THE REPUBLIC OF RWANDA

Water and Sanitation Corporation (WASAC)

FEASIBILITY STUDY, DETAILED DESIGNS AND SUPERVISION OF WORKS FOR THE CONSTRUCTION OF KIVU BELT WATER SUPPLY SYSTEM (PHASE 1)

CONTRACT NO. 11.07.053/622/908/S/IRB/022/18-19/PROC-WASAC-CEO/AM/jbd

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

ESIA REPORT

June 2023

Prepared by

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III. ABBREVIATIONS

AfDB :	African Development Bank Group
DFIs	Development Finance Institutions
EICV:	Integrated Household Living Conditions Survey
ESMP :	Environmental and Social Management Plan
GBV:	Gender Based Violence
GoR :	Government of Rwanda
GRC :	Grievance Redress Committees
GRM:	Grievance Redress Mechanism
ISS:	Integrated Safeguard System
LRP:	Livelihood restoration Plan
LRSP :	Livelihood restoration and strengthhing plan
M&E:	Monitoring and Evaluation
MINALOC:	Ministry of Local Government
MINECOFIN:	Ministry of Finance and Economic Planning
MININFRA:	Ministry of Infrastructure
MoE:	Ministry of Environment
NST1:	National Strategy for Transformation
OS:	Operational Standard
PAPs :	Project Affected People
PHA :	Project Affected Household
PPE:	Personal Protection Equipment
PRSPs:	Country-owned Poverty Reduction Support Programmes
PTC:	Project Technical Committee
RAP :	Resettlement Action Plan
RIT:	Resettlement Action Plan Implementation Team
RLMUA:	Rwanda Land Management and Use Authority
RMC:	Regional Member Countries
RSB:	Rwanda Standards Board
RURA:	Rwanda Utility Regulatory Authority
RWB:	Rwanda Water Resource Board
RWF :	Rwandan francs
SDG:	Sustainable Development Goals
SEA:	Sexual Exploitation and Abuse
SEP :	Stakeholders Engagement Plan
SH:	Sexual Harassment
SPIU :	Single Project Implementation Unit
UN:	United Nations
UR :	University of Rwanda
VUP :	Vision 2020 Umurenge Programme
WASAC:	Water and Sanitation Corporation
WSS :	Water Supply System
WTP:	Water Treatment Plant

IV. EXECUTIVE SUMMARY

This Environmental Impact Assessment (EIA) study including Environmental and Social management Plans (ESMPs) for the proposed development of KIVU BELT WATER SUPPLY SYSTEM has been prepared in compliance with terms of reference issued by Rwanda Development Board, National Regulations as well as AfDB Integrated Safeguards System(ISS) approved in 2013 especially operational safeguards 1: Environmental and Social assessment and Operational safeguards 2: Involuntary resettlement land acquisition, population displacement and compensation involuntary resettlement. Planned activities include Water Intakes, Water Treatment Plants, water reservoirs and water pipelines.

The objective of these EIA/ESMPs is to guide Water and Sanitation Corporation (WASAC) the Implementing Entity (IE) as well as contractors to implement the proposed projects in an environmentally and socially sustainable manner and in full compliance of both national environmental regulations and AfDB Integrated Safeguards System (ISS) as funding entity.

According to Organic law related to the promotion and protection of the environment in Rwanda, Article 67 of the Organic Law N° 04/2005 of 08/04/2005 determining the modalities of protection, conservation and promotion of environment in Rwanda and the Ministerial order N0 001/2019 of 15/04/2019 establishing the list of projects that must undergo Environmental Impact Assessment, instructions, requirements and procedures to conduct environmental impact assessment, a full Environment Impact Assessment (EIA) study was a requirement for the project.

This EIA study was undertaken by a team of independent consultants specialized in Environmental studies in the region, hired by the joint venture KECC-HCC.

The project will consist in the construction of KIVU BELT WATER SYPPLY SYSTEM project including different activities namely the raw water intake, water treatment plant, pumping station, reservoirs as well as laying the pipeline for treated water supply. The Water treatment plant and intake will be constructed on 19,000m2, while 3393, 775m2 are required for new water reservoirs and 298,182.5m2 will be required for water pipeline channels.

The methodological approach followed during this EIA study involved, site walk-over, sites visit, consultation with the client, picture taking and completion of field checklist. During site visit, it was found that the land on which the project has to be developed is occupied by local population for different uses namely residential and agricultural and resettlement will be necessary for the client to acquire the land. Therefore, the expropriation law will serve as tool for this resettlement activity and fair and just compensation should be paid to the affected population prior to the construction works.

The generally accepted environmental, health and safety guidelines and the Rwandan legal and institutional frameworks were considered to analyses the requirements of Environmental Impact Assessment (EIA). Relevant laws determining the modalities for protecting, safeguarding and promoting the environment, institutions, and action plans as well as International legislative frameworks were looked at. There are clear and comprehensive

policies, strategies, laws and programs aiming the protection of environment in Rwanda. Though, the management of environment in Rwanda is multi-facet, the institution designated as responsible of follow-up, regulate and implement environmental matters is Rwanda Environmental Management Authority (REMA), which is under the Ministry of Environment (MoE). For the monitoring of this project activities, REMA has to collaborate with WASAC Ltd as project developer and other public institutions, i.e. Rwanda Housing Authority, Rwanda Land Management and Use Authority, Rwanda Agricultural Board, Rwanda Standards Board as well as the central and local government organizations at all levels, without ignoring the private sector and non-government organizations.

Like any development activity, project or program in an area, it has positive and impacts on physical and biological environment and it was our task to make check and balance between both the negative and positive impacts. Significant positive impacts were found highly rated in comparison to negative impacts. Such positive impacts were mainly determined as compliance with current requirement in development, enhanced socio-economic benefits, spiritual, tourism promotion, employment opportunities that generate significant increase in income for surrounding people (mostly during construction phase), and developing Rwanda as a country in its fast phase of fostering development activities.

The analysis of significant adverse impacts showed that some areas could be adversely affected by the development of this project and its implementation. Impacts differed in terms of significance, extent and duration. The project should affect water body in terms of water quantity and quality, ambient air, noise pollution, public safety, and loss of biodiversity found on the site. But some of these negative impacts will last for short- time and can be mitigated accordingly.

Among proposed mitigation measures:

- Sanitation facilities should be designed and constructed. With consideration of the project location (On top of mountain) it is recommended to construct modern septic tank to manage waste water from toilets;
- During construction phase, fencing should be done on the entire works site as protection measure. Watering exercises should be applied in order to reduce dust to be caused by demolition of existing residential houses and construction activities;
- To avoid noise disturbance for nearest community, construction activities should be done from 7 am to 6pm;
- It is ordered that the project developer should make sure that all construction staffs are using Equipment Personal Protective (EPP). First Aid Kits should be available on site and staff should be trained how to use FAK;
- It was observed that few trees and grasses & shrubs should be cleared before construction. The project developer should make sure that affected biodiversity is compensated by replanting other trees.

The study has developed comprehensive and realistic Environmental Management and Monitoring Plan (EMMPs) which outline the areas of consideration though most if not all have been covered in the management measures outlined after discussion of the impacts.

Overall, the project is environmentally feasible, friendly and sound with few potential negative impacts, which can be minimized or completely mitigated through incorporation of corrective, rehabilitation, restoration and instituting of appropriate mitigation measures. These have been integrated into the project decision-making level so as to ensure that the project designs take into consideration all the highlighted aspects of this study.

The information presented in this report when approved will form the basis for a final design stage of the project.

1. Project activities

The main project activities will be done during all phases of the project implementation and they are listed here below:

- ***During Construction***

  - construction of intake unit and its stability,
  - construction of Water Treatment Plant and operational services;
  - connection of intake to the pumping tanks by pipes;
  - Project camp site installation;
  - construction and installation of pumping station and de-silting basins;
  - construction of storage reservoirs for water;
  - Construction and/or upgrading access roads towards planned areas for infrastructures edification;
  - excavation for installation of pipelines network.

- ***During operation and Maintenance***

  - Pumping water Musogoro river to feed water treatment plant;
  - Management of Water Treatment Plant and its residual effluents;
  - Management of reservoirs for water supplying in the system;
  - Management of pumping stations and accessories;
  - Maintenance of safe and cleaned environment within and around constructed infrastructures;
  - Restore the site to its original or improved condition, including remediation of land, water, and other environmental factors.

- ***During and decommissioning***

  - Project handover
  - Documentation and Reporting: Maintain accurate records of all decommissioning activities and prepare comprehensive reports for regulatory bodies and stakeholders (Operation manual)

2. Project description

Through the loan received from African Development Bank (AfDB), Water and Sanitation Corporation (WASAC Ltd) representing the Government of Rwanda intends to apply a portion

of it to the Feasibility Study, Detailed Designs and Supervision of Works for the Construction of Kivu Belt Water Supply System (Phase I (6,500 m3/day water treatment plant and distribution network). The target is to increase the access to clean water in Karongi and Rutsiro Districts. This project consists mainly in design, construction of Kivu Belt water supply system having the main intake at Musogoro river to enhance availability of water in the districts of Karongi and Rutsiro.

3. Equipment and machineries to be used in construction activities

Construction works of water supply system will use numerous equipment's as well as machineries and the difference depend on designed structure to be constructed. Intake, WTP, campsite, Reservoirs, pipeline networks, electrical lines, pumping stations and landscape restoration are the panned project activities that have different equipment's and machineries like **excavators, backhoes, bulldozers, trenchers, cranes, and drilling rigs**. These machines are used to dig trenches, install pipes, and pumps and generators are used to provide power and water pressure in the system.

4. Size of reservoirs

Water is delivered to the reservoir in the system directly through the transmission main and completely separate from the town's distribution system. These allow greater control over the quality of water delivered to the consumer. There will not be large variations in the length of time that the water is in the system.

The storage capacity required for primary transmission system has been calculated by considering 20% of the average daily water demand (Source: Rwanda regulation on minimum required service level, 2012). The total capacity of storage reservoirs proposed range between 40 – 50% of total water daily demand for covering domestic, industrial and public water needs including the emergency flow in case of pipe breakdown on transmission line or pump failure from primary to tertiary mains for distribution. The proposed water reservoirs within the network are made by reinforced concrete.

The reservoir size is designed in such a way that:

- The volume of water required to even out the maximum peaks in the water demand;
- Strategic reserve to allow for power failure in the pumping facilities or other breakdowns in the supply system;
- Construction of this reservoir unit in one phase for year 2035 has been recommended.

All outlet pipelines are fitted with bulk water meters for the easy measurement of the water level in addition overflow and washout facilities are provided. 10,25,50,100,200,500,1000,4000 m^3 are different Tank capacity to be constructed with a rectangular shape and 99 is the total number of reservoirs.

5. Pipeline

The transmission pipe total length is 116,348.59 m while distribution pipeline is 362,097.95 m and total pipeline network will equal to 478,446.54 m. Moreover, the type of the pipes to be used are all HDPE and DI.

6. Design of road and river crossings

The transmission pipeline above ground or on river crossings shall be supported either on concrete saddle as anchorage or with ring girders again supported on concrete bases (bridge). In general, forces due to gravitational component of pipelines laid on slopes, thermal stresses, provision of expansion joints etc. shall be considered.

Whenever pipeline crosses gravel, asphalt or concrete roads and river/ditch or open ravines, crossing structures, which will protect the pipe are designed. For heavy traffic road crossing, concrete encasements are provided.

7. Campsite and access road

Within the appropriate location the campsite will be Chosen in a suitable area near the Musogoro river water and project site, in consideration of some factors such as factors such as accessibility, safety, availability of resources, and environmental concerns.

Determined layout of the campsite and access road will be based on the project's needs. Consider the size of the construction team, equipment storage requirements, and facilities such as temporary offices, restrooms, and dining areas. Installation of the campsite facilities will be temporary for the construction team at the campsite. This may include tents or temporary cabins for accommodation, mess hall or dining area, restrooms, and basic utilities such as water and electricity.

Safety measures such as proper signage, fencing, and security personnel at the campsite and along the access road. Provide safety briefings and training to the construction team to prevent accidents and ensure compliance with safety regulations. With Regular maintenance of the campsite and access road will ensure cleanliness, safety, and functionality. Regular waste removal, site inspections, and repairs should be carried out.

8. Equipment, Raw materials and material sites

The material sites for these construction materials can be sourced from local suppliers or some selected borrow area as well as quarry within the project location. However, construction material yards, or specialty manufacturers can supply the needed materials. It's important to choose reliable and certified suppliers to ensure the quality and suitability of the materials. Additionally, it's crucial to consider the environmental impact of sourcing and transporting these materials and opt for sustainable practices whenever possible.

Construction works of water supply system will use numerous equipment's as well as machineries and the difference depend on designed structure to be constructed. Intake, WTP, campsite, Reservoirs, pipeline networks, electrical lines, pumping stations and landscape restoration are the panned project activities that have different equipment's and machineries like **excavators, backhoes, bulldozers, trenchers, cranes, and drilling rigs**. Moreover, the following are some other more needed materials:

Pipes: Various types of pipes are used, such as PVC (Polyvinyl chloride), HDPE (High-density polyethylene), ductile iron, or concrete pipes, depending on factors like the water pressure, pipe diameter, and local regulations;

Valves: Valves control the flow of water within the system. Different types of valves, such as gate valves, ball valves, butterfly valves, and check valves, are used depending on their specific functions;

Fittings: Fittings help connect pipes and valves, ensuring a tight and secure fit. Common fittings include couplings, tees, elbows, flanges, and reducers;

Pumps: Pumps are used to transport water and maintain pressure within the system. The type and size of pumps depend on factors like the desired flow rate, head pressure, and system design;

Storage tanks: Storage tanks are used to store potable water. They can be made of concrete, steel, or other suitable materials and can be above-ground or underground, depending on the available space and project requirements;

Treatment chemicals: In water treatment facilities, various chemicals are used to purify and disinfect the water. Examples include chlorine, coagulants, disinfectants, pH adjusters, and corrosion inhibitors;

Control and monitoring equipment: Equipment such as flow meters, pressure gauges, level indicators, control panels, and sensors are used to monitor and control the water supply system.

9. Policy-legal and institutional framework

National policies

The Rwandan national laws, policies, plans and strategies have been reviewed and their relevancy to Kivu belt WSS project highlighted. In the same line, institutions relevant to the project have been mentioned and their missions reported. The following are the reviewed policies:

- National Strategy for Transformation (NST 1) 2017 – 2024;
- National Environment and Climate Change Policy, 2019;
- National Land Policy, 2004;
- National Health Policy, 2016;
- National sanitation policy, 2016;
- National Policy for water resources management, 2011;
- National Biodiversity Strategy and Action Plan, 2016;
- Urbanization and Rural Settlement Sector Strategy 2013-2018;
- Rwanda Biodiversity Policy, 2011;
- National Urbanization Policy, 2015;
- National Occupational Safety and Health Strategy, 2019.

AfDB Integrated Safeguards System (ISS)

Furthermore, the AfDB Integrated Safeguards System (ISS) which is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects under the environmental and social operational safeguards were also considered.
Approved in 2013, the AfDB ISS is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects.

The preparation of the present environmental and social impact assessment for the Muhazi WSS project has also followed the AfDB Environmental and Social Assessment Procedure (ESAP).
The ESAP gives the steps to be considered when undertaking an ESIA study including the generic terms of reference, typical contents of an ESIA and the minimum content of an Environmental and Social Management Plan (ESMP). Furthermore, it defines ESIA as an instrument whose purpose is to identify and assess the potential environmental and social impacts of a proposed project, evaluate alternatives, design appropriate mitigation/ enhancement, monitoring, consultative and institutional strengthening measures.

The AfDB Operational Safeguards (OS) under the Integrated Safeguards System are summarized below:

- OS1: *Environmental and Social Assessment*;
- OS 2: Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation;
- OS 3: Biodiversity, Renewable Resources and Ecosystem Services;
- OS4: Pollution Prevention and Control, Hazardous Materials and Resource Efficiency;
- **OS 5: Labor Conditions, Health and Safety.**

International conventions

Rwanda is a signatory to several international conventions and agreements related to water supply projects. Some of the key ones include:

- In Karongi District, the net primary school enrolments rate is 94.3% whereas the secondary school enrolment rate is 13.7%. This shows that high numbers of pupils that enroll for primary do not continue to secondary school level, an The international Convention on Biological diversity and its habitat signed in Rio de Janeiro in Brazil on 5 June 1992, as approved by Presidential Order No 017/01 of 18 March 1995;
- United Nations Watercourses Convention: Rwanda is a signatory to this convention, which sets out principles and guidelines for cooperation between countries sharing watercourses;
- United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses: Rwanda is also a signatory to this convention, which establishes the rights and obligations of states regarding the use and protection of international watercourses;

- Convention on Wetlands of International Importance (Ramsar Convention): Rwanda is a signatory to this convention, which aims to conserve and sustainably use wetlands, including those that are important for water supply;
- The CARTAGENA protocol on biodiversity to the Convention on Biological biodiversity signed in NAIROBI from May 15, to 26, 2000 and in NEW YORK from June 5, 2000 to June 4, 2001 as authorized to be ratified by Law No 38/2003 of 29 December 2003;
- The United Nations Framework Convention on Climate Change, signed in RIO DE JANEIRO in BRASIL on 5 June 1992, as approved by Presidential Order No 021/01 of 30 May 1995.

10. Bio-physical environment

Climatology

It is characterized by two main seasons: one long dry season that varies between 3 and 5 months with an annual overage temperature varying between 25,3°C et 27,7°C. The monthly distribution of the rains varies from one year to another. Annual rainfalls are estimated at 1,191mm/year and very unpredictable to satisfy the needs in agriculture and livestock along the year.

Karongi District is characterized by high lands with steep slopes with an altitude estimated between 1470 to 2200 meters. Much of the land is prone to erosion due to the steep terrain and high rainfall found in this region. In the study areas, the estimated mean monthly temperature is more or less constant from the month of January to the month of December. The maxima and minima are also constant throughout the whole year. This shows a cool and moderated climate. The data collected from Meteo Rwanda have shown that the available temperature recordings in the vicinity of the study area are Byimana Meteo Station.

Hydrology of Musogoro river

According to the research carried by COMETE, 2012, Musogoro river flows along a South-East North-

West axis and flows into Kivu Lake, 3.5 km north-east of the town of Karongi. A water intake on the river can be seen at 4.5 km from its outlet. The Musogoro is characterized by a low flow of about 1000 m3/h. The principal water resources in the Kivu catchment are as follows (according to the Water Resources Master Plan, 2014:

- The average annual rainfall is slightly above 1,200 mm/annum which equates to some
- 3 000 hm^3/annum from the total land surface area of 2,425 km^2;
- The combined average annual surface flow generated from the numerous small catchments in Rwanda stands at 28 m^3/s or some 900 hm^3/annum;
- The groundwater annual recharge / safe yield is about 600 hm^3/annum with a total storage of 2,400 hm^3/annum which gives a mean residence time of about 4 to 5 years;

- The Kivu Lake collects the surface runoff from the entire catchment located in both Rwanda and DRC and constitutes an important surface water storage reservoir but generates substantial loss of water resources from evaporation.

- ***Flora and Fauna:***

The Musogoro River and its associated wetlands provide important breeding grounds and habitats for various bird species. These wetlands support a diverse range of waterfowl, including herons, kingfishers, and egrets. They are also important for migratory birds, which make use of these wetlands during their seasonal journeys. The banks of the Musogoro River are lined with a variety of vegetation, ranging from grasses and reeds to trees and shrubs. This riparian vegetation plays a crucial role in providing habitat for a diverse array of terrestrial wildlife such as monkeys, antelopes, and various bird species.
Concerning the identified biodiversity that had been identified in the project area, flora species were recorded as well as bird species identified were also recorded.

11. Socio-Economic Environment

Karongi District stretches over an area of 993 km^2 with a total population of 373, 869 distributed into 91,444 households among which 8,794 (10%) live in urban area and 82,650 are located in rural area. The population of Karongi District is composed of 195,452 females and 178,417 males. It is among the districts of Rwanda which has a high density of 482 persons per square kilometer. (NISR, PHC5-2022 Census).
The estimated total population of Rutsiro District in 2022, as provided by NISR, PHC5-2022 Census was 369,180 persons. This represents 12.7% % of the total population of Western Province and 2.8 % of the total population of Rwanda. Females comprise 52.2 % of the population of Rutsiro District and the males represented also 47.8%. The population density in Rutsiro accounts for 565 inhab/sq.km which is near the country average density (503 inhab./sq.km)
In Karongi, accessibility of population to clean water depends on the kind of settlement in place. However, Karongi District has a rate of 74.7 % of total improved water source, 25.1 % of unimproved drinking water from surface water of river and lake as well as unprotected spring. The objective is increasing access to clean water by local population and reduce as quickly as possible the distance covered to fetch water by women and girls.
The number of households having access to clean water in Rutsiro District has increased from 68.2 % to 82.7 % respectively in 2014 and 2015 due to various project yet implemented by the district in conjunction with other partners' such as WASAC, World Vision and LODA.

12. Stakeholders and public consultations

Public consultation meetings have been conducted by the developer of a project through ESIA expert. The public, staff involved in the project as well as other stakeholders get occasions for obtaining information about the Project and to assess their concerns. These consultation sessions will offer an occasion to communicate with members of the community who may be affected by the Project and give them a room to participate in the environmental, social,

safety and health impacts assessment process. The stakeholders and public consultations were carried out in accordance with the provisions of Ministerial Decree N° 001/2019 of 04/15/2019 establishing the list of projects to be the subject of an environmental impact assessment study, instructions, conditions and procedures to carry out the environmental and social impact assessment (ESIA).

Discussions with the Client and his staff, key stakeholders including Administrators at District and Sector levels, District Environmental officer and WATSAN officer were made on the concept and nature as well as the importance of Kivu belt Water Supply System Project, emphasizing the levels of public participation, role of key stakeholders and joint contributions of these actors to the success of the planned project.

Other specific objectives of the consultation meetings were:

- to explain the details of the project to local community living within the project area;
- try to get a complementary socio-economic and environmental information from the audience;
- try to get current information on the effects of under-going activities already perceived by local community.

During the consultation exercise, the ESIA Consultant has presented to the community the project background, objectives, expected outcomes including the potential socio-economic and environmental benefits. After the presentation, the community was given opportunity to express their views, give out their comments as well as queries. Some important questions raised by the community have been answered by the Consultant at their satisfaction.

Stakeholders and public consultations meetings have been organized with the purpose of making the Kivu belt WSS's ESIA study participatory and transparent. Summary of interim key findings in terms of potential positive and negative environmental, social, safety and health impacts with proposed mitigations measures for negative ones were shared with the audiences in order to receive their views and attitudes accordingly. After interactive exchanges as well as responses given to their queries; stakeholders and the public have appreciated the Kivu belt WSS project and took engagement to participate in its successful implementation.

13. Institutional Implementation Arrangements and Reporting Requirements

WASAC

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 role of a contractor will play a critical role in the successful implementation of the project and he will be dependent on the scope of the project and the agreement between the contractor and the client. Their expertise in construction, management, and quality control ensures that the project is completed in accordance with the contract to be designed.

Supervising engineer

The supervising engineer of the project is to oversee and manage the various technical aspects of the project to ensure its successful completion, as long as they are responsible for overseeing and managing the technical facets of the project, they will eventually be ensuring that they are executed efficiently and effectively.

REMA

REMA was established in 2004 to act as the implementation agency 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 matte rs pertinent to the environment and climate change. Key responsibilities of REMA are as follows:

- Advise the Government on policies, strategies and legislation related to the management of the environment as well as the implementation of environment related international conventions, whenever deemed necessary;
- Conduct thorough inspection of environmental management in order to prepare a report on the status of environment in Rwanda that shall be published every two (2) years;
- Put in place measures designed to prevent climate change and cope with its impacts;
- Conduct studies, research, investigations and other relevant activities in the field of environment and publish the findings;
- Closely monitor and assess development programs to ensure compliance with the laws on environment during their preparation and implementation;
- Participate in the preparation of activities strategies designed to prevent risks and other phenomena which may cause environmental degradation and propose remedial measures;
- Provide, where it is necessary, advice and technical support to individuals or entities engaged in natural resources management and environmental conservation;
- Prepare, publish and disseminate education materials relating to guidelines and laws relating to environmental management and protection and reduce environmental degradation risks;
- Monitor and supervise impact assessment, environmental audit, strategic environmental assessment and any other environmental study. REMA may

authorize in writing, any other person to analyze and approve these studies. The ESIA review has been delegated to Rwanda Development Board.

RDB

Rwanda Development Board (RDB)

The Law No 46/2013 of 16/06/2013 establishing Rwanda Development Board (RDB) has determined also its mission, organization and functioning. One of the important missions of RDB is fast-tracking development activities and facilitates the Government and Private Sector to undertake an active role. 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 ESIA reports was entrusted to REMA, this duty has now been transferred to the newly created Rwanda Development Board (RDB) where a department of ESIA has been created and tasked with review and approvals of all ESIA reports for proposed projects and programs before they are approved for implementation. The key responsibility of ESIA department under One Stop Centre in RDB is to:

- Receive and register ESIA 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 (ToRs),
- Publicize Project Briefs and collect public comments during development of ToRs,
- Receive ESIA documents submitted by a developer and verify that they are complete,
- Transmit copy of ESIA Reports to relevant Lead Agencies, Local Governments and Communities to review and make comments,
- Review ESIA 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 ESIA Documents (ESIA 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 ESIA Certificate of Authorization if their projects are approved.

15. Project Alternatives

The alternatives to the project are different ways to achieve the same purpose and needs that the proposed project will achieve. ESIA requires looking into alternatives to the proposed project in order to make prudent decisions. In the present ESIA report, three alternatives will be analyzed namely: (i) Alternative site location utilized, (ii) Alternative construction

techniques and (iii) Alternative zero or no-project in order to make prudent decisions and ensure Districts' sustainable development.

16. Adverse Impacts of the project activities

16.1. Pre-construction impacts

- ***High expectation of the local communities in relation to job posts***: There is within the local population, high expectations about jobs creation. Indeed, although the project will create employment opportunities, the jobs will be limited and it is therefore important that the procurement processes is clear and fair. It is expected that creation of not enough jobs will create frustration on part of the local people and conflicts can occur or be generated in relation to the project.
- ***Expectations of short-term solution to all problems of water supply***: The presence of a new water project can create very high expectations in the population as the immediate solution of all problems in the water supply sector. However, it is known that the solutions will be gradual and there are initiatives taken in the short term and others long-term due to limitations in the existing water sources and the costs involved with the alternatives identified.
- ***Resettlement implications***: Permanent land acquisition is expected where Water Treatment Plant, water intake and water storages will be constructed;
- Temporary land acquisition will be also required for laying pipelines. For project a Resettlement Action Plan will be prepared and compensation provided before civil works. The RAP report will provide details on affected assets and proposed mitigation and compensation measures.
- ***High expectations of getting great compensation in cases of resettlement***: It is highly likely that people who will stand to lose land, infrastructure or business due to the project will have very high expectations of compensation to their loss.
- ***Conflicts among workers and the local population in the project area***: Though it is anticipated that the project will make an effort to employee local population, projects involving major works include, often, the potential for the occurrence of social conflicts between workers who temporarily settle in the local and community residents. Such behaviors are generally related to socially unacceptable behaviors according to local social standards and can be seen, for example, cases of drunkenness and disregard/lack of respect for local customs. This impact should be considered even though an important part of the manpower to be recruited locally.

16.2. Construction Phase

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

- ***Traffic congestion and injuries or fatalities:*** The principal pipeline is mostly designed along the existing roads and at some point, it crosses both paved and unpaved roads. During construction period there will be increase in traffic due to moving machineries and vehicle traffic for material supply. This may cause both congestion and accidents.
    - People struck or run over by moving vehicles (e.g. during reversing), causing minor to major injuries (fractures, wounds) or death;
    - Falling from vehicles, causing injuries or death;

- ***Work related Health issues***: Health related issues are mainly resulted from emission of dust, noise and vibration which can result in possible respiratory irritation, discomfort, or illness to workers and local communities;
- ***Impacts of labor influx***: Migration of big number project workers within the project area will increases the rate of HIV/AIDS and other Sexually Transmitted Diseases (STD). Due to the increase of people from outside of the Though there is no workers camps planned for this projects Communicable disease are anticipated among workers;
- ***Disruption of Public Utilities***: At several points, small domestic water supply pipe lines and electricity and communication cables were observed. During construction, these infrastructures are likely to be affected by the construction activities;
- **Child labor, forced labor, discrimination and abusive dismissal**;
- The implementation of the proposed project should be done in compliance with national and international standards in terms of child labor forced labor and discrimination;
- ***Soil erosion***: Soil damage includes compaction and disturbance of the profile. 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 precondition 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 depends not only on soil damage but also soil type, rainfall, and angle and length of slope;
- **Air Quality / dust releases and nuisance:** Exposed surface areas with loosened topsoil combined with the operation of plant and machinery will increase dust raised from the site, especially during initial levelling and preparation required under each phase of the project. Dust will also be raised by haulage vehicles delivering materials to the site; this is expected to pose a problem off-site as access roads are not paved. The dust raised during construction can pose a nuisance to workers although the impact of this is considered relatively small and localized. Dust levels are likely to be higher at certain strategic locations on the site such as stockpile areas during the off-loading of gravel and aggregate**;**
- Dust raised by construction activities can also pose a nuisance to adjacent settlements especially under dry and windy conditions. The impact of this affecting some parts of the settlements around the construction sites is potentially significant although

intermittent.It can be anticipated that a certain amount of air borne particulate matter (dust) will be generated by earth moving activities during construction phase of water treatment plant and water reservoirs. This situation will be worse during the dry season and during the afternoons when the winds are most prevalent. Air borne particulates may pose a hazard to residents in the vicinity or downwind of the construction site that suffer from upper respiratory tract problems.

- ***Quarries and borrow pits exploitation*:** It is anticipated that the project will need construction material such as sand and stones. Therefore, it is appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, Occupational health and safety of their employees, or environmental degradation in general.
- All borrow pits areas will be properly dressed maintaining drainage to outwards. The side slopes shall be provided with surfing. Topsoil from the opening of burrow pits from agriculture land shall be saved and reused in re-vegetating the pits to the satisfaction of the Engine er / land owner. Additional borrow pits will not be opened without the restoration of those areas no longer in use.

16.3. Operation phase and maintenance

- **Water pollution:** Laboratory test on water where water will be extracted shows that water is already heavily polluted with a lot of sediments. The construction of water intake, water Treatment Plan, the installation of pipeline especially at river crossing section, additional sediments are likely to go to the river.

  - The soils inside the pipes are excavated by hand. If the ground conditions are not good, the soils are excavated using a high-pressure jet, and this makes it possible to make sure of the safety by keeping a certain distance between workers and cutting head;
  - After installing pipe sleeves, water pipes are inserted inside them, and aerated light- weight concrete is filled up between the pipe sleeves and water pipes in order to fix the water pipes in concrete.

- ***Alteration of hydrology and wetland:*** The installation off the pipeline below the wetland 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. The construction phase will involve the use of heavy machines and vehicles and increase of circulation of people. For different purposes lay down yards will be needed, as for storage of parts and construction material, storage of pipes, parking of trucks and construction machines etc. and work camps have to be installed.

- ***Solid waste management:*** Solid waste generated during site preparation and construction work would include cut vegetation and typical construction waste. This waste would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite. Cleared vegetation burnt onsite

would generate smoke, possibly impacting negatively on ambient air quality and human health.

- **Contamination of soil and water bodies due to oil spillage**
- During the construction of proposed structure, no heavy machinery is required but tracks, bulldozer and other equipment require re-fueling, maintenance works and repair works, which in effect result in oil spillage. At point sources, contamination of soils and run-off ending in the receiving bodies could cause water quality degradation, if no mitigation measures are implemented. This impact can be considered of low magnitude, duration and spatial extent since it shall only be experienced during the early construction phases and few tracks will be used
- *Loss of flora and fauna*: Some crops and trees established in the project area will have to be cleared where the intake, WTP, reservoirs, pipeline and pump station will be installed. There is no plant or animal species of special conservation purpose surveyed that will be affected.
- Disturbance of ecosystems habitats: The clearing of existing vegetation will result in the complete loss of associated ecological habitats and their fauna, within the project area. Noise, vibrations, and intrusive activities related to construction works will tend to scare away any animals remaining on the site after vegetation clearance;
- Impacts on bird habitat: The project will be implemented in Musogoro wetland which is not classified as Important Bird Area (IBA) and Construction works especially in the swamps will not have adverse impact on bird's habitat. The works have to be done avoiding or minimizing habitat and species loss and any degradation to habitats and species populations This will preferably comprise the avoidance of the key habitat areas, if at all possible.

16.4. Impacts during the operation phase

The key Environmental impacts resulting from operational phase include wastewater, sludge production, overwater abstractions etc. Environmental impacts related to the operation phase of proposed activities are provided below.

- **Impacts on Hydrology**

The feasibility study team assessed water balance in the Musogoro river catchment and determined the river's minimum flow to be 826l/s; based on the ultimate water intake of 248 l/s, the river' base flow is 578l/s which is released downstream for downstream users.
The water demands for Kivu Belt water supply project is estimated at 14,929 m^3/day as daily average demand and 19,408 m^3/day (≈19,500 m^3/day) as daily max demand for ultimate year 2035. The project is expected to be implemented in phases with each phase having a capacity of 6,500 m^3/day.
This will generate the following Impacts:

- Reduced water flow: Withdrawing water from a river can lead to a reduced flow downstream. This can disrupt the natural water balance and affect aquatic habitats;

- Altered river morphology: Diverting water from rivers can result in changes to the river's natural morphology, including erosion, sedimentation, and altered flow patterns;
- Decline in aquatic biodiversity: Water abstraction can disrupt river ecosystems and lead to the decline of fish and other aquatic species due to reduced flow, altered water temperature, and habitat loss.
- Use water abstraction methods that minimize damage to fish and other aquatic organisms.
- Implement erosion control measures to prevent excessive sedimentation;
- Conduct regular monitoring of the river's morphology and make necessary adjustments to mitigate any adverse impacts.

- **Water pollution**: During the operation phases some chemicals like *Chlorine*, for disinfection and killing harmful bacteria and viruses; *Aluminum sulfate (alum),* for coagulation to remove suspended particles; *Calcium carbonate*, for adjusting pH levels and water hardness; *Sodium* ***Hydroxide,*** **for adjusting pH levels and water alkalinity;** *Activated carbon*, for removing organic contaminants and improving taste and odor; *Potassium permanganate*, for oxidizing organic matter and bacteria; *Fluoride* for preventing tooth decay. Whenever there is a malfunction of the plant, the supplied water will eventually affect human life including life loss.

- ***Sludge handling and disposal:*** During the operational phase two kind of waste is expected including sludge and waste water. If not well handled, this waste may contribute to water pollution and environmental degradation. Therefore, a proper handling and disposal plan is required in order to avoid any pollution or environmental degradation.
- **Wastewater treatment:** Dewatering the sludge will release wastewater and if no well handle it may have adverse impact on environment and on human health as the water treatment plant is located not far from the wetlands. Environmental pollution by wastewater or consumption of wastewater contaminated water might lead to eruption water-borne diseases i.e. cholera, diarrhea, dysentery and typhoid. Problems associated with the unmanaged increased wastewater could last during the whole project life :

- **Loss of income for small water supply operators:** Although this in not a recognized income generation activities and these people are taking advantages of water shortage in the area, the developer should consider this category of people and give them priority in labor for sustainability of the projects. In the case that there are not taken care off they can participate in vandalism of infrastructure and sabotage of the project.

- **Vandalism of water supply infrastructure:** With the coming of the project, a number of infrastructures will be made from metal, steel and concrete some people may be involved in vandalism of that equipment's. The impact could be of low significance in terms of

magnitude. With community policing encouraged in Rwanda and existing security organ in the project area, such an impact might be of short-term scattered periods of vandalism;

- **Loss of biodiversity due to ground water over-abstraction:** During operational phase, over-abstraction of ground water has a negative impact on living organisms including flora and fauna. When the groundwater withdrawals exceed recharge, there is a falling of water table and living organism does not have enough water. Therefore, any project that need ground water should consider the minimum ecological flow to sustain the living organism.
- ***Fire Hazards at treatment works:*** There some potential scenarios that could lead to the fire hazardous incidents at water treatment plant and they are as follows: Electrical malfunctions that may rouse short circuits or equipment overload that will eventually lead to electrical sparks or arcs that could ignite flammable materials nearby. Welding activities, improper handling smocking or mismanagement of chemical storage are the potential factors that may increase the risk further.
- ***Cumulative Impacts:*** The fact that Musogoro river drains into lake kivu that is connected to other more rivers, there will be eventually an impact of the project on Lake Kivu and Ruzizi River on the hydrological regime including flora and fauna. The following are the identified impacts:

    - Abstraction of water from the Musogoro River can lead to a decrease in its flow, which could disrupt the hydrological regime downstream and in Lake Kivu;
    - The reduced flow caused by water abstraction can also result in changes in sediment transport patterns, affecting the natural balance and functioning of the river and lake ecosystems;
    - Habitat alteration as Changes in the hydrological regime due to water abstraction can directly affect the habitats of aquatic and terrestrial species dependent on the Musogoro River and Lake Kivu;
    - Species displacement: Alterations in water flow and habitat quality can lead to the displacement or even extinction of certain species within the affected ecosystem;
    - Water quality degradation: Increased water abstraction can lead to the concentration of pollutants and changes in water quality, affecting the overall biodiversity and ecological balance.

- ***Transboundary Impacts*:** The Mosogoro river drains into lake kivu which empties into Ruzizi River that flows southwards into lake lake tanganyika. So, the water supply project that will abstract water from Musogoro River can have transboundary impacts due to the potential impacts it may have on the downstream ecosystems and communities. The following are some of the impacts and mitigation measures:
    - Impact on Lake Tanganyika: The Musogoro River flows into the Ruzizi River, which ultimately flows into Lake Tanganyika. Therefore, the water abstraction can alter the water flow and quality of Lake Tanganyika. The water supply project can exacerbate the already high levels of water scarcity in the region, which can affect

the lake's fish population, which is a vital source of livelihood for the riparian communities.

- Impacts on Lake Kivu: Musogoro River also empties into Lake Kivu, which is shared by Rwanda and the Democratic Republic of Congo. The water supply project can negatively impact the lake's water quality and flow, which can affect the lake's sensitive ecosystem, which is home to endemic fish species and supports fishing and tourism activities;

- ***Transboundary conflicts***: The water supply project can lead to conflicts among riparian communities and even between neighboring countries. Such conflicts can arise due to various reasons, including the failure to consult downstream communities and countries;

    - Impacts on water quality: The water supply project can introduce pollutants through sedimentation, eutrophication, or other forms of contamination;
    - Erosion and sediment control: Construction activities related to the water supply project may disrupt the natural flow of water, causing erosion and sedimentation, which can negatively impact the aquatic ecosystems in the downstream areas.

16.5. Decommission phase

-The decommissioning phase might result in temporary job losses or reduced economic activity if the project had employed local workers or utilized local businesses.
- Frequent disruption in water supply within the local residents.

I. INTRODUCTION

I.1 Overview of the project

Sustainable Development Goal (SDG) target 6.1 calls for universal and equitable access to safe and affordable drinking water. The target is tracked with the indicator of "safely managed drinking water services" (JMP WHO, 2019) In 2017, 5.3 billion people used safely managed drinking-water services – that is, they used improved water sources located on premises, available when needed, and free from contamination. The remaining 2.2 billion people without safely managed services in 2017 included:

- 1.4 billion people with basic services, meaning an improved water source located within a round trip of 30 minutes;
- 206 million people with limited services, or an improved water source requiring more than 30 minutes to collect water;
- 435 million people taking water from unprotected wells and springs;
- 144 million people collecting untreated surface water from lakes, ponds, rivers and streams.

Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid, and polio. Absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks. This is particularly the case in health care facilities where both patients and staff are placed at additional risk of infection and disease when water, sanitation, and hygiene services are lacking.

When water comes from improved and more accessible sources, people spend less time and effort physically collecting it, meaning they can be productive in other ways. This can also result in greater personal safety by reducing the need to make long or risky journeys to collect water. Better water sources also mean less expenditure on health, as people are less likely to fall ill and incur medical costs, and are better able to remain economically productive.

Rwanda Vision 2050 aspires to take Rwanda beyond high income to high living standards. Improving the access, quality, availability and sustainability of water supply services in RWANDA is the top priority in the Sector; Rwanda has committed to reach SDGs targets by 2030 through the different programs such as the NST1 and 7 Years Government Program with the aim of achieving universal access to basic water and sanitation services by 2024.

To achieve this goal, The Government of Rwanda has a plan to develop towns near borders interacting with the neighboring countries. Towns would decentralize urbanization and reduce the rate of immigration to the city of Kigali, especially youth and unemployed.

Those towns include:

Musanze: borders Southwest of Uganda and is on the road linking Rwanda and Uganda;

Nyagatare and Gatsibo: borders Southwest of Uganda and Northwest of Tanzania;

- Rubavu and Nyabihu: Rubavu borders Eastern DRC;
- Ngoma: borders Northern Burundi;

- Ngororero, Muhanga and Kamonyi: at the center of Rwanda. There is a high economic development and estate development along the road Kigali-Muhanga mainly in Kamonyi district;
- Nyanza and Ruhango: Located in the center of the country and have water scarce area (Amayaga).

