Concern	
Violet-backed Starling		Cinnyricinclus leucogaster	Passeriformes	Sturnidae	Least Concern	
Wahlberg's Eagle		Aquila wahlbergi	Accipitriformes	Accipitridae	Least Concern	Migrant & Breeding record confirmed
White-browed Coucal		Centropus superciliosus	Cuculiformes	Cuculidae	Least Concern	
White-browed Robin-Chat		Cossypha heuglini	Passeriformes	Muscicapidae	Least Concern	
White-browed Scrub-Robin		Cercotrichas leucophrys	Passeriformes	Muscicapidae	Least Concern	
White-headed Mousebird		Colius leucocephalus	Coliiformes	Coliidae	Least Concern	
White-winged Warbler		Xenoligea montana	Passeriformes	Phaenicophilidae	Least Concern	
Winding Cisticola		Cisticola galactotes	Passeriformes	Cisticolidae	Least Concern	
Woodland Kingfisher		Halcyon senegalensis	Coraciiformes	Alcedinidae	Least Concern	
Yellow-backed Weaver		Ploceus melanocephalus	Passeriformes	Animalia	Least Concern	
Yellow-bellied Waxbill		Coccopygia quartinia	Passeriformes	Estrildidae	Least Concern	
Yellow-billed ducks		Anas undulata	Anseriformes	Anatidae	Least Concern	
Yellow-billed Stork		Mycteria ibis	Ciconiiformes	Ciconiidae	Least Concern	
Yellow-backed Weaver		Ploceus melanocephalus	Passeriformes	Ploceidae	Least Concern	
Yellow-fronted Canary		Serinus mozambicus	Passeriformes	Fringillidae	Least Concern	
Yellow-throated Longclaw		Macronyx croceus	Passeriformes	Motacillidae	Least Concern	
Zitting Cisticola		Cisticola juncidis	Passeriformes	Cisticolidae	Least Concern	

Source: BESST Ltd Baseline survey, 2019

Annex 7: List of full plants found in Master Plan area e (herbs, native and planted trees)

No	Common name	Vernacular Name	Scientific name	Order	Family	Conservation Status(IUCN)	Type
1	White Thorn	Umugu	Acacia polyacantha	Fabales	Fabacaea		Native
2	Vachellia sieberiana	Umunyinya	Acacia sieberiana	Fabales	Fabacaea		Native
3		Igitovu	Acanthus pubescens	Lamiales	Acanthaceae		Native
4		Umuko/Umurinzi	Erythrina abyssinica	Fabales	Fabacaea		Native
5	Eucalyptus	Inturusu	Eucalyptus sp	Myrtales	Myrtaceae		Exotic
6	Firestick plants	Umuyenzi	Euphorbia tirucalli	Malpighiales	Euphorbiaceae	Least Concern	Native
7	Balloonplant	Gasaho	Gomphocarpus physocarpus	Gentianales	Apocynaceae		Native
8	Chaff-flower	Umuhurura	Achyranthes aspera	Caryophyllales	Amaranthaceae		Native
9		Umusebeya	Albizia gummifera	Fabales	Fabacaea		Native
10		Igitabitabi	Blumea brevipes	Asterales	Asteraceae		Native

No	Common name	Vernacular Name	Scientific name	Order	Family	Conservation Status(IUCN)	Type
11	Australian pine tree	Filaho	Casuarina equisetifolia	Fagales	Fagaceae		Exotic
12	Southern Silky Oak	Gereveriya	Grevillea robusta	Proteales	Proteaceae		Exotic
13		Gangabukari	Hygrophylla auriculata	Lamiales	Acanthaceae		Native
14		Umusororo	Indigofera errecta	Fagales	Fagaceae		Native
15	Spikesedges	Uruvuya	Kyllinga errecta	Poales	Cyperaceae		Native
16	Tickberry	Umuhengeri	Lantana camara	Lamiales	Verbenaceae		Exotic
17	Christmas candlestick	Igicumucumu	Leonotis nepetifolia	Lamiales	Lamiacesae		Native
18		Urugozi	Mikania cordata	Asterales	Asteraceae		Native
19	Giant sensitive tree	Umugeyo	Mimosa pigra	Fagales	Fagaceae		Exotic
20		Umwenya	Ocimum suave		Lamiaceae)		
21	Napier grass	Urubingo	Pennisetm purpureum	Poales	Poaceae		Native
22		Igorogonzo	Polygonum setulosum		Polygonaceae		
23		Gasiya	Senna spectabilis				
24		Umuravumba	Tetradenia riparia				Native
25		Umubirizi	Vernonia amygdalina	Asterales	Asteraceae		Native
26	Avocado	Avoka	sea Americana	Laurales	Lauraceae	Least Concern	Exotic
27	Cypress	Sipre	trocedrus chilensis	Pinales	Cupressaceae	Near Threatened	Exotic
28	Mango	Umwembe	ngifera indica	Sapindales	Anacardiacea	Data Deficient	Exotic
29	Castoroil plant		nus communis	Euphorbiales	Euphorbiaceae		Native
30	Common guava	Ipera	lium guajava	Myrtales	Myrtaceae		Exotic

Annex 8: List of Consulted stakeholders during data collection

No	Name	Institution	Position held	E-mail	Telephone
1	Marshall Mwanabana	Ministry of Environment	Biodiversity Specialist	mmwanabana@minirena.gov.rw	+250788861374
2	Remy Dukuze	Rwanda Environment Management Authority	Director of Environmental Regulation and Pollution Control	rdukuze@rema.gov.rw	+250788612725
3	Goretti Manikuzwe	Rwanda Water and Forestry Authority	Biodiversity Officer	manygogo@gmail.com	+25(0)788839595
4	Rashidi Mwimba	University of Rwanda	Lecturer	elrash2002@gmail.com	+250 783 182 724
5	Bertrand Uwimana	Kitabi College of Conservation and Environment Management	Assistant Lecturer	ubertrand4@gmail.com	+25082995870
6	Sam Kanyamibwa	Albertine Conservation Association Authority	Executive Director	skanyamibwa@arcosnetwork.org	+250 785 751 900
7	Gilbert Micomyiza	Association pour la Conservation de la Nature au Rwanda	Executive Director	micomyizagilbert@yahoo.com	+250788689526
8	Claudien Nsabagani	Rwanda Bird Education and Tour Company Limited	Managing Director	claudienn2000@yahoo.fr	+250788754615

Annex 9: Minutes of first stakeholders meeting, August 6th, 2019

1. Introduction

On August 6th 2019, the Water & Sanitation Cooperation (hereinafter referred to as "WASAC"), leading Agency for the Project for Water Supply Master Plan for City of Kigali in the Republic of Rwanda (hereinafter referred to as "the WASAC/JICA M/P"), held first stakeholder meeting for explaining progress of the WASAC/JICA M/P under the scheme of technical cooperation supported by Japanese International Cooperation Agency (JICA).

Participants to the meeting include stakeholders from various institutions in Rwanda, Embassy of Japan in Rwanda, JICA Rwanda office, and the Working Team members that includes counterpart (C/P) of WASAC and JICA Study Team headed by Mr. Mamiya Takemasa, with the members from Nihon Suido Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd., from Japan to implement the WASAC/JICA M/P. Various national media were also invited to cover the meeting. The list of all participants is presented in Attachment-2.

The purpose of the stakeholder meeting was: (i) to inform stakeholders the progress made on study (future water demand and social-economic scenario), (ii) to invite local stakeholders for participation and provision of opinions into decision making process comments and inputs to the WASAC/JICA M/P and, (iii) to develop contacts list and communication channel for the WASAC/JICA M/P. To meet the purpose mentioned above, a stakeholder meeting was held to ensure the accountability and transparency of the WASAC/JICA M/P.

2. Opening remarks

In his opening remarks, the representative of JICA, Mr. Koji Nakashima, emphasized that the proposed study is an opportunity to think about the future of Kigali in coping with increasing populations and water demand. He appreciated the presence of various stakeholders from the government, from private sector, civil society and the media. He encouraged them to provide inputs and comments. The WASAC representative, Mr. Bahige J. Berchmas, in his opening remarks informed the participant that the proposed Master Plan is an important Planning Tool, which will help WASAC and the country to achieve its target. Further, the Master Plan will contribute to the proper planning and avoid the past gaps where projects were mainly planned and implemented to address some emergencies and present needs, and where strategic plans for medium and long term were missing.

3. Presentations and discussions

After the opening session, two presentations were provided by WASAC. The first presentation was provided by Mr. Innocent Kimpaye from WASAC and focused on the project background, project schedule and implementation strategy. The second presentation was provided by Mr. Tetsuji Kawamura, Co-team Leader of the JICA Study Team and provide progress on Socio-Economic Scenario and Future Water Demand Forecast. After, each presentation, participants were provided with time for questions, comments and inputs to the WASAC/JICA M/P. Important comments, suggestions and opinions provided are summarized as follows:

- **Linkage of Kigali Master Plan and other master Plans:** all Stakeholders confirmed the importance of aligning the other ongoing Master Plan such as City of Kigali Master Plan (CoK M/P), National Water Supply and Sanitation Master Plan (AfDB M/P) and existing integrated Water Resource Master Plan. The study team confirmed that the water supply Master Plan is being developed in considering other master plans.
- **Spatial Coverage of study:** some stakeholders suggested to include more sectors which are outside of Kigali such as Kinzuzi and Ntarabana on the Kigali-Byumba Road. They are showing signs of development to be urbanized. It was clarified that the WASAC/JICA M/P will cover Kigali city and seven adjacent seven (7) sectors and other areas are covered under National Water and Sanitation Master Plan based on the Record of Discussion.
- **Measures to reduce Non-revenue water:** It was confirmed that in addition to the proposed increased number of staffs, other technological measures should be considered in order to reduce non-revenue water. The study team and WASAC informed that practical measures will be studied in the Master plan.
- **Definition and setting of service ratio:** All parties suggested that the way of explanation on service ratio should be revised. Especially, the service ratio for individual house connection, public tap, and sharing connection are considered as important indexes which targeted the total service coverage reaches 100% in 2024. In this regards, the given figure of those indexes by the study was inconsistent

with the existing study such as EICV5 by NISR.

- **Source of water:** Stakeholders suggested that all source of water, including surface water, ground water, and rainwater should be explored and identified. Further, stakeholders requested an assessment of the efficiency of ground water abstraction and surface water abstraction in current production, and then advise on future projects.
- **Population and Water Demand Projection scenario:** Some stakeholders suggested that both low, medium, and high growth scenario should be assessed. Further, it was suggested that the target for service coverage of the intermediate target might be optimized. The study team took note of the suggestion. The current scenario was considered to be on the safer side to be aligned with other development plans such as the CoK M/P that considers high growth scenario.
- **The production capacity of the private operators:** Some stakeholders indicated that the production capacity of the private operators is not covered in the study. Currently, there are several private operators having a business in the area, and it should be considered in the project.

Other questions, comments and suggestions provided in the meeting are provided in Attachment 1.

4. Closing session

The Closing remark was provided by the Representative of MININFRA, Mpimbazimana Venuste, appreciated the active participation of stakeholders and urged them to support the study team in providing information available in their respective institutions. He highlighted the importance of this Master Plan in country planning process and in urban water supply in particular. He appreciated the progress made by the study team and urged the team to continue engaging stakeholders in order to produce the final Report. He also expressed his gratitude for the support provided to Rwanda by Government of Japan through JICA especially in the water sector.

Table 70: Questions, Comments, suggestions and answers during first stakholders meeting

#	Questions/Comments	By	Response	By
First session				
1	How many feasibility studies will be conducted and water level of details for these feasibility studies under the WASAC/JICA M/P	Water for people Representative	A 15 years investment Plan will be prepared. Among them, one feasibility study is planned for entire water supply system in Kigali City (WTP, Reservoir and Pipeline), and it may be divided into further sub-projects considering project scale.	JST
2	How Kigali Water Supply is linked with the CoK M/P and the AfDB M/P	Water aid Representative	The WASAC/JICA M/P refers both master plans that are going ahead. For example, the CoK M/P is referred for the trends of population increase and development phasing, and information, which is not available in the CoK M/P and/or information for the adjacent sectors are referred to AfDB M/P.	JST
3	Does the WASAC/JICA M/P Consider the assessment of consequences of ground water abstraction, geological formation and cost effectiveness of both surface water and ground water	National Representative	The presentation focused on Socio-economic scenario and future water demand forecast but going forward other area of study will be presented	WASAC
4	Is the Recruitment of additional staff/ technician the only measures for reducing Non-Revenue Water? Or other technological solution considered?	WASAC representative	Recruitment of maintenance staff is only one of measures to reduce In the Master Plan several measures will be studied including pressure control, replacement of old pipes and monitoring system.	WASAC
5	How much money is invested in this project? And when the project will start?	Select Magazine	The WASAC/JICA M/P is a planning tool that will provide an idea for project development, but not a implementation stage of the project	WASAC
6	Why only 7 sector were considered outside of Kigali while there are other sectors that are being urbanized such as Kinzuzi and Tarabana in Rulindo	Water for People representative	The WASAC/JICA M/P will cover Kigali city and seven adjacent sectors and other areas are covered under the AfDB M/P.	WASAC
7	Was there any old Water Supply Master Plan that guided the past and ongoing project in Kigali?	RURA representative	There was no Water Supply Master Plan for Kigali City and projects were implemented ad-hoc basis based on need and emergency, and that is why WASAC and Kigali City are facing challenges in meeting water demand in the city. However, the WASAC/JICA M/P will include assessment of the existing facilities, required projects, and advise on future investment.	WASAC

#	Questions/Comments	By	Response	By
8	It would be good to consider all source of water including surface water, ground water and Rainwater in order to meet future demand and advise on its development	Gasabo district representative	Any possible and practical sources of water will be considered	JST
9	What about other regulations and Requirements such as expropriations?	Gasabo district representative	Applicable regulations will be reviewed and described and during project development all aspects will be considered	WASAC
Second Session				
10	Why not having another scenario where 100% of service coverage can be achieved before 2050 as committed by Government	Water for People Representative	The idea is noted but it should be noted that scenarios are developed based on other urban development plans including CoK M/P and AfDB M/P, which the WASAC/JICA M/P does not have control. To avoid discrepancies with other related master plans, the WASAC/JICA M/P should keep harmonized with those superior plans.	JST
11	It would be good to use data from EICV 5 where the service coverage is 34 instead of 28 presented in EICV 4	WASAC representative	This has also been raised in the previous Joint Coordination Committee (JCC) on 26/July/2019 and it will be considered to revise the demand projection.	JST
12	Why the current status is presented for Kigali City but not in 7 sectors? Are they starting from 0%?	LODA	Baseline service coverage for seven sectors are not available therefore the same assumption is being applied both for the City and the adjacent area. Depending on availability of new reliable data it will be discussed with the working team of the C/P of WASAC	JST
13	Does the High Growth scenario consider other government initiative such as development of secondary cities to reduce pressure on Kigali?	UR representative	The WASAC/JICA M/P follows the high growth scenario in line with the CoK M/P, because it considers timing of development phase and land use transition in detail	JST
14	Why Nzove Water Treatment Plant (WTP) is not working at its optimal Capacity	UR representative	The WTP team of the working team of the WASAC/JICA M/P is assessing conditions of all plants and will share results in future presentations	JST
15	It would be good to use data from other water operator not only data from WASAC given that there other operators providing water to the communities	Water Aid	This was noted. We hope cooperation for sharing data.	JST
16	When WASAC increased water tariffs there is an indication that water use has decreased? Does the WASAC/JICA M/P consider to explorer other parameters that may affect projected water demand?	WASAC	The decrease in water use observed after the new water tariffs may results in different factors such as efficient use of water by households but this may be temporary and may not have a significant impacts on Projected water demand	WASAC
17	It would be good to have a team looking at regular replacement of old structure such as pipe and reservoir.	Water for people Representative	The working team under the WASAC/JICA M/P is working on reviewing conditions of reservoirs, transmission and distribution pipes, in order to draft up propose strategies. It shall be noted that expansion and necessity shall be considered for replacement. Therefor it is not effective to have independent team for regular replacement.	JST
18	Is there any possibility of other stakeholders to join various team formed under the Master Plan	Water for people Representative	The Working Teams have been established to conduct study for the WASAC/JICA M/P. Other stakeholders will have opportunities to be asked when it is necessary for the Working Team to have their opinion	WASAC

Source: Prepared by JST, 2019

Annex 10: List of participants to the first Stakeholders meeting

1. Government of Rwanda

No	Name in alphabet	Position	Organization	Contact No	Email
1	Mpimbazimana Venuste	UWSSE, MININFRA	MININFRA	0788550872	venustempimbazimana@mininfra.gov.rw
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No	Name in alphabet	Position	Organization	Contact No	Email
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2. Media and Others

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3. International

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4. WASAC

No	Name in alphabet	Position	Organization	Contact No	Email
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Source: Prepared by JST, 2019

Annex 11: Minutes of Thematic Working Group meeting (TWG) 20th February 2020

This meeting replaced the second stakeholder meeting that was planned as it was overlapping with Joint Coordination Committee (JCC) meeting held on February13th, 2020.
Time & Date: 9:00 to 12:00, 20th February 2020
Venue: Conference room (4th floor), Ministry of Infrastructure (MININFRA)
Subject: Presentation on Interim Report including master scenario and priority projects, the Project for Water Supply Master Plan for City of Kigali (WASAC/JICA M/P)
Agenda:
8:30 – 9:00 Registration
9:00 – 9:20 Opening address
- by MININFRA
- by WASAC
- by JICA (Rwanda Office)

9:20 – 10:30 Presentation by JST
- General
- Financial & Organizational Issues
- Update of Demand Forecast
- Water Resource Development Plan
- Socio Economic Survey & SEA
- Master Scenario & Candidate Projects (JST)
- Way Forward (JST)

Break
10:45 – 11:30 Questions and Answers/ Discussion
11:30 – 11:45 Closing Note:
- by JICA (Rwanda Office),
- by WASAC
- by MININFRA,

1. Self-introduction by each attendant
Self-introduction from the individual participants.
2. Opening remarks
- Opening speech by Ms. KAYITESI Marcelline, WATSAN Div. Manager, MININFRA, explaining the background and history how the Study had been realized from the signing of R/D between JICA and Rwanda side. She further added the Master Plan study (WASAC/JICA M/P) is for achieving SDGs and the national target that aims at 100% access to safe water (500 m distance from a sources for rural and 200 m in urban).
- Then, Mr. Methode Rutagungira, Director of Urban Water and Sanitation Services (UWSS), WASAC, gave his speech, explaining the background and objectives of the Study, with emphasizing that the Study has so far been conducted under the close collaboration among the working teams of the Study that consist of the counterpart (C/P) members of WASAC and the JST.
- Further, Mr. NAKASHIMA Koji, JICA Rwanda Office, noted that big challenges are being laid out ahead the years to come for Rwandan side including WASAC and MININFRA to approach the SDGs targets as well as future demand according to the Study. Then, he emphasized that the WASAC/JICA M/P is not just a kind of a work leaving all tasks to a consultant, but it is a sort of "Technical Cooperation Program" under which the Rwandan side including C/P are actively involved in the process of planning with the JICA Study Team (JST). He added that, in this context, the JST is not just a group of consultants who are entrusted to work by a client, but the team of experts who will work together with the C/P of WASAC closely to prepare JICA/WASAC M/P.
- Prior to the presentation by the JST, the Co-Team Leader of the JST highlighted that the interim result of the Study implies that the huge investment is inevitable to cover future water demand and in this context he added that today's meeting to share the Study progress among the concerned development partners would help Rwandan side including WASAC and MININFRA to seek future financial sources.

3. Questions, answers and comments raised during discussion
Summary of the Q&A as well as comments raised during the meeting are attached as Annex-1.

4. Closing note
On the wrap-up of the meeting, following comments were raised:
- WATSAN Div. Manager, MININFRA:

➢ expressed her interest on the longlist of the candidate projects presented in the ITR, and encouraged the further participation of the development partners regardless of its capability of investment scale in order

for MININFRA and WASAC to seek any possible funding source.

- expressed her gratitude to everyone presented including JST and the counterpart of WASAC for the work done. Additionally, she has appreciated the presentation and feedbacks from the attendants including development partners.
- urged the working teams for the Study to continue with this approach.

- Representative of the JICA Rwanda office expressed the gratitude and requested to all the participants of continuing cooperation for the Study.
- Director of UWSS, WASAC:

- expressed his best hope for the possibility of the two identified priority projects (A1 and A2 in the candidate projects) could be financed by the Japanese side as well as the candidate for the Japan's Grant Aid Scheme (combination of A4 and A5).
- added that more discussions with MININFRA and other development partners are going to continue during Phase II of the Study for finding a way of financing for the priority projects.

Table 71: Summary of Q&A Session for the second stakeholders meeting

No	Topic	Question/Comments	Answer
	Organizational capacity development and structure	WATSAN Div. Manager,, MININFRA: How does WASAC proceed to enhance the organization capacity for dealing with the operational issues.	JST: Organizational capacity development focus on an increasing productivity Director of UWSS, WASAC: Increase training opportunity for staff, empowering staff for decision making on site are promoted to staff's working motivation that lead to increase productivity. WASAC also aims to creating an organization for sharing skill and knowledge inter directorate/section to improve business operation.
		WATSAN Div. Manager,, MININFRA: Apart from increasing productivity, proper management system of data such as customer and GIS data are important	JST: Agreed. It will be considered in data management process for the MP report.
	Financing for the Project	WATSAN Div. Manager, MININFRA: What does it mean "Transparency of tariff" in Page87?	The structure of tariff setting is unclear in WASAC. For example, the tariff is set based on capital cost and O&M cost due to strategy of "Full cost recovery" in Japan
	Priority Projects:	WATSAN Div. Manager,, MININFRA: Expansion in phase 1 is small (3,000 m3/day) and may be integrated into the phase 2 (30,000 m3/day).	JST: The proposal intended to minimize the initial investment cost for rehabilitation in Phase 1. JST will review the phasing plan in the F/S because it was recommended in the JCC that Karenge WTP expansion should be prioritized.
	Water supply roadmap, small-scale water supply scheme, and priority projects:	(NGO): There seems to be a contradiction between the government's target "100% safe water access by 2024" and the vision in the Master Plan "(100% improved drinking water sources and) 87% piped water supply".	JST: There is no contradiction because the remaining population of 87% will have access to safe water by public taps or the improved springs in our vision of the M/P. The people will gain access to individual connection progressively towards 2050
		Small scale water supply projects were not proposed in the M/P	Noted. JST and WASAC will appreciate if the presenting developing partners have

			specific ideas for the Small Scale Water Services.
		Would like to know the cost information for the candidate projects	The Costs are shown in the IT/R. It will be presented as per requested
		It seems not efficient to have a two WTPs in Karenge and Masaka	Water Sources and the locations of the two WTPs are so different that they cannot be integrated into one. Technically, having only one WTP is not efficient. The result presented today is the one we optimized the capacities of WTPs according to their locations compared to the water demands.
	Water Resource Development Plan (Alignment with Water Resource Master Plan):	WATSAN Div. Manager, MININFRA: What is the alignment of the existing water resources and Proposed water resources in Master Plan?	JST: Water Resources Master Plan indicates the water balance (available water) at each catchment and do not mention particular ground water potential site to develop. Those sites mentioned here were previously studied or under investigation. JST: Potential sites for Water resources development were taken into consideration based on existing data from previous studies, (for example at Nzove both side of the river banks were previously studied), And also at Masaka , ground water investigation will be conducted to know potentiality of the site and volume of water that can be extracted. Of course, discussions with RWFA were conducted but there is an issue of ground water data even if even RWFA is trying to establish ground water monitoring network. Regarding surface water, RWFA is monitoring through hydrological stations and data available on water balance are catchment-based which include all water usage. Thus, some measures for water allocation are available to avoid conflict between water users. In terms of water quality, ground water is preferable compared surface water and also by considering cost-effective water source.
	Water Resource Development Plan(Alignment with Water Resource Master Plan):	Rural Water Supply Senior Eng., MININFRA: The Ministry of environment is conducting a study to rehabilitate Rwesero Dam on Muhazi lake (downstream) for water supply purpose. Is there any possibility to use the water for drinking water purpose for the City of Kigali?	Director of UWSS, WASAC: Muhazi lake is reserved as a water source for eastern province including Rwamagana instead they are considering water from Butamuwa Dam.

	Water Quality Survey	World Vision Rwanda: (p.54 of the slide) In the water quality survey, have you checked arsenic?	JST: The water quality tests result in the presentation has omitted some items which are detecting nothing. The parameters you've mentioned were not included in our test, since it is targeted for spring JST: The parameter you've mentioned will be tested in ground water tests. However, it has been delayed due to land occupation issue and access problem by flooding. It will be carried out including two (2) parameters you've mentioned
	Status of Concession Agreement between GoR and WASAC	JST (Request to MININFRA) : The agreement has not been signed long time since the independence of WASAC in 2014. Ms. Chairperson is a member of WASAC Board of Director. Kindly take initiatives to promote this issue	WATSAN Div. Manager, MININFRA: WASAC has completed the procedures including drafting the agreement. The necessary procedures will be followed like below: To hold the shareholders' meeting and pass the resolution; To get the Cabinet approval ; To sign by both parities
	Water Tariff:	JST (Request to MININFRA): Cash Flow of WASAC is positive; however, profit is negative. The reason is the low level of tariff which is 30% lower than the entire cost including the depreciation of fixed assets. Obviously it means that the future renewal and replacement costs cannot be covered by the operation profit. Kindly push RURA and get it to take more consideration about this	WATSAN Div. Manager, MININFRA: She asked whether the JST has ever met the RURA staff. She advised the JST to get a direct contact with them if yes

Source: Prepared by JST, 2019

Annex 12: Attendance List for Second stakholders meeting/TWG meeting
Member of Thematic Working Group

Names	Position	Institution
Marcelline Kayitesi	Water and Sanitation Division Manager	MININFRA
Fidele Nteziyaremye	WATSAN DM, Ag	MININFRA
Venuste Mpimbazimana	Urban Water Supply Senior Engineer	MININFRA
Kagaga Monique	M& E Expert	MININFRA
Leoncia Mukamwiza	Policy Research & Rent Expert	MININFRA
Hategekimana Uwitonze Bova	WATSAN Economist	MININFRA
Rwabizi Felix	Intern	MININFRA
Emmanuel Hategekimana	Rural Water Supply Senior Engineer	MININFRA
Nakashima Koji	Water and Sanitation Program Manager	JICA Rwanda Office
Kwizera Virgile	Water and Sanitation Program Officer	JICA Rwanda Office
Amos Shyaka Kazora	Head of Sewerage Operations Unit	WASAC
Amandine Umukesha	Senior W&S Expert	AfDB
Nicole Mukunzi	HP&WASH Specialist	USAID
Uwonkunda Bruce	S.P.O	Water for People
Gratien Nizeyimana	Wash & Health Technical Design Manager	WUR
Olivier Ndizeye	MEL Coordinator	Water Aid
Uwingabire Alphonsine	Wash for All Project Officer	UPHLS
Ntakirende JMV	Programs Manager	Living Water Int.

Names	Position	Institution
Duhirimana Theogene	Legal Advisor of Ayateke, Representative of FEPEAR (Forum des Exploitants Privé des systèmes d'Eau et d'Assainissement au Rwanda).	FEPEAR
Fiordalisio Omar	Country Manager	MLFM
Hirwa Christian	Technical Director	Water Access Rwanda
Musabyimana Gedeon	WASH Officer	UNICEF

Working Team for WASAC/JICA M/P

Names	Position	Institution
Rutagungira Methode	Director, UWSSD	WASAC
Gashugi Innocent	Manager Water Operation Service, UWSSD	WASAC
Lobga M. Monia	Water Production Manager, UWSSD	WASAC
Kawamura Tetsuji	Co-Team Leader / Water Supply Planning 2	JICA Study Team
Yoshida Kenji	Water Resource / Water Quality/ Hydrogeology	JICA Study Team
Kobayashi Shinkichi	Water Supply Pipeline Planning	JICA Study Team
Matsubara Koichi	Hydraulic Analysis / GIS Database	JICA Study Team
Oshima Yoshiaki	Cost Estimator / Implementation Planning / Study Coordinator	JICA Study Team
Choso Yoshiyuki	Organization/ Institution	JICA Study Team
Osakabe Noboru	Economic and Financial Analyst	JICA Study Team
Tanaka Uyu	Environment and Social Consideration	JICA Study Team
Nteziryayo Francois Xavier	Supporting Staff for Civil Engineering (Planning /Water supply Pipeline /Water Treatment Plant)	JICA Study Team
Dushimimana Sandrine	Office Secretary	JICA Study Team
Uwiringiyimana Janvier	Specialist in Water Resource Engineering	JICA Study Team

Source: Prepared by JST, 2019

Annex 13: Outcome of third stakeholder meeting on Kigali Water Master Plan held on August 27, 2021.

1. Introduction

The Kigali Water Supply Master Plan was prepared by Water and Sanitation Corporation Limited (WASAC) under the financing agreement signed between the Government of Rwanda and the Government of Japan. The Master Plan was prepared with the support of JICA study team and counterparts from WASAC. Now Master Plan is prepared and due to nature of public works, WASAC as an enacting body, must show transparency in their actions. In disclosing information of their business plans, WASAC will enhances reliability and "legitimacy" of the MP and WASAC itself. Stakeholder meeting for the Master Plan is required for following objectives:

- To share MP (business plan of the WASAC)
- To share current standing point of the water supply sector and necessity of support from public and relating agencies.

2. Participants

Participates to the stakeholder meeting included representative from the City of Kigali, WASAC, representative of districts officials (Rwamagana, Bugesera, Kamonyi and Rulindo, representative of NGos working in water sector, JICA study team and members of Media. List of participants is provided in annex 1.

3. Presentations

The opening remarks was provided by MR. Ntagungira Methodes who welcome all participants and urged them to actively participate in the workshop. He indicated that the objective of the workshop is to present results of work done by WASAC and JICA study team including the Master Plan, the 15years Investment plan and feasibility study of two selected projects as well as the conclusion of Strategic Environmental Assessment.

The Opening remarks was followed by the presentation provided by Mrs Francine Mbateye Umuhoza from WASAC. The presentation focused on the Master Plan Process, key components of the Master Plan and key conclusion of the master Plan. Key issues highlighted in the presentation include the coverage of the Master Plan, water demand forecast, water resource development and water supply master scenarios. She also presented the 15Years Investment Plan with two selected projects that undergone Feasibility Study-Masaka Water Treatment Plan and Rehabilitation of Karenge Water Treatment Plant. She concluded her presentation with the objective and findings of Strategic Environmental Assessment prepared for the master Plan. The Key conclusion from the SEA is that No Project option cannot be considered and project implementation with mitigation measures is recommended. She also informed participants that in addition to the SEA prepared for the Master Plan, two Environmental Impacts assessment were prepared for two selected projects, Masaka and Karenge.

4. Comments, inputs and discussions

After the presentation, participants were provided with the opportunity to provide comments, questions and inputs to the Master Plan. The Table 1 presents key outcome of this session

Table 72: Record of Q&A session during SHM meeting on 27th August, 2021

	Question	Answer
1	**Water Aid Representative**	
	In terms of water source, MP is heavily depends on Nyabarongo River, and Akagera River catchment. What is the reason for excluding Nyabugogo and Muhazi Lake as water source?	JST: there were existing water resource development plan. Therefore, JST didn't considered Nyabagogo River as water source for the MP. WASAC: Muhazi Lake had two (2) water supply projects. Therefore, the MP could not allocate water from Nyabugogo and Muhazi Lake.
	As a one of the option in the future, recycled water should be considered as one of the water sources. (comment)	WASAC: So far, we didn't consider recycle water as water source since there is no information about wastewater treatment masterplan. It may be considered when the masterplan on wastewater treatment is in place.
	In MP, are there any consideration to other water use such as agriculture sector, power sector, and industry sector?	WASAC: The master Plan was prepared in consultation with Rwanda Water Board and it considered available water resources and other users. Further water abstracted permit will be requested to ensure compliance with Water Resource Master Plan
	Through SEA, if there is any alerting issue, please share.	JST/BESST LTD: There is no alarming issues but key environmental and social issues were identified in SEA and recommendations were provided. Key issues identified are land acquisition and involuntary resettlement, floods issues and sludge management as well as issues related to climate change.
2	**Member of the media**	
	Why the objectives and target targeted in 2024 were not achieved and what is the guarantee that the Master Plan target will be achieved in 2050**?**	WASAC: WASAC is working with its stakeholders to achieve all target for 2024. He also provided information on ongoing projects including the rehabilitation of water supply network in Kigali and construction of new plants under AfDB funding. For the implementation of this Master Plan, the Government will work with its partners and private investors to implement projects included in The Master Plan and 15-Years Investment Plan
3	**Water for People**	
	To attract investors, I suggest to WASAC to have followings: - Detail design studies for the project - Above mentioned design documents should be available for the investors	WASAC So far, two projects were included in the Master Plan study but WASAC will explorer the possibility and funding opportunities to conduct other feasibility study which can be used for investors
4	**Bugesera District**	
	If possible, we want to add two (2) more sectors such as Mwogo and Juru in Bugesera as part of this MP**.**	WASAC The Master Plan considered only 7sectors outside Kigali which are considered as the expansion area for Kigali population. However, other sectors are covered in the National Water Supply and Sanitation under preparation.

5. Closing remarks

In his closing remarks, Mr. Methodes from WASAC appreciated the active participation of all invites and urged them to convey the message on general public and invited them to visit WASAC website to consultant details material related to the Master Plan.

