Environmental and Social Impact Assessment of the Kigali Wastewater Project

FINAL

European Investment Bank

November 2016

TA2013039 RW IF2

The technical assistance operation is financed by the European Union under the Cotonou Agreement, through the European Development Fund (EDF). The EDF is the main instrument funded by the EU Member States for providing Community aid for development cooperation in the African, Caribbean and Pacific States and the Overseas Countries and Territories.

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100 Boulevard Konrad Adenauer, L-2950 Luxembourg
File: BD8344-101-100
14 November 2016

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LIST OF ABBREVIATION

CaC	Village/Cell Adjudication Committee
CoK	City of Kigali
Construction RoW	Construction Right of Way
DLB	District Land Bureaux
DLO	District Land Officer
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIB Standard 6	EIB Environmental and Social Standard 6: Involuntary Resettlement
EIB Standard 7	EIB Environmental and Social Standard 7: Rights & Interests of Vulnerable Groups
EIB Standard 10	EIB Environmental and Social Standard 10: Stakeholder Engagement
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
GLARC	Guide to Land Acquisition, Resettlement and Compensation
GoR	Government of Rwanda
GRC	Grievance Review Committee
HH	Households
KPIs	Key Performance Indicators
Legal RoW	Legal Right of Way
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
NGO	Non-Governmental Organisation
NLC	National Land Centre
PAPs	Project Affected People
RAP	Resettlement Action Plan
RCC	Resettlement and Compensation Committee
RDB	Rwanda Development Board
REMA	Rwanda Environmental Management Authority
RIU	Resettlement Implementation Unit
RNRA	Rwanda Natural Resources Authority
RPF	Resettlement Policy Framework
RWF	Rwandan Franc
SEP	Stakeholder Engagement Plan
The Bank	European Investment Bank
The State	Rwandan National Government
WASAC LTD LTD	Water and Sanitation Corporation, Rwanda
WB OP 4.12	World Bank Operating Principles 4.12 on Involuntary Displacement
WWTP	Wastewater Treatment Plant

NON TECHNICAL SUMMARY

This Environmental and Social Impact Assessment relates to the Kigali Wastewater Project, located in Kigali, the capital of Rwanda. The promoter of this project is the Water and Sanitation Corporation WASAC LTD LTD. This final Environmental and Social Impact Assessment (ESIA) is submitted to the Steering Committee of the Project, to the European Investment Bank and to the Rwanda Development Board, as legal authority for the assessment and approval and EIA's according to the Law of Rwanda, and includes updates based on the Transmission of the ESIA Review Findings issued by the Rwanda Development Board on 25 May 2016 to the attention of Mr. James Sano, CEO of WASAC LTD Ltd (ref. RDB/3/JDK/065/05/16.

In June 2016 the proposed project has been adjusted by WASAC LTD LTD and the Steering Committee as follows:

1. A full scale activated sludge processing component has now been added right from the start (originally stage 2), instead of starting with a pilot activated sludge component only (originally stage 1). This will enable the project to reach the Rwanda effluent quality standards at all times, also during times of floods in the Adjacent Nyabugogo River;
2. The originally proposed open sludge drying beds have been replaced by a mechanical sludge drying system, to better manage the sludge drying process generated by the treatment plant also during times of rain.

All other project components remained unchanged. This updated ESIA report takes into account also these two recent project adoptions. This report has been prepared by Royal HaskoningDHV, an international consulting firm with its headquarters in the Netherlands.

The Government of the Republic of Rwanda (GoR) is seeking finance through the European Investment Bank (EIB) towards the implementation of part of this project including the proposed Kigali sewerage system and wastewater treatment works. The priority works consist of gravity sewers and a wastewater treatment works located outside the city. The Water and Sanitation Corporation WASAC LTD LTD is the promoter of this project.

In accordance with the EIB's Statement of Environmental and Social Principles and Standards (2009) as well as its Environmental and Social Practices Handbook (2010), the Project requires an Environmental and Social Impact Assessment to be undertaken to the satisfaction of the Bank and the relevant Rwandan legislation to ensure that the environmental and social concerns of the project activities are properly taken into consideration during the project cycle. The current report presents this ESIA in its final version, and includes an Environmental and Social Management Plan (ESMP). Separate from this report the Consultant have issued a Stakeholder Engagement Plan and a Resettlement Policy Framework.

The proposed Kigali Wastewater Project includes sewerage collection from the central part of Kigali, a trunk main to transport the collected wastewater to a location about 2 km east of the city, and a wastewater treatment plant to treat this wastewater, including a chemically enhanced primary sedimentation system followed by an activated sludge treatment system with an initial capacity of 12,000 m3 / day. The WWTP will be constructed near the bifurcation of the Kigali-Musanze highway and the Kigali-Muhanga highway. The plant includes facilities for sludge digestion and mechanical sludge drying and maturation ponds. The treated effluent will be discharged in the Nyabugogo River, next to the plant and upstream of the confluence with the Nyabarongo River. The sludge will be dried for potential reuse in the agricultural sector, or will otherwise be disposed of at the Kigali Solid Waste Landfill site.

The proposed WWTP and related maturation ponds are located in dedicated wetlands areas according the Organic Law of Rwanda No 04/2005 of 08/04/2005 for Determining the Modalities of Protection,

Conservation and Promotion of Environment in Rwanda. In line with the legal requirements under this Law, a Permit request for construction of this WWTP and maturation ponds have meanwhile been issued by WASAC LTD LTD to the Ministry of Natural Resources (MINIRENA).

Following earlier planning and designs developed by SGI, Mott MacDonald proposed in 2012 a phased implementation of the networked sewer system and the wastewater treatment plant in Gitikinyoni. Since the current project is the first centralized wastewater treatment project in Rwanda, this approach will enable the responsible authorities and operators to get acquainted with the all practicalities of operations aspects ("learning by doing), and to maintain sufficient flexibility to anticipate on future developments. The current stage of the project includes collection of wastewater from the urban areas 1A and 2A only. It is foreseen that in 2020 these areas will generate an estimated 12,000 m3/day average flow from a population of about 120,000. Next to the sewage collection and treatment the City of Kigali promotes the phasing out of latrine toilets and replacing them with flushing toilets. Although not part of the wastewater project this will also have a positive effect on the sanitation and hygiene situation of the citizens of the City.

Flooding events occur up to three times per year in the Nyabugogo wetlands and affect the wetlands along the proposed trunk main and the area of the maturation ponds. The trunk main will start from the Nyabugogo International Bus Terminals, located on the eastern edge of the Kigali-Muhanga highway and will end at the WWTP. This highway is a main thoroughfare used intensively by cars, motorcycles, busses, trucks, bicycles and pedestrians entering and leaving Kigali. Peak traffic causing traffic jams regularly occur during peak hours on the working days.

Today the City of Kigali is supplied by three water treatment plants and 7 pumping stations with an installed capacity of about 81,000m^3. However, about 65,000 m3 /.day is actually produced in existing water plants and provided to the city as piped water. Considering a projected population of 1.33 Million with a total water demand of about 100,000 m3 / day or more, this amount is still modest.

Wastewater in Kigali is today collected predominantly in septic tanks and soakaways. Septic tanks are currently emptied by tanker trucks, which discharge the wastewater in dedicated ponds near the city's central solid waste disposal site, however wastewater from these ponds infiltrate into the soil and groundwater, or overflow into the open surface water surrounding the city. In addition, most of generated wastewater is discharged directly in open watercourses and channels without any treatment, ending in Nyabugogo River carrying all pollutants from the City of Kigali (CoK).

A part of the generated wastewater in Kigali today is treated by decentralized wastewater treatment plants connected by hotels, major governmental buildings and housing area. Today around 18 estates operate semi- centralized sewerage treatment plants connecting about 150 households each. The remainder of the generated wastewater is not treated today, which poses a direct threat to the environment and the public health, as evidenced by the heavily polluted rivers flowing through the city, including the Ruganwa River from the East, the Rwanzekuma from the North.

The project is located in the area where three rivers flow into the Nyabugogo River and its surrounding wetlands. Increased pollution and waste inhibits the wetland from functioning properly, reducing its ability to filter water and provide a safe ecosystem for plants and animals. The Nyabugogo wetland is connected to the Nyabarongo wetland in the east. From a regional perspective, the ecology of the Nyabugogo river and wetlands is important, since it forms the upstream tributary of the Nyabarongo/Akagera River, which drains to the Akagera National Park.

The people affected by the project include communities and businesses located within and downstream of sewer network, the economic centre of the country that attracts upper and middle class people for work and leisure; and communities and businesses affected by land expropriation and/or physical or economic resettlement; mainly along the trunk main and at the site of the proposed WWTP.

This report includes a multi criteria analysis of alternative locations for the wastewater treatment plant, and concludes that the current site at Gitikinyoni, south of the main road would indeed be preferred, provided that the proposed environmental and social mitigation measures will be implemented.

The immediate and one of the most beneficial impacts of the Kigali Wastewater Project will be the cessation of the discharge of untreated sewerage in the environment and the Nyabugogo River, and related public health and environmental benefits.

Within the framework of this ESIA, a review has been made of the current design and project documents, and various recommendations have been formulated to mitigate anticipated negative environmental and social impacts. This includes mitigation of odor nuisance, which may be generated by the wastewater treatment plant due to hydrogen sulfide emissions and other volatile components.

Another recommendation concerns coordination of the planning of the trunk main with planned upgrade of the Kigali-Muhanga highway. Furthermore this ESIA recommends treating the influent wastewater at the WWTP at all times, also during periods of high river water levels and floods, and to study options for the reuse of the effluent near the treatment plant in more detail.

This ESIA recommends that a zoning of 20 m will be respected around the WWTP including sufficiently high trees to break the visual distortion of the WWTP from the main road. It furthermore suggests taking adequate flood preventive measures at the WWTP site, such as construction of a dyke parallel to the main road along the western side of the WWTP, and preparation of additional surface drainage facilities on the western part of the WWTP site in case of flood emergencies.

It is recommended to take biological prevention measures against malaria risks in the maturation ponds, such as introduction of predatory fish that feed on mosquito larvae and distribution of mosquito nets to the people around the maturations ponds. In terms of Green House Gas emission reduction, this ESIA suggests not to flare the gas emissions as proposed, but to consider reuse for power generation.

The proposed area of the WWTP includes an unpaved side road, running southwards from the main road to the hinterland. It is suggested to reroute this road prior to the WWTP will be constructed. In addition, in the direct surroundings of the WWTP a well is used by people for water supply. It is recommended that WASAC LTD replaces this well provides an alternative and reliable water source, before the WWTP is constructed. The western part of the proposed Maturation Ponds is currently used as football field, which is an important leisure and gathering place for the local youth. It is advised to see if an alternative field can be established in the neighborhood before the maturation ponds are constructed.

Finally, this report includes an Environmental and Social Management Plan and a related Environmental Monitoring Plan, separated for the pre-construction, construction and implementation phases of the Kigali Wastewater project. It is suggested to use the proposed construction related mitigation measures as input for the Contractor’s Construction Environmental and Social Management Plan, to be elaborated in his bid for the construction works. The annual costs related to implementing this ESMP are estimated at € 52,000. These costs are to be financed through the operational budget of the Kigali Wastewater Project.

1 INTRODUCTION

1.1 Introduction to the Kigali Wastewater Project

The proposed Kigali Wastewater Project includes sewerage collection from the central part of Kigali, a trunk main to transport the collected wastewater to a location about 2 km east of the city, and a wastewater treatment plant to treat this wastewater. This plant includes facilities for sludge processing and maturation ponds. The treated effluent will be discharged in the Nyabugogo River, next to the plant and upstream of the confluence with the Nyabarongo River.

The Government of Rwanda (GoR) prioritized water supply development during the 2000s, causing a rapid increase in access to improved water sources to 74.2% of the population nationally in 2010/11. Access to improved sanitation facilities has also increased significantly over the past years to reach 74.5% of urban and rural dwellers uniformly in 2010/11 (Millennium Development Goals Rwanda, 2014). However, progress still needs to be made as a large part of the population relies on public shared pit latrines for sanitation and on sanitation facility without a collection system in place. Rwanda Vision 2020 (Ministry of Finance and Economic Planning, 2000) indicated that 'by 2020, the rural and urban areas are to have sufficient sewerage and disposal systems'.

The National Policy for Water and Sanitation of the Ministry of Infrastructure (2010) was updated and it is currently awaiting final approval before being sent to the cabinet in its final stage. In addition, a new water supply and sanitation law is at an early stage of development. The National Policy for Water and Sanitation includes the following objectives in the framework of urban sanitation:

- Total urban household sanitation coverage should rise to 65% by 2012 and 100% by 2020;
- Implement improved sanitation for schools, health facilities and other public institutions and locations;
- Develop safe, well-regulated and affordable off-site sanitation services for densely populated areas (sewerage and sludge collection, treatment and reuse/disposal); and
- Enhance storm water management to mitigate impacts on properties, infrastructure, human health and the environment.

Wastewater disposal in Kigali is currently making use of septic tanks and soakaways, or in some cases direct discharge to open watercourses. In 2008 (SGI) 95% of the households have individual sanitation, of whom 80% have pit latrines and 20% flush toilets. The Kigali City Master Plan (2013) includes a target of 20% for sewerage coverage in the City by 2025 and the wastewater sewerage and storm water drainage system should be separated in 20% of the City. The use of pit latrines has to be phased out gradually by 2025.

To improve the wastewater system in parts of Rwanda's capital Kigali, the GoR has developed the Kigali Wastewater Project, with the objective to:

"Protect the environment of Kigali water catchments and the Nyabarongo River, which is discharging to the Kagera River and further to Lake Victoria, through wastewater treatment and to improve water and sanitation services within the city of Kigali"

Other objectives are to:

- Improve the hygiene and public health situation;
- Reduce deterioration of the quality of groundwater resources by pollutants from septic tanks, soakaways and latrines;
- Support the economic development of the City of Kigali.

In 2007 the first studies were performed by SGI Ingenierie-Projema-I2D (SGI) to update the 1991 Wastewater Master Plan to the horizon of 2020 and to identify priority works. An initial design of the here

concerned priority work was also prepared by SGI, with a phased approach, allowing extensions of the network in the city to be connected to the wastewater treatment plant (WWTP).

Mott MacDonald (MMD) reviewed the studies of SGI and advised in the Rwanda Wastewater Design Stage 2 report (2012) a wastewater project to serve the central business district of Kigali with a sewer network (86.5 km), diversion of wastewater through with a trunk main (3.1 km) to a wastewater treatment plant (WWTP) in the outskirts of Town in Gitikinyoni (10 ha site) and maturation ponds (9.5 ha). The system is designed to accommodate extension of the network to other areas of Kigali in the future.

Mott McDonald's Design Criteria Report of 2014 gives an insight in the phased approach of the development of the wastewater project (see below table). This ESIA is focused on the first two stages.

Table 1 - Projected stages of development of the Kigali wastewater project (MMD, 2014)

Stage	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**
Design year	**2020**	**2020**	**Year 2030 Master Plan**	**Ultimate footprint (Year X)**
Population				
Domestic PE	120,000	120,000	240,000	548,680
Septic Imports PE	3.154	3,154	3,154	3,154
Total PE	123,154	123,154	243,154	551,834
Flows				
Average daily flow (ADF) m^3/d	11,532	11,532	23,023	52,745
Imported Latrine and Septic Sludge m^3/d	41	41	41	41
Loads				
BOD kg/d	6,158	6,158	12,518	27,592
SS kg/d	8,005	8,005	15,805	35,869
Amm.N kg/d	924	924	1,824	4,139
Areas to be connected	Muhima & Nyarugenge	Muhima & Nyarugenge	Nyarugenge, Muhima, Gisozi, Gacuriro (Cell) and Gikondo (partly.	the Nyarugenge, Muhima, Kimihurura (partly), Kacyiru (partly), Nyamirambo (partly), Rwezamenyo (partly) and Nyakabanda (partly) Gisozi, Gacuriro (Cell) and Gikondo (partly).

It should be noted that according to the 2016 design report of Mott McDonald (MMD) it is difficult to exactly determine the future flows due to a number unforeseen parameters. MMD therefore developed alternative flow calculations to determine the likely range of volume of effluent which will need to be treated by the wastewater treatment plant. These estimates have been compared to the potential flows using two different calculations methodologies: Water Demand (WD) based calculations; and Land use based calculations. As such the final 2016 Design Report assumes an influent average flow of 6.800 m3 / day by 2020 instead of the 11.532 m3 / day flow presented in its previous study.

The estimated average flows by MMD (2016) are presented hereafter:

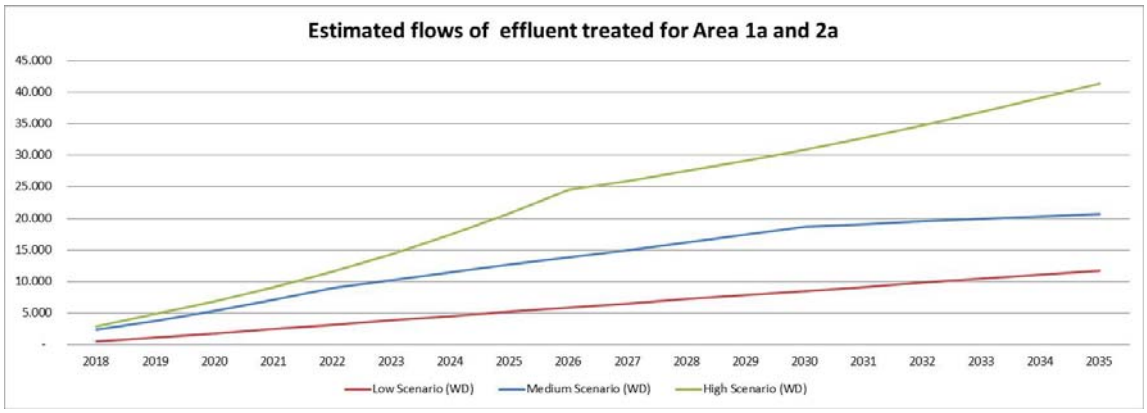


Figure 1 – Estimated flows of treated effluent (based on MMD, 2016)

A geographical overview of the components of the wastewater project is given on below map.

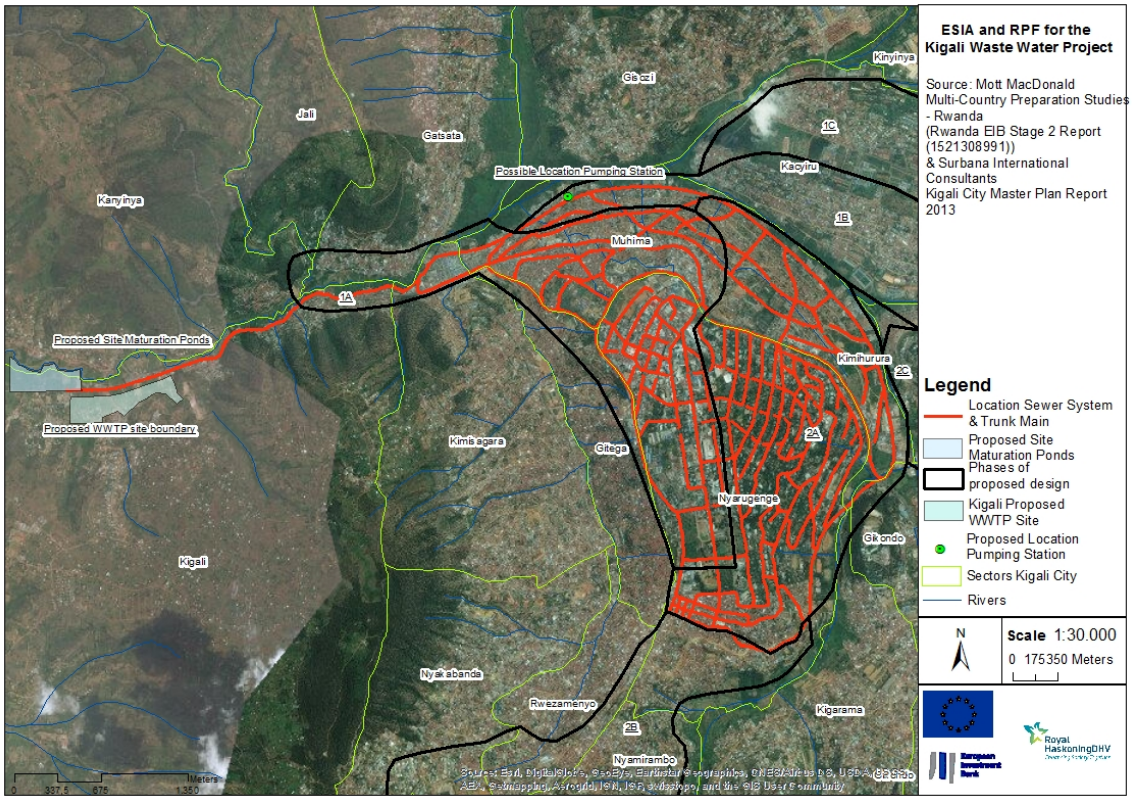


Figure 2 - Location of Kigali Wastewater Project (based on MMD, 2012)

In the Rwanda Wastewater Design Stage 2 report prepared by Mott McDonald in December 2012 a first cost estimate of the capital and operation costs was provided. These figures were updated in October 2016 as presented below. The total CAPEX for the WWTP are M€ 20.9 and for the collection sewers, pumping station and trunk main: M€ 59.2 The annual operating costs (OPEX) for the WWTP are M€ 1.13 and for the sewers, pumping station and trunk main: € 590,000, excluding resettlement and household connection costs, and excluding site power supply, water supply to the site, water usage and sludge disposal costs.

Table 2 – CAPEX and OPEX of the Kigali Wastewater Project (Mott Macdonald, October 2016)

Total CAPEX for Kigali Centralised Sewerage System for Area 1a and 2a				Cost (£ '000) in Rwanda **69.122**	Cost (€ '000) in Rwanda **80.182**	Cost (RWF '000) in RWF **72.232.699**
Wastewate treatment plant CAPEX						
Item	Process	Notes	Asset	Cost (£ '000) in Rwanda	Cost (€ '000) in Rwanda	Cost (RWF '000) in RWF
1,1	Inlet Pumping Station	Stage 1-4 Civil. Stage 1 Mechanical	New	1.075	1.247	1.123.258
1,2	Inlet Works	Coarse and fine screens and grit removal for 12,000 m3/day	New	492	571	514.142
1,3	Chemically Enhanced Primary Sedimentation	4 Nr 13 m Diameter PSTs and Chemical Dosing System	New	1.702	1.975	1.779.025
1,4	Activated Sludge Treatment	Activated Sludge System for 12,000 m3/day	New	5.386	6.247	5.627.923
1,5	Maturation Pond System	3 Nr Ponds at 3.5 hectares each for a total of 10.5 hectares	New	1.107	1.284	1.156.660
1,6	Sludge Thickening and Digestion	Coarse and fine screens and grit removal for 12,000 m3/day	New	2.986	3.463	3.119.964
1,7	Sludge Drying Beds	Digested Sludge thickener and sludge storage	New	1.131	1.312	1.181.639
1,8	Site Services	Buildings, Roads, Emergency Power, Washwater, Site drainage	New	1.168	1.355	1.220.842
			Sub-total:	15.046	17.454	15.723.454
			Contingency:	20%	20%	20%
			Total + contingency:	18055,64058	20944,54307	18868144,4
Sewer CAPEX						
Item	Component	Notes	Asset	Cost (£ '000) in Rwanda	Cost (€ '000) in Rwanda	Cost (RWF '000) in RWF
2,1	Collector sewers	Including laterals and connections	New	41.355	47.972	43.216.135
2,2	Pumping station	Including rising main	New	854	991	892.343
2,3	Trunk sewer		New	4.215	4.889	4.404.753
			Sub-total:	46.424	53.852	48.513.232
			Contingency:	10%	10%	10%
			Total + contingency:	51.067	59.237	53.364.555

Note: No contingency is in-built in the individual items costs for CAPEX

Total OPEX for Kigali Centralised Sewerage System for Area 1a and 2a			Cost/Y (£ '000) in Rwanda **1.646**	Cost/Y (€ '000) in Rwanda **1.909**	Cost/Y (RWF '000) in RWF **1.719.811**
Wastewate treatment plant OPEX					
Item	Description	Notes	Cost/Y (£ '000) in Rwanda	Cost/Y (€ '000) in Rwanda	Cost/Y (RWF '000) in RWF
1,1	Chemicals	Primary chemicals, thickening and dewatering polymers	172	199	179.342
1,2	Power	Aeration, pumping, and sludge thickening	494	573	516.398
1,3	Staff	6 Labourers, 1 site manager, 1 supervisor, and 1 lab/process technician	250	290	261.650
1,4	Operational maintenance	Civil and Mechanical Combined annual maintenance	165	191	171.958
	Total Opex		1.081	1.254	1.129.348
Sewer OPEX					
Item	Description	Notes	Cost (£ '000) in Rwanda	Cost/Y (€ '000) in Rwanda	Cost/Y (RWF '000) in RWF
2,1	Chemicals	None	-	-	-
2,2	Power		321	372	335.274
2,3	Staff		90	105	94.478
2,4	Operational maintenance		154	178	160.711
	Total Opex		565	655	590.462

Assumptions	
Currency Conversion (GBP / RWF)	1045
Currency Conversion (GBP / Euros)	1,16
Civil local cost calibration (including local taxes)	0,7
M&E local cost calibration (including local taxes)	1
% Imported M&E	1
M&E foreign multiplier, (CIF - shipping, insurance)	1,15
M&E foreign multiplier, duties & taxes	1
M&E foreign cost multiplier, combined	1,15
Mechanical Operation Costs	0,02
Civil Operation Costs	0,003
Power Cost (Rwf/kWh)	126
VAT on Power	0,18

Exclusions
Site Power Supply
Water supply to site
Water usage
Sludge Disposal Costs

It is foreseen that the European Investment Bank (EIB) will provide a loan to the GoR to finance the above mentioned capital costs. Resettlement costs are to be covered by the GoR. Household connection costs and annual operational costs are supposed to be recovered by connection and treatment fees to be paid by the users of the system (see Feasibility Study).

1.2 Purpose of this ESIA

As main financier the European Investment Bank requires that the Kigali Wastewater Project will comply with relevant Rwandese legislation and EIB's environmental and social safeguard principles. These are described in the EIB's Statement of Environmental and Social Principles and Standards (2009) and the Environmental and Social Practices Handbook (2010). They include the need for preparing an Environmental and Social Impact Assessment Plan (ESIA) and related Management Plan.