In line with the above, through the loan received from African Development Bank (AfDB), Water and Sanitation Corporation (WASAC Ltd) representing the Government of Rwanda intends to apply a portion of it to the Feasibility Study, Detailed Designs and Supervision of Works for the Construction of Kivu Belt Water Supply System (Phase I (6,500 m3/day water treatment plant and distribution network). The target is to increase the access to clean water in Karongi and Rutsiro Districts.
This project consists mainly in design, construction of Kivu Belt water supply system having the main intake at Musogoro river to enhance availability of water in the districts of Karongi and Rutsiro.
The study identifies and assesses the environmental and socioeconomic impacts of the project, interaction of these impacts, recommends mitigation measures and develops and Environmental Management and Monitoring Plan that will guide implementation of the project.

This study examines the project in terms of the components it entails and their sizes and numbers where possible or applicable. It also considered the zoning, physical, biological and socio-economic aspects, natural aesthetics and scenic beauty of the property while also maintaining the environmental quality and supporting investment value.

I.2 Objectives

I.2.1 Project objective

The principal objective of the project is a hundred percent access to clean water supply in the target areas. The proposed project will also contribute to enhanced hygiene and sanitation hence reducing waterborne diseases. This will also contribute towards alleviation of poverty within the area through the improvement of socio-economic activities in target.

I.2.2 Study objectives

The objective of the study is to ensure that environmentally sound and sustainable development of the project is taken into account in all phases of the project.

I.2.3 Specific tasks or duties

To meet the requirements of the Government of Rwanda (GoR), the Environmental Impact Assessment (EIA) study has undertaken environmental analysis and evaluation in order to:

- Assess the project overall (cumulative) potential environmental and social impacts, drawing on the information and analysis from all sources of information; and

- Assess project specific impacts at the site and propose measures for their mitigation and management to ensure environmentally and socially sound development related to the development.

In addition, the EIA study also provides an Environmental Management Plan that:

- Identifies opportunities, and provides specific measures, for the conservation or restoration of ecological services within and around the site;
- Provides design and operations measures to minimize the risk of pollution and environmental health impacts;
- Prescribes other mitigation measures needed to ensure long-term project sustainability;
- Increase the likelihood that the negative environmental impact of the project that are carried out will be kept to a minimum;
- And promotion of sustainable development.

I.3 Study scope

The study focused on the proposed Kivu Belt Water Supply System in Karongi and Rutsiro Districts, Western Province project activities sites and the surrounding areas that are likely to be impacted by the project. Physical environment covered included landscape, air quality; dust, climate; and water. On the other hand, the cultural environment considered religious beliefs and cultural practices, population perception, space, safety, and ambient environment. While the biological environment covered sensitive ecosystem, important ecosystems and ecological processes within and surrounding the site. The study also covered both the direct and indirect impacts of the project activities. In addition, it also examined the impacts in terms of short term and long- term, cumulative impacts and impact interaction in Project Area. The impacts were classified as positive or negative. A set of mitigation and monitoring measures were then formulated to provide viable and environmentally friendly options to manage both the positive and the negative impacts and to mitigate adverse impacts of the project.

5.1.1 I.4 Methodological Approach

This study adopted a holistic approach to environment at the same time considering the project areas as a catchment.

I.4.1 Definition of Environmental Impact Assessment

EIA is a systematic, reproducible and multilevel process of identification, prediction and analysis of significant environmental impacts (positive or negative) of a proposed project or activity and its practical alternatives on the physical, biological, cultural and socio-economic characteristics of a particular geographical area in order to provide information necessary for enhancing decision making. EIA is used to prevent and mitigate adverse impacts, enhance positive impacts and assist the rational use of resources, hence maximizing the benefit of socio-economic development projects and ensuring sustainable development. EIA assists in

determining whether a proposed project is ecologically viable and facilitates decision-making on its authorization and certification [REMA, 2006].
In practice, EIA is applied primarily to prevent or minimize the adverse effects of major development projects. It is also used as a planning tool to promote sustainable development by integrating environmental considerations into a wide range of proposed actions.

The aim and objective of EIA can be divided into two categories: The immediate aim of EIA is to inform the process of decision making by identifying the potentially significant environmental effects and risks of development projects. The ultimate (long term) aim of EIA is to promote sustainable development by ensuring that development projects do not undermine critical resource and ecological functions or the wellbeing, lifestyle and livelihood of the communities and people who depend on them [REMA, 2006].
In general, EIA focuses on impacts related to:

- Site preparation and vegetation clearance,
- Noise pollution;
- Air quality;
- Employment;
- Solid waste generation;
- Wastewater generation and disposal;
- Traffic obstruction;
- Emergency response in case of accidents;
- Earthquake resistance;
- Flooding;
- Water pollution; and
- Odor.

I.4.2 Baseline Assessment

Baseline data was first collected from secondary data as well as primary filed data. Data collected included information on the physical environment. This includes the geology, topography, soils, climate, surface and ground hydrology, existing water point and non-point pollution discharges, and receiving water quality. The biological environment including flora, fauna, rare or endangered species, sensitive habitats (significant natural sites), species of commercial importance; species with potential to become nuisances, vectors or dangerous. The socio-cultural environment includes the population, land use; planned development activities; water users and uses, subsistence community structures, employment; distribution of income, goods and services; recreation; public health and safety; cultural aspects/properties; aspirations and attitudes.

Data sources used among them included but not limited to:

- Fourth Population and Housing Census, Rwanda, 2012 (RNIS)
- Economic development & poverty reduction strategy (EDPRS2) 2008 – 2012, (2007)
- REMA General guidelines and procedures for environmental impact assessment, (2006)

- Organic Law determining the modalities of protection, conservation and promotion of environment in Rwanda, (2005)
- Ministerial order establishing the list of works; activities and projects which have to undertake an environmental impact assessment, (2008).
- Ministerial order relating to the requirements and procedure for environmental impact assessment, (2008)
- Ministerial Order determining modalities of establishing and functioning of occupational health and safety committees, (2012).

I.4.3 Literature Review

A literature review was conducted to determine the existing conditions within the study area and to identify habitats and species of potential importance that may be affected by the Project. The literature review included feasibility studies, reports undertaken in the area, academic studies, vegetation maps and land use maps and most importantly the Rwanda Wetland Maps.

I.4.4 Field Survey

Following a literature review of available ecological data characterizing the project catchment, field surveys were undertaken project area to get first-hand experience of the area and update and triangulate the validity of the information gathered from secondary information.

I.4.5 Habitat Survey

Habitat survey was carried out in the study area. Special attention was paid to those areas which will be directly impacted by the proposed project. Colored photographs were taken of all habitat types surveyed as well as other features or species of ecological importance or conservation value.

I.4.6 Social environment analysis

It involved collecting primary data from field and matching it with secondary data obtained from desk reviews. Methods of obtaining field data were mainly through questionnaires and interview and expert observation. Social data collected from field question naire administered to local government and local population were on; population project awareness, local impression of the project, identification of likely areas of expropriation, population and demography, land use, infrastructure (roads, water, electricity), health and sanitation, education, cultural heritage. This data was interpreted from which positive and adverse impacts were anticipated to be addressed in proceeding chapters.

Compensation estimations-during the field visit areas demarcated for expropriation for project activities implementation were determined. Valuation data of crops, land and constructions has been estimated reference made to the reference prices elaborated by IRPV and published in special Gazette N0 Special of 08/11/2018.

I.4.7 Terrestrial Flora & Fauna Survey

The terrestrial floral and faunal survey recorded major plant and animal species and their relative abundance (common, sporadic and rare) in each habitat type within the study area. Efforts were also made to find species protected known to be rare, threatened and endemic or of conservation importance on a national basis.

I.4.8 Project Alternatives

The consultant together with the key stakeholders, analyzed the various project alternatives available to achieve this project's objectives but with the least adverse environmental impacts. The alternatives were identified and evaluated determining impacts and cost implications of each alternative. Alternatives assessed during this process included;

- Project technology including water intakes techniques, water treatment technologies.
- Project scale and design.
- Site alternatives in project location particularly with regards to location-based impacts and land use conflicts were assessed.
- Project construction, phasing, operations and maintenance.
- No Project alternative was also assessed to determine the impact of this No Project Scenario.

I.4.8 Public Consultation

Consultations with key stakeholders are a continuous process that was carried all through the study process and would be continued during the construction and operation phases of the project.

During the scoping process, a stakeholder mapping exercises was undertaken to identify Interested and Affected Parties (I&APs) to the project. The mapping exercise was conducted simultaneously with the scoping exercise. The exercise identified all the stakeholders in the area including the communities around the area, organized community groupings administration among other stakeholders. To obtain the sound project results, the consultant worked hand in hand with the WASAC team as developer.

I.5 Impact Prediction and Evaluation

Various methods and techniques were applied in impact identification, prediction and evaluation. The consultants with the help of stakeholders identified and analyzed potential impacts linking these with specific project activities and phase. First the task was to consider both positive and negative impacts of the project. While considering the impacts, the study examined them in light of their characteristics i.e. nature (positive or negative), extent (spatial), occurrence (one-off, intermitted or constant), magnitude, whether reversible or irreversible, direct or indirect, probability of occurrence and significance with and without mitigation. The exercise also examined the cumulative effects of impacts and particularly on land use and water quality.

I.6. Author and developer presentation

I.6.1 Author's presentation

The EIA study has been undertaken by a team of consultants lead by Eng. Evergiste MUREKASHUNGWE as Certified EIA Expert.

Eng. Evergiste MUREKASHUNGWE is 15 years experienced engineer in Civil engineering projects studies and construction, Hydrology and water resources and environmental management. He is member of the RAPEP (Rwanda Association of Professional Environmental Practitioners) and CORPORATE MEMBER of IER: Institute of Engineers Rwanda. He is also a CERTIFIED REAL PROPERTY VALUER: By the Institute of Real Property Valuers in Rwanda (IRPV) from the Year 2010.
Eng. Evergiste MUREKASHUNGWE is now a Lecturer at Rwanda Polytechnic / IPRC Kigali, Civil Engineering Department where different modules such as Groundwater engineering, hydraulics and hydraulic structures, water resources and environmental management are covered by Him.

I.6.2 Developer presentation

Water and Sanitation Corporation is a public company created by the law Nº 87/03 of 16/08/2014. The Water and Sanitation Corporation (WASAC) is the entity setup to manage the water and sanitation services in Rwanda as a result of the Government of Rwanda (GoR) decision to unbundle the national utility former Energy, Water and Sanitation Authority (EWSA).
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II. DESCRIPTION OF THE PROPOSED PROJECT

This section defines the project characteristics including its location, type, design layout and components. It also describes the various activities that will be undertaken during its

development.

II.1. Location

The project is to fully supply drinking water in the villages of the following:

Table II-1 Localization of the project and its area of influence

Districts	Sectors
Karongi District	Rubengera,
	Bwishyura
	Mubuga
	Rugabano
Rutsiro District	Gihango,
	Mushubati,
	Musasa
	Murunda

The project area is to have 100% access to clean water supply in the target area. This project will also contribute to enhanced hygiene and sanitation hence reducing water borne diseases. This will also contribute towards alleviation of poverty within the area through the improvement of socio-economic activities in target area mentioned above. The study comprises the analysis of raw water quality, the proposal of the appropriate water treatment process, the project implementation site selection, the design of the different components of the Kivu Belt water supply system.

II.2. Raw water quality

The Musorogo water was sampled at the proposed intake location and analysed for quality and the results of which were presented in the Feasibility Study Report. On physical and chemical analysis, the water was found to be slightly turbid and coloured and containing slightly higher levels of Manganese, Sulphide and Iron. It also contained unacceptable levels of coliforms that will require the full treatment process. It was found to other water parameters were found to be within the recommended Standards.

II.3. Treated water quality requirements

The basic requirements for drinking water as set by WHO Guidelines are that it should be:

- Free from pathogenic (disease causing) organisms.
- Containing no compounds that have an adverse acute or long-term effect on human health.
- Fairly clear (i.e. low turbidity little colour).
- Not saline (salty).
- Containing no compounds that cause an offensive taste or smell.
- Not causing corrosion or encrustation of the water supply system and not staining clothes washed in it.

Common constituents that do not affect health in concentration in which they normally are present in water may however affect the aesthetic quality of the water. The following quality is desirable for water, which should be generally accepted for human consumption and for all usual domestic purposes (Rwanda national standards and East African community standards for Potable Drinking water and WHO Guidelines).

Table II-2 Aesthetic Quality Requirements of Drinking Water

Substance or Characteristic	Drinking water Limit
Colour in True colour units (TCU), max.	15
Taste and Colour	Shall not be offensive to consumers
Suspended matter	Nil
Turbidity in Nephelometric Turbidity Units, max.	5
Total dissolved solids in mg/l, max.	1,500
Hardness as CaCO3, mg/l max.	500
Aluminium as Al, mg/l	0.1
Chloride as Cl, mg/l, max.	250
Copper as Cu, mg/l max.	0.1
Iron as Fe, mg/l max	0.3
Manganese as Mn, mg/l, max.	0.1
Sodium as Na, mg/l, max.	200
Sulphate as SO4-2, mg/l, max.	400
Zinc as Zn, mg/l, max.	5
PH	6.5 to 8.5
Magnesium as Mg, mg/l, max.	100
Chlorine concentration as Cl, mg/l	0.2-0.5
Calcium as Ca, mg/l	250
Ammonia as (N), mg/l, max.	0.5
Fluoride as (F mg/L) Max	1.5

To achieve desired treated water quality, the design recommends that a full water treatment cycle comprising of coagulation, sedimentation, filtration and disinfection. Aeration is also to be introduced to assist with elimination of sulphide and other volatile matter.

II.4. Design Water Demand and Flows

The water demands for Kivu Belt water supply project is estimated at 14,929 m^3/day as daily average demand and 19,408 m^3/day (≈19,500 m^3/day) as daily max demand for ultimate year 2035. The project is expected to be implemented in phases with each phase having a capacity of 6,500 m^3/day.

Table II-3 Design capacity

Items	Units	Total	Phase 1	Phase 2	Phase 3	Remark
Water demand (daily average)	m3/day	14,929				
Water demand (daily max)	m3/day	19,408				Factor: 1.3

Daily production amount	m3/day	19,500	6,500	6,500	6,500	
Operation loss	m3/day	975	325	325	325	Loss factor: 5%
System capacity	m3/day m3/hr	20,475 930	6,825 310	6,825 310	6,825 310	Operation hr:22

II.5. General Layout

The Kivu Belt Water Supply System obtains its water from Musorogo River. Abstraction is by means of an intake wear from where the water is pumped by low head pumps to the proposed water treatment plant site. The plant is comprised of three phases, all designed with identical capacities, layouts and working mechanisms. However, some components are designed and built for ultimate year as detailed below:

- The raw water pump station: civil and architectural works will be built by once. Mechanical and electrical works will be installed by phase.
- Cascade aerator
- Inlet stilling chamber and parshall flume rapid mixer
- Treated water pump station: civil and architectural works will be built by once. Mechanical and electrical works will be installed by phase

Intake Capacity

Intake facilities are difficult to expand to provide additional future capacity. For this reason, long range
water supply needs must be carefully considered during the intake design. We propose to design the
intake for the final design capacity of the WTP for domestic needs estimated to 19,500 m3/d for the year 2035 respecting a security coefficient for losses of 10 %. So, the design will consider the intake capacity for 19,500 m3/d x 1.10 = 21,450 m3/d. For raw water pumps additional pumps for raw water will be added regarding extension for two other phases.

Intake Level

Water levels at suction well is calculated as below. The ground of each water level is summarized as
shown in Appendix
High water level (flood flow condition): +1593.26 masl
Average water level (Normal flow condition): +1592.67 masl

Location and depth of the intake

The location the intake should be selected to obtain an adequate supply of water of the highest possible quality, with consistent reliability, economical construction, and minimal effect on aquatic life. After field survey by design team, the optimized intake point was identified at X= 435535, Y= 477183 and Z=1595 on Musorogo River in Rubengera sector. It is located 1.7km upstream of the WTP site.

Composition of Intake

Intake facilities divide into mainly three parts, i.e. intake weir, settling basin and pump station. Each

part consists of below structure and equipment.

- Intake Weir

- Weir
- Stilling basion with baffle pier
- Flushing gate

- Settling basin

- Trash rack
- Coarse sereen
- Fine screen (Bar size: width(5mm), depth(25mm), clear space between the bars: 25mm)
- Flushing gates
- Side spillway

- Pump station

- Suction well (length 12.5m x width 1.3 m x height 2.9m)
- Strainer (3 no. for each phase)
- Pumps (9 no. of pumps for 6 on duty and 3 stand-by)
- Vacuum pumps 1 set
- Moter control panel
- Crane (1.5 ton)

II.6. Treatment Process

Following a study of the raw water and desirable treated water quality, along with standard Rwandese practice as directed by the Client, the water treatment sequence adopted comprises of the following:

- Aeration
- Chemical dosing
- Rapid Mixing
- Flocculation
- Sedimentation
- Rapid sand filtration
- Chlorination and contact
- Storage and distribution

The water treatment plant also adopts sludge reticulation mechanisms to avoid water wastage and environmental pollution as follows:

- Sludge thickening
- Sludge drying

II.7. Detailed Design of Water Treatment Process

II.7.1 Inlet Pipe

Raw water from the distribution chamber enters the first phase of the treatment plant through an Epoxy Coated Steel pipe (DN 600). The pipe is fitted with a series of chambers housing the main strainer, the master meter and the sluice valve respectively. The design also provides for a bypass pipe to allow the plant to continue running in the event of maintenance or replacement of fittings within the three chambers. After the raw water main valve, same diameter of inlet pipe adopts to allow suitable velocity of 1.6m/s into the cascade aerator. This inlet pipe is sized as follows:

Table II-4 Inlet Pipe Design Details

Items	Dimensions	Units
Flow Rate at Ultimate year, Q	0.259	m^3/s
Adopted velocity (Min)	1.5	m/s
Inlet Pipe Cross-Sectional Area	0.16	m^2
Inlet Pipe Internal Diameter	0.45	m

II.7.2 Circular Cascade Aerator

From the inlet pipe, the first water treatment process is oxidation through physical aeration. The design has adopted a circular cascade aerator. It has a series of steps of varying diameters to increase the surface area for aeration to occur. The cascade will play a very important role in the oxygenation of the water and the oxidation of organic matter, iron as well as the degassing of any volatile elements present in the raw water.

The aerator structure is designed for ultimate year 2035 with a capacity of 20,475m^3/day. It shall be constructed as one unit during implementation of phase 1 and is expecte d to serve all future phases. The raw water rises to the top of the cascade aerator using head generated by the raw water pumps at the intake location. It then cascades down the steps in thin layers allowing air to dissolve and into the collection channel located at the bottom of the aerator. It exits through a DN600 pipe connected to the inlet chamber via gravity. The design of the cascade aerator is as follows:

Table II-5 Cascade Aerator Design Details

Items	Dimensions	Units
Flow Rate at ultimate year, Q	0.259	m^3/s
Number of Cascade Aerators	1.00	nr
Area Required	18.61	m^2
Number of Drops	5.0	nr
Height of drops	500.00	mm
Step of Drops	500.00	mm
Inlet Velocity Adopted	1.60	m/s
Height of cascade aerator	2.50	m

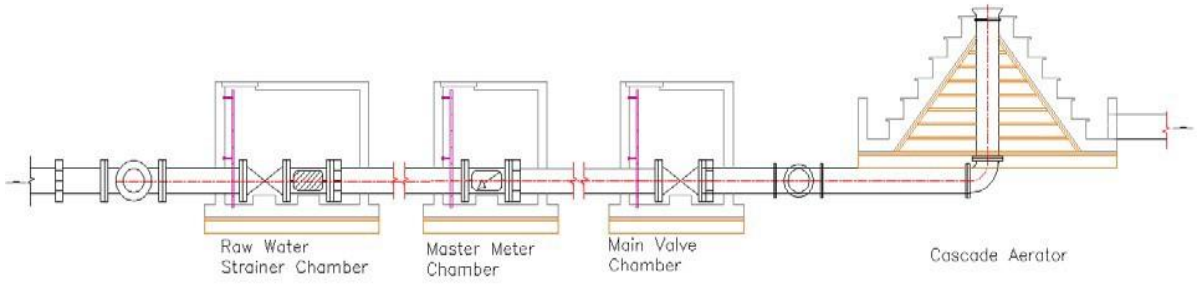


Figure II-1 Inlet pipe and Circular Cascade Aerator

II.7.3 Inlet Chamber

From the cascade aerator, raw water gets into the inlet chamber. The inlet chamber is designed for ultimate year 2035 with a capacity of 20,475m³/day. It shall be constructed as one unit during implementation of phase 1 and is expected to serve all future phases.

This chamber has been provided with an outlet on one end and a washout outlet on the side. Water is to accumulate in this chamber for 60 seconds retention time in order to stabilize flows before the chemical dosing and mixing. The inlet chamber is sized as follows:

Table II-6 Inlet Chamber Design Details

Items	Dimensions	Units
Flow Rate at Ultimate year, Q	0.259	m³/s
Number of Units, N	1.00	No.
Retention Time, Tr	1.00	Minute
Minimum Allowable Volume (Tr x Q / N =)	15.54	m³
Adopted Width	2.50	m
Adopted Length	3.20	m
Adopted Depth of water	2.00	m
Volume of Water	16.00	m³
Freeboard Allowance	0.30	m
Settlement Allowance	0.20	m
Total Depth of tank	2.50	m

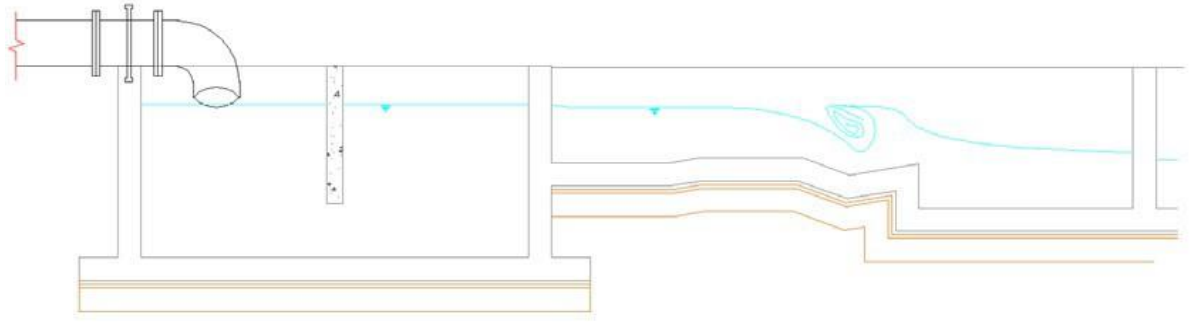


Figure II-2 Inlet Chamber & Chemical Mixing

II.7.4 Coagulant and pH control

For water treatment coagulation is key to achieving turbidity removal. Selection of coagulant has been made in consideration of the amount, quality and turbidity of the raw water while considering the filtration method and sludge disposal system.

Dose control is of high importance and is to be regulated by the lab technicians upon testing of the waters. Dosing is done in the chemical mixing chambers housed in the chemical building and delivered through conduits by gravity dozers. Dosage of soda ash for pH correction is also considered and is to be done as needed upon water tests during operation.

Dosage is determined according to the following:

- Dosage shall be decided on the basis of jar tests conducted regularly on site and set according to the quality of raw water.
- Concentration to which the coagulant is diluted or dissolved for actual dosing must be adequate as viewed from feeding and handling.
- Dosage must be calculated on the basis of water amount treated and feeding rate.
- Mixing must be performed in the mixing basin.

II.7.5 chemicals Mixing

The design proposes a parshall flume rapid mixer which is a fixed hydraulic structure. It is designed to introduce the critical flows and a resultant hydraulic jump immediately downstream of the flume which is utilized chemical mixing. A parshall flume rapid mixer has been preferred over other types of rapid mixers due to the following properties;

- The hydraulic jump obviates the need for mechanical agitation which is would otherwise require external power input and minimizes the clogging from suspended material that would otherwise accumulate on the floor of the rapid mixer
- The flume can be used to measure discharge
- It operates as a single head device with minimum loss of head (about ¼ of that required by a weir under similar flow conditions)
- It can be made entirely of materials locally available; in the case of Kivu Belt WTP, it is can easily be made using reinforced concrete.
- It can handle a wide range of flow rates

The flume comprises of three functional sections:

- The converging section on the upstream end;
- A constricted section or throat;
- A diverging section downstream

The flow of the converging section is horizontal, the floor of the throat inclines downwards and that of the diverging section slopes upwards. This particular Parshall flume is able to handle a variety of flows likely to be encountered at the water treatment plant.

II.7.6 Flocculation

The design has adopted vertical paddles wheel mechanical flocculators to promote agglomeration

to form large, fast-settling floc particles. They have been preferred over other hydraulic flocculators because of their greater flexibility in varying G values and significantly low head losses. Vertical paddle wheels also have the advantage of having no submerged bearings and involve lower investments compared to horizontal paddle wheel flocculators. Equipment manufacturers should be consulted to ensure appropriate paddle wheel designs are adopted for the flow rate.

The design capacity of the mechanical flocculator is 6,825m³/day for each phase. Two basins have been adopted for each phase with each phase having 3 identical flocculation compartments. This is to enable tapered flocculation by typically introducing zones of reduced energy input and to also prevent short circuiting. The first compartment is characterized by a high velocity while subsequent stages have a reduced velocity gradient. The compartments are square in shape to enable the paddle arms cover the maximum possible cross-sectional area of the flocculation basins as well as ease of construction. They are arranged in series and separated by reinforced concrete baffle walls. Water flows from one compartment to the next via penstock gates located on these walls. The floor of the flocculating basin is sloped by 1% towards the washout end. The basins and the paddle wheels have been designed as follows:

Table II-7 Flocculation Design Details

Items	Dimensions	Units
Flow Rate for Phase 1	0.086	m³/s
Type of Flocculator adopted	Mechanical	
Number of flocculation Basins adopted	1	nr
Design Capacity Per Basin	0.086	m/s
Water Volume Treated during retention time	129.26	m³
Cross-Sectional Area of Tank	36.93	m²
Number of Compartments per basin	3	nr
Volume of Compartment	43.09	m³
Width of Compartment	3.50	m
Depth of Water in Compartment	3.50	m
Free Board Depth	0.6	m
Total Depth of Tank	4.10	m
Retention Time	30	Minutes
Velocity Gradient in compartment 1	70	s-1
Velocity Gradient in compartment 2	50	s-1
Velocity Gradient in compartment 3	20	s-1
Gt	70000	
Max Length of Paddle arm (la)	1.50	m
Therefore, Wall Spacings lc	3.50	m
Basin Cross-sectional Area	12.25	m²
Compartment Depth Wa	3.52	m
Length of Paddle b	3.10	m
Area of 4 Paddle Ap	2.46	m²
Paddle width Wp=Ap/4b	0.20	m
Total Area of Paddles	7.39	m²
Clearance from water top	0.30	m
Clearance from Bottom	0.50	m

Depth of Paddles	2.70	m
Total Width of Paddles	2.74	m
Rotating Arms	4.0	Nr
Paddles per Arm	2.0	Nr
Total Number of Paddles	24.0	Nr
Width of one paddle	0.2	m
Clearance from walls	0.25	m
Area of one Paddle	2.46	m^2
Inner Paddle Radius	1.5	m
Outer Paddle Radius	0.75	m

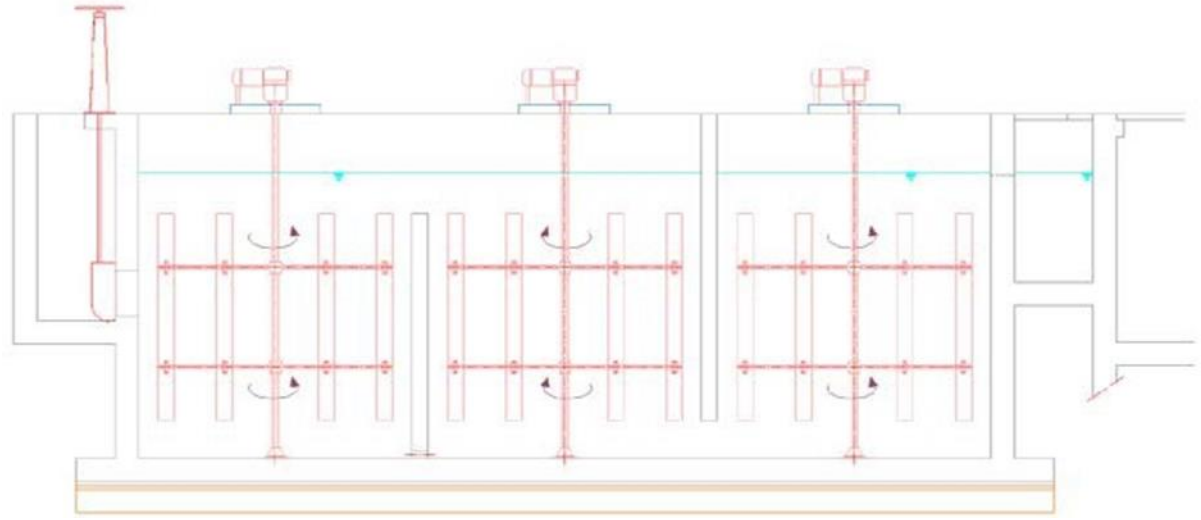


Figure II-3 Flocculation

II.7.7 Sedimentation

After flocculation, the water will undergo sedimentation. The purpose of this process is to remove the formed flocs after coagulation and flocculation through removable of settleable solids, thereby reducing the solid load on subsequent treatment processes. Water from the flocculation tanks will flow into the flocculated water channel from and enter the sedimentation tanks through 2nr. 600mmx600mm penstock-controlled gates.

The sedimentation tank is installed with lamellar plates, which are preferred because they increase settling area while reducing the area occupied by the tank. Below the lamellar the flow is reversed and streams up through the plates. The solids slide down along the lamellar and accumulate in the sludge funnel located at the bottom of the tank. The sludge is to be emptied periodically through sludge washout chambers located at the sides of the sedimentation tanks.

The clarified water flows further upwards and is collected using V-Notch launder weirs to the settled water outlet channel.

The design for the sedimentation tanks is as follows:

Table II-8 Sedimentation Design Details

Items	Dimensions	Units

Flow Rate for Phase 1, Q	0.086	m^3/s
Surface Loading, So	2.5	m^3/m^2h
Retention time, Tr	20.0	min
Sludge collection channel slope	8.0	%
Additional depth for sludge accumulation	1.5	m
Plate Length	2.55	m
Plate Width	1.25	m
Degree of Lamellar inclination (θ)	60.0	o
Plate Thickness	0.7	mm
Horizontal Plate spacing	100.0	mm
No. Of sedimentation Tanks	1.0	nr
Quantity Treated by each basin	0.086	m^3/s
Tank capacity	103.4	m^3
Flow volume per hour	310.2	m^3
Area of one Plate	3.19	m^2
Horizontal projected area of plate, Ap	1.29	m^2
Number of Plates	78	nr
Projected Width of Plate	0.63	m
Spacing of plates + Plate Thickness	7.85	m
No. Of compartments per basin	2	nr
Length of Tank	4.50	m
Projected Depth of Plate	1.08	m
Depth of water above Plates	0.125	m
Depth of Sludge Collection area (Deepest end)	1.50	M
Depth of Sludge Collection area (Gulley Trap end)	1.68	m

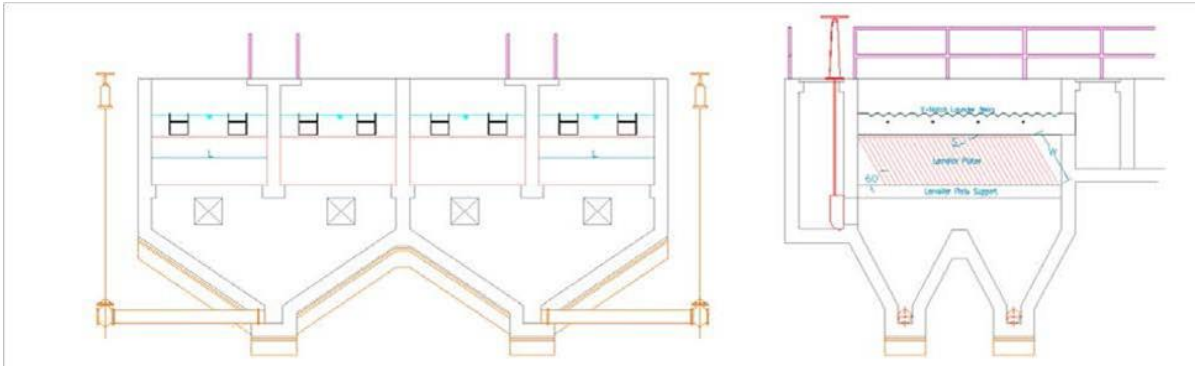


Figure II-4 Sedimentation

II.7.8 Filtration Filter Bed Design

Rapid sand filters of gravity type have been adopted for the project. The design capacity of

the filters is 6,825m³/day for each phase. Each phase has an additional standby filter to be operated during backwashing of each duty filter.

It has been preferred due to the following advantages over slow sand filters:

- Occupy significantly less land
- Easy and quick cleaning via backwashing in case of clogging
- High filter rate per square meter
- Effective in removal of turbidity

Settled water from the sedimentation tank shall flow to the filter inlet channel by means of a 500mmx500mm penstock-controlled gate. To prevent water punching on the sand, water shall be distributed on the filter bed through two channels located 750mm above the filter bed.

A depth of 50mm water shall be maintained above the filter bed at all times to avoid cracking of the filter media. This has been achieved by raising the outlet level in the filtered water sump. The filter media adopted in the design is quartz sand with a gravel support bed at the bottom.

Highlighted below is the design of the filters and associated channels within the filters

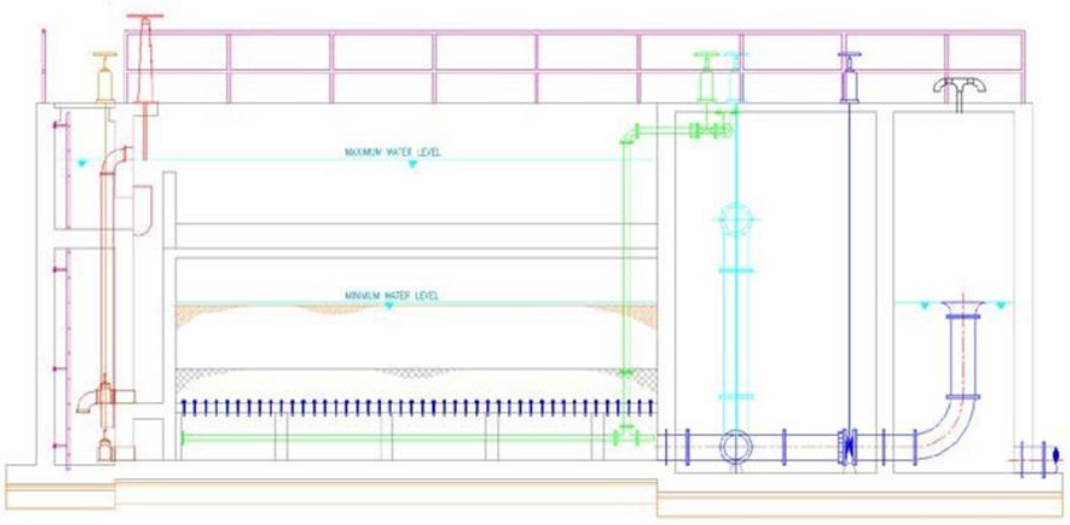


Figure II-5 Rapid Sand Filters

Table II-9 Filter Bed Design Details

Items	Dimensions	Units
Flow Rate at Ultimate year, Qu	0.086	m³/s
Number of duty Units for ultimate, Nu	2	No.
Flow rate per filter	0.043	m³/s
Total number of Units for ultimate + standby	3	No.
Filtration Rate, S	5	m3/m2h
Minimum area required for Filtration, Au	62.1	m²
Minimum area per filter, au	20.7	m²
Area, A	20.7	m²
Breadth, B	5.00	m
Length, L	5.25	m
Total Head loss	11.61	mm
Allowance for underdrains	0.01	m

Depth of filter media	1.00	m
Depth of Support Bed	0.55	m
Clearance above sand bed and below wash water troughs	0.85	m

Under-Drain of the Filters

The adopted underdrain system is strainer nozzles fixed to a false-bottom under the support bed. This type of underdrain has been preferred because of their ability to collect water from the underside of the bed in an even manner and to spread air and water uniformly through the bed during cleaning. They may be constructed of stainless steel, plastic or brass. The density of the nozzles to be taken to be between 30-35 nozzles/m².

Table II-10 Under-drain Details

Items	Dimensions	Units
Flow through one nozzle, (Q/CdA)2/2g)	0.000370	m³/s
Head loss through underdrains (Hfo)	0.16	m

Backwash System for the Filters

Filter backwash is achieved by applying air and water in a reverse direction through the backwash process. The backwash pipe is designed to deliver water at a rate of 40m³/m²/h from the backwash water reservoir located within the clear water tank. This backwash rate is adopted as it is just efficient to induce fluidization velocity with little bed swelling. This process is designed to run for 8 minutes per filter. The backwash water is delivered to the filters by means of low head pumps housed in the pump house. The backwash design calculations are as follows:

Table II-11 Backwash Design Details

Items	Dimensions	Units
Backwash Rate	0.4	m³/s
Backwashing Period	8	minutes
Volume of Backwash Water	140	m³
Diameter of Backash Pipe	0.60	m
Velocity of Flow	1.42	m/s
Total Headloss in Backwash System	9.65	m
Head loss of backwash	4.0	m

17. Disinfection

Disinfection if the last water treatment process in order to remove coliforms before distribution. Disinfection is required for bacterial compliance and the most cost-effective

option is chlorination with the added advantage of giving a residual in the distribution network for improved protection of public health.

The design disinfectant is chlorine in the form Calcium Hypochlorite granules (HTH). The solution is mixed to the appropriate dosage in the chlorine mixing tanks in the chemical house and fed into the water by means of pumping. Chlorine mixing is through agitation via using turbulence created at the clear water tank inlet. A tap for sample collection should be provided at the outlet of the clear water tank.

Clear Water Tank

Filtered water, after chlorination will be retained in a clear water tank for a minimum retention time of 30minutes to allow for contact time. However, the clear water tank is a combination of a contact tank and a storage reservoir, for the distribution system. Hence, more than adequate storage and contact time is provided for than required. Accordingly, 3hours is adopted for storage duration.

A minimum capacity of 930.0 m^3 is therefore required for this purpose. However, the Consultant has provided a clear water tank with a capacity of 1,000m^3 for extra storage during the peak hours and during any downtimes.

The residual should be 0.3-0.5 ppm free chlorine after half an hour contact period. An access manhole is provided at the roof slab for easy access to the clear water tank during cleaning and maintenance. Air vents are also provided to allow proper air circulation within the tank. Baffle walls are provided to reduce short circuiting and zones of dead water.

II.8. Detailed Sludge Treatment Process

Sludge Thickener

To facilitate proper disposal of water used for backwashing of filters, which is as much 5% of total treated water and the sludge collected during cleaning of the sedimentation units, it is advisable to provide a secondary sludge clarifier to thicken the sludge before drying on the sludge drying beds. This is adopted due to the space constraints in the area which does not give much room for traditional waste water lagoons.

The sludge thickeners are designed to accommodate up to nine backwashes daily at ultimate year and 25% volume of the sedimentation tank reserved for sludge storage. It is planned that at least one filter for each phase will be backwashed a daily. It is expected that only one sedimentation tank will be cleaned at a time per day. Cleaning of the sedimentation tanks can be done once every month or as need arises as per the discretion of the scheme manager. Therefore, 420m3 of sludge water will be generated by filters and sedimentation tanks on the critical day. Therefore, the project provides 1 no circular gravity sludge thickeners of 7.0 m diameter and 3.3 m deep (3.0m effective depth, 0.3m free board area) of total tank volume is 153m^3 (115m^3 for the supernatant region and 38m^3 for the hopper region).

The sludge thickener is to be installed with a motor controlled rake arm, rotating within the tank to enable Settlage of particles. These mechanical units are not determined by the

manufacturer before installation on site.

Supernatant water from the sludge thickeners is collected and recycled by pumping back to the inlet chamber. Settled sludge collected from the bottom of the hopper zone is collected and periodically emptied into the sludge drying beds.