Annex 1: List of Participants to the SHM of August 27, 2021

Government of Rwanda and Other related organization

KANANGA Jean Damascene	Water and Sanitation officer, BUGESERA District
KARANGWA Lambert	Senior WASH Expert, WaterAid
DUSINGIZUMUREMYI Eugene	Water for People Program Manager, Water for People

WASAC Management Team

RUTAGUNGIRA Methode	Director, Urban Water and Sanitation Service
GASHUGI Innocent	Manager Water Operations Services
MIREIZ TUTUSAUS	Expert, VEI/WASAC
KABASHA ASAPH Mercy	Project Manager, VEI/WASAC
NDAGIJIMANA Joseph	Water Supply Engineer, WASAC
BUSHAYIJA Yasin	Head of Nzove WTP, WASAC
MAZIMPAKA Claudien	Zoning & Mapping, WASAC
MWIJUKYE Jmes	DCS, WASAC
KAMIRU Desire	DCS, WASAC
TUYISENGE Vedaste	Head of Gikondo Branch, WASAC
MURENZI Rukundo Frank	P.R/Communication, WASAC
UMUHOZA Mbateye Francine	Planning Officer, WASAC
NTIRANDEKURA Valerien	Water Sector Specialist, WASAC
SHUMBUSHO Marcellin	Head of Karenge WTP, WASAC
MUKIZA Anaclet	Head of KANOMBE Branch
MUGWANEZA Vincent de Paul	Director of Rural Water Services
MUSABYEYEZU Jeanne	Head of KACYIRU Branch
LOBGA Monia	Water Production Manager
BAHIGE Jean Berchimans	NRW Manager
NIWENSHUTI Emmanuel	Head of Water and Sanitation Cooperation Unit
DUSHIME Réné	WTP Engineer, Kimisagara WTP
HAKIZUWERA Patrick	Water Distribution Officer, Kacyiru Branch
UWITONZE Desire	Ag. Zoning and Mapping Service, UWSS
RUBAYITA Gilbert	Head of REMERA Branch
SHUMBUSHO Cyrille	Water Distribution Services Officer, UWSS
MBATEYE Francine UMUHOZA	Planning Officer
Egide IYAKARE	Water Distribution Officer/Rwamagana Branch

JICA HQs/TOKYO

YAMAKI Tetsuya Assistant Director, Water Resource Team 2

JICA Rwanda

NAKASHIMA Koji	Water and Sanitation Program Manager
KWIZERA Virgile	Water and Sanitation Program Officer

JICA Study Team in Venue

MAMIYA Takemasa	Team Leader / Water Supply Planning 1, JICA Study Team
KAWAMURA Tetsuji	Co-Team Leader / Water Supply Planning 2, JICA Study Team

NISHIDA Kosei	Business continuity Plan, JICA Study Team
MATSUMOTO Yuichi	Procurement & Quotation of Water Tanker
CHOSO Yoshiuki	Organization/ Institution
SAITO Shuichi	Electromechanical Engineer
KOBAYASHI Shinkichi	Water Supply Pipeline Planning
YOSHIDA Kenji	Water Resource / Water Quality/ Hydrogeology
MATSUBARA Koichi	Hydraulic Analysis / GIS Database
OSAKABE Noboru	Financial and Economic Analysis Specialist
NTEZIRYAYO Francois Xavier	Supporting staff for Civil Engineering (Planning /Water supply pipeline /Water treatment plant), Trust Facility Services
UWIRINGIYIMANA Janvier	Specialist in water resource engineering, Trust Facility Services
NIYIBAHO Jean Robert	Cost Estimate/ Electromechanical Engineer, Trust Facility Services
DUSHIMIMANA Sandrine	Office Secretary, Trust Facility Services
HABUKUBAHO Theogene	Consultant SEA, EIA, Socio-Economic, BESST Ltd

Media

BISERUKA Jean D'amour	Journalist, GASABO.Net
FLORENCE UWAMALIYA	Journalist, IMENA
NTIHABOSE DIEUDONNE	Journalist, OASISGOZETTE.RW
IMANIRIHO Gabriel	Journalist, Isango Star
BANGANIRIHO Thomas	Journalist, lematin d'Afrique
MUVUNYI Leonce	Reporter, The East African Rwanda Today
TALIBU Abdoul	Journalist, KIGALI Today
NTIRUSHWA Anaclet	Journalist, UKURI.RW
AHIMANA Theoneste	Journalist, Muburezsi.com
MPOREBUKE Noel	Journalist, umurabyo.rw
BAGABO John	Reporter, ISANO Radio
GATARAYIHA P. CELESTIN	Cameraman, RBA
KWIZERA John Patrick	Reporter, RBA
KAYITESI CARINE	Journalist, umwezi
NDABATEZE Jean Bosco	Journalist, Radio umucyo
UFITINEMA Ame Q.	Journalist, Impuruza

Annex 14: Water supply private operators in Master Plan Area

	Provider's Name		Seegh	Ageoh	Regie Associatives des Usagers des Points D'Eau Gasabo Ltd.	Socotrim Ltd.	Aqua Rwanda	Ubuzima Bwiza MKM	Ayateke Star Company Ltd.	Ayateke Star Company Ltd.	Paak Kam Ltd.
General information[*1]	-	-	-	-	-	-	-	-	-	-	-
G-1	Type of service		Rural Water Supply	Rural Water Supply	Rural Water Supply	Rural Water Supply	Rural Water Supply	Rural Water Supply	Rural Water Supply	Rural Water Supply	Rural Water Supply
G-2	Service area		Kamonyi Dist.	Rulindo Dist.	Gasabo Dist.	Kamonyi Dist.	Kamonyi Dist.	Rwamagana Dist	Rwamagana Dist	Rulindo Dist.	Gasabo Dist.
G-3	License issued		2016	2016	2016	2016	2016	2016	2017	2017	2018
G-4	License expires		2021	2021	2021	2021	2021	2021	2022	2022	2023
Technicall information	-	-	-	-	-	-	-	-	-	-	-
T-1	Current production (m3/day)	Total in the District		-	-		51.9	259	3	1495	-
		for Shyorongi	-	-	-	-	-	-	-	1495	-
		for Runda		-	-		17.3	-	-	-	-
		for Rugalika		-	-		34.6	-	-	-	-
		for Ntarama	-	-	-	-	-	-	-	-	-
		for Muyumbu	-	-	-	-	-	0	0	-	-
		for Gahengeri	-	-	-	-	-	259	Kabare-Nyabisindu System (3 m3/day)	-	-
		for Nyakaliro	-	-	-	-	-	0	0	-	-
T-2	Plan or possibility of expansion of production (m3/day)	Total in the District		-	-		0	172.8	No Plan	86.4	-
		for Shyorongi	-	-	-	-	-	-	-	Plan of expansion of Maya system (86.4m3/day)	-
		for Runda		-	-		0	-	-	-	-
		for Rugalika		-	-		0	-	-	-	-
		for Ntarama	-	-	-	-	-	-	-	-	-
		For Muyumbu	-	-	-	-	-	0	0	-	-
		for Gahengeri	-	-	-	-	-	172.8	No	-	-
		for Nyakaliro	-	-	-	-	-	0	0	-	-
T-3	Water source (types (Spring, tube well, river, pond, lake) & location)	Total in the District		-	-		3	1	1	6	-
		for Shyorongi	-	-	-	-	-	-	-	All are springs	-
		for Runda		-	-		Spring (Gatare)	-	-	-	-
		for Rugalika		-	-		Rwakayange (Spring), Rwamirambi (Spring)	-	-	-	-

	Provider's Name		Seegh	Ageoh	Regie Associatives des Usagers des Points D'Eau Gasabo Ltd.	Socotrim Ltd.	Aqua Rwanda	Ubuzima Bwiza MKM	Ayateke Star Company Ltd.	Ayateke Star Company Ltd.	Paak Kam Ltd.
	(Indicate on map)	for Ntarama	-	-	-	-	-	-	-	-	-
		for Muyumbu	-	-	-	-	-	0	0	-	-
		for Gahengeri	-	-	-	-	-	Spring	Spring	-	-
		for Nyakaliro	-	-	-	-	-	0	0	-	-
T-4	Service area (Indicate on map)	Total in the District		-	-			-	-	-	-
		for Shyorongi	-	-	-	-	-	-	-	1. Bitete-Rwahi(Rubona cell and a small part of Muvumo Cell(Rusiga Sector); 2.Gisoro-Nyundo(Rubona Cell and Kijabagwe Cell, Rimwe Village); 3	-
		for Runda		-	-		AEP Gatare (Muganza Cell)	-	-	-	-
		for Rugalika		-	-		AEP Rwakayange(Nyarubuye, Kigese and Masaka Cells), AEP Rwamirambi(Sheli Cell, Ntebe Village)	-	-	-	-
		for Ntarama	-	-	-	-	-	-	-	-	-
		for Muyumbu	-	-	-	-	-	0	0	-	-
		for Gahengeri	-	-	-	-	-	See map of attached PDF	Ruhita Village,Kanyangese Cell	-	-
		for Nyakaliro	-	-	-	-	-	0	0	-	-

Final Report:
WASAC
Business Continuity Plan

Nihon Suido Consultants Co., Ltd.
Water and Environmental Consultants

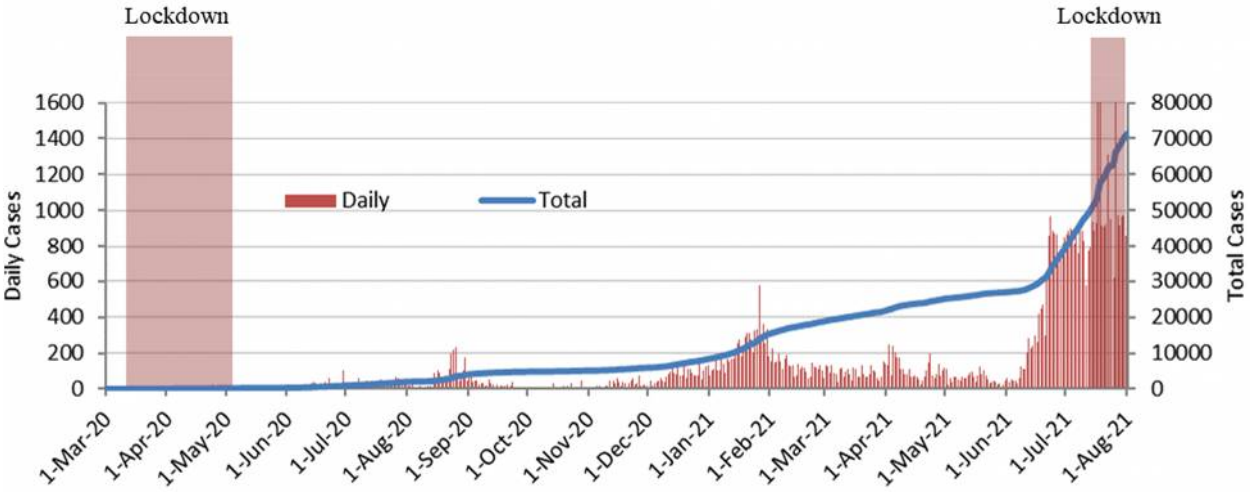
YACHIYO ENGINEERING CO.,LTD.
Consulting Engineers & Architects

Table of Contents

CHAPTER 1. INTRODUCTION

1.1 BACKGROUND

Novel Coronavirus disease 2019 (COVID-19) affects more than 200 countries and the number of global confirmed cases of infection is around 200 million (at 1st of August 2021), threatening global safety and economy. The Government of Rwanda declared two weeks of strict lockdown and shutdown of borders on March 14 a week after the first case was reported in Rwanda, which was eventually remained until May 4. The number of COVID-19 cases dropped at the beginning of August 2020, but the country hit a record 217 cases in a day. Even after the lockdown was lifted except some areas, curfew and travel restriction were introduced. From December 2020, the cases increased. The number of the cases increased again from the middle of June. Second lockdown was introduced in Kigali and other districts on July 17 2021 to contain the spread of the COVID-19 (**Figure 1.1-1**). The government of Rwanda keeps taking action to minimize the impact of COVID-19, but still the future situation is unpredictable.



Source: JST

Figure 1.1-1 Timeseries of Confirmed COVID-19 Cases in Rwanda

WASAC had gone through a tough time under the severe and unprecedented situations such as revenue reduction, limited resources and emergency needs especially during the lockdown. But the situation is still ongoing with drastic change and facing an unpredictable future. On the other hand, WASAC took some unique strategies to continue the essential water services which are critical to public health and necessary to avoid a disruption of business continuity. For example, WASAC continued the billing procedures by asking customers to read their residential water meter or sharing a picture of the meter through SMS instead of meter readers visiting the customers. Summarizing key factors, strategies, and good and bad practices would help to provide the direction for the management and the response of the utility in order to address the risks of future disasters. The experiences that the utility obtained during this period are significantly important knowledge to overcome the situation effectively and resiliently not only for WASAC itself, but also for the other water utilities. Disruption of the business continuity will end up with the crisis in society because water is a vital resource for human health. Since the utility has to ensure the continuity of the water services and operations under

any event, the Business Continuity Plan (BCP) is developed. Furthermore, in order to meet the emergent water needs due to COVID-19 especially in the remote areas, JICA has procured the water tanker for WASAC.

The main objectives of this Business Continuity Plan are to:

1. Summarize Lesson Learned from COVID-19 Pandemic.
2. Formulate Business Continuity Plan
3. Analyze Financial Situation and Impact in WASAC
4. Procurement of Water Tanker

1.2 GENERAL INFORMATION

Coronavirus disease 2019 (COVID-19) is an infectious disease involving the respiratory tract caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The characteristics and general information of COVID-19 from the perspective of water and sanitation management is summarized in below[1].

- As one of the most important information concerning water, sanitation, and hygiene (WASH) and SARS-CoV-2, WHO remarked the importance of frequent and proper handwashing to prevent infection with the virus and water utilities should work on building an environment to improve access to hand hygiene facilities and to raise awareness of its importance.
- No study or research shows an indication that the virus can persist in drinking water, whereas some research groups have found RNA fragments in wastewater but not infectious virus. Water utilities should relate the accurate information to public.
- Conventional water treatment processes that have filtration and disinfection should significantly reduce the concentration of the virus. To ensure effective disinfection of water, residual concentration of free chlorine should be more than 0.5 mg/L after at least 30 minutes of contact time at pH is less than 8.0. These criteria should be applied for other distribution systems such as distribution with water trucks.
- The common routes of transmission of the virus are respiratory droplets and direct contact. An infected person has a potential to transmit the virus to others who are contact with the person.
- Sanitation workers should follow the standard operating procedures such as wearing PPE, keeping the tools and clothing clean, handwashing frequently and self-checking if they see any sign of infection.
- It is also important to ensure enough stocks of chemicals and laboratory reagents for water quality testing in water treatment plants.

1.3 BASIC CONCEPT AND OBJECTIVES

BCP summarizes general information regarding COVID-19, the essential services which are vital to maintaining water supply, communication network to enhance information sharing, critical resources, and public relations.

[1] World Health Organization (WHO), 29 July 2020, Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19

BCP aims to:

- be and emergency response guideline for staff to understand what to do during the crisis;
- raise awareness of emergency among staff and people in the utility to enhance the resilience and solidarity of the team against the unpredicted situation;
- mitigate the influence of the huge disaster, particularly COVID-19 in this document, causing the significant impacts to the business continuity as well as lower the peak and recover to the normal operation level in a certain timeframe without interrupting prioritized functions during the events (**Figure 1.3-1**).

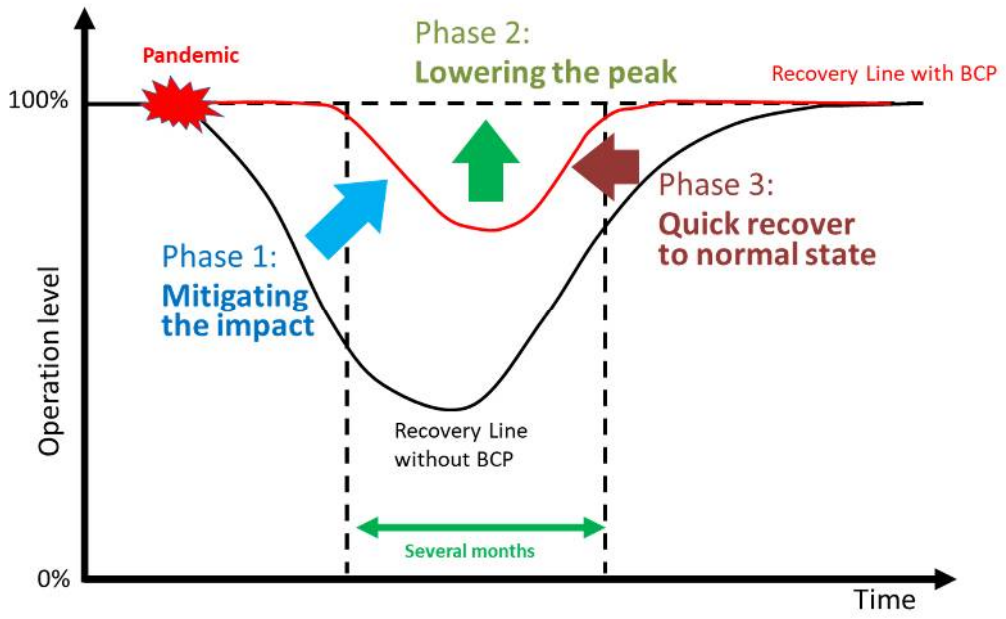


Figure 1.3-1 The schematic image of recovery line with BCP

1.4 SCOPE OF BCP

The scope of BCP is the organizational and communication rules for the emergency response to the Pandemic, especially for the COVID-19 for the following.

- WASAC's all departments in the headquarters, all branches and all water treatment plants including outside of Kigali city.
- All services, operations and facilities mainly focusing on urban water supply.
- Whole duration from the pre-pandemic (first confirmation of infection in another country) to post-pandemic (until the utility recovers to the normal state in terms of operations, services, and financial situation).

1.5 TYPE OF HAZARD

This plan is based on the experience of WASAC from the COVID-19 pandemic. It is important to determine the business continuity level in consideration of infection risk, social responsibility, and management aspects.

The following items are the assumption:

- Financial decrease due to the reduction of water demand.

- Long-term effects with many uncertainties.
- Lockdown.
- Travel restriction.
- Closure/regulation of borders.
- Suspension of international commercial flights.
- Economic stagnation.
- Limited resources including personnel, materials, and transport tools.

The pandemic stage is divided in three phases as Preparation phase, Response phase and Recovery phase shown in **Table 1.5-1**.

Table 1.5-1 Description of each phase

	Preparation phase	Response phase	Recovery phase
Description	COVID-19 infection is confirmed outside of Rwanda	COVID-19 infection is confirmed in Rwanda and the lockdown and travel restriction are introduced	The lockdown and travel restrictions are lifted but still COVID-19 infection is confirmed in Rwanda
Duration	2 months	2~3 months	Several months ~
Attendance rate	As usual	15 ~ 30%	Gradually recovered
Electricity, Water, Gas	As usual	Delay of operations in some areas	As usual
Public transport (Bus, Train)	As usual	Stop	Partially restricted
National/District borders	Partially Restricted	Restricted	Gradually recovered
International commercial flight	Stopped	Stopped	Gradually recovered
Local business (Hardware shops)	As usual	Closed	Partially closed

1.6 BCP TASK FORCE

BCP is formulated with the collaborated work of JICA Study Team (JST) for Kigali Water Supply Masterplan and WASAC BCP Task Force. WASAC BCP Task Force is responsible not only for formulation but also implementation and revision of BCP. The Task Force composes of the directors and managers from DCEO Office, Urban Water and Sanitation Services, Finance, Corporate Planning and Commercial Services who was in charge of management of WASAC to maintain the water supply services even under the pandemic. In addition to their experiences, we collected information and lessons of responses to the Pandemic from other WASAC Headquarters, Branches and WTPs focusing how they continue their work and what they struggled with the most in terms of materials, logistics, operations, maintenances, finance, and commercial services. The Task Force and JST had discussions to identify the bottlenecks which could disrupt the basic functions of WASAC and proposed how the utility could tackle those. Furthermore, we had a collaborate work to evaluate the financial impact of COVID-19 Pandemic to WASAC. Also, the Task Force is a coordinator of the utility who is in charge of instructing staff to respond to the emergency during such events.

CHAPTER 2. LESSON LEARNED

Investigation on the situation at branches during COVID-19 is significantly important to prepare for the next pandemic or other events, which has been done by interviews and questionnaires to branch managers focusing on what kind of problems they faced and how they managed to maintain their business in such situation. This investigation covers all branches (20 branches including branches in Kigali and outside of Kigali) and 5 main WTPs (Gihira, Kadahowa, Mutobo, Nyagatare, and Nzove). The answers of questionnaires are in **Annex 1**.

All branches have done their best to keep stable water supply to the population. Some of them had unique and good responses to the situation. In Muhanga branch, when they suffered from the lack of repair materials due to the lockdown, they managed to get those by asking authorization at local authorities for some hardware shops to open. Most of the branches had similar patterns of situations, but some of them have different patterns. For example, the attendance rate during the lockdown was 25% in Kacyiru branch while it was about 50% in Nyanza branch. For another example, for the question "How was the situation of customer services?", 3 of 10 branches answered as "good" although the other answered as "not very good" or "challenging."

Task Force and JST team has conducted an analysis on the situation during the COVID-19 pandemic based on the interviews, especially focusing on the period of the city lockdown and eventually the five most critical issues are extracted as in the following chapters.

2.1 MATERIAL

Most branches had to respond to implications regarding the availability of materials due to the transport regulations, requiring a new approach for the supply system. As most of hardware stores were closed, it was difficult to get the materials locally. Branches in Kigali faced the same issues due to a lack of material stocks in WASAC central store. Many branches were suffering from the lack of small repair materials but sometimes also big repair materials, suggesting the importance of clarifying the material sources for each type of materials at each branch. They managed to get the materials in many different ways, such as negotiating with suppliers, using petty cash in local hardware shops, and asking authorization at local authorities for some shops to open. However, all branches answered that the materials are not enough because local hardware shops are closed or too small with less availabilities of required materials. Cooperation with other branches and the HQ will be one of the solutions, but the branches far from Kigali were not able to get enough assistance from them, whereas the branches near Kigali might have been able to get. In the standard procedure of the material supply at Branch, they request the quantity of materials they need to the HQ. Depending on the availability of materials in the central store, the materials will be delivered in one month or two months by a truck, or a Branch car. Then, Branch stores those materials at the local warehouse. Giving the right to branches for purchase on ground with their petty cash is not a complete solution because the local hardware shops do not have some of those items.

2.2 TRANSPORT

The vehicles are shared in four main different purposes: transporting staff from home to the workplace, the technical team to the site, commercial workers, and materials. Consequently, many

branches faced a lack of means of transport, which was a significant issue for their business continuity. For example, Gikondo branch had one old vehicle and it was the biggest bottleneck of the material supply system. In the process of materials transport from the central store, they had to take the branch vehicle to pick up the storekeeper at home and return him back to the store. To buy materials at local stores, they had to search for the shop owners and pick them up from their home to the shop. The vehicle of the branch was allowed to pass because they were considered as essential workers, so they were able to transport the technicians and technician helpers from their residence to the site and return them back after their job. But some technician helpers whose residence are very far from the branch and thereby they stayed in WASAC house where the branch has water reservoirs. One of the branch directors mentioned that if they had one more car, they could have improved commercial works. Some branches also concluded the lack of vehicles was the biggest problem in financial and commercial works. Improvement of the transport would be of great importance to mitigate the stagnation of the supply chain.

2.3 MANPOWER

Most branches consider an insufficient staff as the most critical issues for operation works. Due to the travel restriction, the attendance rate of staff decreased significantly because many staff had to work from home. It caused delay in operations such as water leakage repair, delay of intervention and reduction of maintenance works. Lack of information was also challenging as many staff were staying at home. JST team conducted the investigation on the attendance rate of each team at Muhanga Branch. According to the manager, Branch manager mostly came to the office and was responsible for branch management and response to the crisis. Commercial service officer and Billing supervisor managed to work remotely although Accountant team had to work at office since they needed to deal with the procedure of material purchase at office. Commercial filed officer and CACRO were staying at home. The attendance rate of Water distribution officer and technical team was mostly 100%.

2.4 FINANCIAL IMPACT

Billing and collection were also one of the important components according to the result of questionnaire. As part of the unique strategies of WASAC, they continued meter reading by asking customers to check their meter reader and send the picture to WASAC, allowing WASAC to collect water tariffs. Self-declaration via phones caused positive effects but with limitations. Some customers were not able to afford to pay water tariff, resulting in accumulated outstanding balance. In addition, it resulted in increased errors and inaccurate data in the billing system. WASAC experienced revenue reduction because of the several issues; for example, the operation works were limited on urgent works only, no new connection or disconnection was allowed, and big customers such as hotels, schools and bars are not in operation.

2.5 PREPAREDNESS

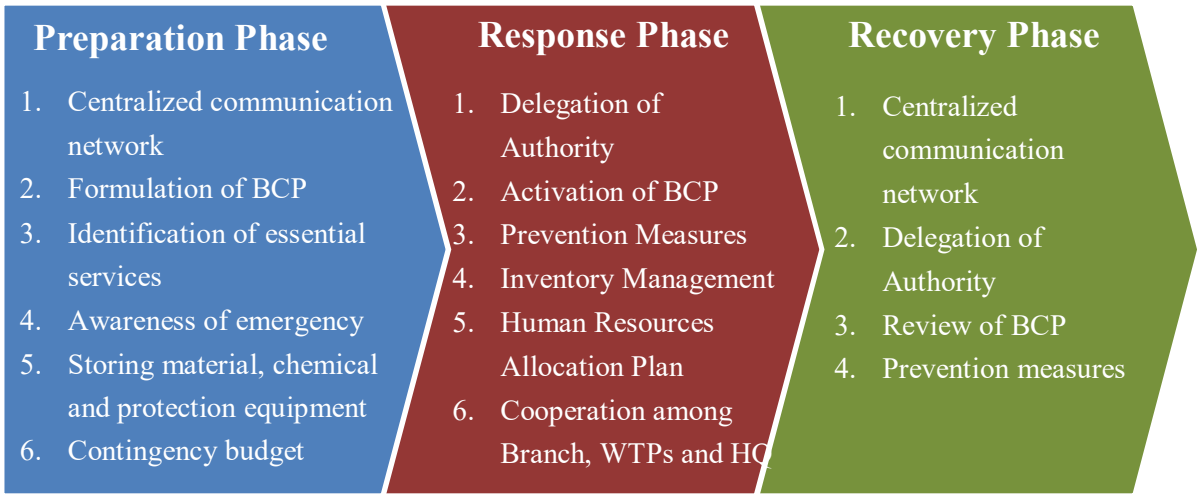
Understanding of “Emergency” is necessary to achieve a quick response to the crisis. Some staff did not have clear understanding of the operations in an emergency in terms of what they have to do and what they do not have to do because they have never experienced such emergency before. However,

since they had gone through the Pandemic over a year, they have developed the responses by themselves. During the early stage of the outbreak, face masks and hand sanitizers were not available at local market in some branches. The managers should know how many contingent materials they should purchase and store. Additionally, it is important to understand the importance of prevention measures such as handwashing, cough etiquette and social distancing to avoid the spread of the virus among workers.

CHAPTER 3. PANDEMIC STAGE TRANSITION

The utility needs to respond to the pandemic with a different approach depending on the stages, as in three phases: the preparation phase, the response phase and the recovery phase as in **Figure 2.5-1**. The definition of these phases is described in Chapter 1.4.

Figure 2.5-1 Pandemic stage transition and relevant feature



3.1 PREPARATION PHASE

1) Centralized communication network

Understanding the situation of emergency is the first step to respond to the crisis. And thereby it is recommended to prepare and establish a centralized communication network, which would help to share important information related to the disaster effectively and quickly, ensuring a reliable and prompt response to the outbreak of the pandemic. The network includes the City of Kigali, MININFRA, Rwanda Joint Task Force and District (**Figure 3.1-1**). The information about the outbreak will be provided appropriately with this network to each department, branch, and WTP and will be made known to the staff, as well as to contractors. It is important to centralize and share information, secure personnel and supplies as necessary, and prepare measures to prevent the spread of infection am

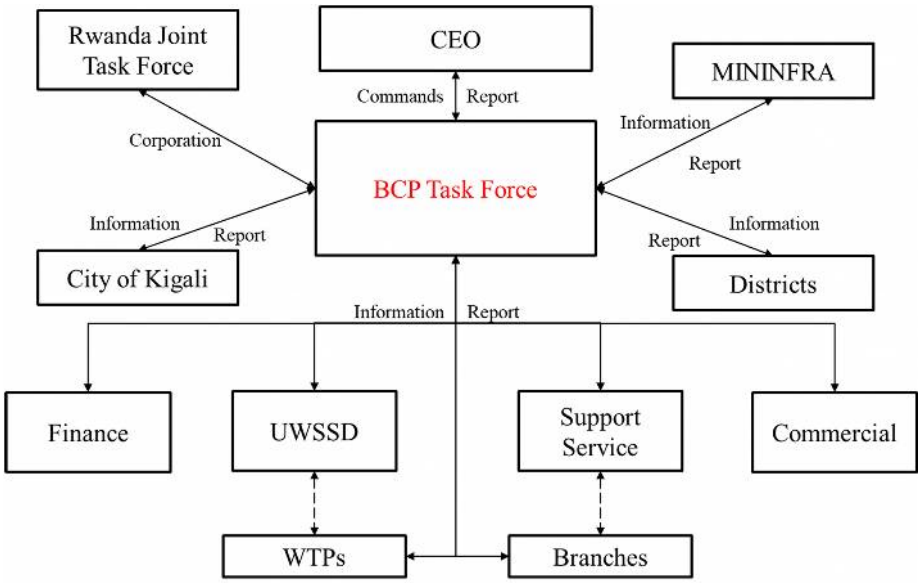


Figure 3.1-1 COVID-19 centralized communication network

2) Formulation of BCP

Ahead of the country-wide outbreak, staff needs to sum up what they have to do during the phase from the domestic spread period to the epidemic period and finally to the recovery period.

3) Identification of essential service

Staff should study in advance the minimum operations required for stable water supply (operation and management operations of water purification plants, etc.), and ensure that water supply services are provided even if there is a shortage of personnel after the outbreak.

4) Awareness of emergency

It is important to educate and enlighten staff by conducting training courses on basic knowledge of COVID-19, infection preventive measures, etc. so that they can understand the situation of emergency and take appropriate action when it occurs.

It is also important to provide the staff with information on measures to prevent the infection, encourage gargling and hand washing on a daily basis, keep in mind the list of prevention measures and "cough etiquette", and raise awareness of self-understanding of the health condition.

5) Inventory management

Even though the water supply workers are considered as essential workers, the movement of staff will be stagnated because there is a limitation for the transport tools during the lockdown or travel restriction. As supply chain will also be stacked due to the lack of transport or the regulation of boarders, the utility might face a shortage of materials such as repair materials, chemicals, and protection equipment. Additionally, there is a stopover for each boarder where people entering the country have to go through the inspection, resulting in the delay of delivery. Accordingly, the central warehouse and local warehouse at each branch level should estimate the amount they need including contingency in consideration of those factors before the crisis.

6) Contingency budget

The revenue from the tariff decreases because the non-domestic water demand decrease; many commercial facilities, markets, hotels and schools stop operation during the lockdown. In addition, the utility has to stop disconnection for the customers who don't pay and stop constructing new connection of water supply. The utility will also face accumulated outstanding balance since the customers cannot afford to pay the tariff. At the branch level, contingency budget will be needed as if they have to get the repair materials at local hardware shops which used to be available by making a request to the HQ.

3.2 RESPONSE PHASE

1) Organization in emergency

Task Force is in charge of the coordination of the utility during the response phase in terms of information sharing, communication, allocation of human resources, emergency responses, implementation of BCP and emergency procedure (**Figure 3.2-1**).

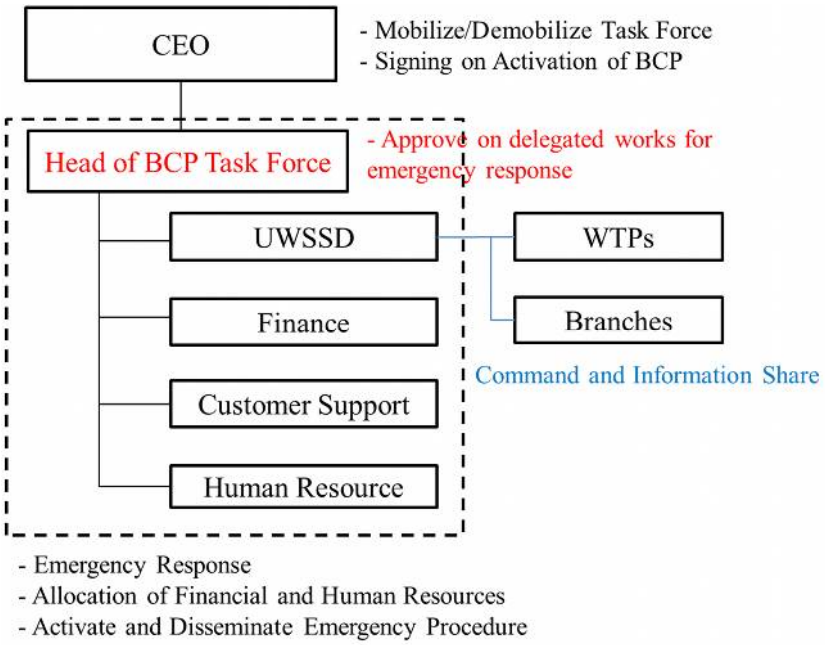


Figure 3.2-1 Organization in emergency

2) Activation of BCP

From the perspective of maintaining lifeline functions in the event of the COVID-19 outbreak, measures such as distributing the list of essential services, the list of emergency items and general caution will be implemented from the early stages of the outbreak based on the BCP.