The purpose of this ESIA is to ensure that the environmental and social concerns of the project design as presented to the ESIA Consultant are properly taken into consideration during the project cycle from planning until the implementation and monitoring/evaluation. This ESIA has been prepared in compliance with above national regulations as described in section 6.2 and international standards, as well the Operational Policies of the World Bank Operational Policy OP 4.12 focused on management of involuntary resettlement issues. This ESIA is based on the studies prepared earlier in the framework of the Kigali Wastewater Project and on additional data collection and socio-economic field surveys performed by the Consultant. This also includes a financial and institutional Feasibility Study that is done parallel to this ESIA study by Atkins. The studies performed earlier did not include a Technical Feasibility Study in the sense of developing and technical comparison of alternative wastewater management scenarios and wastewater treatment technologies.

In addition to the draft ESIA that is presented here, separate reports have been issued on the project's Stakeholder Engagement Plan (SEP) and a Resettlement Policy Framework (RPF). This framework aims at guiding the detailed Resettlement Action Plan following the completion of the detailed design for the project.

2 PROJECT CONTEXT

2.1 Current Situation

Today, wastewater in Kigali is collected predominantly in septic tanks and soakaways. Septic tanks are currently emptied by tanker trucks, which discharge the wastewater in dedicated ponds near the city's central solid waste disposal site, however wastewater from these ponds infiltrate into the soil and groundwater, or overflow into the open surface water surrounding the city. In addition, most of generated wastewater is discharged directly in open watercourses and channels without any treatment, ending in Nyabugogo River carrying all pollutants from the City of Kigali (CoK). A part of the generated wastewater in Kigali today is treated by decentralized wastewater treatment plants connected by hotels, major governmental buildings and housing area. Today around 18 estates operate semi- centralized sewerage treatment plants connecting about 150 households each.

However, the majority of the inhabitants make use of private or shared pit latrines, while only a part of them is emptied by tanker truck, who dispose the waste at the municipal landfill. In addition, sewage (treated or untreated) is collected in drainage ditches, which are mostly covered, but not completely, posing a risk for contact with the sewage. As in the current situation there is no separate discharge system for sewage and storm water in the city, so that in periods of heavy rain the drainage ditches can overflow, bringing sewage water into the streets, where people can get into contact with it.

In the current situation sewage from a large part of Nyarugenge District (including Muhima and Nyarugenge sectors) is drained into the Nyabugogo River, which flows to the west, passing the proposed WWTP site and conflates downstream with the Nyabarongo River. Especially in the dry season, when the pollutants of the sewage are less diluted by rain and river water, the levels of pollutants increase substantially.

The current wastewater situation in Kigali poses a direct threat to the environment and the public health, as evidenced by the heavily polluted rivers flowing through the city, including the Ruganwa River from the East, the Rwanzekuma from the North, Yanze and Mpazi rivers, all tributaries of Nyabugogo River towards the West which flows into Nyabarongo River (Figure 2). Levels of Biological Oxygen Demands (BOD_5) in these rivers vary from 10 – 20 mg / l during the wet season and up to 25 – 35 mg / l during the dry season. As a reference, typical values for pristine rivers have BOD values below 1 mg / l, while moderately polluted rivers may have BOD values in the range of 2 to 8 mg / l. High concentrations of heavy metals (cadmium, lead and chromium) and nutrients exceeding eutrophication thresholds at outflow of Nyabugogo swamp due to industrial areas previously located in Gikondo industrial park were also recorded in previous studies (Sekomo et al., 2010 and Nhapi et al., 2011)

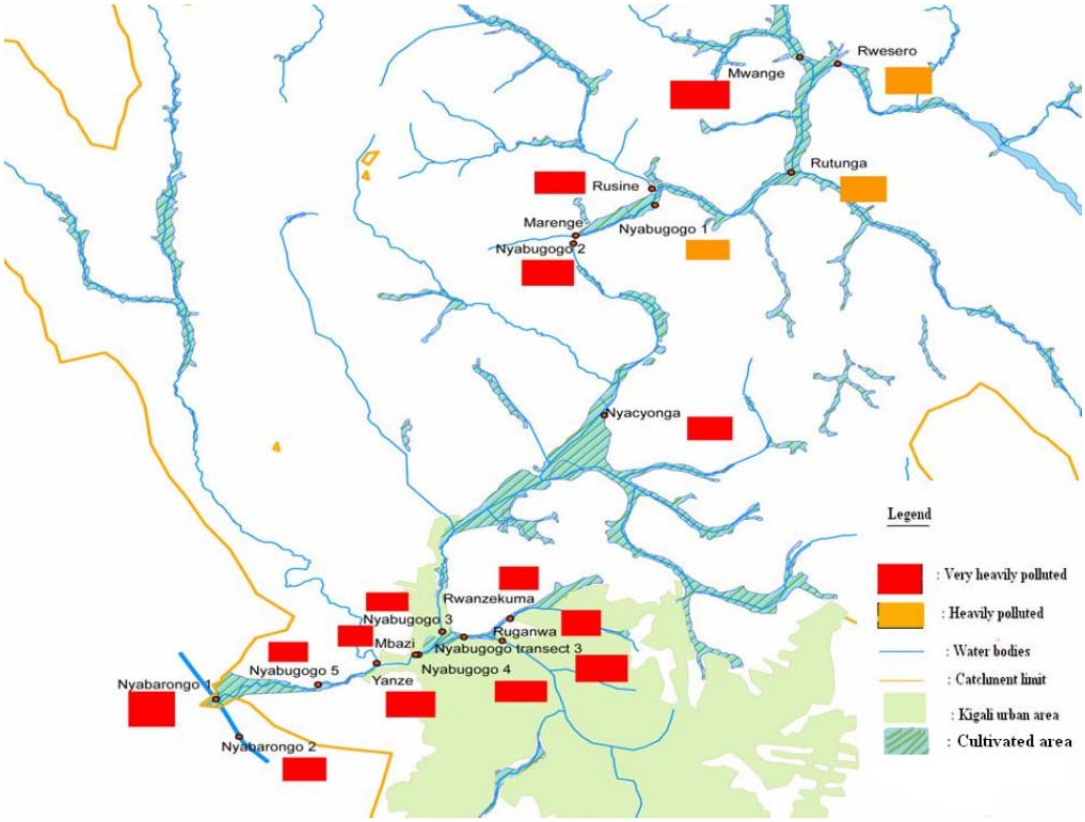


Figure 3 – Pollution Levels of Kigali Surface Waters (Uwonkunda et al., 2009)

During the previous years, research has been carried out and policies have been developed by the Water and Sanitation Corporation (WASAC LTD), the CoK and others to protect the environment of the Nyabugogo water catchments and the Nyabarongo River, through wastewater treatment and improvement of water and sanitation services within the CoKi. Within this context the predecessor of WASAC LTD, the Energy, Water and Sanitation Authority (EWSA) updated the Storm water and wastewater Master Plan for Kigali in 2009, including prioritized interventions through to 2020.

2.2 History of the Project

In 2007, the consortium SGI Ingenierie-Projema-I2D (SGI) was commissioned by Electrogaz, the predecessor of the Energy, Water and Sanitation Authority (EWSA), to update the 1991 Wastewater Master Plan to the horizon of 2020 and to identify priority works. An initial design has been conceived by SGI Ingenierie (SGI) that may be developed in phases, allowing it to be developed when funding is available and appropriate institutional capacity has been developed. SGI developed priority works and produced design and tender documents for a piped waterborne sewerage system in the central area of Kigali. The SGI proposals were reviewed by Mott MacDonald in 2012, resulting is an extension of the urban area to be considered for immediate inclusion as well an extension of the planning and design horizon.

Following the planning and designs developed by SGI, as reviewed by Mott MacDonald in 2012, phased implementation of a networked sewer system and wastewater treatment plant in Gitikinyoni is foreseen. The core project (the Kigali Wastewater Project) has been defined within the above mentioned report “Rwanda Wastewater Design Stage 2” and the costs for designing and building the project developed.

The core works on the network will be to cater for full flows at saturation levels (year X in the City master plan, treated as approximately equivalent to a design horizon of 2030) in areas 1a and 2a identified by SGI, covering Kiyovu-Rugenge, Nyarugenge, Gitega and Muhima, but also allowing for connection of additional semi-collective schemes of Gisozi (20,000 p.e.), Gacuriro (3,000 p.e.) of Gasabo Districtand part of the District of Kicukiro (20,000 p.e.). This is presently projected to amount to average daily flows and loading of approximately 24,000 m^3 and 240,000 p.e, respectively.

A preliminary survey in September 2015 by Atkins in the areas 1a and 2a indicate that about 68% of the households receive piped water supply, with about 70% of the connections receiving water every day, be it not full time, while 30% receive water during only a few times per week or less. The high-income communities and offices in the area predominantly have flushing toilet systems, while only about 5% of the low-income communities in this area use flushing toilets. Most of the lower-income households use pit latrines on a private or shared basis. The majority of these pit latrines are not emptied: users simply cover them up when they are full, and dig a new pit latrine nearby.

The core works to be designed and tendered for the wastewater treatment plant site in Gitikinyoni will be for Chemically Enhanced Primary Treatment, an Activated Sludge Secondary Treatment and sludge processing to cope with year 2020 flows and loads from areas 1a and 2a. The initial design capacity of the plant will be 12.000 m3/day. It is foreseen by MMD (2016) that this plant will treat on average 6.800 m^3/day by 2020. The ultimate footprint and layout of the of plant will be to cope with secondary treatment and sludge processing for a population equivalent of approximately 550.000 people, allowing for future connection of areas beyond those considered at present.

The GoR is seeking finance through the European Investment Bank (“EIB” or the “Bank”) towards the implementation of part of the Kigali sewerage system and wastewater treatment works. The priority works, identified in the updated Master Plan prepared by SGI, consist of gravity sewers and a wastewater treatment works located outside the city. These works are referred to as the “Kigali wastewater project” or the “Project”, which is the subject of this ESIA.

Next to the sewage collection and treatment the Kigali City Master Plan promotes the phasing out of latrine toilets and replace them with flushing toilets. Although not part of the wastewater project this will also have a positive effect on the sanitation and hygiene situation of the citizens of the City.

3 BASELINE DATA

3.1 Introduction

This section outlines the findings during the scoping phase of the current ESIA for the Kigali Wastewater Project. The following methods were used to generate this environmental baseline:

Site reconnaissance
Field visits were performed by the ESIA Consulting Team of Royal HaskoningDHV (RHDHV) in the project area during the period from mid-August to the end of September 2015. These visits were guided by staff of the EIB; engineers from Mott Mack Donald (MMD), who is responsible for designing the sewage networks and the treatment plant; representatives of the Ministry of Infrastructure (MININFRA); the Water and Sanitation Corporate Ltd (WASAC LTD) and the City of Kigali (CoK). These field visits ensured that the study took into consideration potential receptors of impacts, any sensitive environment to the project, surrounding human activities and land uses, biophysical aspects (topography, visual aspects, noise, soils, potential water sources and aesthetic quality) and biological aspects.

Photographic recording
A photographic survey of the sites and surroundings area was also performed using digital camera. Key photographs acquired were used for further analysis in this study. They will be also used as data illustrators in the remainder of this ESIA report.

Desktop study
Baseline data were collected through desktop studies and evaluations. This was done through literature review of project documents available, as well as field studies reports that had been carried out and documented both electronically and through hard copy report surveys. The information was retrieved from WASAC LTD, CoK, MMD and from relevant agencies such as the Rwanda Meteorological Agency Ministry of Infrastructure (MININFRA), Rwanda Natural Resources Authority (RNRA), Ministry of Natural Resources (MINIRENA) Rwanda Natural Resources Authority (RNRA), Rwanda Standards Board (RSB), Rwanda Environment Management Authority (REMA). Annex 1 provides an overview of the related reports and literature.

3.2 Environmental Baseline

3.2.1 Project Location

Rwanda is a small country with a surface area of 26,338 square kilometers and a population of about 12 Million inhabitants, of which 10% lives in the capital city of Kigali. Rwanda is land-locked and located in East Africa. The country is delimited in the North by Uganda, in the West by Democratic Republic of Congo, in the East, Tanzania and in the South by Burundi (see below map).

The Kigali Wastewater Project includes the construction of a sewerage collection system and pumping station, a trunk main, and a central wastewater treatment plant with maturation ponds. These project components are situated in five administrative sectors: the Gitega, Nyarugenge, Muhima, Kimisagara and Kigali sectors, all part of the Nyarugenge District. The sewerage collection area will be located in the first three sectors; the pumping station in the Muhima sector; the trunk mains in the Kigali and Kimisagara sectors and the WWTP and maturation ponds in the Gitikinyoni the Kigali Sector (in the village of Nyabugogo Cell, which is part of the Kigali sector).

The WWTP will be constructed near the bifurcation of the Kigali-Musanze highway and the Kigali-Muhanga highway (See picture below). The trunk main will start from the Nyabugogo International Bus Terminals, located on the eastern edge of the Kigali-Muhanga highway and will end at the WWTP.

Figure 4 - Location of Kigali Wastewater Treatment Plant (Source: RHDHV, August 2015)

3.2.2 Topography

The topographic setup of Kigali is characterized by mountains, hills and wetlands. Mount Kigali in the south west of the WWTP site has the highest elevation in the area, with its top at 1858 m above mean sea level. The sewerage collection area 1A and 2A are located in the centre of Kigali and covers a hilly shaped topography with its centre around 1550 m above mean sea level (msl) and down its flanks around 1400 m above msl. The sewages will flow down to the planned pumping station, where it will be elevated with about 5 m. From here the water will flow further down the entrance of the Trunk Main, located at the Central Bus Station at about 1380 m above msl. The trunk main next follows the Kigali-Muhanga highway towards the east for about 4.2 km until it reaches the entrance of the WWTP at about 1370 m above msl (see figure below).

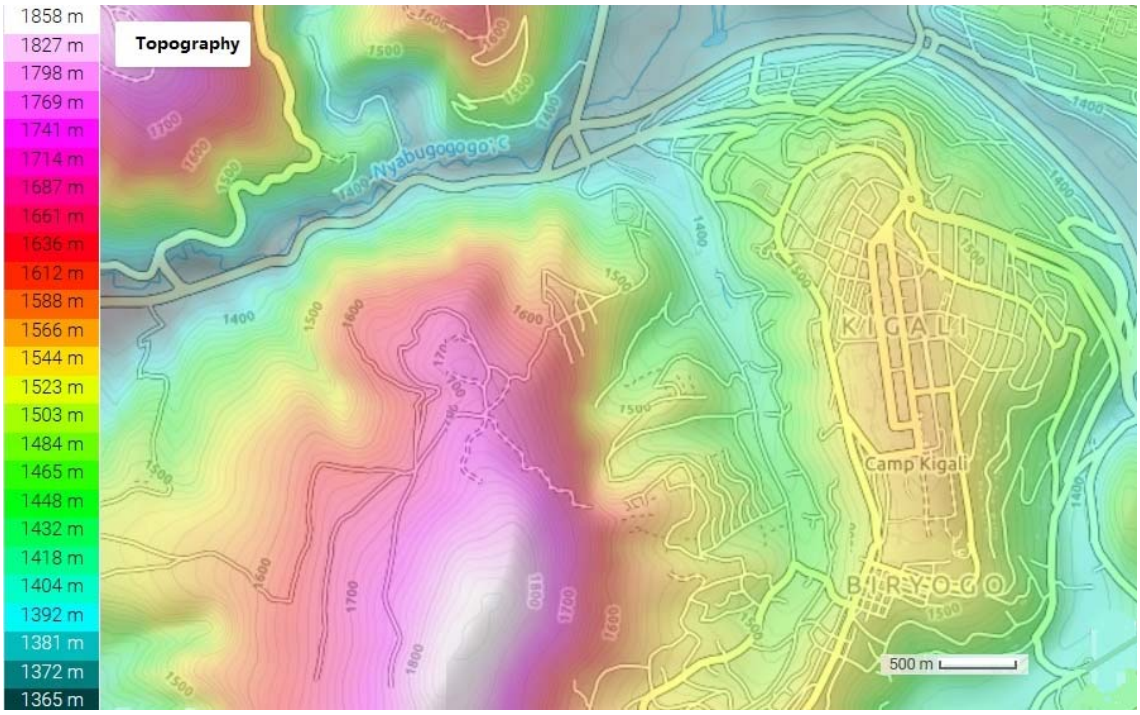


Figure 5 – Topography of the Project Area

The area of the WWTP is located south of the highway and gently slopes down from west (around 1372 m above msl) to east (around 1364 m above msl). The river on the opposite north side of the highway flows down through the same stretch from east to west from about 1364 m to 1362 m. This implies that the height difference between the western part of the WWTP area and the river is limited to about 2 meters only. See map below.

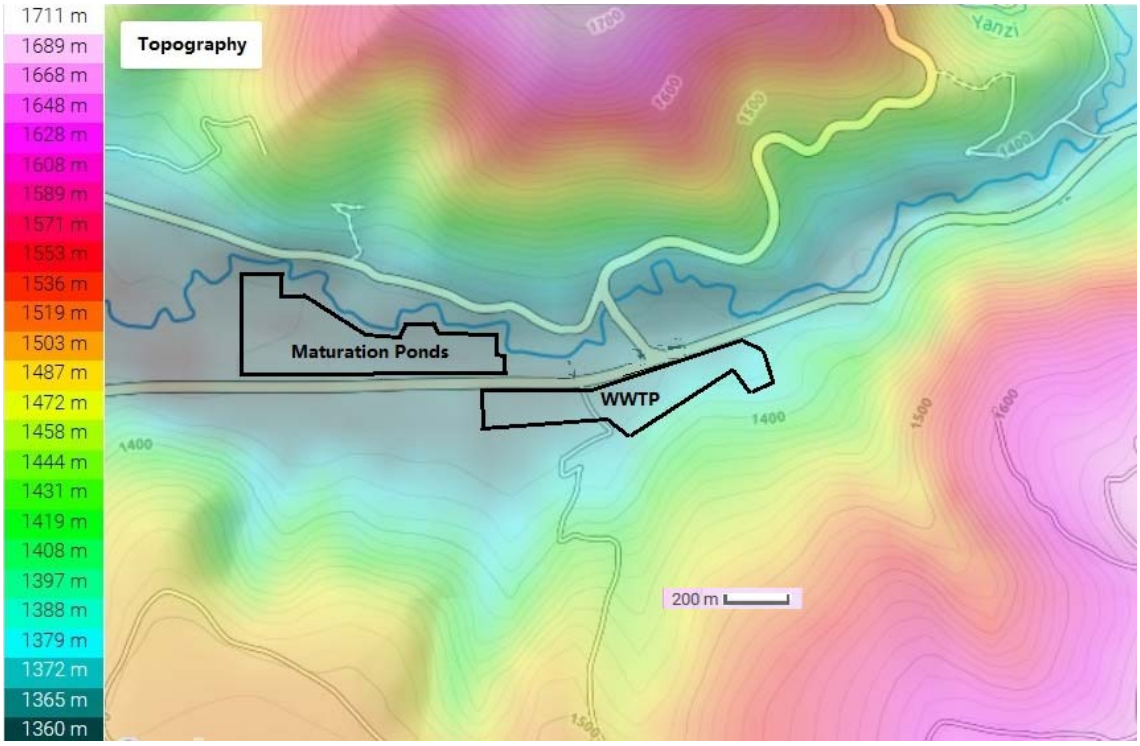


Figure 6 – Topography at the WWTP site

3.2.3 Fragile Ecosystems

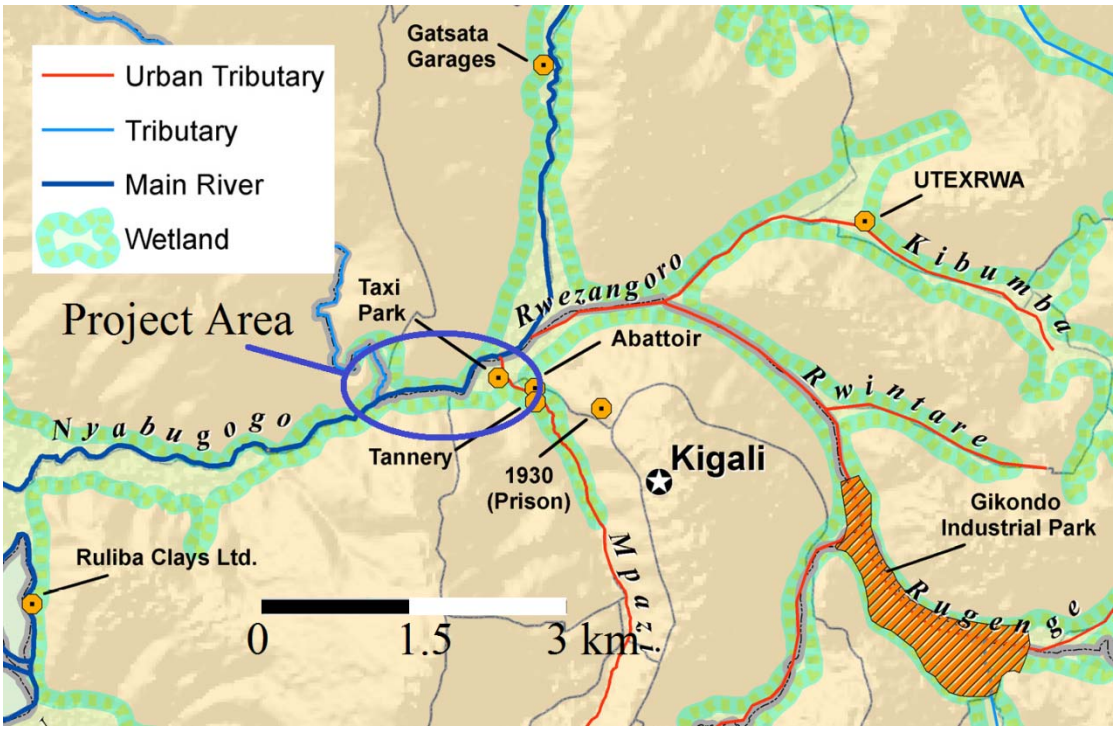


Figure 7 – Wetlands in the Nyabugogo Region (Kigali State of the Environmental Report 2013)

Flora

The project is located in the area where three rivers flow into the Nyabugogo River and its surrounding wetlands (Figure above). Increased pollution and waste inhibits the wetland from functioning properly, reducing its ability to filter water and provide a safe ecosystem for plants and animals. The Nyabugogo wetland is connected to the Nyabarongo wetland in the east.

The Nyabugogo wetlands vegetation is dominated by a large population of the papyrus gonolek, *Laniarius mufumbiri*, and cattle grassland such as *French Cameroun.* Mount Kigali is covered by commercial eucalyptus plantations. The area of the proposed maturation ponds is used for rice cultivation and sugar cane plantations that run further downstream along the Nyabarongo River. Much of the sugar cane is processed by the nearby Kabuye sugar factory. Seasonal crops in the wider area include beans, maize, sweet potatoes and various vegetables such as eggplants, cabbage, onions, carrots and tomatoes. These are cultivated mainly in the dry season when less flood events occur. Downstream of the WWTP site, some small banana and bamboo plantations are found.

Invasive species of water hyacinth is the major threat of Nyabarongo and Akagera rivers, further downstream of the project area. However, national and regional programs have been implemented by the Clean Water Inc in co-operation with the East Africa Community focused on biological control of water hyacinth in the Lake Victoria basin, from Rwanda to Uganda. This program started in 1995 using *Neochetina eichhorniae* and *Neochetina. Bruchi* species[1] . In addition, the local population planted pennisetum grass in a stretch of about 10 meters from the river for production reasons, processed in various handicraft products.

Fauna

The Nyabarongo and Nyabugogo catchments receive a large number of domestic and migratory birds. Typical bird species noticed at the site of the WWTP are the African Spoonbills, African Openbills, Little Egrets and Sacred Ibises, who rest here in the trees, and depend on the nearby rice plantations and wetlands for their food.

Figure 8 – Little Bee-eater, common bird near WWTP site

[1] Moorhouse T. M., P. Agaba and McNabb T. J.2001. Recent Efforts in Biological Control of Water Hyacinth in the Kagera River Headwaters of Rwanda

Other bird species that can be found foraging near the WWTP site are the African Jacana, the Grey-Headed Sparrow, Variable Sunbird, Yellow-fronted Canary, Little Bee-eater (see picture above), Rock Swallow and White-headed Sawwing.

In addition, native fauna includes reptiles, snakes, lizards, hares, jackals and fishes. Under the Nile Basin Initiative, the Nyabugogo and Nyabarongo wetlands have been selected as wetlands of great importance, which need particular protection[2]. Nearby the project area a number of domestic animals such goats, sheep and cattle are kept.

The population in the area is increasingly becoming a mixture of indigenous and urban people. The native population traditionally keeps poultry, pigs and rabbits at small scales for additional income generation.

Figure 9 – Clarias Garienpinus, common fish in Nyabugogo River

From a regional perspective, the ecology of the Nyabugogo river and wetlands is important, since it forms the upstream tributary of the Nyabarongo/Akagera River, which drains to the Akagera National Park. This park is rich in biodiversity, including over 900 species of plants, 530 species of birds, 90 mammals, nine species of amphibians, 23 species of reptiles and over 54 species of birds, representing the highest diversity recorded in Rwanda.

Various other species of fish are also found in Nyabarongo River downstream of Kigali as well as in scattered small lakes, which supply fish to the population of Kigali City and other regions of the country. Fishing in Nyabugogo River becoming less and less important due to the high pollution loads. However, after high rainfall period small fish, especially the *Clarias gariepinus*, (see picture above) is caught from the river for domestic consumption. Finally, in the nearby Nyabarongo river, close to the outflow of the Nyabugogo River, a large of number of crocodiles and hippopotamuses are found, which are both considered endangered and protected species[3].

[2] Nile Basin Initiative 2013. Wetland Management Strategy. ISBN: 978-9970-444-08-6, Entebbe, Uganda.
[3] USAID, 2014. Rwanda Environmental Threats and Opportunities Assessment" (ETOA). prepared by ECODIT LLC.

3.2.4 Climate and Weather Conditions

Weather Conditions

Kigali has a typical tropical climate, which is characterized by high annual rainfall of up to 1400 mm per annum. The area experienced a bimodal rainfall occurring mostly during the period from March to May and September to November (see figure below). High intensity thunderstorms/showers that are generally short lived and cause often flooding in the Nyabugogo wetlands. During the rainy months from March to May and during September and November rainfall may reach 300mm / month. During the dry months from Mid-January to March and from June to August it is about 50mm per month.