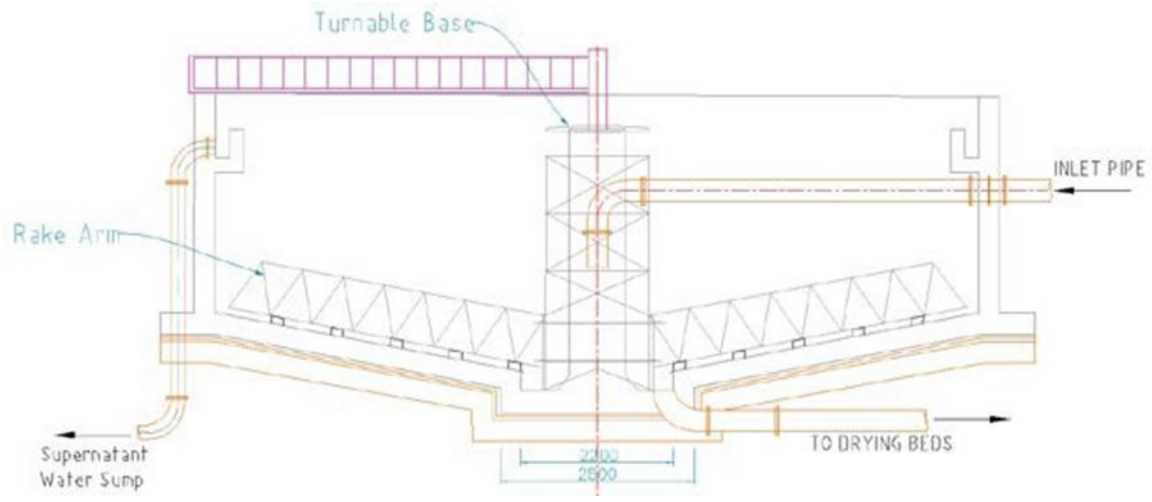


Figure II-6 Sludge Thickener

Sludge Drying Beds

Sludge drying beds are necessary to prevent pollution of the receiving waters. It is proposed that sludge produced in sludge thickener be discharged to the sludge drying pond, supernatant be drained into a soak pit, and dried sludge manually removed from the beds and taken to a landfill away from the treatment works site. The design has adopted 60 days as a satisfactory period for sludge drying before removal.

Due to high turbidity in the rainy season, sedimentation tanks are likely to produce more sludge than in the dry season; therefore, the surface load is taken to be in the range of 0.1 – 0.5 m3/ m2h. The sedimentation rate is assumed to be 0.1% of the surface loading rate though actual rates shall be determined after settling tests are done on water treatment plant during the implementation of the project. Three parallel monolithic drying beds have been provided with dimensions of 13.7m x 4.5 m with a bed slope of 1%. They are to be filled with graded aggregate as detailed in the specification document and the drawings. A DN200 central open jointed concrete pipe is to discard any water (from rain or otherwise) to the soak pit.

II.9. Building Design

In addition to the main elements of the treatment works, the following building works shall be included within the treatment works complex.

- Water treatment works
- Intakes works
- Generator and main power house
- Chemical storage house
- Administration block

- Manager house
- Staff house
- Guard house
- Chlorine storage house
- Warehouse
- Treated water pump house
- Recurculatin Pump House
- Raw water pump house
- Guard house
- Main power house
- Generator house

Description of Structural System

(a) Foundation

Soil investigation was carried out at the site of the proposed project. Based on the recommendation of the soil investigation report and estimation of the loading to be borne by the soil, foundations and retaining walls for the treatment plant tanks were designed.

walls for the project are both load bearing and non-load bearing walls. The load bearing walls acting as retaining walls were designed to support and retain the loads including the imposed loads which are mainly soil and water using the standards and codes given in above chapter 2) Design References.

(c) Slabs

After an intensive analysis of dead and imposed loads on slabs while considering the functional use of the structures; the slabs were designed to carry the analyzed loads. The design was carried out without compromising the required specifications and standards as per the mentioned structural standards and codes in above chapter 2) Design References.

4) Materials

(d) Concrete

Concrete grades for main reinforced Concrete Works shall be as follows:

Structural Concrete:

- Bases, Rc walls: Grade C30/20 (Characteristic strength = 30N/ mm², Maximum aggregate size = 20mm)
- Slabs, beams and Staircases: Grade 25/20
- Blinding Concrete: Nominal mix 1:3:6 (equivalent to C15)

(e) Reinforcement

Reinforcing bars shall comply with BS latest 4449. All steel fabrics shall comply with BS 4483: Specification of steel fabric for the reinforcement of concrete.

- High yield rebar: fy = 500 N/mm² (type I bond characteristics)
- Mild Steel rebar: fy = 250 N/mm² Specification of rebars is in accordance with B.S 4449.

(f) Structural steel

Structural steel shall be grade 43A, 43B, or 43C to the relevant BS, with yield stresses in the range 245 N/mm² to 275N/mm²

(g) Roofing

Corrugated iron sheets on timber trusses.

II.10. Landscape Design

1) Concept of Landscape Design

The goal of this section of the report is to address concepts, procedures and models for conducting landscape analysis for geographic areas, local integrated resource areas, and for linking these analyses together in a hierarchical sense.

The principles of landscape design for this project take into consideration the design brief, the site analysis and the overall aims for the project. These are as follows:

2) A Healthy Outdoor Working Environment

A healthy working environment and safety through the provision of balance and integration between the hardscape and softscape elements.

- Well-distributed trees within spaces to provide a comfortable climate, shade and respite from weather conditions.

3) Comfort and Safety By Design

- That provides Evergreen trees for shade, respite from the weather. Landscape design good circulation and ease of access for users.

4) Sustainable Landscapes and Environmental Enhancement

- Fostering appreciation of the natural values of the site by using native species and local low- cost materials.
- Use of suitable plants and low-cost elements to conserve water and create an efficient system.
- Using locally sourced materials, whenever possible, to minimize transport distances.
- Use of plants that are resilient to severe weather conditions and suitable for the weather conditions.
- Planting selection should minimize & control adverse impacts to human health, safety and the environment from emissions to air.
- Integrating storm water treatment into the landscape for water quality treatment and to maximize water management efficiency.
- Surface runoff from process areas or potential sources of contamination should be

prevented.

- Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales).
- When water quality criteria allow, storm water should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility.
- In order to increase traffic safety, pedestrian interaction with vehicular movement should be minimized.

2) Landscaping Works

Landscape design work is presenting the landscape elements (Hardscape and Softscape) . The principles of landscape design are as follows:

- Distribution of trees and pattern had fulfilled the required comfort climate for open spaces by shading and low temperature to reduce the effect of desert climate.
- Using low-cost maintenance elements.
- Using suitable plants with low water consumption.

Landscape works cover two parts; softscape and hardscape. A brief description for each of the two landscape works sections are described hereinafter:

3) Softscape

The softscape design should provide certain measures regarding safety, sustainability and environmental enhancement, which are as follows:

- Providing shadow
- Creating a comfortable micro-climate
- Emphasizing gates entrances
- Protect areas from dust and sand storm
- Provide a healthy outdoor environment

(a) Softscape Elements

The planting palette for this project has been carefully selected and is outlined below.

- Trees: Albizia julibressin, Plumeria alba & Ficus benjamina
- Groundcovers: Lantana montivedednse & Wedelia trilobata
- Grass: Paspallum Vaginatum Sea Shore

The details of the selected plants are provided below.

Table II-12 Trees

Tree	Albizia julibrissin	Plumeria alba	Ficus benjamina
Common Name	Persian silk tree	White franggipani	Weeping fig
Height	7-12m	6m	30m

Spread	6m	4m	12m
Water Requirement	High	High	Medium
Light Rq	High	High	High
Salinity Tolerance	Low	Low	Medium
Uses	Shade, ornamental	Shade, Fragrant	Shade

Table II-13 Grass

Grass	Paspalum Vaginatum Sea Shore
Common Name	Sea shore
Height	0.125m
Spread	0.1m
Water Requirement	High
Light Requirement	High
Salinity Tolerance	Low
Uses	Lawn

4). Hardscape

High quality and comfortable hardscape elements are important landscape features. It complements the soft scaping and are used to direct pedestrian and vehicular circulation.

(a) Hardscape Design Guidelines

The hardscape selection must be with low-cost materials that provide minimal maintenance, also to be used with local materials to minimize the overall cost of transport.

(b) Hardscape elements

The following hardscape elements have been selected for project:

18. Gravel

4 mm. Gravel is a widely used commercial product, with a variety of applications. Many roadways are surfaced with gravel, and this material works well in a range of soil conditions.

19. Interlock

Interlocking concrete pavers are generally low cost, easily installed and maintained, and have high durability. Interlocking is a popular alternative to brick, clay or concrete.

The benefits of interlocking concrete pavers are the large variety of paving styles, colors, flexibility, the low-cost, low-maintenance and strength. The pavers also move well with soil conditions.

II.3. Raw water quality analysis process

The Consultant drew samples from the proposed intake works at location X=434940, Y= 4771746, Z= 1601 and hired three different laboratories for raw water quality sampling, testing and analysis. These were WASAC, University of Rwanda (UR) and RSB laboratories. The WASAC laboratory was used for the tests in Table below, University of Rwanda laboratory was

used for Sodium parameter and RSB laboratory was used for residuals of pesticides and potassium parameter. The supporting documents on the laboratory test results are attached in the Appendix 1.

The results for Sodium parameter, residuals of pesticides and potassium parameter, results for the physio-chemistry and bacteriology using the Rwanda national standards and East African community standards for Potable Drinking water (RSEAS12:2018Third Edition).

The results for Musogoro Water quality analysis from the proposed water intake showed the following key information for water treatment purpose:

- While designing the WTP process our design have given
- particular attention to the following physico-chemical and Bacteriological parameters (Total coliforms, E-coli, Turbidity, Colour, Manganese, Suspended Matter, Sulfide, Iron) because there above the set standards.
- The jar test results provided by WASAC laboratory concluded that the succeeded tests were found to be at 6 ppm as optimum SUDFLOC 3870 to treat this water. Since the flocs are large it means the treatment process will need lesser time to settle down.

For Musogoro raw water sampled from the proposed intake at Rubengera sector to comply with Rwanda National Standards and East Africa Community Standards for portable drinking water, a full treatment process is recommended.

II.2.2 Conclusion on Raw Water Quality

The raw water quality of the Musogoro River is characterized by:

- Medium turbidity 209 NTU on the time of the sampling (August 2020) which corresponding to the dry season; the design has taken care of the increasing of this value during the rain and flood season. For this we have designed a WTP to treat water with a Turbidity of a 400 NTU to avoid any problem when this turbidity will increase after a flood.
- The suspended matter of 77 mg/l and the color of 692 mg/l Pt, this value for color is relatively high but can be controlled by a conventional water treatment stage.
- The concentration of Iron element 2.67 mg/l which should not exceed 0.3 mg/l fixed by the standards for the treated water.
- The concentration of sulfide element 0.109 mg/l which should not exceed 0.05 mg/l fixed by the standards for the treated water
- The high concentration of the Silica element 14 mg/l which should not be detectable on the treated water. The Coagulation process using the Sud floc followed by a flocculation and settling will remove the Silica.
- The normal raw water biological quality (Total coliforms and Escherichia coli). The oxidation, removal of suspended matter and disinfection will produce clean treated water from all pathogens.

Regarding the table below and except the color value, the raw water for Musogoro River can be classified according to the European Communities (Quality of Surface Water Intended for

the Abstraction of Drinking Water) Regulations, 1989 as the Category A2 waters.

For this Raw water category, a normal physical treatment, chemical treatment and disinfection, e.g. prechlorination, coagulation, flocculation, decantation, filtration, disinfection (final chlorination) is sufficient and can be adapted:

- To Improve and ensure the treaded water quality we propose to use the Activated Carbon which can remove the excess of heavy metals in our case Nickel concentration by adsorption. We maintain the Powder Activated Carbon (PAC) cheaper and simple to employ compared to Granulated Activated Carbon (GAC).

II.3 Proposed Water Treatment Processes

As a result of the analysis and evaluation of the raw water available, the choice of the treatment method to be adopted has been made up of:

- Perchlorinating - oxidation of the raw water by the Calcium chloride (oxidant for color, iron and sulphide).
- Cascade Aerators especially needed to remove the sulphide from raw water; lime milk dosing for pH adjustment especially on rainy season;
- Coagulation on rapid mixing and SUDFLOC 3870 dosing;
- Dosing PAC (Powder Activated Carbon) to remove Micro-pollutant and heavy metals (anticipate the river Contamination);
- Flocculation on slow mixing within sludge recirculation to improve sedimentation efficiency for low raw water turbidity;
- Clarification with tube Settlers tanks equipped with circular sludge collection systems with corner sweeps to increase the sedimentation efficiency;
- Rapid Granular media filtration system;
- Lime milk dosing for treated water pH adjustment.
- Disinfection as a final chlorination by Calcium chloride.

Before the clarification, it was considered necessary to insert the adsorption with activated carbon to refine the treatment in terms of elimination of any, odors, organic (traces of pesticides) or mineral (traces of heavy metals) micro pollutants.

As well to increase the sedimentation efficiency, the sludge recirculation is maintained due to the low raw water turbidity difficult to settle or to allow quick restart after shut down or stoppage of production.

Table II-14 Raw water quality Classification according to European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989

Parameters	Unit	Musogoro River results	Surface Water Regulations [1989] For A2 Waters
Total coliforms	MPN/I00 ml	**>2419.6**	<25000
E.Coli	MPN/I00 ml	**>2419.6**	5000 Faecal coliforms

Turbidity	NTU	**209**	1000.0
pH	-	**7.5**	5.5-9
Color	mg/l Pt	**692**	100
Suspended matter	mg/l	**77**	No reference
Iron	mg/l	**2.67**	0.3
Silica	mg/l	**15**	No reference
Sulfide	mg/l	**0.109**	No reference
Nickel	mg/l	**0.07**	No reference

The jar test results provided by WASAC laboratory concluded that the succeeded tests were found to be at 6 ppm as optimum SUDFLOC 3870 to treat this water. Since the flocs are large, it means the treatment process will need lesser time to settle down.

To Improve and ensure the treaded water quality we propose to use the Powder Activated Carbon which can remove the excess of heavy metals concentration by adsorption. We maintain the Powder Activated Carbon (PAC) cheaper and simple to employ compared to Granulated Activated Carbon (GAC).

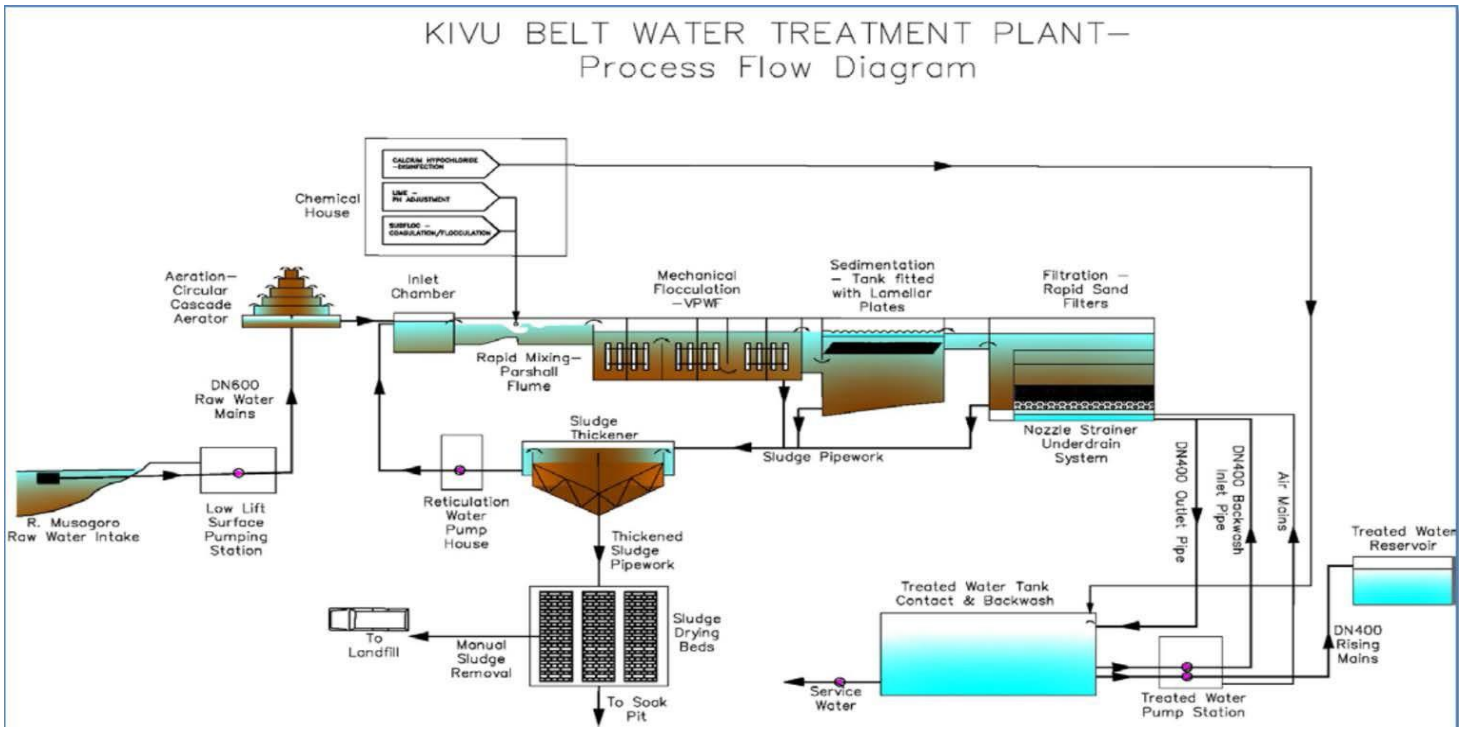


Figure II-1 ***Water treatment process Flow***

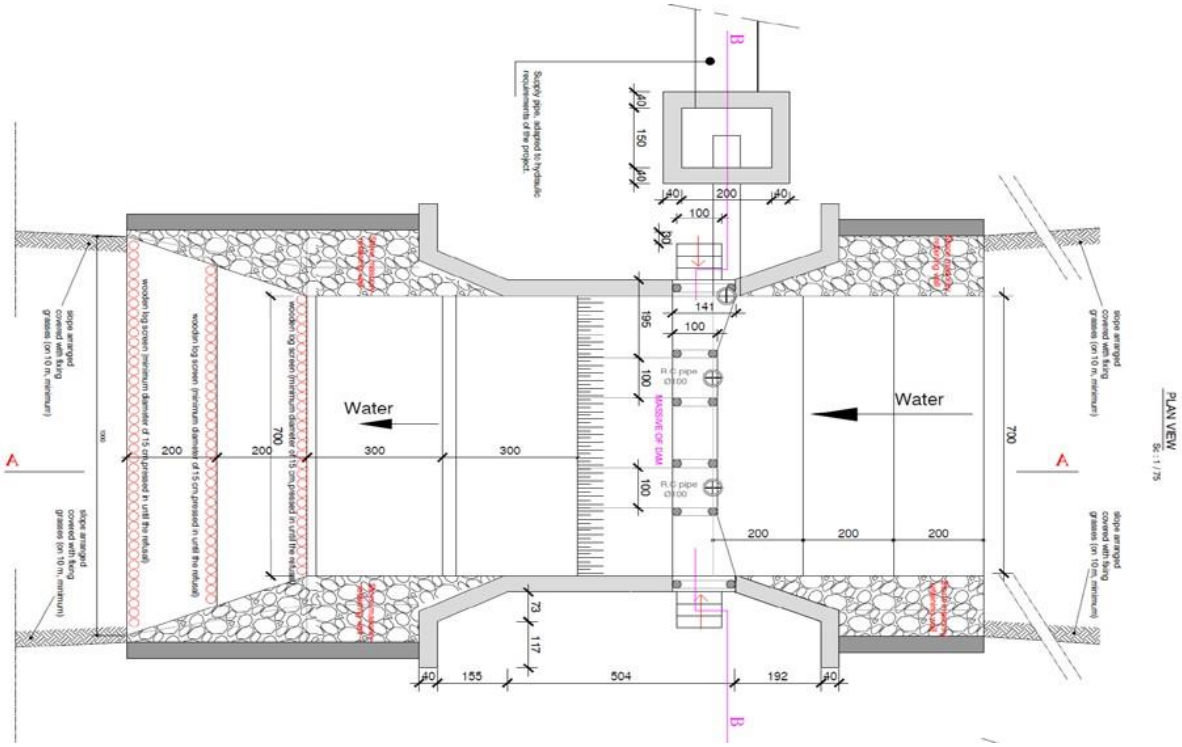


Figure II-8 Intake plan view

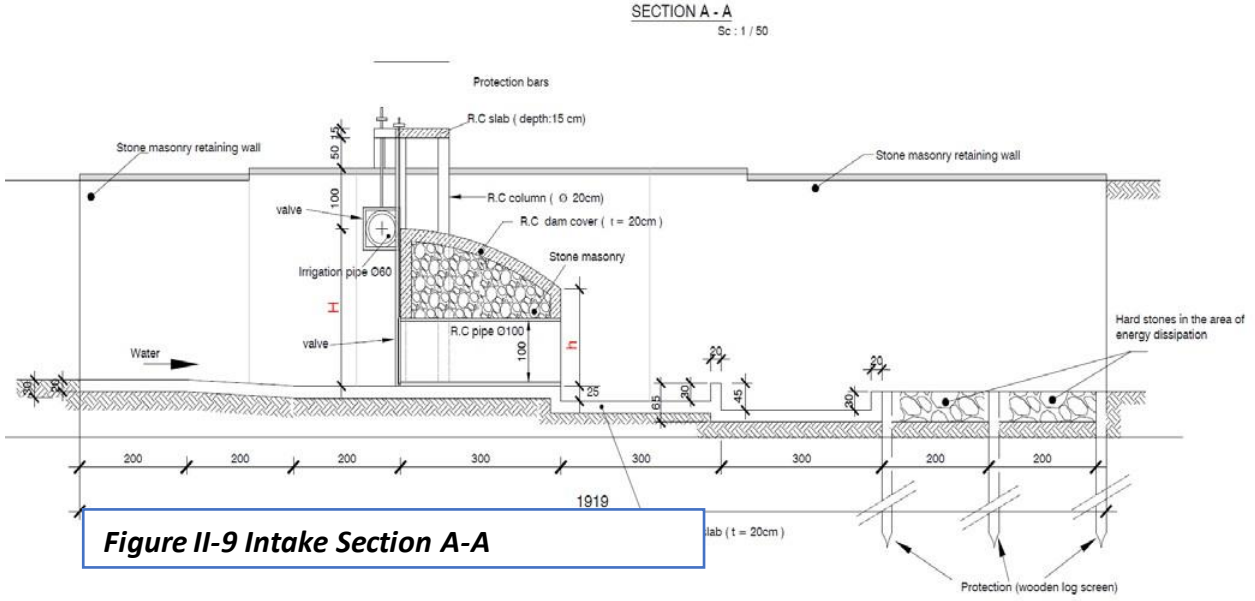


Figure II-9 Intake Section A-A

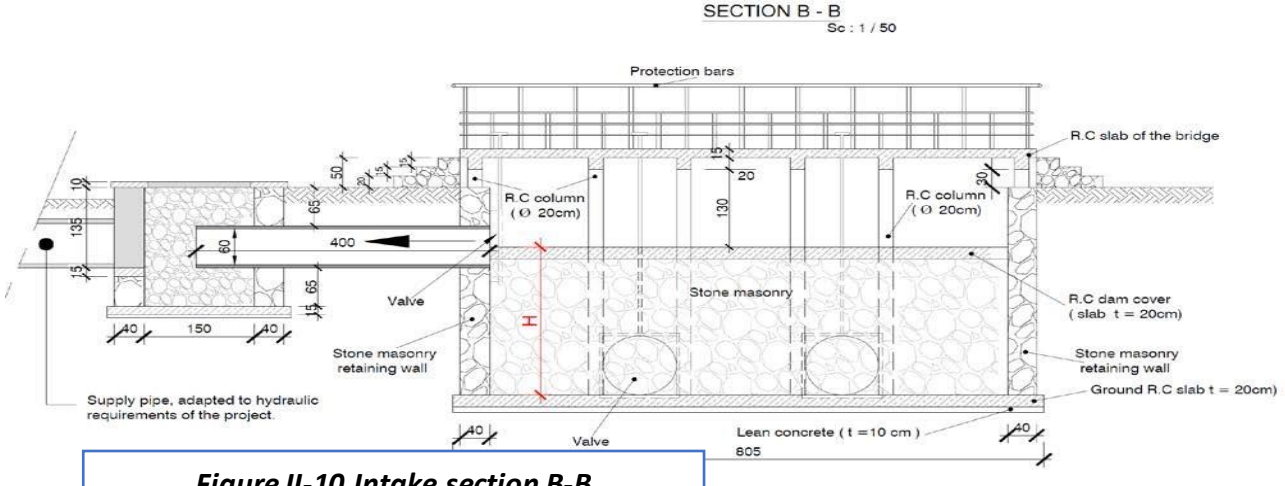
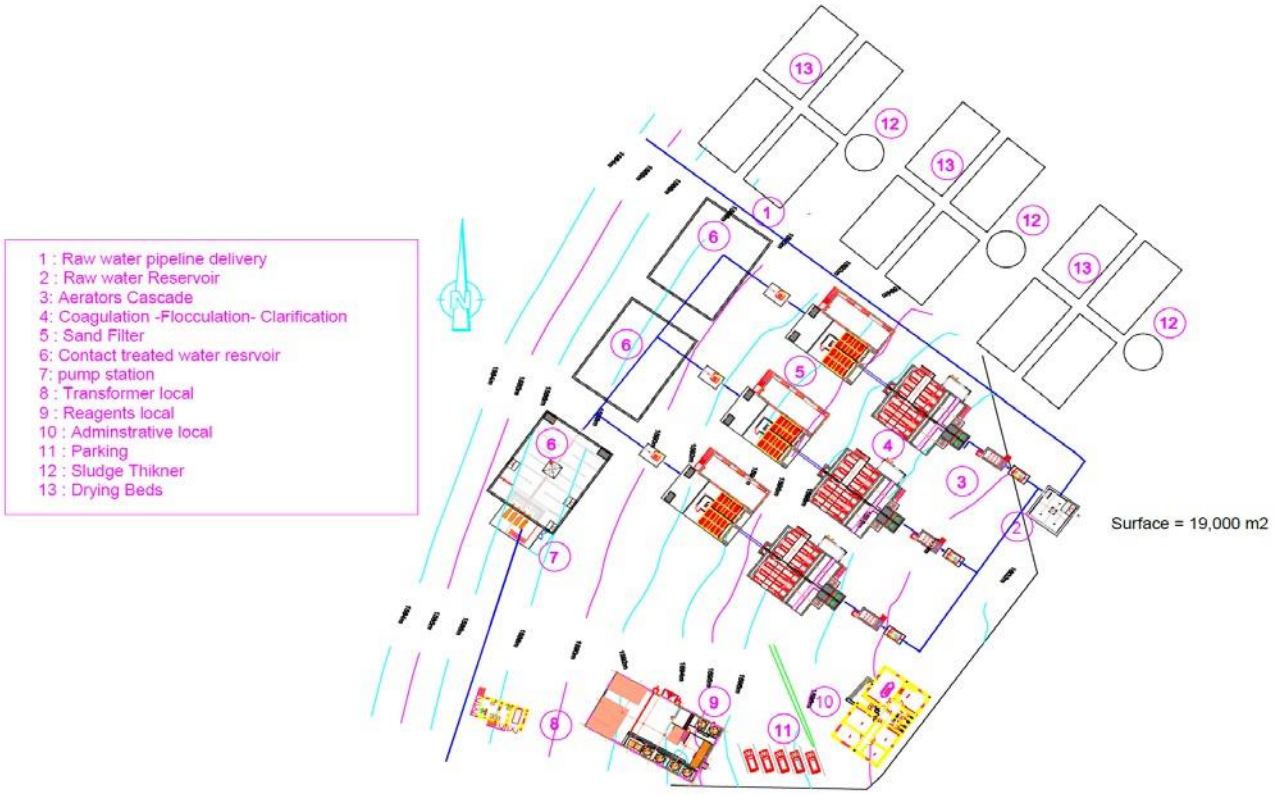


Figure II-10 Intake section B-B



II.4. Installation of pumping stations (capacity, technology)

9 pumps will install for supply water amounts for final stages. Each phase has 2 duty pumps and 1 stand by pump. Civil and architectural works will be built by once. Mechanical and electrical works will install by phase. Therefore, all the raw water pumps (6 on duty and 3 stand-by) will be installed in the first phase.

- Flow: 170 m3/hr for each pump
- Head: 22 m

There will be a Vacuum pump if the length of suction pipe is increase, it is impossible to lift water from suction well level to pump elevation without any additional equipment. 5.8m long suction pipe is adopted in order to prevent excessive earthworks for the Kivu intake pump station. Thus, a vacuum pump plan to install in order to lift and fill water in the suction pipe when main pumps restart.

- Flow: 70 m3/hr x 1 vacuum pump;
- Head: 740 mmHg

The Main pumping station at of Musogoro river to deliver water at the first booster to keyenzi reservoir located to Bunyankungu village, Musogoro pumping station will be have 2 pumps unity on duty with capacity of Q=165m3/h and TDH=230m each and one standby for Phase I. Based on the pipeline plan layout drawing and the profile drawing, the pipeline components including pipes, junctions, valves, pumps and reservoirs are set up in the hydraulic model and the pipeline profile together with the system Head Curve are manipulated by a module integrated in Water Cad software.

Selection of operational site of possible Pumping Station

The pumps are designed based on maximum hour demands. The total dynamic head will determine the number of pump stages required. Pumping stations are designed to suit the maximum day demand of the year 2035. All mechanical / electrical works are designed to enable a straightforward expansion of capacity. This ensures minimum disruption to the water supply system during any future expansion. Wherever possible, pumps operate under a negative suction head and are of the horizontal split-casing centrifugal type. Each pump has a gate valve upstream and downstream for maintenance purposes together with a non-return valve downstream. Pump protection devices will be specified to prevent damages to pumps caused by no water or closed delivery valves. Motors have to be protected against phase failure as well as too low or high voltage. The common delivery pipe from the pumps will be equipped with a bulk flow meter plus a pressure gauge.
The requirements for surge protection are determined on a case-by-case basis during the design. The velocity at the suction side of the pump shall not exceed 1m/s on inlet main and 1.5 m/sec on inlet branches if available. The velocity on the outlet side shall not exceed 2m/sec on outlet branches. The principle of pump design for a water supply system is shown here in below.

Pump Capacity and Hydraulic Design

The hydraulic design includes the determination and sizing of the following Components:
•Design head

•Design pump capacity (flow rates)

•Selection of pump type and system characteristics

When pumping water from a well, reservoir or any water source to a higher elevated reservoir, the required pumping head, "H", consists of a Static Head "HST" also called geodetic head and the head of the Transport system, also called Dynamic Head, "HDY"

$H = H_{ST} + H_{DY}$

The Static Head, "HST is the difference in water levels between pump suction and discharge points,
i.e., the reservoir maximum water level.
Governing criteria for estimation of dynamic head is the hydraulic design of transmission pipe which accounts parameters such as flow rate, velocity, and hydraulic gradient and friction losses and other minor dynamic head loses in the fittings etc.
Accordingly, the Hazen-Williams equation has been used to determine the Dynamic head of the pump as follows:
The head loss in the transmission main is calculated using Hazen Williams's formula
$Hf = 10.67 \cdot Q^{1.852} \cdot C^{-1.852} \cdot D^{-4.87} \cdot L$ (1) Where Hf= Friction loss in meter

Q= Discharge in m3/s (maximum day demand assuming 20-hour pumping)
C= Hazen William's Coefficient (HWC)
D= Diameter in meter
L=Length of the pipe in meter

To determine the flow of electromechanical equipment, number and the power required, we took into consideration the following principles:

- Theoretically two or more (number n) of identical pumps operating flow Q, giving simultaneously (parallel operation) Q1 flow less than the sum of flow rates (Q *n). Providers generally recommend considering only 90% of the total flow rates (90% x n x Q)
- We recommend one more reserve pump.
- power of pumping equipment is calculated using the following formula:

$$PP = \frac{(\rho\rho\ gggg\ HH\ QQQQ)}{yy}$$ With:

- P: the power of pump unit (combination of the pump and electrical motor) inWatts.
- ρ: density of water in kg/m3 (taken equal to 1000 kg/m3)
- g: Average intensity of gravity (taken equal to 9.81 kg/m2)
- H: height of the total load by meter (which corresponds to the TDH)
- Q: Flow rate in m3 / s.
- η: efficiency of pumping unit (taken equal to 75%)

II.5. Pressure breakers

Pressure breakers within the project area are 8 with 2m^3 per each of the planned to construct

II.6. Design of electric power supply to run electric equipment

Special attention will be required in locating and indicating the existing powerlines that could be extended for power supply to the proposed water treatment plant, raw water pumping stations and treated water pumping stations within the network.
The power demand to operate the raw water pump station, is expected to be allocated from the nearest public electricity network passing through the area which is three-phase mean voltage (MV) power grid that was identified at Rubengera sector.

Regarding the provisional power balance for the WTP and all booster pumping stations, the estimated value of the Total Active absorbed Power (Pa.T) the electricity cost is estimated for every option are summarized in the table bellow

Table II-15 Summary of Power consumption on each option

Name	Average Energy per Day (kWh)	Average Energy per Month (kWh)	Energy per Year (kWh)
Option 1	68,782	1,925,896	23,110,752

Generator

Due to fluctuations in electrical power supply experienced in the region, it is a good practice to provide a standby generator at the water treatment works and Intake. A direct diesel driven generator shall be provided a generator house has been provided to house the generator.

Earthing and Lightning Protection System

In the western province specifically in karongi and Rutsiro district where is the concern of lightening, so based on this experience in the project area, the lightening protection need is proposed to be installed in all major water supply installations.

- The electrical system and equipment will be grounded in compliance with the NFC C17-102, NFPA 780 and IEC 62305. A double insulated copper down conductors of 35 sq.mm shall be installed;
- A lightning protection level one (1) has been considered with a coverage distance of over 79Meters radius each. Three lightning arrestors will be installed in the plant to provide coverage for the whole area;
- The H-poles that terminate to the transformers shall be installed with surge diverters, solidly ground with an independent earth mat;
- A disconnect box shall be installed to connect the lighting to the earth mat;
- The disconnect box shall also double up as a test pit to measure the resistance (minimum resistance required should be less than 10 ohms) A 35 sq.mm grounding ring will be provided around all buildings and major structures;
- Electrical equipment, devices, panel boards, and metallic raceways will be connected to the ground conductors;
- Transformer neutrals of wye-connected transformers will be solidly grounded through a grounding conductor connected to the grounding system;
- A dedicated earth mat of 10 X 10 grid shall be installed in the plant area;
- A ground wire will be installed in all raceways that contain power conductors at any voltage;
- The single exception is the medium voltage circuits that use shielded conductors or cable;
- These circuits will not have a separate ground conductor in the conduit.

II.7. Storage reservoirs

Volume of necessary reserves

Water is delivered to the reservoir in the system directly through the transmission main and completely separate from the town's distribution system. These allow greater control over the quality of water delivered to the consumer. There will not be large variations in the length of time that the water is in the system.

The storage capacity required for primary transmission system has been calculated by considering 20% of the average daily water demand (Source: Rwanda regulation on minimum required service level, 2012). The total capacity of storage reservoirs proposed range between 40 – 50% of total water daily demand for covering domestic, industrial and public water needs including the emergency flow in case of pipe breakdown on transmission line or pump failure from primary to tertiary mains for distribution. The proposed water reservoirs within the network are made by reinforced concrete.

The reservoir size is designed in such a way that:

- The volume of water required to even out the maximum peaks in the water demand;

Strategic reserve to allow for power failure in the pumping facilities or other breakdowns in the supply system

- Construction of this reservoir unit in one phase for year 2035 has been recommended.

All outlet pipelines are fitted with bulk water meters for the easy measurement of the water level in addition overflow and washout facilities are provided.

The reservoirs shall be semi underground for the stability of the reservoir, the table below shows the summary of the proposed reservoirs.

Table II-16 Proposed tank size

TANK CAPACITY (m3)	No.	SHAPE	MATERIAL
10	55	RECTANGULAR	CONCRETE
25	10	RECTANGULAR	CONCRETE
50	5	RECTANGULAR	CONCRETE
100	8	RECTANGULAR	CONCRETE
200	4	RECTANGULAR	CONCRETE
500	14	RECTANGULAR	CONCRETE
1000	2	RECTANGULAR	CONCRETE
4000	1	RECTANGULAR	CONCRETE
Total	**99**		

Pipelines network-supply network design

Optimization processes have focused on steady (or nearly steady) state conditions. Even though this preoccupation in most water supply projects is understandable, transient phenomena are themselves unavoidable and often crucial to system performance and reliability. Despite their intrinsic importance, transient considerations have frequently been ignored or relegated to a secondary role when supply systems are designed or constructed. In order to protect a system from the impact of water hammer, various kinds of strategies are

commonly suggested. Protection approaches range from installing specialized devices such as relief and reducing valves, air chambers and tanks to the selection of pipe properties and the modification of operational procedures.

Pipe optimization considering Transient

Transmission lines

The transmission main has been profiled at an average trench depth of 1.5 m. Washouts and air valves are provided where required along the pipeline. The profile and other more detailed drawings are presented in the drawing's album.

The transient state simulation is carried out to ascertain the capacity of the pipeline to withstand transient forces caused by a water hammer in the pipeline due to power failure. Under normal operating conditions of transmission pipeline, water hammer is unlikely to occur, as the pumps are equipped with soft start device. However, water hammer will occur in case of power failure. Water hammer calculation was performed with the aid of Bentley Water Hammer software V8i.

The power outage that causes transient conditions in the pipeline is assumed to occur after 2seconds of pump operation.

The simulation is done considering two scenarios:

- Scenario 1. The pipeline without surge protection
- Scenario 2. The pipeline with surge protection

The transient calculations will make it possible to characterize the behavior by a hydraulic model and simulate the most unfavorable transient conditions and thus to define the necessary protection elements. Any modification in an established hydraulic regime (start or stop of a pump, closing of valve) causes the appearance of a transient high-speed hydraulic phenomenon, always referred to as "water hammer".

This phenomenon is very dangerous if it is not controlled because the extent of negative or overpressures it causes can reach or exceed the pressure bearing capacity of the pipeline.

In pumping stations, the most economical and safe solution for protection is the use of hydro pneumatic tanks (with bladder or without bladder for large volumes).

Since soft starters are installed on the pump cabinets, we will carry out simulations of transient pump disjunctive conditions that may occur during power outages and shutdown of pumps.

The most sensitive criterion for selecting and sizing the protection device is to prevent the pressure inside.

Design of pipeline fittings and protections

- •Determination of optimal shock of the pipe work to minimize the costs of the earthworks and the protection works (air valve and wash out chamber);
- •Protection of the pipework against corrosion and thrusts;

- •Whenever the pipeline changes direction horizontally or vertically or changes size, the reinforced concrete thrust blocks are designed to resist the thrust force in the piping system.
- •Concrete supports for pipes are designed whenever the pipe is laid above ground surface and also in situations where foundation formations are not good.
- •Lateral transverse anchorage in reinforced concrete structures is designed for conditions where pipe is laid in steep slopes to hold the pipeline in the same position.
- •Pipe Backfilling and leveled bedding shall be ensured A typical trenching, backfilling and bedding for pipe are designed encompassing backfilling material type and bedding thickness so that the soil cover on top of the laid pipe is at least 800mm thickness.

In summary, the transmission pipe total length is 116,348.59 m while distribution pipeline is 362,097.95 m and total pipeline network will equal to 478,446.54 m. Moreover, the type of the pipes to be used are all HDPE and DI.

II.8 Design of road and river crossings

The transmission pipeline above ground or on river crossings shall be supported either on concrete saddle as anchorage or with ring girders again supported on concrete bases (bridge). In general, forces due to gravitational component of pipelines laid on slopes, thermal stresses, provision of expansion joints etc. shall be considered.

Whenever pipeline crosses gravel, asphalt or concrete roads and river/ditch or open ravines, crossing structures, which will protect the pipe are designed. For heavy traffic road crossing, concrete encasements are provided.

The transmission pipe total length is *3,297. 48 m* while distribution pipeline is *362,097.95 m* and total pipeline network will equal to 1,030,428 m. Moreover, the type of the pipes to be used are all HDPE and DI.

II.9. Equipment and machineries to be used in construction activities

Construction works of water supply system will use numerous equipment's as well as machineries and the difference depend on designed structure to be constructed. Intake, WTP, campsite, Reservoirs, pipeline networks, electrical lines, pumping stations and landscape restoration are the panned project activities that have different equipment's and machineries like excavators, backhoes, bulldozers, trenchers, cranes, and drilling rigs. These machines are used to dig trenches, install pipes, and pumps and generators are used to provide power and water pressure in the system. However, the following table comprises other more equipment's and machineries that will be used in the present project.