3) Prevention measures

HQ and Branch should instruct staff to raise awareness of the outbreak and, if they have symptoms suspected of being infected with the virus, ask them to make a contact with a public health center immediately and follow their instructions. They should try to understand the situation of the staff as

much as possible. In addition, they should distribute supplies such as face masks to the target staff and recommend them to wear and use infection control equipment with a poster that is easy to see and understand.

4) Inventory Management

Branch request the quantity of materials they need and manage it at the local warehouse. Depending on the availability of materials in the central store, the materials will be delivered in one month or two months by a truck, or a Branch car. This study recommends finding out the material that each branch is in need frequently. For those materials, the central store can make a security store for that purpose when the pandemic comes again. Giving Branch the right to purchase on ground with their petty cash is not a solution because the local hardware shops do not have some of those items. When the one is used, they request immediately and report which one is used.

5) Human Resources Allocation Plan

During lockdown or restrictions, the utility has to follow the attendance rate determined by the government. Therefore, the utility needs a proper human resources allocation plan. Since each department, branch and WTP have their own responsibilities and member compositions, they need their own plans.

6) Cooperation between Branch, WTP and HQ

Frequent communication and cooperation between Branch and HQ, also WTP and HQ during the crisis is of great importance starting with the centralized communication network as a first step. As the location of branch is far from Kigali, the cooperation tends to be less even though they face many implications.

3.3 RECOVERY PHASE

1) Centralized communication network and organization in emergency

The utility should maintain a centralized communication network and organization in the recovery phase as long as the country confirms any active case of the infection. In addition, it is important to evaluate the current system in terms of the frequency of contacts and the smoothness of the network and the organization.

2) Review of BCP

The utility should keep implementing the measures based on BCP. At the same time, they should work on the review of BCP which will help to prepare for the next disaster more effectively (**Figure 3.3-1**).

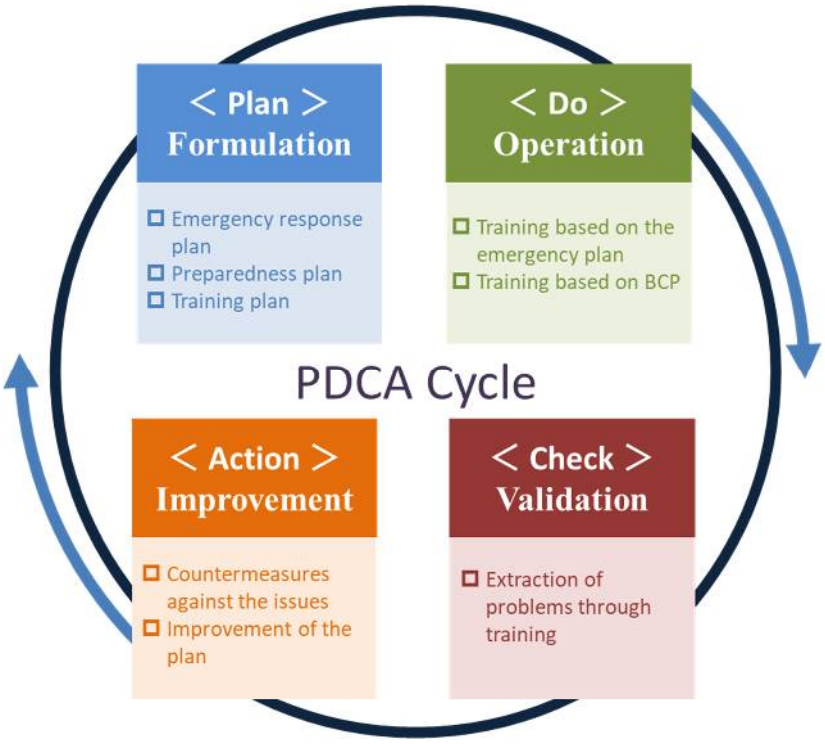


Figure 3.3-1 PDCA Cycle of BCP

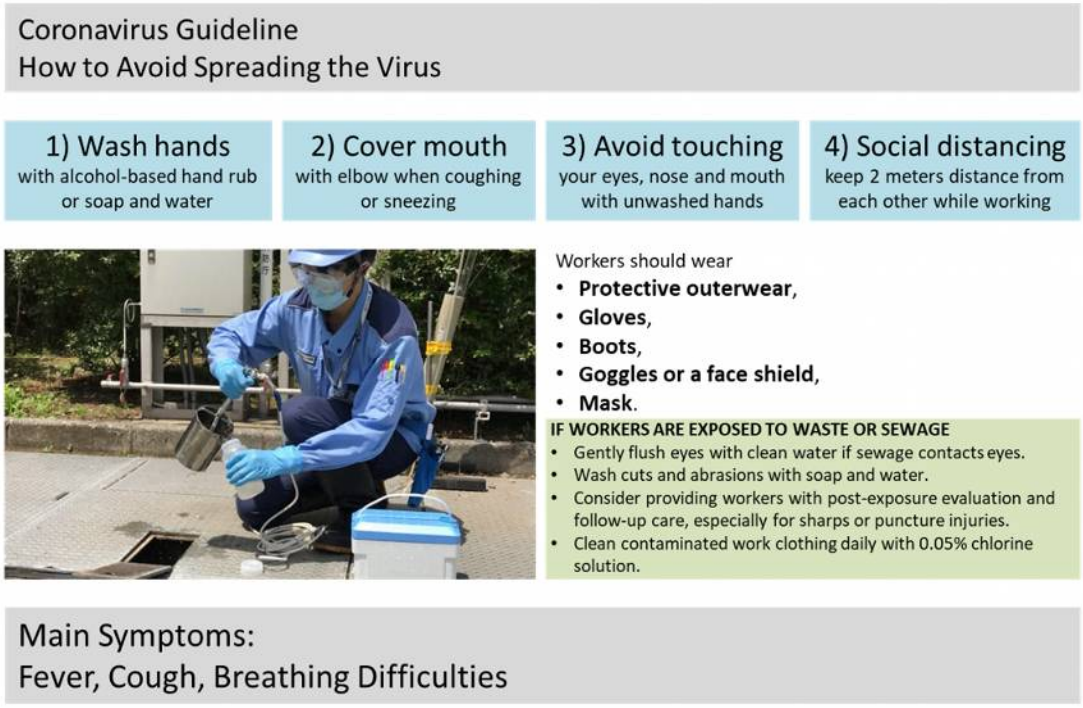
3) Prevention measures

The utility should continue giving instruction to staff to control the situation.

CHAPTER 4. PREVENTION GUIDELINE

The understanding of proper prevention measures would help to reduce the spread of the virus and thereby it is significantly important to instruct every worker to learn how to avoid spreading the virus using a simple guideline (e.g., **Figure 3.3-1**). The utility is recommended to put the simple guideline on the wall at the workplaces including branches and WTPs.

Figure 3.3-1 COVID-19 Prevention guideline



"Cough etiquette" is also one of the guidelines to prevent the spreading of the virus due to ejecting virus-containing droplets and infecting others (**Table 3.3-1**).

Table 3.3-1 Cough Etiquette

Cough Etiquette
Purpose: • Measures to prevent splash infection due to coughing and sneezing
Effect: • Cough etiquette can prevent the spread of droplets excreted by an infected person.
Method: • When coughing or sneezing, cover your mouth and nose with a tissue, look away from other people, and keep at least 2 m away. If you do not have a tissue, hold your mouth with your arm to prevent splashes from spreading. The reason for holding down with the arm is that the chances of contact infection can be reduced because there is less contact with other places. Immediately dispose of tissues containing respiratory secretions (nasal discharge, sputum, etc.) in the trash. • The hands and arms pressed when coughing or sneezing should be washed immediately afterwards but be careful not to touch the surroundings unnecessarily before washing your hands so as not to cause contact infection. It is recommended that you have a quick drying rubbing alcohol preparation that you can carry in case there is no room to wash your hands. • Actively encourage people who are coughing to wear masks. Appropriate wearing of a mask can

prevent the spread of splashes.

Staff should understand the recommendations to prevent the spread of the virus (**Table 3.3-2**).

Table 3.3-2 Recommendations

Purpose	Category	Preventive Measures
Decrease infection risk of workers	Operation	Focus on important operations (essential to maintain stable water supply)
	Personnel	Tele-working Improve Internet environment
	Commute	Flexible working hours
	Customer	No face-to-face meeting Use online meeting
Prevent infection at workplace	Check Temperature	Ask workers or visitors not to enter the workplace if they have a high temperature (e.g., over 37.5 degree)
	Social Distancing	Regulate the number of people in working space Keep distance at restaurants by arranging the lunch time of workers Flexible working hours
	Droplets and Contact	Remind wearing a face mask, cough etiquette, handwashing, gargling Keep the clean working space
	Handwashing	Let people wash their hands before entering a working space Prepare disinfection at the entrance
	Check name and contact information of visitors	Ask visitors to write their name and contact information to follow the infection route If visitors are from other countries, ask for their contact information and countries where they were recently
	Suspected or Confirmed Case of COVID-19	If any staff has COVID-19 symptoms, the staff has to take the rapid test of COVID-19 If any COVID-19 case is confirmed, all the relevant staff should take the rapid test and the facility should be cleaned and disinfected. Inform all the visitors about the situation.

CHAPTER 5. ESSENTIAL SERVICES

The utility will identify and prioritize “essential service” that is necessary to provide vital services such as basic water supply. It must be performed under the limited set of resources due to the pandemic to avoid a disruption of the basic function of business continuity. All other normal services that can be deferred until the recovery from the emergency state, “suspend-able operation” should also be identified. Besides normal services, WASAC has to respond to emergency needs, resulting in “additional tasks” such as responses to increased demands for hand-washing and public awareness.
As an emergency response plan, this document will organize a human resource allocation based on the list of essential services. One of the most important factors for business continuity is human resources, which is directly influenced by the disaster like COVID-19 pandemic.

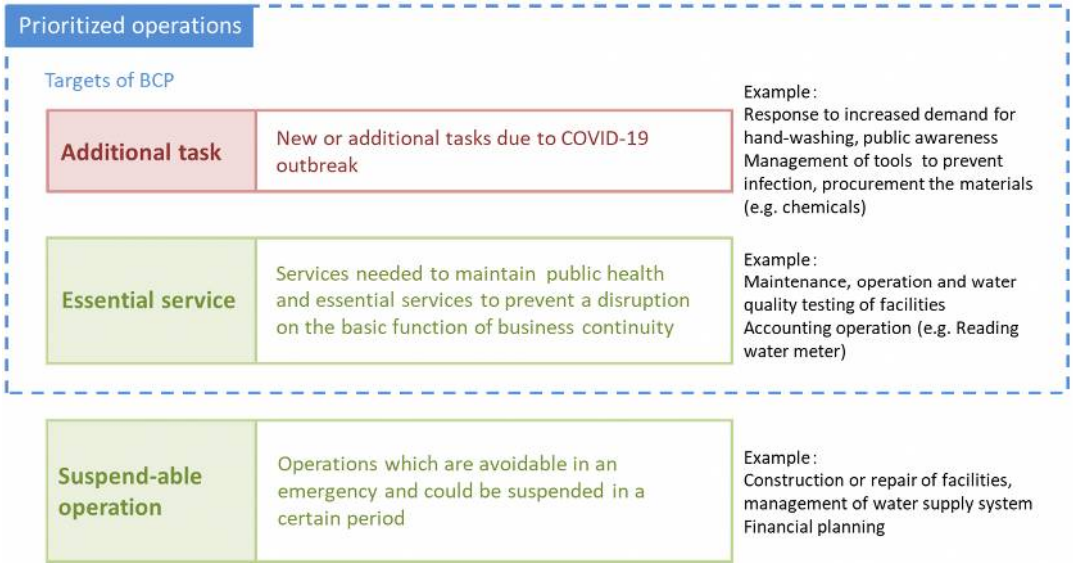


Figure 3.3-1 The classification of the operation and service

Additional tasks are the most prioritized operation. Maintain proper essential services. Re-allocate the human resources from suspend-able operation to essential services. Request self-quarantine to staff who has symptoms of the infection. Spread all staff of technical guidance on infection prevention at the workplace.
This section will identify and prioritize “essential service” that is necessary to provide vital services such as basic water supply and must be performed under the limited set of resources due to the pandemic to avoid a disruption of the basic function of business continuity. All other normal services that can be deferred until the recovery from the emergency state, “suspend-able operation” should also be identified. As an emergency response plan, each department, branch and WTP should organize a human resource allocation based on the list of essential services. One of the most important functions for business continuity is human resources, which is directly influenced by the COVID-19 pandemic.

5.1 POLICY OF BUSINESS CONTINUITY

1. Maintain essential service at any event.
2. Move the personnel from suspend-able operation to essential service.

3. Request self-quarantine to staff who has symptoms of the infection
4. Spread all staff of technical guidance on the infection prevention at the workplace

5.2 LIST OF ESSENTIAL SERVICE

Additional Task is listed up in **Table 5.2-1**, which is new or additional tasks due to the disaster.

Table 5.2-1 List of Additional Task

Additional Task	Department	Remarks
Drafting emergency budget request to the Ministry	CEO Office	
Securing the Credit Line with the Brank	CEO Office	
Coordination with external agency	CEO Office	
Establishing notice and management policy for the contracting construction works	CEO Office	
Notification of emergency state	CEO Office	
Emergency coordination with City/District	CEO Office, UWSSD	
Procurement of cars	Support Services	
Procurement and maintenance of Digital Infrastructure in emergency	Support Services	
Emergency purchase and procurement request	Support Services, Branch, UWSSD	
Survey and monitoring of emerging water needs	UWSSD	
Establishing and disseminating PR policy of water safety responding to customers	Branch	
Notices of prevention measures to staff	Branch	
Summary and report of Cashflow	Finance	
Allocation and management of petty cash for emergent needs	Finance	
Securing prevention equipment such as face mask, protective outerwear, gloves, face shield and boots	All	
Staff attendance management	All	

Essential service is listed up in **Table 5.2-2**, which helps staff to understand what kind of operations they should continue for adequate water supply to citizens.

Table 5.2-2 List of Essential Service

Essential Service	Department	Remarks
HR management (Health & Safety)	Support Services	Remotely
HR management (Salaries)	Support Services	Remotely
IT	Support Services	Remotely
Procurement	Support Services	
Driver	Support Services	
Pumping attendant operation	UWSSD, WTP	

Laboratory test	UWSSD, WTP	Minimized
Electro-Mechanical operation	UWSSD, WTP	
Water production operation	UWSSD, WTP	
Sewer operation	UWSSD, WTP	
Water distribution operation	UWSSD	
Pipe network maintenance	UWSSD	
Leakage repair	Branch, UWSSD	
Customer care	Branch	Remotely
Driver	Branch	
Billing	Commercial, Branch	Remotely
Revenue collection	Commercial, Branch	
Accounting	Finance, Branch	Remotely
Budget control	Finance	Remotely
Inventory management for maintenance	Support Services, Branch, UWSSD	

The operations that the utility can skip during the emergency are summarized in the list of suspend-able operation (**Table 5.2-3**). Noted that the utility should carefully choose the period of suspensions as the situation will drastically change with the phases.

Table 5.2-3 List of Suspend-able Operation

Suspend-able Operation	Department	Remarks
HR management (Recruitment)	Support Services	Suspend-able
Procurement of non-emergent assets	Support Service	Suspend-able
Mapping of Distribution pipelines	UWSSD	Remotely / Suspend-able
Leak detection	UWSSD	Suspend-able
Theft inspection	UWSSD	Suspend-able
Pressure management	UWSSD	Suspend-able
Statistics and reporting	UWSSD	Suspend-able
Annual report	UWSSD	Suspend-able
Workshop operations	UWSSD	Suspend-able
Construction of new pipes	UWSSD	Suspend-able
Construction of new facilities	UWSSD	Suspend-able
Meter reading	Branch	Remotely / Suspend-able
Extension and New Connection	Branch, UWSSD	Suspend-able
Disconnection	Branch, UWSSD	Suspend-able
Marketing	Commercial	Suspend-able
Budget planning	Finance	Remotely / Suspend-able
Asset management	Finance	Remotely / Suspend-able
Contract works	All	Minimized / Suspend-able

Human resource allocation should also be planned based on the above lists. Task Force prepares the lists of essential service and suspend-able operation to ensure the functions of the utility. Since insufficient staff have a negative impact on operation works, the proper human resource management method is required. Accordingly, we propose to make a human resource allocation plan based on the list of essential services to specify the number of necessary staff and who will be in charge for each service, allowing us to determine the required attendance rate to maintain essential services. It is helpful not only to understand what each staff has to work on during an emergency but also to find out how many cars they need. If the attendance rate was regulated by the decision of authorities, the intervention of HQ would be necessary. The required attendance rate and human resources allocation

plan are formulated through Step 1~5 as followed. The flow chart is shown in **Figure 5.2-1**.

Step 1: List-up essential service

First of all, you list up the essential services at the branch level.

Step 2: Organize current status

You organize the data of human resources at branch level such as number of staff and team formation.

Step 3: Estimate number of staff for each service

You estimate the number of staff and decide who will be in charge for each essential service and additional task.

Step 4: Calculate required attendance rate

Based on the number of staff for each service estimated in Step 3, you calculate the attendance rate which is necessary to continue basic functions of the business.

Step 5: Optimize service and staff allocation

If the required attendance rate is too big, re-prioritization of services and staff allocation are needed.

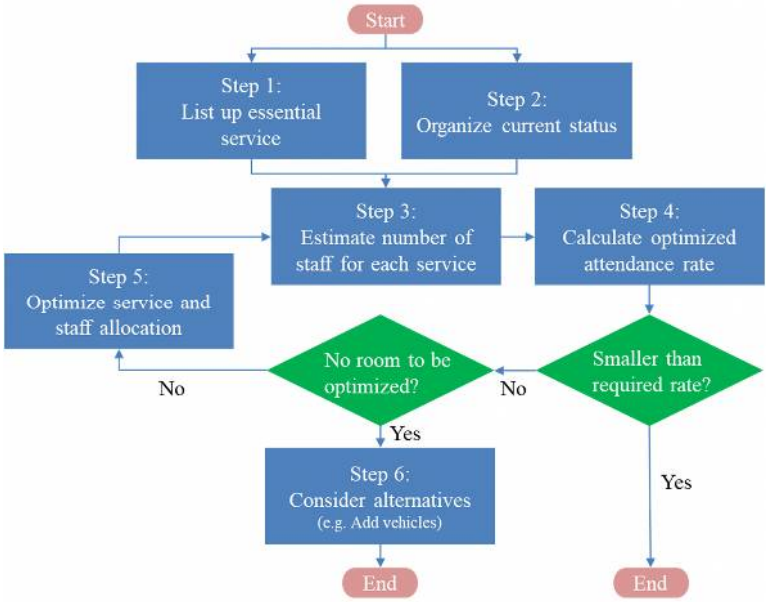


Figure 5.2-1 Flow chart of human resource management

Human resource allocation shall be based on the **Table 5.2-4**.

Table 5.2-4 Operations for each phase with different attendance rate

Classification			Contents	Preparation Phase		Response Phase				Recovery Phase	
				No Case	Case Increase	Restriction	Restriction	Lockdown	Restriction	Restriction	Case Decrease
				100%	100%*	60%	30%	15%	30%	60%	100%
Prioritized Operation	Additional Task	New or additional tasks due to COVID-19 outbreak	Drafting emergency budget request to the Ministry								
			Securing the Credit Line with the Brank Notice and management policy for construction works								
			Procurement of cars								
			Survey and monitoring of emerging water needs								
			Coordination with external agency								
			Securing prevention equipment								
			Notices of prevention measures to staff								
			Notification of emergency state								
			Emergency purchase and procurement request								
			Staff attendance management								
			Emergency coordination with City/District								
			Summary and report of Cashflow								
			Allocation of petty cash for emergent needs								
			Establishing and disseminating PR policy Procurement and maintenance of Digital Infrastructure								
	Essential Service	Services needed to maintain public health and essential services to prevent a disruption on the basic function of business continuity	HR management (Health & Safety)								
			HR management (Salaries)								
			IT operations								
			Procurement of materials								
			Driver								
			Pumping attendant operation								
			Laboratory test								
			Electro-Mechanical operation								
			Water production operation Sewer operation								
			Water distribution operation								
			Pipe network maintenance Leakage repair								
			Customer care								
			Accounting								
			Billing								
			Revenue collection								
			Budget control								
			Stock management for maintenance								
Non-Prioritized Operation	Suspend-able operation	Operations which are avoidable in an emergency and could be suspended in a certain period	Meter reading								
			Pressure management								
			Leak detection Procurement of non-emergent assets								
			Disconnection								
			Construction of new pipes								
			Construction of new facilities								
			Extension and New Connection								
			Asset management								
			Contract works								
			Budget planning								
			Mapping of Distribution pipelines								
			Statistics and reporting								
			Marketing								
			Theft inspection								
			Annual report Workshop operation								
			HR management (Recruitment)								

* Percentage (%) shows attendance rate determined by the government.

CHAPTER 6. CRITICAL RESOURCES

For the issue of material in Chapter **2.1** , we propose an inventory management scheme avoiding the insufficiency of the materials in the local warehouse at each branch by enhancing the communication between HQ and Branch with the introduction of checklist. Major issue regarding material was the lack of materials at branch and they needed to procure those items from a local hardware shop or the central warehouse using branch cars. However, if branch and HQ could have estimated the contingency materials at branch warehouse, they could have decreased the use of transport. In addition, the proposed human resource management scheme enables to classify which operations are essential or could be done remotely and thereby the branch can get rid of unnecessary use of cars. This chapter also suggests discussing the necessity of additional car since one of the branches said if they had one more car, they could have improved customer services. Consequently, the issue of transport in Chapter **2.2** will also be improved by decreasing the use of transport with the proposed practical measures.

Chapter **8** will tackle the financial issues described in Chapter **2.4** which is a problem not only for branch but also for the entire utility.

As mentioned above in Chapter **2.5** , understanding of emergency is important to build a resilient team to deal with additional pressure related to the crisis like the COVID-19 pandemic. Working on the practical measures will be a good opportunity to enhance staff to learn how they respond to the emergency. The main questions that the staff will be eventually able to answer would be what kind of materials they can get from local hardware shops or a central store, how much and what kind of materials they need to store for contingency, how many staff they need in order to maintain their works, what kind of services and operation should be prioritized and how many vehicles are required in order to satisfy these criteria. Training will also be conducted through BCP, resulting in the raising awareness of emergency.

Most of the branches mentioned a lack of materials as the bottleneck for logistics. Since the supply system is vulnerable to the travel restriction, inventory management mainly related to what you have to prepare in advance for an emergency state is significantly important to respond to such situation effectively and quickly. For example, a checklist of material availability at the local hardware shop will be helpful to visualize the current situation of material stocks.

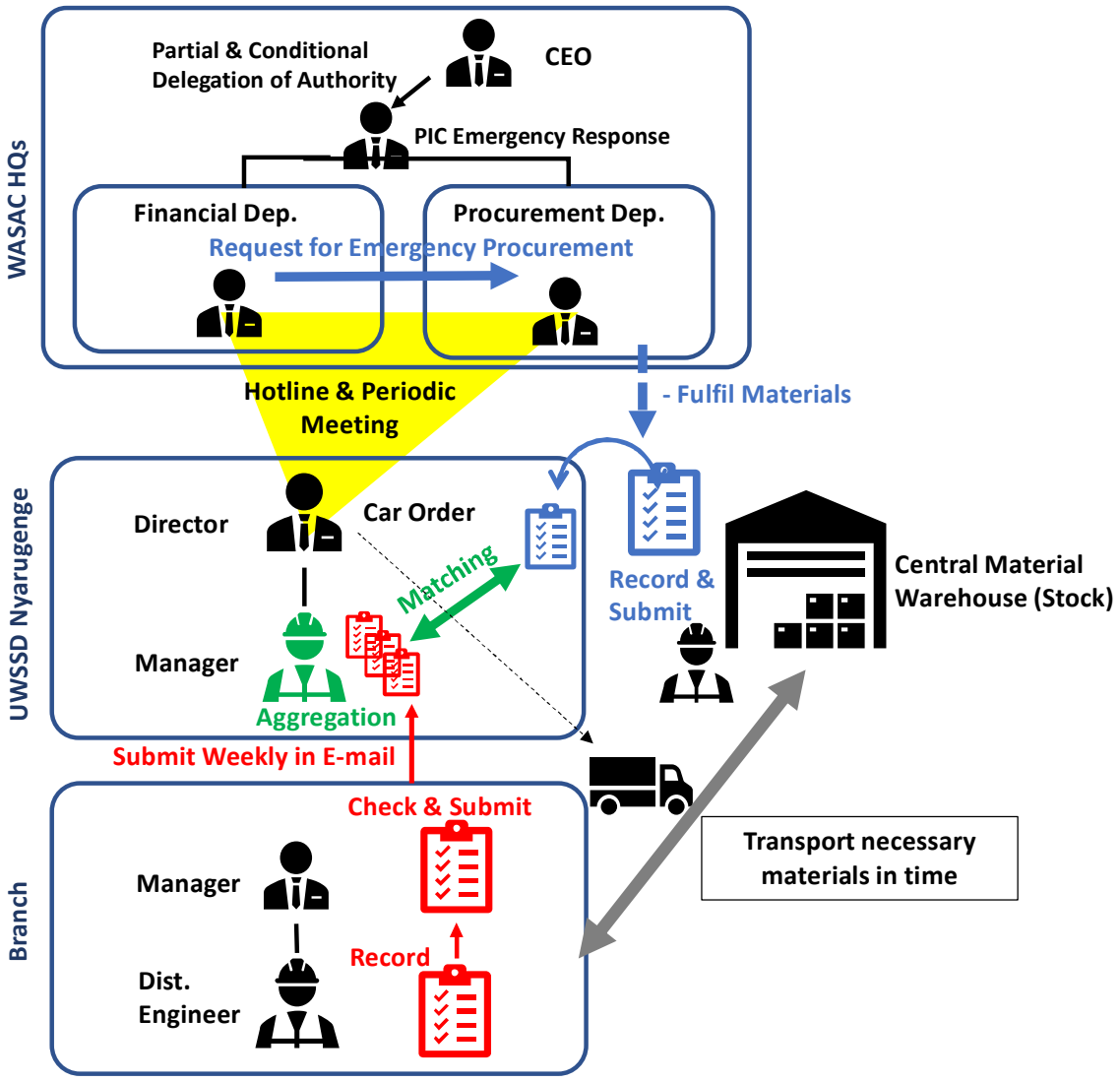


Figure 5.2-1 Schematic for Inventory Management in Emergency

If necessary, petty cash for purchasing at a local shop as a contingency fund should be given beforehand or during an emergency by HQ with a certain threshold for it.

In the current system, Branch request the quantity of materials they need and manage it at the local warehouse. Depending on the availability of materials in the central store, the materials will be delivered in one month or two months by a truck, or a Branch car. It is recommended to find out the material that each branch is in need frequently because the types of materials are different at each branch. Then, the central store can make a security store for that purpose when the pandemic comes again. Giving Branch the right to purchase on ground with their petty cash is not a solution because the local hardware shops do not have some of those items. When the one is used, they request immediately and report which one is used. It is important to specify what kind of materials they have to get from the Central Material Warehouse.

CHAPTER 7. PUBLIC RELATION

Even though there is no evidence that shows COVID-19 present in drinking water[2], it is important to share the information through SNS or HP of the utility because some customers may worry about its safety. Continuous public sharing of WASAC's activities such as the installation of handwashing facilities, water leakage repairing and billing through phones would help customers to understand the situation.

Possible questions and answers are shown in **Table 5.2-1**.

Table 5.2-1 List of question and answer regarding the relation between water and COVID-19

Question	Answer
Do you get the Coronavirus from tap water?	Chlorine disinfection works effectively against the Coronavirus. It has been reported that if the free residual chlorine concentration in tap water is secured as usual, and there is no problem in using tap water for drinking. In general, the routes of the infection are as follows: droplet infection caused by coughing or sneezing and contact infection; for example, when touching something with a virus attached and touching the mouth or nose with the fingers.
If the water purification plant staff get infected, will the tap water be affected?	Since chlorine disinfection is generally effective against the Coronaviruses, even when staff members are infected, proper water purification treatment and disinfection are performed, and there is no fear of the infection due to tap water.
If an employee gets infected, will you cut off the water supply?	The utility will formulate a COVID-19 countermeasure plan like the BCP and, assuming the case where some staff members are infected, priority work has been established, and non-emergency work has been temporarily stopped so that the water supply can be continued with a small number of personnel, so the water supply will not stop immediately.
Is handwashing with tap water or gargling effective in preventing infection?	Tap water is safe and effective for chlorine disinfection, and hand washing and gargle are effective in preventing infection. In addition, it is desirable to wash your hands with soap etc. for at least 15 seconds. After washing, it is important to wipe off the water thoroughly with a clean cloth or paper towel.

[2] WHO, 29 July 2020, "Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19"

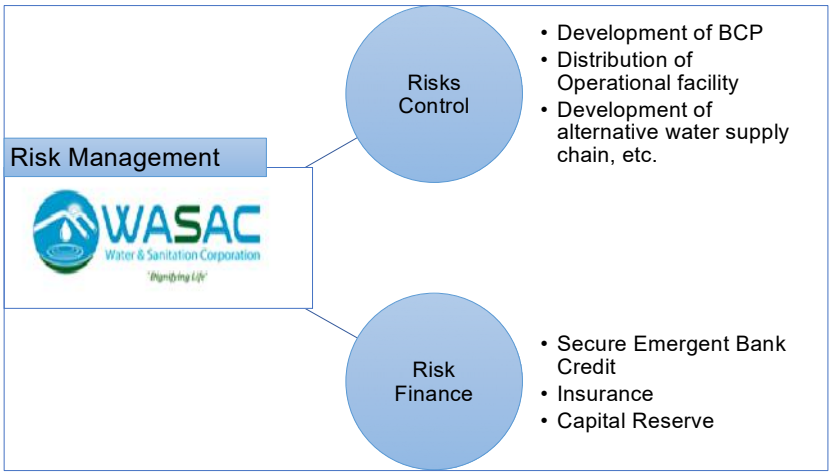
CHAPTER 8. EMERGING FINANCIAL NEEDS TO SUPPORT THE WATER SECTOR

8.1 POSITION OF RISK FINANCE FOR EMERGENCY

The risk of Covid-19 is one of the most important of sudden risks in the business environment of WASAC. It can have a serious impact on the management of businesses, therefore, ensuring the continuity of businesses through appropriate preparations is essential for not only ensuring business operation, but keep supplying safe water to the regional economy and the life of Kigali citizens.

In regard to means of preparing for the risk of Covid-19, while risk control is actually reducing risks, risk finance consists of the temporal or spatial transfer of risk or making finance that is the lubricant of a smoothly functioning economy function in order to reduce the damage on water supply operation or accelerate recovery.

A conceptual diagram of risk control and risk finance is indicated in **Figure 8.1-1**.



Source: JST

Figure 8.1-1 WASAC Revenue (RWF, million)

8.2 COST AND FINANCIAL COUNTER-MEASURE

(1) Financial Cost and Losses by Covid-19 and its Financial Counter Measure

Suspension and stagnation of business a cause various loss and additional cost. Counter-measured financial resource should be prepared for not stopping the operation. These losses, costs and counter measures are stated in the **Table 8.2-1**.

Table 8.2-1: Financial Costs and Losses by Covid-19 and Counter Measure Financial Resource

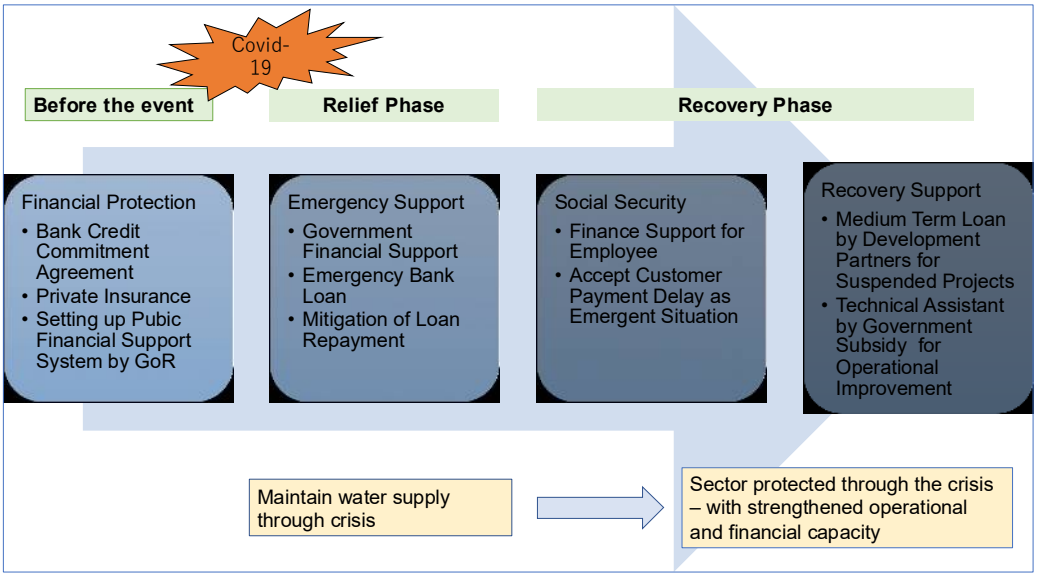
Expected Financial costs and losses by Covid-19	Description	Types of main financial resources available / accessibility
Cost for Preparation against Covid-19	• Cost of implementing BCP, • Buying insurance policy/guarantees • Improving or relocating buildings/facilities	• Company reserves • Bank loans • National / local government grants • Equity Investment

Loss of sales / profit	• Loss of Sales revenue due to closing of business / operating with lower capacity • Loss of consumers • Loss of access to markets	• Company reserves • Insurance • Bank loans • Guarantee
Additional costs for delayed payment of debt	• Additional fees / costs for delayed debt payment to banks	• Company reserves • Insurance • Bank loans • Special grace-period provided by banks / financial institutions
Cost of support for employees	• Salary advances • Reduced work schedules • Payment for additional task to BCP related staffs	• Company reserves • Insurance • Bank loans • Guarantee

Source: JST

8.3 Financial Counter-Measure Phase to Support Water Sector

The financial counter-measures are essential in short and longer-term for issues created by Covid-19. The following **Figure 8.3-1** to address such measures for ensuring the water sector survives the shock and can strengthen its resilience following the crisis.