The study area experiences seasonal temperature variations with highest temperatures during the dry season and the coldest period occurs during the rainy season. The average monthly maximum temperature ranges between 22-27^{o}C while the average minimum temperature ranges between 17-20^{o}C. The average sunshine is about 1675 hours per year with high sunshine in the dry season and smaller amounts of rainfall in the rainy season (SGI, 2009). The hydrological year starts in September with the short rainy season known in Kinyarwanda language as *"umuhindo"*, coinciding with the start of the agricultural season and ends in mid-January with harvesting subsistence's crops. During this period, rainfall intensity varies from lower to higher and sometimes causing landslides in high risk zones.

From mid-January to earlier of March a short dry season (*"urugaryi")* with low to moderate sunshine is important for drying harvested crops in January and serves as transition to the rainy season in March-June commonly known as *"Itumba".* High rainfall and thunderstorms, often causing landslides and flooding occur in many parts of the country. Most of flooding events in Nyabugogo area occurred in this season. Then from mid- June to August, a dry season in the whole country territory occurs, except in some regions experiencing orographic precipitations such North-West (Volcanoe Park) and South West (Nyungwe National Park).

Analysis of time series data set of rainfall and temperature recorded at Kanombe International Airport in Kigali (latitude 01^{0}58', longitude 030^{0}08, altitude 1,490 m above sea level) from 1964 to 2005 show an increase in average annual temperature (see below) and fluctuation in cumulative annual rainfall. There are 15 rainfall stations in the Nyabugogo catchment. Since 1994 most of them are not recording data and therefore this report uses data provided by the Kanombe International Airport weather station[4].

Lower rainfall values observed in 1993-1994 should be questioned, and seem more related to the lack of sufficient rainfall data as the country was in the period of high insecurity and most of rainfall gauges were not functioning or were vandalized. Kigali is characterized by high evaporation rate estimated to 1200 mm/year, exceeding the annual rainfall and monthly ranging between 70 and 150 mm in May and August respectively. The relative humidity in Kigali varies between 61% in August and 85 % in April.

[4] Munyaneza O., Nzeyimana Y.K and Wali U.G. 2013. Hydraulic Structures Design for Flood Control in the Nyabugogo Wetland, Rwanda. Nile Basin Water Science & Engineering Journal, Vol.6, Issue 2, 2013

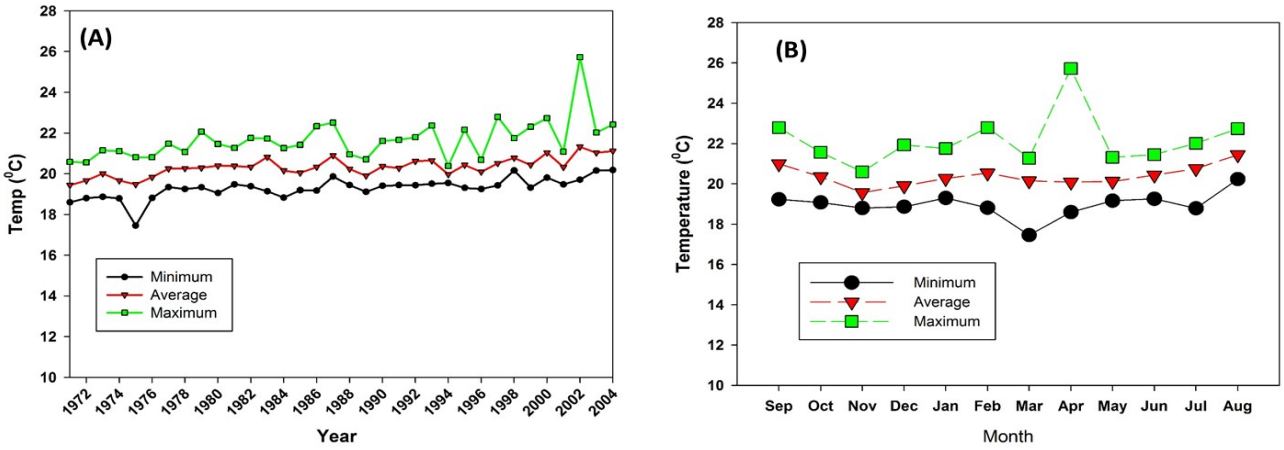


Figure 10 – Seasonal Temperatures in Kigali City (1964-2005) at Airport of Kanombe

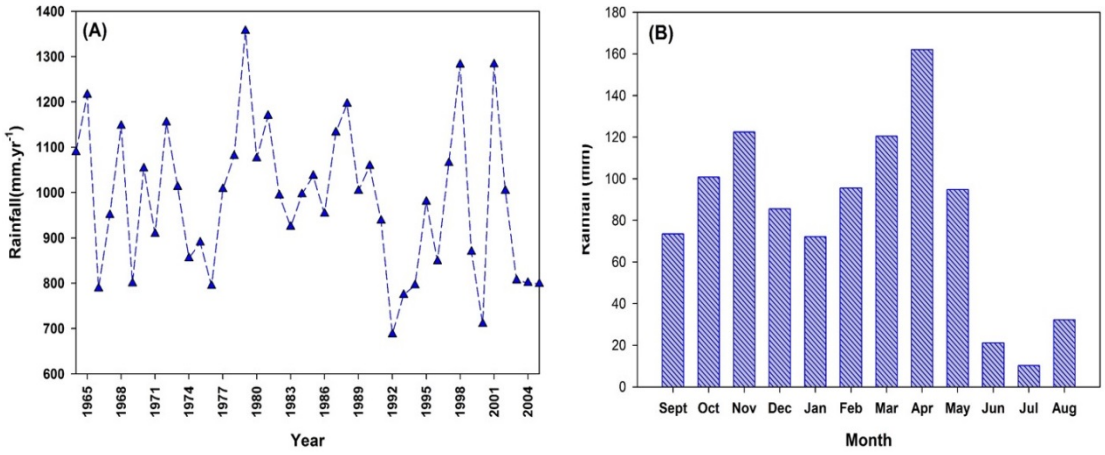


Figure 11 – Annual and Monthly Rainfall measured at Kanombe International Airport (1964-2005)

Over the course of the year typical wind speeds at the Kanombe International Airport vary from 0 m/s to 6 m/s (calm to moderate breeze), rarely exceeding 111 m/s (hurricane). The highest average wind speed of 3 m/s (light breeze) occurs around early February 5, at which time the average daily maximum wind speed is 5 m/s (gentle breeze).

The lowest average wind speed of 2 m/s (light breeze) occurs around the end of February, at which time the average daily maximum wind speed is 5 m/s (gentle breeze). The wind comes most often from the south (12% of the time) and least often from the south west (4% of the time).

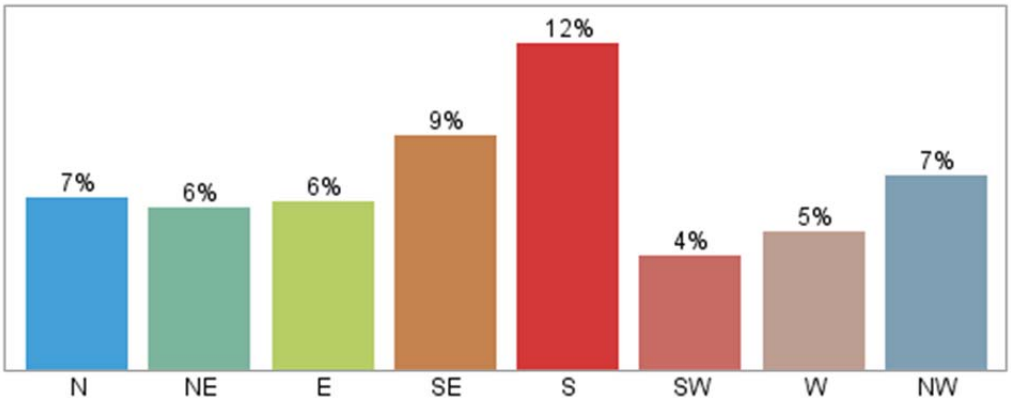


Figure 12 – Timely Distribution of Wind directions at Kanombe International Airport (Kigali)

Above figure provides an overview of the relative duration of the wind blowing from the various directions over the entire year. These values do not sum up to 100%, because the wind direction is undefined when the wind speed is zero (ref. weatherspark.com)

No specific wind values are available at the site of the proposed Kigali WWTP. However, due to the east / west topographic characteristics around the site, it may be expected that west- and east-ward wind directions here will occur somewhat more frequently than at Kanombe International Airport.

In terms of risks for spreading of odor generated by the WWTP, this means that no dominant spreading direction may be identified, and that risks for odor nuisance is about the same in all directions.

Climate Change

Climate change will impact Rwanda as well, particularly in terms of drifting the weather conditions more to the extremes, both in terms of drought periods as well as rainfall intensities and related flooding risks. A 2009 Economics of Climate Change in Rwanda study found that climate change is likely to cost 1% of GDP per year by 2030. Climate change will increasingly influence agricultural production, energy generation, water resource management and public health.

In terms of impacts on the Kigali Wastewater Project, this means the following:

1. The success of this project will also depend on provision of sufficient water to the connected sewer areas in Kigali, both during the current phase as well as when the connected areas will be expanded. Climate change will increase the challenge for the authorities to find sufficient water resources in the years ahead
2. Flooding risks are likely to become bigger, also in the Nyabugogo River. This implies that the need for taking adequate flood protection measures on the WWTP site is likely to increase over time.

3.2.5 Public Health

According to the Médecins Sans Frontières and the World Health Organisation, the health and livelihoods of people in Rwanda have greatly improved over the last decade. After the 1994 genocide against this Tutsi, the healthcare system in Rwanda collapsed and epidemics of infectious diseases were devastating the country. Today, however, the growing economy has led to significant improvements of the healthcare system.

The World Bank indicates that life expectancy at birth has dramatically increased for both men and women, with life expectancy at birth for females in 2013 at 66 years of age compared to 53 years of age in 2003. Life expectancy at birth for males in 2013 was 62 years of age compared to 51 years of age in 2003. This supports the improved efforts in the healthcare system. The WHO[i] also reports a dramatic decrease in child mortality, with the decrease in maternal mortality; from 1,400 (per 100,000) live births in 1990 to 320 in 2013.

At the country level, the top three causes of child mortality are: respiratory infections, trauma & burns and diarrhea (see below figure). Septicemia represents 16% of causes and 23% of deceased children had clinical features of malnutrition. Malaria represents 19% of cause (see figure below).

The number of HIV/ AIDS cases in the city of Kigali is still relatively high, with a prevalence of 7.3% (per 1,000 people). Based on the World Bank[ii] data, the net HIV/AIDS cases at the National level make 2.9%. The Ministry of Health with UNAIDS and Rwanda Biomedical Centre published a report[iii] in 2014 that states that HIV prevalence in Rwanda has remained stable since 2005 until 2010 at around 3% in people between 15 and 49 years of age. The World Bank puts HIV/AIDS prevalence amongst women aged 15-24 at 1.2% in 2013, which is significantly higher than men at 0.9%, with the same situation at the Nyarugenge District level.

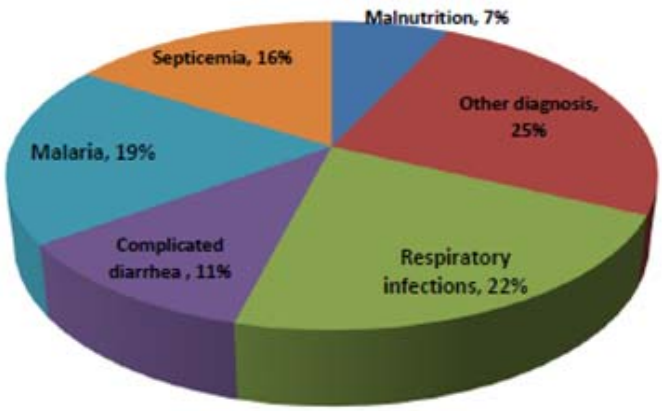


Figure 13 – Causes of Child Deaths in Rwanda[iv]

According to the National Household Survey (2012), 0.2% of children and 0.1% of women reported cases of Malaria in Kigali City; cases in men were not reported during the survey. However, the data collected by Nyarugenge District in 2014 and 2015 from the health centers in the district show another picture. It should be recognized that these data may be influenced by people coming from outside Nyarugenge district for medical treatment, so the numbers do not reflect only the health situation of the concerned sector.

In Kigali sector (where the WWTP will be constructed) 34% of the people going to the health centre have malaria. The reason may be that a large area of this sector is wetland. This is the highest percentage of the five sectors impacted by the wastewater project, with lower percentages in the sectors Muhima (7%) and Nyarugenge (9%), where the sewer network will be constructed.

In Kigali City in 2014/2015 81.4% of the people slept under an insecticide-treated net (ITN). However, this percentage appears to be lower for lower income households[v]. The Ministry of Health distributed in the past years millions of mosquito nets to households and the prevalence of malaria was decreasing. However, in recent years the prevalence is increasing again, especially in areas near wetlands. The Ministry is also engaged in Indoor Resident Spraying (IRS) campaigns.

Diarrhea appears to be more common among children, with the survey reporting that 11.4% of children had had diarrhea within a two-week period when the survey was conducted. At the Nyarugenge District level, 10.1% of children under five have diarrhea[vi].

The data of the sectors of Nyarugenge district, where the project is located, show that water-borne diseases gastritis and duodenitis, endameba and diarrhea have similar occurrence among the sectors, between 3 and 7% of the patients registered at the health centers.

Respiratory infections are more common in Kigali, with 4.6% of children reported as having symptoms, the second highest occurrence rate at the country level. Respiratory infections (like a cold, pneumonia and bronchitis) are the most reported disease in Nyarugenge District with the people going to the health centers and is similar in the five districts (around 48%).

Table 3 – Key Health Indicators in the Project Area

Sectors	KIGALI		KIMISAGARA		GITEGA		MUHIMA		NYARUGENGE	
Component project	**WWTP and trunk main**		**small part trunk main**		**Downstream of network**		**Sewer network (partly)**		**Sewer network**	
2014 / 2015	Number	%	Number	%	Number	%	Number	%	Number	%
Total Health centre registrations	9.287	100%	19.701	100%	9.786	100%	22.428	100%	19.715	100%
Top 10 prevalence diseases										
Respiratory infections	4.009	43%	10.585	54%	4.723	48%	10.085	45%	9.199	47%
Malaria confirmed	3.188	34%	1.341	7%	1.768	18%	1.038	5%	1.734	9%
Urinary Tract Infections	370	4%	788	4%	322	3%	881	4%	-	
Gastritis and duodenitis	341	4%	1.107	6%	502	5%	1.148	5%	1.129	6%
Entamoeba	308	3%	590	3%	-		874	4%	-	
Diarrhea no dehydration	266	3%	740	4%	-		1.638	7%	874	4%
Physical traumas other than fractures	222	2%	866	4%	643	7%	-		1.144	6%
Gynecological problems	195	2%	2.337	12%	772	8%	3.661	16%	1.865	9%
HIV infection probable or suspected	195	2%					-		-	
Teeth and gum Infections	193	2%			246	3%	1.022	5%	-	
Skin Infections			690	4%	296	3%	-		2.052	10%
Discharge Vaginal			657	3%	252	3%	-		651	3%
Eye problem					262	3%	995	4%	-	
absesses							1.086	5%	-	
Workplace injuries									1.067	5%

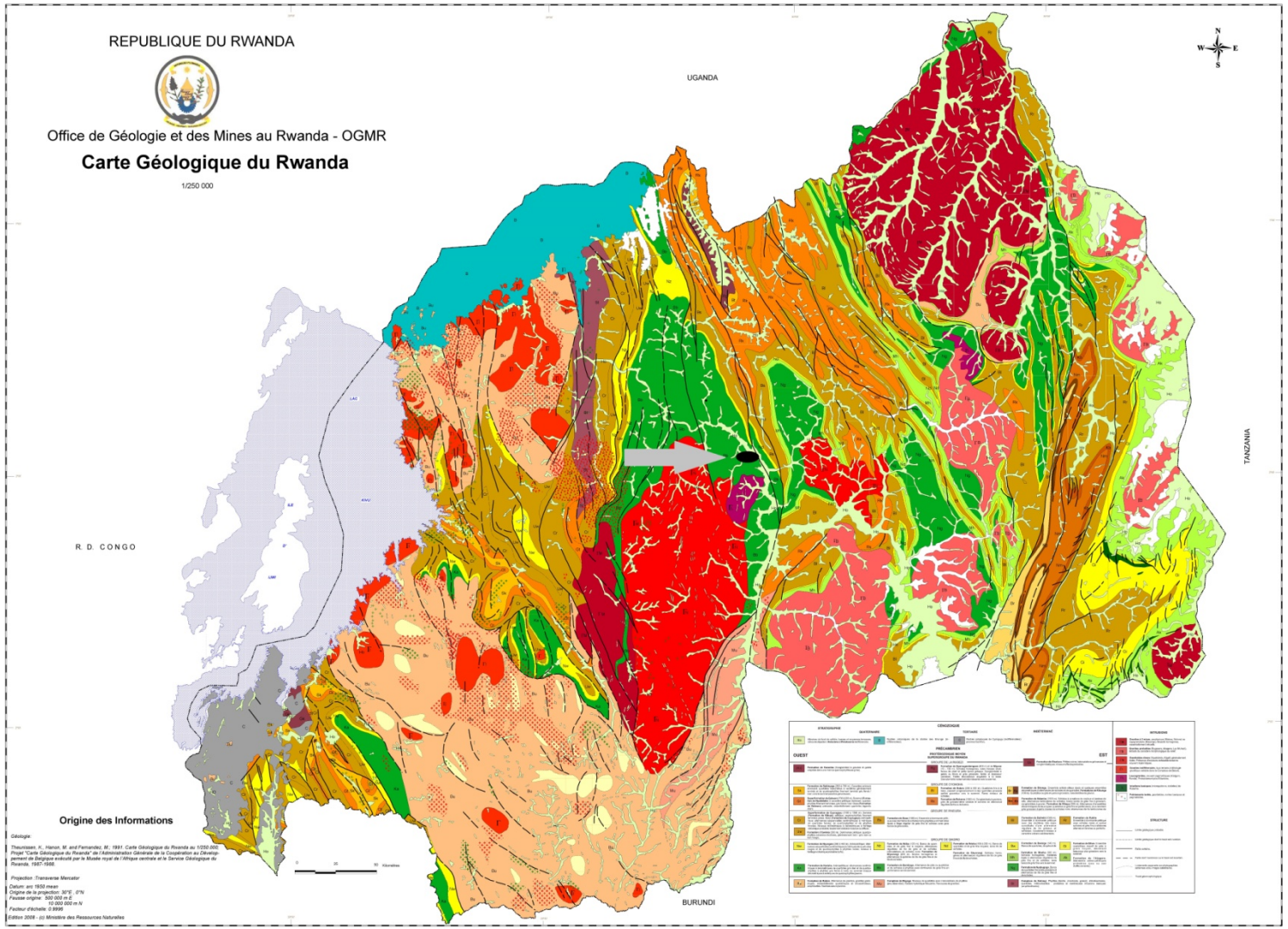
Another notable figure is the relatively high percentage of workspace injuries (5%) in Nyarugenge sector. This can probably be explained by the intense construction activities in the area, resulting in health and safety incidents. Above table provides an overview of the key health indicators in the project area.

No specific information is available that links the current sanitation problems and river water pollution to public to public health data. However, contact with the polluted river surface water may lead to exposure to bacteria, viruses, fungi and parasites such as worms and protozoan. This increases risks for stomach and intestines related diseases, as well as skin, eye, and respiratory infections. The HIV virus in not passed on through wastewater. The overall objective of the Kigali Wastewater Project is clearly to reduce these risks, and to improve overall public health conditions.

3.2.6 Geology and Soil Type

Below map shows the geology of Rwanda. The area of the Kigali Wastewater Project is indicated with the grey arrow. This area, north of the Mounts Jali and Gisozi is dominated by quartzite and quartzite-conglomerate rocks. The geology in and around Kigali is dominated by granitic rocks with schists predominance, silt stones and sand stones. From Muhima to Giticyinyoni and other areas of Kigali, alternative metarmorphic rocks composed of schists and quartzite are found (SGI, 2009).

The soils of Gitikinyoni at the WWTP site are characterized by lateritic soils, as witnessed at the abandoned recent laterite mining site, directly south of the site. The soil is rich in iron and aluminium. The drainage area of Nyabugogo and Nyaborongo rivers are mostly predominated by alluvial and organic soils.


REPUBLIQUE DU RWANDA
Office de Géologie et des Mines au Rwanda - OGMR
Carte Géologique du Rwanda
1/250 000
UGANDA
TANZANIA
R. D. CONGO
BURUNDI
Origine des Informations

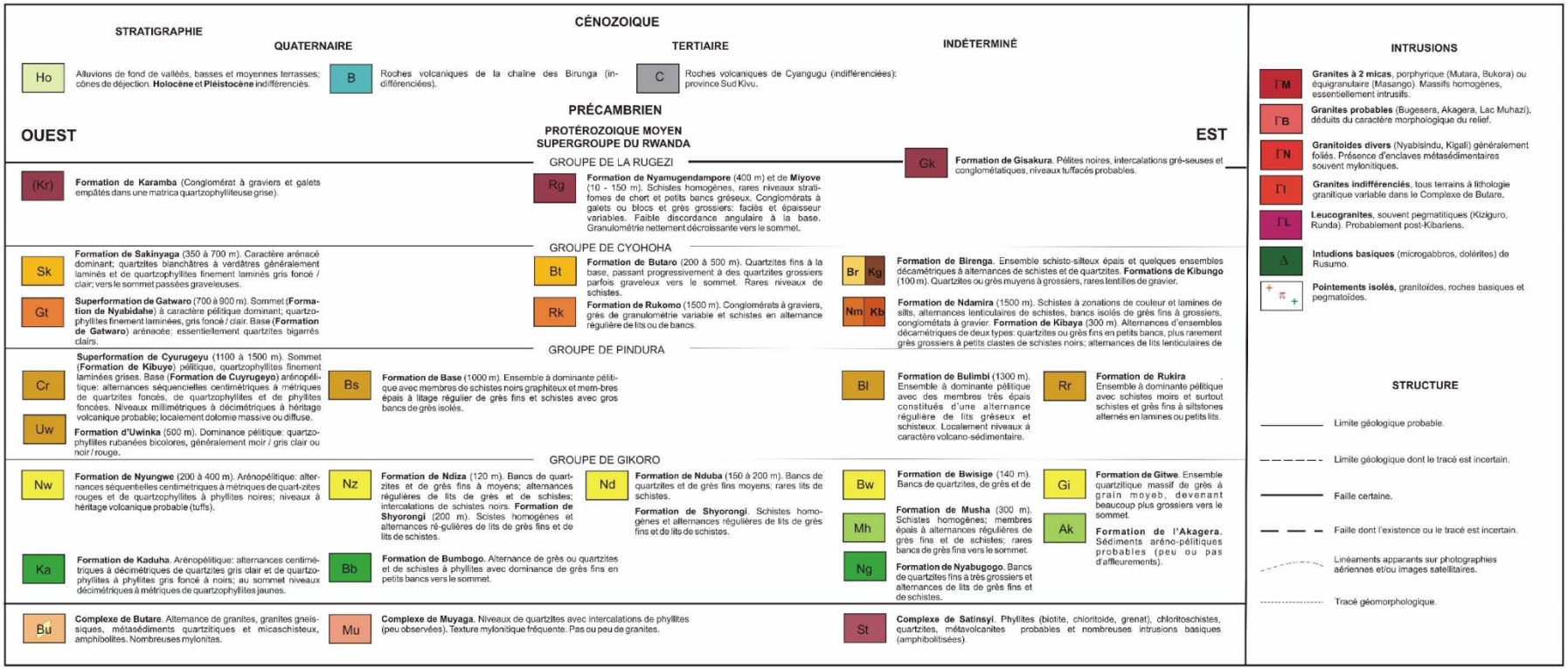


Figure 14 - Geological Map of Rwanda

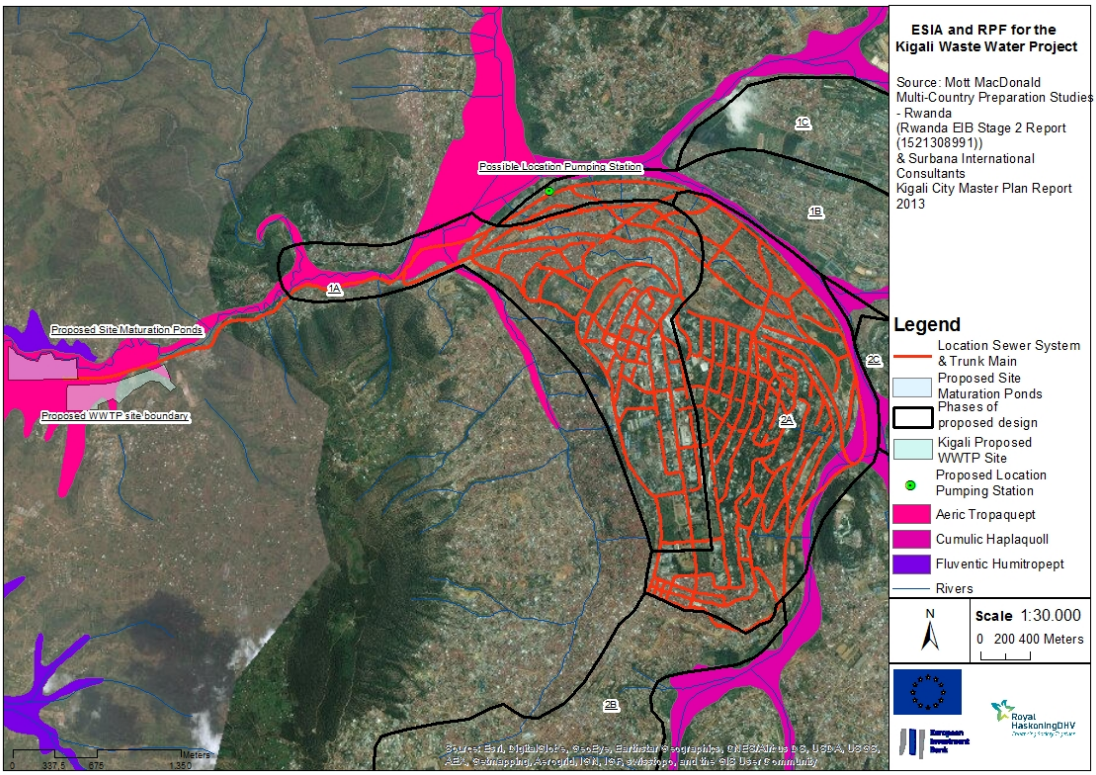


Figure 15 – Soil Types in the Project Area

According to the US soil classsification the project area contains four classes of soils with following characteristics:

1. **Ultisols** as a resultant of mineral alteration and the dominance of iron and aluminum oxides. The presence of the iron oxides causes the A horizon of these soils to be stained red. Leaching causes these soils to have low quantities of base cations.
2. **Oxisols** are characteristics of tropical and subtropical latitudes that experience high precipitation and temperature. The profiles of oxisols contain mixtures of quartz, kaolin clay, iron and aluminum oxides, and organic matter. This type of soil has not clearly marked horizons. The abundance of iron and aluminum oxides found in these soils results from strong chemical weathering and heavy leaching. Many oxisols contain laterite layers because of a seasonally fluctuating water table.
3. **Inceptisols** are young soils that are more developed than entisols, relatively recent deposits of stream alluvium.. This type of soil is dominant in the drainage zone of Nyabugogo wetland and at the location of maturation ponds and in small part of WwTP area where rice is grown
4. **Entsols** are unaltered soils that do not show any profile development other than an A horizon. This soil is found to the mountain surrounding the WWTP site having [5] (SGI, 2009).