Table II-17 List of equipment's and machineries to be used during Kivu belt WSS construction

Plumbing works		
PVC Downpipe 50mm diam. + Accessories	Item	4.
Wash hand bassin	Item	1.
English toilet seat cascade type	Item	1.
Pavement tiles in toilet	Item	1.
Metal soap holder stainless steel	Item	1.
Mirroring its 40cm x 80cm with Accessories	Item	1.
Toilet paper holder	Item	1.
internal plumbing and waste evacuation	Ite	1.
Design of scada and automation system plus supply and installation of all equipment for construction of the system including instrumentation all	Item	1.00
Supply and install of CCTV Cameras (all work included)	Lps	1.00
Provide and fix stainless steel V-Notch Launder Weirs including all accessories	Item	8.0
Provide, prepare and apply 3 coats of approved epoxy paint on all V-notch weir	Lps	1.0
DI SINGLE flanged with PUDDLE pipe DN300 PN16 l=1842mm	Item	4.0
DI FLANGED REDUCED TEE DN300X100	Item	4.0
DI flanged Dismantling Joint DN300 PN16	Item	4.0
DI flanged MOTORIZED Gate Valve DN300 PN16	Item	4.0
DI FLANGED ADAPTOR DN300 PN16	Item	4.0
DI FLANGED ADAPTOR DN100 PN16	Item	4.0
DI double flanged pipe DN300 PN16 l=1064mm	Item	4.0
MOTORIZED PENSTOCK GATE VALVE 600mmx600mm	Item	4.0
GS elbow DN100 PN16	Item	4.0
DI FLANGED ELBOW DN500 PN16	Item	2
DI FLANGED ADAPTER DN500 PN16	Item	3
DI FLANGED BELLMOUTH DN500 PN16	Item	1
DI DOUBLE FLANGED EMBEDDED PIPE WITH PUDDLE DN500 PN16, LENGTH	Item	1
DI FLANGED PIPE DN500 PN16, LENGTH 785MM	Item	1
DI FLANGED PIPE DN500 PN16, LENGTH 1920MM	Item	1
DI FLANGED TEE DN500X500X500 PN16	Item	1
DI FLANGED PIPE DN500 PN16, LENGTH 5605MM	Item	1
DI FLANGE SADDLE CLUMP DN50 PN16	Item	1
PVC FLANGE DN50 PN16	Item	1
PVC REDUCER DN50-32 PN16	Item	1
PVC THREADED ADAPTER DN32 PN16	Item	1
PVC CLEAR PIPE DN32 PN16	Item	1
Supply and installation of solar kit of 7W including accessories for installation and all	Item	1.0
Supply and installation of LED lights of 7W	Item	3.0
Supply and installation of sockets	Item	2.0
Supply and installation of switches	Item	3.0
Supply and install fire alarm system with fire detectors, fire control panel and all	Item	1.0
Supply and installation of power extinguisher 9 kg to be installed all accruals	Item	1.0
Supply and installation of CO2 fire extinguisher all accruals included	Item	1.0
Distribution box	Item	1.0
One gang one way switch	Item	2.0
Surface mounted lighting fitting 1200 mm, light source: LED power 1X18 W Diffuser:	Item	4.0
Surface mounted lighting fitting 1200 mm, light source: LED power 2X18 W Diffuser:	Item	4.0

II.10. The total number of project workers

To the extent known, the total number of workers to be used during construction and operation phase of the project have been estimated as 657. During the construction phase there will be 631 while during operation phase, the number employees of water treatment plant will be 26.

II.11. The materials to be used during construction (including their sources)

The sources of construction materials to be used will be identified by the Contractor during project implementation whereas the selected borrow areas and quarries that will be approved by Supervising Engineer as well as the local government within the project area, in consideration to the environmental policies. So far, there is no identified site as a source of construction materials.

II.12. Wastes and chemicals

With regard to the wastes to be generated (identified) effluent and solid including hazardous wastes during the construction and operation phase. Solid and chemical wastes will be generated as soon as the construction and operation phases commenced.

Chemical House

Space for the storage of 100 days chemicals for the treatment of the ultimate flows is recommended for coagulant and chemicals. The chemicals to be used at the treatment works are sudfloc polymer, lime, aluminum, sodium chloride and polymer. Chemicals for 3 months are to be included in the contract.

Chemical mixing tanks and the necessary facilities will be in the chemical house. It will be located upstream of flocculation chambers to allow for dosing of the chemicals into the mixing chamber. The chemical block house will be built of masonry or block work walling with timber truss roof covered with galvanized iron sheets.

Solid wastes

Construction activities will generate some solid waste is which will be the combination of various materials, containing inert waste, non-inert waste, hazardous waste, and non-hazardous waste. Construction and demolition waste also concerning the types of materials including in each category, the potential for recycling, recovering, and reusing of materials, or within a localized context.

Among the wastes to be generated, sludge will be the most hazardous wastes during operation of the water treatment processes. To facilitate proper disposal of water used for backwashing of filters, which is as much 5% of total treated water and the sludge collected during cleaning of the sedimentation units, it is advisable to provide a secondary sludge clarifier to thicken the sludge before drying on the sludge drying beds. This is adopted due to the space constraints in the area which does not give much room for traditional waste water lagoons.

The sludge thickeners are designed to accommodate up to nine backwashes daily at ultimate year and 25% volume of the sedimentation tank reserved for sludge storage. It is planned that at least one filter for each phase will be backwashed a daily.

It is expected that only one sedimentation tank will be cleaned at a time per day. Cleaning of the sedimentation tanks can be done once every month or as need arises as per the discretion of the scheme manager. Therefore, 420m3 of sludge water will be generated by filters and sedimentation tanks on the critical day. Therefore, the project provides 1 no circular gravity sludge thickeners of 7.0 m diameter and 3.3 m deep (3.0m effective depth, 0.3m free board area) of total tank volume is 153m³ (115m³ for the supernatant region and 38m³ for the hopper region). The sludge thickener is to be installed with a motor-controlled rake arm, rotating within the tank to enable Settlage of particles. These mechanical units are not determined by the manufacturer before installation on site. Supernatant water from the sludge thickeners is collected and recycled by pumping back to the inlet chamber. Settled sludge collected from the bottom of the hopper zone is collected and periodically emptied into the sludge drying beds.

III. PROJECT AREA DESCRIPTION

3.1 Introduction

This chapter provides the context within which the project is to be located. The baseline study examines the biophysical, social, economic, political and cultural environments of the proposed project area.

As stipulated by the request of proposal published by WASAC for the current study, the provision of adequate water supply system services is more generally a prerequisite and indicator for socio-economic development. The pre-feasibility study includes an Environmental and Social Impact Assessment (ESIA) which has assessed the environmental and social issues of the proposed water supply systems, including the access roads on the sites and surrounding environment.

The Government of Rwanda plans to develop towns near borders interacting with the neighboring countries. Towns would decentralize urbanization and reduce the rate of immigration to the City of Kigali, especially youth and unemployed people. These towns include: Musanze borders Southwest of Uganda, Nyagatare and Gatsibo border Southwest of Uganda, Rubavu and Nyabihu, Rubavu borders Eastern Democratic Republic of Congo, Ngoma borders Northern of Burundi, Ngororero, Muhanga and Kamonyi at the Center of Rwanda as well as Nyanza and Ruhango located in the center of the Rwanda.

3.2 Project location

The project is to fully supply drinking water in the villages of the following:

- Four Sectors of Rutsiro District i.e.: Gihango, Mushubati, Musasa and Murunda
- Four sectors of Karongi District i.e.: Rubengera, Bwishyura, Mubuga and Rugabano. The project area is to have 100% access to clean water supply in the target area. This project will also contribute to enhanced hygiene and sanitation hence reducing water borne diseases. This will also contribute towards alleviation of poverty within the area through the improvement of socio-economic activities in target area mentioned above.

All these sectors as shown in the following figure will be supplied with drinking water from the reliable water sources, which are described in the next sections of this report.

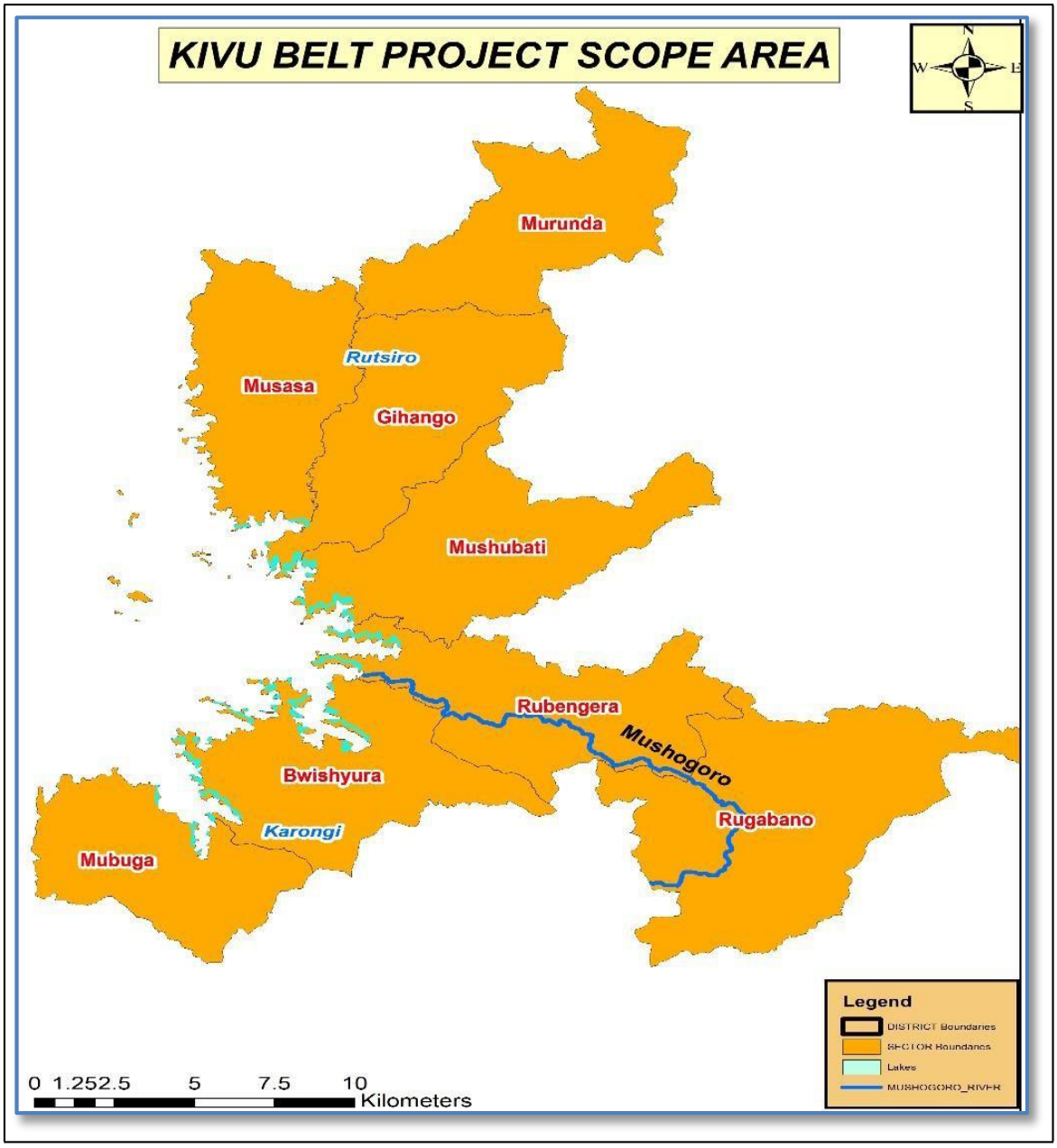


Figure III-1 Geographical Location of the project (Source: KECC-HCC)

3.2.1 Karongi District

Karongi District is one of the seven Districts in the Western Province. It is bordered by Rutsiro to the north, Ngororero and Muhanga districts to the north-east, Nyamasheke and Nyamagabe districts to the south, Ruhango district to east and it borders with the Democratic Republic of Congo and Lake Kivu to the west. Karongi District is divided into; 13 administrative sectors (Imirenge), 88 cells (Akagari) and 538 villages (Imidugudu).

Karongi district is characterized by the high lands area with steep features. Karongi District has an altitude varying between 1470 to 2200 metres. On one hand, the topographical characteristics allow the district to be faced with soil erosion.

The various land uses decrease forest area accentuates the erosion phenomena, bring heavy siltation downstream, and in some cases, the floods may occur.

Karongi District experiences tropical climate of high altitude. It is one of the Rwanda regions which have high rainfall. The amount of rainfall in the district benefits the area and is characterized by two dry seasons covering the period from December to January and from June to mid-September, and is also characterized by two rainy seasons the long rains start in mid-September and end in December and from February to June with an annual average of temperature varying from 16ºC to 21º 5C. Annual rain falls ranging from 1100 to 1500 mm, thus these features are favourable to agriculture and livestock development. But they are the source of erosion and environmental degradation in the regions of high altitude. So, there should be a continuous protection of environment in these areas.

Karongi district soils can be categorized into various types. According to the altitude feature, the soil in some areas is poor soil degraded by erosion. This situation is getting worse by agricultural practices such as over exploitation of land, small size of land for farmers which does not leave the field lying fallow land; In other areas, the soil is good but needs to be protected against environmental phenomena. These considerations imply a need to add organic and mineral fertilizers in agriculture, and farmers are not able to get these inputs and this increases the level of vulnerability and poverty of farmers in Karongi. In other areas, there are valley and marsh soils which are favourable for vegetables, maize and Irish potatoes.

3.2.2 Rutsiro District

Rutsiro District is one of the seven Districts making up the Western Province, located at 150 km from Kigali. The altitude of the district varies between 1,400 meters at the edge of Lake Kivu and 2,600 meters beyond the top of Mount Crete Congo-Nile. Its geographical coordinates are: Latitude: -1°57'36'' Longitude: 29°23'22''. This diversity offers the opportunity to have a multitude of crops suitable for each climate zone.

District Rutsiro has a tropical climate with the average temperature is between 20 ° and 24 °

C. Rainfall increases gradually as we approach the mountains chain of the Congo-Nile covered by Gishwati forest. As a whole, the relief of the new Rutsiro District is characterized by a chain of mountains and plateaus respectively with an average altitude of 2,000m and 1,600m. The relief of the district is further characterized by the channel on the Congo Nile hosting the natural forest elevation Gishwati. Rutsiro soil is basaltic, generally permeable and rich in iron. It is an acid soil pH with an average content of clay group karyokinesis. In some places on Lake Kivu, there are sometimes derived soils phyllodes, clay, hard, containing quartz crystals and semi - strongly leached quartz.

They are very susceptible to erosion and therefore less fertile. District Rutsiro knows a dense hydrographic dominated by Lake Kivu in the west. He also knows several rivers which each head to the Congo basin, the other to the Nile. The most important of these rivers are: Muregeya, Koko, Nyangore and Gashashi Kimbili, Nyamwenda, Bihongora,

Bikeneko Sebeya and flowing into the Congo Basin, Satinskyi, Nyamwotsi Kiguhu and pointing in the Nile Basin.

Hydrography of Rutsiro District is also characterized by a variety of sources and furnished other undeveloped. All these waters belong to the basin of the Congo and goes to Lake Tanganyika via the Rusizi River. This is one of the major rivers draining the country of Lake Kivu and connecting it to Lake Tanganyika.

3.3. Project Site Physical characteristics

The project intake is located on Musogoro river in Karongi District, in Western Province of Rwanda. The river Musogoro drains into the Lake Kivu in the central part of it. It is part of Kivu basin part of Rwanda. All kivu basin streams and rivers are characterized by steep slopes from mountainous region of the Congo-Nile water divide above 2500 m elevation down to 1400 m at the lake. The intake is located on the river almost 1 km downstream from the main road Rubengera-Karongi. The first important aspect is the determination of the minimum guaranteed runoff which is a key issue in the estimate of available water resources at the intake site. Given the fact that the intake will not provide any storage reservoir, the minimum flow is more significant as compared to average flow.

Musogoro river is ungauged and no flow data on the river, the secondary data have been mostly used to better estimate the guaranteed flows at the intake site. Comparable streams and rivers in the same basin (Kivu basin of Rwanda) will also be used to simulate flows at the intake.

3.3.1. Basin Characteristics

The numeric elevation data of the Musogoro river watershed within Kivu L1 catchment which are required to survey its characteristics, were derived herein from a 30m×30m grid of DEM by Rwanda Water Resources Board (RWB). The same DEM model was downloaded from SRTM.

3.3.2. Catchment area & channel length

A process where precipitation leads to river runoff is significantly affected by the topographical factors of a target basin, including catchment area, channel length, basin shape, etc. These characteristic factors are very important in understanding & analyzing the river in the target basin, serving as basic factors to determine basic hydrograph in a runoff analysis, etc. Figure below shows the location of Musogoro river sub catchment. Reference source indicates its physiographic characteristics, including catchment area, channel length, mean width, shape factor, etc.:

Table III-1 Physiographic Features of the Musogoro River Watershed

Location		Area (km2)	Length (km	Mean width A/L(km)	Shape factor A/L2
Lat.	**Long.**				
- 2.06 (S)	29.42 (S)	110	25	4	0.176

According to the research carried by COMETE, 2012, Musogoro river flows along a South-East North- West axis and flows into Kivu Lake, 3.5 km north-east of the town of Karongi. A water intake on the river can be seen at 4.5 km from its outlet. The Musogoro is characterized by a low flow of about 1000 m3/h. The principal water resources in the Kivu catchment are as follows (according to the Water Resources Master Plan, 2014:

- The average annual rainfall is slightly above 1,200 mm/annum which equates to some 3 000 hm3/annum from the total land surface area of 2,425 km2.
- The combined average annual surface flow generated from the numerous small catchments in Rwanda stands at 28 m3/s or some 900 hm3/annum
- The groundwater annual recharge / safe yield is about 600 hm3/annum with a total storage of 2,400 hm3/annum which gives a mean residence time of about 4 to 5 years.
- The Kivu Lake collects the surface runoff from the entire catchment located in both Rwanda and DRC and constitutes an important surface water storage reservoir but generates substantial loss of water resources from evaporation.

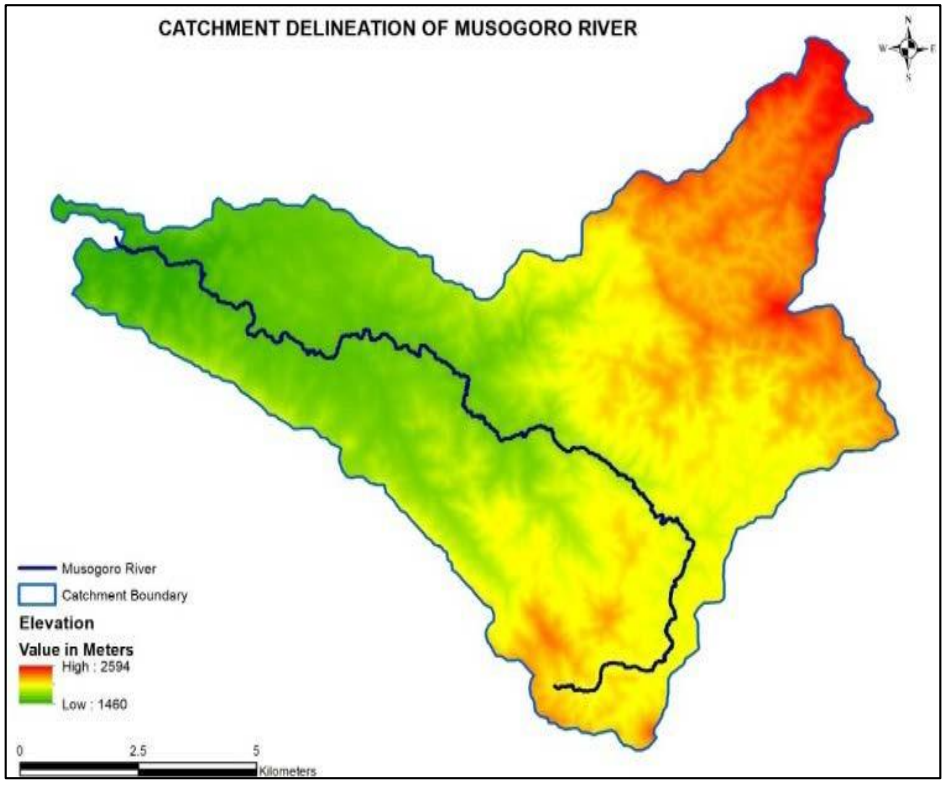


Figure 1: Musogoro River Watershed

Maximum and minimum elevation present in the watershed is EL. 2,300m and EL.1, 700m, respectively, with EL.1, 880m as mean elevation.

Table III-2 Elevation-Area Distribution (Musogoro River Watershed)

Elevation in m	Area in Sq. Km		Area Ratio (%)	
	Non-Cumulativ	Cumulative	Non-Cumulativ	Cumulative
Below 1,700	24.36	24.36	24.08	24.08
1700.01-1900	18.13	42.49	17.93	42.07
1900.01-2100	30.99	73.49	30.64	72.64
2100.01-2300	21.29	94.78	21.05	93.69
Above 2,300	6.38	101.16	6.31	100.00

3.3.3. Slope distribution

Figure III-4 and Table III-3 show the distribution of slopes in the Musogoro watershed, which was derived herein from the DEM data. Most of the Musogoro watershed is most in its great part characterized by mountainous land with a slope of 82.5~15.5°.

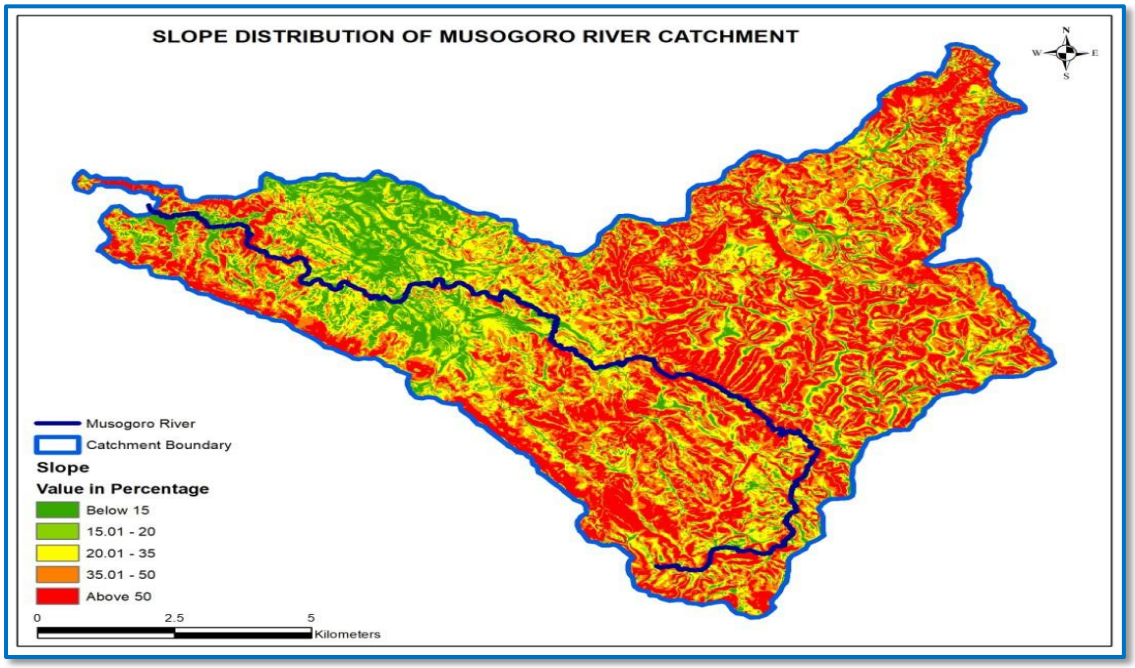


Figure III-4 Slope Distribution Musogoro Catchment

Table III-3 Slope distribution (Musogoro Stream watershed)

Slope %	Area in SqKm		Area Ratio (%)	
	Non-Cumulative	Cumulative	Non-Cumulative	Cumulative
Below 15	11.81	11.81	11.74	11.74
15 – 20	7.07	18.88	7.03	18.77
20 – 35	23.90	42.78	23.76	42.53
35 – 50	26.44	69.22	26.29	68.82
Above 50	31.36	100.58	31.18	100.00

3.4. Climatology

It is characterized by two main seasons: one long dry season that varies between 3 and 5 months with an annual overage temperature varying between 25,3°C et 27,7°C. The monthly distribution of the rains varies from one year to another. Annual rainfalls are estimated at 1,191mm/year and very unpredictable to satisfy the needs in agriculture and livestock along the year.

Karongi District is characterized by high lands with steep slopes with an altitude estimated between 1470 to 2200 meters. Much of the land is prone to erosion due to the steep terrain and high rainfall found in this region. In the study areas, the estimated mean monthly temperature is more or less constant from the month of January to the month of December. The maxima and minima are also constant throughout the whole year. This shows a cool and moderated climate. The data collected from Meteo Rwanda have shown that the available temperature recordings in the vicinity of the study area are Byimana Meteo Station.

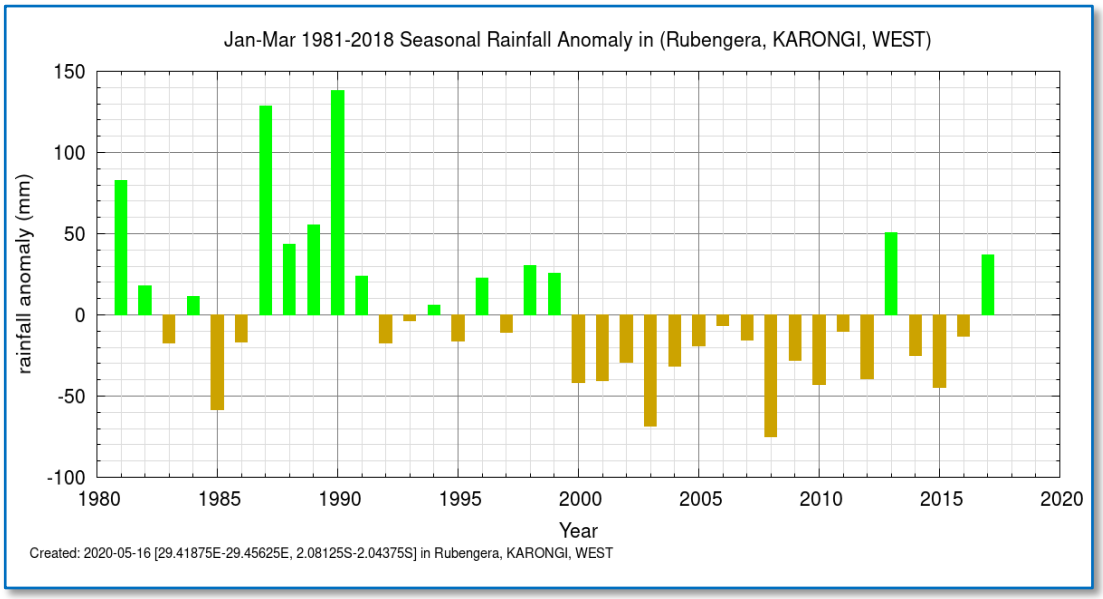


Figure III-5 Climatology of Project Area

Relative humidity, wind speed and sunshine are among other climatic data covered in the report. Table III-4 indicates the variation of those parameters at Karongi and Rutsiro districts.

Table III-4 Relative Humidity, Wind Speed and Sunshine Data (Meteo Rwanda 2020)

Variable	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Relative humidity	(%)	75.2	73.2	77.6	81.2	79.9	70.2	58.8	59.4	62.5	73.3	77.1	78.4
Wind speed	(m/s)	1.6	1.6	1.6	1.4	1.3	1.2	1.3	1.4	1.7	1.6	1.7	1.7
Sun Shine	(Hrs)	5.7	5.5	5.6	5.4	5.4	7.2	7.9	7.6	6.3	5.8	5.5	5.2

Wind speed	km/day	140	140	138	123	110	102	112	119	146	142	146	146

Critical missed data in and around the project area are wind speed and relative humidity. Project area wind speed and humidity data are derived from Rubengera Meteo stations with the assumptions as indicated in FAO, paper 56 that air masses are of the same origin and the general relief is similar.

3.5. Water Balance

Based on the requirement of the terms of reference, the project is meant to produce 6,500 m^3/day (0.075 m^3/s) for phase I. This amount of water is to be increased for the planning horizon. The intake location is assumed to have capacity to supply required amount of water till the planning horizon. Assuming doubling of the water demand, the intake will need 0.15 m^3/s in the extreme cases of tripling the water demand, the requirement is still 0.23 m^3/s which is equivalent to 50% of the guaranteed minimum flow at the intake site.

We can safely conclude that we have enough water to supply the water demand for the planning horizon. We have enough water for environment and other users downstream and we don't need a storage dam, a simple intake structure is enough.

3.6. Environmental flow

According to the research carried by COMETE, 2012, Musogoro river flows along a South-East North-West axis and flows into Kivu Lake, 3.5 km north-east of the town of Karongi. A water intake on the river can be seen at 4.5 km from its outlet. The Musogoro is characterized by a low flow of about 1000 m3/h.

The principal water resources in the Kivu catchment are as follows (according to the Water Resources Master Plan, 2014:

4. The average annual rainfall is slightly above 1,200 mm/annum which equates to some 3000 hm^3/annum from the total land surface area of 2,425 km^2;
5. The combined average annual surface flow generated from the numerous small catchments in Rwanda stands at 28 m^3/s or some 900 hm^3/annum;
6. The groundwater annual recharge / safe yield is about 600 hm^3/annum with a total storage of 2,400 hm^3/annum which gives a mean residence time of about 4 to 5 years;
7. The Kivu Lake collects the surface runoff from the entire catchment located in both Rwanda and DRC and constitutes an important surface water storage reservoir but generates substantial loss of water resources from evaporation.

3.7. Estimation of Storage Required Gauging Stations: Rainfall Gauging Station

The precipitation data were requested and received from Meteo Rwanda at climate station located at Rubegngera Meteo station with the following coordinates x: -2.057°, y: 29.42° and altitude of 1860 meters above sea level (asl) in July 2020. The daily rainfall values for 37 years (1981 to 2017) have been used to estimate rainfall behavior in Musogoro catchment.

Table III-5 Monthly Precipitation at Rubengera Meteo Station (Meteo Rwanda, July 2020)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total annually
1981	130	49	187	131	161	26	11	124	80	229	84	69	1281
1982	71	74	110	135	96	75	0	22	215	116	170	128	1212
1983	54	88	144	269	78	27	7	48	82	196	186	83	1262
1984	77	96	161	80	46	8	39	20	50	103	124	91	895
1985	65	118	96	326	57	4	0	4	24	31	122	93	940
1986	103	114	58	186	178	35	0	3	106	166	122	71	1142
1987	117	175	160	120	121	13	0	35	166	66	354	178	1505
1988	51	118	196	185	154	0	27	188	103	44	136	77	1279
1989	39	118	141	116	134	38	19	44	92	128	151	246	1266
1990	69	206	196	223	66	0	0	70	144	80	171	198	1423
1991	50	118	176	150	107	74	7	35	67	100	47	81	1012
1992	27	118	121	121	78	46	22	2	109	216	72	59	991
1993	42	97	162	72	166	44	0	64	17	19	82	104	869
1994	108	38	163	124	101	24	14	36	97	76	177	141	1099
1995	111	114	147	151	256	0	0	0	123	118	182	153	1355
1996	101	119	205	135	193	0	0	77	194	60	189	197	1470
1997	85	119	194	150	257	130	0	0	226	93	182	183	1619
1998	98	145	165	152	168	100	123	64	235	127	176	115	1668
1999	108	84	181	142	59	0	0	80	215	116	232	252	1469
2000	66	97	120	132	144	0	0	77	80	132	228	179	1255
2001	101	80	181	137	198	0	144	0	259	107	186	224	1617
2002	102	143	171	139	224	0	0	63	159	76	132	190	1399
2003	34	102	157	154	228	98	0	74	242	130	160	123	1502
2004	78	125	215	152	249	0	0	79	192	42	70	224	1426
2005	40	37	120	40	141	23	55	18	99	68	92	146	879
2006	73	141	223	132	240	0	0	209	193	132	158	190	1691
2007	68	156	142	141	193	103	89	46	214	111	144	162	1569
2008	15	34	106	81	106	128	4	74	169	56	137	131	1041
2009	123	56	36	33	90	91	3	17	179	155	184	192	1159
2010	71	185	159	165	163	49	0	0	145	107	92	161	1297
2011	59	135	173	117	64	99	20	66	128	117	238	199	1415
2012	53	89	197	129	150	58	22	35	90	111	83	139	1156
2013	82	72	217	168	3	1	1	34	84	45	106	205	1018
2014	102	74	93	82	23	70	14	90	127	192	103	168	1138
2015	84	41	78	92	139	221	0	20	144	209	185	132	1345
2016	88	53	201	173	130	0	40	8	206	65	195	83	1242
2017	55	48	51	14	89	0	0	36	56	92	161	29	631
Avg.	70.0	96.8	143.6	129.4	129.4	40.6	16.9	47.7	131.0	103.3	143.9	138.3	1,191.46

The annual rainfall at Rubengera was computed at 1,191.46 mm per year. The months of March and November are the wettest months with more than 143 mm each. The driest is July with less than 17 mm.

3.8. Temperature

In the study areas, the estimated mean monthly temperature is more or less constant from the month of January to the month of December. The maxima and minima are also constant throughout the whole year. This shows a cool and moderated climate. The data collected from Meteo Rwanda have shown that the available temperature recordings in the vicinity of the study area are Byimana Meteo Station.

Considering the daily averages, the monthly temperature data recorded at Byimana and Kigali stations starting from 1977 till 2008 are presented in Table III-6. It is to be noted that Kigali station has been used here to serve as reference station as it is one of the complete and well-maintained stations we have in Rwanda.

Table III-6 Monthly Temperatures in the Project Area

Month	Byimana			Kigali		
	T_Mean	T_Max	T_Min	T_Mean	T_Max	T_Min
January	20.5	24.8	16	20.7	26.3	15
February	21	26.9	15.7	20.8	26.5	15.1
March	20.3	24.4	16.3	20.8	26.4	15.2
April	20.1	23.5	16.6	20.6	25.7	15.5
May	20.4	23	16.5	20.4	25.3	15.6
June	20.7	23.2	16.1	20.3	25.8	14.7
July	21.1	23.6	16.7	20.4	26.4	14.4
August	21.7	25	16.3	21.4	27.4	15.3
September	21.5	25	17	21.3	27.5	15.2
October	20.7	24.9	16.3	21	26.7	15.3
November	19.8	23.2	16.1	20.3	25.7	15
December	20.2	24.3	16	20.4	25.8	14.9
Annual Mean		20.6		20.7		
Annual Maximum		24.3		26.3		
Annual minimum		16.3		15.1		

At Byimana station, the mean annual temperature for the period starting from 1977 till 2007 is equal to 20.6^{o}C. During the same period the annual maximum temperature is computed to be 24.3^{o}C whereas the annual minimum temperature is found to be equal to 16.3^{o}C. On the other hand, Kigali station exhibits almost the same pattern. The mean annual temperature equals to 20.7, the minimum temperature comes out to be 15.1 and the maximum goes as higher as 26.3.

*3.9. **Geology of the Area***

Karongi and Rutsiro districts soils can be categorized into various types in reference to the altitude features. In some areas, there are infertile soils, strongly degraded by erosion, and worsening by the traditional agricultural practices such as over exploitation of land without fertilizer inputs. In other areas, there are valley and marshland soils which are favourable for vegetables, maize and Irish potatoes.

Kivu belt water supply system project passes through different geological zones as depicted in the figure III-6 in which the project line is overlaid on the geological map of Rwanda.

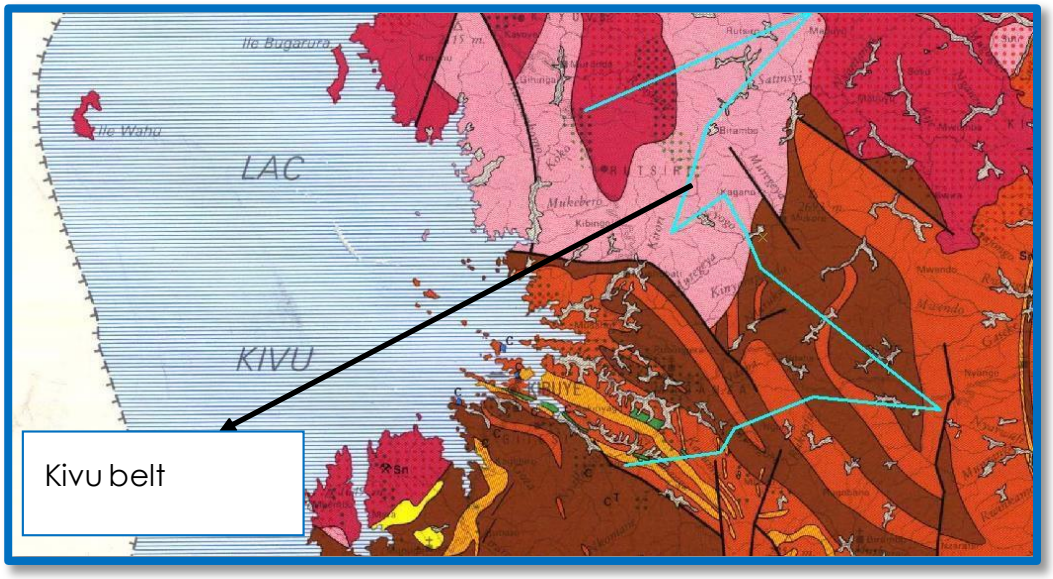


Figure III-6 Kivu Belt Water Supply System Alignment Overlaid on Geological Map of the Area

According to the geological map of Rwanda, the tested reservoirs and water treatment plant are located in the region divided into four small geological zones from Rutsiro to Karongi as depicted in figure III-7 and summarized in table III-7.

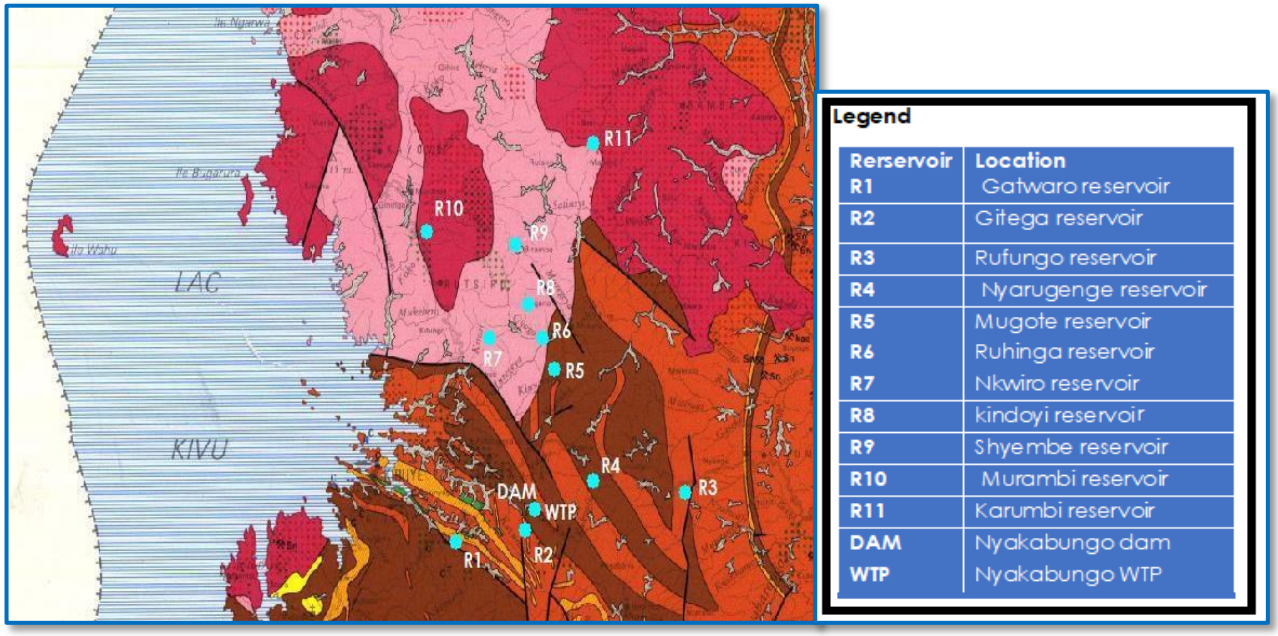


Figure III-7 Tested Reservoirs Overlaid on Geological Map

Table III-7 Tested Reservoirs Geological Description Zoning

ZONE	RESERVOIRNUMBER	GEOLOGICALDESCRIPTION
I	R6,R7,R8,R9,R10,R11	Granitic rocks paragneiss and orthogeiss
II	R5,R4,intake,WTP	Schists, micachists, phyllonites
III	R1,R3	Quartz schist and mica schists
IV	R2	Quartzitic sandstone

3.4. Biological Environment

3.4.2. Terrestrial Flora and Fauna

In Karongi and Rutsiro Districts, remnant forest areas still exist, especially at the Congo-Nile mountainous ridges or at the top of hills. Individual plantations of eucalyptus trees and agroforestry plants are observed dispatched between agriculture lands. Most of the time you have three categoriesof vegetation:

- Remnant of pristine or semi-pristine forests in protected areas;
- Bushed grasslands dispatched on flat ground and at hilly sides;
- Some woodland and shrubs growing along the river beds and on flood plains.