Source: JST

Figure 8.3-1: Financial Counter-Measure at Each Phase

(1) Before the event

Providing financial protection is necessary before the event in case of receiving the emergent funds.

- Negotiate with government-affiliated financial institutions for preferential loan interest rate

systems

- Credit Commitment line agreement from commercial bank
- Preferential insurance premium systems from casualty insurance companies

(2) Relief Phase

Immediate financial support is essential for business continuity by giving the financial liquidity to operation, that is to maintain water supply through crisis. Government emergent subsidy is important especially for utility entity to operate for public welfare. Such financial supports are;

- Emergent borrowings/grants from the government financial institutions
- Emergent commercial bank loan based on credit commitment agreement

(3) Recovery Phase

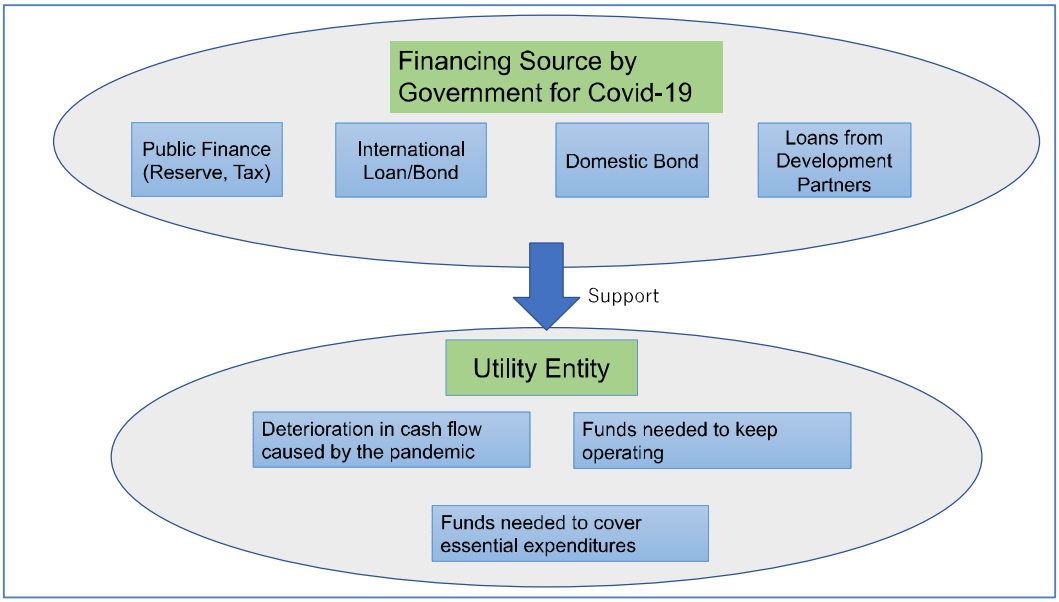
Financial support at recovery phase should focus on protecting water supply business not only for surviving, but for the business of strengthen operational and financial capacity. Such financial supports are;

- Medium term loan by developing partners for suspended projects
- Technical assistant by government subsidy for operational improvement

8.4 COUNTER-MEASURE BY GOVERNMENT AND FUNDING FOR THE CRISIS

Financial impact by Covid-19 likely goes beyond the capacity of the utility's financing risk control. Therefore, the following measure of financial supports by the Government is suggested.

- Immediate financial support by public sector such as grant and guarantee are essential for giving the liquidity finance to the business operation.
- In response to the entity, an advisor from government ministries made visits to listen to the status of damage, requests, and issues from the businesses affected.
- The creation of insurance market against disaster damage and the existence of transparent insurance contract transaction.
- Government reserves or tax receipts or earmarking a percentage of an existing special revenue tax to flow directly to capitalize the entity facility.
- National government commercial borrowing, such as bond issuance by the national government or borrowing from commercial banks.
- Commercial borrowing by the entity with sovereign guarantee. The entity could borrow money from commercial banks, with a sovereign guarantee.
- Official credit enhancement by an international agency of sovereign commercial borrowing.
- Request concessional loans to international agencies.



Source: JST

Figure 8.4-1: Financial Support by the Government

8.5 IMPACT OF COVID-19 ON WASAC BUSINESS ACTIVITY

The following situations have led to revenue losses and operational suspension for WASAC.

(1) Many large users of water have downscaled or reduced activities resulting in declining industrial demand.

- A decline in demand from large industrial and commercial users due to lockdowns and travel restrictions will significantly reduce revenues to water utilities.

(2) The crisis measures affected WASAC business activity

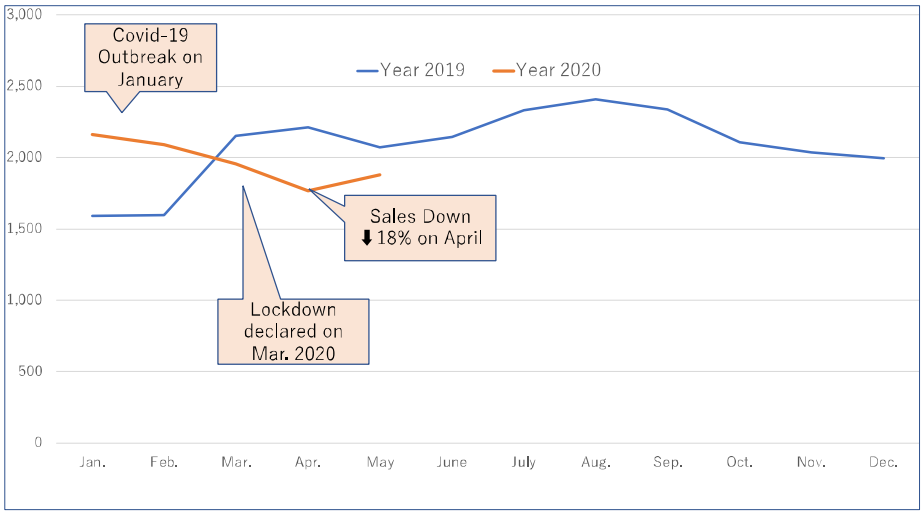
- Operations is suspended by the increased risk of contagion among utility staff, including both routine operations and construction works.
- The partial suspension of invoicing, self-declaration of bill and moratoriums on water service cut-offs for non-paid customers have been the affected revenue.
- Suspension the new customer-connection due to the suspended operation have affected revenue.
- Stockpiling of chemical and energy are decreased drastically as new production materials are not purchased due to the shortage of operational fund. As a result, water production/supply has decreased.
- New capital projects for business expansion are suspended as WASAC prioritize emergency response.

8.6 IMPACT OF COVID-19 ON WASAC FINANCIAL STATUS

(1) Financial Status of 1st quarter 2020 after Covid-19 break

Sales revenue stared to decline in February 2020, and down 18% at April. Such down trend is quite

unusual when compare it with 2019 sales figure. Such down trend of sales clearly indicates the negative effect of Covid-19 affected WASAC financial status (**Figure 8.6-1**). Alco, the meter index was read and reported by the customer directly, due to the suspended work of water meter reader job from WASAC branch, but this may underreport the usage of water by the customer.



Source: JST

Figure 8.6-1: Comparison of Sales Revenue 2019 and 1st quarter 2020 (RWF, million)

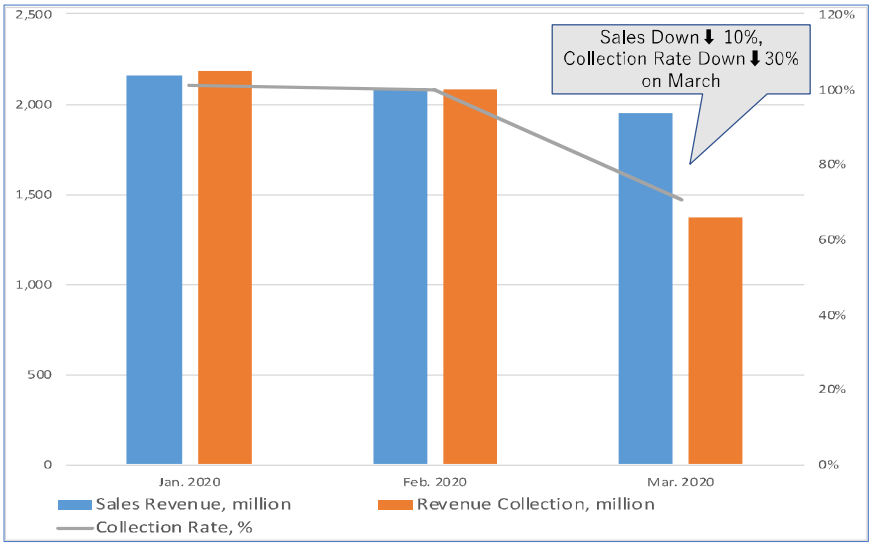
Not only big down of sales revenue, but a decline of revenue collection rate from customer is very drastic. Collection rate is usually around 100%, thanks to the operational efficiency of WASAC. However, this rate went down 30% at March 2020 due to the job suspension of reading the water meter index (**Table 8.6-1**, **Figure 8.6-2**). It indicates the difficulty of payment by the customer due to the aggravated economic situation caused by Covid-19.

Table 8.6-1: Collection Record at Branch for 1st quarter 2020

BRANCH	Jan-2020	Feb-2020	Mar-2020	TOTAL AMOUNT COLLECTED	TARGET Q3/ Collection %	
BUGESERA	57,129,101	63,841,812	35,930,585	156,901,498	209,815,856	75%
GICUMBI	19,661,613	20,954,758	12,499,205	53,115,576	63,595,809	84%
GIKONDO	240,233,307	218,882,295	145,910,676	605,026,278	705,992,552	86%
HUYE	80,317,899	76,126,659	44,635,672	201,080,230	283,535,156	71%
KACYIRU	311,147,482	296,510,624	207,853,491	815,511,597	997,745,233	82%
KANOMBE	181,427,295	214,622,469	152,071,633	548,121,397	739,309,536	74%
KARONGI	16,197,115	20,336,148	10,148,204	46,681,467	60,562,290	77%
MUHANGA	57,797,199	46,409,820	34,624,706	138,831,725	162,606,503	85%

MUSANZE	117,466,925	104,724,225	71,259,887	293,451,037	372,334,203	79%
NGOMA	23,614,297	22,973,134	18,163,917	64,751,348	85,852,613	75%
NYAGATARE	56,860,154	56,379,160	33,588,621	146,827,935	229,372,207	64%
NYAMAGABE	27,420,366	20,744,991	20,541,288	68,706,645	86,082,137	80%
NYAMIRAMBO	93,273,733	81,355,123	55,891,271	230,520,127	271,024,817	85%
NYANZA	32,393,921	35,717,877	19,558,514	87,670,312	111,756,580	78%
NYARUGENGE	338,418,026	277,297,946	180,649,669	796,365,641	1,052,020,497	76%
REMERA	252,698,716	263,356,216	185,672,628	701,727,560	899,498,059	78%
RUBAVU	140,831,469	125,463,990	62,405,565	328,701,024	397,191,672	83%
RUHANGO	17,227,868	18,303,338	12,696,257	48,227,463	60,816,824	79%
RUSIZI	46,228,037	44,278,833	26,479,297	116,986,167	162,571,947	72%
RWAMAGANA	76,597,436	76,030,212	44,022,405	196,650,053	262,051,224	75%
TOTAL Q3	2,186,985,790	2,084,353,492	1,374,647,382	5,645,855,080	7,213,735,717	78%

Source: WASAC



Source: JST

Figure 8.6.-2: WASAC Revenue Collection (RWF, million) and Collection Rate (%)

(2) Projection of Financial Impact

Considering the negative effects of the Covid-19 that may continue, Projection is made for WASAC Revenue, Income and Cash flow on 12 months period. Impact on financial activity such as interest rate and debt payment are ignored.

Projection of financial impacts on monthly operating cash balance are stated in the **Table 8.6-1 , 8.6-3** and **Figure 8.6-3.**

Assuming a decline of water consumption by household and commercial customer, sales revenue is

directly affected and the monthly cash balance decreased. Operation Cost is also declined, but not as much as revenue.

Based on this projected financial impact, such declined amount of cash balance should be compensated by the extra government budget support or emergent bank credit should be reserved for keep WASAC operation going.

Table 8.6-8.6-2: Projected Financial Impact by Covid-19 on WASAC

Assumption	Revenue	Operating Income	Operating Cash Flow
Water Consumption Down 15%, See the Projection Sheet	Decrease of RWF3,400 million in 12month period	Decrease of RWF2,000 million in 12month period	Decrease of RWF2,000 million in 12month period

Source: JST

The sheet for the projection is listed below. The projected financial impacts might be changed as real numbers such as Revenue and Collection rate might differ based on the ongoing Covid-19 situation.

Table 8.6-3: Projection Sheet for Financial Impact using World bank Template

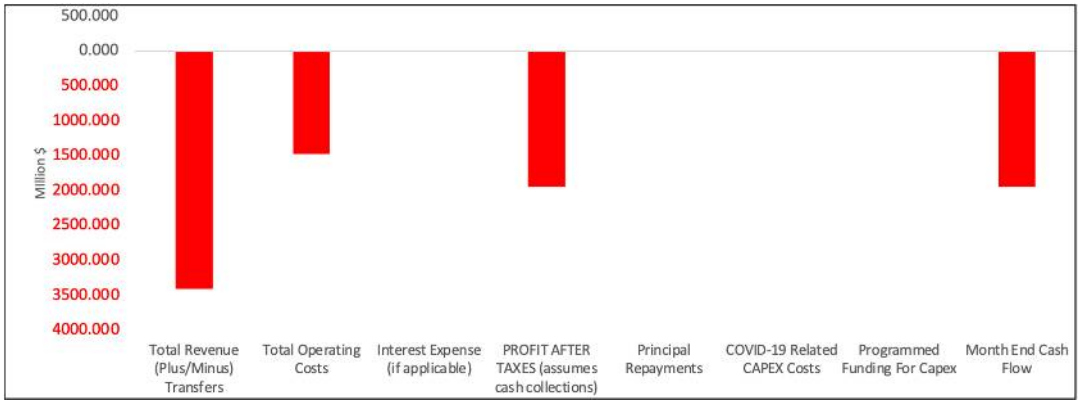
WSP Financial Projections Period	July2020-June2021
Name of WSP	WASAC
Name of Contact Person	BCP Task Force/Finance
Contact Tel and Email Address	
Opening month	6 *Enter month number*
Currency	RWF *Please enter data in blue cells* in Millions

INCOME STATEMENT	**Actual Average**	**Projection**												**Pre Covid**	**Post Covid**	**Financial Impact**
Enter Average Revenue Over Last 12 Months	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Total**	**Total**	**Total**
REVENUES																
Billed Revenue from Water Sales (million)	1800.000	1552.603	1558.485	1566.571	1573.213	1578.467	1582.733	1587.909	1594.868	1601.013	1603.843	1607.792	1613.321	21600.000	19020.815	2579.185
Billed Revenue From Sewerage Sales (million)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Revenue collection efficiency (%)	95%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%			
Actual revenue collected (million)	1710.000	1397.342	1402.636	1409.914	1415.891	1420.621	1424.460	1429.118	1435.381	1440.911	1443.458	1447.013	1451.989	20520.000	17118.734	3401.266
Connection Revenue	21.198	20.339	20.339	20.339	20.339	20.339	20.339	20.339	20.339	20.339	20.339	20.339	20.339	254.381	244.068	10.313
Other revenue *(please specify, if applicable)*	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	360.000	360.000	0.000
TOTAL REVENUES	1761.198	1447.681	1452.975	1460.253	1466.230	1470.960	1474.799	1479.457	1485.720	1491.250	1493.797	1497.352	1502.328	21134.381	17722.802	3411.579
Local Government Transfers (Plus/Minus)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Revenue (Plus/Minus) Transfers	**1761.198**	**1447.681**	**1452.975**	**1460.253**	**1466.230**	**1470.960**	**1474.799**	**1479.457**	**1485.720**	**1491.250**	**1493.797**	**1497.352**	**1502.328**	**21134.381**	**17722.802**	**3411.579**

INCOME STATEMENT														**Pre Covid**	**Post Covid**	**Financial Impact**
OPERATING COSTS	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Total**	**Total**	**Total**
Water Operating Costs																
Water Operating Salaries	527.464	543.720	543.720	543.720	543.720	543.720	543.720	543.720	543.720	543.720	543.720	543.720	543.720	6329.572	6524.640	195.068
Water Extraction Cost	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Water Production Electricity Cost	541.356	429.480	431.179	432.878	434.577	436.276	437.975	439.674	441.373	443.072	444.771	446.470	448.169	6496.274	5265.896	1230.378
Chemical Treatment	142.619	119.479	119.952	120.425	120.897	121.370	121.843	122.315	122.788	123.261	123.733	124.206	124.679	1711.431	1464.948	246.483
Maintenance & Repairs	71.219	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	854.630	660.000	194.630
Pension Expense	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Adminstration	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	200.000	2400.000	2400.000	0.000
Other Water Operating Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Water Supply Operating Costs	1,482.659	1347.680	1349.851	1352.023	1354.195	1356.366	1358.538	1360.709	1362.881	1365.053	1367.224	1369.396	1371.568	17791.907	16315.484	1476.423
Waster Water Operating Costs																
Wastewater Employee Salaries	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Electricity Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maintenance & Repairs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Administrative Expenses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other Wastewater Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Wastewater Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Other Direct Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Operating Costs	**1,482.66**	**1347.680**	**1349.851**	**1352.023**	**1354.195**	**1356.366**	**1358.538**	**1360.709**	**1362.881**	**1365.053**	**1367.224**	**1369.396**	**1371.568**	**17791.907**	**16315.484**	**1476.423**
Interest Expense (if applicable)	-													0.000	0.000	0.000
Depreciation Expense	332.000	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	3984.000	3992.777	8.777
TOTAL COSTS	**1,814.66**	**1680.411**	**1682.583**	**1684.754**	**1686.926**	**1689.098**	**1691.269**	**1693.441**	**1695.613**	**1697.784**	**1699.956**	**1702.127**	**1704.299**	**17791.907**	**16315.484**	**1476.423**
PROFIT BEFORE TAXES	53.461	232.730	229.608	224.502	220.696	218.138	216.471	213.984	209.893	206.534	206.158	204.776	201.971	3342.474	1407.317	1935.158
Income Taxes (if applicable)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PROFIT AFTER TAXES(assumes cash collections)	(53.461)	232.730	229.608	224.502	220.696	218.138	216.471	213.984	209.893	206.534	206.158	204.776	201.971	641.526	2585.460	1943.933

CASH FLOW STATEMENT														**Pre Covid**	**Post Covid**	**Financial Impact**
	Jun	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Total**	**Total**	**Total**
PROFIT AFTER TAXES (assumes cash collections)	53.461	232.730	229.608	224.502	220.696	218.138	216.471	213.984	209.893	206.534	206.158	204.776	201.971	641.526	2585.460	1943.933
Add: Depreciation Expense	332.000	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	332.731	3984.000	3992.777	8.777
Operating Cash Flow	278.539	100.002	103.124	108.230	112.036	114.593	116.261	118.748	122.839	126.198	126.573	127.956	130.760	3342.474	1407.317	1935.158
Principal Repayments	35.000	0.000	0.000	0.000	42.438	48.241	43.609	44.172	55.139	45.455	51.198	46.703	52.422	420.000	429.377	9.377
Cash Flow After Debt Service	243.539	100.002	103.124	108.230	69.598	66.353	72.652	74.575	67.700	80.743	75.375	81.252	78.338	2922.474	977.940	1944.533
COVID-19 Related CAPEX Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Programmed Funding For Capex	0.000													0.000	0.000	0.000
Month End Cash Flow	**243.539**	**100.002**	**103.124**	**108.230**	**69.598**	**66.353**	**72.652**	**74.575**	**67.700**	**80.743**	**75.375**	**81.252**	**78.338**	**2922.474**	**977.940**	**1944.533**

Source: JST



Source: JST

Figure 8-6-3: Projection of COVID Income and Cash Flow Financial Impact on 12 months period

8.7 Financial Condition of WASAC after the Lockdown March 2020

The Lockdown to stop the flow of people for Covid-19 prevention has eased since May 2020. The financial performance of WASAC is reviewed since the that time.

(1) Shortage of Working Capital

WASAC's working capital has shortened for purchasing chemicals to produce water supply at the time of the Lockdown. The situation was urgent enough for WASAC to ask JICA for receiving chemical materials as an emergent situation of water production.

This shortage of working cash has caused by a decrease of revenue and a dramatic increase of delayed payment of customers at the period of Lockdown. The inventory for water supply is also decreased as a constraint of cash. A change of WASAC current assets by these factors are showed in the **Table 8.7-1**.

Table 8.7-1: Current Assets Balance of WASAC (RWF, million)

	Jun-20	Jun-19
Inventory	3,320	3,978
Account Receivable*	15,709	9,208
Cash and cash equivalents	1,098	5,614

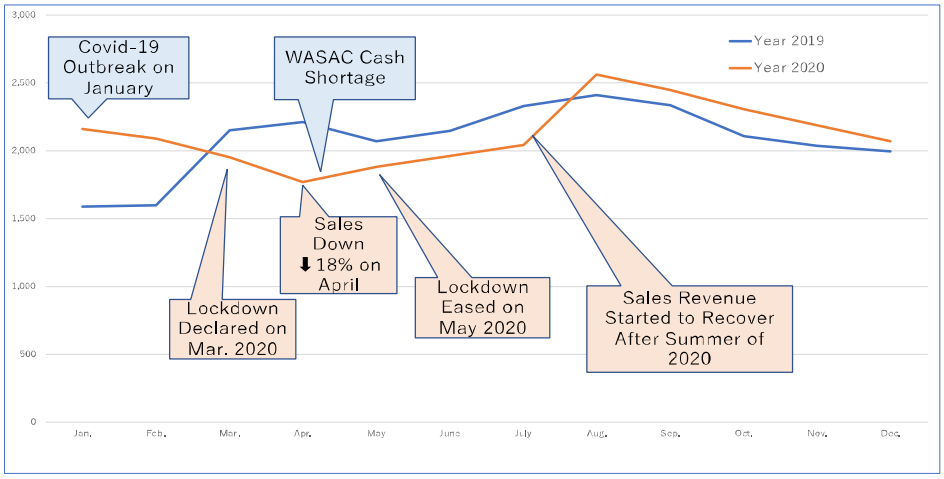
*An increase of Account Receivable results a decrease of cash in accounting cash flow term.

Source: JST based on WASAC financial statement 2020

8.8 Financial Condition of WASAC Afterwards the Easing of Lockdown June 2020

(1) Sales Revenue of Year 2020 has recovered after the easing of Lockdown

Sales revenue has started to recover after the summer of 2020 since the easing of the lockdown (**Figure 8.8-1**). This sales recovery was realized as the lockdown period was relatively short period of two months.



Source: JST

Figure 8.8-1: Comparison of Sales Revenue 2019 and 2020 (RWF, million)

(2) Budget Implementation Status

An initial budget for June 2020- June 2021 period was planned at spring of 2020, during the lockdown period. This budget has been revised up for both operating and expense, as water supply operation has recovered up after the easing of lockdown (**Table 8.8-1**).

Table 8.8-1: Budget of Operating Revenue and Expense (June 2020- June 2021)

	Initial Budget	Additions	Revised Budget	Actual as at 30 Apr.2021	Progress of Budget as at 30 Apr.2021
Operating Revenue	23,641	783	24,424	19,285	79%
Operating Expense	22,711	1,187	23,898	17,899	75%

Source: JST based on WASAC budget 2020-2021

(3) Special Circumstance of Water Supply in Kigali

Water sales has recovered at the summer of 2020 even though the business activities such as hotels, restaurants and tourism has not recovered yet as the operation and working hour are limited due to preventing Covid-19.

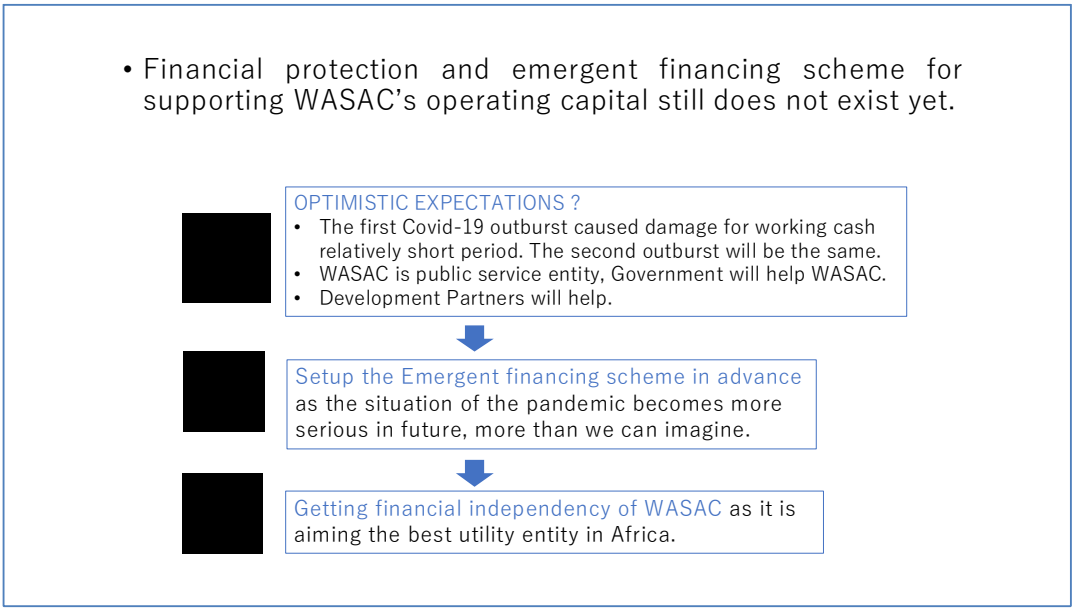
This special circumstance happened as the water supply capacity lack to meet the demand of residents of Kigali even now. It means that water supply has increased to residents that replacing the reduced demand of water by business customers.

(4) Ready Status of Emergency Finance Method by WASAC

The proposed methods for financial protection and emergent financing scheme for supporting WASAC's operating capital still does not exist, even after this Covid-19 pandemic became apparent.

The reason for the lack of ready status of WASAC came from 1) This Covid-19 caused damage for working cash relatively short period, 2) Support by development partner was obtained and 3) WASAC is essential utility company owned by the government, therefore, an official support is expected in case of serious shortage of capital.

However, it is advisable to setup the financing scheme in advance as the situation of the pandemic becomes more serious in future, more than we can imagine. Moreover, it is essential to have financial independency for WASAC as it is aiming the best utility entity in Africa.



Source: JST

Figure 8.8-2: Ready Status of Emergency Finance Method by WASAC

CHAPTER 9. PROCUREMENT OF WATER TANKER

9.1 BACKGROUND AND OBJECTIVES

As mentioned at the beginning of the body text, the Business Continuity Plan (BCP) for the Pandemic was developed for the sustainable service of the water supply because water is vital to human health and the utility has to ensure the continuity of the water services and operations under any event. From this perspective, It's the challenge currently facing water utilities as they aim to keep water flowing during the COVID-19 (coronavirus) pandemic, while the outbreak places substantial stresses upon them. Under these circumstances, a series of meeting was held among parties concerned such as WASAC, JICA, JICA Study Team (JST) for the Technical Cooperation Project for NRW reduction (JST for NRW) and JST for the Project for Water Supply Master Plan for City of Kigali (JST for M/P) through last early summer to autumn in 2020 in order to alleviate such difficult conditions since the official request letter for supporting WASCO had been forwarded to JICA. As the result of this, the following equipment procurement plans were arisen as a link in the chain of THE PROJECT FOR WATER SUPPLY MASTER PLAN FOR CITY OF KIGALI as well as the other THE PROJECT FOR STRENTHENING NON-REVENUE WATER CONTROL IN KIGALICITY WATER NETWORK by JST for NRW.

Work allocation

1. JICA office: Procurement of water tanks and its stands : 25sets
2. JICA HQ (JST for M/P): Procurement of Water Tanker : 1 truck
3. Project (JST for NRW): Procurement of pipe material to Tanks: 25 sets
   Bulk water meter and Engine pump : 18 sets
4. WASAC: Installation of Tanks with Public Taps and Operation
5. Project (JST for NRW): Sub-contract for delivery water by water tanker2

9.2 EMERGENCY WATER SUPPLY FOR THE PEOPLE WHO HAVE LIMITED ACCESS TO CLEAN WATER BY WATER TANKER IN INITIAL STAGE

In order to utilize fully and efficiently the above equipment and other incidental sub-contract scheme with private companies, the following terminable operation plan was proposed by JST for NRW as an initial step of Water Transportation Work of Emergency Water Supply for People who have Limited Access to Clean Water for a limited time operation.

9.2.1 Site Locations

Site locations of water reservoirs are shown in **Table 9.2-1** and **Figure 9.2-1**.

Table 9.2-1 Site Locations of Water Reservoirs

Branch	Site No	Site Name	JICA/ WASAC	Water Tank		Distance from Kimisagara	Water Volume		Required Working Hours		Tanker Number	
				Tank	Total		Dry Season	Rainy Season	Distance	Moving Time	Rainy Season	Dry Season
				nos	nos		m3	m3	km	hour		
Remera	1	Bibre	WASAC	1		Middle	10	5	14	0.7		
	2	Zindiro	JICA	1		Middle	10	5	16	0.8		
	3	Kamahinda	JICA	1		Middle	10	5	13	0.7		
	4	Musave 1	JICA	1	7	Middle	10	5	17	0.9	1	1
	5	Musave 2	JICA	1		Middle	10	5	17	0.9		
	6	Avega	JICA	2		Middle	20	10	15	0.7		
Kanombe 1	7	Busanza Masaro	JICA	1		Middle	10	5	20	1.0		
	8	Busanza Gikundiro	JICA	1		Middle	10	5	20	1.0		
	9	Busanza Gashyushya Bitare	JICA	1		Middle	10	5	20	1.0		
	10	Rwinbogo Upper	WASAC	2	8	Middle	20	10	14	0.7	1	2
	11	Gasaraba Downstream	JICA	1		Middle	10	5	14	0.7		
	15	Masaka Gitaraga 1	JICA	1		Middle	10	5	20	1.0		
	16	Masaka Gitaraga 2	JICA	1		Middle	10	5	20	1.0		
Kanombe 2	12	Muyumbu 1	JICA	1		Far	10	10	37	1.8		
	13	Muyumbu 2	WASAC	2		Far	10	10	37	1.8		
	14	Muyumbu 3	JICA	1	4	Far	10	10	37	1.8	1	2
Kacyiru	17	Ntora 1	JICA	1		Near	10	10	7	0.5		
	18	Ntora 2	JICA	1		Near	10	10	7	0.5		
	19	Gasanze 1	JICA	1	7	Middle	10	10	14	0.7	1	1
	20	Gasanze 2	JICA	1		Middle	10	10	14	0.7		
	21	Gasanze 3	JICA	1		Middle	10	10	14	0.7		
	22	Nduba	JICA	2		Middle	20	20	25	1.2		
Nyarugenge	23	Muganza National	JICA	1		Near	10	10	2	0.2		
	24	Nyagasozi	JICA	1	4	Near	10	10	7	0.5	0.5	1
	25	Amakawa	JICA	1		Near	10	10	7	0.5		
	26	Rebero	JICA	30	30	Near	60	60	7	0.5	4.5	7
						Far	30	30				
						Middle	200	125				
						Near	60	60				

Note
Distance: Between Kimisagara WTP and Site
Moning time: Between Kimisagara WTP and Site
Work time site: Work time at site
Day work time: Required working hours per day in total by 16m3 tanker

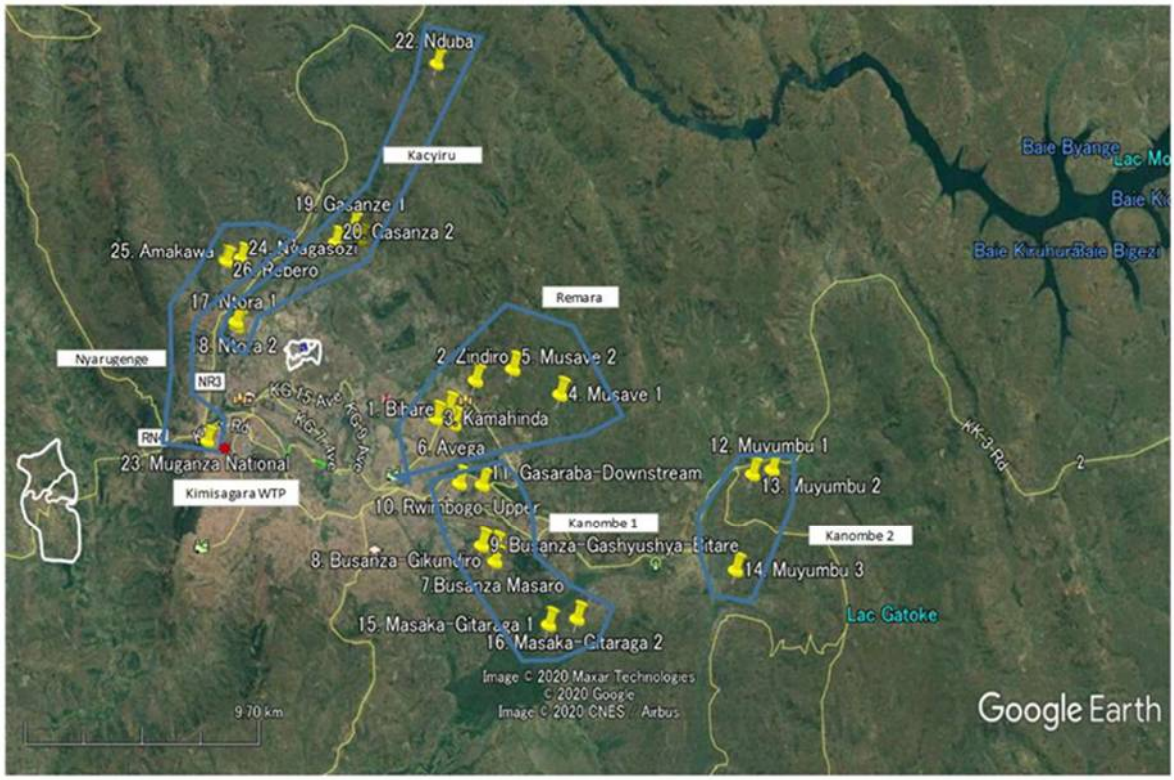


Figure 9.2-1 Site Location Map

9.2.2 Transport means of water to the temporary reservoir tanks

As an emergency measure, water distribution plan for the people who have limited access to clean

water was commenced in last summer in accordance with the schedule and the concept as shown in the below.