[5] SGI Ingénierie SA, 2009. Actualisation du plan directeur d'assainissement des eaux pluviales et eaux usées de la Ville de Kigali. Etude d'impact environnemental et social (EIES) de la tranche prioritaire (version définitive).

3.2.7 Air quality

The current status of air pollution in Rwanda is not alarming, but there are indications of air quality deterioration from 1990 to 2012. Recent air pollution data generated by the UNEP-GEMS Water Program, shows the Rwandese population weighted exposure to particulate matter since the year 2000. Source of data: Boys et al. (2014).

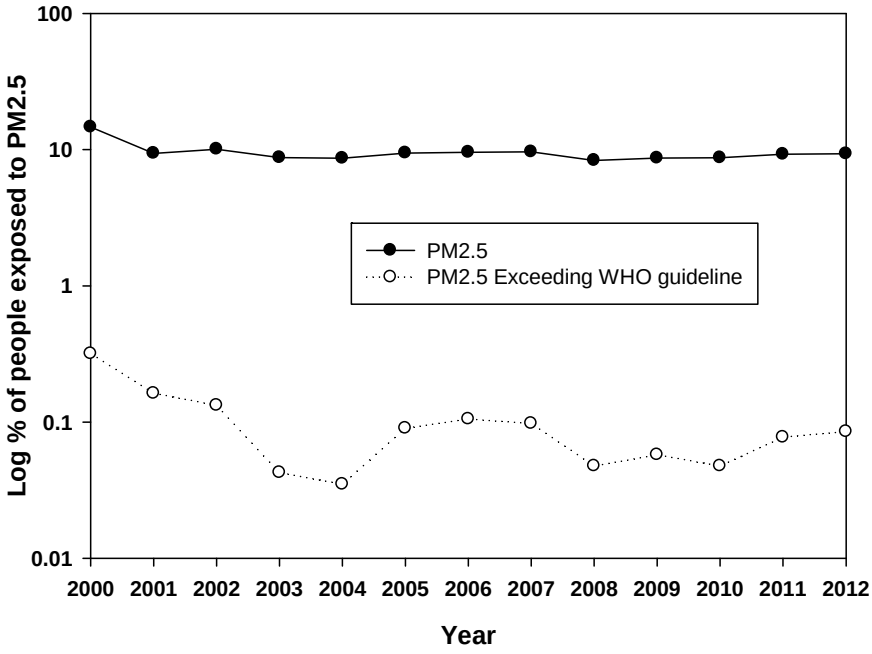


Figure 16 - Percentage of people exposed to particulate matter in Rwanda

Major causes of air pollution in Kigali are:

- major industries and factories in Gikondo (a sub-catchment of Nyabugogo) with inadequate pollution control measures
- Rapid urbanization with increase in motorized used cars in the city
- Use of fossil fuel, in thermal power plants, generating almost 50% of the electricity production in the country
- Cement factories and steel mills[6](Nsengimana et al., 2011)
- High rate of the use of charcoal and firewoods for domestic cooking. Due to the relative high price of electricity provided by the Rwanda Energy Group (REG) and relative low income levels about 60% of the Kigali population use firewood as a source of energy for cooking
- Use of old fashioned cook stoves is common in the city

Even though few investigations on air pollution of Kigali City are available in the literature, researchers have showed that vehicle emissions are the major sources of pollution. For example Henninger[7] (2009) measured particle matters in three sites of Kigali City including (Kacyiru and City Center in Gitega) found high values, ranging between 175-900 $\mu g.m^{-3}$ and 1400-2400 $\mu g.m^{-3}$ in the morning and evening respectively. Considering that the World Health Organization (WHO) guideline for short time exposure to PM_{10} is 50 $\mu g.m^{-3}$, this puts Kigali City's population at some risk for inhalation of air pollutants, which may

[6] Nsengimana H., J.P Bizimana and Sezirahiga Y.2011. A Study on Air Pollution in Rwanda with Reference to Kigali City and Vehicular Emissions. The National University of Rwanda Consultancy Bureau (NUR-CB), Butare Rwanda.

[7] Henninger, S. (2009) Urban Climate and Air Pollution in Kigali, Rwanda. The seventh International Conference on Urban Climate, 29June-3July 2009, Yokohama, Japan

cause respiratory diseases. This means that the population of Kigali may sometimes be exposed to elevated concentrations of particulate matter during their stay outdoor, particularly in the city business center and near junctions of paved roads.

An analysis of wind direction data from Kigali International Airport of Kanombe shows an annual trend from North and North-East to the South. As air pollutants transportation and dispersion are influenced by wind direction and, considering the topography of Kigali, the sewer collection areas project are likely subject to relative high level of air pollution. The WWTP and maturation ponds are located west of the city and are less influenced by the urban air pollution. However, they are located close to a cement factory, the Skol breweries as well as some garages (petrol stations), near the junction of the two major highways. This may exposes the area to air pollution from congested traffic.

3.2.8 Traffic and transport network

The proposed sewer network covers the Nyarugenge and Muhima areas of the City of Kigali, a trunk main starting from the Nyabugogo International Bus Terminals along the Kigali-Muhanga highway, and the wastewater treatment plant near the bifurcation of the Kigali-Musanze highway and the Kigali-Muhanga highway (See picture below).

The Kigali-Muhanga highway from the Nyabugogo Bus Terminal to the junction with the highway to Musange is a main thoroughfare used intensively by cars, motorcycles, busses, trucks, bicycles and pedestrians entering and leaving Kigali. Peak traffic causing traffic jams regularly occur during working days mainly between 7:00 and 8:00 AM in the morning and in the afternoon between 4:00-6:00 PM.. Various international bus companies depart from here to neighbouring countries such as Burundi, Uganda, DRC, Kenya and Tanzania. This bus terminal also connects the City of Kigali with its districts and the rest of the country. The major road networks are presented below.

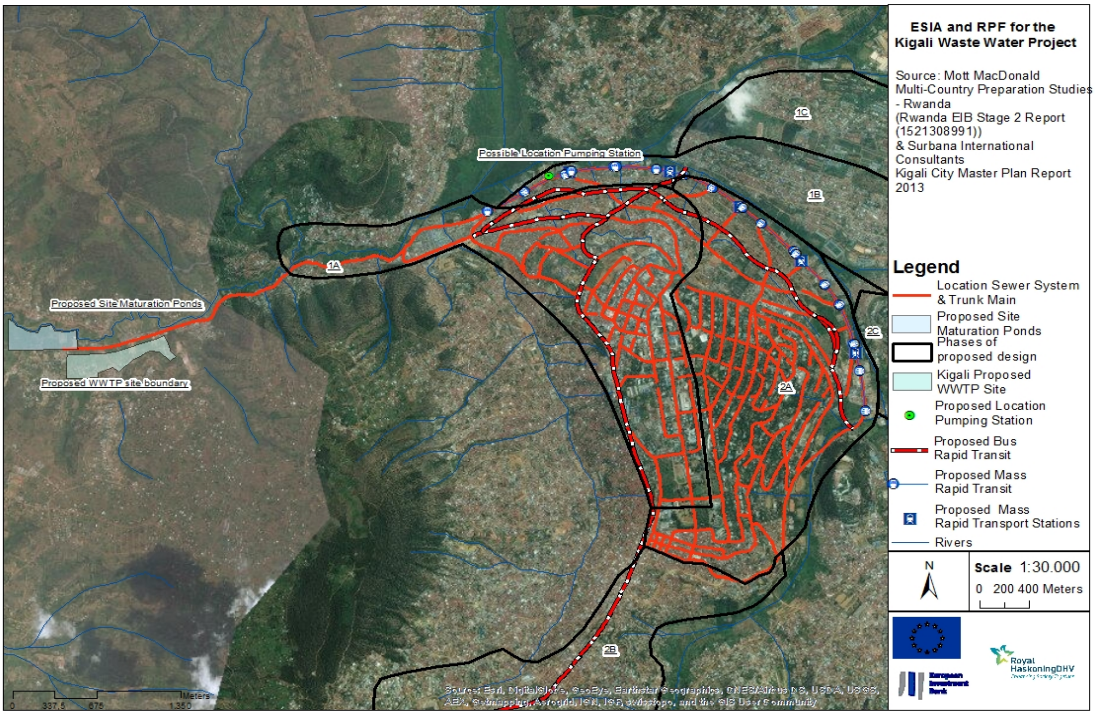


Figure 17 – Major Bus Transit and Transportation Stations in the Project Area

Specifically during the rush hours the Kigali-Muhanga highway is often congested. Although specific travel density information is not available, we estimate a traffic intensity of about 1500 – 2000 passages per hour during rush hours, both ways, coming down to less than 500 passages per hour for the remainder of the day.

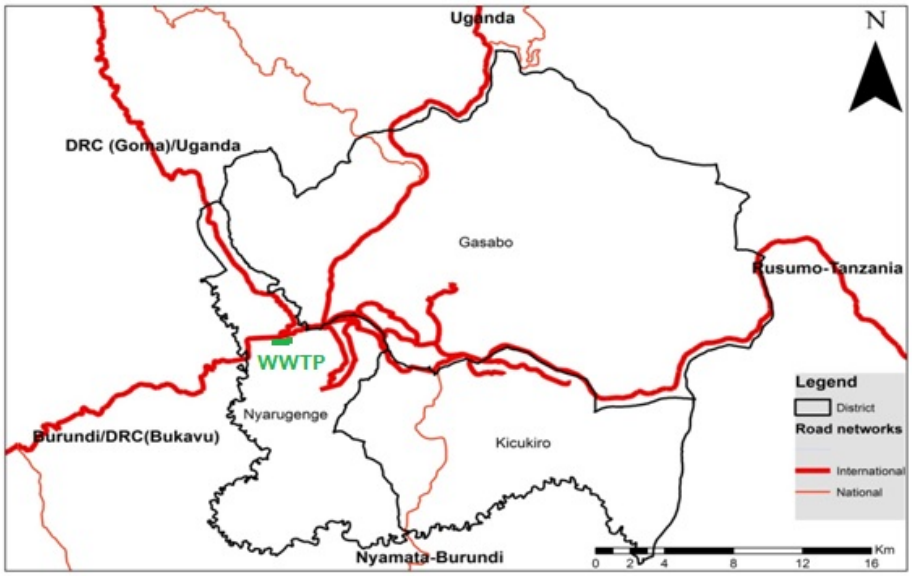


Figure 18 - Road Network connecting the City of Kigali

3.2.9 Land use and land cover changes

Kigali City contains urban built-up areas, including residential buildings, offices; lower cost housing, paved and unpaved roads, paved public spaces, industrial areas, parking and bus stations and a small percentage of water bodies. The surrounding of Kigali City is dominated by agricultural, including forest plantations and cultivated areas, covering over 50% of the province area. See below maps.

Residential areas are concentrated on the ridge of road networks and on top of mountains and hills of the CoK. However after the adoption of the CoK/districts master plans, a decrease in informal resettlements is apparent in the city centre as a result of master plans implementations, particularly in the foreseen sewer network areas 1A and 2A.

Informal and formal resettlements are scattered around the Nyabugogo wetland, near the project area. Specifically south and south east of the WWTP, various new housing projects are underway, also enabling the urban population to acquire land and built their houses. The area along the Kigali-Muhanga highway and the proposed trunk main is dominated by commercial and residential houses.

Subsistence agricultural activities for vegetables are practiced throughout the food plains of the Nyabugogo River near Gitikinyoni. Some bamboo plantations on the ridge of the Nyabugogo River near the WWTP site have been seen, as well as some banana plantations. Mount Kigali, the highest mountain in Kigali with an elevation of 1850 m above sea level, is located directly south east of the WWTP site and is covered mainly by forestry plantations.

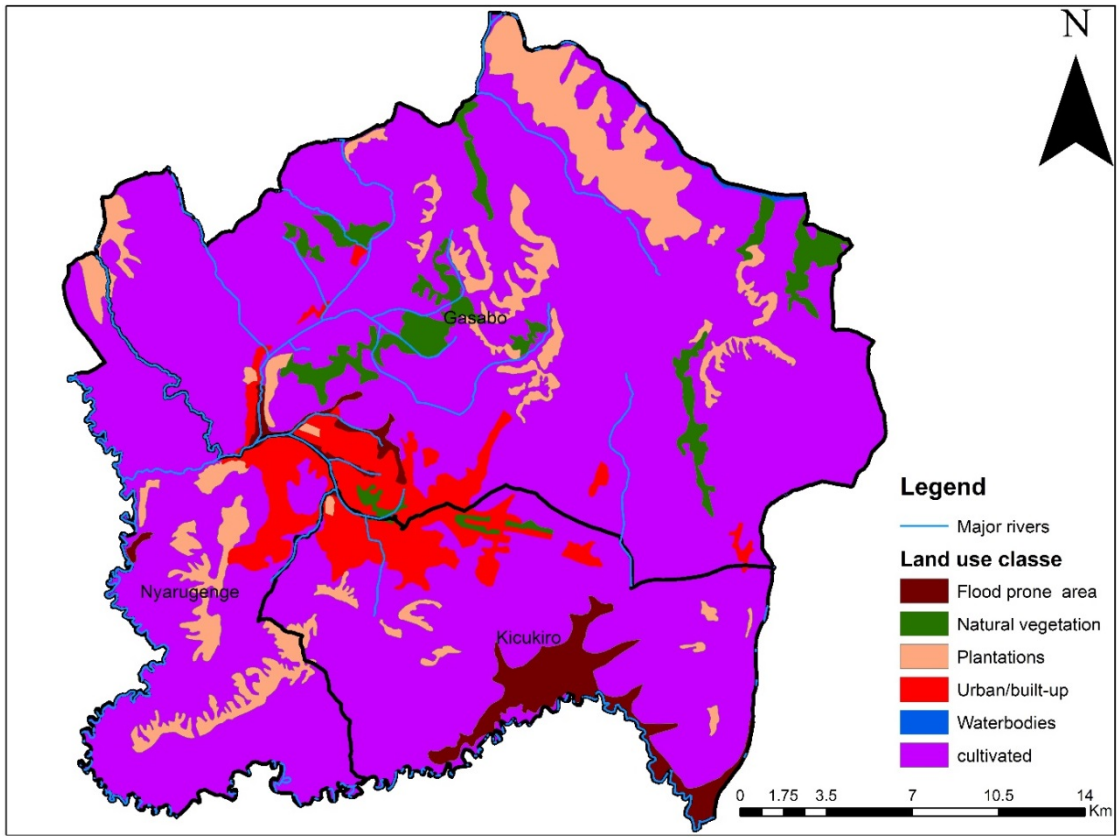


Figure 19 – Land Use in and around the City of Kigali

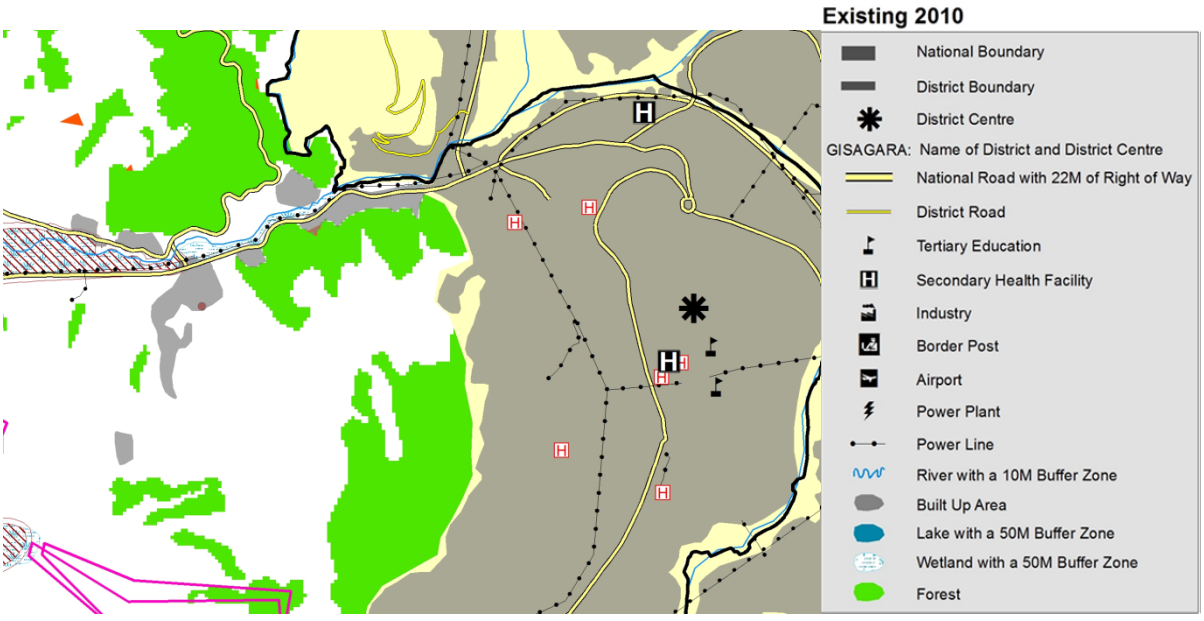


Figure 20 – Land Use in the Project Area (2010)

The lands downstream of the project areas are dominated by agricultural activities, mainly sugarcane plantations owned by the Kabuye Sugar Cane Processing Factory. The area is also used by grazing cattle, which is strongly regulated by Rwandese country laws.

Figure 21 – Aerial Photograph of proposed WWTP and Maturation Pond

A built up area specifically relevant in this ESIA is located directly south of the proposed WWTP, as can be seen on above aerial photo. This area depends on the unpaved access road leading north through the proposed WWTP area to the main road. According to the 2013 Kigali City Master Plan, this area will continue to have a residential function, as can be seen in below section of this Master Plan.

Other land marks in the vicinity of the WWTP are:

- A cement factory located about 500 m from the proposed maturation ponds
- Petrol stations and car garages along the main road
- Skol Breweries located in the Kanyinya Sector towards the west
- A proposed permanent sanitary landfill of Kigali, about 4 km south east of the WWTP site

Further away from the project area a regional hydroelectricity power plant is being constructed by Rwanda, Burundi and Tanzania at the Rusumo Water Falls on the Akagera River.

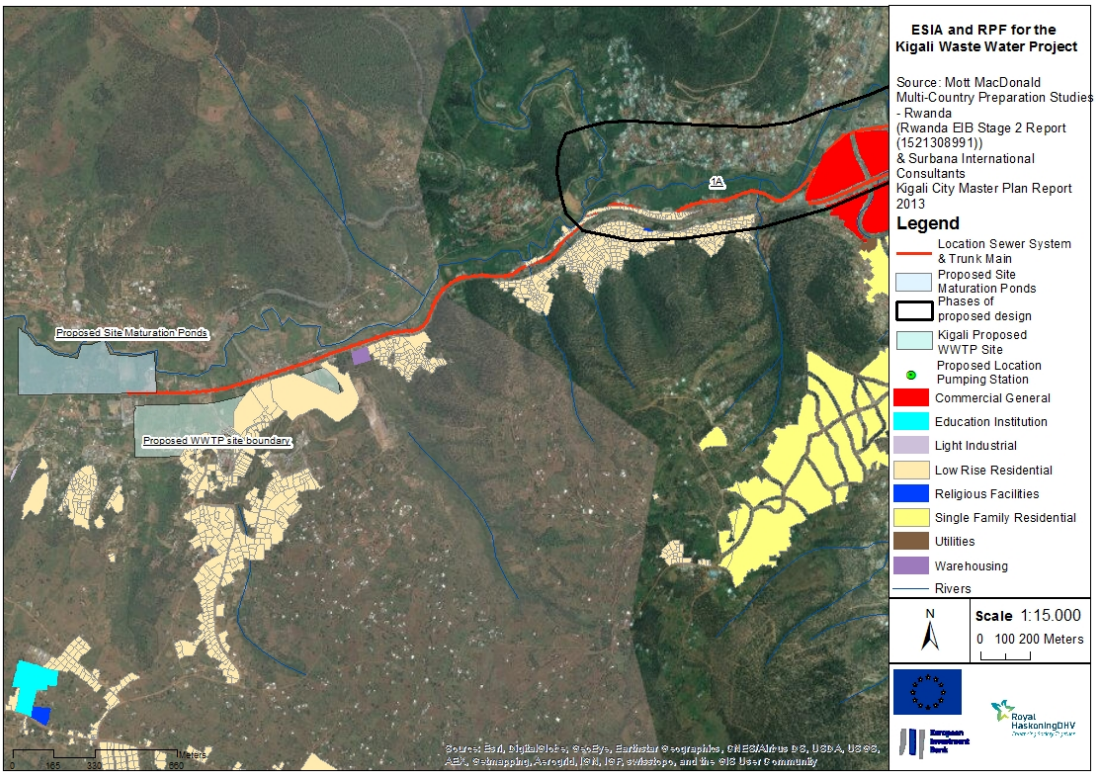


Figure 22 – Planned Built up areas around Trunk Main and WWTP

3.2.10 Hydrology and Flooding

The study area is located at the outlet of Nyabugogo Catchment. The main river crossing Kigali City is the Nyabugogo River, originating from Lake Muhazi. The main tributaries of the Nyabugogo River are located in the Gasabo District and a few in the Kicukiro and Nyarugenge Districts.

The Rwampara stream forms the boundary between the Nyarugenge and Kicukiro districts. It joins the Mugatenga stream from the Kicukiro District, and the Kinamba and Rwintare streams from the Gasabo district before flowing into the Nyabugogo River near the Nyabugogo international bus parking. Near the Nyabugogo bus terminal, the Mpazi stream separates the Kimisigara and Muhima sectors and confluences with the Nyabugogo River near the bridge.

Downstream of the proposed WWTP, the Yanze stream is the main the source of raw water for the Kimisagara Water Treatment Plant of WASAC LTD, flowing into Nyabugogo River near the Kiruhura market.

Before flowing into the Nyabarongo River, the Nyabugogo River becomes the boundary between the Kanyinya and Kigali sectors, both part of the Nyarugenge District. The trunk main will pass by the flood zone of the Nyabugogo River from the Nyabugogo bus terminal to Giticyinyoni, where the WWTP will be constructed. The maturation ponds are located in the flood prone area of the Nyabugogo and Nyabarongo Rivers.

Further downstream, the Nyabugogo River flows into the Nyabarongo River near the Nzove Water Works. The Nyabarongo continues to flow in the direction of South Eastern part of Rwanda and joins the Ruvubu River from Burundi near Lake Rweru. Together they form the Akagera River that flows from South East, around the country toward the North, forming the border between Rwanda and Tanzania. It ends up in Lake Victoria which outflows into the River Nile.

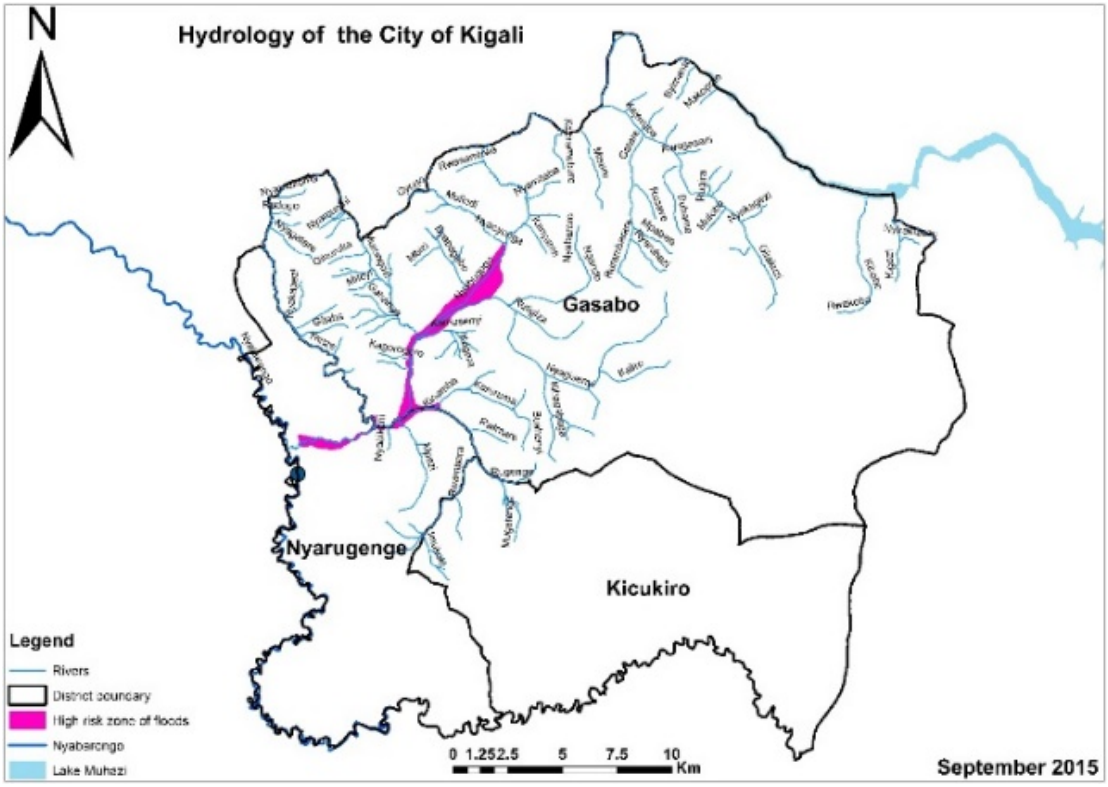


Figure 23 - Hydrological network of Nyarugenge District and Kigali City

Flooding events occur up to three times per year in the Nyabugogo wetlands and affect the wetlands along the proposed trunk main and the area of the maturation ponds. On the 23rd of February 2013 a major flood occurred in the Nyabugogo, causing loss of properties, four human lives, and disruption of business and public life. (See photo's below).