Table III-8 Bird species and their conservation status

Family	Species name	Common name	Vernacular name	IUCN Status
Alcedinidae	Ceryle rudis	Pied king fisher	Nyiramurobyi	least concern
Alcedinidae	Alcedo cristata	Malachite king fisher	Nyiramurobyi	least concern
Phalacrocoracidae	Phalacrocorax carbo	Great cormorant	Ishopfu	least concern
Phalacrocoracidae	Phalacrocorax africanus	Long tailed cormorant	Ishopfu	least concern
Ploceidae	Euplectes axillaris	Fan tailed widow bird		least concern
Ploceidae	Ploceus castanops	Northern brown-throated weaver	Isandi	least concern
Ploceidae	Euplectes orix	Southern led bishop	Rweza masaka	least concern
Ploceidae	Ploceus baglafecht	Baglafecht weaver	Isandi	least concern
Ploceidae	Ploceus cucullatus	Black headed weaver	Isandi	least concern
Ploceidae	Amblyospiza albifrons	Grosbeak weaver	Isandi	least concern
ploceidae	Ploceus melanogaster	Black billed weaver	Isandi	least concern
ploceidae	Ploceus ocularis	Spectacled weaver	Isandi	least concern
Scopidae	Scopus umbretta	hamerkop	Sarupfuna	least concern
Cisticolidae	Cisticola woosnami	Trilling cisticola		least concern

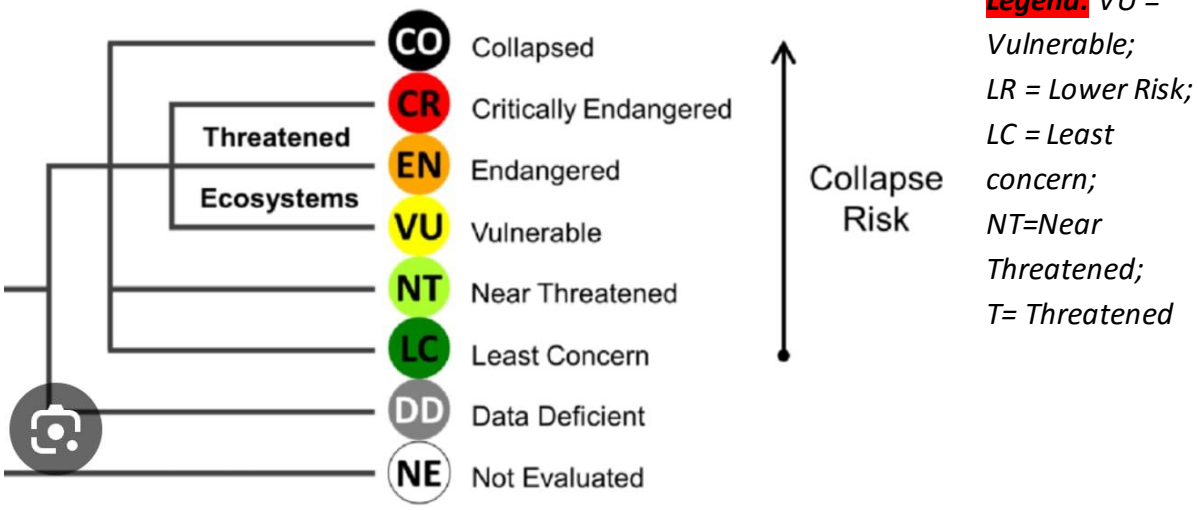
Cisticolidae	Cisticola cantans	singing cisticola		least concern
Cisticolidae	Eminia lepida	Grey capped warbler		least concern
Cisticolidae	Prinia sub flava	Tawny flanked Prinia		least concern
Cisticolidae	Cisticola robusta	Stout cisticola		least concern
Cisticolidae	Cisticola erythrops	Red faced cisticola		least concern
Cisticolidae	Camaroptera brachyuran	Grey backed Camaroptera		least concern
Cisticolidae	Cisticola Chubbi	Chubb' s cisticola		least concern
Columbidae	Streptopelia Semitorquata	Red eyed dove	Inuma	least concern
Columbidae	Streptopelia capicola	Ring necked dove	Inuma	least concern

Table III-9 Flora species and their conservation status

Family	***SPECIES***	**Common name**	**Vernacular name**	**IUCN**
Acanthaceae	*Acanthus polystachyus*	Acanthus	Igitovu	NE
	Asystasia gangetica	Chineese violet		NE
	Hygrophla auriculata			LC
Amaranthaceae	*Achyranthes aspera*		Umuhurura	LC
	Cyathula polycephala	Pastureweed	Igifashi	NE
Amaryllidaceae	*Agapandus*			
Anacardiacea	*Mangifera indica*	Mango	Umwembe	DD
	Rhus longipes	Large-leaved rhus	Umusagara	
	Rhus natalensis	Natal rhus	Unusagara	
Apiaceae	*Centella asiatica*			
	Centella asiatica	Centella	Gutwikumwe	LC
	Hydrocotyle sp			

Apocynaceae	*Carissa spinarum*	Simple spined carissa	Umuyonza	
	Catharanthus roseus			
Araceae	*Clocasia esculenta*	Clocasia	Iteke	NE
Araliaceae	*Cussonia arborea*	Octopus cabbage tree.	Igitegamajanja	
Caesalpinioideae	*Caesalpinia decapetala*	Mysore thorn	umufatangwe	NE
Capparaceae	*Capparis tomentosa*	Capparis	Umuhokera	
Casuariaceae	*Casuarina equisetifolia*	Casuarina/Australian pine	Filaho	NE
Celastraceae	*Maytenus senegalensis*	Thorny staff tree	Umweza	
Clusiaceae	*Harungana madagascariensis*	Orange-milk tree	Umushayishayi	
	Symphonia globurifera		Umushishi	
Combretaceae	*Terminalia superba*	Terminaalia		NE
Convoluvulaceae	*Ipomea cairica*			
	Ipomea rubens			NE
Crassulaceae	*Crassula granvikii*			
Cucurbitaceae	*Momordica foetida*	Bad smelling	Umwishywa	NE
	Zehneria scabra	Zehneria	Umushishiro	NE
Cupressaceae	*Cupressus lusitanica*	Mexican cypress	Isadara	LC
Cyperaceae	*Cladium mariscus*			LC
	Cyperus dives		Urukangaga	NE
	Cyperus latifolius	Cyerus	Urukangaga	NE
	Cyperus Papyrus	Papyrus	Urufunzo	LC
	Scirpus subulatus	Smooth flatsedge	Ubusuna	LC

Legend:



Legend: *VU = Vulnerable; LR = Lower Risk; LC = Least concern; NT=Near Threatened; T= Threatened*

Delineation of on-Site Wetlands by Soils and Plants

According to the Annex I to the Prime Minister's order Nº 006/03 of 30/01/2017 establishing a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management, Mosogoro river is located within a wetland of local importance, without any conservation status and may be used without any specific conditions.

3.5. Socio-Economic Environment

Karongi District stretches over an area of 993 km^2 with a total population of 373, 869 distributed into 91,444 households among which 8,794 (10%) live in urban area and 82,650 are located in rural area. The population of Karongi District is composed of 195,452 females and 178,417 males. It is among the districts of Rwanda which has a high density of 482 persons per square kilometer. (NISR, PHC5-2022 Census).

The estimated total population of Rutsiro District in 2022, as provided by NISR, PHC5-2022 Census was 369,180 persons.This represents 12.7% % of the total population of Western Province and 2.8 % of the total population of Rwanda. Females comprise 52.2 % of the population of Rutsiro District and the males represented also 47.8%. The population density in Rutsiro accounts for 565 inhab/sq.km which is near the country average density (503 inhab./sq.km)

In Karongi, accessibility of population to clean water depends on the kind of settlement in place. However, Karongi District has a rate of 74.7 % of total improved water source, 25.1 % of unimproveddrinking water from surface water of river and lake as well as unprotected spring. The objective is increasing access to clean water by local population and reduce as quickly as possible the distance covered to fetch water by women and girls.

The number of households having access to clean water in Rutsiro District has increased from 68.2 %to 82.7 % respectively in 2014 and 2015 due to various project yet implemented by the district in conjunction with other partners' such as WASAC, World Vision and LODA.

In Karongi District, the net primary school enrolments rate is 94.3% whereas the secondary school enrolment rate is 13.7%. This shows that high numbers of pupils that enroll for primary do not continue to secondary school level, and this situation is due to little number of 12 years' basic education schools, long walking distance to basic services, and increasing household poverty in the district.

3.5.1. Identification of populations for resettlement

The locations were the intakes and WTP are proposed are used by communities for sand mining for intakes and for agricultural purposes and housing as well. With the construction of the project the livelihoods of the communities will be disrupted due to the nature and sensitivity of the project.

3.5.2. Communities and their Livelihoods

The locations were the intake and WTP are proposed are used by communities for sand mining for intakes and for agricultural purposes and housing as well. With the construction of the project the livelihoods of the communities will be disrupted due to the nature and sensitivity of the project.

IV. INSTITUTIONAL LEGISLATIVE AND REGULATORY FRAMEWORK

This chapter describes the relevant policies and strategies, legal instruments, institutional arrangement and international framework applicable to water supply projects development in Rwanda. It summarizes the National Laws and describes the procedure for obtaining

environmental permits to allow project implementation. The awareness of environmental and social issues started as early as in 1920. The environmentally friendly initiatives were also supported by vast campaigns for soil conservation from 1947. In 1977 action program of environmental nature were launched such as: human settlement (1977), stockbreeding (1978), soil protection and conservation (1980), water supply in rural areas (1981), erosion control (1982) and reforestation (1983). However, it is only in 2003 that an elaborate National Environment Policy was established by the Government of Rwanda.

The policies, plans and strategies to be considered include:

Policy Framework for Rwanda

1) *Rwanda Vision 2050*

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. Environmental and climate change considerations are reflected in key priority areas as follows:

High Quality and Standards of Life: Moving beyond meeting basic needs to ensure a high standard of living by focusing 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

Developing Modern Infrastructure and Livelihoods: Modernization 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.

2) *National Strategy for Transformation (NST1/2017-2024)*

The National strategy for transformation (NST1/2017-2024) which is 7 Government Programme, takes environment and climate change as one of the cross-cutting areas which

will be embedded within Sector Strategic Plans and District Development Strategies.

In the area of environment and climate change, Rwanda has made significant progress in environment and climate change mainstreaming, as reported in State of Environment Reports (SEORs, 2009 and 2015). The environment is protected by relevant environmental laws and regulations that are captured under the Environmental Organic Law of 2005, as revised to date, and Climate Change has been addressed and informed by cross sectoral strategies, including the Green Growth and Climate Resilient Strategy (GGCRS) and the Nationally Determined Contributions (NDCs) for climate change mitigation and adaptation.

In this regard, focus will be on improving cross sectoral coordination to ensure smooth implementation of environmental policies and regulations. In this regard, critical sectors identified for strengthening include: agriculture, urbanization, infrastructure and land use management. Additional emphasis will be put on

Strengthening monitoring and evaluation. High impact areas selected include implementation of: Environmental and social Impact Assessments, biodiversity and ecosystem management, pollution and waste management.

3) *Rwanda Vision 2020, revised 2012*

The revised Vision 2020 recognizes the three principles of the green economy: social cohesion, economic empowerment and environmental intelligence. The three principles will contribute to the country becoming a middle-income and knowledge-based economy by 2020 and progressively to be a developed climate-resilient, low-carbon economy by 2050.

4) *Sustainable Development Goals (SDGs)*

The Sustainable Development Goals (SDGs) are a set of 17 goals the world will use over the next 15 years to end extreme poverty, fight inequality and injustice, and fix climate change. Formed through extensive consultation with all levels of society, the SDGs are a comprehensive development plan to leave no person behind. With the SDGs, Rwandans have the opportunity to act upon their vision for the future. No poverty, zero hunger, good health, gender equality and infrastructure are among 17set goals.

5) *National Policy on Environment for Rwanda*

The policy seeks to achieve its overall objective of the improvement of human wellbeing, the judicious utilization of natural resources and the protection and rational management of ecosystems for a sustainable and fair development through improved health and quality of life for every citizen and promotion of sustainable socio-economic development through a rational management and utilization of resources and environment, integrating environmental aspects into all the development policies, planning and in all activities carried out at the national, provincial and local level, with the full participation of the population, conservation, preserve and restoration of ecosystems and maintenance of ecological and systems functions.

The key principles mentioned among others that:

- It is every person's right to live in a safe and stable environment, but on the other hand, they must keep it healthy;
- The national economic growth must be based on rational use of resources and take into account environmental dimensions;
- Active and effective participation of the whole population for environment protection and management;
- A special emphasis must be laid on environmental education and sensitization programme at all levels with more involvement of women and the youth;
- Environmental impacts are to be analyzed while conducting studies of development projects.

Further, the policy proposes the elaboration or updating of master plans and special planning in urban areas with regard to population and land development aspects. In natural resources management (including land and water), the policy proposes:

- Ensure the preservation and protection of soils against any form of degradation;
- Ensure that a prior study of environmental impact which underlines costs and benefits from slopes and underlying ecosystems protection is conducted for any development projects and;
- Encourage programs of rainwater collection, stocking and use.

The policy also proposes the following in regard to biodiversity, forests, wetlands management and other natural reserves and or ecosystems:

- Set up protection measures for slopes to avoid degradation of swamps;
- Promote the rehabilitation of ecosystems under degradation and restoring endangered species.

On the issue of environmental education, information and research, the policy proposes among others to reinforce the human and institutional capacity building with regard to environment and to sensitize the population to protect the environment.

On health and sanitation, the policy proposes among others:

- Set up a system of waste collection, transport, disposal and elimination;
- Establish norms of zone protection between dumps, human buildings and water sources;
- Set up an appropriate canal and evacuation system for waste waters and rainwater in towns and resettlement sites "Umudugudu".

The National Policy on Environment for Rwanda harmonizes other policies like on agriculture, energy. The policy further proposes that the Central Government will be concerned with conservation and protection policies while tourism and environmental management will be transferred to the District and Kigali City levels.

6) *National Land Policy*

In the past, apart from a few scattered land regulations, most of which date back to the colonial period, Rwanda has never had a proper land policy nor has it ever had a land law, a situation that enhances the existing duality between the very restrictive written law and the widely practiced customary law, giving rise to insecurity, instability and precariousness of land tenure.

The Rwandan Government, therefore, found it compelling and necessary to establish a national land policy that would guarantee a safe and stable form of land tenure, and bring about a rational and planned use of land while ensuring sound land management and an efficient land administration. Currently, the land tenure system in Rwanda operates in a dual legal system:

- The customary law, which governs almost all the rural land and promotes the excessive parceling out of plots through the successive father-to-son inheritance system;
- The written law, which mostly governs land in urban districts and some rural lands managed by churches and other natural and legal persons. This law confers several land tenure rights to individuals such as land tenancy, long term lease and title deeds.

On the whole, Rwanda's land tenure system requires comprehensive reforms, from the elaboration of a national land policy to the establishment of a land law and land code, which will guide the judicious use and management of the land resource for the economy to be able to take off in such a way that our country is freed from the grips of poverty.

In the perspective of the harmonious and sustainable development, the overall objective of the national land policy of Rwanda is to establish a land tenure system that guarantees tenure security for all Rwandans and give guidance to the necessary land reforms with a view to good management and rational use of national land resources. The policy introduces the consideration of master plans for use and sound management of land resources. 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.

7) *National Transportation Policy*

The mission of the transport sector is to strengthen the institutional framework and capacity of transport institutions and stakeholders in the planning and management of the sector.

The objectives are to:

- Reduce and control transport costs

- Assure the quality and durability of the rural, urban and international transport network
- Improve safety for goods and passengers on the principle modes of transport
- Increase mobility of the population in order to improve access to essential services, education, and employment
- Establish a system to ensure sustainable financing of road maintenance
- Facilitate access to cost effective transport services

8) *National Biodiversity Strategy and Action Plan of June 2000 and its revision of December 2016*

This strategy defines the objectives and priorities for the conservation and sustainable management of biodiversity. The action plan includes hillsides, wetlands and protected areas as some of the areas that need to be conserved.

The national biodiversity strategy and action plan approved in June 2000, defined the objectives and priorities for sustainable biodiversity conservation and management. Biodiversity includes wetlands, protected areas and the strategies are ranked as follows: Political and legal frameworks relating to environment unknown by the population and/or decentralized entities; ii) low level of awareness among people with regard to environment; iii) inadequate exploitation of forests; iv) erosion; v) exploiting quarry sites without restoring exploited parts; vi) insufficient knowledge on environment status; vii) weakness of decentralized structures in environment management; viii) absence of appropriate environment-friendly technologies.
The strategy on biodiversity aims at: improving conservation of protected areas and wetlands; sustainable use of biodiversity in natural ecosystems and agro-ecosystems; rational use of biotechnology; development and strengthening of policy, institutional, legal and human resources frameworks; and equitable sharing of benefits derived from the use of biological resources.

The revised NBSAP lists 5 objectives and 19 national targets that aim to stop biodiversity loss and increase the economic benefits associated with the biological resources utilization and ecosystems services. It reflects the country‟s vision for biodiversity and the broad strategic mechanisms that Rwanda will take to fulfill the objectives of the CBD. This strategy has a long term vision of ensuring that by 2040, national biodiversity will be restored and conserved and hence contributing to economic prosperity and human well-being through delivering benefits essential for Rwandan society in general.

9) *Integrated Water Resources Management Policy of 2011*

This policy aims at fair and sustainable access to water, improvement of the management of water resources among others through reforestation and afforestation of hillsides and water catchments areas. There is need to harmonize this policy with other policies like agriculture and mining policies by specifying the distances vis-à-vis other economic activities like marshland development. The policy also needs to adopt a holistic approach

to the management of water resources and integrate other polices related to it including the forest, wetlands, agriculture, infrastructure development along water bodies and land use.

10) Environmental Health Policy, 2008

The Environmental Health Policy is articulated on four following priority programmes:

- ***Environmental education**:* This policy provides the way to improve hygienic and sanitary conditions in urban and rural areas.
- ***Promotion of food security and water**:* Food security and water issues constitute the basic problems in many areas particularly in restaurants, bars and public places. Environmental health officers will be in charge of monitoring and follow through the inspection of water and food quality. The inspection and monitoring will be conducted in all areas where water and food are stored for human consumption.
- ***Compliance with safety and environmental standards in construction activities**:* Environmental health officers will be involved in the application of plans and layouts of buildings particularly the sanitation facilities designs.
- ***Promotion of efficient management of solid and wastewater**:* Environmental health officers in collaboration with learning institutions will propose efficient and cost benefit technologies for solid waste and wastewater in communities, families and enterprises. This will contribute to avoid pollution and achieve sustainable development. The selection criteria for these technologies are: their accessibility, the affordability for people to acquire them and their ability to reduce the contamination and pollution of water, food, air and the environment in general. The implementation of this project will comply with safety, environmental education and environmental standards in construction activities and efficient management of solid and wastewater.

11) Mining Policy, 2010

The policy replaced the one of 2004 covers wider aspects of regulation, institutional and investment framework for the mining industry, value addition and capacity building strategies as well as providing a clear plan of action to support the sub sector's growth. The mining policy covers not only the mineral extraction, processing and export, but also the quarrying, production of construction materials and extraction and processing of semi-precious stones.

12) National Sanitation Policy, 2016

The National Sanitation policy of 2016 recognizes that Rwanda's economic growth and

poverty reduction Goals are hampered by a lack of improved sanitary facilities as well as limited service provision for excreta disposal, management of solid and liquid wastes, combined with inadequate hygienic practices and storm water risks.

To increase sanitation coverage, Rwanda can build on some valuable scalable sanitary achievements. Most Rwandan households have already financed and built their waterless sanitary facilities and adhere to basic principles regarding garbage disposal and recycling (composting). The decentralization process provides an adequate framework for community participation and sensitization.

Modern sanitation service provision, solid waste and storm water management require efficient institutional capacities and somewhat costly infrastructure. Investments with high economic but low financial return are usually not very attractive for the private sector and may need public finance and/or subsidies.

The policy principle is built on the fact that most of the Rwandese population relies on individual sanitation, and specific approaches for both individual and collective services must be considered. Households have demonstrated their willingness and capacity for building their own sanitation facilities in most areas of the country – although many of the facilities do not yet comply with the definition of improved facility. The willingness and sense of responsibility existing among the population is a strong asset that should be acknowledged and supported. A second asset is certainly the dynamic of the Rwandan business sector.

The Legal Framework

1) *The Constitution of the Republic of Rwanda 2003, Revised in 2015*

As the supreme law of the country, the constitution of the Republic of Rwanda stipulates that the state shall protect important natural resources, including land, water, air, wetlands, minerals, oil, fauna and flora on behalf of the people of Rwanda. This constitution entrusts the government with the duty of ensuring that Rwandese enjoy a clean and healthy environment. Article 22: Right to a clean environment: Everyone has the right to live in a clean and healthy environment. Article 53 states that everyone has the duty to protect safeguard and promote the environment. The State ensures the protection of the environment. A law determines modalities for protecting, conserving and promoting the environment. Article 34: Right to private property: Everyone has the right to private property, whether individually or collectively owned. Private property, whether owned individually or collectively, is inviolable. The right to property shall not be encroached upon except in public interest and in accordance with the provisions of the law. Article 35: Private ownership of land and other rights related to land are granted by the State. A law determines modalities of concession, transfer and use of land.

2) *Law on Environment No 48/2018 of 13/8/2018*

The most relevant legal provisions towards feeder road rehabilitation works are stated in the following chapters and articles:

- Chapter IV: Conservation and protection of built environment, specify modalities of wastes management in Article 17, Article 18, Article 19 and Article 20, respectively indicating the way liquid wastes, solid wastes, hazardous and toxic wastes, and electronic wastes; and
- Chapter VI: Prohibited Acts and Penalties in Article 42, and Article 46, respectively stating, prohibitions in wetlands and protected areas, and implementing a project without EIA.

Statements of articles cited up are presented in *Table IV-1.*

Table IV-1 Environmental Law, Articles and Statements

Articles/Statements
Article 17: Liquid waste management - The collection, transport and disposal of waste water are conducted in accordance with special regulations and guidelines issued by the competent authority. - Water from the sewage system and any type of liquid waste must be collected in treatment factories for purification and serve thereafter to perform hygiene, sanitation and developmental activities.
Article 18: Solid waste management - No person is authorized to discard solid waste in an inappropriate place. - Solid waste must be sorted, collected and transported to appropriate destination in accordance with relevant laws. - Solid waste must be disposed of in appropriate landfill or in a waste processing factory for production purposes.
Article 42: Prohibitions in wetlands and protected areas Acts prohibited in wetlands and protected areas are as follows: - to dump any solid, liquid waste or hazardous gaseous substances in a stream, river, swamp, pond, lake and in their surroundings

Article 46: Implementing a project without environmental impact assessment clearance

Any person who does not carry out environmental impact assessment before launching any project that may have harmful effects on the environment while it is required, is punished by suspension of his/her activities or closure of his/her association and ordered to rehabilitate the damage to environment, persons and property. He/she also pays an administrative fine of two percent (2%) of the total cost of the project.

3) Ministerial Order No 001/2019 of 15/04/2019

The order establishes the list of Projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment as published by the Ministry of Environment.

Article 3 talks about the list of works, activities and projects that must undergo a full environmental impact assessment. 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.

The paragraph 11 of this list includes construction and repair of international, national, District roads and repair of large bridges.

4) 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 of this Order as follows:

Animals: Gorilla, Chimpanzee, Black rhinoceros, Elephant, Roan antelope, Sitatunga, Lions, Leopard, Klipspringer, Buffalo, Cheetah, Zool mongoose, Cephalophus, Zool serval, Wild dog, Bushbuck, Hippopotamus, Burchell's zebra.

Birds: Black-headed Heron, Cattle Egret, Grauer's Swamp Warbler, Owls, All Lemuroids, Grey Crowned-Crane, wallow, Arrow-marked Babbler, Cape Robin- Chat, All pangolins, Vulture, Bee-eater, and Scimitar bills, Hamerkop, Sunbirds

Reptile: Tortoises (all species), Python, Crocodile, Viper

Plants: Ficus thonningii, Prunus Africana, Pentadesma reindersii, Myrianthus holstii, Thonningia sanguine, Hypoestes trifolia, Aloe sp., Syzygium guineense, Erythrina abyssinica, Fagara chalybea, Kigelia Africana, Orchidaceae, Eulophia streptopetala, Eulophia horsafalli, Diaphananthe bilosa, Disa emili, Disperis kilimanjarica, Euggelingia ligulifolia, Polystachyia

hastate, Tridactyle anthomaniaca, Entandopheragma sp, Podocarpus usambarensis, Albizzia sasa, Piptadenia Africana, Podocarpus milinjianus, Carapa grandiflora, Strombosia Scheffleri.

The Order specifies that the listed animals and plant species shall not be destroyed without permission of the competent authorities.

This project will endeavour to respect and protect these organisms, their habitats and the regulation enforcing the measures of their protection.

5) Ministerial Order N° 007/16.01 of 15/07/2010 determining the length of land on shores of lakes and rivers transferred to public property

Article 1: Purpose of this Order

This Order aims at determining the length of land on shores of lakes and rivers affected in the public domain for environmental protection.

Article 2: Land considered as public on lake shores

The land within a distance of fifty (50) meters from the lakeshore is public property. The length mentioned in this Article shall be calculated beginning from the furthest line reached by water depending on successive floods.

Article 3: Land considered as public on river shores

The land within a distance of ten (10) and five (5) meters from the shore of big rivers and small rivers respectively is public property.

The list of the rivers referred to in paragraph one is annexed to this Order and may be revised, whenever deemed necessary.

For any other rivers not listed in this order, the land of two (2) meters length from the shores of the river is of public domain.

Article 4: Management and land use of public land on the shores of lakes and rivers

Public land referred to in this Order shall be a protected area. Authorities are not allowed to issue this land as a private property.

No activities or buildings are authorized on the said land except activities aiming at protecting lakes, rivers, shores or activities authorized by the Minister in charge of environment and when such activities are deemed not destructive to the environment on condition that a prior environmental impact assessment study has been done.

Article 5: Safeguarding and restoring shores of lakes and rivers

The land within a distance of fifty (50) meters from the lakeshore and the land on the river shore within the distance referred to in Article 3 are reserved as natural vegetation.

Artificial vegetation can be grown on this land in case of restoring the damaged land or if that vegetation is responsible for protecting the environment by stopping soil erosion, being habitats for living organisms.

Article 6: Prohibited activities on shores of lakes and rivers

Within the distance provided for in Articles 2 and 3 of this Order, the following are prohibited:
- Dumping solid wastes;
- Dumping liquid wastes.

6) *Law N°57/2008 of 10/09/2008 relating to the prohibition of manufacturing, importation, use and sale of polythene bags in Rwanda*

The law prohibits the use, sell and importation of polythene bags. However, exemptions are provided in writing for medical and agricultural sectors. A management plan of plastic waste generated by projects that benefit exemption has to be provided.

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

Purpose of this Law

This Law determines modalities for management and conservation of biological diversity within Rwanda.

8) *Ministerial Order N°004/16.01 of 24/05/2013 determining the list of water pollutants*

Purpose of this Order

This Order determines the list of water pollutants.

A water pollutant is any substance that may contaminate a water body which is directly or indirectly discharged into such a water body and produces harmful effects to aquatic life.

9) *Law No 43/2013 of 16/06/2013 governing land in Rwanda*

The law entrusts the state with ownership over land including lakes, rivers, natural forests, national parks, swamps, tourist sites among others. The law calls for inventory of the all swamps and their boundaries the structure of the swamps, their use, how they can be organized. In order for the swamp land to be efficiently managed and exploited, a Minister must give an order having Environment in his or her attributions that shall determine a list of swamps and their boundaries. The law further requires that such a list shall clearly indicate the structure of the swamps, their use, how they can be organized so that they can be beneficial to Rwandan nationals on a sustainable basis. The ministerial

order must also certify the modalities of how swamp land shall be managed, organized and exploited.

10) Law N°55/2011 of 14/12/2011 governing roads in Rwanda

Purpose of this Law

This Law regulates the road network in Rwanda and determines its reserves, classification and management.

Article 22: Road reserve for national roads, Districts and City of Kigali roads and those of other urban areas

The road reserve for national roads, Districts and City of Kigali roads and those of other urban areas –Class One shall be demarcated by two parallel lines at twenty-two (22m) meters on both sides of the road from the median line.

The road reserve for Districts and City of Kigali roads and those of other urban areas –Class 2, shall be delimited by two parallel lines at twelve (12) meters on both sides of the road from the median line.

Indicative feeder road project is classified as a District road.

Article 27: Restrictions within public road reserve

The following activities are prohibited on the road reserve for national roads, Districts and City of Kigali roads and those of other urban areas roads:

- to erect new buildings, modify or rehabilitate existing ones;
- to induce land degradation by using materials that constitute such land;
- to plant any type of trees without authorization of the authority responsible for the concerned road;
- to mount any advertising billboard without authorization of the authority responsible for the road depending on its class.

11) Law N° 32/2015 of 11/06/2015 Relating to Expropriation in the Public Interest

This Law determines procedures relating to expropriation in the public interest.

The law defines the activities or projects that can be classified as public interest and process and requirements for expropriation activities as well as the cost for goods and other infrastructure to be expropriated. The law provides a window for appeal for somebody who is not satisfied by the cost of compensation.

The proposed feeder road project will undertake this process for some families to be fully or partially expropriated and other public works and utilities in the project zone.

12) *Ministerial Order Nº002/16.01 of 26/04/2010 determining the reference land price outside the Kigali City*

Purpose of this Order

This Order determines the reference land prices to be used in Rwanda outside the Kigali City as provided for in the annex attached thereto.

- Complementary instructions

All what is not mentioned in this Order, with regard to land prices shall be complemented and clarified by Ministerial Instructions.

13) *Law N° 13/2014 of 20/05/2014 on mining and quarry operations*

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 EIA Certificate will be required for each quarry to be exploited in the framework of this project.

14) *Ministerial Order N° 001/16.01 of 03/01/2012 on explosives used in mining, quarrying and infrastructure activities*

Purpose of this Order

This Order determines the requirements for importing and exporting, manufacturing, transporting, trading and using explosives and their accessories used in mining and quarrying activities and civil engineering works.

Principle of environmental protection and security safeguard

Any person who imports or exports, transits, transports, uses, manufactures explosives and their accessories or trades in Rwanda, has the obligation to abide by legislation relating to the environment and security preservation.

15) *Ministerial Order N°003/MINIRENA/2015 of 24/04/2015 determining modalities for application, issuance and use of Mineral and Quarry Licenses*

This Order determines:

- modalities for application of mineral license;
- modalities for the transfer of a mineral license between the holder thereof and third party;
- modalities for application for the renewal of a mineral license;
- modalities for application for the grant or renewal of a quarry license;

- requirements and conditions for transfer of quarry licenses;
- content of reports and their intervals;
- non-refundable fee to be paid by an applicant for the grant, transfer or renewal of mineral or quarry license;
- annual fees to be paid by the holder of a mineral or a quarry license for the surface area covered by the license.

16) *Ministerial Order N°02 of 17/05/2012 determining conditions for occupational health and safety as published by the Minister of Public Service and Labour.*

Purpose of this Order

This Order determine the general and specific rules and regulations relating to health and safety at workplace in order to secure the safety, health and welfare of persons at work and protect them against risks to safety and health arising from work. It also determines the types of works prohibited for pregnant or breastfeeding women.

Scope

This Order shall apply to workers in formal and informal sectors and self-employed persons. Enterprises may request practical guidance from competent authority when they want to set up regulations on safety and health.

17) *The Law No 59/2008 of 10/09/2008 on prevention and punishment of gender based violence*

This Law is aimed at preventing and suppressing the gender- based violence, defined as:

- Gender Based Violence: any act that result in a bodily, psychological, sexual and economic harm to somebody just because they are female or male. Such act results in the deprivation of freedom and negative consequences. This violence may be exercised within or outside households them

In its article 2, the law states that it is forbidden to use threat of depriving someone of certain rights for the purpose of having them indulge in any gender based violence act.

18) *The Law N° 66/2018 of 30/08/2018 regulating labour in Rwanda*

In its article 6 state that it is prohibited to subject a child below the age of eighteen (18) years to any of the following forms of work:

- Forms of work which are physically harmful to the child;
- Work with dangerous machinery, equipment and tools, or which involves

the manual handling or transport of heavy loads;

- Work in an environment which exposes the child to temperatures, noise levels or vibrations damaging to his/her health

Article 8: state that Sexual harassment in any form against supervisee is prohibited.

2) EIA Guidelines for Rwanda, 2006

EIA guidelines serve as a protocol for use by various stakeholders involved in the conduct of environmental impact assessment.

Guidance is needed of a more technical nature to streamline the conduct of EIA and appraisal of EIA reports. As such, the establishment of "General Guidelines and Procedures for Environmental Impact Assessment", which unifies the legal requirements with the practical conduct of EIA, meets a need in the pursuit for sustainable development in Rwanda. EIA is a tool for prevention and control of environmental impacts caused by socio-economic development. The "General Guidelines and Procedures for Environmental Impact Assessment" were prepared to contribute to improvement of EIA practice in Rwanda and they aim to serve agencies and individuals taking part in the EIA process. These guidelines were designed to ensure that participants in the EIA process understand their roles and that laws and regulations be interpreted correctly and consistently.

Two main principles underlie these general guidelines:

- They comply with the legal and institutional frameworks on environmental protection in Rwanda and;
- They contribute to improvement of quality and efficiency of EIA process in the country, and as such merge, step by step, with general global trends and practice of conducting EIA.

These general guidelines were developed with the aim of providing information necessary when carrying out an environment impact assessment. It should be noted that our team carried out this EIA study under the guidance of these general guidelines. See Figure IV-1 (EIA Process in Rwanda).

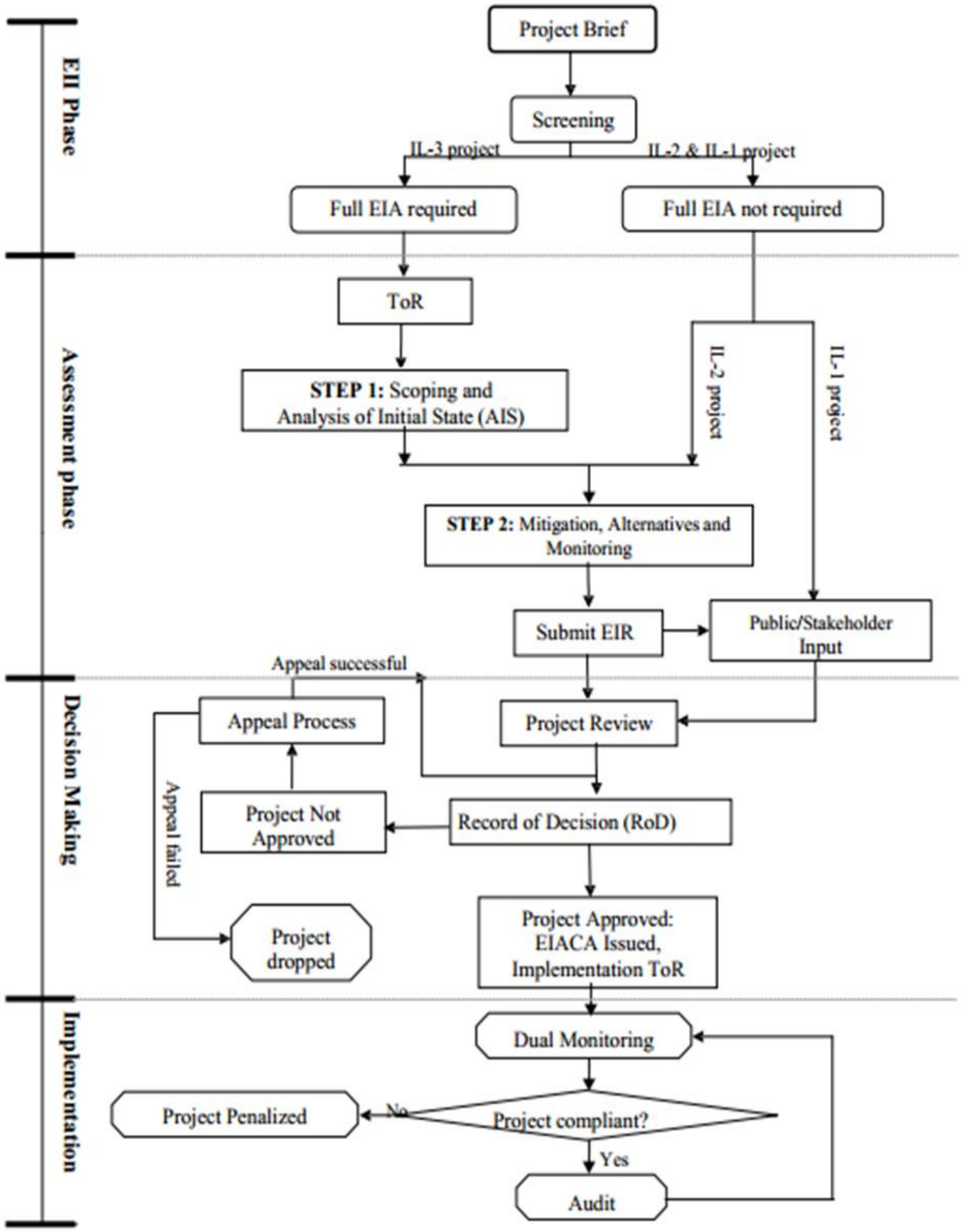


Figure IV-1 EIA process in Rwanda

International legal framework

The following conventions and regulations have been signed and ratified by Rwanda and are to be taken into consideration through the overall KFH project cycle.

i. The international Convention on Biological diversity and its habitat signed in Rio de Janeiro in Brazil on 5 June 1992, as approved by Presidential Order No 017/01 of 18 March 1995;
ii. The CARTAGENA protocol on biodiversity to the Convention on Biological biodiversity signed in NAIROBI from May 15, to 26, 2000 and in NEW YORK from June 5, 2000 to June 4, 2001 as authorized to be ratified by Law No 38/2003 of 29 December 2003;
iii. The United Nations Framework Convention on Climate Change, signed in RIO DE JANEIRO in BRASIL on 5 June 1992, as approved by Presidential Order No 021/01 of 30 May 1995;
iv. The KYOTO Protocol to the framework on climate change adopted at KYOTO on March 6, 1998 as authorized to be ratified by Law No 36/2003 of December 2003;
v. The RAMSAR International Convention of February 2, 1971 on Wetlands of International importance, especially as water flows habitats as authorized to be ratified by Law No 37/2003 of 29 December 2003;
vi. The STOCKHOLM Convention on persistent organic pollutants, signed in STOCKHOLM on 22 May 2001, as approved by Presidential Order No 78/01 of 8 July 2002;
vii. The ROTTERDAM International Convention on the establishment of the international procedures agreed by states on commercial transactions of agricultural pesticides and other poisonous products, signed in ROTTERDAM on 11 September 1998 and in New York from 12 November 1998 to 10 September 1999 as approved by Presidential Order No 28/01 of August 2003 approving the membership of Rwanda;
viii. The BASEL Convention on the Control of Tran boundary Movements of Hazardous wastes and their disposal as adopted at BASEL on 22 March 1989, and approved by Presidential Order No 29/01 of 24 August 2003 approving the membership of Rwanda;
ix. The MONTREAL International Conventional on Substances that deplete the Ozone layer, signed in LONDON (1990), COPENHAGEN (1992), Montreal (1997), BEIJING (1999), especially in its article 2 of LONDON amendments and Article 3 of COPENHAGEN, MONTREAL and BEIJING amendments as approved by Presidential Order no 30/01 of 24 August 2003 related to the membership of Rwanda;
x. The BONN Convention opened for signature on June 23, 1979 on conservation of migratory species of wild animals as authorized to be ratified by Law No 35/2003 of 29 December 2003.

Institutional Framework

The institutional framework for environmental management in Rwanda is guided by the Law N° 63/2013 of 27/08/2013 determining the mission, organization and functioning of Rwanda Environment Management Authority (REMA) and Law N^{O} 48/2018 on Environment of the 13/08/2018.

Other key institutions for this proposed project include: The Ministry of Environment, Rwanda Mines, Petroleum and Gas Board, Rwanda Land Management and Use Authority, Rwanda Development Board, Ministry in Charge of Emergency Management (MINEMA), and decentralised entities or Local Authorities.

4.1.1 The Ministry of Environment (MoE)

The Ministry of Environment was established to ensure the conservation, protection and development of the environment. It also ensures the safeguard of green and climate resilience for growth of the economy; as stipulated in the Prime Minister's Order Nº 131/03 of 23/12/2017, the Ministry of Environment (MoE), has the following main responsibilities;

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

2) Rwanda Mines, Petroleum and Gas Board (RMB)

The institution with the proposed project has the following mission:

- To implement national policies, laws and strategies related to mines, petroleum and gas;
- To advise the Government on issues related to mines, petroleum and gas;
- To monitor and coordinate the implementation of strategies related to mines, petroleum and gas;

- To conduct research in geology, mining, petroleum and gas and disseminate research findings;
- To carry out mineral, petroleum and gas resources exploration operations in the country;
- To provide advice on the establishment of standards and regulations in Mining, Petroleum and Gas;
- To supervise and monitor public or private entities conducting mining, trade and value addition of minerals operations;
- To assist the Government in valuing mining and quarry concessions;
- To cooperate and collaborate with other regional and international institutions carrying out similar mission.