The Party in charge and Work Period

Emergency Water Supply for Disaster COVID-19

Items	2020						2021					
	July	Aug	Sept	Oct	Nove	Dec	Jan	Feb	Mar.	Apr	May	June
1. Procurement of Tanks by JICA Office	Ameki		◄	———	►							
2. Procurement of One Water Tanker by JICA		◄	———	———	———	———	———	———	———	———	►	
3. Installation of Temporal Water Tanks with Taps by WASAC				◄	———	►						
4. Operation of Water Tanker by the Project (1)			Preparation ▽	◄	———	Contract ►	t Operation					
5. Operation of Water Tanker by the Project (2)						Ext ▽	ensio n ◄	----	Operation	----	►	

Note: Implementation period of the 5. Operation of Water Tanker by the Project (2) was postponed until the beginning of October 2021 due to delayed operation of the water tanker by the Project (1).

Operation Plan of Water Tanker

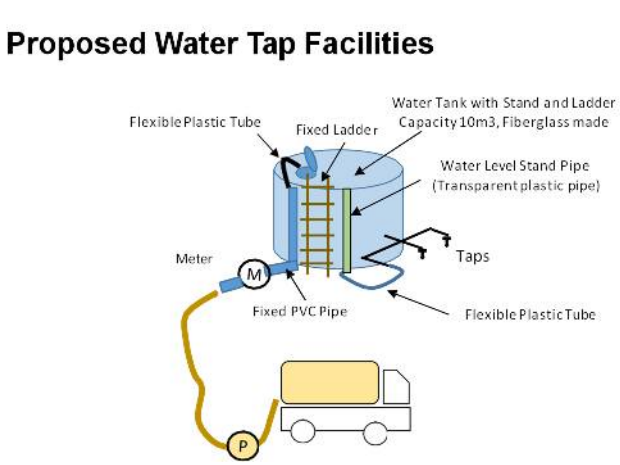
- Operation area of the water tanker shall be divided into 4 areas in accordance with the management area of each Branch office.
- Before the contract with the owner is made, a draft of operation schedule of water tanker shall be prepared by WASAC and JICA expert.
- However, it shall be re-examined when that method is not realistic to the real situation including the seasonal change at each site.
- Based on present estimation, 5 Tankers for rainy season and 7 Tankers for dry seasons will be requested.
- WASAC has responsibility to the water quality management of the water tanks.

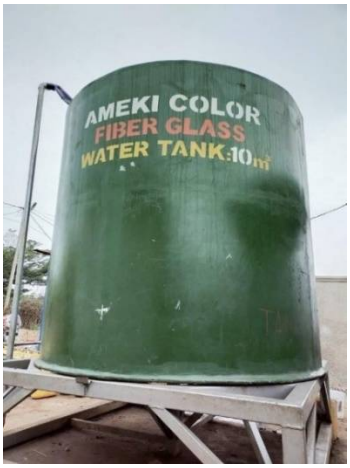
9.2.3 Transport means of water to the temporary reservoir tanks

Initially, clean water shall be loaded at the Kimisagara Water Treatment Plant as a water supply base and distributed to each site by the water tankers operated by the private companies and managed by THE PROJECT FOR STRENTHENING NON-REVENUE WATER CONTROL IN KIGALICITY WATER NETWORK. And then, this single water supply base should be diversified including nearby hydrant and/ or reservoirs upon commencement of the operation of the water tanker procured by THE PROJECT FOR WATER SUPPLY MASTER PLAN FOR CITY OF KIGALI because of improving transport efficiency with the only one tanker truck to be operated by WASAC.

9.2.4 Structure of the reservoir tanks and delivering water

Basic structure of the reservoir tanks and delivering water is as illustrated by the figure below.





(Left) Figure 9.2-2 Structure of the reservoir tanks and delivering water
(Right) Figure 9.2-3 Newly installed tank

9.2.5 Preliminary survey for delivering safe water by water tanker

Water tankering (also known as water trucking) can be a rapid means of transporting water to areas in need during the initial phase of an emergency. Tankering operations, however, are expensive and relatively time-consuming to administer. Therefore, various key issues relating to the effective and efficient use of tankers during an emergency should be considered beforehand.

1) Types of tanker

Water can be carried in a variety of different containers, some specifically designed for the task and others fabricated to meet an urgent need.

Figure 9.2-4 specifically designed tanker **Figure 9.2-5 Fabricated type to meet an urgent need**

Whatever possible, specially designed water tankers are suitable. They will be safer and more reliable. Temporary tankers made from flat-bed trucks with portable storage tanks attached can be dangerous if the tank is not securely fastened. The delivery of bottled water may be a short-term option, but it is expensive and inefficient. It also produces a major solid waste problem resulting from empty, discarded water bottles.

2) Chassis size and specifications

Apparently as a result of the above consideration 1), specifically designed tanker shall be selected for delivering clean water to the reservoir tanks, chassis size and incidental specifications shall be examined as follows.

Table 9.2-2 Comparison of Chassis size and specifications

Item/Category	Medium size Truck	Large size Truck	Large Semi Trailer
Appearance			
Size	6000 x 2150 x 2400	10000 x 2500 x 3000	14500 x 2500 x 3000
Gross Vehicle Weight	11.5t	21t	28t
Loading Capacity	6t	11t	20t
Operation Cost	Small	Medium	Large
Maintenance Cost.	Small due to medium weight and 6 small size wheels	Medium due to heavy weight and 10 large size wheels	Large due to heavier weight and 14 large size wheels
Purchases Cost	Reasonable Approx. 12 Mil. yen	Expensive	Expensive
Delivery Time	6-8 months	More than 1 year	More than 1.5 years
Rating	○	△	non-conformity

Considering the above specific aspects, medium truck base water tanker seemed to be the most suitable for the objective of the master plan project because of its affordability as well as easiness and simplicity of daily operation and maintenance. Consequently, the loading capacity of the water tanker was determined to be 6,000 liters.

3) Logistics

Other logistical factors to consider include:

Table 9.2-3 logistical factors

Item	Description	Remarks
Fuel	Regular supplies are essential. Consider setting up a storage tank if supplies are unreliable.	n/a in Kigali city
Drivers	Vehicles are likely to be more reliable if operated by an experienced driver. Always test-driving skills before employing drivers and consider providing advanced driving training if necessary.	Recommendation to WASAC
Spare parts	All vehicles need maintenance and in emergencies this is even more important. Consider purchasing spares in bulk. (Essential spare parts were procured with the tanker.)	ditto
Maintenance staff.	In remote areas, it may be difficult to find skilled vehicle maintenance staff. (Periodic inspection and/ or maintenance will be conducted by the designated dealer Akagera motors.)	n/a in Kigali city
Filling points	Try to use various filling points including hydrants and piped reservoir tanks close to the delivery point. Check that the source has sufficient quantity for their needs and the water quality is acceptable.	Recommendation to WASAC

The above table indicates that there seem not be any difficulty nor obstacles as logistical factors.

9.2.6 Procurement process of the water tanker

Entire procurement process of the water tanker is as follows,

Table 9.2-4 Procurement Process

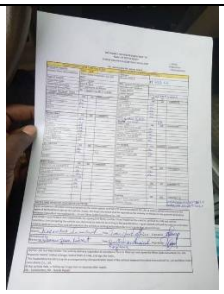
Basic information Contract Term Delivery Date	 November 10, 2020 – Oct0ber 31, 2021 August 16, 2021 *extended to September 30
Basic information November 10,2020	 Conclusion of the contract between FutureBud International Co., Ltd. and Nihon Suido Consultants Co., Ltd.
May 24, 2021	Factory Inspection of the water tanker at KYOKUTO KAIHATSU KOGYO CO., LTD.
June 2, 2021	Pre-shipment Inspection at YOKOHAMA Port
June 11, 2021	Departure at YOKOHAMA
June 14, 2021	Official Letter was issued to WASAC on their obligatory duties. To be borne by WASAC 1.Custody of Water Tanker 2.Registration of the above 3.Arrangement of operational staff such as drivers
June 15, 2021	JST for M/P held a meeting with Director Mehode to request for arrangement of necessary procedures mentioned in the above.
June 22, 2021	Customs documents were mailed to JICA
July 12, 2021	Arrival at Dar es Salaam
July 16, 2021	JST for M/P called on Akagera to discuss initial traininng and other relevant issues. Mr. Methode joined as well.
July 29, 2021	Joint meeting was held to discuss vehicle registration method among parties concerned JICA HQ, JICA Rwanda and JST for M/P
July 30, 2021	Arrival at Kigali
August 5, 2021	Procedures for IT registration was discussed with JICA HQ and JST for M/P on IT Number plate for study purpose.
August 10, 2021	Official Letter was issued to WASAC on execution of IT registration
August 24, 2021	Permission of MFA issued
September 8, 2021	Delivery at Kimisagara WTP Acceptance Inspection was conducted
September 15, 2021	Initial Operational Training by KYOKUTO
September 17, 2021	Issuance of Certificate of Receipt to FutureBud from WASAC with JST for M/P
September 20 - 21, 2021	

End of September to the beginning of October	Extended operational training for WASAC technical staff by Akagera, local agent of KYOKUTO KAIHATSU Joint operational training with NRW project team as well as trial operation from Kimisagara WTP to each site

9.2.7 Inspection activities, initial operational instruction and trainings for operation and maintenance

As shown in **Table 9.2-4,** various inspection activities, initial operational instruction and trainings for operation and maintenance were conducted.

Table 9.2-5 Inspection and training

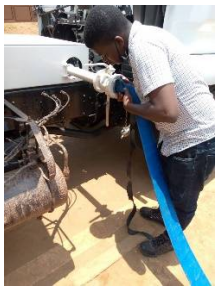
Date/ Description	Photograph	Remarks
June 2, 2021 Pre-shipment Inspection at YOKOHAMA Port	 Front view  Rear view	Shipping preparation was confirmed as well as required documents.
September 8, 2021 Acceptance Inspection	 Overall view  Defective light cover  Inspection sheet	Even though some minor defects such as missing parts were detected, the vehicle was accepted by WASAC and JST for M/P. All the defective points were fixed later.
September 15, 2021 Initial Operational Training by KYOKUTO September 20 - 21, 2021 Extended operational training for WASAC technical staff	 Briefing  Cab rising  Engine room  Manhole operation  Rear axl  Underbody inspection	Initial Operational Training by KYOKUTO followed by Extended operational training for WASAC technical staff by the local dealer were conducted successfully It was step by step practical training with detailed explanation on each part as well as mechanical functions.

	   4 way cock operation Hose connection Gravity watering	
Additional safety devices and Japanese flag logo seal	   Extinguisher Reflection board Japanese flag seal	A couple of devices were additionally installed to meet the local traffic safety standard.

9.2.8 Daily monitoring activities

Now the water tanker operation is in transition period from the trial to full operation though daily running distance is still low compared to the hired water tankers managed under the NRW project. JST for M/P has been being monitoring daily activities to improve WASACs' operation management capacity.

Table 9.2-6 Monitoring

Date/ Description	Photograph	Remarks
September 27, 2021 - Present	   Gravity watering Transporting Hose connection	Visited sited and running distance Sep 27: Kimisagara → Nyagasozi, Kimisagara → Robero → Kimisagara Total: 32km/day Sep 28: Kimisagara → Nyagasozi, Kimisagara → Robero Total: 37km/day
	   Reservoir tank inlet Flow meter Ameki color 10m3	Sep 30: Robero → Kimisagara 、 Gasanze → Kimisagara Gasanze→ Kimisagara Gasanze→ Kimisagara Ntora→Kimisagara Total: 118km/day

9.3 LESSONS LEARNED AND RECOMMENDATIONS

9.3.1 Current operating conditions

Current operating conditions are summarized as follows,

1) There are 11 small size un-piped reservoirs in Kigali city.
2) It's necessary to transport water from Kimisagara WTP to these reservoirs by water tankers at this stage. Any other water sources are out of consideration.
3) Even though it's difficult to cover the all reservoirs with one tanker, shiftwork in 24hours makes it barely be possible with conditions of filling the reservoirs not in full water but two-third to three-quarter levels, although it depends on the season.
4) Shortening transportation distance by adding water taking facilities including water hydrants other piped reservoir tanks seems to improve the above conditions.
5) Yearly cost estimation for operating the water tanker can be calculated as shown in the below,

1.Fuel Cost	26mil RWF*	
2. Engine Oil Replacement	0.4mil RWF	8 times/Year
3. Tire Replacement	6mil RWF	4 times/Year
4. Other consumable, Repairs	0.6mil RWF	4 times/Year
Total:	33mil RWF	

Remarks:
1) The above figures were calculated by estimated travel distance approx. 10,000km/month.
2) Additionally, labor cost for a couple of drivers, tax and dues, auto insurance, etc. shall be imposed.

* Approx. 68L (71,000 RWF) for 24 hours operation
(= Need a full gas recharge in every 36 hours operation (every 2 to 5 days))

9.3.2 Lessons learned and Recommendations

Our procurement service of one unit of the water tanker seems to be rather simplified project, and thus regarded as an easy task compared to other complicated projects we have experienced. However, some unforeseen factors acted as obstacles causing remarkable foot-dragging in several stages. Especially, we should pay enough attention for government approval and licenses. Actually, it took almost a month to clear customs after arrival of the water tanker in Kigali. In spite of tireless efforts of all the stakeholders to tackle with this matter, procedures grow at a sluggish pace. Considering any other minor issues as well, our lessons learned as reflective experiences were itemized in the following table.

Table 9.3-1 Lessons learned

No.	When raised	Event/ Category (Positive or negative)	Early warning signs?	Action(s)	Status	Recommendations
1	Initial phase in Jul 2020	Prior consent: It took rather long time than expected for forming prior consent on outline specification of the water tanker.	WASAC preferred bigger size tanker.	Explanation with detailed catalogue data on sizewise merits and demerits	Closed	Visual and numerical comparison data will facilitate mutual understanding among stakeholders.
2	-ditto-	Preliminary works: Any preliminary works both of documentation and technical issues should be expedited with organized procedures and templates.	Common challenge	Collecting information from inside and outside companies	In progress	To introduce effective and useful knowledge sharing platform as well as the existing data base
3	Jun-Aug 2021	Transport operations: Transport operations and customs clearance are key issues on schedule control. In the last, both contract term and delivery date were obliged to postpone until end of September.	Common challenge	Close communication and/or facilitation among parties concerned such as FutureBud, JICA HQ, JICA Rwanda, WASAC and NSC leaded to amicable settlement.	Closed	These series of precious experience should be shared as an internal intellectual asset and applied to any similar case arisen in future.
4	Sep-21	Operation management: WASAC has been having difficulties for organizing operation management of the water tanker since it was taken over.	Limited financial and human resources of WASAC	Consecutive intervention through meeting and workshops, monitoring activity by the NSC local staff Director Mr. Gorge, DSS committed to assign a supervisor to control daily water tanker operations as well as back-up drivers.	In progress	Keeping close communication between WASAC and NSC to monitor current activity status, and then to provide timely advise and necessary supports as to finding solutions.
5	Oct-21	Settling down phase: The above inadequate organizational situation has been being settled by intervention from stakeholders concerned. 1. The supervisor to manage entire operation was assigned. 2. Buck-up drivers will be arranged shortly. 3. Vehicle Routing Problem (VRP) method will be elaborated in accordance with their accumulated experience and knowledges.	Common challenge	For example, 1. Assistances for operation schedule planning by NRW reduction team, WASAC since they have sufficient experience through the similar technical cooperation project. 2. Various intervention including daily monitoring, providing necessary advise and documents by NSC 3. Self-help-efforts for improvement activities among WASAC technical staff is indicating effects.	In progress	Continuing improvement is the key factor for leading to efficient operation and maintenance, cost reduction as well as customer satisfaction. This includes, 1. Development of optimized water source and delivery routing by VRP and/or other ingenuity 2. Applying adequate driving method to reduce fuel consumption and minimizing wear and damage to the tanker 3. Prioritization of water delivery order to the sites to minimize water shortage always

ANNEX 1. QUESTIONNAIRE TO BRANCH AND WTP

The list of Questionnaire to Branch and WTP is in **Table A-1**, **Table A-2**.

Table A-1 The list of questionnaires to branch

Problems during the outbreak	MUSANZE Branch	Nyamagabe Branch
What was the biggest problem in Material and Logistics?	Availability of staff at the central store and private hardware	We didn't find problem, because of if even the materials are not in the main store, we bought them from our petty cash
What was the biggest bottleneck to the above problems?	Access to the hardware's for material which are not in central store.	
Were there enough materials such as repair materials?	no	For now, we have them, even if in the central store they don't have them, we buy them from our petty cash locally.
What kind of materials was hard to get?	Accessories for pipes ND 40,50,63,ND75,ND160	All materials here was available, we bought them by petty cash
How did you manage to get it under the COVID-19 outbreak?	We used the service vehicle	We make requisition in our main store (HO), if they don't have them we often have petty cash to buy them locally
Did you have anything you needed for assistance from Headquarter?		
What was the biggest problem in operation works?	The huge number of casual workers ,it was difficult for social distancing	We often find problem of transport (one car in operation combining with the commercial services)
Have you done the operation and maintenance for water facilities or pipelines as usual? If not, would you explain what the difference was?	Yes it was done as usual	Yes
How much percentages of employees were coming to the workplace during the lockdown?	Hundred percent (100%) for water distribution and maintenance team plus the Head of branch, the Store keeper(who is also a Branch Accountant),a driver and two recovery agents as volunteers Which made 49% of all the personnel of Musanze Branch	100 % (we have got permission to go to take them in case of travelling problem)
Did you reduce the operation works? What kind of operations did you skip? (e.g. reduce the frequency of taking sample)	Network extensions and equipment's maintenance	No (we do all operations as usually)
Did you have anything you needed for assistance from Headquarter?		
What was the biggest problem in financial and commercial works?	Commercial workers couldn't Leave their home ,the meter reading was taken by phone call to customers ,which was not accurate ,and the recovery operations was not working	The biggest problem is the transport, seeing that we have to share one car on both operations (finance and network maintenance)
Did you have any problem on revenue collection?	Yes ,revenue collection decreased very much no recovery operation could be done and some customer provided wrong indexes from their meters	Yes, because customers don't often pay their bills in due time, even if we disconnect him they pay difficultly (poverty during the CORONA period)
How did you respond to unpaid water tariff?	Because of covid-19 at the time of lockdown we couldn't disconnect people ,we waited till the end of the lockdown	The new tariff is to cover the production cost of water from the water treatment plant to the customers, nowadays customers are well explained about that tariff and there are satisfied.
How was the situation of customer services?	At least 50% goog	The service of customers was well managed and customers was satisfied.
How did you manage to do financial and commercial works? (e.g. billing, meter reading, accounting, payroll management)	Commercial workers couldn't Leave their home ,the meter reading was taken by phone call to customers ,which was not accurate ,and the recovery operations was not working, the branch accountant who is also a store keeper joined the maintenance and operation team to provide some needed materials	Every end of the month we have a meeting with Commercial Service Officer and Commercial Field Officer in order to see all problem found on the site during the closed period and

Bugesera Branch	Gicumbi Branch	GIKONDO Branch
The biggest problem is lack of the fittings at the right time in terms of repair the leaks, and the customers may spent more than 5 days without water in such situation of Covid- 19, and where we can buy them the hardware was been closed.	The problem is how to get Materials and their fittings to help us in repair of leaks	It was difficult to find materials. If we had to request materials from central store we had to take the branch vehicle to pick the store keeper at home and return him back. If we had to buy the materials outside from the shops, all of them were closed due to lockdown. We had to search for the shop owners and pick them from their home to the shop and take them back home. For logistics, the vehicle of Gikondo branch was allowed to pass due to the nature of our job, we had to transport the technicians and technician helpers from their residence to the Job and return them back after job. But some technician helpers whose residence are very far from the branch we managed to lodge them in wasac house located in Gikondo where we have water reservoirs supplying Gikondo area.
The biggest bottleneck of the problems is the materials and fittings.	The biggest bottleneck are to get appropriate materials which are not in central store.	Long time to provide a service, due to the process of getting materials and transporting staff from home to workplace and vice versa. Working many hours due to that long process
Not at all, and to get the hardware to lend the repair materials were the challenge.	No, there isn't	Not enough
Small materials to repair the service pipes like: - Sockets, unions, nipple and some HDPE fittings from ND 25 up to ND 63	To get materials and fittings from 50Ø to 200 Ø for repair here in Gicumbi District	PVC Sockets Materials to repair small individual connections such as pipes of 25 and 32 inches and their fittings
We had have some permitted hardware and we picked them but hardly.	We used the Branch's vehicle	We had to call the dealers and transport them with our vehicle. From home to the shop and vice versa
	The facilitation needed from Headquarter was to get protection masque (udupfukamunwa) and hand sanitizer which was not available at local market and respect with casual workers of social distance but now it is okay everyone know how to do	
Lack of materials and fittings as well.	We don't have enough water production according to the population in Gicumbi Branch and the pipeline are old	To get staff at workplace and availability of materials
Not. The difference was to did what is necessary than others in order to maintain the service as usual.	Yes we do the operation and maintenance difficulty way because we don't have materials	Yes we worked as usual with few staff
90% of technicians and plumber helpers and 20% in commercial section were coming at workplace.	70% of technicians located here at Gicumbi was coming and sometime Head of Branch, customer Care ,the Store keeper (who is also a Branch Accountant), Water distribution officer and the driver every time he is needed.	Only 4 technicians and 7 casual workers and Branch manager when necessary. (22%)
The operation works were seems stagnant especially the projects and extensions under starting.	Network extensions and field work of CFOs and CACROs	Not doing new connections and new water extensions Not doing customers disconnection due to unpaid bills
	We apologize for the operations doesn't work in normal way.	
Index were not well taken and the billing comes worse at the customer level. Sales was decreased at the percentage of 11.6% between March and April but between April and May the sales have been increased at the ratio of 26% until now there an increasement.	Commercial workers couldn't leave their home ,the meter reading was taken by phone call to customers ,which was not accurate ,and the recovery operation was not working in normal way because our customers doesn't have activity .	Customers were not paying their bills and on our side we could not make accurate bills because we had to wait for the customers to read the meters for us and send them. Many of them did not send the readings
Revenues has been decreased considerably between the February and March at the ratio of 44%. Between March and April has been also decreased continuously at the ratio of 48%. Between April and May the revenue collection had been increased at the ratio of 90%. Between May and June revenue becomes 91%.	Yes , the revenue collection decreased very much because no recovery operation could be done and some customers get the big bill due to the new tariff which is change according to their consumption	Yes, customers did not pay their bills as usual for exemple in April 2020 we collected only 70,877,282 out of 235,330,831 of target (30% of the target)
While the lockdown were become partially the unpaid water bills starting to be paid by some customers but others do not understand to pay them and some others starting complaining to their bills because of wrong index given to the commercial field Officers.	The explanation of new tarrif was done and customers with unpaid are asked to pay it in installment	It was a big problem, even to get a salary was not easy. You can imagine to pay suppliers was not possible
The customer services was a bit tight between Bugesera WASAC's branch and customers in such situation of lockdown especially in communication way but there are other customers complaining in such delivery service which was not sufficient.	The customer services was usually done by rationing program and its communicate via their phone numbers and group watsaap	Customers' service was good, water was reaching almost to all households because the businesses and offices were off.
The public notice from the HQs is the main chain for information about billing and meter reading. Accounting were totally stopped at branch level. Payroll was send through online channel in order to avoid the circulation of hard sheets (For casual workers).	We apologize customers with full explanation about new tariff and we ask them to pay in installments	Billing and meter reading was done through self-declaration by the customers. We requested customers to read the meters and send them to our billing staff, they have their numbers but some of them did not do it. Pay roll was done online.

Huye Branch	Kacyiru Branch	Kanombe Branch
Lack of fittings for repair	Public Transport and staff of logistic was not permanent to the workplace Availability of private hardware	To get fittings for repair and means of transport.
Budget	Lock of materials which were not available in central store it was not easy to get them from private hardware	Budget
Not enough	Not enough	Not enough
Fittings to repair leaks on connections	Materials not found in WASAC central store like Accessories for pipes DN 40,50,63N75,160	Fittings to repair leaks
Using petty cash we buy them at particulars quincailleries	I managed to negotiate with supplies (hardware)	To buy them out of WASAC stores
Yes, we needed cash on time to buy them		Yes ,we needed cash to buy them
Get materials for repair	Insufficiency of staff due to lack of public transport and social distancingi	To get materials for repair
Get materials for repair is the hard problem we are facing usually	I have done but with difficulty	Not as usual because to get materials for repair was so hard
All technical staff and 70% in commercial sevice were used	For technical team it was 100% while for commercial service it was 10%	Technical unit 100 % were coming at work every day and 50% in commercial services were attended by shift
New connection reduced, extension not done	YES - Disconnection - Taking readings - Network extension	Yes like new connections reduced, water network extension
To get petty cash on time		Yes like fuel for vehicle
Revenue reduced and no meter replaced in this period of locdown	Enforcement (Disconnection) of recovery was stopped Increase of errors in billing because the readings was sent by phones which was not sometime not accurate New connection and replacement stopped	Revenue collection was a big challenge, meter replacement ,billing
We have it.Most of our big customers like schools and Hotels are not operated	Yes Decrease of revenues	Yes
After lockdown recovery was very hard because of cumulative bills not paid. So that many customers came to as payment in instalment. Also it was hard to explain and correct some bill done basis of average	Because of lockdown, we could not disconnect customers, which failed to pay their bills we tried to inform them by phone.	It was very hard to explain ,because the consumption was to high to the customers .
Of course not very good because customers not got their bills	It's was not very good	Was not good because some they did not get their bills as requested
Financially revenues and sales reduced on highly percentage.	Commercials workers was not able to reach their working place for billing the meter reading was sent by phones and the recovery operations was not working.	Financially revenues reduced on high percentage, sales also was reduced because many customers was not billed as usual.

Karongi Branch	Muhanga Branch	Ngoma Branch
For material not available in our store, it was difficult to get them as Hardware store was closed, Also transport for technicians to come to service was not easy	Lack of materials for repair and network maintenance, the shop we use to buy them was closed. Shortage of means of transport to and from workplace	The biggest problem was lack of enough fittings and transport to speed up repairs.
Sometime quick intervention was not easy	To find where to buy materials of repair during lockdown	The biggest bottleneck is not having enough funds to buy required fittings.
No	No, the materials was not enough. The shop where we buy small materials was closed	Not enough.
Small repair parts (Fittings for ¾'' and HDPE Pipes)	Materials for leaks repair on small pipeline (DN 25, 32, 40, 50, 63, 75 mm)	Big size fittings to repair big supply lines e.g DN 63 and above Including HDPE fittings.
Some Hardware store keeper were connected with us, and after paying on mobile money, we were served with the needed material	We manage to get it by asking for authorization at local authorities for some shop to open	We could buy from open market using petty cash but couldn't buy all what is required because it is not enough and it is not available whenever is needed.
		We did not get anything we needed for assistance from Headquarter because there was when we requested and found that what was needed was not available.
When leaks become numerous, the intervention was not as quick as usual since the team was not complete	Transportation of technicians and materials. Availability of materials Long time to reach the damaged areas	The biggest problem was not getting enough fittings for repair works and not having enough transport because one vehicle could not transport all staff at ago.
Those activities were done as usual	No, maintenance of water facilities and operation was not done as usual. The technicians in charge was in lockdown	The operation and maintenance of water facilities was not done as usual because of not having enough fittings and not using all the technical team because we had to respect COVID-19 guide lines.
95% of the Operation Team	Around 30% attend workplace during the lockdown	30%
Yes, some of the operations were stopped such us network extensions and new customer connections frequency were reduced	The operations works was limited on urgent work only. No new customer connected	NO
		What was available was provided
Accountant and some Commercial staff were not present to the office reason why some payment were recorded in the system. Some clients didn't respond to the call for being billed	Customers did not pay their water bill. Accumulation of outstanding balance	The biggest problem in financial and commercial was reduction of revenue
Yeah since the revenue recovery operations were stopped and few customers paid their bills	The recovery process seems to be impossible as the recovery agents could not reach customers and some clients were unwilling to pay due to uncertain future. Compared to the last year and our targets, we realized a decrease of about 40% of revenue collection.	Yes Revenue reduced
Just to call and remind them for paying their unpaid bills, now we started disconnections	We manage to call and send messages to customers with big amount of outstanding balance	We responded by reminding customers to pay their water bills on line.
Based on customer calls and sms, they were provided with the needed services	The situation was precariousness, no technicians to visit customers, delay of interventions	The situation of customer services was not as usual because the two staffs in commercial services were alternating which means 50% of the work force was the one working.
Meter reading was done by customer himself and communicated to the meter reader then after bill them; Payroll management was done by Financial Department at head office	Financial and commercial works was done by reinforcing the communication with our customers where we used Emails, phone call, SMS and social medias.	We managed to do function and commercial works by means of Customer self-declaration; telephone calls, customers taking pictures of indices and send them on whatsap; could call customer to tell the index in the meter and bill while away and sending messages.

Nyagatare Branch	Nyamirambo Branch	Nyanza Branch
Repair materials (pipes, fittings and other accessories used in the repair of leakages.(especially those for the small pipes) Means of transport to different parts of the branch (Number of people in the car was restricted). Getting protective equipment for COVID 19	Storekeepers, private vendors were not operating hence challenge to get repair materials	Lack of materials for repair and maintenance such as: Pipes and accessories due to lockdown
Movement of staff to different areas of intervention was restricted Hardware were closed It was not easy to get enough protective equipment for COVID 19	repairs materials	The biggest bottleneck for the above problem were no movement of cars and closed market (Hardware store) in order to fight against COVID-19.
-The repair materials were not enough	no	No
-Small pipes repair materials because the hardware were closed.	Type of materials not availed in WASAC central store	There are some fittings and pipes which are not available in store at Branch level of repair and maintenance
Some institutions which provide essential services were allowed to operate but with limited movements and staff. That is how we managed to get them	Negotiated some private vendors and we had to transport them by WASAC car.	Whenever we faced that challenges, we used to communicate with other Branches and DUWSS for support.
	yes	
-Using few people in operations, especially in the repair works -Getting repair materials in time	Materials and Insufficient staff (support staff)	Transport means was difficult and also lack of appropriate materials for repair. Again, lack of information was a challenge as many people were locked at their homes.
The operations and maintenance are not done as usual because we have to respect prevent ive measures (transporting a limited number of staff in the car and social distancing). Before the outbreak of COVID 19, movement of staff to different areas of intervention was easy Delivery of materials was easy Monitoring of the network was not hard	No, due to insufficient staff and materials	Off course not, however as service provider we have tried to provide a good service to the clients by working as good as we can.
30%	20%	About 50%
Some operations were skipped; eg taking meter readings from the clients, disconnection, reconnection and connecting new customers	Yes, delay in repair, replacement of old meters, stopped new connections and recovery activities	We have not reduced the operation works, but we have reduced the maintenance works depending on their magnitude.
	yes	
-Revenues reduced from 149,316,815 frw - 109,939,830frw(26% reduction) -Sales also reduced from 158,900,066frw - 120,791,297frw(24% reduction) -New connections reduced from 200 -141 customers(29% reduction)	Some works stopped, e.g; Enforcement in recovery (disconnection), new connection, billing analysis and correction of errors	The biggest problem in financial and commercial works are the big customers which are not in operation due to lockdown (like Schools, Bars, Hotels...)
-Customers stopped paying because most of them were not working -We suspended disconnection activities of defaulters	yes	Yes, revenues were reduced by 50% due to inadequate access to our customers to get their bills even customers were not able to access banks for payments.
-Reminding customers to pay the bills through social media -After lockdown we started disconnections to those who had not paid.	Practically none, only those with willingness to pay managed to pay some bills. We only tried to give customers bills via phone	Response was done after lockdown because we have no right to go their places for collecting revenues, We have used different advertisement trough Whatsap, Instagram, Twitter and phone calls to help people to be aware of knowing their arrears and how to pay through their phones.
customers were encouraged to use online facilities. Some technicians were distributed in different parts of the branch for interventions.	Not good	The situation of customer services was about70% because water leakages were repaired, even water bills was given through phone calls and WASAC website.
Meter reading was done by calling customers on phones to get their readings. Some could also call our staff and send their readings. Accounting was done on a limited scale by the accountant but respecting preventive measures. Payrolls were made and submitted for approval electronically.	Billing and meter reading done via self-declaration by phone, calls and messages.	The management of financial and commercial works were done through day to day advertisement via phone calls, short messages.