Figure 24 – Flooding Events in Kigali, Nyabugogo on 23rd Feb 2013

The zone within the project area prone to flooding, as developed by the Rwanda National Resources Authority, is presented below. It shows that flooding risks are obvious for the wetland area, as well as the western part of the WWTP.

The formal boundaries of the wetlands as established by the Rwanda Environmental Management Authority in and around the proposed WWTP site and maturation ponds are presented below.

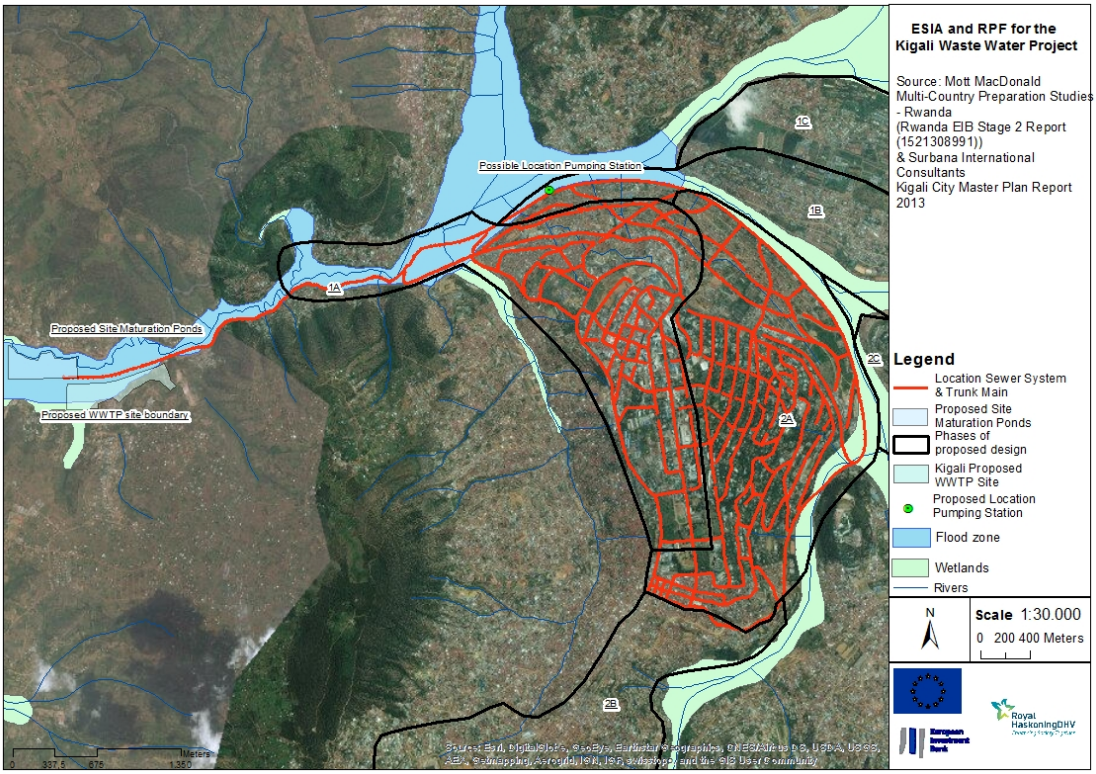


Figure 25 – Flood Zones and Wetlands in the Project Area

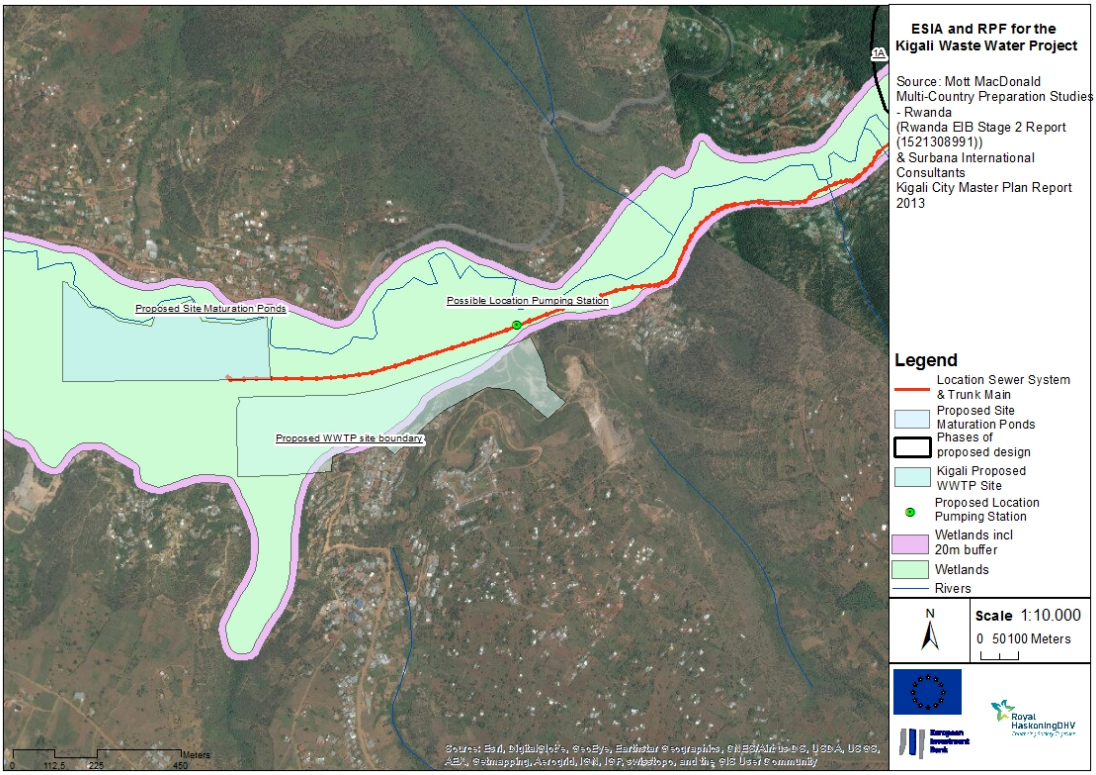


Figure 26 – Dedicated Wetlands including 20 m Buffer Zone at proposed WWTP

3.2.11 Water Quality

The current wastewater situation in Kigali poses a direct threat to the environment and the public health, as evidenced by the heavily polluted rivers flowing through the city, including the Ruganwa River from the East, the Rwanzekuma from the North. These streams are tributaries of the Nyabugogo River, which flows towards the east into the Nyabarongo River.

Levels of Biological Oxygen Demands (BOD_5) in these rives vary from 10 – 20 mg / l during the wet season and up to 25 – 35 mg / l during the dry season. As a reference, typical values for pristine rivers have BOD values below 1mg / l, while moderately polluted rivers may have BOD values in the range of 2 to 8 mg / l. High concentrations of heavy metals (cadmium, lead and chromium) and nutrients at outflow of Nyabugogo swamp were also recorded in previous studies due to industrial emissions from industries previously located in Gikondo industrial park (Sekomo et al., 2010 and Nhapi et al., 2011).

There is evidence of water quality deterioration of the Nyabugogo River and tributaries through the water quality sampling program carried out by the National University of Rwanda for the Rwanda Natural Resources Authority in the Nile and Congo basins. However, these measurements are merely snapshots during certain river flow events, and there is still a lack of accurate water quality data sets. Automatic sampling is still required at different sites with well calibrated gauging weirs. However, the current national Integrated Water Resources Management (IWRM) project within the Rwanda National Resources Authority, financed by the Netherlands Government, aims at closing some of these information gaps.

The main causes of water quality deterioration of Nyabugogo Rivers and tributaries are:

(1) The old urban fringe with poor population in the CoK concentrated in slums with inadequate or water supply and sanitation services
(2) Lack of appropriate drainage systems and the traditional pit latrines commonly used in Kigali City (and in the country)
(3) Behavioral issues of the population dumping illegally solid wastes in open channels, especially during the night
(4) Discharging of untreated wastewater from public markets, industries, food processing factories, public car parks, commercial and residential areas directly into rivers or wetlands and
(5) Poor and unsustainable water and sanitation infrastructure. However, the recent Kigali Sanitary Master Plan[8] has addressed these issues thoroughly, leading to, among others the current Kigali Wastewater Project.

[8] Dusingizumuremyi E. 2007. Impacts of Inadequate Sanitation and Unsafe Drinking Water on Human Health: A Case Study of Kigali City, the Capital of Rwanda. WHO Collaborating Centre for Health Promoting Water Management and Risk Communication, Bonn, Germany.

Table 4 - Water quality data of Nyabugogo, Nyabarongo and Yanze rivers

Water Quality		2011				2012			
		Oct-Nov 2011				Apr-May 2012			
Water variables	***Unit***	***S1***	***S2***	***S3***	***S4***	***S1***	***S2***	***S3***	***S4***
Temperature	^0C	23.8	24.6	23.6	23.5	23.3	20.8	20.7	20.1
pH		7.3	7.1	7.5	7.6	7.4	7	6.8	7.2
Turbidity	NTU	4.3	37.1	87.3	362	5.5	561	451	861
Conductivity	$\mu S.cm^{-1}$	512	54	349	161	834	70.1	224	133.5
TSS	$mg.L^{-1}$	3	27	76	187	1	281	1960	735
Total Nitrogen	$mgN.L^{-1}$	1.1	3.1	1.2	2.1	7.2	7	6.5	6.4
Total phosphorus	$mgP.L^{-1}$	0.16	0.11	0.08	0.17	0.1	0.65	1.1	0.9
COD	$mg.L^{-1}$	30.8	29.6	35.5	-	9.6	68.4	226	72.5
BOD_5	$mg.L^{-1}$	17.5	19	13	15	8.6	6.2	8.2	9.12
DO	$mg.L^{-1}$					3.4	4.9	3.4	4.1
Copper	$mg.L^{-1}$	0.02	0.02	0.02	0.02		0.05	0.11	0.16
Zinc	$mg.L^{-1}$	0.42	0.47	0.08	0.2	0.1	0.47	0.39	0.02
Iron	$mg.L^{-1}$	0.04	0.39	0.29	1.17	0.06	2.08	1.54	1.6
Manganese	$mg.L^{-1}$	0.03	0.06	0.36	0.09	0.03	0.23	0.64	0.4
Total hardness	$mg.L^{-1}CaCO_3$	150	36	116	66	132	20	38	30
Cadmium	$mg.L^{-1}$	-	-	-	-	0.03	-	-	0.05
Lead	$mg.L^{-1}$	-	-	-	-	-	-	-	-
Faecal coliforms	$CFU.100mL^{-1}$	$8x10^1$	$9x10^2$	$7x10^4$	$9x10^5$	$4x10^2$	$2x10^3$	$1x10^2$	$9x10^2$
Escherichia Coli	$CFU.100mL^{-1}$	$5x10^2$	$7x10^2$	$7x10^4$	$9x10^5$	$4x10^2$	$<1x10^0$	$4x10^1$	$5x10^2$

S1: Nyabugogo outlet of Muhazi Lake

S2: Yanze stream tributary of Nyabugogo River downstream of Nyabugogo business centre

S3: Nyabugogo at Nemba gauging station near Giticyinyoni

S4: Nyabarongo after confluence of Nyabugogo at Ruliba

Above table provides physico-chemistry water quality data from selected sites along the Nyabugogo, Nyabarongo and Yanze rivers, collected in dry and rainy seasons (RNRA, 2012a[9], and b[10])

[9] RNRA, 2012a. Water quality monitoring in Rwanda for Rwanda Natural Resources Authority (RNRA): report I(October-November 2011) submitted by the National University of Rwanda, B.P. 117 Butare Rwanda

[10] RNRA, 2012b. Water quality monitoring in Rwanda for Rwanda Natural Resources Authority (RNRA): report II(April-May 2012) submitted by the National University of Rwanda, B.P. 117 Butare Rwanda

3.2.12 Water Supply and Sanitation

Water Supply

In 1976, ELECTROGAZ was established as a public company responsible for supply of water and electricity. In 2008, ELECTROGAZ was split into two public companies: the Rwanda Electricity Corporation (RECO) and the Rwanda Water and Sanitation Corporation (RWASCO)[11]. Two years later they were merged again into the Energy, Water and Sanitation Authority (EWSA). EWSA had a mandate of providing water to Kigali City and all urban centres of Rwanda, using a total of 18 water treatment plants. Rural areas were mainly supplied by natural springs or private water supply facilities.

In 2014, EWSA was split in two private limited companies, WASAC LTD and REG, respectively dealing with energy and with water supply and sanitation. Both companies REG and WASAC LTD are supervised by the Ministry of Infrastructure[12]. Today, water supply in Kigali and in Gitikinyoni in particular is the responsibility of WASAC LTD.

According to the Water Supply and Sanitation Strategy of the Ministry of Infrastructure (MININFRA), water and sanitation services should be affordable for the entire population. WASAC LTD has the responsibility that those serves are provided to the population and the role of the central Government is to make sure that these institutions are able to comply with these responsibilities[13].

Rwanda has abundant rainfall and water resources, totaling 5 Billion m3 per year. But despite this abundancy, , Rwanda's water resources are scarcely developed. It is estimated that less than 10% of the country's surface water resources are used for water supply, with the remaining water flowing untouched through the rivers across its borders into Lake Victoria.

There has been a tremendous development in access to safe drinking water and improved sanitation services in Rwanda since 1990. However a very limited amount of wastewater has been treated so far due to lack of central treatment facilities. In 2012, 68% of the country population had access to potable water and 60% of the population had access to sanitation services, compared to 62% to drinking water and 32% to sanitation services in 1990. See below figure (source UNEP-GEMS/Water program)[7]

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[11] Law Nº 43-44/2008 of 09/09/2008 establishing Rwanda Water and Sanitation Corporation and determining its responsibilities, organization and functioning (RWASCO)

[12] Law n°97/2013 of 30/01/2014 repealing law n°43/2010 of 07/12/2010 establishing Rwanda Energy, Water and Sanitation Authority (EWSA) and determining its responsibilities, organization and functioning

[13] Ministry of Infrastructure. 2013. Water and Sanitation Sector Strategic Plan 2013/14 - 2017/18.

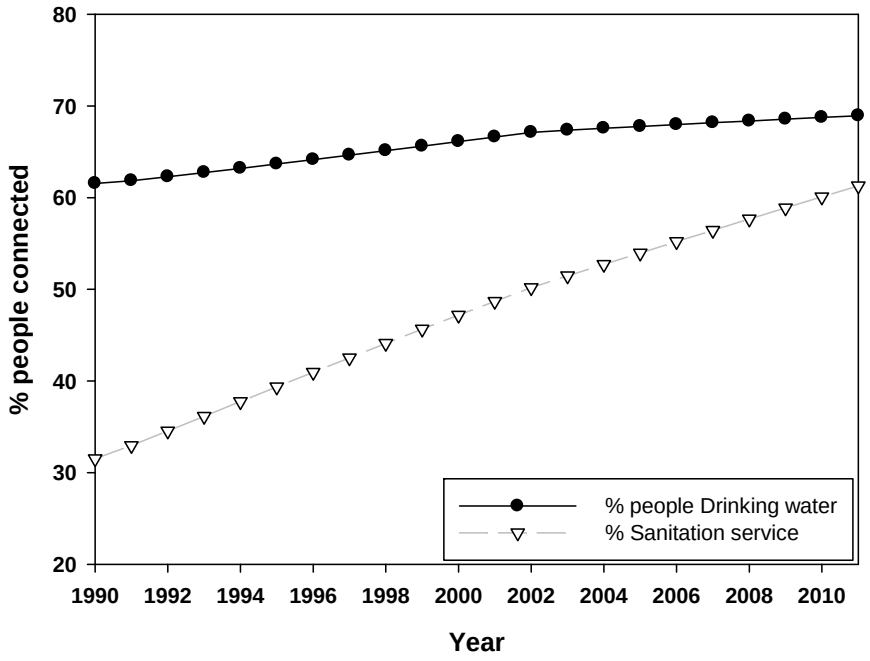

Figure 27 – Access to Drinking Water and Sanitation from 1990 – 2010

Today the City of Kigali is supplied by three water treatment plants and 7 pumping stations with an installed capacity of about 81,000m^3. This includes the well field and water treatment plant in the Nyabugogo basin, west of the current WWTP site (about 20,000 m3 / day). However, some of the plants produce less than 65% of their installed capacity, due to various technical and operational bottlenecks (case of Nzove Water Works)[14]. In 2012, access to drinking water in Rwanda was 72.1 % and 86.4% in rural and urban areas, respectively. Only 1.6% of the population of Rwanda was using flush toilets, while 92.2% uses waterless pit latrines. Formally, open defecation even in the bush is forbidden and punishable in the country[15].

Today about 65,000 m3 /.day is actually produced in existing water plants and provided to the city as piped water. Considering a projected population of 1.33 Million with a total water demand of about 100,000 m3 / day (about 70 – 100 liter per person per day) or more, this amount is still modest. Consequently, water is only provided during a limited periods throughout the week, and some of the city's poorer inhabitants still rely on local wells and tanker trucks for their daily needs.

[14] Office of Auditor General for Finances in Rwanda, 2014. Performance audit report of water production and distribution in Kigali City by EWSA for the period 01 January 2011–30 September 2013

[15] National Institute of Statistics of Rwanda (NISR), 2013. Third Integrated Household Living Conditions Survey (EICV 3 2001/2012)

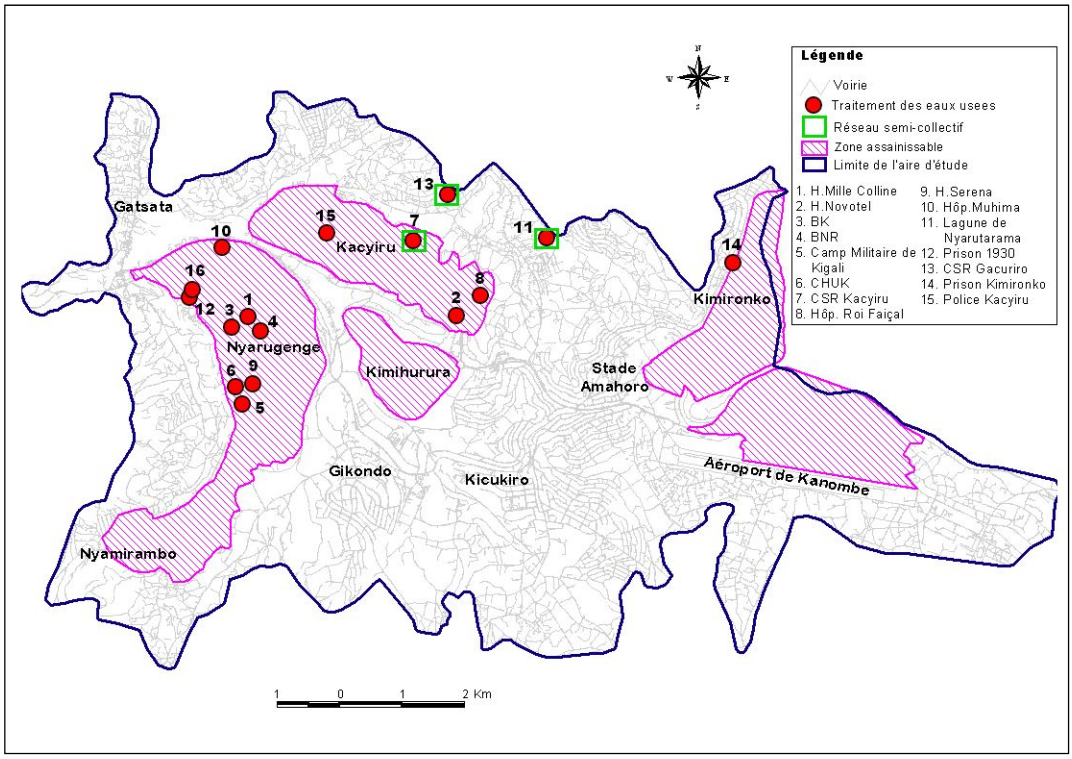

Figure 28 – Water Treatment Plants in Kigali (CGI, 2009)

However, in March 2015, the government signed a 27-year contract with a private company to invest $75 million to upgrade the Nyabugogo well fields and water treatment plant, to provide a total of 40,000 m3 / day of bulk water to the capital Kigali. In this respect, Rwanda started well of, since this is the first contract of its kind in Sub-Saharan Africa.

Until recently the water in Kigali was RWF 240 per m3 for the first five cubic meters per month and RWF 300 per m3 for any consumption between 6 and 20 m3 per month. Higher tariffs were charged for higher consumption rates. However, In November 2015 the water tariff has been increased according to below table.

Table 5 - Water Tariff in the CoK (WASAC LTD, per 2015)

Consumption	Water Tariff in RFR per m3 excluding VAT (18%)
At Public Water Kiosk	323
0- 5 m^3	323
6 -20m^3	331
21-50m^3	413
51-100m^3	736
>101 m^3	847
Industries	736

Sanitation

In terms of sanitation, the City of Kigali does not have a centralized wastewater collection and treatment system. Individual household wastewater collection systems are used by 95% of the CoK population and include simple or aerated pit latrines and public latrines found in public areas, like car parking stations and in public markets

Some new housing projects, hotels, hospitals and major offices have built their own small and decentralized wastewater collection and treatment systems, such as the Prison, the Caisse Social (Kacyiru) at Gacuriro, the King Faisal hospital, the Kigali University Teaching Hospital (CHUK), Hotel des Mille Collines, Serena Hotel, the Umubano Hotel, and the Textiles Factory in Rwanda (UTEXIRWA). In total about 18 estates operate semi- centralized sewerage treatment plants connecting about 150 households each.

These small wastewater treatment systems usually comprise of settlement units and aerobic maturation ponds and sometimes constructed wetlands, such as the one constructed in the Nyarutarama neighborhood. However, because of poor maintenance and lack of operation skills the Nyarutarama plant is not functioning properly.

On the positive side, many of these decentralized units apply and reuse the treated wastewater in their gardens or greeneries, and sometimes apply the generated sludge as fertilizers, which is clearly a positive aspect of the current arrangements. In contrast: the currently proposed centralized wastewater treatment plant does not yet include options for reusing the treated wastewater.

3.2.13 Waste management and disposal

The concept of integrated waste management and disposal is still new in Kigali City. Nonetheless, Kigali is among the cleanest cities in Africa as a result of banning of the use of plastic bags and enforcing this regulation effectively.

The amount of solid waste collected in Kigali is increasing. The traditional method for waste handling includes composting and reuse for agricultural production. However, separation of biodegradable and non-biodegradable wastes in Kigali was not known, and an increasing amount was collected and disposed of at the Nyanza Dumpsite in the Kicukiro District. Today about 100 tons of waste is collected per day by a variety of private waste collectors.

However, this dump site was shut down in 2013 due its nuisance towards surrounding residential areas, and due to its limited size, not being able to cope with the rapidly growing population. The site had major problems of bad odor, methane gas explosion, garbage drainage and groundwater pollution and polluted runoff.

The place was used as a dumping site of all wastes and rubbish generated in Kigali City without any prior separation. The landfill received over 100 tons of wastes per day and the load was expected to increase to 1000 tons per day by 2020[16]. Lack of sanitary protection has transformed the site into a public threat, and a major source of organic and inorganic water pollutants.

16 http://www.rw.undp.org/content/rwanda/en/home/operations/projects/environment_and_energy/consolidated_waste_management_project_in_rwanda.html

The Government of Rwanda with financial and technical supports from the United Nations Development Program (UNDP) improved the daily operations of the Nyanza landfill, and developed plans for waste-to-energy projects together with investors[17]. Under the UNDP project, a technical design for a new landfill site was made as well, to be constructed in the Muremure Cell, Nduba Sector of Gasabo District, all in accordance with the 2009 RURA guidelines for landfills operation and management.

3.2.14 Sources of Energy

The traditional source of energy in the Gitikinyoni area is biomass used for both domestic cooking and lightening. Today, electricity is supplied by REG and most of commercial centers and people living in the project area have access to electricity. However, with a price of 29 Cent USD /Kwh (including VAT) for small consumers and 0,20 Cent USD (including VAT) for industries, most of the population cannot afford to use electricity for cooking. Instead people still use wood or related biomass, or the more environmental liquefied petroleum gas (LPG), which reduces the pressure on forest cutting. Other incentives are also in place through REG, such as the production and use of natural gas through biomass digestion systems, or the use of solar water heaters.

The WWTP will be connected to the city's electricity grid. However, the city experienced a steep increase in electricity demand, while the supply is lacking behind. This leads to regular power cuts throughout the city, and requires that the WWTP will be equipped with adequate back-up power generators.

3.2.15 Communication

The mobile phone network coverage in Kigali City approaches 100% and is supplied by three international telecommunication companies operating in the country: MTN Rwandacel, Air Tel and Tigo. In all commercial centers air times selling kiosks can be found. A landline is still used in few public and private buildings.

In 2013 Rwanda ranked first in Africa for internet broadband download speed. The Internet has been available from mobile cellular phones since 2007, but the high cost of phones and limited bandwidth still restrained its popularity to some extent. With completion of the government-sponsored fiber-optic cable expansion project in 2011, telecommunication services throughout the country have improved and since then the mobile cellular Internet access and use has increased.

3.2.16 Noise

Data on noise pollution in Kigali city or in the project area is not available. The Rwandese environmental law addresses noise pollutants mainly in the urban context, such as sirens and horns of vehicles, music, and noise generated by churches and mosques, which may impact the surrounding neighborhoods.

[17] Rwanda Development Board. 2012. Methane, Peat and Waste-to-Power Projects in Rwanda, Opportunities for Investment in Rwanda. Energy Investment Forum Kigali, Rwanda. Available at: http://www.rdb.rw/investinrwandaenergy/Energy1/Methane_Peat_Waste_Breakout_session.pdf, accessed on 8th October 2015.
http://www.rw.undp.org/content/rwanda/en/home/operations/projects/environment_and_energy/consolidated_waste_management_project_in_rwanda.html, accessed on 8th October 2015.

The noisiest phase related to the project is expected during construction as a result of trucks movements, unloading of materials, ground works and building activities. Generally, wastewater treatment plants do not generate noise nuisance, commonly below 20 Decibels, and the current WWTP will most likely not disturb the surrounding neighborhoods.