3) *Rwanda Environmental Management Authority (REMA)*

Based on Law N° 63/2013 of 27/08/2013 determining its mission, organization and function; REMA is the authority in charge of supervising, monitoring and ensuring that issues relating to environment are integrated in all national development programs. REMA shall have the following mission:

- To implement Government environmental policy;
- To advise the Government on policies, strategies and legislation related to the management of the environment as well as the implementation of environment related international conventions, whenever deemed necessary;
- To conduct thorough inspection of environmental management in order to prepare a report on the status of environment in Rwanda that shall be published every two (2) years;
- To put in place measures designed to prevent climate change and cope with its impacts;
- To conduct studies, research, investigations and other relevant activities in the field of environment and publish the findings;
- To closely monitor and assess development programs to ensure compliance with the laws on environment during their preparation and implementation;
- To participate in the preparation of activities strategies designed to prevent risks and other phenomena which may cause environmental degradation and propose remedial measures;
- To provide, where it is necessary, advice and technical support to individuals or entities engaged in natural resources management and environmental conservation;
- To prepare, publish and disseminate education materials relating to guidelines and laws relating to environmental management and protection and reduce environmental degradation risks;

- To monitor and supervise impact assessment, environmental audit, strategic environmental assessment and any other environmental study. REMA may authorize, in writing, any other person to analyze and approve these studies;
- To establish relationships and cooperate with national and international institutions and organizations in charge of environment and any other bodies that may help REMA to fulfill its mission.

4) *Rwanda Land Management and Use Authority (RLMUA)*

The Authority is responsible for land resource management and has the following main missions:

- To implement national policies, laws, strategies, regulations and Government resolutions related to the management and use of land;
- To provide advice to the Government, monitor and coordinate the implementation of strategies related to the management and use of land;
- To promote activities relating to investment and value addition in the activities related to the use and exploitation of land resources in Rwanda;
- To register land, issue and keep land authentic deeds and any other information relating to land of Rwanda;
- To supervise all land-related matters and represent the State for supervision and monitoring of land management and use;
- To execute or cause to be executed geodetic, topographic, hydrographic and cadastral surveys in relation to land resources;
- To initiate research and study on land, publish the results of the research and disseminate them;
- To prepare, disseminate and publish various maps and master plans relating to land management using the most appropriate scales;
- To establish and update basic topographic maps and thematic maps

- To define standards for: land administration; land surveys; the geo-information, spatial information and land information data collection; cartographic representations of geographic features and national spatial data infrastructure;
- To set up principles and guidelines related to use of land;
- To organize, coordinate and monitor collection use and dissemination of geo information in the country under the National Spatial data Infrastructure Framework;
- to issue technical instructions related to land management and use to district land bureau and follow up their implementation;
- to receive and evaluate proposals to purchase or lease private state-owned land and to issue, on behalf of Government, long term leases and permits to occupy such lands in accordance with the Law governing land in Rwanda;

- To monitor and to enforce the execution of terms of land lease contracts and to advise on their amendment;
- to undertake or cause to be undertaken all State land valuation for the purposes of its classification for sale, lease, taxation and cession;
- to carry out an inventory of all land resources in the country, their quality and their use, and act as the keeper and custodian of all national maps, aerial photomaps collections and their database;
- to resolve conflicts relating to land use and management which were not resolved at the District or City of Kigali levels;
- To establish cooperation and collaboration with other regional and international institutions with an aim of harmonizing the performance and relations on matters relating to management of land;

5) *Rwanda Water Resources Board (RWB)*

The mission of the RWB is to ensure the availability of enough and well managed water resources for sustainable development. The institution has the following responsibilities:

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

6) *Rwanda Forestry Authority (RFA)*

The mission of RFA is to ensure growth of forest resources, their management and protection for sustainable development purpose.

The institution has the following responsibilities:

- to implement policies, laws, strategies and Government decisions related to the management and utilization of forest resources;
- to advise the Government in matters relating to management and utilization of forest resources;
- to work with public and private institutions in charge of management of forests in a bid to increase their production and control of soil erosion;
- to prepare the plan for increasing forest resources;
- to establish strategies for multiplication and supply of tree seeds;
- to develop strategies for sustainable forest management and establish the significance of forests in the national economy;
- to support Districts and the City of Kigali in the management and sustainable utilization of forest resources;
- to conduct research on forest issues and disseminate the findings;
- to establish standards and regulations relating to the management and utilization of forest resources;
- to provide relevant organs with strategic guidance and participate in the rehabilitation of degraded landscapes through tree plantation;
- to set strategies related to processing of and value addition to production from forests and ensure their implementation;
- to set and ensure the implementation of strategies related to non-timber forest products processing and value addition;
- to monitor the respect of conditions to get a license for utilization of forest resources;
- to monitor and coordinate the implementation of strategies related to management and utilization of forest resources;
- to cooperate with other international institutions and organizations sharing a similar mission.

7) *Rwanda Development Board (RDB)*

Rwanda Development Board (RDB) is established by the Law No 46/2013 of 16/06/2013 determining its mission, organization and functioning. As it is stated in this Law, the institution has been established for the following mission;

- to fast-track development activities and facilitate the Government and private sector to undertake an active role;
- to promote local and foreign direct investments in Rwanda;
- to promote exports to regional and international markets of goods and services with added value;
- to participate in initiating and implementing policies and strategies in matters

relating to tourism and conservation of national parks and other protected areas in matters relating to tourism, and advise the Government on the promotion of the tourism sector;

- to participate in initiating and implementing policies and strategies in the field of Information and Communication Technology and advise the Government on the promotion of the sector;
- to provide guidelines, analyze project proposals and follow up the implementation of Government decisions in line with public and private investments
- to carry out privatization programs, monitor them and advise the Government accordingly
- to promote entrepreneurship and support the creation and development of private enterprises;
- to initiate, implement and follow up the activities relating to modernization, harnessing partnership and registering trading companies and businesses, secured transactions, intellectual property rights and the rights to initiate, exercise and cause business activities cessation;
- to promote investment in capacity building and mobilize private sector for employees' skills development programs in order to improve efficiency and competitiveness;
- to facilitate and help investors meet environmental standards;
- to cooperate and collaborate with other regional and international institutions having similar missions ;
- to advise Government on all activities which can fast track development in Rwanda

Initially the responsibility for reviewing and approving EIA reports was entrusted to REMA, this duty has now been transferred to RDB to speed up investment and good service for locals and international investors in one place, RDB. One stop center, EIA unit in RDB is responsible for review and approval of all EIA reports for proposed projects and programs before the implementation. The Key responsibilities are:

- 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 References (ToRs),
- Publicize Project Briefs and collect public comments during development of ToRs,
- 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.

8) *Ministry of Emergency Management (MINEMA)*

Policy planning and coordination of disaster prediction, and response in mining activities/ areas.
Rwanda Standards Board (RSB)

Drinking Water Testing, standards setting, certification of water and food products Decentralized entities For this project, local government and decentralized entities refers to Karongi and Rutsiro districts which must ensure the implementation of laws, policies, strategies, objectives and programs relating to the protection, conservation and promotion of the environment in Rwanda. In particular, decentralized entities are responsible for:

- Ensuring activities related to better management of land, especially fighting soil erosion and tap rain water;
- Afforestation, protection and proper management of forests;
- Protection 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, protected animal and plant species;
- Designing plans of removal, collecting, piling and treatment of domestic waste;
- Determining a hygiene and sanitation service fee.

Therefore, reference on the new Mining law N^{O} 58/2018 of 13/08/2018 on mining and quarry operations of the 13/08/2018 and related Ministerial orders and regulations of 2019.

4.4. AfDB Integrated Safeguards System (ISS)

The African Development Bank (AfDB) has sets of environmental and social assessment procedures that formalize the process to be followed when formulating, designing, constructing and operating programs and projects.

Approved in 2013, the AfDB 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, social and safety risks;

The preparation of the present environmental and social impact assessment for the Kivu belt WSS project has also followed the AfDB Environmental and Social Assessment Procedure (ESAP).

The ESAP gives the steps to be considered when undertaking an ESIA study including the generic terms of reference, typical contents of an ESIA and the minimum content of an Environmental and Social Management Plan (ESMP). Furthermore, it defines ESIA as an instrument whose purpose is to identify and assess the potential environmental and social impacts of a proposed project, evaluate alternatives, design appropriate mitigation/ enhancement, monitoring, consultative and institutional strengthening measures.

The AfDB Operational Safeguards (OS) under the Integrated Safeguards System are summarized below:

OS1: *Environmental and Social Assessment*

This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements: the scope of application; categorization; use of the appropriate Environmental and Social Assessment ESA (SESA, ESIA, ESMF, ESMP); climate change vulnerability assessment; public consultation; community impacts; appraisal and treatment of vulnerable groups; and grievance procedures. It updates and consolidates the policy commitments set out in the Bank's policy on the environment.

To the extent possible, the assessment complies with the relevant legislation and standards applicable in the local jurisdiction, bearing in mind the equivalence of standards with those of the Bank, and it takes into consideration national- or regional- level programming documents that are under implementation or in preparation.

OS 2: Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation

This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on involuntary resettlement, and it incorporates refinements designed to improve the operational effectiveness of those requirements.

In particular, it embraces comprehensive and forward-looking notions of livelihood and

assets, accounting for their social, cultural, and economic dimensions. It also adopts a definition of community and common property that emphasizes the need to maintain social cohesion, community structures, and the social interlinkage that common property provides.

The specific objectives of this OS is to avoid involuntary resettlement where feasible, or minimize resettlement impacts where involuntary resettlement is deemed unavoidable after all alternative project designs have been explored.

The safeguard retains the requirement to provide compensation at full replacement cost; reiterates

the importance of a resettlement that improves standards of living, income- earning capacity, and overall means of livelihood; and emphasizes the need to ensure that social considerations, such as gender, age, and stakes in the project outcome, do not disenfranchise particular project-affected people.

The affected populations are offered a range of different compensation package, resettlement assistance, and livelihood improvement options, as well as options for administering these measures at different levels (e.g., family, household and individual), and the affected persons themselves are given the opportunity to express their preferences.

OS 3: Biodiversity, Renewable Resources and Ecosystem Services

This Operational Safeguard outlines the requirements for borrowers or clients to (i) identify and implement opportunities to conserve and sustainably use biodiversity and natural habitats, and (ii) observe, implement, and respond to requirements for the conservation and sustainable management of priority ecosystem services.

The specific objectives of the OS are to: (i) Conserve biological diversity and ecosystem integrity by avoiding or, if avoidance is not possible, reducing and minimizing potentially harmful impacts on biodiversity; (ii) Endeavour to reinstate or restore biodiversity, including, where some impacts are unavoidable, through implementing biodiversity offsets to achieve "not net loss but net gain" of biodiversity; (iii) Protect natural, modified, and critical habitats; (iv) and Sustain the availability and productivity of priority ecosystem services to maintain benefits to the affected communities and sustain project performance.

OS4: Pollution Prevention and Control, Hazardous Materials and Resource Efficiency

This operational safeguard outlines the main pollution prevention and control requirements for borrowers or clients to achieve high-quality environmental performance, and efficient and sustainable use of natural resources, over the life of a project.

The borrower or client applies pollution prevention and control measures consistent with national legislation and standards, applicable international conventions, and inte rnationally recognized standards and good practice. When national legislation and regulations differ from the standards and measures presented in the EHS Guidelines, borrowers or clients are normally required to achieve whichever is more stringent.

Throughout the different phases of the project's lifecycle—planning and design, construction, commissioning, operations and decommissioning—the borrower assesses and evaluates

resource-efficiency and pollution-prevention techniques and implements them, taking into consideration their technical and financial feasibility and cost-effectiveness.

OS 5: Labor Conditions, Health and Safety

According to the Bank principles, labor is one of a country's most important assets in the pursuit of poverty reduction and economic growth. The respect of workers' rights is one of the keystones for developing a strong and productive workforce. This operational safeguard outlines the main requirements for borrowers or clients to protect the rights of workers and provide for their basic needs.

This safeguard further establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation. It covers working conditions, workers' organizations, occupational health and safety, and avoi dance of child or forced labor.

The AfDB has 5 Environmental and Social Operational Safeguards and these shall be triggered or not by the Kivu belt WSS Project as shown in the table below:

Table IV-2 AfDB Operational Safeguards triggered or not by Kivu belt WSS Project

Operational Safeguard (OS)	**Relevance of KIC to the OS**	**Triggered (Yes or Not)**
OS 1: *Environmental and Social Assessment*	Kivu belt WSS project triggers OS 1 because it falls under category 2, hence requires an Environmental and Social Assessment. As an integrated development, the Kivu belt WSS's ESIA will serve as an important tool used to manage the impacts generated through different activities.	**Yes**
OS 2: *Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation.*	The Kivu belt WSS triggers OS 2 because for the construction of project's infrastructures, several hectares of individual lands will be acquired, so that fair expropriation/compensation procedures will be followed with reference to the national expropriation/compensation Law 2015.	**Yes**
OS 3: *Biodiversity, Renewable Resources and Ecosystem Services.*	The WSS Kivu belt project triggers OS 3 because the intake for collecting water from Lake Kivu belt will be constructed in a buffer zone, generally recognized as a feeding and breeding area of several bird species and ubiquitous small mammals inhabiting the lakeshores.	**Yes**
OS 4: *Pollution Prevention and Control, Hazardous Materials and Resources Efficiency*	The Kivu belt WSS project will trigger OS 4 because produced sludge shall be well managed and backwash water from the water treatment plant shall be treated before its releasing to the natural environment. In that line, the elaborated ESMP will provide appropriate mitigation measures for their management.	**Yes**
OS 5: *Labor Conditions,*	The Kivu belt WSS project will trigger the OS 5 because several	

Operational Safeguard (OS)	Relevance of KIC to the OS	Triggered (Yes or Not)
Health and Safety	hundreds of unskilled and skilled workers shall be recruited locally or outside the project areas. With their presence, potential social, safety and health positive and negative impacts are likely to occur. Their management will be in compliance with Occupational Safety and Health Management Plan. Moreover, the ESIA will provide mitigation measures related to abuse of workers' rights, social exclusion, and gender-based violence etc…	**Yes**

V. IDENTIFICATION AND ANALYSIS OF ANTICIPATED IMPACTS

5.2 General Overview

Generally, an environmental and social impact refers to the changes of existing conditions of any area or environment caused by human activities or any internal or external influence which may be positive or negative. The impacts may also be direct or indirect, long term or short term and may be local or extensive. During the process of identification of impacts of

this project on the environment, it was discovered that during the project phases especially during construction and operation, a number of positive impacts on the human environment and some negatives impacts will occur.

The proposed construction of Kivu Belt Water Supply System is anticipated to impact on a range of biophysical and socio-economic components of the environment. One of the main purposes of the environmental baseline process is to understand the significance of these potential impacts and to identify suitable mitigation measures. These include potential impacts, which may arise during the construction, operation and decommissioning of the proposed Water supply system.

- The objective of impacts assessment is to identify and assess all the significant impacts that may arise from the undertaking of an activity and findings used to inform the competent authority's decision as to whether the activity should be either authorized, authorized subject to conditions that will mitigate the impacts to within acceptable levels, or refused.

5.3 Impacts types

Different types of impacts may occur from the implementation of this type of project, which may be positive or negative, and can be categorized as being either direct (primary), indirect (secondary) or cumulative.

- Direct impacts are impacts that caused directly by the activity and generally occur at the same time and at the place of the activity (for example, dust generation excavation activities). These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

- Indirect impacts are induced changes that may occur as a result of the activity (for example the use of water from a natural source at the activity will reduce the capacity for supply to other users). These types of impacts include all the potential impacts that either do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity (REMA, 2006).

- Cumulative impacts are impacting that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reason ably foreseeable future activities (for example, removal of vegetation may cause soil erosion, leading to excessive sediments in receiving stream, leading to reduced sunlight penetrating the water and thus reducing dissolved oxygen in the water and adversely affecting aquatic life and water quality). Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

5.4 Methodology of impacts evaluation

This section includes expected environmental and social impact assessment during construction and operation process of Kivu Belt Water Supply system. Methods used for impact assessment, as well as quantitative and qualitative criteria were developed for unify and standardization of the assessment system, which ensures the objectivity of the assessment. Impact assessment methodology preparation was based on guideline from REMA **[REMA, 2006].**

Impact on natural and social environment has been assessed in accordance with the determined criteria. During the assessment, special attention was paid to the impact which has been considered as significant in the given conditions.

The following scheme was used for environmental and social impact assessment of the planned activities:

- Determination of the impact based on general analysis of activities, which may be important for the Kivu Belt Water Supply system
- Search and analysis of the existing information
- Characterization and assessment of the impact
- Determination of the mitigation measures.
- Residual impact assessment: Determination of the expected value of change in the environment after implementation of the mitigation measures.
- Monitoring and Environmental management plan development

5.4.1 Identification of potential impacts

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

5.4.2 Impact on receptors and their sensitivity

Implementation of the works may cause such qualitative and quantitative characteristic changes of physical and biological resources in the impact area, such as:

- Water quality and quantity
- Air quality and acoustic background of the environment;
- Soil stability and quality;
- Visual changes of the landscapes;
- Habitats, flora and fauna ,etc;

5.4.3 Impact Characterization

To estimate environmental impact major impact factors are identified for construction and operation phases. Anticipated impact is assessed according to the following classification:

- Character – positive or negative, direct or indirect;
- Magnitude - insignificant, low, medium, high or very high;

- Likelihood – low, medium or high risk;
- Impact area – working site, project area or region;
- Duration – short-, mid- or long-term;
- Reversibility–reversible or irreversible

5.5 Impact characterization for the Project

The significance of potential impacts was assessed using the risk assessment methodology that considers impact magnitude and sensitivity of receptors, described below. The same methodology shall also be applied in E&S studies to the impact assessment for subprojects under this project.

5.5.1 Impact Magnitude

The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria. These magnitude categories are defined in the following table;

Table V-1 Parameters for Determining Magnitude

Parameter	Major	Medium	Minor	Nominal
Duration of potential impact	Long term (more than 35 years)	Medium Term Lifespan of the project (5 to 15 years)	Limited to constructio nperiod	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location withinproject component or site boundaries with no detectable potential impact
Reversibility yof potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or withlimited intervention within a few months	Baseline remains constant

Parameter	Major	Medium	Minor	Nominal
Legal standards and established professional criteria	Breaches national standards and or international guidelines/obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

5.5.2 Sensitivity of Receptor

The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in the following table.

Table V-2 Sensitivity levels

Sensitivity Determination	Definition
Very Severe	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation
Severe	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation
Mild	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low	Vulnerable receptor with good capacity to absorb proposed changes or/and good opportunities for mitigation

5.5.3 Impact Significance

Following the determination of impact magnitude and sensitivity of the receiving environment or potential receptors, the significance of each potential impact has been established using the impact significance matrix shown below;

Table V-3 Significance of Impact Criteria

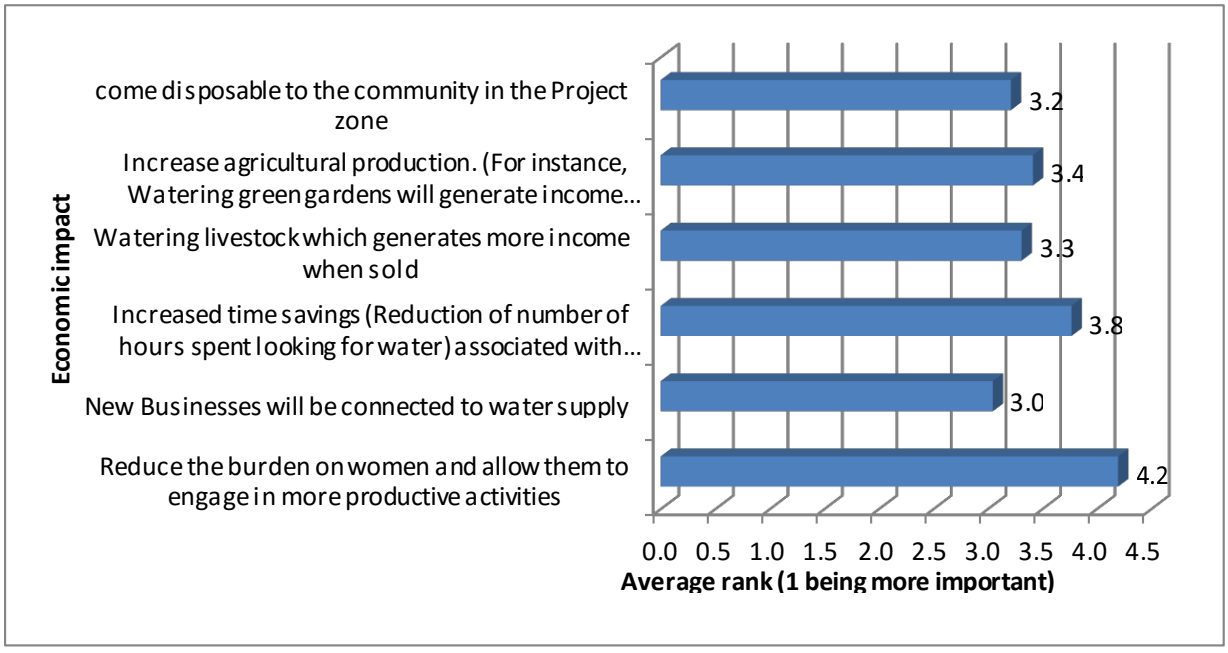
Sensitivity of Receptors				
Very Severe		**Severe**	**Mild**	**Low**
Major	Critical	High	Moderate	Minimal
Medium	High	High	Moderate	Minimal
Minor	Moderate	Moderate	Low	Minimal
Nominal	Minimal	Minimal	Minimal	Minimal

5.6 Impacts Assessment

This chapter identifies the key potential environmental and social impacts due to project activities based on the analysis of subprojects during pre-construction, construction and operation phases, assesses their significance, and proposes appropriate mitigation measures to address these impacts.

5.6.1 Potential Positive impacts of the project

a) Economic Impacts



Source: Data collection in Karongi and Rutsiro District, November 2020

In the ranking of Economic Impact, the highest rank is 6 and the lowest is 1. The findings from the above bar chart show that 149 women respondents ranked "reduce of burden on women and allow them to engage in more productive activities" as the highest average rank of 4.2. In the districts covering the project, women and young girls form a high percentage of population, but are inadequately participating in development activities due burden of

fetching water. Increased availability of water will relieve them and thereby give them an opportunity to engage in development activities.

Secondary, they ranked "increased time savings (Reduction of number of hours spent looking for water) associated with having water close to home" with average rank of 3.8. Obviously, accesses to water will in the long-term result in improved income levels and health of the local people, this consequently lead to poverty reduction. Reduced distances travelled and time used to collect water is relevant to economic activities.

Thirdly, Increase agricultural production. (For instance, Watering green gardens will generate income through the sale of green vegetable with average rank of 3.4. The access to the clean water will also allow the improving food security and nutrition. Through diversification of farming activities of high yield, using irrigation, as well as expansion of farming can increase agriculture production and by the way boosting food security.

With access to the clean water, there will be different business like opening of the restaurants, hair saloon, etc. In additional, The Project will create temporary jobs during the execution of civil works, which will include the following professions: man agers and executives, engineers, technicians, support administrative staff, carpenters, structural steel fitters, cement workers, welders, electricians, mechanics etc. For the mechanical and electrical work, foreign as well as national labour will be needed including supervisors or highly skilled labour.

There will be a need for multiple diverse services to support the workforce. Services can be expected to include the catering, cleaning, guards, transport, repair work, provision of goods etc. The provision of services will be by preference provided by existing local companies or companies from outside the area.

b) Social Impacts

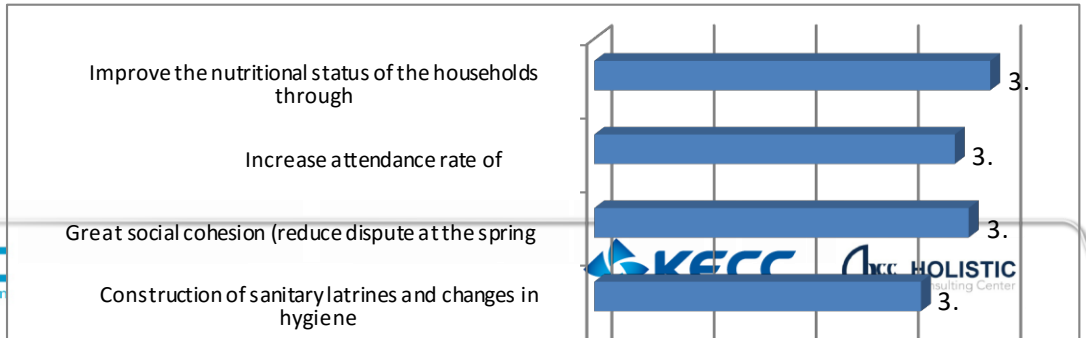


Figure V-2 Social impacts of the project

Source: Data collection in Karongi and Rutsiro District, November 2020

For the ranking of Social Impacts, the highest rank is 6 and the lowest is 1. 149 respondents have ranked "Improve the nutritional status of the households through the consumption of green vegetable" with average rank of 3.9 (highest). Access to water will allow families to cultivate in all seasons especially the cultivation of vegetables. It will be easy to maintain well their crops, have the kitchen gardens and water them during the dry period. This will allow these families to have fresh and green vegetables all the time and thus improve their nutrition status.

They ranked "Great social cohesion (reduce dispute at the spring taps)" at second place with 3.7 average rank. Access to water clean will resolve the problem of insufficient of water and reduce the dispute at spring taps. The families will have taps water in their houses and there will be enough public taps to allow the families to get easily water without waiting a long time at spring taps.

"Lives would be more comfortable and better" is at third place with average rank of 3.5. The employment opportunities will increase the income and spending capacity of the local population. The increased income should enable people to improve their standing of living for example by improving their housing conditions and purchasing commodities; which in turn will increase general economic development. Taxes paid to local government will increase the national treasury.

The Increase school attendance rate of children was ranked with average rank of 3.5. The distance from household to water source, involvement of children in collection of water lead to decrease of school attendance rate. The access to clean water will increase the school attendance rate. In addition, improving water in school is essential towards improving children's health and educational achievement.

The respondents ranked the "reduce the number of cases of dysenteries like cholera and typhoid in the project zone with average rank of 3.3. Improved water quality for domestic consumption will reduce risk to the waterborne diseases of the consumers and dependents of water resources. General hygiene in the served areas will improve through use of acceptable water quality. In other hand, the project will produce enough water to meet the

demand in all concerned Sectors.

Table V-4 Waterborne Diseases in Karongi and Rutsiro Districts

District	Waterborne Diseases	2015	2016	2017	2018	2019	2020
Karongi District	Entamoeba	4742	6403	8406	8121	13484	20225
	Giardia Positive	1937	1543	1938	2947	2583	3746
	Ascariasis Positive	9423	10364	10168	10664	11638	12179
	Trichuris Positive	356	348	626	299	414	444
	Schistosoma Positive	17	3	5	40	20	10
Rutsiro District	Entamoeba	4246	5269	7084	5832	7955	13792
	Giardia Positive	401	289	441	611	486	847
	Ascariasis Positive	9544	11274	13496	14221	14440	14277
	Trichuris Positive	1565	1740	2249	2233	2042	1420
	Schistosoma Positive	70	88	216	111	140	231

Source: Health Information System (HMIS), Extraction performed on 21/04/2021

- Entamoeba histolyca, Giardia positive, Ascariasis positive and trichuris are transmitted by drinking unsafe (contaminated water). Complication and consequences of those diseases are Diarrhea, malnutrition/ stunting, and sometimes death

- Schistosoma positive penetrate through the skin when washing the body with contaminated water or when in contact with contaminated water during fetching in lakes, in dams or marshalnds. Its complication/consequences are skin rash, ascites (urushwima), malnutrition/ stunting and sometimes death

Table V-5 Surveys for Intestinal Worms in Karongi and Rutsiro Districts

		only children screened		Children & adults screened
District	**Waterborne**	**200**	**2014**	**2020**
Karongi	Schistosoma	67,5	72,3%	50,8%
Rutsiro	Giardia Positive	93,5	87,7%	72,1%

Source: National mapping report, RBC

c) Socio- Economic benefits of project

In Urban area, the water supply system is managed by WASAC while the ones in rural area is undermanagement of Rutsiro and Karongi District officials and private operators.

In accordance with RURA board decision of setting water tariff, the water tariff in WASAC is based on monthly water consumption per m^3 as indicated below:

Table V-6 Water tariff

Customer Category	Block of consumption per month	Applied tariff in Rwf (VAT exclusive)
Public tap	Flat rate per m^3	323
Residential	0-5m^3	340
	6-20m^3	720
	21-50m^3	845
	Above 50m^3	877
Non-Residential	0-50m^3	877
	Above 50m^3	895
Industries	Flat rate per m^3	736

Some households have water into dwelling and other buy water at public tap of WASAC at 20 RWF forone Jerrican of 20 litters and 8 RWF/Jerrican in rural area where the water supply is managed by the private operators. According to the discussion conducted with different people in the area, the water supply is not enough considering the current need; some time, there is a shortage of water. WASAC staff announced that they manage the situation by putting in place a rotating system where water is distributed to different parts according to a schedule with equal days of distribution. At least, in each area, WASAC avail water in 1 or 2 days a week andfor other days, there is a shortage. It means that when there is water, the households try to store a lot of water. To cope with a total shortage of water, the households go to fetch water at river, from spring or they collect rainwater and some time there are the households who buy water at expensive price example 100 RWF for 20 litters.

Kivu Belt project will bring the social and economic benefits. For example, the project will respond to the issue of shortage of water and related problems. This will reduce the time spent while going to fetch water and the household members could concentrate more to other economic activities like income generating activities. They will save the money that they spend for water at expensive price from the private operators who store water and determine their own prices when there is a shortageand buy at price fixed by RURA.

It will also reduce the problem of waterborne diseases, as the households will use improved water. In addition, there will be increase of jobs creation. The table below indicates the performance indicators for Kivu Belt WSS.

Water performance indicators for Kivu Belt project

Table V-7 Performance indicators for Kivu belt WSS

#	INDICATORS	Baseline	Target		
	ACCESS TO WATER SUPPLY SERVICES	2020/21	2025	2030	2035
1	% of households with improved water source in dwellings	18	90	95	**100**
2	% of population using an improved water source	95	100	100	**100**
3	% of rural households using an improved water sourcewithin 500m	70	100	100	**100**
4	% of population using an improved water source within30 minutes round-trip in rural areas	65	100	100	**40**
5	% Waiting time at drinking water source less or equal to30 minutes	80	100	100	**100**
6	% of households using an improved water source within200m	48	90	100	**80**
7	% of population using an improved water source within30 minutes round-trip in Urban areas	65	100	100	**90**
8	% of health centers with improved Water Supply	TBD	100	100	**100**
9	Primary and secondary schools with improved water supply	TBD	100	100	**100**
10	Motel and hotels with improved water supply	TBD	100	100	100

Some baseline data were calculated based on data collected through Socio-Economic survey tool and analyzed with SPSS software

Some baseline data were calculated based on data collected through Socio-Economic survey tool and analyzed with SPSS software.

5.6.2 Potential Negative Impacts

a) Impact on hydrological regime downward

By construction of dam and water intake on Musogoro River, downstream sections of the dam river may undergo important changes in hydrological regime associated with filling of the reservoir, storing water and water treatment plant operating modes. Thus, abstraction of more water from the Musogoro River might reduce flow level downstream. This induces change in physico-chemical parameters which may in turn affect aquatic biodiversity. Lower flow levels mean that water will not be sufficient for downstream users.

b) Impact of heavy sedimentation from the watershed and during construction

Tributaries of the Musogoro River such as Ndaba, Kavumbi and Karuganzu pass through a mining region and their waters are used to separate minerals from mud and other aggregates. Thus, waters are heavily loaded with sediments to such an extent that Musogoro, which receives these, is impacted by sediment pollution (Turbidity more than 240 NT). Furthermore, release of high sediment load in Musogoro waters may occur mainly from erosion in rainy season and during works on the diversion channel construction, excavation works at dam site, construction of protection dikes and coffer-dams, quarrying works, sand borrowing in river bed, etc. These activities may create an increase in the sediment load discharged into the river.

The Musogoro river is also polluted by the liquid waste from the coffee processing plant which is flowing directly into the river without any treatment Figure V-3.

Figure V-3 High Turbidity in Musogoro (L), Black Liquid Waste from Kopakaki Coffee processing Plant (R)

c) Potential water quality deterioration due to direct release of mixed sludge and backwash water from WTP.

For the project Kivu belt water supply systems, the water treatment plant will be constructed at about 300 meters on the Kayenzi hill overlooking the Musogoro valley. Thus, accumulated sludge and backwash water containing chemicals from the WTP shall be treated before any release to environment and in particular to Musogoro river. Otherwise, there may be severe effects on the

downstream population which relies on the river for domestic and cattle water supply, washing and irrigation activities. The treatment and realese of the sludge and backwash water is explained in in

II.4.2 Treatment train and process, section 8 focusing on the sludge disposal.

d) Impact generated by chemicals handling and use

Water purification process requires the addition of chemicals such as Sudfloc nd Chlorine to assist in the removal of particles suspended in water. Improper use of these chemicals may have an impact on water and soil quality. The standard level of chemicals to be added to water for purification are presented in 8.1.3. Treatment train and process, section focusing on Chemical reagent.

e) Impact from noise and vibrations

Some of the storage reservoirs may be constructed at rocky based sites which would necessitate blasting activities for platforms preparation Figure V-7. Therefore, high noise levels will be produced during blasting activity as well as during transport of materials using heavy trucks. Therefore, the use of vehicle horns, and speakers and bursting or cracking by construction companies shall be monitored to meet the RSB standard DRS 236: 2020 related to acoustics, Noise Pollution and Tolerance limit. High quality equipment with low vibration shall be encouraged to be used by contractors.

Figure V-4 Rocky Based sites in the area which may serve as the foundation for the Construction of Storage Reservoirs

f) Impact on the water quality in the river at the intake site and downstream from the intake

Spreading of large volumes of gasoline, lubricant products as well as significant quantities of explosives and chemicals (concrete additives, paints, thinners, solvents) which will be stored and handled on the construction sites, with related risk of leakage or accidental spill in the

environment. The contractors, prior to works starting should submit for approval their C-ESMP, for the authority to be sure of their plan to manage those impacts.

g) Soil and water pollution by solid waste generated during construction and decommissioning phases

Spreading of large quantities of solid construction waste including mainly scrap metal, wood, plastic, cement bags, used tires and batteries will also be produced and will require proper management.

Environment pollution by domestic waste.

Domestic waste will be produced by staff and workers in camps sites and the release of pathogens and coliforms in the river may affect the population as well as domestic animals downstream.

h) Impact on lands acquisition and their utilization

The project's facilities construction associated with creation of small reservoir, water diversion channel, water treatment plant, storage reservoirs and excavation for pipelines network installation will require acquisition of several hectares of lands, with destruction of agriculture crops such as: Irish potatoes, bananas, coffee trees, maize, eucalyptus plantations as well as expropriation of several individual properties (houses, fences, toilets etc). The magnitude and importance of the potential impact on the lands acquisition and use will depend on the overall surface areas required for the execution of project's activities.

Figure V-4 Impact of Lands Acquisition Inducing Expropriation (L), Compensation of Individual Properties (R)

i) Temporary blocking of access to community facilities

The access to facilities, shops/businesses and houses might be blocked during the construction of new and rehabilitation of existing water supply and sewerage pipes. If the access is fully blocked, it might cause temporary loss of business. If not well managed, the

excavated open trenches would bring risk to the community safety. Such impact is estimated as moderate.

To address the risk, the contractors should fence the construction site or install visible signs and lights at the open trenches. In addition, paths should be provided over the trenches to the facilities. In the case of fully blocking, the contractors should arrange bypass roads and crossings for pedestrians and cars and inform the community with the plan prior to the construction. If any business/economic loss is foreseen, the compensation should be agreed and paid in accordance with that laid out in the RPF. With these measures, the residual impact will be low.

j) Inventory of possible compensations or expropriation

The construction of water intake, water lifting channel, water treatment plant, storage reservoirs and excavation for pipelines network installation will require a certain portion of land and eventually the destruction of crops and trees on acquired land.

Land for pipeline network will be temporary acquired and re-used after soil replenishing. Only affected crops and trees will be evaluated and compensated.

Land for WTP, water intake and water reservoirs will be permanently acquired and will need to be compensated. Correspondingly, Crops and trees on acquired land will also be destroyed and compensated as well.

The Water treatment plant and intake will be constructed on 19,000 m^2 while 6532.65 m2 are required for new water reservoirs and 298,182.5 m^2 will be required for water pipeline channels.

Water distribution network is underground; its accommodation will entail excavation activities on around 3.5 m of width and for the whole length of the distribution network affecting all crops and trees on the concerned land. Affected trees and crops will be compensated. However, land on distribution network will not be compensated as long as after land filling affected land will be used again either for agriculture or for animal husbandry purposes. The estimated cost was calculated in reference with "Land and crops prices as provided in special Gazette no. Special of 08/11/2018 and is presented below. Note that the exact cost will be determined in the RAP elaboration phase.

Table V-8 Area to be covered by new reservoirs (99)

Name	number	l of each (m)	r of each (m)	area covered (m^2)
tank of 10	55	5.1	3.3	925.65
tank of 25	10	5.4	3.6	194.4
Of 50	5	7.5	5.7	213.75
of 100	8	10.95	7.2	630.72
0f 200	4	13.15	9.5	499.7
of 500	14	17.5	13.5	3307.5
0f 1000	2	19.75	12.2	481.9
of 2500	1	21.3	13.1	279.03
	99		TOTAL	6532.65

The permanently required land and estimated cost is presented table V-4

Table V-9 Permanently required land and estimated cost

N0	Type of infrastructu	Required land (m2)	Price of land by m2	Estimated cost (Rwfs)	comment
1	WTP & Intake	19,000.00	3,800	72,200,000	Estimate cost for land to accommodate WTP intake.
2	New reservoirs (99)	6,533	3800	24,824,070	Estimate cost for land to accommodate new
Sub/Total				97,024,070	
Temporally required land and estimate cost for crops to be affected					
3	Affected crops by water pipeline channel (85,195m *3.5m)	298,182.5=29.81825 Ha and 2500 tree plants per ha 74,545 trees	3,200 RWF/tree	238,544,000	Estimate cost for Crops to be compensated (Banana was generalized for whole area).
4	Affected crops by WTP intake (19,000 m^2) and new reservoirs	22,393.775m^2= 2.239.3775 ha and 2500 tree banana per ha	3,200 RWF/tree	17,913,600	Estimate cost for Crops to be compensated (Banana was
Sub/Total				**256,457,600**	
General Total				**341,553,945**	

Source: special Gazette N0 Special of 08/11/2018 establishing land reference prices and the IRPV, 2018 (Published reference prices for crops and construction)

5.7 Summary of Assessed Impacts

The impact assessment concluded that the Project will generate mostly positive socio-economic benefits due to the improvement of water supply and sanitation (WSS) facilities in Bukhara region. Construction and rehabilitation of WSS infrastructure will significantly improve living conditions, water supply and sanitation, which will overall have significant

effects on the health of population and environment of region in general.

At the same time the proposed project activities might generate various adverse environmental and social impacts. These impacts would be associated with physical and economic displacement particularly related to land acquisition for the new facilities, generation of wastes, noise, dust, air pollution, wastewater, impacts on cultural heritage, disturbance to community and traffic, health hazards and labour safety issues, due to facility siting, civil works and operation and maintenance.

The project's potential environmental and social impacts have been assessed with the methodology described in Section V.3 above. The key impacts are summarized in Table V-8.