Nyarugenge Branch	Remera Branch	Rubavu Branch
Materials; The needed materials that were not in the store of WASAC were bought petty cash as we were I lockdown each places were closed and not easy to get the martials Concerning the materials that were in WASAC stores, it was not easy to get them due to the fact that many staff were not working thus this could take long to get them Logistics: We have using only one vehicle and this made the assignment harder than earlier	the biggest problems were: requisitioning materials in stock for repair, petit cash, transport of staff before and after work	Lack of materials in branch stores
The above mentioned problems led us to deliver a non convenient service to our clients	lack of materials in stock	Accessibility to WASAC's Central stores
Materials for repairs were not enough	no	Repair materials weren't enough in branch stores
Materials to repair the small pipes example; dn 25,dn32,dn40,dn 50,dn 63 and 75 were hard to get	Accessories for pipes ND 40,50,63,ND75, DN 90,DN 125,ND160, DN315 (all PN 16)	Fittings and pipes used in repair for main pipeline (Big size)
As WASAC vehicle used to have a 'PASS' we used it to manage the situation	we had to move the staff officers in stock from home to central store, and for the materials not found in stock, we had negotiated with the businessman to move them and paid after quarantine	We used to request the support from Headquarter
Yes ,we needed Fund release from Headquarter due to some materials which were needed and can not be obtained via petty cash		Yes, but not on time as needed
During the lockdown the main issue was getting materials for repair and using one vehicle in all activities especially nyarugenge branch which having big coverage area	The huge number of casual workers ,it was difficult for social distancing, and transport them at home before couvre feu	Staff transportation
Not as usual because to get materials for repair was so hard	Yes it was done as usual	Not, due to the time and staff transportation, branch's vehicle used to correct all staff from their places and return them back after work, some leakages has been stopped but not repaired due to the limited time.
During the lockdown we were working in shifts almost 50% of all branch staff	Branch manager and commercial services = 50% Water distribution and maintenance team = 100 % Which made 60% of all the personnel of Remera Branch	30 % employees were coming to the workplace during the lockdown and all were technicians
Yes operational work was reduced e.g; New connection, Extension, Rehabilitation, meter replacement and onsite meter test	No, the maintenance operations were increased for reasons that we were in the rain season, only the extensions network was stopped	Yes, new connection and meter testing has been skipped during that period
Yes; fuel for vehicle		Yes, but not on time as needed
Revenue collection was a big problem because recovery was not done as usual, normal customers having long outstanding balance were to be disconnect the service but during the lockdown we were not allowed to do that. Sales reduced because we billed customers the previous index instead of billing the real index due to the fact that also, CFO were in lockdown. Meter replacement also were not done	Commercial workers couldn't leave their home ,the meter reading was taken by phone call to customers ,which was not accurate ,and the recovery operations was not working	Wrong data in the billing. All data used in billing has been provided by customers through calls all messages and sometime the given data was wrong Inaccessible system (CMS) which didn't allow supervisors to monitor billing while they are not in offices
As I said above revenue collection was a problem because recovery were not done except the committed customers to pay their bills on time	Yes, revenue collection decreased very much no recovery operation could be done and some customer provided wrong indexes from their meters. we mobilized customers to pay by mobile money and bank transfer but it was not efficient	Yes, no physical recovery made
During the lockdown all family members were obliged to stay at home, this makes consumption to be high so to explain this different was not easy for our customers	Because of covid-19 at the time of lockdown we couldn't disconnect people	We used to call customers and encourage them to pay their bill by using online payment.
Customer service was not good; -Customers didn't receive their bills on time -taking long to repair leakages	customer service works 40%	The situation was good.
At branch level financial and commercial works was going at low rate because all activities like; Billing ,meter reading, recovery and repair their management was very very hard and this gives a negative impact to the whole company.	for finance, the accountant should work 3 days a week to record the accounting documents in oracle and the customer payments by bank transfer in CMS, as well as the commercial operations , we worked in 2 teams which alternated after 2 days	We have announced to our customers how they can get our services, by sharing our phone number and emails with them.

Ruhango Branch	Rusizi Branch	Rwamagana Branch
the problem is all the stores were closed so it was not easy to purchase any repair materials that are not in our stores	Lack of water materials in branch stores during the lock down	Repairing materials, transport means
The big problem, it was not easy to repair customer pipes right away.	Accessibility to WASAC's Central stores	Getting Repairing materials
Not enough	Repair materials weren't enough	Materials which were not available in WASAC stores
The small pipes (3/4'', 1'',…) and fittings for repair	Fittings and pipes used in repair	Unions, sockets, repairing sockets
We stopped the leakage while waiting for the availability of materials.	We used to request the support from Headquarter	By loan from hardware houses
Yes, during that time we needed the protection from Covid-19, and they gave us the gloves and masks.	Yes	
It was not easy to excavate the trenches because everyone was at home and not allowed to go out.	Staff transportation during the lock down	To get to working area
It was not like usual, because as I said before, we had the problem of materials to fix the leakages, and all stores were closed.	Yes we did but with limited time	yes
60%	30% and all technicians attended their job according to the nature of the job.	All technical team were in work
Some operations were stopped, like new connections, control of clients, taking readings ...	We reduced branch's operation like new connections, meter testing, recovery and visit of big customers.	Reduce new connection
Yes, like protections equipment at work and against covid-19 and the materials to fix the leakages.	Yes, but with more limitation	
In commercial the problem was to take the readings for billing, and to follow how the billing cycle is done.	The issue of accurate billing and poor revenue collection	Money has been little
Of course, because all banks were closed, and no person was not allowed to go out. So we had the problem of revenues.	Yes, the revenue trend has been fallen down.	The problem is there because , clients did not pay
We tried to communicate to our customers through our telephones and whatsapp to pay the invoices with their phones, by using the Mobile Money.	We used radio announcement to mobilize our customers to pay with online payment.	
Comme notre numéro de téléphone se trouve sur notre site Web de WASAC, chaque client qui avait un problème, pourrait nous appeler et intervenir. The situation was not good as usual, but we tried to do our best.	The situation was good.	There are some places where water was insufficient because of the leakage the transport was difficult
Billing: we called our customers and gave us the readings in their meters and the bill is done, and after the bad period we go to the field to see if really the readings given are corrects. Our Accountant was at home.	We did it through call.	We try to work in difficult condition but we work

Table A-2 The list of questionnaires to WTP

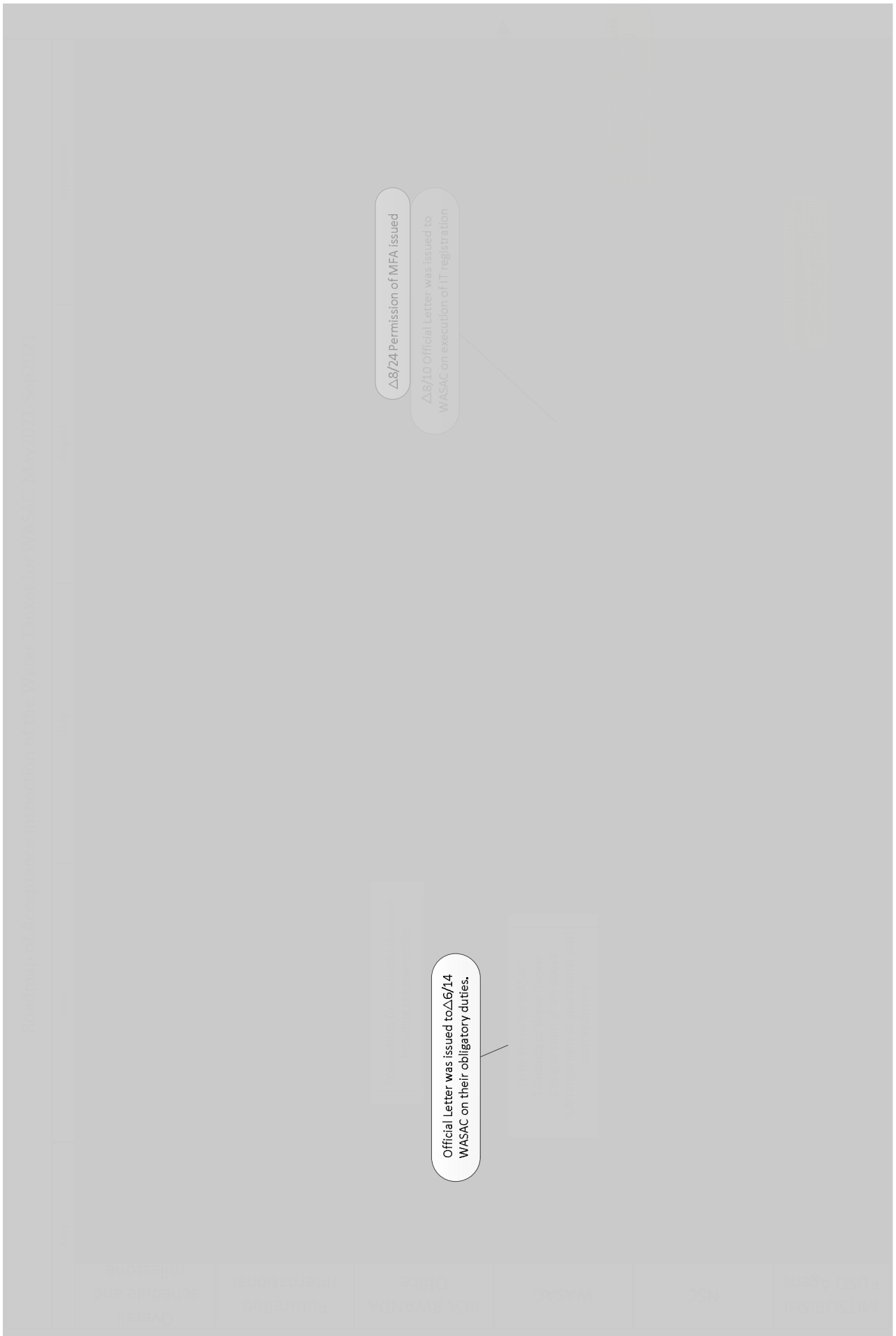
Problems during the outbreak	GIHIRA WTP	KADAHOWA WTP
What was the biggest problem in Material and Logistics?	Getting on time the materials from central stores	The accessibility of central store was available except the private market which was not ease to get materials which were not in central store
What was the biggest bottleneck to the above problems?	We did not stop the service	The hardwares were closed during outbreak, the accessibility of materials were difficulty to get and we were supposed to look for the sellers
Were there enough materials such as repair materials?	No, there were not enough	The repairing materials were hard to get
What kind of materials was hard to get?	Chemicals like Calcium hypochlorite and Sudfloc 3870	Repairing accessories for pipes
How did you manage to get it under the COVID-19 outbreak?	Communication at time with concerned persons	We managed to get them by using vehicle services
Did you have anything you needed for assistance from Headquarter?	Approval of requisitions	Sanitation equipments
What was the biggest problem in operation works?	Moving of shift team for attending the workplace	The biggest challenge was means of transport for staffs to reach at workplace and social distancing
Have you done the operation and maintenance for water facilities or pipelines as usual? If not, would you explain what the difference was?	Yes	Yes, it was done as usual even the situation was hard
How much percentages of employees were coming to the workplace during the lockdown?	90%	The employees were attended works 100%, the working team were shifted as usual
Did you reduce the operation works? What kind of operations did you skip? (e.g. reduce the frequency of taking sample)	Yes, taking sample once time per week	There were no any work were skipped due to outbreak, operation works were done effectively
Did you have anything you needed for assistance from Headquarter?	Yes, we have received at time the assistance	Sanitation equipments

MUTOBO WTP	NYAGATARE WTPs	NZOVE WTP
Availability of staff at the central store and private hardware	The biggest problem was unavailable materials in central store and DIY store and very hard to get transport of materials.	Lack of enough cars for staff transport, chemicals transportation, and very hard to reach staff home and plant at time, very difficult to find all small spare parts, very difficult to find manpower to off-loading the tracks.
Access to the hardware's for material which are not in central store.	No access to the hardware's for material which are not in central store and private hardware.	Sometime lack of those small spare parts , affect water quality and reduce slightly production
no	no	No enough materials such as: some hydraulic fittings, pump and motor bearing, N-EUPEX FLENDER, …
Water quality analysis chemical	Fitting for repair pipeline DN280 PN16; and accessories of pumps for repair and maintenance; submersible pump to replace one which was short-circuited, the COVID 19 stopped supplier to get it from outside of country because the factories was closed.	Chemicals, hydraulic and electrical spare parts
We used the service vehicle after acquiring special permission	We used other alternative like arrangement to get old fittings and the pump which is not appropriate to raw water in order to have provisional solution while waiting sustainable solution after COVID-19	To call directly hardware shop owner ,to discuss with manpower how to off-loading the tracks
Getting enough protecting equipment for staff at work	Yes, we have worked with General maintenance team from headquarter and we got advice from Directorate of Urban Water and Sanitation Services at Headquarter level.	Yes, to have a strategic store and enough cars for support
Yes it was done as usual	The bacteriology test was not done as provided because during COVID-19, sharing equipment is no allowed to stop spreading of it.	No respect of standard working hours in a week
Hundred percent (100%) Because we normally works in shift,so everyone gets to work according to the schedure	Yes, was done usual.	Not the same as usual ,the difference was time of receiving spare part, and intervention on time.
No. the sampling was done as usual	During the lockdown, 100% were presented, but as usual 50% a day and 50% to night.	100% (few staff work in different stations).
It was difficult to get operation fund(petty cash replenishment)	Yes, sampling for bacteriology test reduced from twice per month to once per month.	Yes, some operation works has been reduced, water sampling in the customer house has been reduced because at that time we were not allowed to enter in customer house.
		To have emergency house to accommodate some staff to help during special time like lockdown

ANNEX 2. PROCUREMENT OF WATER TANKER

1) Roadmap
2) Acceptance Inspection Sheet
3) Acceptance Receipt
4) Meeting memo
5) Emergency Water Supply – Operation Time Schedule elaborated for October 2021

1) Roadmap


△8/24 Permission of MFA issued
△8/10 Official Letter was issued to WASAC on execution of IT registration
Official Letter was issued to△6/14 WASAC on their obligatory duties.

2) Acceptance Inspection Sheet

THE PROJECT FOR WATER SUPPLY MASTER PLAN FOR CITY OF KIGALI

VEHICLE DELIVERY & ACCEPTANCE INSPECTION

□ Initial Inspection
□ Reinspection

OK - Satisfactory NR - Needs Repair

Complete Inspection & Circle Pass or Fail			
Inspection Results:	PASS	FAIL	
Company Name (Vehicle Owner)	Nihon Suido Consultants Co., Ltd. (NSC)		
Type of Vehicle :	Water Tanker		
Inspection Date:	July 29, 2021		
Inspection Company:	NSC witnessed by WASAC		
Inspector Name/Title:	Mr. T.Kawamura, Mr. K.Nishida		
Inspector Signature: Initial			

ENGINE COMPARTMENT	OK	NR	COMMENTS:
Fluid levels	OK		
Battery connections	OK		
Leaks	OK		
OTHER			

Drivers Area	OK	NR	COMMENTS:
Drivers Seat	OK		
Floor mats	OK		
Guages	OK		
MIRRORS	OK		
WINDOWS/OPERATION	OK		
Interior lighting	OK		
SUN VISOR	OK		
Safety apparatus	OK		
OTHER			

AC / HEATER	OK	NR	COMMENTS:
HEATER	OK		
CAB A/C	OK		N/A
OTHER			

CAB / BODY	OK	NR	COMMENTS:
FRONT DOOR OPERATION	OK		
PASSENGER SEATS	OK		
GRAB RAILS	OK		
SIDE/FRONT/REAR/CEILING PANELS	OK		
FLOOR COVERING	OK		
WINDSHIELD	OK		
WIPERS	OK		
Damage			
OTHER			

Inspector must initial mileage	INITIALS:
Mileage:	
License Plate #	RT 732 RG
VIN: Vehicle Identification No	
Manufacturer: Kyokuto	
Tanker Model:	
Chassis Model:	FM 657HA 45001
Year: 2021	

	YES	NO
LIGHTING	OK	NR	COMMENTS:
HEADLIGHTS	OK		
TAIL / STOP	OK		
CLEARANCE / MARKER	OK		
IDENTIFICATION .	OK		
REFLECTORS	OK		
Other NUMBER PLATE			
LAMP COVER		NA	

Water Tank	OK	NR	COMMENTS:
Water tank, Level gauge	OK		
Suction and Discharge Pump	OK		
Piping, Valves, Cocks, etc.	OK		
Manhole, Rear ladder	OK		
Other Accessories (Hoses)	OK		

ON-BOARD	OK	MISSING	COMMENTS:
Spare Tire and Wheel	OK		
Standard Tool Kit	OK		
ODA logo/mark seals	OK		
Other			

EXHAUST	OK	NR	COMMENTS:
LEAKS	OK		
PLACEMENT	OK		
Other			

TIRES	OK	NR	COMMENTS:
DAMAGE	OK		
OTHER			

Training	OK	NR	COMMENTS:
Water Tank and Pump			SCHEDULED ON 31 SEPT 2021
Vehicle Chassis			SCHEDULED ON SEPT 2021

NOTES AND AREAS OF CONCERN/FOLLOW UP:

Upon completion of initial training programs by the video system of KYOKUTO KAIHATSU KOGYO CO.,LTD as well as verbal instructions by the agent of MITSUBISHI FUSO for the vehicle chassis, this inspection sheet shall be regarded as the delivery certificate for the payment procedure between FutureBud International Co., Ltd and Nihon Suido Consultants Co., Ltd.

RECIPIENT ACCEPTANCE AND SIGNATURE: By signing this form, I certify I have inspected the vehicle, verified the VIN and vehicle condition. I am accepting the vehicle was delivered as ordered according to the specifications. I agree WASAC will add the vehicle to the their Vehicle Maintenance Plan and will maintain the vehicle according to the Manufacturer's guidelines at a minimum.

Recipient Name MARAMBWA Innocent Title Transport officer Signature

Witnessed by Name NIYIBAHO Jean Robert Title Electro-mechanical Engineer Signature

INSPECTOR NSTRUCTIONS: The vehicle delivery inspection & acceptance form is filled out and signed by Nihon Suido Consultants Co., Ltd.
Inspector MUST: Initial mileage, Select PASS or FAIL, and sign the form.
This inspection checklist may be accompanied by the specification sheet of the contract between FutureBud International Co., Ltd and Nihon Suido Consultants Co., Ltd.
If the vehicle fails, a follow-up inspection is required after repair.
OK - Satisfactory NR - Needs Repair

3) Acceptance Receipt

Certificate of Receipt

To: Futurebud International Co., Ltd.

This is to confirm and certify that the Products procured by Nihon Suido Consultants Co., Ltd. on behalf of JAPAN INTERNATIONAL COOPERATION AGENCY under the Project for Water Supply Master Plan for City of Kigali in Rwanda have been duly received in satisfactory conditions.

Name of the Supplier: Futurebud International Co., Ltd.
Name of the Product: Water Tank Truck

Item No.	Name of the Products	Quantity	Package
1	Water Tank Truck	1 unit	Bare
2	Spare Parts and Accessories for Water Tank Truck	1 lot	Pallet

Date of Receipt of the Products at the Site(s): 8th September , 2021

Date : 17th September , 2021

Procured by

Mr. George BARIGYE
Director of Support Services (DSS)
Water and Sanitation Corporation
(WASAC)

Mr. MAMIYA Takemasa
Team Leader, The Project for Water
Supply Master Plan for City of Kigali
Nihon Suido Consultants, Co., Ltd.

Witnessed by

Mr. Methode RUTAGUNGIRA
Director of UWSSD
Water and Sanitation Corporation
(WASAC)

4) Meeting memo

Workshop

2021/08/25 11:00 AM at Board room, WASAC HQs

RUTAGUNGIRA Methode, WASAC, Director of Urban and Water Sanitation Service
MWIJUKYE James, WASAC, Director of Commercial Department, DC
BARIGYE George, WASAC, Director of Support Services, DSS
KARANGWA Innocent, WASAC, Transport officer
RWABUGANDE Benon, WASAC, Administration and logistics
BAHIGE Jean Berchmans, WASAC, NRW Manager
MAMIYA Takemasa, JST
KAWAMURA Tetsuji, JST
MATSUBARA Koichi, JST
MATSUMOTO Yuichi, JST
NISHIDA Kosei, JST
NTEZIRYAYO Francois, JST

JST explained the background and the current schedule of the water tank truck procurement, pointing out the importance of selecting water tanks that need water supply by the truck and securing the budget for private water tankers. JST also explained the operation plan of the water tank truck. Additionally, JST carried out the explanation of water tank truck including how to use it through the video created by the manufacturer.

(DSS) If it is under WASAC, we can operate. We can consider the budget for private tankers at next budget planning. I promise that we are in charge of Operation, Maintenance, Insurance and Securing of the truck.
(JST) We need to know how you maintain and operate the truck including who is in charge of it and budget. We can estimate and provide how much fuels you need for the one-year operation. Regarding the current operation of each tank, when the tank is empty, the owner calls to JICA NRW Team. Who will be in charge of this procedure?
(DC) We can arrange how we operate the truck and tanks. Logistics will be the owner of the water truck.
(Logistics) We have Transport officer and Mechanical engineer too.

MEETING NOTE

FOR THE PROJECT FOR WATER SUPPLY MASTER PLAN FOR CITY OF KIGALI

Theme: **WATER TANKER OPERATION**
Location: WASAC HQs AND TOKYO
Host: NSC (Zoom meeting)
Date and Time: 17 September 2021_ 8:00 - 9:00, Kigali time
Attendance : as referred to hereinafter

The meeting started with an introduction of Mr. Matsubara, NSC who talked about the water tanker operation and maintenance in general.

1. Maintenance and insurance of the vehicle will be managed under the responsibility of WASAC.

2. The IT plate belongs to JICA; the transfer will be made later because of taking advantage of the current import tax exemption method.

3. The capacity of the water tanker is not enough to meet the total demand after complete suspension of the private water tanker operation in the end of this month. He emphasized on necessity of extended training course to be conducted by car dealer Akagera Motors which had been already trained by the vehicle manufacturer.

4. The training for WASAC driver and other technical staff who in charge of transport and maintenance will focus on how to use the water tanker (e.g: daily check, pump operation, lubrication points, etc.); The fuel cost calculation (in excel sheet) was elaborated by Matsumoto/ Mechanical Engineer who in charge of Procurement of the water tanker.

Mr. George/DSS/WASAC mentioned WASAC Staff concerned by the training as follows,

1. Mr. Innocent/Transport officer; the driver: Mr. Bosco and Mr. Antoine/ Mechanical Engineer; shall be key persons for operation and maintenance.

2. He appreciated the IT plate for the moment in an expedient manner until adjective ownership transfer later; he emphasized appreciation from the WASAC Management where the water tanker will contribute to supply water in areas not yet piped or having a concern of water supply.

Mr. Matsubara suggested as shown in the below,

1. If the training can be held on Wednesday, 22nd Sept.2021 at Kimisagara WTP by Akagera Motors, 3 people: Driver, Transport Officer and Maintaining Engineer should attend.

2. He mentioned that there are 11 tanks to be supplied in water: Amakawa, Rebero, Ntora (2 tanks), Gasanze (3 locations), Masaka (2 locations), Nduba, Musave, Nyagasozi. The total maintenance cost will attend 33 Mil RWF.

Otani san/ Team Leader of NRW project explained briefly the proposal for the joint operation of WASAC water tanker under the NRW assistance as follows,

1. He showed the operation plan of private water tanks which will end by 24th September, 2021 as well as the start for activities by new water tanker operation.

2. Regarding the trial operation and preparation for operation schedule; Mr. Ally and Mr. Vedaste are requested to assist WASAC Staff. For location of water tanks, 11 public taps are supplied though initially 23 sites were

starting, due to the improvement of water supply, the number of sites was reduced from 23 to 11 places. Water tanker will be ordered at Kimisagara WTP to deliver to water to the public tap in charge of selling water to the customers; public tap sold water according to the price established (20 RWF/20 L Jerrycan), and then will pay the bill to WASAC according to the tariff rate.

The following issues have been discussed as well,

1. As a common view among parties concerned, depreciation cost of the vehicle, driver expenses, maintenance fees shall be borne by WASAC.

2. For the operation of the work, WASAC. has to prepare the recording sheet for water loading at Kimisagara WTP and at the public tap.

3. Mr. Desire/NRW raised a concern about the training that can be done earlier on Monday, 20th Sept. or Tuesday, 21st Sept, before the end of the contract with private water supply operators for a better continuity of water supply without interruption and the time for the new driver to know all sites of public taps location. Mr. Robert and Mr. Francois have been charged to coordinate the training of Akagera Motor at Kimisagara from Monday; this will help to conclude operations of private operators on Friday, 24th Sept.2021.

4. Mr. Vedaste asked a question regarding water transportation: calculations made to WASAC for billing system in branches, he highlighted an issue also of water pump management after 24th Sept. For water pump management, the new water tanker has its engine pump driven by PTO. For calculations which have to close by end of the month, Mr. Vedaste will assist how to handle this issue in sense the contract with private operators will terminate by 24th September 2021; from Monday the NRW Team will start to inform public tap users the change of water supply operation after 24th Sept, in accordance with Branches concerned.

Mr. James/Dir. of Commercial Department agreed to sit together to make the schedule be successfully and see how the water demand will be managed to satisfy the needs of customers.

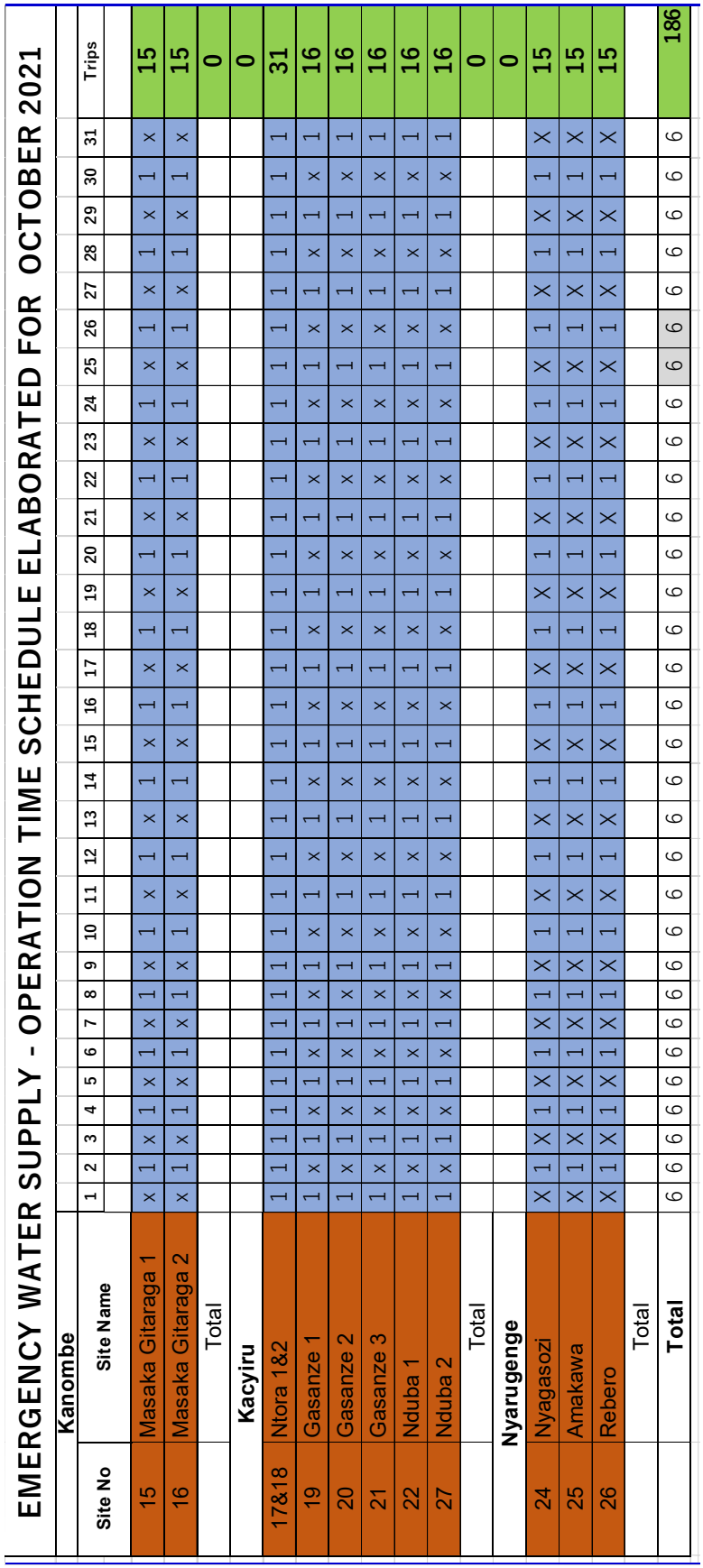
Mr. George thank a lot JICA and its Experts for the kind cooperation and the offer of water tanker truck.

Participants

Name	*Institution*	*Position*
MWIJUKYE James	WASAC	Director of Commercial Department
RUTAGUNGIRA Methode	WASAC	Director of Urban water & sewerage Services
KARANGWA Innocent	WASAC	Transport officer
ITANGISHAKA Vedaste	JICA NRW Project	Assistant NRW project
TSUTSUI Nobuyuki	JICA NRW Project	JICA Expert
BARIGYE George	WASAC	Director Support Services, DSS
BYIRINGIRO Ally	JICA NRW Project	Emergency water transport supervisor
NTAMUTURANO Desire	WASAC	Head of Leak detection and pressure management
NIYIBAHO Jean Robert	JST	Electromecanical Engineer
NTEZIRYAYO Francois Xavier	JST	Supporting Staff-RWA
OTANI Shigeo	JICA NRW	Team Leader

	Project	
KAWAMURA Tetsuji	JST	Co-Team Leader
MATSUBARA Kouichi	JST	Engineer, Hydraulic
NISHIDA Kosei	JST	BCP
MATSUMOTO Yuichi	JST	Engineer, Mechanical

5) Emergency Water Supply – Operation Time Schedule elaborated for October 2021



EMERGENCY WATER SUPPLY - OPERATION TIME SCHEDULE ELABORATED FOR OCTOBER 2021

Site No	Site Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Trips
Kanombe																																	
15	Masaka Gitaraga 1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	15
16	Masaka Gitaraga 2	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	15
	Total																																0
Kacyiru																																	0
17&18	Ntora 1&2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
19	Gasanze 1	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	16
20	Gasanze 2	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	16
21	Gasanze 3	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	16
22	Nduba 1	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	16
27	Nduba 2	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	x	1	16
	Total																																0
Nyarugenge																																	0
24	Nyagasozi	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	15
25	Amakawa	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	15
26	Rebero	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	1	X	15
	Total																																
	Total	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	186

APPENDIX 31: Basic Technical Criteria of Waterworks Facility in Rwanda

Table of contents

List of boxes

Preface

At present, there are no unified criteria or practical guidelines for planning and designing of water supply facilities in Rwanda.

Accordingly, the Water Supply Master Plan for the City of Kigali (the WASAC/JICA M/P or the Greater Kigali Water Supply Masterplan) is being formulated based on the internationally-available guidelines including the ones in Japan as well as the experience of the working team members of the Greater Kigali Water Supply Masterplan in the WASAC and engineers of the JICA Study Team who are working closely with the WASAC in this regard.

This document, named as the "Basic Technical Criteria of Waterworks Facility in Rwanda (the Basic Criteria)", has been prepared by summarizing the basic concept, criteria and philosophy that are employed in formulating the Greater Kigali Water Supply Masterplan, with reference to the content of the Japanese "Ministerial Ordinance Regarding the Technical Standards for Waterworks Facilities".

The Basic Criteria are compiled with the objective of providing philosophies and criteria to all those involved on planning or design of water supply facilities of the WASAC. The Basic Criteria will also serve as a basic concept and proper direction in preparing detailed design criteria or practical design manual for the waterworks facility in Rwanda in future.

Instructions to the Users

The Basic Criteria are intended for anyone who are being or going to be involved in planning and design of water supply facilities, regardless of headquarter or branch office levels, the WASAC or private sectors including local consulting engineers, in order for them to have an uniform understanding and view on planning and design process and thereby proceed forward in the right direction.