3.2.17 Archeology and Cultural Heritage

Within the project affected areas no specific archeological sites, or site of specific cultural heritage importance have been found. However, in the direct vicinity of the project, the following sites are located:

Gisozi Genocide Memorial Site

The Gisozi genocide memorial site located in the Gasabo District accommodates over 250,000 victims buried at the Kigali Memorial Centre Mass Grave, killed in the Kigali area alone. In additional to that, the CoK has other two national memorial sites: the Nyanza and Rebero memorial sites respectively for Tutsi and politicians killed in the 1994 genocide. In the project's sewer collection area in Nyarugenge sector, there is memorial site of nine UN Belgian blue helmets killed on 7th April 1994 in Camps Kigali opposite of Kigali University Teaching Hospital (CHUK).

Other Cultural Heritage

Other interesting cultural sites located in Nyarugenge district among other are:

(1) Natural History Museum-Kigali commonly known as Richard Kandt Museum, located in Muhima sector of Nyarugenge. Dr Richard Kandt was a Geman explorer who came in Rwanda in 1897 searching the source of Nile River. The house accommodating the museum is situated at 10 km from Kigali international Airport and is among the oldest houses constructed in Kigali City
(2) The Central Prison of Kigali, called also the "1930 Prison" (the year of its construction) in Muhima Sector is among the oldest houses constructed in the country during Belgian colonial period
(3) Sainte Famille Roman Catholic church Parish also in Nyarugenge district built in 1913 is among historical buildings in the CoK and particulary in the project area.

Despite the fact that no archeological or culturally important sites have been identified within the project area, it is recommended to monitor any occurrence of potential cultural valuables, including graves, during ground works, and to inform the authorities in case of their appearance.

3.3 Socio-economic Baseline

3.3.1 Introduction

This section provides the socio-economic background of the city (Kigali) and the project area, including land tenure in the project area, demographic profile of the people in the project area (education, income and expenditure, poverty, occupation, housing type, health, gender issues), current livelihood & agriculture patterns, the presence or lack of indigenous people and vulnerable groups, businesses in project area,, available workforce and migration patterns.

Kigali City has witnessed a rapid urbanization in the last twenty years, due to the country's history of repatriation of refugees from neighboring countries, rural-urban migration, natural population and politico-economic stability of the country after 1994 genocide mainly against the Tutsi. The population of Kigali City has shifted from 765,325 to 1,135,428 inhabitants from 2002 to 2012 respectively, representing 48.4% of increase in ten years. With an annual population growth rate of 4% in the City of Kigali, this rate is double of the national annual population growth. This positions Rwanda among the densely populated countries in Africa (NISR, 2012)[18].

3.3.2 Project Impacted Communities and Businesses

The geographical focus of this socio-economic baseline is located in the Nyarugenge District of Kigali. Below figure gives an overview of the direct area of influence of the project. The communities that are impacted by the project can be distinguished in four groups. These communities will experience different types of impacts from the Kigali Wastewater Project and will therefore be addressed in different ways in the ESIA

1. Communities and businesses located within the area of the sewer network, who will be connected to the new sewers (part of Muhima and whole Nyarugenge sectors) and their downstream areas;
2. Communities and businesses affected by land expropriation and/or physical or economic resettlement:
   a. Communities and businesses present along the alignment of the trunk main and the pumping stations (the Nyabugogo Boulevard section in the Kigali , Kimisagara, Nyarugenge and part of Muhima sectors);
   b. Users of the area proposed for the Maturation Ponds (Kigali sector);
   c. Owners and users of the area proposed for the WWTP (Kigali sector);
3. Communities and businesses close to the future WWTP (Kigali sector); and
4. Communities and businesses close to the alignment of the trunk main and close to the sites of the pumping stations (Kigali sector).

[18] National Institute of Statistics of Rwanda, 2012. 2012 Population and Housing Census, Report on the Provisional Results

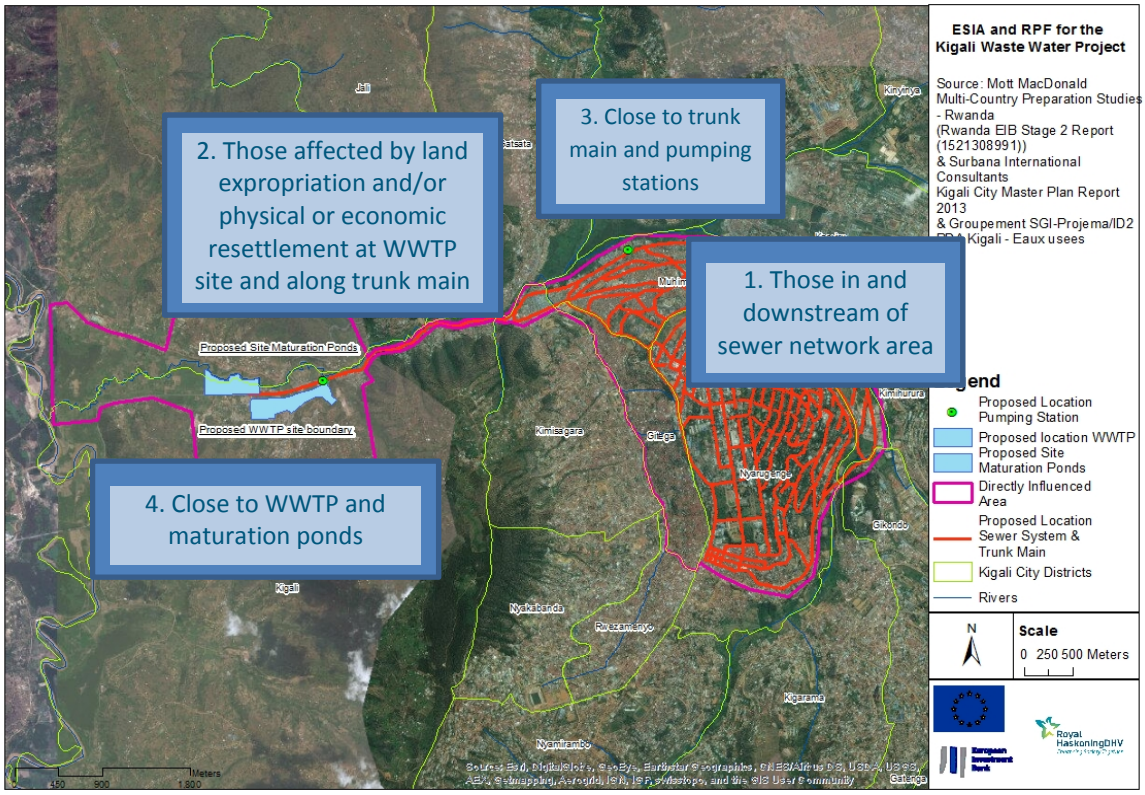

Figure 29 - Communities and Businesses Impacted by the Project

The Project will impact particularly upon these four groups of communities, but also on the wider Nyarugenge District. This baseline chapter therefore examines the macro socio-economic environment, the district context and then looks in more detail at the way in which households and individuals, potentially impacted by the Project, currently are functioning.

3.3.3 Sources of Information

Literature Sources

The information provided in this socio-economic baseline chapter has been gathered from a wide range of sources. It draws upon a review and analysis of existing information, including data collected for earlier reports prepared for the projects (Mott Macdonald and SGI reports, 2012 and 2013) and from other available sources, including the reports from the Rwandan National Statistics Bureau, national census data (published in 2015) and data from the local authorities of the Nyarugenge District of Kigali.

Baseline Surveys

In addition to the latest national statistics data and project reports, a sample socio-economic household survey was also carried out in August 2015 in the WWTP and the trunk main area through household questionnaires and interviews for this baseline.

The purpose of this sample socio-economic household survey (SSEHS) was to establish a reliable socio-economic baseline of the local communities' living conditions which was then overlaid on the national

census and statistics data, thus creating a robust socio-economic data set. The obtained data will be used not only for the assessment of the social impacts and further monitoring, but also for the budget estimates presented in the separate Resettlement Policy Framework Report.

The sample of the survey respondents was arranged as follows:

- Land tenure and land usage stratification (three sub-population groups – land-users/tenants, landowners and businesses);
- Members of the approached households from various age groups to achieve the most representative view of the society in the project area;
- Balanced gender participation in the survey.

One hundred and ninety eight (198) households in the project area took part in a household survey organized by the Consultant. A small minority declined the request, and 193 households agreed to take part in the survey. Hence, the respondents represent the view of the estimated 15% of the households potentially affected by land expropriation and/or physical or economic resettlement. This is a healthy and relatively large sample of the potentially affected households, which contributes to the higher statistical validity of the results.

A socio-economic household survey questionnaire was prepared and covered the issues such as:

- Households composition,
- Employment,
- Education,
- Income and livelihoods, including temp and full time jobs,
- Agricultural production on their land plots,
- Health and vulnerability,
- Land ownership and assets.

The survey interviews took place mostly at the homes of respondents and were conducted over a week period in August 2015. The socio-economic baseline based on the socio-economic household survey results and the recent national census data (published 2015) is described throughout this chapter. More details on the survey results are presented in the Resettlement Policy Framework.

Reconnaissance visits
Several walk-overs in the project area, visual observation of the households in the study area, informal conversations with the local residents complemented the data from literature and the socio-economic survey.

3.3.4 Demography

National Demographic Profile

After the 1994 genocide, the population of Rwanda was 5,663,838 in 1995 compared to 7,214,696 in 1990 (World Bank Data). According to the Human Rights Watch, of this 1995 population, up to 65% were female. The demographic imbalance was due to the huge loss of life during the civil war and genocide when over one million people died, the majority being males[8]. It was therefore women who assumed responsibilities predominately regarded as ‘male roles’; heads of households, community leaders, financial providers and so on. The table below summarizes the national level demographic data.

Table 6 - National Level Demographic Data

Socio-economic Indicator	National Level	Year	Information Source
Population	12,100,049	2014	World Bank
Age Structure	0-14 years: 42% 15-64 years: 55% 65+ years: 3%	2014	World Bank
Net migration	-0.8 migrants/1,000 population	2010-2015	International Organisation for Migration (UN IOM)
Birth rate	Rate per 1,000 people :35	2014	World Bank
Death rate	Rate per 1,000 people: 7	2014	World Bank
HDI value (Human Development Index)	151 (compared to the lowest rank being 187)	2013	UN Development Program

The national census of 2012 put the total population at 10,515,973. The latest data from the World Bank states that the population of Rwanda in 2014 was 12,100,049, which represents a growth of 1,584,076 in two years. This positions Rwanda among the densely populated countries in Africa (NISR, 2012).

51.2% of the World Bank estimated population are female. According to the Third Integrated Household Living Conditions Survey (EICV III, 2012), international migrants currently represent about 1% of Rwanda's population. Most come from neighboring countries, the Democratic Republic of Congo (43%), Tanzania (31%), Burundi (14%), Uganda (11%) and other African countries (1%). Labor migration is typically the cause of the migration statistics, as well as internal rural to urban migration, where people are moving in search for employment and skilled labor.

City of Kigali

The national 2012 census recorded the population of the CoK as 1,132,686, representing 10% of the country's total population. The graph below shows the population spread between Rwanda, the City of Kigali and the district of Nyarugenge. Kigali City has witnessed a rapid urbanization in the last twenty years, due to the country's history of repatriation of refugees from neighboring countries, rural-urban migration, natural population and politico-economic stability of the country after 1994 genocide. The population of Kigali City has grown from 765,325 to 1,135,428 inhabitants from 2002 to 2012 respectively, representing 48.4% of increase in ten years. With an annual population growth rate of 4% in the City of Kigali, this rate is double of the national annual population growth. In the city of Kigali, 48.3% of the population consisted of women (546,563) in 2012.

District of Nyarugenge

According to the latest census data, the district of Nyarugenge is the most densely populated in the city of Kigali, 2,124 inhabitants/ km^2. The population of the Nyarugenge district is estimated to be 284,000 people in total, where about 39% of the population is 19 years old or younger. 87% of the district population is under 40 years of age. The average size of a typical household in of the Nyarugenge district is 3.9 persons per household, which is higher than in some rural districts of the country despite the fact that Nyarugenge is an urban district in Kigali.

In the district of Nyarugenge about 51% of the population consisted of females in 2012. A comparison of the percentage of men and women at a national, regional and district level is presented below.

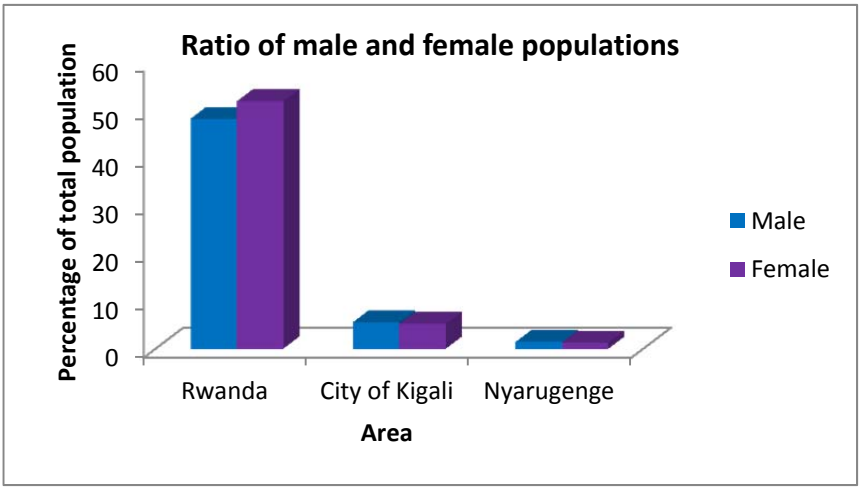

Figure 30 - Demographic Male to Female Ratio

The age distribution of both male and female populations of the Nyarugenge district is shown below. The group 0-17 year olds represents 39.2 % of the total district population. The group 16-64 years represents the economically active group, 63.4% of the population.

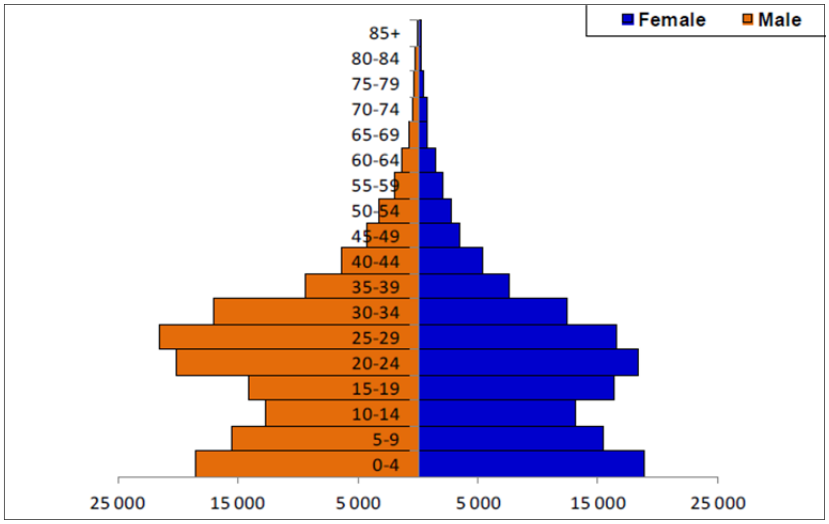

Figure 31 - Age distribution in the Nyarugenge district

The average size of a typical household in of the Nyarugenge district is 3.9 persons per household, which is higher than in some rural districts of the country despite the fact that Nyarugenge is an urban district. This number is very close to the average household size data obtained through the sample socio-economic household survey in the study area. At a national level, 28.7% of households are headed by women however, the women-headed households made circa 23% of the surveyed households in the study area.

Below table shows the Sectors covered by the Nyarugenge District and the total population figures for each Sector, which is impacted by the project. Kimisagara and Kigali sectors are the first and third most populous sectors of the Nyarugenge District. According to the Nyarugenge District Development Plan

2013-2018[9], the overall population of the district has grown by 20.2% since the last census (2002), although the population in the Muhima and Nuarugenge cells of the Nyarugenge District is now lower than it was in 2002 (-2.9% and -3.7% respectively).

Table 7 - Population in 2012 impacted by the project in Nyarugenge District

Sectors	Total Population
Gitega	28,728
Kanyinya	21,859
Kigali	30,023
Kimisagara	46,753
Muhima	29,768
Nyarugenge	21,302

Religion and nationality

The dominant religious group in Rwanda is the Catholics, who represent 44% of the resident population of the country. The second most prevalent religious group are the Protestants (38%), while other religion groups are made up of Adventists (12%), Muslims (2%) and Jehovah's Witnesses (1%)[10]. While those with no religious affiliation represent 2.5%, adherents of the traditionalist/animists and of other religions each represent less than 1% of the population.

In the Nyarugenge district, 35% of the population is Catholics, 36.5% are Protestants, 9.5% are Adventists, and 12.8% are Muslims, with 6.2% being of "Other" religious affiliation.

Based on the answers of the surveyed households in the WWTP and the trunk main areas, Catholicism is a predominant religion in 45% of the surveyed households, while Protestantism is practiced in close to 40% of the surveyed households. Muslims made 8% of the responding households, which is a higher number than the proportion of Muslims at the national level.

The population of the Nyarugenge District mainly consists of Rwandan citizens (98.4%), with the rest (1.6%) being defined as "foreigners".

3.3.5 Education

The Nyarugenge district has the second highest record of children within the 6-15 year old group who attend school (90.7%). The district also ranked second for the literacy level among the population aged 15 and above (86.7%). Across the Nyarugenge district, 92.4% of the users of education services in 2011 were satisfied with the provided education services.

Based on the latest UNICEF data, Rwanda has the highest primary school enrolment rates in Africa for both boys and girls, and it is estimated that the country is on track to achieve universal access to primary education by 2015. The 2012 statistics show that primary net enrolment rate was 96.5%; with 95% for boys and 98% for girls. Gender parity at primary school level has been achieved; the overall completion rate at primary level is 73% in 2012, a huge increase from the previous 2008 data indicating 53% enrolment.

Secondary school net enrolment rate is not as high as primary. The latest census data states that net enrolment was 28%, with 30% for girls. Girls now make up 52% of students in secondary education.

In Rwanda, 'youth' are described as 14-35 years of age. The latest census shows that the youth who never attended school in the district of Nyarugenge is much lower than that compared to the national percentage (5.4% compared to 12.4%).

53% of the heads of the surveyed households received elementary/primary education, close to 38% have received not only primary education but also secondary education, and nearly 9% of them have a college or a university degree. The level of education in the surveyed area is much higher than the national average where only circa 22% of adults have attained secondary level education, and 3.3% received a college or a university degree (see below figure).

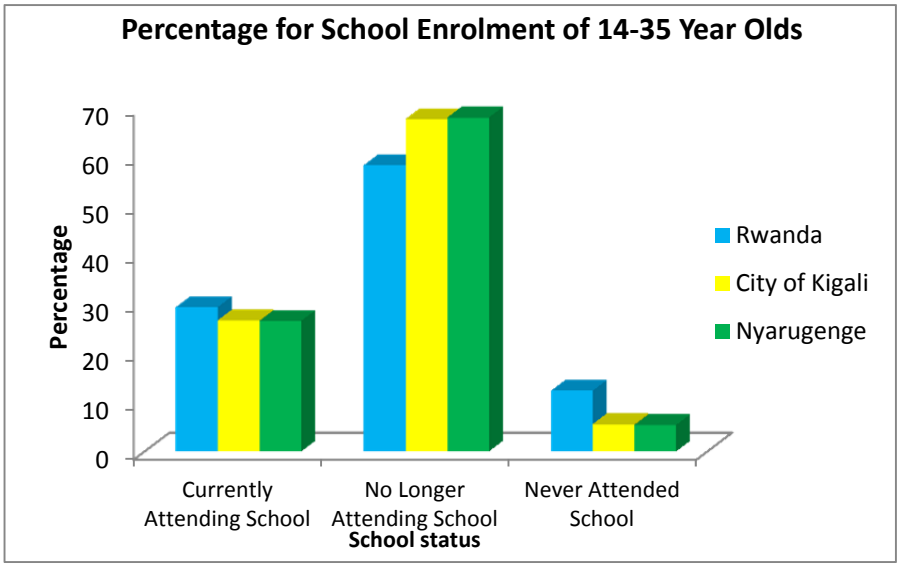

Figure 32 – School Enrolment

The 2012 Rwandan census indicates that Nyarugenge district has a high primary school enrolment rate with 47.8% of 14-35 year olds attending attaining primary level education. 35% of 14-35 year olds also have completed secondary school, and 10% have attended university. This is much higher than the national average where 21.7% of 14-35 year olds have attained secondary level education, and 3.3% university level.

3.3.6 Health

According to USAID, MSF (Médecins Sans Frontières) and the World Health Organization (WHO), the health and livelihoods of Rwandans have greatly improved over the last decade. After the 1994 genocide, the healthcare system in Rwanda collapsed and epidemics of infectious diseases were devastating the country. Today, however, as a result of the growing GDP, Rwanda's economy has been transformed and this has led to significant changes to the healthcare system.

The World Bank[11] indicates that life expectancy at birth has dramatically increased for both men and women, with life expectancy at birth for females in 2013 at 66 years of age compared to 53 years of age in 2003. Life expectancy at birth for males in 2013 was 62 years of age compared to 51 years of age in 2003. This supports the improved efforts in the healthcare system. The WHO[12] also reports a dramatic decrease in child mortality, with the decrease in maternal mortality; from 1,400 (per 100,000) live births in 1990 to 320 in 2013.

At the country level, the top three causes of child mortality are: respiratory infections, trauma & burns and diarrhea (see below). Septicemia represents 16% of causes and 23% of deceased children had clinical features of malnutrition. Malaria represents 19% of cause.

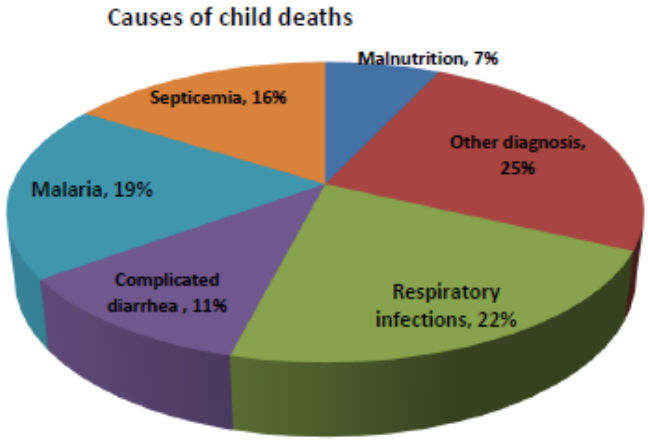

Figure 33 - Causes of child deaths

The number of HIV/ AIDS cases in the country is still relatively high in the city of Kigali, with a prevalence of 7.3% (per 1,000 people). Based on the World Bank[13] data, the net HIV/AIDS cases at the National level make 2.9%. The Ministry of Health with UNAIDS and Rwanda Biomedical Centre published a report[14] in 2014 that states that HIV prevalence in Rwanda has remained stable since 2005 until 2010 at around 3% in people between 15 and 49 years of age. The World Bank puts HIV/AIDS prevalence amongst women aged 15-24 at 1.2% in 2013 which is significantly higher than men at 0.9%, with the same situation at the Nyarugenge level.

According to the National Household Survey (2012), 0.2% of children and 0.1% of women reported cases of malaria in Kigali City; cases in men were not reported during the survey. However, it should be recognized that these data may be influenced by people coming from outside Nyarugenge district for medical treatment, so the numbers do not reflect only the health situation of the concerned sector.

In Kigali sector (where the WWTP will be constructed) 34% of the people going to the health centre have malaria. The reason may be that a large area of this sector is wetland. This is the highest percentage of the five sectors impacted by the wastewater project, with lower percentages in the sectors Muhima (7%) and Nyarugenge (9%), where the sewer network will be constructed.

In Kigali City in 2014/2015 81.4% of the people slept under an insecticide-treated net (ITN). However, this percentage appears to be lower for lower income households[15]. The Ministry of Health distributed in the past years millions of mosquito nets to households and the prevalence of malaria was decreasing. However, in recent years the prevalence is increasing again, especially in areas near wetlands. The Ministry is also engaged in Indoor Resident Spraying (IRS) campaigns.

Diarrhea appears to be more common among children, with the survey reporting that 11.4% of children had had diarrhea within a two-week period when the survey was conducted. At the Nyarugenge District level, 10.1% of children under five have diarrhea.

The data of the sectors of Nyarugenge district, where the project is located, show that water-borne diseases gastritis and duodenitis, endameba and diarrhea have similar occurrence among the sectors, between 3 and 7% of the patients registered at the health centers.

Respiratory infections are more common in Kigali, with 4.6% of children reported as having symptoms, the second highest occurrence rate at the country level. Respiratory infections (like a cold, pneumonia and bronchitis) are the most reported disease in Nyarugenge District with the people going to the health centers and is similar in the five districts (around 48%).

Another notable figure is the relatively high percentage of workspace injuries (5%) in Nyarugenge sector. This can probably be explained by the intense construction activities in the area, resulting in health and safety incidents.

3.3.7 Land Tenure

The *igikingi* system was a common land tenure system in central Rwanda in the 19th century. Land was distributed to warriors or other individuals who gained the respect of the community. This nearly always applied to men only. During the colonial period land tenure changed substantially and until 1916, the king's authority over land was widely recognized. After 1919, colonial administration replaced traditional land administration and mainly assigned land to colonialists and other foreigners settling in Rwanda.

The 1994 genocide claimed over one million casualties, and around 30% of the population fled to neighboring countries, Rwanda faced the challenge of relocating millions of refugees displaced by the genocide, and earlier disrupted communities, as well as internally displaced people on the limited land. After the 1994 Genocide, it was difficult to identify the owners of land parcels, with multiple claims being made. Customary land rules were not always adequate to deal with the complex land situation and the new resettlement programs. Many men had died, or were imprisoned or in exile as a result of the genocide which meant that many women assumed positions of authority and responsibility.

The many women-headed households required proactive efforts to ensure they had rights and those rights were protected. As such, Rwanda's Land Tenure Reform Program introduced a land registration program that was designed to promote land access and address tenure insecurity and organized a land registration program along with a Crop Intensification Program. As a result of the 1994 genocide, women gained new land inheritance rights in Rwanda. Customary systems responsible for resolving land and matrimonial

disputes – such as the Abunzi (Mediation Committees) became integrated into formal law under Article 159 of the Constitution and by the 2006 and 2010 Laws on Mediation Committees. Originally the role of the Abunzi was to place responsibility for peace in the hands of individuals at the local level. This committee has jurisdiction over different types of disputes between people in their local area, including matrimonial disputes and property disputes.

The Rwandan constitution recognizes state and private property and grants every Rwandan citizen the right to private property. The state has the authority to grant rights to land (including private ownership rights) and establish laws governing land acquisition, transfer and use.