Table V-10 Summary of Potential Impacts and their Significance

Potential Impacts	Duration	Spati	Reversible	Likelihoo	Magnitud	Sensitivit	Significance Prior to	Significance after
Improved water supply system	Long term	Local	Yes	Certain	Major	-	High positive	N/A
Improved sewerage system	Long term	Widespread	Yes	Certain	Major	-	High positive	N/A
Impacts related to Project siting								
Impacts on community facilities and places of socio-cultural significance	Short term	Local	Yes	Likely	Medium	Low	Minimal impact	Minimal impact
Land acquisition and resettlement	Medium term	Local	Yes	Likely	Major	Mild	Moderate	Low
Loss of farmlands and income	Short term	Local	Yes	Certain	Major	Mild	Moderate	Low
Environment impacts during construction phase								
Land cover and land use changes	Short term	Within project boundary	Yes	Certain	Medium	Mild	Moderate	Moderate
Loss of trees and crops	Short term	Local	No	Certain	Medium	Mild	Moderate	Moderate
Loss of fertilized soil	Long term	Local	Yes	Certain	Major	Severe	High	Moderate
Impacts on borrow areas	Short term	Widespread	No	Certain	Medium	Severe	High	Moderate
Air pollution	Short term	Widespread	Yes	Certain	Major	Mild	Moderate	Low
Noise and vibration	Short term	Local	Yes	Certain	Medium	Mild	Moderate	Low
Water pollution	Short term	Widespread	Yes	Likely	Medium	Mild	Moderate	Low
Soil contamination	Medium term	Local	Yes	Certain	Medium	Severe	High	Moderate
Solid wastes	Short term	Local	Yes	Certain	Medium	Mild	Moderate	Low
Hazardous wastes (including	Short term	Local	Yes	Certain	Medium	Severe	High	Moderate

Occupational health and safety	Short term	Local	Yes	Likely	Medium	Severe	High	Moderate
Site clearance and restoration	Short term	Local	Yes	Certain	Medium	Mild	Moderate	Low
Social impacts during construction phase								
Impacts on cultural resources	Short term	Local	Yes	Likely	Medium	Mild	Moderate	Minimal
Temporary blockage of access to community facilities such as shops, houses and schools, etc.	Short term	Local	Yes	Likely	Medium	Mild	Moderate	Low
Disturbance to the traffic	Short term	Widespread	Yes	Certain	Major	Severe	High	Moderate
Disturbance to public utilities (electricity, telecom cables, gas pipes and etc.)	Short term	Widespread	Yes	Likely	Medium	Severe	High	Low
Community health and safety	Short term	Widespread	Yes	Likely	Medium	Severe	High	Low
Influx of workers and labor issues	Short term	Widespread	Yes	Likely	Medium	Mild	Moderate	Low
Environmental impacts during O&M								
Impacts on groundwater	Long term	Local	No	Likely	Medium	Severe	High	Moderate
Generation of wastes including hazardous materials	Long term	Local	Yes	Certain	Major	Mild	Moderate	Low
Increasing of sewage due to increase of water supply	Long term	Widespread	Yes	Certain	Major	Mild	Moderate	Moderate
Air pollution	Long term	Widespread	Yes	Certain	Major	Mild	Moderate	Low

Noise and vibration	Long term	Local	Yes	Certain	Major	Severe	High	Moderate
Water pollution	Long term	Widespread	Yes	Certain	Major	Mild	Moderate	Low
Water consumption	Long term	Widespread	No	Certain	Major	Mild	Moderate	Moderate
Occupational health and safety	Short term	Local	Yes	Likely	Medium	Severe	High	Moderate
Social impacts during O&M								
Emergency situations	Short term	Local	Yes	Occasional	Medium	Severe	High	Low

Table V-11 Matrix used for identification of potential impacts associated with proposed work

Environmental components			**Physical (Land-Water-Air)**								**Biological**				**Socio-economic**										
			Geology	Soil		Water			Air	Visual	Flora		Fauna		Resettlement						Quality of life				
Project activities			Geological	Soil pollution	Soil erosion	Water Pollution	Runoff and	Underground	Air quality	Visual impacts	Flora species	Flora Succession	Fauna species	Fauna Habitat	Loss houses and	Loss of Crops	Loss of private	Loss of public	Loss of income	Infrastructure and public	Occupational health and	Employment	Skills transfer	Cultural and	Noise and
Project phase	N0	Main Activity																							
Designing and planning	1	Preliminary Survey and detailed design including EIA and RAP																				X	X		
Construction	2	Construction of access roads	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X		X
	3	Influx of construction workers																			X	X	X	X	
	4	Construction of water intakes	X	X	X	X		X	X	X	X		X		X	X	X	X	X	X	X	X	X		
	5	Installation of pipe	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
	6	Installation of reservoirs					X		X												X	X	X		X
	7	Construction of WTP	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
	8	Construction pump station		X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X		X
	9	Disposal of sludge and construction material		X		X	X	X	X												X				X
Operation and Maintenance	10	Operation of water Pumps																							X
	11	Maintenance and rehabilitation of water infrastructure	X	X	X	X	X	X	X													X	X		X
Decommissioning	12	Site closure	X	X	X	X	X	X	X																X
	13	Decommissioning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X		X

VI. PROJECT ALTERNATIVES

The purpose of the analysis of alternatives as part of the ESIA process is to select the best among all possible project options. The assessments and recommendations made by the ESIA Team are presented below:

6.1 No- Project alternative

The No Project alternative option will entail leaving the population in the present situation and this option is not desirable considering the need of water supply in different part of the country. Though this option will not have direct environmental impacts there are many significant and specific benefits that would results in project implementation.

6.1.1 Benefits of the No-Project Option

The minor benefits of the No-Project Option are:

- Present flow regime of the proposed Water Supply source would be maintained.
- Short Term impacts caused by construction activities e.g. noise, dust generation, vibrations, etc., would not exist.
- Loss of the relatively small land to be used for construction of Water Treatment Plant, Water Storage Reservoir, etc., would not exist.
- Temporary inconvenience caused by construction activities in project area e.g. temporary road closure for pipeline crossings, would not exist.
- The limited possible water contamination associated to human activities within the area would not exist.
- The health risks associated with Water Treatment Plants i.e. handling of slightly harmful water treatment chemicals would not exist.

6.1.2 Negative Effects of the No-Project Option

The negative effects of the No-Project Option are:

- The growing population in project area will continue to suffer from water shortage caused by inadequate existing water supply system and a large percentage of the population living outside of the area of coverage of the existing water supply would continue having no access to safe water.
- The target for vision 2020 of having access to clean water will not be achieved.
- Occurrence of diseases caused by consumption of untreated drinking water would continue to appear.

- Employment opportunities connected with the Project during and after implementation would not be available. Economic development of the area expected as a result of the Project would also be missed.

Alternative sources of energy during operation for pumping station

Special attention will be required in locating and indicating the existing powerlines that could be extended for power supply to the proposed water treatment plant, raw water pumping stations and treated water pumping stations within the network.

The power demand to operate the raw water pump station, is expected to be allocated from the nearest public electricity network passing through the area which is three-phase mean voltage (MV) power grid that was identified at kiramuruzi sector.

The need for minimizing the extent to which pumping is required will be essential to the overall efficiency of each water supply system. Recurrent electric expenditure is a significant element of the system operating costs and hence the water tariff to be applied to the consumer.

d) Alternative source of water supply

With regard to the other sources of water supply within the project area, Musogoro river have been found as the only relevant source of water supply to the defined water demand. The intake is located on Musogoro river in Karongi District, in Western Province of Rwanda. The river

Musogoro drains into the Lake Kivu in the central part of it. It is part of Kivu basin part of Rwanda. All

kivu basin streams and rivers are characterized by steep slopes from mountainous region of the Congo-Nile water divide above 2500 m elevation down to 1400 m at the lake. The intake is located on the river almost 1 km downstream from the main road Rubengera-Karongi. The first important aspect is the determination of the minimum guaranteed runoff which is a key issue in the estimate of available water resources at the intake site. Given the fact that the intake will not provide any storage reservoir, the minimum flow is more significant as compared to average flow. The analysis of low flows will be conducted in the coming pages.

Musogoro river is ungauged and no flow data on the river, the secondary data have been mostly used to better estimate the guaranteed flows at the intake site. Comparable streams and rivers in the same basin (Kivu basin of Rwanda) will also be used to simulate flows at the intake.

6.2 Project with mitigation measures

After rejection of non-project option, the consultant assessed different option of implementing the projects with mitigation measures and better options. Alternatives were assessed mainly in terms of site location and design of proposed structures:

6.2.1 Site selection

The site selection focused mainly some advantages and disadvantages of type of source for water abstraction and tries to rank the sources as per few selection criteria.

6.2.2 Topographic Survey

Topographical surveys, hydrological and geological surveys were conducted in the study area in order to identify where the water supply line will pass and where new water tanks will be constructed to satisfy 100% in the four sectors of Karongi district and four sectors of Rutsiro in terms of drinking water supply. The preliminary geological survey was done at the tanks and water treatment plant intake to inform the Detailed Feasibility Study.

6.2.3 Survey of Possible Sites and Assessment of Their Suitability

During field visit sites were selected based on the topography, geology and main parameters to obtain cost effective system.

6.2.3.1 Selection of Raw Water Intake Structures

During field visit, two sites for intake structures were selected among which one has been selected based on field investigation, cost and effectiveness.

6.2.3.2 Selection with Respect to Geology and Topography

For selection of site for intake and water treatment plant, topography was taken into consideration to avoid flooding which may cause damages and suitability of the site support the imposed structure in terms of bearing capacity and other geological parameters.

The location the intake should be selected to obtain an adequate supply of water of the highest possible quality, with consistent reliability, economical construction, and minimal effect on aquatic life. After field survey by design team, the optimized intake point was identified at X= 435535, Y= 477183 and Z=1595 on Musorogo River in Rubengera sector. It is located 1.7km upstream of the WTP

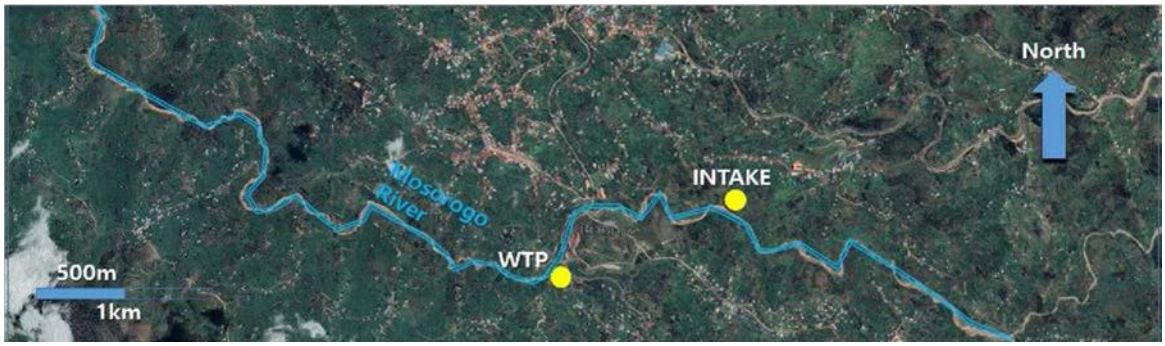


Figure VI-1 Location of WTP and Intake

VII. PUBLIC CONSULTATION AND ENGAGEMENT

7.1 BACKGROUND

Public consultation meetings have been conducted by the developer of a project through ESIA expert. The public, staff involved in the project as well as other stakeholders get occasions for obtaining information about the Project and to assess their concerns. These consultation sessions will offer an occasion to communicate with members of the community who may be affected by the Project and give them a room to participate in the environmental, social, safety and health impacts assessment process. The stakeholders and public consultations were carried out in accordance with the provisions of Ministerial Decree No 001/2019 of 04/15/2019 establishing the list of projects to be the subject of an environmental impact assessment study, instructions, conditions and procedures to carry out the environmental and social impact assessment (ESIA).

According to the AfDB policies, project affected persons and host communities are to be meaningfully consulted early in the planning process and encouraged to participate in all stages up to the execution of the project. Therefore, the present ESIA report will document stakeholders concerns or suggestions as well as the ways and strategies allocated by the project to address these.

7.2 Stakeholders and Public consultations objectives

The main objective of these consultations is to inform, consult and involve the stakeholders at different levels concerned by the project in order to ascertain their sensitivity to the project (acceptance, reluctance, nature of fears and requirements), the needs of the actors and their recommendations in view of good environmental performance of the project.

The specific objectives of the ESIA stakeholders and public consultations process are to:

Apprehend the opinions and attitudes towards the project from stakeholders, especially communities neighbouring the project and project affected persons;

Explain and make the compensation process transparent, but more detailed in the ARAP;

Share, comment and find a consensus on proposed potential positive and negative environmental, social, safety and health impacts and their proposed mitigation measures;

5.7.1 Provide a platform for future consultations and collaboration with all by:

- ***conflict reduction through early identification of contentious issues;***
- ***improving transparency and accountability of decision making;***
- ***facilitating participation to increase public confidence in the ESIA process and smooth project implementation;***
- ***Identifying stakeholders with whom further constructive dialogue and collaboration will be necessary in subsequent stages of the project.***

7.3 Key Stakeholders Consultations and outcomes

Discussions with the Client and his staff, key stakeholders including Administrators at District and Sector levels, District Environmental officer and WATSAN officer were made on the concept and nature as well as the importance of Kivu belt Water Supply System Project, emphasizing the levels of public participation, role of key stakeholders and joint contributions of these actors to the success of the planned project.
The roles of key stakeholders and expected contributions of beneficiaries as well as population affected or not by the project's activities were emphasized by the ESIA Expert during consultation meetings held within the project area. Moreover, the scope of the proposed project and possible means of maximizing local communities' social, economic and environmental benefits from the project implementation were underlined.

Local residents inhabiting the areas where project's infrastructures will be constructed have been consulted and the meeting was held in Rarugwe and Bubazi cell and headed by the local government representatives.

The main objective of this public consultation was to gather information on the concerns of public and key stakeholders, their perceptions, reactions and fears of the livelihood changes to be brought about as a result of the project implementation in area.

Other specific objectives of the consultation meetings were:

- ***To explain the details of the project to local community living within the project area;***
- ***Try to get a complementary socio-economic and environmental information from the audience;***
- ***Try to get current information on the effects of under-going activities already perceived by local community.***

Photos Nº 5 &6: Public consultation within the project area.

During the consultation exercise, the ESIA Consultant has presented to the community the project background, objectives, expected outcomes including the potential socio-economic and environmental benefits.

After the presentation, the community was given opportunity to express their views, give out their comments as well as queries. Some important questions raised by the community have been answered by the Consultant at their satisfaction. This kind of meetings were arranged to share point of views with different stakeholders on the background of the planned project (Kivu belt Water Supply System). Benefits and negative effects of the project implementation were presented, and the consulted stakeholders within project area have raised some issues during a flow discussion as following:

- sustainability and durability of the planned project within the districts covering it;
- identification of different environmental problems related to the project implementation;
- relevant socio-cultural and economic parameters to be considered in enhancing and mitigating associated positive and negative impacts respectively.
- Concerns and views raised by PAPs and other participants as well their responses are summarized in the following table.

Table VII-1 Concerns and views of PAPs and others

#	Concerns	Response
1	Loss of land, crops, trees, houses	Any affected property shall be fairly valuated and compensated prior then use of the land and assets.
2	How can ensure that the valuation of affected properties shall be fair	- The valuation shall be guided by the law provisions related to expropriation and compensation, - Prices of each item including land and other assets (houses, crops, trees, …) are known and listed in the "Journal official", - Where the values of different item are too low, market price shall be used further applying the replacement cost compensation method. - GRC will help in addressing any complaint in collaboration with the project implementers
3	Some of the land owners do not have required documents	Local administration will help and speed up the acquisition of such documents
4	How to get job in the WSS project	Priority shall be given to local people, especially the PAPs who want to compensate the advantage lost due their displacement. However, children are not at all allowed to work in the project.
5	Compensation payment is most of time delaying and affected people are not allowed to use the affected land	WASAC and the districts are involved in the compensation process and they will make the follow up and ensure all PAPs are compensated prior the use of his land.
6	When the construction works will start	Once the study is complete, construction works will follow.

VIII. IMPACTS AND MITIGATION MEASURES

8.1 Impacts identified and proposed mitigation measures

This section presents potential impacts associated with the implementation of the proposed activities under Kivu Belt Water Supply project as per general guidelines for Environmental Impact Assessment in Rwanda (REMA 2006) and AfDB Integrated safeguards System both positive and negative impact associated with project were assessed. A summary of impacts analysis in tabular form is also presented at the end of this section. An Environmental Management and Monitoring Plan for the projects is provided in the following chapiter.

8.2 Positive socio-economic impacts

The proposed project is likely to have substantial positive socio-cultural and economic impacts in the region. Obvious positive impacts are the provision of employment and water infrastructures that can support the country's objectives in terms of water supply and economic development. The following section highlights the potential social-cultural and economic impacts associated with the proposed project.

8.2.1 Local employment

The implementation of this project will provide employment opportunities for local population. The use of local labors and skilled workers will improve the skill resource base in the targeted districts through the implementation of training and development programmes. These are both positive outcomes of the project and for the local population. However, there will be an influx of people looking for work in general. If not carefully managed, this strain would be a negative impact.

8.2.2 Access to potable water and reliability of water supply system

The construction of Water Treatment Plant, water reservoir and pipeline will increase clean water production and the number of households with access to clean water. The improvement and expansion of water supply system will enable greater responsiveness to the demand, increasing also the reliability of the operating system. The reliability of the system will allow adequate planning for water supplies.

8.2.3 Knowledge transfer

Technical and planning skills will be gained by the local people that will be employed by the project and this is likely to contribute to the capacity building.

8.2.4 Economic Diversification and Improved local socio-economy

It expected that all works related to the project will provide a positive increase to the local and national economy in general this will contribute to the socio-economic benefits within and around the project area. The economic expansion will enable alternative businesses and economic activities to develop. Also, increased earnings by staff will most likely be spent

locally further supporting already established businesses in the area, as well as potential new businesses that may emerge.

8.2.5 Gender balance enhancement

It is expected that during the project implementation women will equally benefit as men in terms of employment benefits. In Rwandan culture, it is the responsibility of a woman to collect water and during water shortages, women and girls use most of their time for water. Therefore, the proposed project will be highly beneficial to women and girls.

i. Healthcare for Employees

Employees and their immediate families will be provided with basic healthcare. This will benefit the overall health of the local population. HIV/AIDS information will be dispersed to employees to prevent the spread of the disease amongst the project employees and their families.

ii. Possibility of savings for the employees

The increase of the project's employee's revenue will lead to the possibility of savings in local banks and micro-finances.

8.3 Negative socio-economic impacts

Pre- construction impacts

i. High expectation of the local communities in relation to job posts

There is within the local population, high expectations about jobs creation. Indeed, although the project will create employment opportunities, the jobs will be limited and it is therefore important that the procurement processes is clear and fair. It is expected that creation of not enough jobs will create frustration on part of the local people and conflicts can occur or be generated in relation to the project

ii.Expectations of short-term solution to all problems of water supply

The presence of a new water project can create very high expectations in the population as the immediate solution of all problems in the water supply sector. However, it is known that the solutions will be gradual and there are initiatives taken in the short term and others long-term due to limitations in the existing water sources and the costs involved with the alternatives identified.

iii. Resettlement implications

Permanent land acquisition is expected where Water Treatment Plant, water intake and water storages will be constructed. Temporary land acquisition will be also required for laying pipelines. For project a Resettlement Action Plan will be prepared and compensation provided before civil works. The RAP report will provide details on affected assets and proposed mitigation and compensation measures.

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

It is highly likely that people who will stand to lose land, infrastructure or business due to the project will have very high expectations of compensation to their loss.

v. Conflicts among workers and the local population in the project area

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

Construction Phase

i. Injuries or fatalities from improper manual handling

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

Proposed mitigation measures:

- Health and safety measures should be observed including provision of Personnel Protective Equipment (PPE),
- First aid kit,
- Occupational Health and Safety (OHS) and,
- Training and health insurance to all workers
- Working conditions should respect the minimum requirement per as Rwandan law (N°13/ 2009 of 27/05/2009 regulating labor in Rwanda) and international rules such as OHSAS
- Measures are taken to oblige workers to wear safety boots and helmets and to manage waste properly, in order to prevent accidents during the construction work
- The safety and sanitation plan will be prepared and regular safety education will be implemented, in consultation with a district work safety inspector
- Security guards, who are provided with training of health and safety, are assigned and measures are taken such as installation of fence and signboards in order to prevent accidents and troubles involving local residents near the construction site.

ii. Traffic congestion and injuries or fatalities

The principal pipeline is mostly designed along the existing roads and at some point, it crosses both paved and unpaved roads. During construction period there will be increase in traffic due to moving machineries and vehicle traffic for material supply. This may cause

both congestion and accidents.

- People struck or run over by moving vehicles (e.g. during reversing), causing minor to major injuries (fractures, wounds) or death;
- Falling from vehicles, causing injuries or death;
- Injuries or death because of vehicles overturning.

Proposed mitigation measures include:

- Provision of training to train drivers
- Preparation of traffic management plan and
- Provision of safety people to guide traffic especially where the works will be undertaken near paved road with busy traffic and during busy traffic.

iii. Work related Health issues

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

Proposed mitigate n measures

- PPE should be provided to workers who are exposed to dust, noise and vibration for a prolonged period.
- Water should be splayed in working area especially near business places and schools at least two time a day.
- watering regularly to suppress excessive dust during construction, use of gas masks and go goggles for dusty sections is strongly recommended;
- The contractor together with local authorities is required to enforce acquiring medical insurance
- "mituelle de santé" for all workers as a means of affordability of treatment.
- The safety and sanitation plan will be prepared planned and regular safety education will be implemented, in consultation with a district work safety inspector.

iv. Impacts of labor influx

Migration of big number project workers within the project area will increases the rate of HIV/AIDS and other Sexually Transmitted Diseases (STD). Due to the increase of people from outside of the Though there is no workers camps planned for this projects Communicable disease are anticipated among workers.

Mitigation measures

- Regular sensitization on ways of HIV/AIDS prevention, importance of proper hygiene is important during execution of this project;
- Prepare awareness program to all workers on the avoidance and related risks to GBV and CAE;
- The contractor should be aware on labor Law and most importantly the article on the Child Labor;

- Female workers should be sensitized on their rights and encouraged to report any gender-based violence or threat.

v. Disruption of Public Utilities

At several points, small domestic water supply pipe lines and electricity and communication cables were observed. During construction, these infrastructures are likely to be affected by the construction activities.

Mitigation measures

- The contract will avoid as much as possible this infrastructure but where are affected they will be rehabilitated.
- Rehabilitation of affected structures and infrastructures;
- Identification of new water source and construct alternative water spring.

vi. Child labor, forced labor, discrimination and abusive dismissal

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

Proposed Mitigation Measures

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

vii. Soil erosion

Soil damage includes compaction and disturbance of the profile. 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 precondition 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 depends not only on soil damage but also soil type, rainfall, and angle and length of slope.

Soil erosion is mostly anticipated on steep slope of Karongi and Rutsiro, cross river point and river. Without adequate water management on site, soil erosion will persist and result in loss of soil and sedimentation especially near water bodies. Contamination of soil may occur from the spillage of oils and lubricants during construction and operation activities. Degradation of the surrounding soil will affect flora and fauna and may restrict the future land use.

Mitigation measures proposed:

- Setting safety fence at bottom of the slope made by wooden/ steel pile with mesh-wire
- Setting mono-rail in order to carry the dug soil out of the site.
- Manual-excavating and carrying the dug soil.
- Constructing concrete foundation and the stairs to carry the pipes on the foundation.
- Installing pipes and welding joint.
- Fixing pipes by covering with the concrete at some points.

viii. Changes of landscape - Visual impact

Impacts on the physical environment will consist of landscape transformation causing visual impacts. Installing water pipe, river cross bridge and water pump station will alter slightly the landscape at some localities. These impacts will remain during operational phase. Temporary physical impacts will occur during the construction period at places selected to store construction material and pipes and at accommodation places for workers. However, those sites will be decommissioned after the construction phase; the visual impact is restricted to the construction period.

Mitigation measures

- to clear only the area demarcated for construction;
- Rehabilitation of construction sites.

ix. Noise and vibration emissions

Noise and vibration during construction will be generated by the operation of heavy machines, heavy trucks, right of way preparation, soil stripping, trenching, pipe stringing, welding and laying and backfilling activities.

Limited construction activities may have to continue on a 24 hours basis increasing the exposure time of the workers and community people to noise. These impacts are of temporary nature.

Proposed mitigation measures include the:

- limitation of heavy works in daytime 6am to 7pm;
- Provision of PPE to workers;
- If necessary, local residents should be given notice of intended noisy activities so as to reduce degree of annoyances.
- Workers operating equipment that generates noise should be equipped with noise protection gear.
- A regular monitoring of noise will be conducted as to check the compliance of noise pollution with permissible level.
- As most of the expected noise is from vehicles, truck and machines, the contractor will be requested to use equipment in good condition and certificate

of technical control will be required.

x. *Air Quality / dust releases and nuisance*

Exposed surface areas with loosened topsoil combined with the operation of plant and machinery will increase dust raised from the site, especially during initial levelling and preparation required under each phase of the project. Dust will also be raised by haulage vehicles delivering materials to the site; this is expected to pose a problem off-site as access roads are not paved. The dust raised during construction can pose a nuisance to workers although the impact of this is considered relatively small and localized. Dust levels are likely to be higher at certain strategic locations on the site such as stockpile areas during the off-loading of gravel and aggregate. Dust raised by construction activities can also pose a nuisance to adjacent settlements especially under dry and windy conditions. The impact of this affecting some parts of the settlements around the construction sites is potentially significant although intermittent.

It can be anticipated that a certain amount of air borne particulate matter (dust) will be generated by earth moving activities during construction phase of water treatment plant and water reservoirs. This situation will be worse during the dry season and during the afternoons when the winds are most prevalent. Air borne particulates may pose a hazard to residents in the vicinity or downwind of the construction site that suffer from upper respiratory tract problems.

Mitigation measures

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

xi. Quarries and borrow pits

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

Mitigation measure

- To ensure adequate mitigation of potential adverse impacts, only licensed quarrying operations are to be used for material sources. Efforts should be made to use material commonly found along the roadway as a construction material.

- Borrow pits areas shall preferably be selected from high land and/or waste land. Although locations of the borrow areas are negotiated between contractor and landowners. The excavation and restoration of the borrow areas and their surroundings, in an environmentally sound manner to the satisfaction of the Supervising Engineer, is required before final acceptance and payment under the terms of the contract.
- All borrow pits areas will be properly dressed maintaining drainage to outwards. The side slopes shall be provided with surfing. Topsoil from the opening of burrow pits from agriculture land shall be saved and reused in re-vegetating the pits to the satisfaction of the Engine er / land owner. Additional borrow pits will not be opened without the restoration of those areas no longer in use.

Operation phase

i. Water pollution

Laboratory test on water where water will be extracted shows that water is already heavily polluted with a lot of sediments. The construction of water intake, water Treatment Plan, the installation of pipeline especially at river crossing section, additional sediments are likely to go to the river.

Mitigation measures

- in addition to the respect of 10-meter river buffer zone, technical design will be used to avoid soil erosion apply here including;
- Before starting to use heavy equipment near the river side, the soils of the riversides have to be replaced with the durable materials in order to prevent it from falling into the river;
- Construction period: should be during the dry season;
- After preparing for the Launch and Reception shafts, centrifugal reinforced concrete pi pesare inserted into the ground as pipe sleeves by hydraulic jacks;
- The soils inside the pipes are excavated by hand. If the ground conditions are not good, the soils are excavated using a high-pressure jet, and this makes it possible to make sure of the safety by keeping a certain distance between workers and cutting head;
- After installing pipe sleeves, water pipes are inserted inside them, and aerated light-weight concrete is filled up between the pipe sleeves and water pipes in order to fix the water pipes in concrete.

ii. Alteration of hydrology and wetland

The installation off the pipeline below the wetland 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. The construction phase will involve the use of heavy machines and vehicles and increase of circulation of people. For different purposes lay down yards will be needed, as for storage of parts and construction material, storage of pipes, parking of trucks and construction machines etc. and work camps have to be installed.

Proposed mitigation

- Construction yard, equipment maintenance area should be placed far from water bodies and wetlands;
- For the installation of water pipe in the marshlands appropriate construction met hod is considered and consist at open cut method that will be taken by backhoe excavating by the backhoe, however, the contractor shall be careful the cutting angle not to collapse the soil because the soil is very soft.

iii. Solid waste management

Solid waste generated during site preparation and construction work would include cut vegetation and typical construction waste. This waste would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite. Cleared vegetation burnt onsite would generate smoke, possibly impacting negatively on ambient air quality and human health.

Mitigation measures

It is anticipated that construction waste will be generated. To manage the generated quantity of waste it is proposed:

- A temporary storage place is established,
- Transporting to the Dump site located away from the construction site,
- Waste recycling is also an option whereby construction companies can use recycled soil and concrete debris as road bed materials, but they have to inform the sources of materials to the client.

iv. Contamination of soil and water bodies due to oil spillage

During the construction of proposed structure, no heavy machinery is required but tracks, bulldozer and other equipment require re-fueling, maintenance works and repair works, which in effect result in oil spillage. At point sources, contamination of soils and run-off ending in the receiving bodies could cause water quality degradation, if no mitigation measures are implemented. This impact can be considered of low magnitude, duration and spatial extent since it shall only be experienced during the early construction phases and few tracks will be used.

Mitigation Measure(s)

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

v. Loss of flora and fauna

Some crops and trees established in the project area will have to be cleared where the intake, WTP, reservoirs, pipeline and pump station will be installed. There is no plant or animal species of special conservation purpose surveyed that will be affected.

Mitigation measures

- This impact is unavoidable and will be mitigated through compensation measures which will include compensation of land, crops and trees.
- The site clearance should be only done on an area demarcated for construction;
- rehabilitation of construction site should include tree planting.

vi. Disturbance of ecosystems habitats

The clearing of existing vegetation will result in the complete loss of associated ecological habitats and their fauna, within the project area. Noise, vibrations, and intrusive activities related to construction works will tend to scare away any animals remaining on the site after vegetation clearance.

Mitigation measure

Clearing and construction activity should be restricted to within the area of the development.

vii. Impacts on bird habitat

The project will be implemented in Musogoro wetland which is not classified as Important Bird Area (IBA) and Construction works especially in the swamps will not have adverse impact on bird's habitat. The works have to be done avoiding or minimizing habitat and species loss and any degradation to habitats and species populations This will preferably comprise the avoidance of the key habitat areas, if at all possible.

Other Impacts during the operation phase

The key Environmental impacts resulting from operational phase include wastewater, sludge production, overwater abstractions etc. Environmental impacts related to the operation phase of proposed activities are provided below.

i. Impacts on Hydrology

The feasibility study team assessed water balance in the Musogoro river catchment and determined the river's minimum flow to be 826l/s; based on the ultimate water intake of 248 l/s, the river' base flow is 578l/s which is released downstream for downstream users.

The water demands for Kivu Belt water supply project is estimated at 14,929 m^3/day as daily average demand and 19,408 m^3/day (≈19,500 m^3/day) as daily max demand for ultimate year 2035. The project is expected to be implemented in phases with each phase having a capacity of 6,500 m^3/day.

This will generate the following Impacts:

- Reduced water flow: Withdrawing water from a river can lead to a reduced flow

downstream. This can disrupt the natural water balance and affect aquatic habitats;

- Altered river morphology: Diverting water from rivers can result in changes to the river's natural morphology, including erosion, sedimentation, and altered flow patterns;
- Decline in aquatic biodiversity: Water abstraction can disrupt river ecosystems and lead to the decline of fish and other aquatic species due to reduced flow, altered water temperature, and habitat loss.

Mitigation measures

- Implement habitat restoration projects to compensate for any habitat loss caused by water abstraction;
- Conduct regular monitoring of the biodiversity in the river and take necessary conservation measures to protect the affected species;
- Regular monitoring of water level and water table should be conducted as to maintain the minimum ecological flow especially in dry season (June, July and august. Bases on the monitoring result, the system operator will decide on the amount of water to be extracted;
- Design and construct diversion structures that minimize the disruption to the natural flow patterns;
- Implement water management plans to ensure sustainable water abstraction and minimize harm to the river ecosystem;
- Consider the minimum flow requirements to maintain the environmental health of the river;
- Use water abstraction methods that minimize damage to fish and other aquatic organisms.
- Implement erosion control measures to prevent excessive sedimentation;
- Conduct regular monitoring of the river's morphology and make necessary adjustments to mitigate any adverse impacts.

ii. Water pollution

During the operation phases some chemicals like ***Chlorine,*** for disinfection and killing harmful bacteria and viruses; ***Aluminum sulfate (alum),*** for coagulation to remove suspended particles; ***Calcium carbonate***, for adjusting pH levels and water hardness; ***Sodium hydroxide,*** for adjusting pH levels and water alkalinity; ***Activated carbon***, for removing organic contaminants and improving taste and odor; ***Potassium permanganate***, for oxidizing organic matter and bacteria; ***Fluoride*** for preventing tooth decay. Whenever there is a malfunction of the plant, the supplied water will eventually affect human life including life loss.

Mitigation measures

- It is proposed to remove this sludge by dewatering m/c to be constructed at the Treatment plant area.
- There will be regular monitoring of the

- All chemical sludge will be properly handled on site and brought to designated landfill and this one will be monitored continuously. It is recommended that there not be any sludge disposal into rivers and lakes
- Disinfection if the last water treatment process in order to remove coliforms before distribution.
- Disinfection is required for bacterial compliance and the most cost-effective option is chlorination with the added advantage of giving a residual in the distribution network for improved protection of public health.
- The design disinfectant is ***chlorine*** in the form ***Calcium Hypochlorite granules*** (HTH). The solution is mixed to the appropriate dosage in the chlorine mixing tanks in the chemical house and fed into the water by means of pumping. Chlorine mixing is through agitation via using turbulence created at the clear water tank inlet.
- A tap for sample collection should be provided at the outlet of the clear water tank

iii. Sludge handling and disposal

During the operational phase two kind of waste is expected including sludge and waste water. If not well handled, this waste may contribute to water pollution and environmental degradation. Therefore, a proper handling and disposal plan is required in order to avoid any pollution or environmental degradation.

Mitigation measures

- 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 like brick making. Therefore, the plausible opportunity of sludge reuse would be in bricks making within the project area where people will generate income by making the bricks;
- The only tested or treated sludges may be utilized in agriculture actions;
- **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, linin g of the landfill with clay or plastic liner may be required to prevent contamination of groundwater;
- Sludge disposal should be done in appropriate designated landfill approved by District authority and in accordance with environmental policies.

iv. Wastewater treatment

Dewatering the sludge will release wastewater and if no well handle it may have adverse impact on environment and on human health as the water treatment plant is located not far from the wetlands. Environmental pollution by wastewater or consumption of

wastewater contaminated water might lead to eruption water-borne diseases i.e. cholera, diarrhea, dysentery and typhoid. Problems associated with the unmanaged increased wastewater could last during the whole project life.

Mitigation measures:

- The filtrate water which is generated from sludge dewatering will be recycled to the water treatment plan;
- Wastewater from sanitary sewage which is generated from administration building, guard room, workshop will be treated in septic tanks.

v. Loss of income for small water supply operators

Although this in not a recognized income generation activities and these people are taking advantages of water shortage in the area, the developer should consider this category of people and give them priority in labor for sustainability of the projects. In the case that there are not taken care off they can participate in vandalism of infrastructure and sabotage of the project.

Mitigation measures

- During construction the contactor/ the developer will try offer temporary jobs to them de pending on the available opportunities.
- During the operational phase they will be encourage joining Water users' association and will participate in selling water on public water point to be provided in centers.
- Reference made to the Government policy on cooperatives, they will be encouraged to joi n existing cooperatives and invest in other lucrative activities.

vi. Vandalism of water supply infrastructure

With the coming of the project, a number of infrastructures will be made from metal, steel and concrete some people may be involved in vandalism of that equipment's.

The impact could be of low significance in terms of magnitude. With community policing encouraged in Rwanda and existing security organ in the project area, such an impact might be of short-term scattered periods of vandalism.

Mitigation Measure(s)

- Sensitization of local communities to ensure project ownership and use community polici ng as a means of ascertaining security, will collectively avoid vandalism.
- Regulations on penalties to perpetrators convicted of vandalism are necessary. Punitive actions towards perpetrators by the authorities will facilitate compliance by the locals there by avoiding vandalism.

vii. Loss of biodiversity due to ground water over-abstraction:

During operational phase, over-abstraction of ground water has a negative impact on living organisms including flora and fauna. When the groundwater withdrawals exceed recharge, there is a falling of water table and living organism does not have enough water. Therefore, any project that need ground water should consider the minimum

ecological flow to sustain the living organism.

Mitigation measure:

- Regular monitoring of water level and water table should be conducted as to maintain the minimum ecological flow especially in dry season (Ju n e, July and August. Bases on the monitoring result, the system operator will decide on the amount of water to be extracted.

viii. Fire Hazards at treatment works

There some potential scenarios that could lead to the fire hazardous incidents at water treatment plant and they are as follows: Electrical malfunctions that may rouse short circuits or equipment overload that will eventually lead to electrical sparks or arcs that could ignite flammable materials nearby. Welding activities, improper handling smocking or mismanagement of chemical storage are the potential factors that may increase the risk further.

Mitigation measures

- Awareness and training Regular of the site workforce as well as regular inspection of the electrical functions and chemical storage;
- Setting proper preventing measures;
- The fire detection and alarm system shall operate in the event of a signal being initiated from any of the break-glass units, heat detectors or smoke detectors;
- A central fire detection and alarm system panel complete with manual call points, optical smoke detectors, heat detectors and electronic sounders will be provided for protection of life and property;
- Having a well-documented emergency response plan and installation of firefighting equipment's at a strategic location;
- The fire alarm system shall be supplied and installed by a specialist, with the necessary technical capability to offer long-term technical maintenance support.

ix. Cumulative Impacts

The fact that Musogoro river drains into lake kivu that is connected to other more rivers, there will be eventually an impact of the project on Lake Kivu and Ruzizi River on the hydrological regime including flora and fauna. The following are the identified impacts:

- Abstraction of water from the Musogoro River can lead to a decrease in its flow, which could disrupt the hydrological regime downstream and in Lake Kivu;
- The reduced flow caused by water abstraction can also result in changes in sediment transport patterns, affecting the natural balance and functioning of the river and lake ecosystems;
- Habitat alteration as Changes in the hydrological regime due to water abstraction can directly affect the habitats of aquatic and terrestrial species dependent on the Musogoro River and Lake Kivu;

- Species displacement: Alterations in water flow and habitat quality can lead to the displacement or even extinction of certain species within the affected ecosystem;
- Water quality degradation: Increased water abstraction can lead to the concentration of pollutants and changes in water quality, affecting the overall biodiversity and ecological balance.

Mitigation measures:

- Conduct species inventories and ecological surveys to identify vulnerable species and their potential displacement;
- Introduce species translocation or habitat enhancement programs to ensure the long-term conservation of affected species;
- Implement stringent water quality monitoring programs to identify and mitigate potential pollution sources;
- Promote best management practices in agriculture and industries to minimize the release of pollutants into the Musogoro River;
- Implement water abstraction limits to ensure sustainable water flow in the Musogoro River;
- Monitor water levels and flow rates to ensure compliance with ecological thresholds;
- Implement sediment management strategies to mitigate the potential negative impacts on downstream habitats;
- Consider introducing artificial sediment replenishment in downstream areas if necessary.

x. Transboundary Impacts

The Mosogoro river drains into lake kivu which empties into Ruzizi River that flows southwards into lake lake tanganyika. So, the water supply project that will abstract water from Musogoro River can have transboundary impacts due to the potential impacts it may have on the downstream ecosystems and communities. The following are some of the impacts and mitigation measures:

- **Impact on Lake Tanganyika**: The Musogoro River flows into the Ruzizi River, which ultimately flows into Lake Tanganyika. Therefore, the water abstraction can alter the water flow and quality of Lake Tanganyika. The water supply project can exacerbate the already high levels of water scarcity in the region, which can affect the lake's fish population, which is a vital source of livelihood for the riparian communities.
- **Impacts on Lake Kivu**: Musogoro River also empties into Lake Kivu, which is shared by Rwanda and the Democratic Republic of Congo. The water supply project can negatively impact the lake's water quality and flow, which can affect

the lake's sensitive ecosystem, which is home to endemic fish species and supports fishing and tourism activities;

Transboundary conflicts: The water supply project can lead to conflicts among riparian communities and even between neighboring countries. Such conflicts can arise due to various reasons, including the failure to consult downstream communities and countries;

- Impacts on water quality: The water supply project can introduce pollutants through sedimentation, eutrophication, or other forms of contamination;
- Erosion and sediment control: Construction activities related to the water supply project may disrupt the natural flow of water, causing erosion and sedimentation, which can negatively impact the aquatic ecosystems in the downstream areas.

Mitigation measures:

- One possible mitigation measure is to develop mechanisms that ensure that the water withdrawal leaves enough water in the river for downstream users and ecosystems.;
- Mitigation measures can include taking into account the competing water demands and negotiating and implementing coordinated water management agreements.
- To mitigate transboundary conflicts, project developers can engage in consultations with all stakeholders, including downstream users, and negotiate and implement basin-wide water management agreements.
- To mitigate potential negative impacts on water quality, the project can adopt measures such as adopting sustainable land use practices that reduce erosion, protecting critical riparian vegetation, and properly disposing of undesirable wastes;
- To mitigate such impacts, developers can implement erosion and sediment control measures, including the use of silt fences, sedimentation basins, and sediment traps to control soil erosion and sedimentation.

Decommission phase

-The decommissioning phase might result in temporary job losses or reduced economic activity if the project had employed local workers or utilized local businesses.

- Frequent disruption in water supply within the local residents.

Mitigation measures

-Consideration of affected residents whenever decommissioning process create new job opportunities such as waste management or demolition sectors:

Engaging and communicating with the local community is essential during the decommissioning phase, if possible, provide alternative arrangements or timelines to mitigate any inconvenience.

IX. ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLANS

The Environmental Management Plan outlines a plan of actions to be instituted by the project to ensure that environment quality is maintained and improved throughout the life of the project. This project bears the potential for a number of negative impacts on the environment. However, if proper environmental management procedures are in place and adhered to, then there would be very minimal negative impacts of concern emanating from it. Areas that

require significant mitigation measures include water, soil and air pollution, safety and waste management.