By doing so, risk for moving in a wrong direction while proceeding planning and design can be minimized. Moreover, the WASAC and private sector engineers' time can be used more effectively if the framework for his/her works are clearly defined. We believe that "the Basic Criteria" will also contribute in ensuring quality planning and design of water supply facilities that will ensure optimal utilization of their potential function in the long run.

This document should not replace the sound judgement of the user and does not relieve the design engineer of his/her responsibility to design an economical and effective water supply system.

However, any deviation from general guidelines or the detailed criteria shall be justified and brought to the attention of the responsible engineers in the WASAC.

The Basic Criteria contain the philosophy and directions for planning and design of water supply facilities. However, simplicity and reliability should always take preference over sophistication.

For the above reason and nature of this document, the update work of the Basic Guidelines should never be considered complete, and it should be reviewed and updated by WASAC from time to time.

(GENERAL)

1 General

Water supply facilities shall fulfill the following requirements:

1.1 Facilities shall be able to provide clean water continuously with the quality that meets the national water quality guidelines as stipulated in the Water Supply Act, along with necessary amount, and with sufficient pressure.

1.2 Facilities shall be able to provide clean water steadily and efficiently in response to the demand fluctuation.

1.3 Following measures shall be taken as necessary in order to improve the water supply reliability:

1.3.1 Spare facilities or equipment shall be furnished.

1.3.2 Water intake facilities, water storage facilities, water transfer facilities, water treatment facilities, water transmission facilities and water distribution facilities shall be furnished in a dispersed manner.

1.3.3 Water supply facility itself or a facility of the same series shall have multiple numbers of units/series (A system should have sufficient backup and provisional capacity in order to be prepared for an emergency).

1.4 Facilities shall be designed to minimize the impact on water supply such as water outage and to recover immediately in case of disasters or other emergencies.

1.5 Facilities shall be designed taking environment conservation into consideration.

1.6 Facilities shall possess structures resilient to anticipated loads such as dead weight, loading weight, water pressure, earth pressure, lifting pressure, buoyancy, seismic force, ice pressure and temperature pressure, taking into account topography, geology and other natural conditions.

1.7 Facilities shall possess structures that are robust and resilient to external forces and should be designed taking into account impacts caused by ground displacement and its secondary impact such as liquefaction and lateral flow depending on their levels of importance.

1.8 Facilities shall possess adequate water tightness to prevent water leakage.

1.9 Facilities shall be designed in consideration that operation and maintenance can be

performed surely and easily.

1.10 Facilities shall have culvert structures or other necessary measures such as installation of fence in order to protect water from pollution.

1.11 Necessary equipment to monitor and control flow rate, water pressure, water level, water quality and other operating conditions shall be furnished according to their scales and characteristics.

1.12 Shut-off valves and other equipment necessary to prevent expansion of damages shall be furnished, as necessary, in case of disasters or other emergencies.

1.13 In case where seawater or brine (hereinafter referred to as "seawater") is used as raw water, facilities shall be able to supply treated water whose boron content is less than 1.0 milligram per liter.

1.14 In case where coagulant, coagulant aid, hydrogen ion concentration adjuster, powdered activated carbon and other chemicals or disinfectants (hereinafter referred to as "chemical agents") are injected into finished water and/or water being treated, facilities shall be furnished with equipment which can inject necessary amounts of chemical agents according to their characteristics (hereinafter referred to as "chemical injection equipment"), and whose materials are corrosion resistant under the conditions of use of the concerned chemical agents.

1.15 In case of furnishing the chemical injection equipment, spare equipment shall be furnished. Note however, that this shall not apply as long as the suspension of chemical injection equipment does not impede the stable water supply.

1.16 Chemicals added into finished water and/or water being treated, shall be safe and not harmful to the human body as well as natural environment.

1.17 Equipment or facilities shall fulfill the following requirements:

1.17.1 Equipment or facilities shall possess strength, durability, wear resistance, corrosion resistance and water tightness, as necessary, according to conditions of their usage.

1.17.2 Equipment or facilities shall possess no water pollution risk.

1.17.3 Materials of equipment or facilities in contact with water after or under treatment (except for pumps, fire hydrants and others where water touching area is extremely small) shall be safe and not harmful to the human body as well as to the natural environment.

Box 1-1: Issues to be considered while preparing master plan

The master plan is a long-term and comprehensive plan related to the basis of the components of the project, in which the respective water utilities and bulk water suppliers (hereinafter referred to as "respective water utilities etc.") are going to undertake facility improvement, replacement, expansion etc. in the near future under the natural, social and local circumstances. The master plan contains a basic goal, principal items and components to be provided.

The following items shall be taken into account when preparing a master plan:

1. Securement of a quantitatively reliable water source
2. Securement of qualitative water safety
3. Securement of proper water pressure
4. Provisions against disasters and accidents
5. Improvement and replacement of facilities
6. Consideration to the environment
7. Consideration to sanitation

Box 1-2: Determination of key orientations and policies in preparing a master plan

The following matters shall clearly be defined at the time of deciding the basic policy:

1. Matters related to the service area
2. Matters related to the compatibility with a plan at the higher level
3. Matters related to the level of water service
4. Matters related to the measures for disasters and accidents
5. Matters related to O&M
6. Matters related to consideration to the environment
7. Matters related to management of the water utility

Box 1-3: Basic survey for preparation of a master plan

The basic survey for the preparation of a master plan shall be carried out in accordance with the following items after understanding the present status:

Additionally, the survey shall be conducted with reference to the study items presented in the respective chapters.

1. Collection and study of basic data necessary for the decision of the service area
2. Collection of data necessary for the determination of the water service volume and study on related plans
3. A survey of the superior (governing) plans at the higher level, the related plan for the water supply project or the one for bulk water supply project
4. A survey of the natural and social conditions required for the decision of the location and structure

of the water supply facilities

5. Collection and study of data on water supply facilities of water utilities of the same size and similar in nature along with their experience of operation
6. A survey of the possibility of application, yield and quality of various type of water sources
7. Evaluation of the existing facilities to decide the scope and time for the facilities for which improvement or replacement is required.
8. Evaluation of the influence to the environment to prevent the pollution and the protection of the environment

Box 1-4: Key issues for setting out framework of a master plan

When preparing a master plan, the basic parameters shall be clarified in accordance with the following items:

1. Design year: The design year is the objective time period for the master plan, so the point of time is 10 to 20 years ahead of the time of preparing the plan.
2. Design service area:

It is an area where distribution mains are laid, and water is served by the design year. The design service area is determined based on a wide area point of view.

3. Design population served:

It is determined based on the estimation of population in the administrative area.

4. Design water service volume:

It is as principle determined based on the water demand by water use category. As for the bulk water supply utility, the design bulk water flow shall be determined based on the demand estimate from the recipient utilities as a whole, or the total of the design water service volumes of the recipient utilities.

Box 1-5: Determination of project components for a master plan

For the decision on the project components, the scope, work schedule, rough cost estimate etc. of the project shall clearly be identified taking into account the integration of facilities as a whole.

Box 1-6: Quality of chemicals used for treatment

Chemicals added into finished water and/or water being treated shall meet the criteria as presented under Appendix-1.

Box 1-7: Quality of material for water supply facilities

The material used for water supply facilities shall provide safety to the human body and natural environment. Leachate test for the material that are in contact with water should demonstrate the compliance with the standard for leaching test. Guideline values presented under Appendix-2 may be

considered as a reference.

(WATER INTAKE FACILITIES)

2 Water intake facilities:

2.1 Water intake facilities shall fulfill the following requirements:

2.1.1 Types and location of intake shall be designed considering utilization of optimal available raw water quality.

2.1.2 Equipment which can suspend the intake of water, in case of disasters or other emergencies or during inspection of facilities shall be furnished.

2.1.3 Besides '2.1.2' above, facilities shall be able to intake necessary amount of raw water having maximum good quality as possible.

2.2 Water intake facilities for surface water shall fulfill the following requirements:

2.2.1 Locations and types of the facilities shall be designed to lower the risks of water intake issues encountered due to flood, scour, driftwood, sediment, etc., taking topography and geology into account.

2.2.2 In case of furnishing weir, sluice, etc., the structures shall be safe against the impact of running water by flood.

2.2.3 Screens shall be furnished at intake points as necessary.

2.2.4 Equipment necessary to remove sand out of raw water shall be furnished as necessary.

2.3 Water intake facilities for groundwater shall fulfill the following requirements:

2.3.1 Locations and types of the facilities shall be designed to prevent water from being polluted

2.3.2 Catchment burials shall possess structures to lower risks of blockage.

2.3.3 When determining locations of catchment burials, aquifer should be located nearby.

2.3.4 Depth from surface of riverbed to catchment burials should be such so as to prevent the catchment burials from exposure or spill away.

2.3.5 Facilities shall possess enough capacities to intake maximum amount of water per day at any time.

2.4 In order to determine the capacity referred under 2.3.5 above, result of permeability tests shall be referred for infiltration galleries, and result of pumping tests shall be referred for wells.

Box 2-1: Determination of intake volume

The design volume of water intake shall, as standard practice, be set at the design daily maximum water service volume as well as volume needed for O&M.

Box 2-2: Water Permission and monitoring

After the design volume is calculated, water permission is required to be obtained from the concerned regulatory authority. In addition, the volume of water intake must be measured and should not exceed the permitted amount. Abstraction records must be submitted to the concerned regulatory authority

Box 2-3: Selection of intake method

As for the water intake facilities, taking into consideration the situation of the intake point, the volume of intake etc., the most suitable type of facilities shall be selected from the intake weir, intake tower, intake gate, intake pipe or conduit, intake crib, infiltration gallery, shallow well, and deep well.

Box 2-4: Improvement and replacement of raw water intake facilities

Improvement and replacement of raw water intake facilities shall be undertaken in accordance with the following:

1. The intake facilities of surface water are required to maintain their function for a long time. Hence, their inspection and maintenance shall properly be carried out, and their improvement and replacement shall be undertaken systematically.
2. The groundwater intake facilities sustain a decline in yield due to clogging of screens and so forth; and drawdown in water level or deterioration in water quality is brought about because of change in the surroundings etc. As such, the condition of the facilities shall be monitored by installing measurement apparatus, and, in addition, systematic improvement and replacement of the facilities shall be implemented.
3. At the time of improvement and replacement of the water intake facilities, consideration shall be practiced to provide proper capability of resistance to ground displacement.

Box 2-5: Key aspects to be surveyed for surface water intake

A survey shall be undertaken on the proposed location of water intake and its surroundings on the following matters:

1. Status of the river such as flow and water level etc.
2. Master plan for development of the river basin
3. Water use situation
4. Geography and geology of the region

5. Water quality etc.
6. Influence to the environment

Box 2-6: Selection of intake location for surface water

The location of water intake shall be selected according to the following:

1. To be able to reliably abstract the design raw water intake volume
2. Good quality of water can be obtained for the future as well as present.
3. Structural safety can be secured.
4. Not too close to the facilities for management of the river, and other work pieces.
5. Not to be affected by the implementation of the river improvement plan.
6. Reduction in environmental burden shall be taken into account.

Box 2-7: Key aspects to be surveyed for groundwater intake

For the intake of the groundwater, a survey shall be conducted on the following items as a general rule:

1. Preliminary survey
2. Hydrological and geological survey
3. The water quality survey
4. Groundwater development potential

Box 2-8: Selection of intake location for groundwater

The location of water intake shall be in conformity with the following:

1. It does not affect the existing wells or infiltration galleries.
2. It is not affected by seepage in the ground due to pollution in the vicinity.

Box 2-9: Decision of the aquifer for water intake

The aquifer for water intake shall be selected based on the following data to be obtained during drilling of the test well:

1. Soil samples taken every time the stratum changes.
2. Existence of quantitative and qualitative changes in the slurry, a gush of water, water loss etc. during boring.
3. The result of the geophysical survey such as electrical logging and gamma logging.

Box 2-10: Determination of production (yield volume)

The decision of water production shall be in conformity with the following:

1. The proper pump discharge, in case the design water intake volume is obtained by a single well, shall

be judged by a pumping test.

2. In case the design water intake volume is obtained by more than one well (including existing wells), the decision of the design water intake volume shall be made as follows:
   1) The number of the wells shall be determined in consideration of the mutual influential areas of the wells.
   2) The pump discharge shall be a safe value, with which the water level does not continuously draw down at the test well as well as the other wells in the neighborhood.

(WATER STORAGE FACILITIES)

3 Water storage facilities

3.1 Water storage facilities shall fulfill the following requirements:

3.1.1 Locations and types shall be designed in consideration of safety and economic efficiency, depending on water storage capacities, topography and geology of the region.

3.1.2 Facilities shall possess the structures that are robust and resilient to natural disaster and waves caused by strong winds.

3.1.3 Spillways and other equipment necessary to deal with floods shall be furnished.

3.1.4 Installation of aeration equipment and other necessary measures shall be taken, if necessary, to prevent deterioration of water quality.

3.1.5 Necessary measures shall be taken to prevent water leakages.

3.1.6 Facilities shall be designed to prevent discharged water from giving adverse effects on the water storage facilities and its vicinity.

3.1.7 Besides above, facilities shall possess necessary capacities to provide raw water with the requisite amounts even during drought events.

3.2 Water storage capacities referred in 3.1.1 above shall be designed based on precipitation, river flow, demand and other necessary parameters.

3.3 Dams shall fulfill the following requirements:

3.3.1 Concrete dams shall possess structures which will not slide or fall due to any anticipated loads.

3.3.2 Rockfill dams shall possess structures which will not slide by any anticipated loads or collapse due to seepage failure.

3.3.3 Foundation grounds of dams (including areas in contact with embankments; the same shall apply hereinafter) shall possess water tightness, and should be designed to prevent slip failure or toppling failure due to any anticipated loads.

3.3.4 Loads on embankments and foundation grounds of dams shall be designed based on the type of dams and water level of reservoirs as presented under Table 3 in the appendix.

Box 3-1: Selection of type of water storage facilities

For selection of the type of water storage facilities, the design water intake volume, future water

quality, location of construction, structural stability, economic benefits, influence to the environment etc. need to be examined.

Box 3-2: Improvement and replacement of water storage facilities

Improvement and replacement of water storage facilities shall systematically be carried out in accordance with the following:

1. Proper measures for the inflow of earth and sand shall be made considering the surroundings of the impounding reservoir, geology, economic benefits etc.
2. Required repair, strengthening etc. of such structure such as a dam etc. shall be undertaken after examining the observation data and the structural materials. At the same time, measures such as the prevention of water leakage and conformity with the standards required under the structural ordinance for river management facilities shall be considered.
3. For ancillary equipment, improvement and replacement work shall be carried out not to impair its operability and reliability based on its day-to-day inspection and upkeep.

Box 3-3: Key aspects to be surveyed for water storage facilities (e.g., exclusive dam for water supply)

When planning exclusive water storage facilities, a survey shall be conducted on the respective matters for the following:

1. Hydrology
2. Topography and geology
3. Situation of water use
4. Water quality
5. Sand deposit
6. Compensation etc.
7. Influence to the environment
8. Others

Box 3-4: Determination of required capacity of water storage

The required capacity of water storage shall be determined according to the following:

1. It shall be determined based on the computation of water balance in the design standard year.
2. During water balance computation, it shall be clarified that the design water intake volume can reliably be abstracted, and that the normal river flow shall not be interrupted.

Box 3-5: Key aspects to consider structure of dams

1. The type of the dam shall be determined based on the examination of the topography of the dam site, geology, spillway, and materials of the dam body.

2. As for foundation ground, the geological property of the dam site, characteristics such as the thickness, dip, permeable faults, crevices etc. of the strata, which support the dam body, shall be examined.
3. The spillway of the dam shall be of the scale, type and layout in order to dispose flood, and can assure the safety of the facilities.
4. Since the discharge facilities for releasing water for water supply, the maintenance of river flow etc. are operated under high water pressure, their structure shall possess good compatibility with the dam body, and not adversely affect the downstream section of the river.
5. The structure of the dam should have the required water-tightness and durability in consideration of the property of the type of the dam, foundation ground, spillway etc., and, at the same time, shall be safe against the expected loads.

Box 3-6: Considerations for protection of water quality of dams

In case occurrences of troubles are expected due to water pollution in the reservoir, measures for protection of water quality shall be undertaken.

Box 3-7: Considerations when abstracting water from multi-purpose dam

In case of securing water source through participation in a project of multi-purpose storage facilities (multi-purpose dam etc.), the following matters shall be taken into consideration.

1. The components of the project shall be identified in each stage of survey, construction and completion, and the water utility shall take the required steps so that the mission of the utility can be fully achieved while making coordination with the executing body of the dam project and other concerned offices.
2. In case more than two entities participate as water users in the project, joint use of water intake and transmission facilities shall be examined.
3. The allocation of the developed yield of water shall be made based on the thorough (comprehensive) adjustment (review) of respective project plans of the participants so that the effects of their purposes can be realized as a whole.
4. Coordination shall be made between the water utility, the executing body of the project and other concerned offices for specific items of management so that the prerequisite purposes of the water supply utility are achieved and that smooth operation can be made.
5. To aim at the effective use of the limited water resources, the securement of water sources by means of transfer of water use purposes etc. shall be examined.

(RAW WATER TRANSMISSION FACILITIES)

4 Raw water transmission facilities

Raw water transmission facilities shall fulfill the following requirements:

4.1 Locations and methods shall be designed in consideration of stability and economic efficiency, according to the elevation of water supply facilities nearby, the amount of water supply, topography, and geology.

4.2 Raw water retention reservoir shall be furnished, as necessary, to be able to stably provide necessary amount of raw water with stable quality.

4.3 Spillways, joint wells, drainages, water control valves, water control doors, air valves, and expansion joints shall be furnished according to topography and geology.

4.4 Necessary measures shall be taken to reduce water hammer effects as required in case of furnishing pumps.

4.5 Raw water pumps shall fulfill the following requirements:

4.5.1 Pumps shall have enough capacities, numbers and structures to provide clean water with the necessary raw water amount steadily and sufficiently.

4.5.2 Spare equipment shall be furnished. Note, however, that this shall not apply if the suspension of pumps does not impede the stable water supply.

4.6 Besides above, necessary equipment to provide the desired amount of clean water shall be furnished.

Box 4-1: Determination of design flow of raw water transmission

The design flow of raw water transmission facilities shall be based on the design flow of raw water intake.

Box 4-2: Determination of raw water transmission method

The type of raw water transmission shall be determined in consideration of the difference in elevation between the raw water intake facilities and the water treatment facilities, the design flow of raw water transmission, geographical condition of the transmission route, construction cost, the cost of operation and maintenance etc.

Box 4-3: Determination of raw water transmission route

The selection of the route of raw water transmission shall be in conformity with the following:

1. The route shall be determined based on due consideration from the various aspects including economic benefits such as construction cost, resiliency (resistivity) to external forces including ground displacement, convenience of construction and O&M works after their comparative studies based on several alternative routes.
2. The land to be used for laying raw water transmission mains shall principally be a public road or the property owned by the water utility.
3. The route of raw water transmission mains shall basically be positioned lower than the minimum hydraulic gradient.

Box 4-4: Determination of pipe material (in case of transmission by pipe)

Pipe material of distribution mains shall basically be in conformity with the following:

1. Pipe material, with which no risk of water contamination is brought about
2. It is safe against inside pressure and external forces.
3. It conforms to the burial condition.
4. It possesses good property of laying which conforms to the environment of burial.

Box 4-5: Determination of pipe diameter (in case of transmission by pipe)

The diameter of the raw water transmission main shall be determined as follows:

1. The diameter of the raw water transmission main shall be computed based on the low water level at the commencement of the raw water transmission main; and the design water level as its terminal level.
2. In the case of raw water transmission by pumping, the pipe diameter shall be determined in consideration of the correlation between the pipe diameter and the annual cost.

Box 4-6: Flow velocity (in case of transmission by pipe)

The flow velocity to be used for the design of a raw water transmission main shall be determined as follows:

1. In the case of the gravity flow type, the maximum flow velocity shall be 3.0 m/s or so.
2. In the case of the pumping type, the flow velocity shall be the most economic velocity.

Box 4-7: Location and depth of pipe (in case of transmission by pipe)

Refer to Box 7-20

Box 4-8: Pipe laying under unstable soil condition (in case of transmission by pipe)

1. Slope protection measures shall be undertaken for the slope shoulder, edge and surface of mountain

ridge; and the drainage of surface water, seepage water and groundwater shall be considered so as to prevent the erosion and collapse of the slope.

2. In case pipe laying is carried out in sloping ground such as a steeply inclined road or slope, concrete blocks or a shielding wall shall be provided to prevent the moving of the pipe and soil erosion.
3. In case pipe laying is undertaken where the topography or the nature of soil abruptly changes, in embankment or in soft ground, pipe material and joint, with which uneven sinking of soil can be dealt with, shall be selected. In addition, measures for the improvement of soil to restrain the subsidence of pipe shall be implemented if required.
4. Appropriate pipe materials and joints shall be selected in the soil, in which liquefaction can be expected, and, what is more, improvement of soil shall be undertaken.

Box 4-9: Surge (water hammer) protection (in case of transmission by pipe)

The following points shall be considered regarding water hummer occurring in a pumping facility:

1. Occurrence of water hummer at the time of abrupt stoppage of a pump shall be examined.
2. Countermeasures shall be provided against water hummer if there is a risk of its occurrence.

Box 4-10: Foundation of pipe (in case of transmission by pipe)

Refer to Box 7-21

Box 4-11: Protection of special fittings (in case of transmission by pipe)

Refer to Box 7-22

Box 4-12: Protection against corrosion of pipe body (in case of transmission by pipe)

Refer to Box 7-23

Box 4-13: Determination of type and structure (in case of transmission by conduit)

The type and structure of the raw water transmission channel shall be in conformity with the following:

1. The raw water transmission channel shall be structurally safe, and possess sufficient water-tightness, resistance to external force such as due to ground displacement, and durability.
2. The raw water transmission channel may be a culvert depending on the needs. In case it is unavoidably shaped as an open channel due to the requirement of a large cross section or the like, measures for the prevention of pollution and safety shall be undertaken.
3. Expansion joints shall be installed at every 20 m to 30 m or so along the open channel and culvert.
4. At points where ground formation changes, and at both ends of a water main bridge, weir, gate etc. expansion joints with flexibility shall be provided.
5. Ventilation holes shall be provided for the culvert.

Box 4-14: Flow velocity (in case of transmission by conduit)

The maximum allowable average flow velocity in the raw water transmission channel shall be 3.0 m/s or so and its minimum limit shall be 0.3 m/s or so.

Box 4-15: Storage facilities for raw water (e.g., regulating pond/reservoir)

When building a raw water regulating reservoir, the following points shall be taken into account:

1. The raw water regulating reservoir shall be installed in-between the water intake facilities and the water treatment facilities.
2. Its capacity shall be appropriate in consideration of draughts, accidents related to water quality etc.
3. Ancillary facilities such as pumps etc. shall be installed if required.
4. Measures against water pollution and prevention of hazards shall be undertaken if required.

Reservoir should have at least two units for O&M convenience (to be prepared in case of suspension during cleaning and/or repair work)

(WATER TREATMENT FACILITIES)

5 Water treatment facilities

5.1 Water treatment facilities shall fulfill the following requirements:

5.1.1 In case surface water or groundwater is the raw water, the facilities shall be able to provide clean water with sufficient quality through disinfection, slow sand filtration, rapid sand filtration, membrane filtration, powdered activated carbon treatment, granular activated carbon treatment, ozone treatment, biological treatment or other necessary treatment facilities in response to the variations of quantity and quality of the raw water.

5.1.2 Facilities shall fulfill following requirements in case of using raw water with high level of salinity.

5.1.2.1 Necessary measures shall be taken for release of concentrated water which will be generated when desalinating water with high salinity level and other anticipated adverse effects to the environment.

5.1.2.2 In case of using reverse osmosis or electro dialysis, equipment for pre-treatment to provide clean water with sufficient quality shall be furnished

5.1.3 Facilities shall be designed so that each water treatment process can fully exhibit the respective functions and installation and maintenance can be done efficiently.

5.1.4 Equipment for measuring turbidity, hydrogen ion concentration index and other water quality, water level and water volume shall be furnished.

5.1.5 The disinfection equipment shall fulfill the following requirements:

5.1.5.1 Structure including dimensions of a disinfectant facility shall be so designed as to enjoy sufficient contact time with disinfectant to ensure effect of disinfection.

5.1.5.2 Equipment for adjusting the supply amount of disinfectant shall be furnished.

5.1.5.3 Stand-by disinfectant injection equipment shall be furnished.

5.1.5.4 Necessary measures shall be taken to supply disinfectant constantly and stably.

5.1.5.5 In the case where liquefied chlorine is used, necessary measures shall be taken to neutralize the liquefied chlorine whenever it leaks

5.1.6 In the case where water supply is likely to be impeded by remodeling, renewal or inspection of facilities, necessary spare facilities or equipment shall be furnished

5.1.7 Treated water storage equipment shall be furnished to send treated water stably and efficiently in response to the water supply fluctuations.

5.1.8 In the case where chlorine-resistant pathogenic organisms are likely to be mixed into raw water, filtration or other equipment that can remove these shall be furnished.

5.1.9 In the case where filtration pond or filtration membrane (hereinafter referred to as "filtration equipment") is established, spare equipment shall be furnished; Note, however, that this shall not apply if the suspension of filtration equipment doesn't impede the stable water supply.

5.1.10 In the case where the drainage from filtration facilities, wastewater from sedimentation basins, and other wastewater generated in the treatment process (hereinafter referred to as "treatment process wastewater") is discharged into public water bodies, necessary equipment shall be furnished so that the wastewater causes minimal disruption to the living environment.

5.1.11 In the case where a filtration pond is established, installation of the cover or other necessary measures shall be taken as necessary to prevent the water contamination.

5.1.12 In the case where treatment process wastewater is used as raw water, necessary measures shall be taken not to impede the treated water or water treatment process.

5.1.13 Facility shall be designed not to be corroded significantly by the quality of treated water.

5.1.14 Besides above, necessary equipment shall be furnished for producing the desired amount of treated water that meets the water quality standards.

5.2 Water treatment facilities that involve slow sand filtration process shall satisfy the following requirements;

5.2.1 Filtration ponds shall have a structure that can effectively remove suspended solids.

5.2.2 Filter sand shall have a particle size distribution that can effectively remove suspended solids in the raw water.

5.2.3 Facilities shall possess the structures that enable water to contact the filter sand during the necessary time in order to obtain the required quality according to the quality of raw water.

5.2.4 In addition to filtration pond, clarifier and other necessary facilities shall be furnished according to the quality of raw water.

5.2.5 In the case where a sedimentation basin is established, facilities shall possess the structures that can effectively precipitate suspended solids and easily discharge the sediment.

5.3 Water treatment facilities that involve rapid sand filtration process shall satisfy the following requirements:

5.3.1 In addition to chemical injection facilities, coagulation/flocculation basins, sedimentation basins and filtration basins, necessary equipment to obtain required water quality according to the quality of raw water shall be furnished.

5.3.2 The coagulation/flocculation basin shall have a structure in which good flocs are formed by appropriately mixing the coagulant with the raw water.

5.3.3 The sedimentation basin shall have a structure that can effectively precipitate the suspended solids and easily discharge the sediment.

5.3.4 The filtration basin shall have a structure that can effectively remove suspended solids.

5.3.5 Facilities shall have the structure that can effectively remove suspended solids adhering to the filter medium and discharge the removed suspended solids by washing the filter materials.

5.3.6 The filter medium shall have a particle size distribution that can effectively remove suspended solids in the raw water.

5.3.7 The filtration rate shall be set according to the water quality after flocculation and precipitation treatment, the filter medium and the thickness of the filter bed in order to stably produce the filtered water with the required quality.

5.4 Water treatment facilities that involve membrane filtration process shall fulfill the following requirements:

5.4.1 The membrane filtration equipment shall have a structure that can stably filtrate on the entire surface area of the membrane.

5.4.2 Facilities shall have the structure that can effectively remove suspended solids adhering to the membrane module and its effluent discharge.

5.4.3 Facilities shall furnish the equipment that monitors the difference in water pressure on both sides of the membrane, the amount of membrane filtered water and the turbidity of membrane filtered water, and can promptly stop the operation of the related water treatment facility in case of unusual conditions.

5.4.4 The membrane modules shall not be easily damaged or deformed, and have the necessary water permeability and pressure resistance.

5.4.5 The membrane module shall have a structure that can effectively remove suspended solids in

the raw water.

5.4.6 The filtration rate shall be set according to the quality of raw water, minimum water temperature, membrane type and pretreatment to stably produce the filtered water with the required water quality.

5.4.7 In addition to membrane filtration facility, pretreatment facility and other necessary facility shall be furnished according to the quality of the raw water.

5.4.8 Pretreatment facility shall have the structure that enables to provide water of the required quality according to the structure, material and performance of the membrane module.

5.5 Water treatment facilities that involve powdered activated carbon treatment process shall fulfill the following requirements.

5.5.1 The powdered activated carbon injection equipment shall be installed at a position where water contacts the powdered activated carbon during the necessary time to obtain the appropriate effect.

5.5.2 Powdered activated carbon shall have the necessary characteristics to obtain the required water quality.

5.5.3 Necessary measures shall be taken to prevent the leakage of powdered activated carbon into the purified water after the powdered activated carbon treatment.

5.6 Water treatment facilities that involve granular activated carbon process shall satisfy the following requirements.

5.6.1 Facilities shall have the structure to enable water to contact with the granular activated carbon during the necessary time for obtaining the required water quality.

5.6.2 Facilities shall have the structure that can effectively remove suspended solids adhering to the granular activated carbon and discharge the removed suspended solids by washing the granular activated carbon.

5.6.3 The granular activated carbon shall have the necessary characteristics to obtain the required water quality.

5.6.4 Necessary measures shall be taken to prevent the leakage of granular activated carbon, its fine powder and microorganisms in the granular activated carbon layer into the treated water.

5.6.5 In the case where water is treated with microorganisms in the granular activated carbon layer, necessary measures shall be taken to maintain an appropriate habitat according to the

characteristics of the microorganism in the granular activated carbon layer.

5.7 Water treatment facilities that involve ozone treatment shall fulfill the following requirements:

5.7.1 The ozone contact chamber shall have a structure in which ozone and water are mixed efficiently.

5.7.2 The ozone contact chamber shall have a structure where water contacts with ozone during the necessary time in order to obtain the required water quality.

5.7.3 A granular activated carbon treatment facility is installed followed by the ozone treatment facility.

5.7.4 The necessary measures shall be taken to detect or prevent leakage of ozone.

5.8 Water treatment facilities using biological treatment shall fulfil the following requirements:

5.8.1 The contact chamber shall have a proper structure to ensure that the water is fully in contact with microorganisms, and shall have the necessary time to ensure stable biological treatment. Necessary measures shall be taken to maintain an appropriate habitat according to the characteristics of the relevant microorganisms.

5.8.2 Necessary measures shall be taken to prevent leakage of microorganisms in the contact tank from leaking into the purified water after the contact chamber.

Box 5-1: Research

For research for planning of water treatment facilities, the following items of aspects shall be included:

1. In the case of new construction or expansion:
   1) Research for planning of the site of water treatment facilities
   2) Research for planning of water treatment facilities
   3) Research for planning of facility construction
2. In the case of improvement and replacement:
   1) Research for planning of improvement and replacement
   2) Research for the implementation of improvement and replacement.

Box 5-2: Design water treatment flow and the capacity of the plant

The design water treatment flow and the capacity of the water treatment facilities are to be set as follows:

1. The design water treatment flow is set based on the total of the design maximum daily demand and the consumption for process water in the plant.

2. The water treatment facilities shall be able to properly process the design water treatment flow. It is desirable for the facilities to have spare capacity to strengthen the safety of the water supply system during the event of a disaster, accident etc. even at the time of improvement and replacement.

Box 5-3: Selection of water treatment methods and water treatment facilities

The selection of water treatment method and water treatment facilities shall be carried out in accordance with the following:

The water treatment method shall be capable of reliably producing tap water in conformity with the Rwandan drinking water quality standards; it shall be selected from the methods of disinfection only, slow sand filtration, rapid sand filtration, membrane filtration or advanced water treatment method (if required), in accordance with raw water quality and the management goals for treated water quality etc.. Thereafter, the method shall be chosen taking into account the size of the water treatment plant, the technical level of operation, control and maintenance etc.

The general steps needed for the selection of water treatment methods are presented below and illustrated in Figure 5-1

1. Apply disinfection by chlorine;
2. Determine the management goals for treated water quality, based on the results of water quality analysis;
3. Classify the substances in water into dissolved and suspended matters, and determine their management goals for treated water quality control;
4. Find suitable combination of methods effective for the treatment of the objective substances. It is needed to make the water treatment flow balanced and efficient with unit treatment processes each sharing rational proportion of the load.