The 2004 National Land Policy states that:

- All Rwandans have the same rights of access to land;
- All land shall be registered, and land shall be transferable;
- The consolidation of household plots is encouraged; and
- A title-deeds registration system is how land administration is now managed.

A Full title is available for private land of individuals, state land, the City of Kigali and district land. Various types of leases are usually granted for long terms and require prescribed land uses and development types.

3.3.8 Socio-economic Situation

GDP

Rwanda is a small, landlocked, heavily populated country with diverse terrain, an abundance of water resources, and one of the world's biodiversity hotspots. Rwanda has made numerous economic policy and regulatory reforms promoting private sector growth, thus helping it to achieve macroeconomic stability and rapid annual GDP growth of 7.5 % from 2005 to 2009[16], whilst the World Bank reported a GDP growth from 4.7% in 2013, to 7% in 2014. From 2001/2001 to 2013/2014 there is a sustained trend in per capita GDP growth (from US$ 211 to US$ 718)

Employment

The national census indicates that the labor force participation rate within the city of Kigali varies between sectors from 67.3% in Kicukiro to 70.1% in Gasabo. The census data also shows that employment participation is greater amongst males, 75.6% compared to 59.8% of females. The figure below shows the employment rates for men and women in Rwanda, the city of Kigali, and the project area.

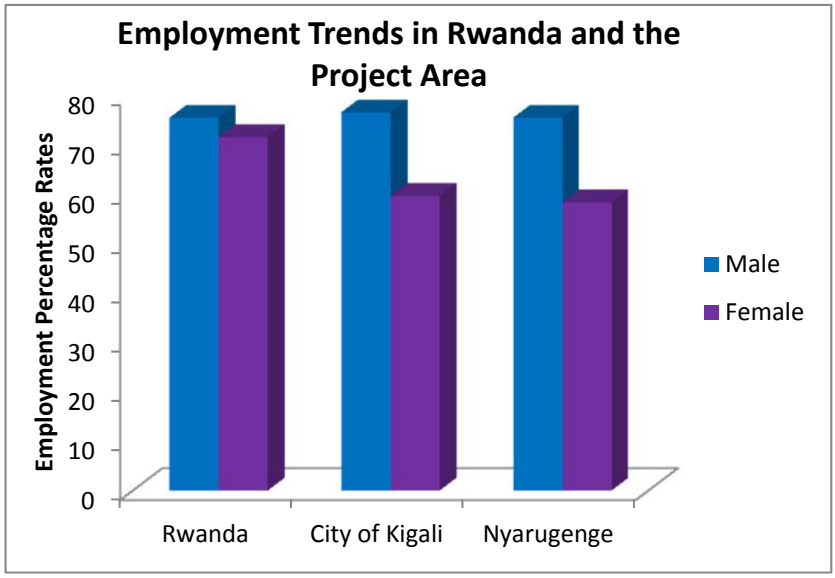

Figure 34 - Employment Rates in Rwanda

The overall employment rate is 71% among the Nyarugenge population who are aged 16 years and above; the unemployment rate is 9% and the economic inactivity rate is 22% (where people have irregular work). Nyarugenge district has the lowest employment rate compared to other districts in Kigali.

The majority of the working age population in the Kigali City is engaged in non-farm related work, which is either independent work or wage labor. In Nyarugenge District, over 78% of the working population is engaged in non-farm employment, being engaged either in business/commerce activities or being self-employed or regularly receiving wages/salaries (see figure below).

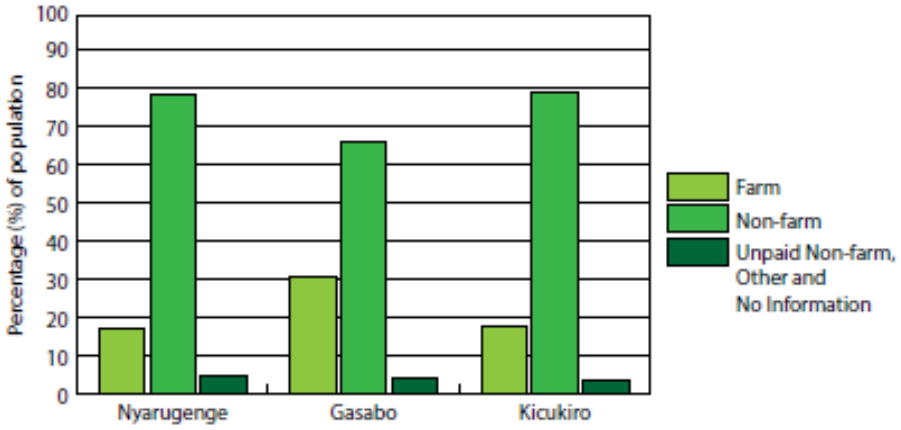

Figure 35 - Type of Employment in the three Districts

Given that only 24.8% of Nyarugenge district's population lives in a rural area, agriculture is not the main source of income for most living within the area. The household survey in the WWTP and the trunk main area shows similar data. Over 86% of the surveyed population confirmed that their livelihoods are driven by non-farm work, where they are either engaged in business/commerce activities (64.6%) or regularly receive salaries, i.e. wage labor (21.7%).

UN Economic Commission for Africa (UNECA) report Rwanda's and in particular Kigali's service sector has been among the most dynamic between 2007-2013, with wholesale and retail trade, education, finance and insurance, and transport, storage and communications all growing at average rates in excess of 10% per year since 2007. A 2013 Rwanda Environment Management Authority Report[17] highlights the city of Kigali being Rwanda's financial and economic hub, contributing to 50% of the country's GDP.

Income

Based on the 2012 data, the household income in Nyarugenge is driven mainly by salaries/wages (53%), followed by business income (23%); 14.3% are independent farmers i.e. they survive through subsistence agriculture on their plots of land, with the smallest contributor to a household income being public transfer income (3%) which covers pensions, welfare and various subsidies.

The August 2015 household survey in the study area revealed a different picture among those households where respondents agreed to answer this question. The surveyed households' main income is mainly driven by business/commerce activities (64.6%), followed by salaries/wages (21.7%), house rent (5.7%), family support (4.3%) and only small minority of the surveyed households claimed to have their main livelihood being generated by agricultural activities (3.7%). This situation can be explained by the location of the study area along one of the main roads in the capital, the Nyabugogo Boulevard.

No all households of the survey agreed to reveal their combined monthly income. The following average amounts were quoted for every main source of income among the surveyed households, however it should be noted that people usually tend to report lower income data than real.

Table 8 - Details of average main monthly income per household

Declared as a main source of combined household income	In RWF (rounded numbers)	In EURO (rounded numbers)
Business/commercial activities	250,465.00	303.00
Salaries/Wages	127,742.00	154.00
Renting out a House	153,750.00	186.00
Family Support/Remittances	47,500.00	57.30
Agricultural Activities/Subsistence agriculture	100,000.00	120.70

The surveyors also asked about additional income and 24 people (or 12.4% of the surveyed individuals) confirmed to have additional income, where:

- 12 people (50% of those with additional income) declared that they rent a house, with an average monthly rent income of RWF 73,000 although the consultants have low confidence in this declared figure;
- 7 people (29% of those with additional income) declared that they derive additional income through subsistence agriculture, with an average monthly agricultural income of RWF 75,000; and
- 5 people (21% of those with additional income) declared that their additional income comes from business activities, with an average monthly income of RWF 85,000.

Poverty

From 2001/2001 to 2013/2014 poverty reduced with a sustained trend from 58.9% to 39.1%

Poverty is defined as annual amount of money a household can afford to spend to buy food that provides the minimum number of calories required for an adult who is likely to be involved in physically demanding work (equivalent to RWF 118,000/household). Extreme poverty: the annual amount of money a household can afford to spend on food that provides the minimum number of calories required to support sedentary life style (equivalent to RWF 83,000/household)

The Nyarugenge district is the second wealthiest district in Kigali and comparing with the national poverty level (44.9% and 24.1% of the population identified as poor and extremely poor), the district has 16.8% poor people and 7.8% extremely poor

Over 67% of all interviewees of the socio-economic survey agreed to reveal what they spend monthly on food, which is a good indicator to check potential vulnerability related to poverty (if most of the monthly income is spent on food) and also allows to check the declared monthly food expenses versus the declared monthly income.

Based on the RWF 97,400 declared average monthly food expenditure per a household, nearly 65% of the interviewed households can be viewed as being financially secure where they do not spend more than 1/3 of their monthly average income on food and have a healthy disposable income after the food expenditure. About 35% of interviewed households declared that they usually spend most of their monthly income on food. These people include those 12% of interviewees who declared that they do not have sufficient income to balance their living needs (food, etc) and therefore require an additional income to make ends meet every month. If the circumstances of these 35% of interviewees turn for the worse (illness of a main income provider in a household, etc) then they can easily fall into the “poor” category.

The Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 1 implies perfect inequality. Income inequality in Rwanda as measured by the Gini coefficient rose from 0.505 to 0.522 in the period between 2001 and 2005, while it declined to 0.49 in 2010/11, below the level in 2000/01 In recent years it dropped further to 0.448. The gini-coefficient in Kigali City is the highest in the country; 0.559 in 2011.

3.3.9 Social Services and Facilities

Housing

The 2012 census recorded the different types of housing which are described as:

- Clustered rural settlement (*Umudugudu*);
- Dispersed/ isolated housing;
- Planned urban housing;
- Spontaneous/ squatter housing and
- Other type of housing

Whilst the most common type of dwelling throughout Rwanda is an Umudugudu (49.3%), only 3.5% of the housing in Kigali city and 2.8% in Nyarugenge district is considered as rural settlement. The main type of dwellings in Kigali city and also in Nyarugenge district is the unplanned/spontaneous residential housing

with 65.7% and 76.1% respectively. Below figures show the distribution of the different types of housing in Nyarugenge district compared to the national average.

Housing characteristics show that the Nyarugenge district is ranked the second among all districts of the Kigali city where cement is the most commonly used material for flooring (66%).

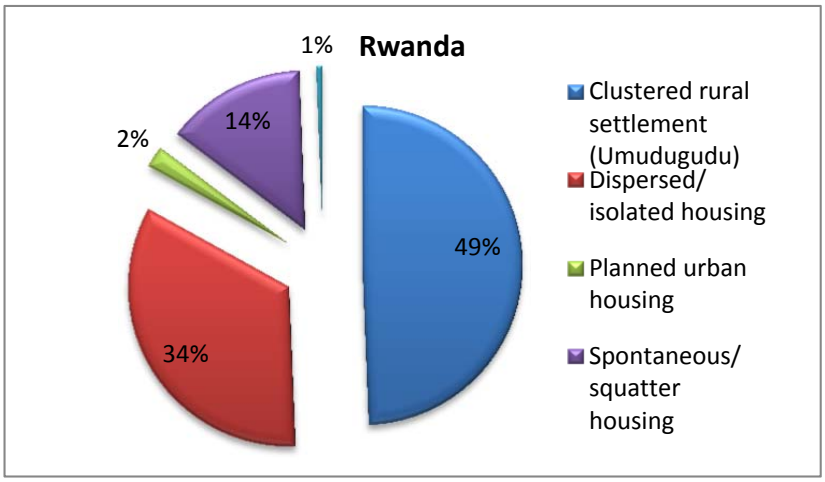

Figure 36 - Housing distribution in Rwanda (National Census 2012)

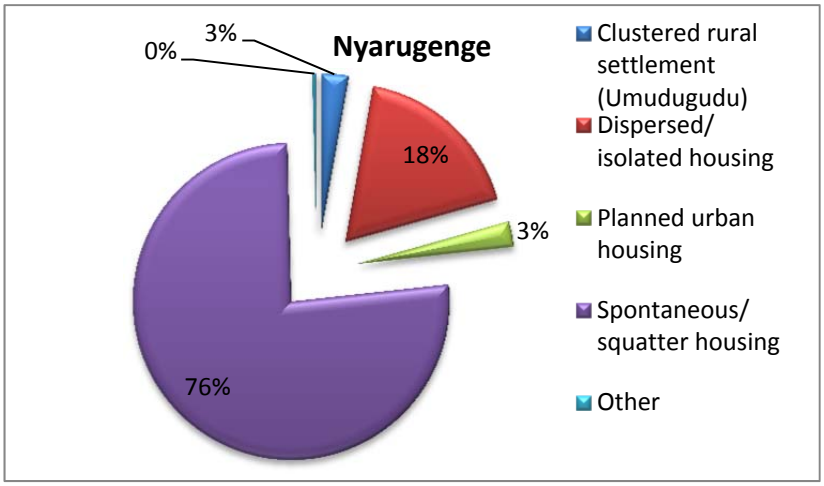

Figure 37 - Housing distribution in the district of Nyarugenge (National Census 2012)

Electricity: 61.6% of the households in the Nyarugenge district have electricity supplied to their houses.

Telecommunication: 80.7% of the households in Nyarugenge own a mobile phone, which is the 2nd highest rank in the capital.

Education: The mean walking distance to a primary school in the Nyarugenge district is 17.3 minutes.

Health: The mean walking distance to a health centre in the Nyarugenge district is 25 minutes, comparing to the mean national walking distance to a health centre which is 35 minutes in urban areas and one hour in rural areas.

Bank accounts: 65.3% of the households in the Nyarugenge district have at least one saving account and comparing this data with the national-level information, the district takes the second highest position with regards to the usage of financial services and possession of a bank account.

3.3.10 Gender Aspects

Rwanda has a Gender Inequality Index of 0.414, ranking it 76 out of 148 countries in the 2012 index. Neighboring countries like Uganda, Burundi, Tanzania and Congo have higher inequality between men and women. In Rwanda, 51.9 percent of parliamentary seats are held by women, and 7.4 percent of adult women have reached a secondary or higher level of education compared to 8 percent of their male counterparts. For every 100,000 live births, 340 women die from pregnancy related causes; and the adolescent fertility rate is 35.5 births per 1000 live births. Female participation in the labor market is 86.4 percent compared to 85.4 for men.

The government of Rwanda initiated the Vision 2020 program, a long-term framework for Rwanda's development strategy. Gender was made a cross-cutting issue in Vision 2020, identifying land registration as a critical element for improving land productivity and livelihoods, empowering women and overall governance. Women in Rwanda face cultural, customary, economic, legal, and social constraints that hinder them from accessing land and other property. Discriminating laws and practices regarding land, coupled with land scarcity, have hindered women's land rights and have had a negative impact on female-headed households.

Nationally, over 75% of households are headed by men, who own land. The legal framework concerning inheritance and property includes statutory succession law co-existing with and incorporating customary norms. At the same time, the Inheritance and Marital Property Law awards equal inheritance rights to sons and daughters. The Constitution of 2003 strengthens the principles of gender equality and the reduction of discrimination against women. It stipulates that women should constitute 30 percent in all leadership positions in the country. National Laws have been ratified and revised to ensure gender equality. In particular, the Land Law and the Inheritance and Marital Property Law set out rules governing access to land, property rights, and equality between spouses in the management of their property, avoiding discrimination between male and female children.

Based on the Ministry of Natural Resource data (2013), throughout Rwanda, 39.4% of households include women who own land as a de-facto owner or an official owner. In Rwanda, 23.8% of the households were headed by women in urban areas in 2012. In the Nyarugenge District, 22.8% and 10.7% households are headed by women and widows respectively, and the socio-economic survey in the study area revealed similar figures. Put together, over 33% of households in the Nyarugenge district are headed by women (based on various circumstances).

3.3.11 Vulnerable Groups

Vulnerable Groups – are population groups that suffer from discrimination, unequal access to rights, unequal access to and control over resources or unequal access to development opportunities. As a result, they may be poorly integrated into the formal economy, may suffer from inadequate access to basic public

goods and services, may be excluded from political decision-making, and may therefore face a higher risk of impoverishment and social exclusion. More often than not, the resilience levels of such groups to adverse impacts are lower. These population groups could include ethnic minorities, widows, elderly, the disabled and sick, low income households and also child-headed households and orphans. Vulnerability is a pre-existing status that is independent of the project to be assessed. The project could, however, exacerbate these vulnerabilities if existing sensitivities and coping mechanisms are not adequately understood or considered.

In the context of the wastewater project of Kigali, children, elderly people, women and people with disabilities and HIV infections are considered vulnerable people who need specific attention. Nearly 6% of the population aged 0–20 are orphans with both parents deceased (5.7%) and 15.3% are orphans with one parent deceased. The socio-economic survey showed that the percentage of households headed by people with disabilities is 5.6%. The vulnerability of such households is exacerbated further where such households have young children and where the household head is the sole bread earner.

1.6% of the population of Nyarugenge District is 65 years and older. The Nyarugenge population has 2.7% of people with a major disability. This percentage is below the national average of 4.5% and is only slightly higher than the overall rate for the Kigali City (2.3%). Considering that the average HIV infection rate in the country is 3%, the HIV infections rate in the Nyarugenge District is alarmingly high, especially among women. The Nyarugenge HIV-positive cases for women stand at 9.8% while those for men stand at 6.8 %. The data is even more alarming, as the HIV infections are high among youth of 15-24 years of age where HIV positive cases stand as 4.8% for young women.

The household survey in the study area (Aug 2015) revealed that the households in the project area might have higher proportion of various types of vulnerabilities in their households. For example, 12.4% of the surveyed households reported that they have at least one member of their household with a major disability, which is nearly 3 times higher than the number of people with major disabilities at the national level. Nearly 12% of the surveyed households reported to have at least 1 orphan (where at least one parent is deceased) in their household which is close to the orphan data at the national level summarizes the social issues which are prevalent in the Nyarugenge District.

Table 9 - Summary of Social Issues in the Nyarugenge District.

Poverty Rate	Extreme Poverty Rate	% wage non-farm (women)	% wage non-farm (men)	% HIV infected (women)	% HIV infected (men)	% of h/h headed by disabled	% of h/h headed by women	% of h/h headed by widows
10.1	3.6	40.6	63.5	9.8	6.8	5.6	22.8	10.7

3.3.12 Project Affected People

The characteristics of the four groups of communities and business, who will be impacted by the Kigali wastewater project, are described below.

1.Communities and businesses located within and downstream of sewer network
In general the users (employees) and visitors of the buildings of the large water consumers as offices, banks and hotels, where the sewage will be collected have a relative good socio-economic status compared to the national average in Rwanda, in terms of income, education, health and perspectives for

the future. This area is the economic centre of the country, which attracts upper and middle class people for work and leisure.

Next to the large water consumers a part of the single households will be connected. In the current state most of the households in the area do not have flushing toilets (around 90%) or and connection of these households is not foreseen in the beginning of the operation of the wastewater system. Only when modern housing with flushing toilets will be constructed in the coming years the single households will be connected. With the start of the project about 10% of the households will be directly connected in the start of the project and the remaining in a later stage.

The households that have flushing toilets in the area, belong usually to the more wealthy part of the population in the country. In the poorer neigbourhoods of Muhima and Nyarugenge sectors (Biryogo, Kabeza, and part of Muhima) willingness-to-pay surveys were conducted in September 2015 among 94 households by Atkins (2015). In these areas only 5% of the households have flushing toilets and 60% a household water supply connection.

Also the areas downstream of the neighborhoods that will be connected to the sewer system will benefit from the operation of the sewer system, as less wastewater will pass through their areas in the current open water courses. In Gitega, just west of Nyarugenge had in 2012, a number of 28,728 people (about 7,000 households) residing.

2. Communities and businesses affected by land expropriation and/or physical or economic resettlement
Based on three walk-overs in the project area, visual observation of the households in the study area, and the performed socio-economic survey, it is estimated that about 1230 people (a combination of land owners, tenants and employees of small businesses) could be affected by land expropriation and/or physical or economic resettlement in the future WWTP, trunk main and maturation ponds sites.

Based on the survey in the WWTP and the trunk main area, there are circa 120 small businesses (mainly small retail operations and a few warehousing companies) that could be affected by land expropriation and/or physical or economic resettlement. However, this preliminary estimate will need to be reviewed in the Resettlement Action Plan.

From the socio-economic survey it can be concluded that about 65% are more of less financially secure, as they do not spend more than 1/3 of their monthly average income on food and have a healthy disposable income on top of their food expenditures. However, the remaining 35% of interviewed households declared that they usually spend most of their monthly income on food, which makes them vulnerable for poverty, when unexpected changes in their income occur.

3. Communities and businesses close to the future WWTP and maturation ponds
Based on ArcGIS-data on the Kigali City Master Plan and visual observations of the households in the area of influence of the WWTP and maturation ponds, it is estimated that about households may be impacted in various degrees close to the future WWTP. These households all are located in the Kigali sector.

The households residing in the valley close to the boundaries of the sites of the WWTP and maturation ponds in general have a lower socio-economic status than the households in the sewer network area, who will be connected to the system. There seems to be no full electricity and water supply to the houses in this area. When going uphill in southern direction the socio-economic status seems to increase, with new housing plots at the top of the hill. However, this area will no be affected by the project. In addtion, the building houses in this uphill area in not in accordance with the city plans and the may be relocated soon.

4. Communities and businesses close to the trunk main and pumping stations

Considering the currently proposed alignment of the proposed trunk main and the two pumping stations, it is estimated that about 86 households (84 along the proposed trunk main and 2 at the proposed northern pumping station) in the sectors Kigali, Kimisagara and Muhima are potentially impacted in various degrees. This assessment is based on ArcGIS-data on the Kigali City Master Plan and visual observations.

4 DESCRIPTION OF THE PROJECT

4.1 Staged Kigali Wastewater Project

The Kigali Wastewater Project will be built in a modular fashion, with stages in line with the foreseen network expansion and as the population of Kigali grows. Since the current project is the first centralized wastewater treatment project in Rwanda, this approach will enable the responsible authorities and operators to get acquainted with the all practicalities of operations aspects ("learning by doing), and to maintain sufficient flexibility to anticipate on future developments. The current Stage 1 of the project includes collection of wastewater from the urban areas 1A and 2A only. Based on the estimates of MMD in 2016 it is foreseen that by 2020 an estimated 6.800 m3/day average flow of wastewater will be treated from these areas. The stage 1 WWTP will also allow receiving small amount of sludge brought by tanker trucks from areas using septic tanks or pit latrines only.

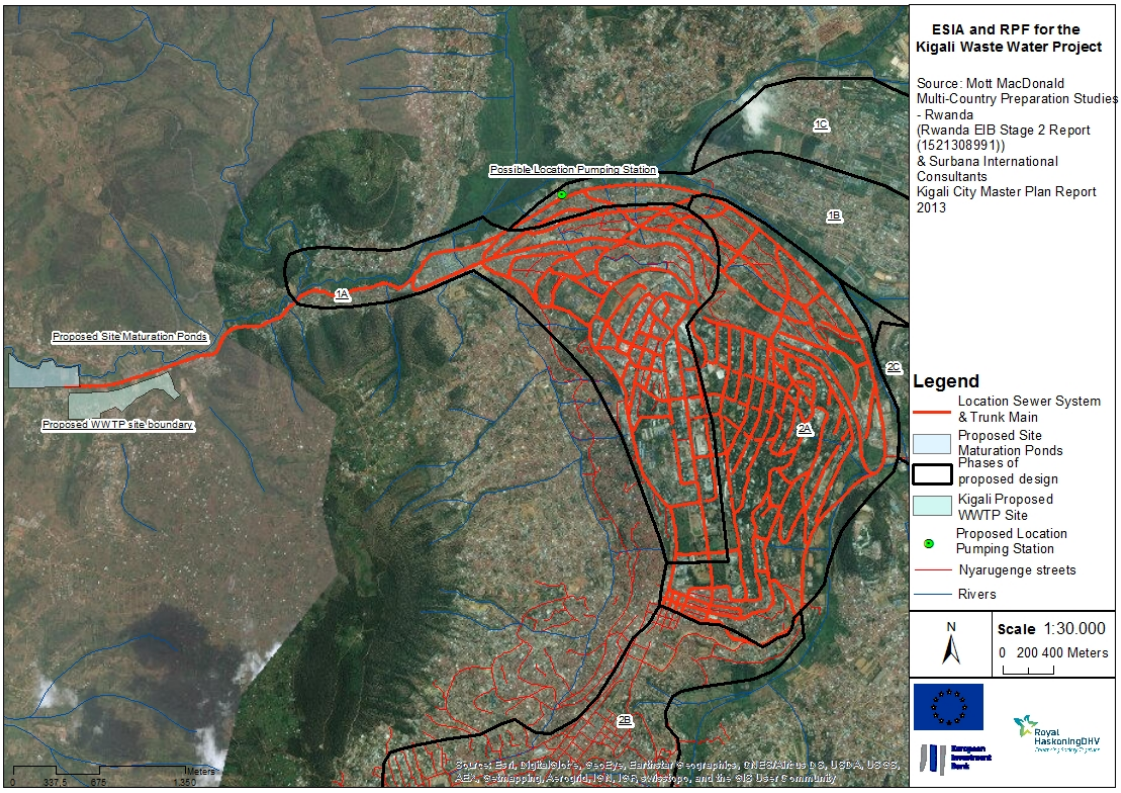

Figure 38 – Stage 1 Project Area and Foreseen Sewer Collection Areas

During the first stage of the project a full scale activated sludge processing component has been added right from the start (originally stage 2), instead of starting with a pilot activated sludge component only (originally stage 1). This will enable the project to reach the Rwanda effluent quality standards at all times, also during times of floods in the Adjacent Nyabugogo River. This first phase of the project will also include the installation of additional equipment, such as an additional digester, a mechanical thickener for surplus activated sludge and additional mechanical sludge dewatering equipment.

During stage 2 (originally stage 3), the capacity of the primary chemical treatment and secondary activated sludge components will be expanded to 24,000 m3 / day to cater for a connected population of 240,000. During this stage full mechanical dewatering of digested sludge will be realized and full scale disinfection either through expanding the maturation ponds or introduction of UV disinfection, depending on the performance of the WWTP and the maximum desired pathogen levels of the effluent. Stage 3 might also include a combined heat and power co-generation system for electricity generation and heated digestion using surplus heat from the power generation.

Finally, during stage 3 (originally stage 4) it is foreseen to in increase the capacity of the plant to 550,000 PE. During the final stage the chemical enhanced primary treatment system may be replaced a more advanced systems, and UV disinfection will be applied to meet the highest international standards.

However, stages 2 and 3 will be subject to further assessments, and can today not yet be fully determined. Consequently current stage 1 has been designed to in a way that facilitates sufficient flexibility in the future. However, the land take under stage 1 of the current WWTP design is already sufficiently large to realize an ultimate 550,000 PE WWTP.