9.1 Policy

The management policy of this development is ensuring a clean and safe environment within the site and support of environmental management initiatives both within and outside the project through proactive and responsible activities.

9.2 Objectives

i. Ensure environmental conservation and sustenance to ensure a balanced approach between the development and the ecosystem.

ii. Ensure and enhance safety within the development both within the construction and operation phases.

iii. Promoting environmental ethics within concerned parties and users. These measures should be implemented under the following framework.

9.3 Land

✓ Ensuring vegetative cover on unpaved surfaces to maintain the integrity of soil structure within the project area;

✓ Proper waste management (both solid and liquid) to avoid polluting the soil and unsightly environment.

✓ To minimize the use of concrete surfacing

9.4 Biological Diversity

✓ Maintaining all trees and larger flora;

✓ Planting of more trees at site during and after the construction phase of the development;

9.5 Air

Maintaining low dust levels during preparation through either surfacing the non- surfaced portion of especially preparation outside the wetland and water spraying for dusty area.

This will reduce the amount of dust generated.

- ✓ Erection of screens and buffer fences (noise barriers) to reduce the amount of dust and noise generated during preparation reaching neighbouring utilities.
- ✓ Use of noise absorbent padding in fixed plant installations;
- ✓ Use of ear- muffs by employees to reduces any exposure from noise;
- ✓ Use of sound proofing material as finishing before occupying the temple.

9.6 Water

Ensure conservation of water quality and quantity in the preparation phase through wise and only necessary use as well as recycling where applicable and appropriate.

- ✓ Management of any liquid and solid wastes to ensure that they do not contaminate the surface water in the streams and the underground waters;
- ✓ Maintaining vegetative cover within the non- paved area so as to reduce direct surface evaporation and enhance stream recharge.

  In this section we are presenting the environmental social management and monitoring plan (ESMMP) for the construction of Kivu Belt Water Supply System. For ESMP to be successful and implementable, several institutions who are directly or indirectly involved in this project will intervene and a close collaboration among them is very important. Generally, the monitoring plan defines and identifies monitoring activities which will take place, when and by whom and identifies the indicators and data collection methods and identifies budget needs of the institutions and persons to implement the plan (seeTable IX-1; Table IX-2, Table IX-3 and Table IX-4).

Table IX-1 Environmental and Social Management Plan for Kivu Belt Water Supply System

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
1	**Pre-Construction**				
1.1	Site clearing, leading erosion, sedimentation and vegetation loss	- Vegetation clearance should be limited to only areas where construction is meant to be carried out, and restored/ revegetated after construction works - Sediment control measures should put in place before clearing vegetation in areas where the potential for sedimentation exist. - In order to avoid loss of ground vegetation urban area close supervision of earthworks will be observed in order to confine land clearance within the RoW of the pipeline - The contractor will stockpile topsoil for reinstating flora along the road or in the areas which have been cleared vegetation. - The contractor will not fell/cut trees without a written consent from the competent authority and permission obtained from the respective officer for cutting of trees, along with a justification on the need for tree cutting	Site inspection by WASAC	Contractor, (Primary responsibility) Consultant / WASAC (secondary responsibility)	During mobilization, site preparation and construction Activities.

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
1.2	Interference with existing utilities	- A work plan with clear responsibilities for each party should be developed to ensure smooth execution of the construction. - Consult with the utility departments to demarcate the locations and alignments of electrical cables, water mains and communication cables. - Prepare a detailed planning and construction phasing schedule, and coordinate service interruption with public utilities and public administrations. (Works phasing shall be established in a way to reduce the disruption time)			Daily monitoring by Contractor, and WASAC and traffic police.
		- Advise citizens in advance concerning programmed interruptions in water, and other services.			
2	**Construction phase**				

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.1	Traffic Management	- Trucks carrying materials should be restricted to hours for delivery of material and pick up of waste material. (delivery hours must be set a part of planning) - Provide citizens advanced warning about partial/ temporary road closures and rerouting of vehide and pedestrian traffic, especially where schools/ colleges concerned. - Phasing of open work fronts should be scheduled - so that multiple sites are not affected at the same time - At night time, all barriers and signs will remain at sites, with lighting and / or fluorescent signs placed as required to warn both vehicular and pedestrian traffic, especially where trenches are left open. - The Contractor shall restore the project sites to the state to which it was or better, prior to construction.	On site inspection monitoring of agreed mitigation measures	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor , and WASAC. Quarterly monitoring by WASAC

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.2	Accessibility to properties	- Prior information and consultation with hospitals, - Schools, institutions and local authorities wherever any sensitive receptor is concerned, and access should not be disturbed or affected. - Where areas are excavated, temporary fencing, bridges, and access routes should be provided. - Signage should clearly mark the dedicated - pedestrian route, to facilitate access and avoid accidental falls into these areas - Prior consultation and notification to the impacted and interested.	Daily inspection on all open work fronts Consultations with public and Local authorities GRM mechanism	Contractor, (Primary responsibility) / WASAC (secondary responsibility.	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.3	Land Contamination due to improper disposal of hazardous and construction wastes	- The contractor shall handle construction materials and waste in accordance with approved procedures - Sites for temporary piles should be agreed with PIU and local authorities. - The community should be made aware of constraints imposed on the contractor for waste collection, storage and disposal - In case of accidental waste dispersion, / WASAC shall be informed and restoration measures shall be applied. - Waste materials are to be disposed at an approved landfill - Waste concrete will be reused and recycled to the extent possible to help in pollution prevention and conservation of natural resources. - All storage containers containing fuel, oil, lubricant should be adequately sealed and labelled.	- Periodic inspection of 'construction waste management register' including details on generation and disposal of any 'hazardous waste'. - Periodic observation of labour camp for waste management issues. - Memorandum of Understanding with RURA approved recycler for disposal	Contractor, (Primary responsibility) / WASAC	Daily monitoring by Contractor, and WASAC. Quarterly

		- The contractor will utilize officially approved landfill for waste generated on the construction - All waste and wastewater generated from the labour camp will be managed as per RURA published instructions such that there is no significant impact on camp residents, the biophysical environment or surrounding communities. - The contractor shall maintain the MSDS Sheets in case of any hazardous materials on site. - Adopt the provisions in the Emergency Response Plan in case of any leakage or hazardous material spill. - Construction contractor will ensure daily collection, a designated storage area, segregation and periodic (monthly) disposal of construction waste generated as per the RURA regulations. - Littering and burning of waste at the labour camp will be strictly prohibited. - Segregated Domestic waste generated at the labour camp will be stored onsite and handed over for proper disposal by contractor - Construction contractor will ensure that there is no unauthorized dumping of used oil and other hazardous wastes. Such wastes will be stored safely onsite and disposed periodically through RURA approved recyclers and records of the same will be maintained. - Transport vehicles and equipment will undergo regular maintenance to avoid any oil leakages. - Unloading and loading protocols will be prepared	of hazardous waste, if generated.		

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
		- for diesel, oil and used oil respectively and workers will be trained to prevent/contain spills and leaks			
2.4	Land Contamination due to improper disposal of waste at labor camp	- Littering and burning of waste at the labour camp will be strictly prohibited. - Domestic waste generated at the labour camp will be segregated onsite and collected by the contractor for management. - Concrete flooring and oil interceptors should be provided for workshops, vehicle washing and fuel handling area. - Water separated and collected from oil interceptor should be reused for dust suppression. - All arrangements for transportation during dismantling and clearing debris, considered incidental to the work, will be implemented by contractor in a planned manner as approved.	Periodic observation of labour camp for waste management issues.	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC
		strips and scraps of metal, PVC pipes, rubber and poly urethane foam, auto mobile spares, tubes, tires, belts, filters, waste oil, drums and other such materials shall be either reused or will be sold /given out for recycling. - Septic tank must be provided for toilets and the sludge should be cleared by municipal exhausters. - The municipal waste from the labour camp will only be routed through proper collection and handover to local municipal body for further disposal.			

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.5	Soil Erosion	- Top soil will be managed as indicated in the previous section - Construction activities (especially excavation work) will be undertaken in the dry season. - The contractor shall contain excavated materials in the vicinity of the worksite to prevent dispersion and sedimentation of drains, creeks, streets and adjacent properties - Stripping of topsoil shall not be conducted earlier than required to prevent the erosion (wind and water) of soil. Excess topsoil will be used for landscaping purposes. - The disturbed areas and soil stock piles will be kept moist to avoid wind erosion of soil. - Topography will be restored and re-vegetated for slope stabilization immediately after the completion of construction at each location. - In case of areas in the proximity of water bodies, small bunds will be created and silt traps will be provided to prevent washing of the soil into these water bodies.	- Review of Contractor's work plan. - Periodic inspection of worksites. - Review of implementation of the 'Muck Disposal/ Management Plan'	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly Monitoring by WASC

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.6	Impact on Water availability	- The contractor will ensure sourcing of water - through tanks will be done after proper verification of the source of water - Construction labour will be sensitized about water conservation. - Optimum use of water will be done during sprinkling on roads for dust settlement, washing of vehicles, etc. - Wastewater generated from the washing/cleaning area in camp site, after passing through oil & grease trap and curing area can be re-used for water sprinkling and wheel washing. - Total 2-3 days will be required for replacing the rising main line. Adequate communication regarding this will be made to local communities through print media and notices minimum 7 days prior to construction activity. The existing Storage tank will be filled up before the replacement of pipeline , to minimize water scarcity and in addition, alternate supply of water through tankers will be undertaken during this period.	Proper legal permit for sourcing of water Periodic inspection of worksites Communications undertaken to local communities for non-availability of water Supply of tanker water to all wards	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC
2.7	Impact on Water Quality	- Wastewater from construction site should not be allowed to accumulate at site as standing water may lead to breeding of mosquitoes. Septic tanks/soak pits should be provided for its disposal - Proper cover and stacking of loose construction material and excavated loose soil will be ensured to prevent surface runoff and contamination of receiving water bodies. - Dumping of debris in or nearby water bodies will be strictly avoided. All the waste generated (construction waste, labour	Periodic inspection of worksites. Review of implementation of the 'Muck Disposal/ Management Plan	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
		camp waste) will be collected, segregated, stored and disposed in an environmentally suitable manner. - The contractor will ensure that the activities undertaken at the intake does not degrade the river and/or bank and no silts get into the river – using techniques to control the movement and deposition of silt, e.g., silt curtains or barriers to completely enclose the cofferdam installation. - Sheet piling will be cut off at elevations approved in advance by JUIDCO –Engineer in order to minimize damage to foundation soils adjacent to the structures, and the cut off portions will be removed from the site			

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.8	Air Pollution	- The batching plant will conform to CPCB general emission and noise standards for noise. The contractor will obtain a consent from Pollution control board before the plant is operational. - The emissions from diesel generators (meant for emergency power requirement) will be controlled to minimise impacts of air emissions by optimised operations, orientation at the site and providing stack height as per stack height criteria from ground level for wider dispersion of gaseous emissions. Proper maintenance of engines and use of vehicles with 'Pollution under Control Certificate' will be ensured. - Fugitive dust emissions will be suppressed by spraying water and wetting of the stockpiles. - Proper location of material stockpiles will be ensured (especially sand and soil). All such loose material will be provided with temporary bunds and screens to prevent erosion and generation of fugitive dust. When not in use, all stockpiles of the loose construction material will be covered with tarpaulin sheets.	Periodic inspection of worksites. Air Quality Monitoring by REMA accredited laboratory. Monthly statement of Ambient Air Quality Monitoring to be submitted to REMA	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC
		- Trucks transporting soil and material will be covered with tarpaulin sheets. - Dust masks and eye protection against dust, splinters, debris etc. should be provided to construction workers where required according to OHS management			

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.9	Noise Pollution	- All vehicles and machinery will conform to RSB Standards on the Noise - Hammering and vibration compaction will be minimised when in close proximity to structures, buildings or property boundary where applicable, residential class mufflers and engine shrouds (acoustic lining) will be used on all equipment. - Normal working hours of the contractor will be between 06:00 and 18:00 hours. Contractor should ensure that the ambient noise level near the project site is within the day time noise standard (refer to RSB standards). - Only well-maintained equipment will be operated on-site, and, regular maintenance of equipment such as lubricating moving parts, tightening loose parts and replacing worn out components will be conducted. - Machinery and equipment that may be in intermittent use will be shut down or throttled down during non-work periods. - Low noise equipment will be used as far as practicable, and the number of equipment operating simultaneously will be reduced as far as practicable. - Equipment known to emit noise strongly in one direction will be oriented so that the noise is directed away from nearby sensitive receptors as far as practicable.	Periodic inspection of worksites. Noise Monitoring by REMA accredited laboratory. Monthly statement of Noise Monitoring to be submitted to REAMA	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
		- Earplugs should be provided to workers involved in unloading operations - Timely maintenance and servicing of transportation vehicles and the machinery/pumps to be used during construction phase to reduce the noise generation due to friction and abrasion - In cases where contractor will perform night time work, prior notice and consent will be taken from nearby residents. - Monitoring of Noise levels shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP			
2.10	Occupational Health & Safety Risk	- The contractor will follow the provisions for OHS management plan. In addition, all Workers will be trained on Environment Health and Safety with an aim of improving awareness. this includes use of PPE, HIV prevention, maintenance of campsite hygiene. - AfDB, EHS guidelines should be refered and used by the implementing agency WASAC - Provision for all workers with requisite personal protective equipment. - Provision of onsite drinking water and sanitation facilities. - Provision of signage's at all construction sites, enforcing/ reminding use of PPE and safety practices.	- Periodic checking of Accident Register (for record of accidents at intake, WTP, Storage tanks). - Review of bid documents for use. - Periodic visual assessment of risk at accident-prone areas. - Inspection of PPE use by workers, first-aid kit.	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
		- Safety conditions in the trenches during construction phase shall be ensured using appropriate shoring systems and dewatering mechanisms. - Safe access and thoroughfare must be provided on construction site always. Dangerous areas shall be clearly identified with appropriate signs, lights and flagmen. - Excavated areas shall be clearly marked to avoid accidental falls into these areas, and clearly lit at night. - Regular monitoring by supervising engineers of contractors' compliance with safety procedures. - Use of de-watering, side-walls support, and slope gradient adjustments that eliminate or minimize the risk of collapse, entrapment, or drowning in excavated areas - Providing safe means of access and egress from excavations, such as graded slopes, graded access route, or stairs and ladders - Job rotations should be practised for people, working in high noise level areas - Risk of free fall of materials should be minimized by installing telescoping arm loaders and conveyors - Firefighting facility should be provided at the camp site and trained personnel should be available at site who can operate the fire extinguishers and other fire-fighting equipment.	- Periodic checking of records on training/awareness programs organized for workers on EHS aspects.		

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
2.11	Community Health and Safety Risk	- Contractor to hire workers through recruitment offices and avoid hiring "at the gate" to discourage spontaneous influx of job seekers. - Vaccinating workers against common and locally prevalent diseases; and establishment of health centres at camp and construction site for routine health screening. - Mandatory and regular training for workers on required code of conduct and consequences for failure to comply with law - Measures described earlier for controlling impact on air quality, noise levels and improper wastewater discharges will also help to mitigate the community impacts. - A traffic management plan will be prepared by the contractor, approved by the RNP, and implemented throughout the construction period, to ensure smooth traffic flow and minimize disruption. - Public information notices with work start and completion dates, contact details of RNP officials, traffic diversion details, etc., will be put up in local newspapers and distributed as pamphlets (including in the local language). - The contractor will follow the specifications in the labour camp plan - WASAC will issue the directives to Contractor and Contractor will accordingly prepare code of conduct for all labour and staff. - Necessary directives will be given to Contractor for hiring the local work force.	Periodic checking of Accident Register. Periodic visual assessment of risk at accident-prone areas.	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC. Quarterly monitoring by WASC

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
		- Responsibilities for managing these impacts will be reflected as a contractual obligation, with appropriate mechanisms for addressing non- compliance. - Caution boards, barricades, etc., will be used to warn the public about unauthorized access and danger. Additional monitoring on these aspects will be undertaken at locations close to sensitive receptors such as schools and playgrounds. - Deploy temporary security guards in critical areas such as labor camp, construction camp, to prevent unauthorized access. - Install lighting devices and safety signal devices in the temporary access areas and construction sites. - A transportation plan of materials will be prepared by the contractor, approved by the RNP, and implemented to avoid their delivery at peak traffic hours. - Warning signs and other protective barriers shall be erected to prevent accidents to citizens due to open ditches, heavy machinery and construction vehicles etc.			
2.12	Site restoration	- On completion of the works, all temporary structures and construction equipment will be removed, all waste cleared, waste disposal pits/trenches filled in and effectively sealed off and the site left clean and tidy. - All waste will be disposed in accordance with the Construction Waste Management regulations - The site will be properly levelled and re-vegetated.	Site inspection.	Contractor, (Primary responsibility) / WASAC (secondary responsibility),	Daily monitoring by Contractor, Consultant and WASAC.

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
3	**Operation Phase**				
3.1	Air Pollution	-	Periodic observation and document check (e.g., maintenance record of DG set, PUC of vehicles, etc.) Noise Monitoring by REMA accredited laboratory. Monthly statement of Noise Monitoring to be submitted to REMA	WTP monitoring Operator	Periodic monitoring by WTP Operator and Noise Monitoring by REMA accredited laboratory
3.2	Noise Pollution	- The DG sets will have inbuilt acoustic enclosure, silencers, air release valve, essential hoods, etc., and will meet the RSB noise standards of 75 dB (A) at 1 meter from the enclosure surface. - The motors and pumps to be procured will be selected in such a way that the noise levels will be in the range of 40 – 55 dB - Ear plugs and ear muffs will be provided for the workers near noise generating sources at the intake and WTP. - Thick canopied trees will be planted to attenuate noise, if any, arising from the WTP in line with the guidelines of REMA.	Periodic observation (noise levels, use of protective gear by workers, survival of tree plantation in premises) Document check (e.g., specifications of DG sets, motors and pumps; tree plantation record). Noise Monitoring by REMA accredited laboratory. Monthly statement of Noise Monitoring to be submitted to REMA	WTP monitoring Operator	Periodic monitoring by WTP Operator and Noise Monitoring by REMA accredited laboratory

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
3.3	Impact due to waste generation	- Backwash from filter beds will be sent to a storage tank, and after allowing adequate time for settlement of solids, clarified water will be pumped to WTP inlet - Any excess waste water that needs to be disposed will be first tested for ensuring compliance with the RSB's 'general standards for discharge of environmental pollutants' and disposed at a location authorized by REMA. - Accumulated sludge from clari-flocculators, filter backwash, etc., will be channeled to the sludge drying beds for natural drying. - Dried sludge will be disposed at the designated approved landfill site only.	Periodic inspection of working of backwash recirculation facility and sludge drying beds. Periodic checking of waste water quality testing results and their conformity to RSB standards for disposal. Periodic checking of sludge transport and disposal register.	WTP monitoring Operator	Periodic monitoring by WTP Operator and Noise Monitoring by REMA accredited laboratory
3.4	Reduced downstream flow	- The sub-project will adhere to the limits in the water use permit issued by the RWB; - Periodic monitoring of the downstream flow will be undertaken by the RWB	Periodic inspection of the records at the intake and WTP on water intake and supply Monitoring of downstream flow	WTP monitoring Operator	Periodic monitoring by WTP Operator and Noise Monitoring by REMA accredited
3.5	Increased Wastewater in the area	- WASAC and RURA will develop and implement a long-term plan for sewerage management in the area. MININFRA will support the ongoing state and national programmes, will implement sewerage network and treatment infrastructure system in the next 3-5 years	Periodic observation of any water stagnation, inspection of soak-pits	WTP monitoring Operator	Periodic monitoring by WTP Operator and Noise Monitoring by

S. No	Impacts	Mitigation Measures	Monitoring/ Action	Responsibility	Frequency of Monitoring /
3.6	Occupational Health & Safety Risk	- Handrails and guards will be installed around tanks, trenches, pits, stairwells, and other accident-prone areas. - Flooring will be of non-skid type.	Periodic checking of Accident Register (for record of accidents at intake, WTP, ESRs) Periodic	WTP monitoring Operator	Periodic monitoring by WTP Operator and Noise Monitoring by
		- Storage and handling of chemicals will be as per the applicable code of safety (MSDS – Material Safety Data Sheet) issued for the chemicals. - Adherence to safety procedures for chlorination detailed in IS 10553 will be ensured through training for personnel and monitoring for compliance. - A plan for emergency response to accidental releases will be prepared and implemented as required. - Provision will be made for the necessary PPE and first-aid kit. - Periodic training on EHS aspects will be provided to the personnel by the operator.	visual assessment of risk at accident-prone areas Inspection of PPE use by workers, first-aid kit Periodic checking of records on training/awareness programs organized for workers on EHS aspects.		
3.7	Public Health	- Daily water quality testing to ensure compliance to IS 10500:2012 will be undertaken at the WTP through a fully functional REMA approved laboratory. - Checking water System leaks and loss of Pressure (Water system leaks does not only reduce the pressure of the water, it also compromises the quality of the water by allowing contaminated water to leak into the system) Monthly water quality monitoring at end user points will be conducted to ensure that water being circulated through distribution lines is meeting the necessary standard.	- Periodic checking of Water Quality Testing register.	WTP monitoring Operator	Periodic monitoring by WTP Operator and Noise Monitoring by REMA accredited laboratory

Table IX-2 Environmental and Social Management Plan for the Construction Phase

Activity	Adverse Impacts	Proposed Mitigation measures	Implementation Schedule	Responsibility	Estimated Budget ($
Site installation and Site clearing for WTP and water storages facilities	Soil erosion and contamination of water in the adjacent streams	All earthworks for site preparation and levelling will be carried out during the dry season of each implementation phase and the permanent storm water, road and site drainage system will be in place before the onset of the following rains.	Construction phase	Contractor	Contractor budget
	Loss of biodiversity	Establishment of garden and stabilize soil with grasses and trees; Stabilize borrow pit with grasses and trees	After construction	Contractor	2,500
	Loss of Soil Cover	Create contour drains during Construction;	Before excavation	Contractor	1,000
	Land acquisition	Purchase land from owners and work with District to make sure these PAPs have found alternative land	Prior works	WASAC Ltd/ Districts	96,000
	Loss of crops and trees	Compensation of affected crops and trees	Prior works starting	WASAC and Districts	29,000
Construction of small tanks and pipeline	Potential soil erosion during construction	Only clear areas earmarked for construction; Constructions of water ways with check dams as to reduce sediment	Construction phase	Contractor	Contractor budget
	Injuries, accident and diseases	Provision of protective equipment; Sensitization of workers on safety measures; First aid kit on the site	Construction phase	Contractor	Contractor budget
		Training of workers on safety measures	Construction phase	WASAC LTD & Contractor	2,000
Purchase of Construction materials during construction such as stones, gravel/ laterite and sand	Potential Water and Land degradation	Procurement of all raw materials and construction inputs from approved sources, pits and quarries.	Construction phase	Contractor	No budget required
Extraction of materials for construction	Land degradation	Backfilling borrows pits after excavation and rehabilitating with vegetation	Construction phase	Contractor	Contractor budget

Construction of plant & reservoirs	Fugitive dust generated during excavation works could cause respiratory diseases	Wetting the surface during construction	Construction phase	Contractor	Contractor budget
		Provision of protective equipment to workers	Construction phase	Contractor	Contractor budget
	Air pollution	Maintenance of Equipment engine, fuel and emission systems of construction machinery and vehicles in accordance with manufacturers' recommendation to minimize exhaust smoke, fuel and oil leaks.	Construction phase	Contractor	Budget of the Sub-Contracted company
Excavation	Dust emission	Regularly watering when clearing land to reduce the dust	Construction phase	Contractor	Contractor budget
		Provision of protective equipment to all workers	Construction phase	Contractor	Contractor budget
Construction of reservoirs and water pipelines	Disturbance of natural soil structure, mixing of layers and	Top soil to be stored separately from subsoil. After completion of works, the top soil to be spread over those areas which can be partially restored in order to facilitate natural regeneration of those areas. Compaction of soil to be minimized by careful stockpiling and separation of top and sub-soils.	Construction phase	Contractor and WASAC	Contractor budget
Extraction of construction materials (sand, stones etc.)	Water and land degradation	Ensure that all raw materials and construction materials (Stones sand and gravel etc.) are procured from approved sources by competent authorities.	Construction phase	Contractor	No budget is required

Levelling of the WTP, Reservoir Sites and excavation of trenches for water pipelines,	Land degradation	All earthworks for site preparation and levelling shall be carried out in a proper designated manner and have to be done by the qualified engineers; Wastes produced have to be disposed of in a designated area.	Construction phase	Contractor	Construction cost
Construction of intake	Siltation and Diversion	Care to be taken to minimize and manage the work area particularly at the intake site but also at the Water Treatment Plant Site and along the transmission pipelines.	Construction phase	Contractor	No budget required
Construction Of W T P and reservoirs	Contamination of surface and ground water by human waste	Adequate sanitary facilities shall be provided for workers and in proper way	Construction phase	Contractor	Contractor budget
	Sedimentation of river	Observe 10m from the stream for the excavation	Construction phase	Contractor	No budget required
Excavation and aliment of pipe	Disturbance of traffic	Appropriate equipment and manpower in order to complete the works in short time especially for the section that cross the Roads; Appoint staff in charge of guiding cars; Excavation and backfilling of the affected section during evening hours where there is no heavy	During construction phase	Contactor	Construction budget
	Accident and injuries	Provision of protective equipment; First aid kit; Training of workers on safety measures	During construction phase	Contactor	Contractor budget

Table IX-3 Environmental and Social Management Plan for operational phase

Activity	Adverse Impacts	Proposed Mitigation measures	Responsibility	Timing	Budget ($ US)
Water abstraction	Decrease of base flow, water table and loss of biodiversity in the wetland	Regular monitoring of water level and maintain ecological flow	WASAC	Operational Phase	4,800
Use of chemicals during treatment process	Ground and surface Water pollution	Sludge to be properly processed and stored in designated areas as illustrated in the design document.	WASAC Ltd/ MoE	Through operation phase	6,000
Water supply	Loss of water due to break of pipe or, water storages	Regular monitoring and repair of infrastructures	WASAC LTD	Through operation phase	Maintenance budget
	Vandalism of equipment and structures	Provision of guards and sensitization of locals on ownership and protection of infrastructure	WASAC Ltd/ Contractor and Districts	Through construction and operation phase	3,000

Table IX-4 Environmental and social Monitoring Plan

Impact	Parameter	Indicator	Responsible	Frequency	Budget ($ US)
Water and soil pollution	Contamination of surface and ground water	Records to be kept on site of inspection and approval of fuel and oil storage and dispensing facilities. Routine inspections will be made of such facilities for leaks and discharges to ground.	WASAC Ltd	Daily	None
Chemical uses during treatment process	Contamination of groundwater and discharge area	Amount of the sludge produced and the discharge area and surface. Routine inspection of raw water turbidity	WASAC Ltd	Bi-weekly	1,500

Water quality	Clean water quality parameters	Routine inspection of raw water quality and clean water at different point to assess the water quality at	WASAC Ltd	Daily	1,000
Sanitation and clean water parameters	Contamination of treated water	Laboratory results	WASAC LTD/ REMA	Daily	2,000
Equipment and automobiles in good condition	Certification from Automobile inspection	Number of Automobiles with certification on site	EPC contractor	Quarterly through the construction phase	No cost applicable to monitor.
Restriction of noise emitting activities to working hours. Use of certified construction equipment in good condition. Spraying of water to reduce dust.	Sound decibels.	Sound levels Air quality emission levels	EPC contractor	At the time of earth works or concrete vibrations.	Cost of a sound meter level is about 150
Regular inspection of electrical installations, Fire extinguishers, water tanks	Fire management equipment	Number of fire extinguishers and water tanks	EPC contractor/ WASAC Ltd	Quarterly through the construction phase	150 / trip to inspect.
Reforestation to offset lost grasses and trees	Planted area	Number of planted hectares (ha)	Communities/ Districts/WASAC Ltd	Every quarter of a year	200
Compensation for land and houses lost	Houses expropriated Land expropriated	Number of houses. Land area	WASAC Ltd	Once before construction	200
Safety gear for workers	Safety gear versus number of workers	Number of workers with safety gear	EPC contractor /WASAC Ltd	Quarterly through the construction phase.	150 trip to inspect.
Total cost for ESMMP implementation					147,250

X. CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSION

This project is a public initiative that contributes to the development of country through the increase e the access to clean water in Karongi and Rutsiro Districts. In undertaking this study to elaborate an Environmental Management Plan, it is important to take into account the importance of the project to the nation as well as impacts of the project on the environment.

The Scoping Exercise has identified a number of issues pertaining to the proposed subprojects under sustainable water and sanitation programs. The issues/impacts have been assessed and described in some detail to gain an adequate understanding of possible environmental effects of the proposed project from design to decommissioning, in order to formulate mitigation measures in response to negative aspects which have emerged. The Environmental and Social Management Plan (ESMP) provides a way forward for implementation of the identified mitigation measures. The ESMP should be implemented as a prerequisite for a positive Record of Decision (RoD) by the appropriate authorities. The estimated costs of implementing the mitigation measures are just indicative. In any case the consultant has used informed judgment and cost for similar project to come up with these figures.

The Environmental Monitoring Plan provides parameters to be monitored and responsibility. While the consultant is aware that each monitoring aspect need to have a separate budget line.

The figures given are considered to be absolute maximum such monitoring could cost. However, regular internal monitoring shall be carried out by the project proponent.

Based on the study, the Consultant is of the opinion that most of the potential environmental impacts identified can be mitigated. The proposed Environmental and Social Management Plan and Environmental Monitoring Plan if implemented will safeguard the integrity of the environment. Given the nature and location of the development, the conclusion is that the potential impacts associated with the proposed development are of a nature and extent that can be reduced, limited and eliminated by the application of appropriate mitigation measures.

10.2 RECOMMENDATIONS

In addition to the Environmental and Social Management Plan and the proposed mitigation measures the consultant came up with the following recommendations:

1. Before the implementation, the Resettlement Action Plan (RAP) should be developed and compensation made prior any civil work,
2. Affected people and local communities should be given priority in works;
3. The Project Proponent shall assign the Environmental and social safeguard officer to undertake the monitoring of the mitigation measures for the project through its existence. This way the proponent will achieve sustainable project implementation at reduced cost for undertaking the monitoring.
4. All project activities should be implemented beyond a buffer zone of more than 10 m from river banks and 50m from the lake as to avoid any contamination between river and the project.
5. WASAC should work closely with local authorities in raising awareness among local communities for the protection and maintenance of planned infrastructures;
6. Before the construction works start, the contractor should prepare and submit the Contractor Environmental and Social Management Plan to WASAC Ltd and the Supervising firm for approval.

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V. APPENDICES

Annex 1 : EIA Certificate

RDB | RWANDA DEVELOPMENT BOARD

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) CERTIFICATE

N°: RDB/EIA/2738/06/21 Issued Date: 29/06/2021

This is to certify that the Environmental Impact Statement (EIS) was received from **WASAC LTD**

Project title: **Works for the Construction of Kivu Belt Water Supply System, Phase I in Rubengera Sector, Karongi**

Project objective:

Construction of Kivu Belt Water Supply System (Phase I (12,000 m3/day water from Musogoro River, a treatment plant and distribution network) targeting to increase the access to clean water in Rutsiro and Karongi Districts.

Location: **Karongi** District(s) , **Rubengera** Sector(s), **Ruragwe, Kibirizi** Cell(s).

The EIS has been submitted in accordance with the Laws and Regulations relating to the requirements & procedures for Environmental Impact Assessment in Rwanda and has been reviewed and found to have sufficient and relevant mitigation measures to the identified likely impacts of the project on the environment.

It was therefore approved subject to fulfilment of the conditions attached to this certificate.

Clare AKAMANZI

Chief Executive Officer

Copies to: MININFRA, REMA,Karongi District

Annex 1: Project Brief

1. **Objectives of the project**

The main objective of the assignment is to undertake Environmental Impact Assessment (EIA) for the CONSTRUCTION WORKS OF KIVU BELT WATER SUPPLY SYSTEM (PHASE I). The EIA will address environmental impacts which may arise from construction and operation activities and provide mitigation plan to prevent or minimize adverse impacts.

2. **Brief on Project Background**

The Consultant shall provide description or profile of the developer, background to the project proposal and its justification, need and purpose of undertaking the study, EIA study methodologies and approaches applied and structure of the report.

3. **Description of the Proposed Project**

The Consultant shall describe project components and activities to be implemented in each phases of project life cycle i.e. pre construction, construction, post-construction (demobilization) and operation. This part is meant to give a general idea of what the project will entail. To avoid unnecessary details, focus on the project activities based on project phases i.e. mobilization or pre-construction phase, construction phase, operation phase and decommissioning phase. The description shall include the following information:

Background information:

Background information shall include: Title of the proposed project and developer; Project justification and objectives; Funds and source of funding or financier(s); Project location including maps of appropriate scale; Project design, size, and capacity; Area of influence of the project works; Project life span and Project components; Land size required;

Project activities

Description of project activities shall be based on phases of project life cycle i.e. mobilization or pre-construction, construction, operation and maintenance, decommissioning phases.

4. **Baseline Condition or Description of the Environment**

In order to forecast the impacts, it will be necessary to determine the initial reference or baseline state. It is therefore, required to describe the existing environment that would be directly and/or indirectly affected by the construction of the proposed project. The 'environment' to be affected must be based on the project definition of the term that would include:

- Physical environment,
- Biological environment,
- Socio-economic and socio-cultural environment,

Only those environmental factors that are necessary to understand the impacts of the planned development should be considered. 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. The methodologies employed to obtain baseline and other data should be clearly presented.

5. Legal, Policies and Regulatory Framework

Describe the policy, legal, institutional framework as well as regulations, strategies, standards, international conventions and treaties that are of relevance to the environmental management and the proposed undertaking in particular. They should be those, which relate to but not limited to environmental quality, health and safety, protection of sensitive areas and protection of endangered species. The objective of this section is to show compliance of the developer with the existing policies, laws administrative/institutional conditions both at national and international levels.

Furthermore, the consultant shall clearly describe the linkage between the functions of the relevant institutional or administrative frameworks and the proposed project undertakings;

6. Impact Identification and Assessment

The Consultant shall identify, describe, analyze and assess environmental and social impacts of the proposed project works on natural resources, human beings and the ecosystems based on the phases of project life cycle i.e. mobilization or pre-construction phase, construction phase, operation phase and decommissioning and demobilization phase. Methods applied in impact identification and the criteria used in evaluating the levels of impacts significance of the proposed project works must be specified.

Description of direct and indirect impacts of the project on the environment during site preparation, construction and implementation:

- Description of the methods used in the analysis, description and classification of impacts;
- Analysis of direct and indirect environmental impacts of the project;
- Description of the likely significant effects of the proposed project on the environment;
- Identification and description of the potential adverse impacts and environmental risks associated with implementation of the proposed project,
- Identification and evaluation of effects, description of their impact on biological and physical environment and on the sensitive ecosystems such as air quality,

wildlife, wetlands, surface and underground water; sources if any on the project site or near it;
- Descriptions of the impact of the project on the socio economic environment.

7. Analysis of alternatives

Analysis of alternatives to the proposed project based on plot location, design, technology selection, construction techniques and phasing, operating and maintenance procedures:

- Description of different alternatives to the project and their respective impacts on the environment,
- Justification of the proposed choice.

8. Propose Impact Mitigation Measures

The Consultant shall suggest cost-effective measures for minimizing or eliminating adverse impacts of the proposed project works. Measures for enhancing positive or beneficial impacts should also be recommended.

Measures envisaged for avoiding, reducing, minimizing or compensating potential adverse impacts of the project:

- Detailed description of the appropriate mitigation and compensatory measures together with designs, equipments description and operational procedures (as appropriate) to respond to these impacts or to avoid or reduce risks,
- Analysis of the proposed alternatives and description of mitigation measures to their environmental impacts.

The mitigation measures shall consider but not limited to the following:

- Policy interventions;
- Engineering interventions;
- Social-economic interventions.

9. Environmental Monitoring and Management Plan (EMMP)

The Environmental monitoring and Management Plan focuses on three generic areas: implementation of mitigation measures, institutional strengthening and training, and monitoring. The Consultant shall prepare Environmental Management Plan which will include proposed work programme, budget estimates, schedules, staffing and training requirements and other necessary support services to implement the mitigation measures. Institutional arrangements required for implementing this management plan shall be indicated. The cost of implementing the monitoring and evaluation including staffing, training and institutional arrangements must be specified.

Description of the modalities provided in the project for the implementation of the proposed mitigation measures to its potential negative impacts:

- Description of the methods that will be used in monitoring and evaluating the state of the environment before and during the implementation of the project,
- Detailed mitigation measures including an estimation of the cost of the implementation,
- Detailed description of a monitoring and evaluation plan with an estimation of its implementation cost,

This Environmental Management Plan should be summarized in a table format.

10. Reporting

Notwithstanding the above requirements, the contents and the structure of the Environmental and Social Impact Assessment Report should be in accordance with the Environmental Impact Assessment Regulations and Guidelines.

The EIA should be concise and limited to significant environmental Issues. The main text should focus on actions supported by summaries of the data collected and citations for any references used in interpreting data.

Annex 3: EIA CERTIFICATION CONDITIONS OF APPROVAL

RDB | RWANDA DEVELOPMENT BOARD

EIA CERTIFICATION CONDITIONS OF APPROVAL

ESIA conditions of approval for the project on construction of Kivu Belt Water Supply System in Rubengera, Bwishyura, Mubuga and Rugabano Sectors of Karongi District and Gihango, Mushubati, Musasa and Murunda Sectors of Rutsiro District.

In addition to the implementation of mitigation measures outlined in the EIA report, this certificate of approval is granted under condition that the developer shall comply with the conditions given herein:

1. **General conditions**

- This certificate of approval loses its validity if the project does not commence in the three (3) year period after its issuance. Otherwise, it is valid for the whole lifecycle of this specific project unless henceforth revoked or suspended;
- Observe all relevant national policies, regulation and legislation that guide this specific project throughout its life cycle;
- Ensure that this certificate together with the Environment Impact Statement (EIS)are present at the project site during project development/construction and operation, and are available at all times for monitoring purposes;
- Obtain all other necessary approvals/permits from other relevant institutions as required before commencement and operation. This certificate does not replace other required approvals/permits;
- Fulfill other environmental conditions and requirements as may be prescribed from time to time by Environmental Authority or any other lead agency;
- Ensure that the Environmental Management Plan is implemented as prescribed in the EIS and ensure that records are kept for future monitoring or environmental audits;
- Carry out regular environmental audits and submit Audit Reports to the Authority;
- Ensure that any other undesirable environmental impacts that may arise due to the implementation of this project but were not contemplated at the time of undertaking this Environmental Impact Assessment are mitigated.

2. **Specific Conditions**

Construction and operation phases:

- Operation and Maintenance of the Water Supply should comply with the international Best Practices and the principles of environmental management including the principles of sustainability, prevention, precaution, and polluter pay principle and public participation.
- Baseline and progressive water quality tests of the reservoir are necessary to determine mitigation measures for likely non-point source water pollution.
- Ensure that expropriation and compensation exercises are dully completed before the start of construction works and where possible, the works should be planned at harvesting time to minimize impacts on crops;
- When staffing, priority shall be given to local population;
- Provide to the workers Personal Protective Equipment(PPEs) as required and enforce their use at work;
- Regular campaigns on health and safety measures shall be held and measures especially those intended to avoid accidents, contamination and spread of the epidemic and endemic diseases applied;

- ❖ Construction materials shall be sourced from approved sites. Otherwise, acquisition, exploitation and rehabilitation of the quarries and borrow pits should follow the provisions of laws and regulations in place;

- ❖ Construction and other noisy works shall be carried out during day time in order to avoid disturbance of the communities in the vicinity of the project site;
- ❖ The water source abstraction, water distribution system construction and rehabilitation works should preserve protected animal and plant species if found in the project area, and should not in any case negatively impact on historical and memorial sites as well as any cultural heritage;
- ❖ An environmental flow should be left after spring abstraction for biodiversity and other water use needs downstream the spring;
- ❖ Trenches are quickly and well backfilled especially where they cross roads and pathways, where they expose other facilities or where they may constitute risks of accidents;
- ❖ No project activities shall be carried out within protected ecosystems in the area;
- ❖ The springs and water fetching points should be protected and people should be organized to sustainably manage and protect the whole water supply system for rational use of water resources;
- ❖ The Developer of the project shall play active role in activities aiming at protecting the entire catchment of project area mainly in protection of water bodies, tree planting and erosion control programs.

The EIR is thus approved subject to the fulfillment of the conditions described above together with all mitigation's measures identified in the EMP of the project.

N.B. Note that in case of non-compliance of the conditions described above, RDB reserves the right to withdraw the certificate.

Signed by:

Clare AKAMANZI
Chief Executive Officer

Gisele UMUHUMUZA
Ag Chief Executive Officer

Annex 4 : Public Consultations Documentation

WTP site in Ruragwe Cell, Rubengera Sector, Karongi, near

Tanks site at Kayenzi