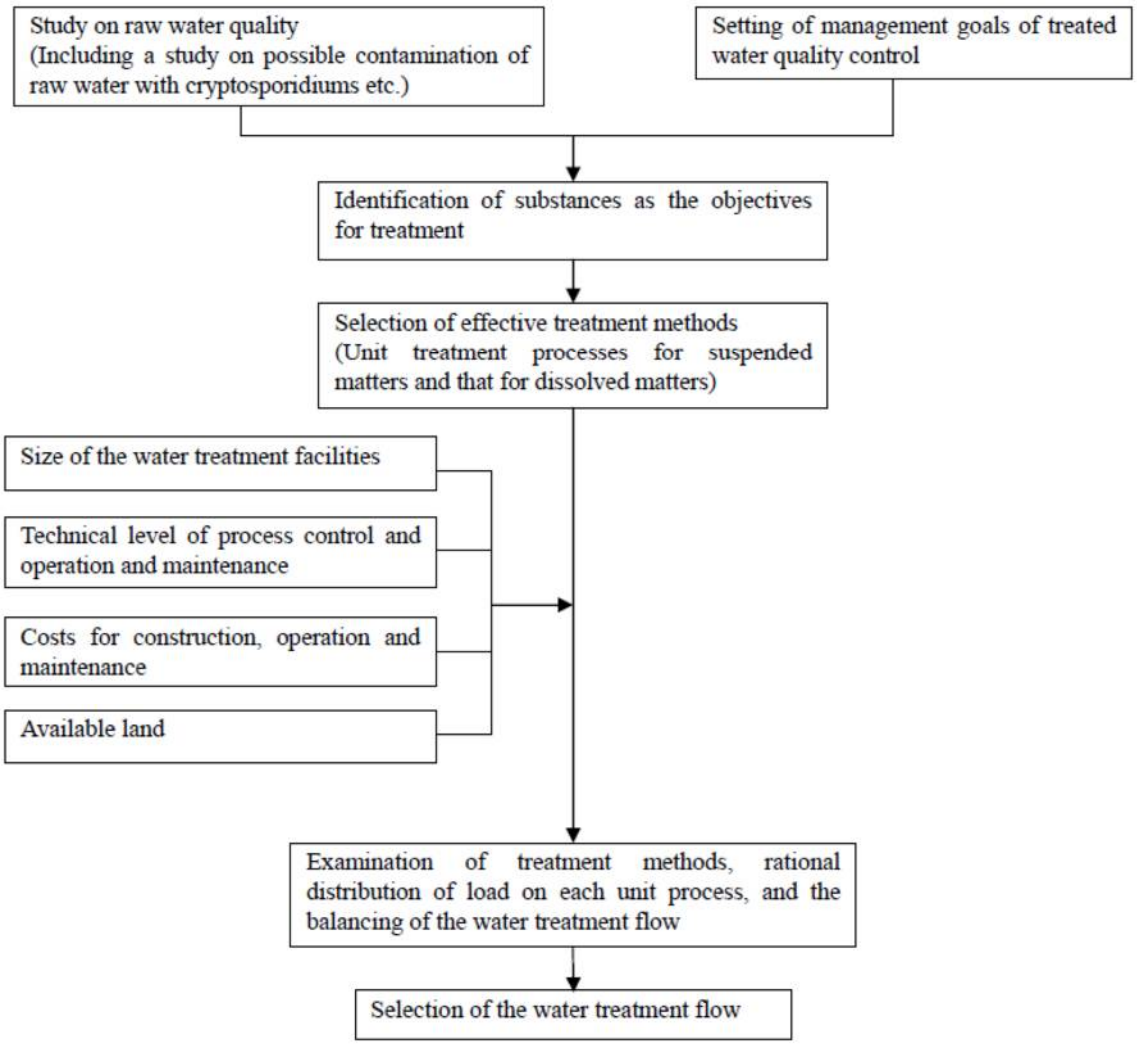


Figure 5-1 General procedures of selecting water treatment method

Box 5-4: Wastewater treatment

The following aspects shall be considered for planning wastewater treatment facilities:

1. The wastewater treatment facility shall possess sufficient functions and capacity to treat and dispose of wastewater generated from the water treatment facilities.
2. A proper method of wastewater treatment shall be selected considering the relationship with the water treatment facilities, raw water quality, quality and volume of wastewater, characteristics of sludge, the method of the reuse or disposal of dewatered cake, operation and maintenance, site area, construction cost, the environment of the surroundings etc.

Box 5-5: Layout plan of water treatment facilities

The following aspects shall be considered for laying out water treatment facilities:

1. Water treatment facilities shall be so laid out that each water treatment process can fully work;

that harmonization and efficiency of all the facilities are made; and that operation and maintenance, expansion, improvement, or replacement of facilities can be easily achieved.

2. The facilities shall be divided into more than two series according to their size as much as possible.
3. The water levels at each facility shall be determined based on the required water head losses by means of hydraulic analyses and experiments.
4. The garbage collection site, cesspits etc. must be built and located so as not to cause pollution.

Box 5-6: Water quality control

As for water quality control in water treatment facilities, the following aspects shall be taken into account:

1. To control the quality of finished water in order to meet the prerequisite goals of water quality control, a necessary water testing laboratory shall be provided at the water treatment plant. In case water testing is undertaken as required by the Rwanda Standard (RS 546), the laboratory shall be set in a favorable testing environment and be capable of equipping necessary analytical instruments.
2. Water quality shall be studied considering the effects of chemicals dosed in the water treatment processes and the apparatus and materials which will come in contact with water.

Box 5-7: Improvement and replacement of facilities

The following aspects shall be considered for improvement and replacement of facilities:

1. An evaluation and assessment of facilities must be performed beforehand for improvement and replacement of facilities. The new or replaced facility shall be able to perform with its full capacity without affecting the capacity, reliability, and consistency of the operation of the existing ones.
2. To supplement the reduction in the capacity of the system in operation during the improvement or replacement work, relief measures shall be provided so that the effect of the work to the existing facilities shall be minimized.

Box 5-8: Safety measures

The water treatment facilities must be provided with certain safety measures against natural disasters, accidents of machinery and apparatus, water quality accident, human casualties, and so forth.

(TREATED WATER TRANSMISSION FACILITIES)

6 Treated water transmission facilities

Treated water transmission facilities shall fulfill the following requirements:

6.1 Locations and methods shall be designed in consideration of stability and economic efficiency, according to the elevation of water supply facilities nearby, the amount of water supply, topography, and geology.

6.2 Joint wells, drainages, water control valves, air valves, and expansion joints shall be furnished according to topography and terrain.

6.3 Necessary measures shall be taken to prevent negative pressures in water pipes.

6.4 Necessary measures shall be taken to reduce water hammer effects as necessary in case of furnishing pumps.

6.5 Pumps shall fulfill the following requirements:

6.5.1 Pumps shall have enough capacities, numbers and structures to provide clean water with the necessary amount in a steady and sufficient manner.

6.5.2 Spare facilities shall be furnished. Note, however, that this shall not apply if the suspension of pumps does not impede stable water supply.

6.6 Besides above, facilities shall possess necessary equipment to provide clean water with the desired amount.

Box 6-1: Determination of design flow of treated water transmission

As a general rule, the design treated water transmission flow shall be based on the design maximum daily supply.

Box 6-2: Determination of treated water transmission method

The most desirable type of treated water transmission shall be chosen after comparison of the difference between the elevations of water treatment plant and the service reservoir, the design treated water transmission flow and the geographical situation of the route of the transmission main.

Box 6-3: Determination of treated water transmission route

Refer to Box 4-3.

Box 6-4: Determination of pipe material

Refer to Box 4-4

Box 6-5: Determination of pipe diameter

Refer to Box 4-5

Box 6-6: Flow velocity

Refer to Box 4-6

Box 6-7: Location and depth of pipe

Refer to Box 7-20

Box 6-8: Pipe laying under unstable soil condition

Refer to Box 4-8

Box 6-9: Surge (water hammer) protection

Refer to Box 4-9

Box 6-10: Foundation of pipe

Refer to Box 7-21

Box 6-11: Protection of special fittings

Refer to Box 7-22

Box 6-12: Protection against corrosion of pipe body

Refer to Box 7-23

(WATER DISTRIBUTION FACILITIES)

7 Water distribution facilities

Water distribution facilities shall fulfill the following requirements:

7.1 Water distribution zones shall be divided into appropriate areas as necessary, to enable reasonable and economical operation and maintenance of the facilities, taking into consideration natural conditions including topography and terrain as well as the social condition including the land use of the concerned areas.

7.2 Facilities shall be furnished efficiently according to the natural conditions including topography and terrain of distribution zones.

7.3 Water distribution system shall be developed taking into consideration of upstream facilities, elevation of water distribution areas, the amount of distribution, topography and others are taken into consideration.

7.4 Reservoirs furnished with required equipment shall be installed in order to distribute water continuously controlling fluctuation of distribution volume to each area. And Pipes with appropriate diameter shall be laid.

7.5 Drainage equipment, water control valves, pressure reducing valves, air valves or expansion joints shall be furnished according to topography, terrain and water supply conditions.

7.6 Necessary measures shall be taken to sample clean water in water distribution facilities.

7.7 Necessary measures shall be taken to minimize the impact on water supply such as water outage in case of disasters or other emergencies.

7.8 Minimum hydraulic pressure of water distribution pipes at the point where water distribution pipes divide into water service connections shall be kept at adequate level which does not impede stable water supply.

7.9 Positive pressure shall be maintained at inside of the water distribution pipes, regardless of the above, in case of using fire hydrants.

7.10 Maximum hydrostatic pressure of water distribution pipes shall be kept at a certain level to be set considering the site condition and pipe material.

7.11 Reservoirs shall fulfill the following requirements:

7.11.1 Reservoirs shall be located near water distribution zones, and where safety is taken into

consideration according to topography and geology.

7.11.2 Reservoirs shall possess enough capacities to adjust fluctuations in demand, and on which stabilities of water supply are taken into consideration in case of disasters or other emergencies as necessary.

7.12 Distribution pipes shall fulfill the following requirements:

7.12.1 Necessary measures shall be taken to prevent negative pressures in pipes.

7.12.2 In case of laying distribution pipes, appropriate type of pipes and expansion joints shall be used according to the site conditions

7.12.3 Necessary measures shall be taken to prevent corrosion as necessary.

7.13 In case of furnishing pumps, necessary measures shall be taken to reduce water hammer effects.

7.14 Pumps shall fulfill the following requirements:

7.14.1 Pumps shall have enough capacities, numbers and structures to provide clean water with necessary amount in a steady and sufficient manner, according to possible demand fluctuation and conditions of use.

7.14.2 Stand-by pump unit shall be furnished. Note, however, that this shall not apply if the suspension of pumps does not impede the stable water supply.

7.15 Besides above, necessary equipment shall be furnished to provide clean water with the desired amount continuously and at pressure above certain levels.

Box 7-1: Setting out of distribution areas

The distribution area shall be set in consideration of such natural conditions as topography and geography and social requirements so that rational and economic operation and maintenance of the facilities can be carried out.

Box 7-2: Determination of design distribution flow

The design distribution flow, as the general rule, shall be the design maximum hourly distribution flow in the service area in question.

Box 7-3: Hourly peak setting

The coefficient for hourly peak as the base of the design maximum hourly distribution flow is determined with reference to the experiences or the condition in the region under similar characteristics.

Box 7-4: Layout of distribution facilities

The layout of distribution facilities shall be in conformity with the following:

1. The layout shall be suitable for the topography and geography of the service area.
2. Distribution mains shall be laid out so that they form a reticulation.
3. The layout shall bring about rational and economical operation of the facilities.
4. Operation and maintenance shall be easily conducted and maintenance cost shall be economical.

Box 7-5: Determination of distribution method

The type of water distribution shall be determined in consideration of elevations of water supply facilities situated upstream of the present facilities and the service area, the volume of water distribution, characteristics of the service area etc.

Box 7-6: Consideration in renovation and replacement

Renovation and replacement of distribution facilities shall be undertaken on the designed schedule in consideration of available technologies and funds after precisely evaluating and judging the functions and capacity of the existing facilities.

Box 7-7: Determination of structure and type of reservoirs

Function, outlook, the ease of construction, economic benefits etc. shall integrally be evaluated when selecting the structure and type of the service reservoir.

Box 7-8: Determination of capacity of reservoirs

The capacity of the service reservoir shall be in conformity with the following:

1. The standard capacity of the service reservoir shall be 8 hours equivalent of the maximum daily supply of the service area; and it is desirable to be 12 hours of daily maximum demand.
2. The firefighting water has to be added to the above capacity as necessary.

Box 7-9: Effective depth of reservoirs

The recommended effective depth of the service reservoir shall be 3 m to 6 m.

Box 7-10: Inlet pipe, outlet pipe and bypass pipe

The inlet, outlet and bypass pipes of the service reservoir shall be in conformity with the following:

1. The installation of the inlet and outlet pipes shall be in conformity with 5.9.5 Inlet pipe, outlet pipe and bypass pipe.
2. At the inlet end of the service reservoir, an inlet weir shall be provided; the water shall freely fall from the inlet pipe; or a non-return valve shall be installed on the inlet pipe. An emergency isolation valve shall be provided on the outlet pipe as required.
3. In case the flow in the inlet and outlet pipes are to be regulated, flow control valves shall be installed on them.
4. The bypass pipe should always be provided and an isolation valve shall be furnished on it.

Box 7-11: Structure of elevated tanks

The structure of the standpipe and the elevated reservoir shall be in conformity with the following:

1. The structure shall secure hygienic safety, sufficient durability and water-tightness.
2. Structural safety against wind force when it is empty and external force due to ground displacement when it is full shall be secured.
3. A proper heating and insulation device shall be provided in a cold district if needed.
4. The freeboard shall be determined based on a hydraulic analysis.

Box 7-12: Capacity of elevated tanks

Refer to Box 7-8

Box 7-13: Water depth of elevated tanks

The water depth of the standpipe and the elevated reservoir shall be in conformity with the following:

1. The total depth of the standpipe shall be determined after considering its structure, construction and economic benefits into account.
2. The effective depth shall be determined in consideration of condition for installation, the characteristics of the distribution networks, the required water pressure and so forth.

Box 7-14: Foundation and supporting pillars of elevated tanks

The foundation and supporting pillars of the standpipe and the elevated reservoir shall be in conformity with the following:

1. The foundation shall be placed in good and sound ground, which has the required bearing force, and possesses sufficient stability.
2. In case they are required to be placed in an unfavorable location such as loose soil etc., an appropriate measure like foundation construction method or a soil improvement method etc., which is the most suitable for the soil condition, shall be applied.
3. The supporting pillars of the elevated reservoir shall be fabricated with steel or reinforced concrete, and

firmly joined to the foundation.

4. The water tank portion of the elevated reservoir and the base on the supporting pillars shall be firmly joined.

Box 7-15: Inlet pipe, outlet pipe and bypass pipe of elevated tanks

Refer to Box 7-10

Box 7-16: Procedure of the design of distribution mains

Detailed design of distribution mains shall be in conformity with the following:

1. Design shall be based on the latest technical standards etc. while identifying the purpose of laying the distribution mains.
2. A reconnaissance and survey of buried objects at the site shall be undertaken prior to detailed design, and a safe and reliable construction method shall be adopted.

Box 7-17: Determination of pipe material

Pipe material of distribution mains shall basically be in conformity with the following:

1. Pipe material having no risk of water contamination shall be brought about
2. It is safe against inside pressure and external forces.
3. It conforms to the burial condition at site.
4. It possesses good property of laying which conforms to the environment of burial.

Box 7-18: Pressure

Water pressure of distribution mains shall be maintained within the following range:

1. The minimum dynamic water pressure at the tapping points on the distribution main for branching of service connections shall be more than 100 kPa (0.10 MPa). Note, however, that this shall not apply if the higher pressure does not impede stable water supply
2. The maximum static water pressure in the distribution main shall be less than 1,000 kPa (1.0 MPa). Note, however, the lower the maximum pressure, the better.

Box 7-19: Determination of pipe diameter for distribution pipes

The diameter of distribution mains shall be determined based on the following:

1. The dynamic water pressure in the distribution mains under normal conditions shall be so determined that it is higher than the minimum dynamic pressure required in the area in question; and that the distribution of the water pressure becomes as uniform as possible.
2. The low water level of the service reservoir, standpipe or elevated reservoir shall be the datum level for

the computation of the diameter of distribution mains.

Box 7-20: Location and depth of pipe for distribution pipe

The location and depth of laying of distribution mains shall be in conformity with the following:

1. In case distribution mains are laid in the public road, the location and depth of laying shall be in conformity with the Road Law and the related regulations, and subject to coordination with the administrator of the road. Also in case distribution mains are laid in land other than public roads, consent of the administrator for the use of such land shall be obtained.
2. In case distribution mains are laid across or in the vicinity of other buried objects, more than 0.3 m of space shall be provided between them.
3. Anti-floating measures shall be provided where the groundwater level is high or expected to become high.

Box 7-21: Foundation for distribution pipes

The design of the foundation etc. of buried water mains shall be in conformity with the following:

1. The foundation etc. of buried water mains shall be designed taking into consideration the condition of the soil, loads on the mains and the characteristics of the pipe material used.
2. Soil for backfilling shall be selected so that compaction of soil for backfilling can be carried out properly.
3. In case water mains are laid in loose soil etc., the condition of the ground and the magnitude of subsidence of the mains shall be examined; and then the suitable laying method, pipe material and joints shall be chosen.

Box 7-22: Protection against thrust force

Protection against thrust force shall be in conformity with the following:

1. The maximum water pressure shall be the total of the maximum static water pressure and the surging water pressure in consideration of safety.
2. Protection against thrust force for the ductile iron pipe and the hard PVC pipe shall as a general rule be made by concrete blocks or restraint joints. However, fixtures for the prevention of escape can be used for small size water pipes in case sufficient binding force of surrounding soil can be expected.
3. The requirement for the protection of special fittings can be reduced or omitted for the welded steel pipe, the stainless steel pipe and the polyethylene pipe with fusion joints. However, protection with concrete blocks etc. shall be made in case expansion joints or any loose joints are installed within the effective distance for the joints to suppress the imbalanced stress.

Box 7-23: Protection against corrosion of pipe body (in case of transmission by pipe)

Corrosion prevention of the outside wall of water mains shall be in conformity with the following:

1. Proper measures for corrosion prevention shall be provided in advance based on study on the situation in case metal water mains are unavoidably laid in the vicinity of a railway or another facility of corrosion control.
2. Proper measures such as corrosion prevention coating shall be provided when water pipes are laid in an area having high corrosive soil or in a region where there is a risk of salt water intrusion and so forth.
3. Proper measures for the prevention of macro-cell corrosion shall be provided for pipes at the points where it pierces through concrete; they laid in the interface of different soil formations; and different metals come in contact.
4. After the implementation of cathodic protection, it is desirable to regularly check its effectiveness for management of the protection system.

(FACILITY LAYOUTS)

8 Facility layouts

Certain and easy operation and maintenance, easy expansion, modification and update, and stability to secure raw water with sufficient qualities shall be taken into the consideration while determining the position and arrangement of water supply facilities.

Box 8-1: Locations and layout of entire water supply facilities

The locations and layout of entire water supply facilities shall be examined based on the following items, and determined according to the result of examination;

1. To make compatibility with the geography, and utilize it as much as possible;
2. To be suitable to address future form of the city such as the trend of population so as not to cause troubles during improvement, replacement and expansion of the facilities;
3. Not to cause suspension of water service as much as possible even at an emergency;
4. To be able to reliably obtain good quality raw water up to the future;
5. To be able to undertake construction and O&M of facilities safely and easily, and give consideration to rationality and economy.

(SERVICE CONNECTIONS)

9 Service connections

9.1 Basic requirements on pressure resistance:

9.1.1 Equipment used for service connection shall have the following pressure resistance performance:

9.1.1.1 Service connection shall not generate water leak, deformation, damage or other abnormality when applying a hydrostatic pressure of 1.75 megapascals for 1 minute

9.1.1.2 Pressure adding device and service pipe installed downstream shall not generate water leak, deformation, damage or other abnormality when applying a hydrostatic maximum discharge pressure for 1 minute.

9.1.1.3 Pressure adding device shall be incorporated.

9.1.1.4 Pressure reducing valve shall be installed.

9.1.1.5 Pressure adding device shall be installed downstream of the pressure reducing valve.

9.1.1.6 Service connection with a structure that secures the water tightness by compressing the packing with water pressure shall have the performance specified in 9.1.1.1, and shall not generate water leak, deformation, damage or other abnormality when applying a hydrostatic pressure of 20 kilopascals for 1 minute in accordance with the pressure resistance performance test.

9.1.2 Jointing place of the service connection shall be joined appropriately depending on their structure and material for securing the sufficient resistance to water pressure.

9.1.3 The main piping inside a house should be such that it can be easily repaired in the event of water leakage. This can be achieved by devising the piping route in such a manner so that it does not pass under any structure.

(Standard regarding quality of material)

9.2 Requirements for material quality and leachate

9.2.1 Material for the portion of service connection in contact with supplied water shall not be harmful to human body.

9.2.2 Service connection shall not have a structure in which water stagnates due to the dead end at the terminal portion. Note, however, this shall not apply to those with a drainage system installed at

its terminal portion.

9.2.3 Service connection shall not be installed near a facility that stores or handles cyanide, hexavalent chromium and other substances that may contaminate water.

9.2.4 Service connection installed in the place where mineral oil, organic solvent and other oils may infiltrate should adopt appropriate preventive measures such as using a material that does not allow the oil to permeate or using sheath pipe.

9.3 Requirements for water hammer resistance:

Water taps and other water supply devices that may generate water hammer effect shall have sufficient performance against the water hammer. Note, however, this shall not apply in cases where appropriate measures for water hammer prevention are taken such as installing an air chamber or other water hammer prevention equipment close to the upstream side of the water supply device.

9.4 Anticorrosion:

9.4.1 Durability against acidic and alkaline corrosion

Service connection installed in a place where there is a risk of being corroded by acids or alkalis shall adopt appropriate measures to prevent corrosion such as covering with materials that have corrosion resistance to acids or alkalis, or coating with anti-corrosion materials.

9.4.2 Durability against galvanic corrosion

Service connection installed in a place where there is a risk of being eroded by a leakage current shall adopt appropriate electric corrosion protection measures such as covering with non-metallic material or insulating materials.

9.5 Backflow prevention

9.5.1 General:

Service connection shall not be installed to allow backflow. Service connection installed in a place where there is a risk of backflow, following arrangement shall be considered:

9.5.1.1 The service connection that has the performance to prevent backflow shall be installed at an appropriate position for preventing the backflow

9.5.1.2 Pressure reduction type backflow preventing device shall not generate water leakage, deformation, damage or other abnormality.

9.5.1.3 Check valve and water supply device equipped with backflow prevention device shall not

generate water leakage, deformation, damage or other abnormalities.

9.5.2 Special attention in case of supplying water to a place having potential risk of water pollution:

With regard to service connection that supplies water to the place which has a risk to be contaminated due to business activities, appropriate measures shall be taken to prevent backflow by securing the vertical and horizontal distance, and by separating the water pipe and other devices from the service connection.

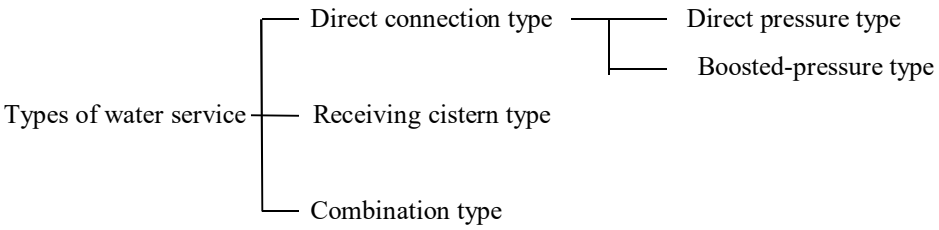
Box 9-1: Quality of material for service connections

The material for service connection should demonstrate the compliance with the standard for leaching test. Guideline values are as presented under Appendix-2 for reference

Box 9-2: Type of water service

As to the types of water service, there are the direct pressure type, the receiving cistern type and the combination type with the direct water pressure and the cistern methods. The actual type shall be determined in consideration of the height of taps, volume of water used, purpose of water use, maintenance, demand of customers, condition of distribution mains etc.

1. Under the direct connection water service type, there are direct connection direct pressure water service type which serves water by the pressure of the distribution main; and the direct connection boosted-pressure water service type which serves water by booster pump facility (hereunder boosted-pressure water service facility) installed halfway in the service pipe.
2. Under the receiving cistern type, water is first received in a receiving cistern from the distribution main, and is served from it.
3. Under the combination type, both direct pressure and receiving cistern water service type are used in a building.



Box 9-3: Structure and material for water service fittings

1. The structure and material for water service fittings shall be in conformity with the standards to be prepared by WASAC.
2. The confirmation of conformity with the standards can be made by the selection of products with self-certification or certification by the authorized plumbers to be certified by WASAC.

Box 9-4: Installation of water service fittings

The installation of water service fittings shall be inconformity with the following:

1. The installation of water service fittings stand for setting or alteration of water service fittings.
2. The water utility can designate those who can properly undertake the installation of water service fittings so as to secure the compatibility of the structure and material of the fittings of the water user to be served by the said utility to the standards. In this instance, the water utility can, in accordance with its water service code, set a condition for water service to the water user that his (her) water service fittings are installed by the said utility or those who possess such designation (licensed contractor for water service fittings). In case installation of water service fittings are carried out by persons other than one with such designation, the utility can reject the application for water service or suspend the service in accordance with its service code.
3. The water utility can impose the above conditions as the method of installation, the term of the work etc. for water service fittings from the branching point on the distribution main to the water meter.

Box 9-5: Design volume for water use

The design volume for water use is the base for planning such main parameters as the diameter of the service pipe and the capacity of the receiving cistern etc. It shall be determined taking into account the use and floor area of the building, the purpose of water use, the number of residents, the number of taps etc.

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Box 9-6: Pipe diameter

The diameter of water service pipe shall be the one that can serve the design water use at the time of minimum dynamic pressure design of the distribution main.

Box 9-7: Pipe material

The service pipe shall be in conformity with the quality standards for structure and material. Besides this, when laying it, the pipe material shall not only be in conformation with the standards for water service fittings system for structure and material but also it should be the most suitable to the geotechnical property of the site, the external force acting on the pipe, climate, characteristics of the pipe, its maintenance after laying etc.

Box 9-8: Branching of the service connection from the distribution main

It is desirable for water utilities to incorporate the method of branching of the service connection

from the distribution main and its implementation in the standards for construction work etc. Branching of the service pipe shall be undertaken as follows:

1. Tapping on the distribution main by drilling shall not cause adverse effects to the strength of the pipe and its inside coating.
2. For the purpose of branching of the service pipe from the distribution main, the corporation cock, the corporation cock with saddle, the plastic tee fitting (for hard PVC or polyethylene main), the tee fitting or the separate tee fitting for other pipe materials in accordance with the pipe material and diameter of the distribution main and the diameter of the service pipe shall be considered.
3. In case taping is made using a corporation cock or a corporation cock with saddle, the interval of tapping shall be more than 30 cm.
4. For making a branch for service pipe using a plastic tee fitting, a tee fitting or a separate tee fitting for other pipe materials, its size shall not be larger than the diameter of the distribution main.

Box 9-9: Pipe Laying

Laying of the service pipe shall be undertaken in accordance with the standards for the water service fitting system for the structure and material to be prepared. Since the water utility can specify the laying method of water service pipe from the tapping on the distribution main to the water meter, it is desirable to incorporate such a method in the standards of service pipe laying. The pipe laying shall be in conformity with the following:

1. When laying a water service pipe in a road, the location and the depth of exclusive occupation of the pipe shall not be mistaken. Besides this, more than 30 cm of space shall be maintained between the pipe and other buried objects.
2. Backfilling shall be made with soil of good quality or sand; and the backfill shall properly be compacted to protect the pipe.
3. In case the pipe is laid in the premises of a house, the location of the curb cock and the water meter shall be selected to facilitate their maintenance; and the pipe shall be laid in a straight line as much as possible even in the premises.
4. In case the pipe is laid on the ground floor or the second or higher floor, stop valves etc. shall be fitted at each floor; and its sections, which are laid vertically or horizontally and exposed, shall be fastened to the building at an appropriate interval.
5. While crossing an open channel, the pipe shall be laid underneath the channel as much as possible.
6. In case the pipe is laid in reclaimed land or soil of high corrosiveness, resistance against external force caused by ground displacement and protection from corrosion shall adequately be considered.

Box 9-10: Selection of materials and equipment in consideration of water quality

To secure the water quality the following aspects shall be taken into consideration:

1. Pipe material, which does not give an adverse effect on water quality, shall be selected.
2. A drainage facility shall be provided according to needs.
3. For pipe laying, appropriate and careful work shall be conducted.

Box 9-11: Prevention of backflow

To prevent accidents caused by backflow in water service fittings, proper measures as mentioned in the following shall be implemented:

1. The service pipe shall not be directly cross-connected with other pipe, machine, facilities etc. than the present water service fittings.
2. In case water is fed to a water tank, sink or other container, a required air gap between the overflow levels of the tank should be provided, and the mouth of the tap shall be secured.
3. A water service device with the prescribed function shall be installed at an appropriate location to prevent backflow.

Appendix 1 (Article 1 relations, i.e. Standards on chemicals applied for water treatment)

No.	**Item**	**Standard**
1	Cadmium and its compounds	< 0.0003 mg/L as Cd.
2	Mercury and its compounds	<0.00005 mg/L as Hg
3	Selenium and its compounds	<0.001 mg/L as Se
4	Lead and its compounds	<0.001 mg/L as Pb
5	Arsenic and its compounds	<0.001 mg/L as As
6	Chromium (VI)	< 0.005 mg/L
7	Nitrite-N	<0.004 mg/L
8	Cyanide ion and Cyanogen's chloride	<0.001 mg/L
9	Nitrate-N and Nitrite-N	<1.0 mg/L
10	Boron and its compounds	<0.1 mg/L
11	Carbon tetrachloride	<0.0002 mg/L
12	1,4-dioxane	<0.005 mg/L
13	Cis-1,2-Dichloroethylene and trans-1,2-Dichloroethylene	<0.004 mg/L
14	Dichloromethane	<0.002 mg/L
15	Tetrachloroethylene	<0.001 mg/L
16	Trichloroethylene	<0.001 mg/L
17	Benzene	<0.001 mg/L
18	Chlorate	<0.4 mg/L
19	Bromate	<0.005 mg/L
20	Zinc and its compounds	<0.1 mg/L as Zn
21	Iron and its compounds	<0.03 mg/L as Fe
22	Copper and its compounds	<0.1 mg/L as Cu
23	Manganese and its compounds	<0.005 mg/L as Mn
24	Anionic surface active agent	<0.02 mg/L
25	Nonionic surface active agent	<0.005 mg/L
26	Phenols	<0.0005 mg/L as phenol
27	Organic substances (Total Organic Carbon)	<0.3 mg/L
28	Taste	Not abnormal
29	Odor	Not abnormal
30	Color	<0.5 degree
31	Antimony or antimony compounds	<0.002 mg/L
32	Uranium or uranium compounds	<0.0002 mg/L

33	Nickel or nickel compounds	<0.002 mg/L
34	1,2-Dichloroethane	<0.0004 mg/L
35	Chlorous acid	<0.6 mg/L
36	Chlorine dioxide	<0.6 mg/L
37	Silver and its compounds	<0.01 mg/L
38	Barium and its compounds	<0.07 mg/L
39	Molybdenum and its compounds	<0.007 mg/L
40	Acrylamide	<0.00005 mg/L

Appendix 2（Article 1 relations, i.e. Guidelines on leachates）

No.	**Item**	**Standard**
1	Cadmium and its compounds	< 0.0003 mg/L as Cd.
2	Mercury and its compounds	<0.00005 mg/L as Hg
3	Selenium and its compounds	<0.001 mg/L as Se
4	Lead and its compounds	<0.001 mg/L as Pb
5	Arsenic and its compounds	<0.001 mg/L as As
6	Chromium (VI)	< 0.005 mg/L
7	Nitrite-N	<0.004 mg/L
8	Cyanide ion and Cyanogen's chloride	<0.001 mg/L
9	Nitrate-N and Nitrite-N	<1.0 mg/L
10	Fluoride and Nitrite-N	<0.08 mg/L as F^-
11	Boron and its compounds	<0.1 mg/L
12	Carbon tetrachloride	<0.0002 mg/L
13	1,4-dioxane	<0.005 mg/L
14	Cis-1,2-Dichloroethylene and trans-1,2-Dichloroethylene	<0.004 mg/L
15	Dichloromethane	<0.002 mg/L
16	Tetrachloroethylene	<0.001 mg/L
17	Trichloroethylene	<0.001 mg/L
18	Benzene	<0.001 mg/L
19	Formaldehyde	<0.008 mg/L
20	Zinc and its compounds	<0.1 mg/L as Zn
21	Aluminum and its compounds	<0.02 mg/L as Al
22	Iron and its compounds	<0.03 mg/L as Fe
23	Copper and its compounds	<0.1 mg/L as Cu

24	Sodium and its compounds	<20 mg/L
25	Manganese and its compounds	<0.005 mg/L as Mn
26	Chloride ion	<20 mg/L
27	Total solids	<50 mg/L
28	Anionic surface active agent	<0.02 mg/L
29	Nonionic surface active agent	<0.005 mg/L
30	Phenols	<0.0005 mg/L as phenol
31	Organic substances (Total Organic Carbon)	<0.5 mg/L
32	Taste	Not abnormal
33	Odor	Not abnormal
34	Color	<0.5 degree
35	Turbidity	<0.2 NTU
36	1,2-Dichloroethane	<0.0004 mg/L
37	Amines	<0.01 mg/L as Triethylenetetramine
38	Epichlorohydrin	<0.01 mg/L
39	Vinyl acetate	<0.01 mg/L
40	N･N-Dimethylaniline	<0.01 mg/L
41	Styrene	<0.002 mg/L
42	2,4-toluenediamine	<0.002 mg/L
43	2.6-toluenediamine	<0.001 mg/L
44	1,2-butadiene	<0.001 mg/L
45	1,3-butadiene	<0.001 mg/L