The Kigali sewerage system is designed to accommodate foul sewage flows only, with surface water storm drainage from the city entirely separated. However, the wastewater will be pumped up from the lower end of the sewer system (about 5 m) to reach the inlet of the trunk main, and the influent water from the trunk main will again be pumped up next to the WWTP. This allows full gravity feed again from the inlet of the WWTP down to the maturation ponds and further down to the point of discharge into the river.

The treatment plant and maturation ponds are separated by the main road. The whole WWTP site will be fenced and foreseen with an entrance at the head of the WWTP, in the east, and another towards the sludge processing facility more to the west. It is understood that the WWTP area will include a buffer zone around it, which will include a visual barrier (trees). However, details about this zoning have not yet been included in the available design documents.

The road will be crossed on two points: a tunneled connection of the main trunk to the WWWTP; and a tunneled connection of the WWTP to the maturation ponds. Discharge pipes will allow for maximum flows between 1 and 2.5 m/sec.

The mechanical, electrical, instrumentation, control & automation (MEICA) design criteria will focus on reliability and robustness, and include standby equipment and power generation.

The design foresees in a drainage plan to collect peak storm water of 10 years return period, and send this water back to the head of the WWTP. The areas not yet used in stage 1 will be drained separately and discharged through separate culverts towards the river.

4.2 Stage 1 Project Components

4.2.1 Sewerage Network and Pumping Stations

The collector sewers will cover Kigali Central Districts 1A and 2A (as identified in the SGI Sanitation Master Plan) managed by WASAC LTD's Nyarugenge and Muhima branches. This area is dominated by commercial and government buildings, as well as higher end residential houses, in addition to paved roads, parks and other open spaces.

The planned sewers will collect all effluent from the existing and future buildings in this area and will convey this to the trunk sewer. The sewers will be designed with capacities sufficient to collect all projected wastewater generation in these areas for the year 2020: about 52,000 people in the Muhina sector, and about 40,000 people in the Nyarugenge sector. This represents a population density between 5 to 10 thousand people per square km. Until 2020 the population will likely decline with about 2 to 4 %. This relates to foreseen institutional and commercial developments that will replace original living houses.

The sewer capacities have been designed on the basis of current and projected water consumption and related wastewater generation, and assume an average consumption of 186 liter per capita per day for residential houses, and for commercial and institutional buildings a consumption ranging between 3 and 133 liters per connection. The connections with the largest water consumption are hospitals (100 m3 per day) and the prison (133 m3 per day). Wastewater return flows have been set at 80% of the water consumption, with peak flows around 08.00 hours and 18.00 hours (about 140% of average), and low flows between 0.00 and 04.00 hours at night (around 60% of average).

The sewer network has been designed on a gravity flow basis, with no pumping stations required. It includes a primary network of 500 mm in the valley bottom; a secondary network carrying the wastewater from the hills to the primary network, and a tertiary network long all roads in the collection area. Manholes will be put every 50 to 80 meters.

The sewer system has been designed to flow under full gravity. It is understood that a pumping station will be put at the northern downstream end of the system to pump the water up for 5 meters, in order to continue further gravity flow through the final stretch of the sewer, into the trunk main, and down to a second pumping station near the entrance of the wastewater treatment plant. However, information about the design criteria for these pumping stations was not yet available at the time of this report.

Finally, before the construction an assessment will be made of existing underground infrastructure, such as water supply, power lines and fiber cables to ensure these will not be affected.

4.2.2 Trunk Main

The trunk main will be designed with a 1 meter diameter. However, the final and detailing lining and related design specification have not yet been elaborated. So far, the design engineer took over the original routing of the trunk main as provided in the SGI Sanitation Master Plan of 2008, as shown in the next maps. This routing has also been the basis for performing the socio-economic survey under this ESIA and assessment of required resettlement and expropriation. The data from this survey have been used as input for the Resettlement Policy Framework, issued separately in draft in November 2015.

Meanwhile the Rwanda Transport Development Agency and the City of Kigali are in the process of planning an expansion of the Kigali-Muhanga high way, possibly up to six lanes (two times three lanes). Further discussions with the Design Engineer have clarified that there are no technical limitation to alternative routes of the trunk main along the main road.

The ESIA consultants and Design Engineers conclude jointly that the best option is to put the trunk main in the middle, between the two tracks of the new high way. However, this requires that the final lay out of the high way shall be available to the Design Team before completion the final design of the trunk main. This particularly requires coordination between the City of Kigali, WASAC LTD and the Rwanda Transport Development Agency, both under this Ministry of Infrastructure, prior to completion of the design and

tender documents for the Trunk main. This coordination will enable effective coordination in terms of ground works, construction works, resettlement action planning and expropriation unit pricing and implementation.

Figure 39 – Aerial Photograph of Eastern Section of the Trunk Main (SGI, 2008)

Figure 40 – Aerial Photograph of the Central Section of the Trunk main (SGI, 2008)

Figure 41 – Aerial Photograph of the Western Section of the Trunk main (SGI, 2008)

4.2.3 Wastewater Treatment Plant

The collected wastewater will be conveyed through the trunk main to the WWTP. The stage 1 project WWTP components have been designed under the BS-EN design standards, specifically the 2002 standards BS EN 12255 1 to 11. This includes a lifetime of the civil works of 50 years.

The preliminary treatment includes a 10 mm fine screen and screening handling; a 0.2 mm grit removal, including grit handling and flow measurement. Grease removal is not provided in the preliminary treatment. Next, a Chemically Enhanced Primary Treatment (CEPT) facility will treat all inflowing wastewater with a design capacity of 12,000 m3/day. This includes a combined coagulation and a chemical flocculation system using Ferric Chloride, Aluminum Sulphate and a polymer flocculants, as well as primary settlement tanks and a sludge pumping station. At very low initial flows (below 1500 m3 /day) the coagulation/flocculation system will be bypassed and the preliminary treated effluent will be sent directly the activated sludge distribution chamber.

The secondary Activated Sludge treatment step will next process all wastewater generated by the primary treatment in a nitrifying biological treatment facility. The secondary treated wastewater will flow into maturation ponds for further reduction of pathogen and polishing of the effluent. This activated sludge step will allow for carbonaceous treatment, nitrification, some denitrification and suspended solids removal. Final Settlement Tanks (FSTs) shall separate the biomass from the treated effluent and provide a degree of thickening for the secondary sludge. The effluent targets from the FSTs are: BOD <25mg/L; Ammonia <5 mg/L; Suspended Solids <50 mg/L.

The current plant also caters for a sludge processing (from all wastewater), including sludge thickening, unheated digestion including an anoxic zone and aeration zone, a settlement tank, pumping station and a mechanical dewatering facility. The biogas generated here will initially be stored (2 production hrs capacity) and flared, but in the future it could be used for power generation or biofuel.

The mechanical sludge dewatering includes belt thickeners and centrifuges, which will be located in building no. 33 in below figure 42. Their aim is pressing out the water from the sludge, generating a dry sludge. This will reduce sludge volume and transportation costs. A piping and pumping station will return the collected liquid back to the process prior to the CEPT.

The open spaces indicated in figure 42 on the south-west and western parts of the WWTP are reserved to allow for any change at the detailed design stage as well as to secure land for future stages and to prevent / delay the need for another site. It is also important to keep a reasonable footprint for sludge storage in case of problems with the sludge disposal process or with the mechanical dewatering during operations.

The treated wastewater will next pass a culvert under the main road to reach the Maturation Pond (10.3 ha) on the other side of the road, in the wetland area next to the river.

An emergency overflow to the river is recommended if a complete power failure and backup power failure to the WWTP would occur. This should not be acceptable under any normal circumstances, but it would provide a controlled means of overflow of the network in case of an emergency. This bypass will allow wastewater from the inlet pumping station to bypass the entire wastewater treatment process and be discharged directly to the maturation pond. It should however be noted that during low river flows, this bypass will lead to high concentrations of pollutants in the river. At that stage adequate information to the surrounding population shall be provided to avoid any direct contact with the river segment downstream of the wastewater treatment plant. In addition, prevention of direct contact shall further be enforced through clear information signs and surveillance along the river.

Figure 42 –WWTP General Arrangement (Mott MacDonald, 2016)

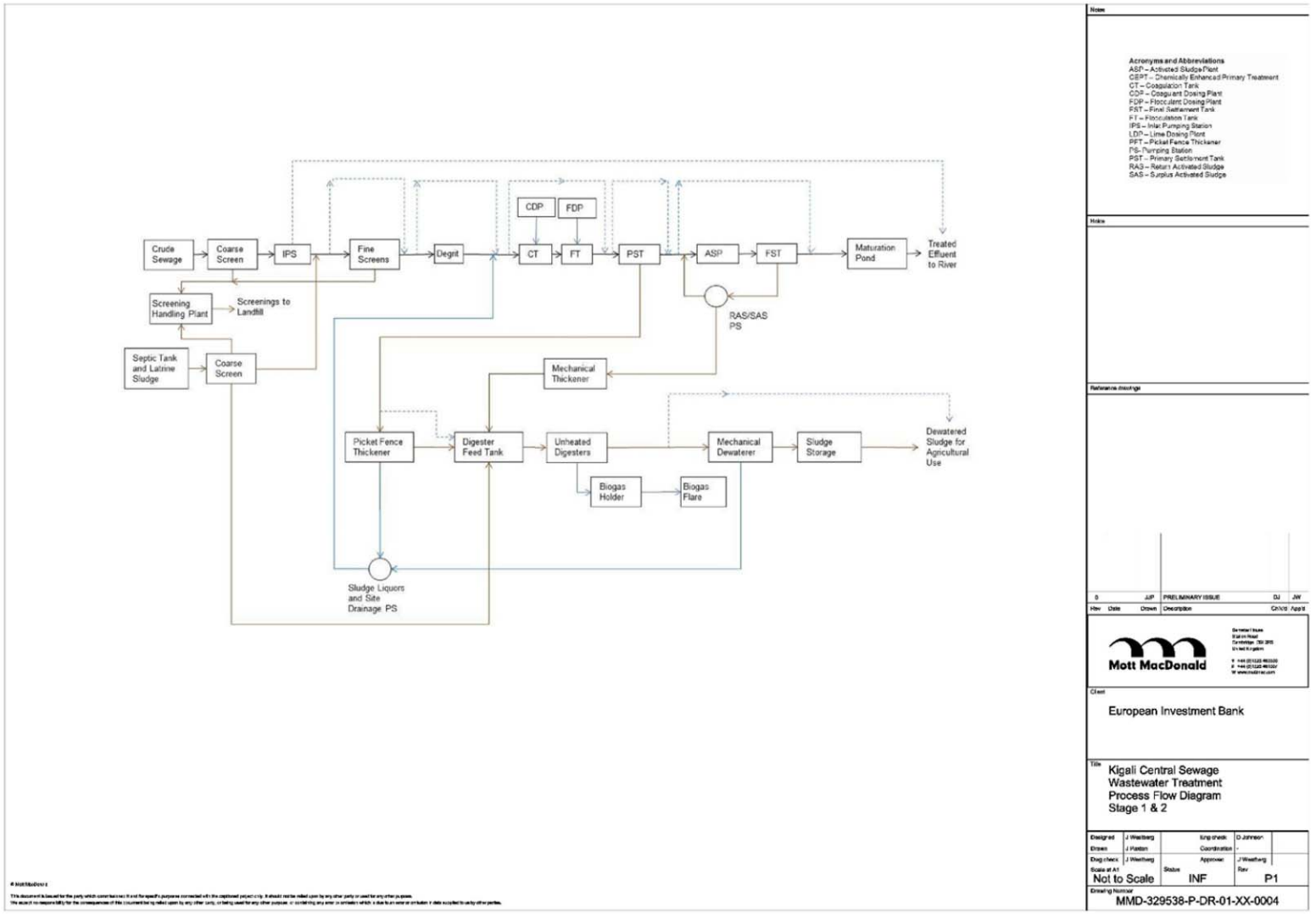

Figure 43 –WWTP Process Flow Scheme (Mott MacDonald, 2016)

4.2.4 Maturation Ponds

The purpose of the proposed Maturation Ponds is to act as a natural sunlight disinfector during the stages 1 and 2 of the project, where the capacity of the plant will be 12,000 m3 / day. There will be three ponds with an area of 3.4 ha each. The ponds will also act as a natural biological degradation step (polishing), leading to further reduction of BOD and pathogen.

During stage 3, the capacity of the primary chemical treatment and secondary activated sludge components will be expanded to 24,000 m3 / day. During this stage full scale disinfection will take place either through further expanding the maturation ponds or introduction of UV disinfection, depending on the performance of the WWTP and the maximum desired pathogen levels of the effluent.

Finally, during final stage 4 the capacity will be increased to about 55,000 m3 / day and the chemical enhanced primary treatment system may be replaced by a more advanced systems. In addition, UV disinfection will be applied to meet the highest international standards, which may lead to a reduction in the size of the maturation ponds.

The ponds will probably see the growth of some water plants, as well as algae providing oxygen to the water. These algae may require the construction of a subsurface flow area in the wetland between the outlet of the ponds and the actual discharge into the river, in order to prevent these algae reaching the river.

It is foreseen that the wetland will be flooded up to 3 times per year, leading to occasional flooding of the maturation ponds as well. Clearly, during these periods the ponds will lose their disinfection and biological degradation functions. However, the WWTP effluent will then be diluted strongly, leading to no or limited impacts on the surface water quality. In addition, the maturation ponds will be constructed with natural materials only, resulting in no negative impacts on the environment during flood events.

4.3 Project Phases

4.3.1 Pre-construction Phase

The pre-construction phase relates to all activities required to initiate the actual construction works. They include planning and studies, design works, setting the financial, contractual, legal and organizational arrangements, land acquisition and resettlement issues and tendering of the construction works. The next table provides an overview.

Table 10 – Pre-construction Phase

	Pre-construction Phase
p1	Surveys and field investigations
p2	Preparation of preliminary and interim design and functional specifications
p3	Completion FS Finance, Institutional, Legal issues
p4	Completion of RAP and Land Acquisition Plans (not part of this assignment)
p5	Final designs (areas 1A and 2A; Trunk Main; WWTP; sludge processing and maturation ponds)
p6	Traffic Management Planning
p7	Detailed Operating and Financing plans
p8	Preparation Detailed Resettlement Action Plan
p9	Final Decision Loan Agreement EIB
p10	Preparing Construction Tender Documents
P11	Permits to Construct and Operate
p12	Land Acquisitions and Resettlement Actions
p13	Tendering, tender evaluation and contract awarding of Construction Works

4.3.2 Construction phase

During this phase all physical elements of the Kigali Wastewater Project will be constructed. This includes preparatory activities and logistics by the selected contractors, realization of temporary construction facilities, manpower, infrastructure and ground works. Subsequently the actual construction of the sewer systems, trunk main, the wastewater treatment plant and the maturation ponds takes place, including access roads, surrounding facilities and water, sanitation, power and telecom related facilities and connections. Below table provides an overview.

Table 11 – Construction Phase

	Construction Phase
c1	Fields Surveys and Final Construction Designs by Selected Contractor
c2	Preparing / Implementation of Construction Environmental Management Plan by Contractor
c3	Hiring Construction labor force
c4	Setting up construction office and yard
c5	Purchase of Construction Materials, and preparing transport logistics
c6	Mobilization of Construction Equipment
c7	Field preparations - construction Works
c8	Construction Primary, Secondary and Tertiary sewers in areas 1A and 2A
c9	Construction Pumping station and Trunk Main, including site clearance an restoration
c10	Construction Treatment Plant and Sludge Processing, including site clearance
c11	Construction Maturation Ponds, including site clearance
c12	Final preparations for Wastewater Operations, including electricity supply, operating staff and resources, and all related financial, organization and legal operational preparations
c13	Testing and Handing over Construction Works to Operator
c14	Demobilization Construction Equipment, office and workers

4.3.3 Operational Phase

Once the construction works have been completed and handed over to the operator, the actual operational phase starts. This phase focuses on operations and maintenance of the Kigali Wastewater Project components. This includes physical operations in terms of management of wastewater flows, water treatment and effluent discharge, as well as fee collection, administration, financial and human resources management, clients interface, implementation of the Environmental and Social Management Plan, emergency response management, and monitoring, evaluation and enforcement issues.

On the 30th of June 2016 it has been decided by the Steering Committee during a meeting with the EIB and the Minister of Mininfra that the project will be realized through a Design, Build Operate and Transfer (DBOT) contract, including a two years period for the operations and capacity building. Afterwards the assigned contractor will transfer the operations to WASAC LTD, who already acts as operator for water and sanitation services in Kigali and the owner and manager of the related urban assets. The next table provides an overview.

Table 12 – Operational Phase

	Operational Phase
op1	Mobilizing and Training Operation Staff and Resources
op2	Connecting Houses and Sceptic Tanks to Tertiary Sewer System
op3	Operating & Maintenance of all wastewater collection and treatment facilities and maturation ponds, including use of chemicals
op4	Surface water discharge of (treated) wastewater, including monitoring
op5	Provision / selling of processed sludge to agricultural sector, including monitoring
op6	Financial and Administrative operations, including billing and external relations
op7	Expansion of current stage 1 Kigali Wastewater Project to stages 2, 3 and 4.

4.3.4 Decommissioning Phase

The decommissioning phase relates to the end of the project's life time, when the investments have fulfilled their purpose and it is decided to demolish or remove the physical project components. However, decommissioning of the Kigali wastewater Project, including the treatment plant or the sewer system is not expected in the coming decades. It is not foreseen that neither the WWTP nor the sewer system would be decommissioned after the lifetime of the system has passed. On the other hand, repair, replacement and expansion investments will be expected, since the need for sanitation in Kigali will increase over time and more and more sectors of the City will get connected to the system. The WWTP site is chosen to accommodate this increase in sewage collection at least for the coming 50 years.

However, whenever decommissioning would be decided, this will include rehabilitation of the sites used, including possibly landscaping and transfer of land ownership.

Table 13 – Decommissioning Phase

	Decommissioning (if any, at least >> 50 years?)
dc1	Decommissioning of wastewater management components
dc2	Rehabilitation of soil, waste and groundwater related pollution problems, if any
dc3	Landscaping and replanting
dc4	Transfer of land ownership

5 OTHER RELEVANT DEVELOPMENTS IN THE AREA

5.1 Other Water and Wastewater projects

Water Supply

The Government of Rwanda has made great progress in water supply and sanitation whereby 71% and 88% of rural and urban population respectively, have gained access to clean and safe drinking water. This is a result of political commitments under Economic Development and Poverty Reduction strategies (EDPRS I and II) and Rwanda Vision 2020. The government of Rwanda target is to achieve universal drinking water supply by 2017. Therefore, it is still a long journey to reach a secured and reliable water supply of Kigali City as the daily water demand of the population of CoK is estimated to 100,000m^3 while it is supplied with 65,000m^3. Hence there is a need to start new water supply projects to cover this gap of 35,000m^3 which will keep increasing[19]. The following two major water works supplying the CoK are located in the region of the WWTP project area of:

Nzove Water Treatment Plant (Nzove WTP)
Construction activities of the Nzove WTP started in 2003 and were completed in 2009. Located in Kanyinya Sector of Nyarugenge district, the water work was expected to produce 40,000 m^3/ day but till now it is supplying only 27,000 m^3/day. Water intake is composed of 32 drilled boreholes in the watershed of the Nyabarongo River. Water is pumped from underground aquifers to the conventional water treatment plant located in the same area. Then, treated water is supplied to service reservoirs through pipes crossing Nyabugogo River near Kiruhura before being distributed to the population of Kigali. To meet a growing water demand in Kigali City, WASAC LTD has launched in July 2015 an international request for expressions of interests to upgrade and rehabilitate Nzove WTP to reach its proposed capacity of 40,000m^3 per day[20]. The funding of approximately 75 million USD will be provided by the Government of Rwanda.

Kimisagara Water Treatment Plant
Kimisagara Water treatment plant (KWTP) is one of the oldest water works, supplying drinking water to the population of the CoK. Constructed in 1981-1988, KWTP produces over 20,000 m^3 per day. The source is composed of diverted intake structure constructed at the Yanze River in Kanyinya Sector with a sedimentation pond to reduce total suspended solids in raw water. From the pond, raw water is transported by gravity to the Kimisagara Water Treatment Plant in Kimisagara Sector. Raw water pipes cross Nyabugogo River and Nyabugogo-Gitikinyoni highway. Treated water is pumped to a service reservoir before distribution to the population of three districts of Kigali City.

Decentralized Wastewater Treatment

In the framework of the Kigali Master Plan it is compulsory for project developers of major new building projects to develop and finance a system of wastewater treatment before construction permits will be

[19] WASAC LTD, 2015. WASAC LTD in new drive to improve water supply : available at : http://www.WASAC Ltd.rw/index.php/media-centre/news/227-WASAC Ltd-in-new-drive-to-improve-water-supply. Accessed on 11 October 2015.

[20] WASAC 2015 International Request for Expressions for Upgrading and Rehabilitation of Nzove Water Treatment Plant (Provide Technical Resources for Rehabilitate and Upgrading the Existing Plant to 40,000 M3/D). Tender Reference Nº: 11.07.053/W/010/ICB/15-16/PROC-WASAC/MD/JS/lm.

issued. In practice many project developers have opted for the Airoxy® mechanical wastewater treatment plant concept, based on activated sludge treatment – SBR (Sequencing Batch Reactor). A list of some installed units, their capacities, owners and locations are summarized in below table. This table presents the installed or nearly completed mechanic WWTP units in the CoK with installed capacity greater than 200 PE (Source: ECO Protection Industrial area, 2013).

Table 14 – Installed or nearly completed decentralized WWTP units in the CoK

N°	WWTP owner	District	TYPE/capacity
1	Mille Colline Hotel	Nyarugenge	Airoxy 350 PE
2	Union Trade Centre (UTC)	Nyarugenge	Airoxy 800 PE
3	Kigali Investment Company (KIC)	Nyarugenge	Airoxy 2500 PE
4	RSSB-Grand Pension Plazza	Nyarugenge	Airoxy 800 PE
5	SONARWA	Nyarugenge	Oxyfix 200 PE
6	Mairie de la Ville de Kigali (City Council)	Nyarugenge	2 x Oxyfix 200 PE
7	Nobilis Hôtel	Nyarugenge	Oxyfix 250 PE
8	Chez Lando Hotel	Kicukiro	Oxyfix 200 PE
9	Sport View Hotel	Kicukiro	Oxyfix 200 PE
10	Ruterana Hôtel – Remera	Kicukiro	Oxyfix 200 PE
11	Groupe Scolaire Remera Catholique I	Kicukiro	Oxyfix 200 PE
12	SGIT - Ishema Evariste	Kicukiro	Oxyfix 200 PE
13	Hopital Militaire Kanombe	Kicukiro	Airoxy 1200 PE
14	R&B Estates	Kicukiro	Oxyfix 250 PE
15	BHR-Gaculiro/GPD	Gasabo	Airoxy 1700 PE
16	Maisons moyen standard (Thomas & Piron)	Gasabo	Airoxy 1050 PE
17	Gorillas Golf	Gasabo	Airoxy 350 PE
18	Lemigo Hotel	Gasabo	Airoxy 350 PE
19	Police Hospital	Gasabo	Airoxy 700 PE
20	Top Tower Hotel	Gasabo	Oxyfix 200 PE
21	One Dollar Campaign	Gasabo	Airoxy 700 PE
22	Nkundunkundiye Jean Bosco	Gasabo	Oxyfix 300 PE
23	Kacyiru Executive Apartments/RSSB	Gasabo	Airoxy 350 PE

PE: population equivalent

Other relevant water and wastewater projects ongoing in Kigali are:

- The preparation of designs, Employer's Requirements and tender documents for FIDIC Design-Build Contract(s) for the Kigali Wastewater Project, being carried out by Mott McDonald.
- The preparation of a financial and institutional Feasibility Study for the Kigali Wastewater Project, carried out by Atkins UK.
- The preparation of an urban sludge management concept, including designs, for Kigali and other cities, that is underway with funding from the GOR, underway.
- Assistance to water and sanitation by the World Bank through the Lake Victoria Environmental Management Program.
- Water and Wastewater Master Plan for Kigali.
- UN Habitat MoU with the Ministry of Infrastructure for urban planning

5.2 Kigali City Master Plan

The City of Kigali established in 1907 is among the fast growing cities in Africa in terms of economic development, population growth and rapid urbanization. In 2007 the CoK celebrated its 100 year anniversary, and developed the idea of developing a long term physical planning concept for the city to advance long sustainability of the city and its population.

Plans for developing a long term Kigali Conceptual Master (KCMP) was launched by the President of Rwanda HE Paul Kagame, and the project was implemented by the Ministry of Infrastructure having infrastructure and urban planning in its attributions. The study was completed in 2007 by OZ Architecture Team in 2007 and was officially approved by Rwanda Parliament in 2008.

The KCMP presents a broad vision and guidelines for the entire city, serving as the basis for more specific planning at the District, CBD and sub-area level. It presents the most advanced sustainability in land use, infrastructure, environment, society and economy. The development of KCMP considered six key drivers of sustainable development of the city and its people:

1. To guide short, medium and long term physical development, based on the economic vision for the City Business District (CBD) and the City.
2. To create state-of-the-art, attractive commercial and office spaces in the CBD which will help launch Kigali City as a regional hub.
3. To provide comprehensive mix use and housing components within the CBD.
4. To support development with efficient transportation and infrastructure facilities.
5. To conserve and enhance the natural and built assets.
6. To ensure adequate allocation of land for commercial, residential, infrastructure and public facilities in order and to create sustainable and high quality working and living environments[2122].

After adoption of the CoK Master, each district of the CoK developed its own detailed master plan, supplementing the initial KCMP developed in 2007.

The Nyarugenge district, in which the Kigali Wastewater Project is located, has completed its master plan in 2013, whereby each sector has a detailed planning[23]. All districts have acquired their physical master plan, In addition, the CoK developed a Transport Master Plan, aiming to make the CoK a future transit-Oriented City, with a Complete Transport System and with a sustainable transport network[24].

[21] Karunakaran A. and Damani H., 2010. Kigali City Sub-areas Planning, Detailed Master Plan and Urban Design Report for CBD1, CBD2 and Kimicanga, city of Kigali, Rwanda.

[22] S. Joshi, S. Joshi H. Damani, Juvena Ng and Lauwa L. 2013, Kigali City Master Plan report , Detailed Physical Plan for Gasabo and Kicukiro, Kigali

[23] Karunakaran A. and Damani H., 2010. Kigali City Planning, master plan report for Nyarugenge district, Volume 1.

[24] James Ellison J. A., Ang and Nugroho A. 2013. Kigali City Transport Master Plan Report, detailed physical plan for Gasabo and Kicukiro, Kigali

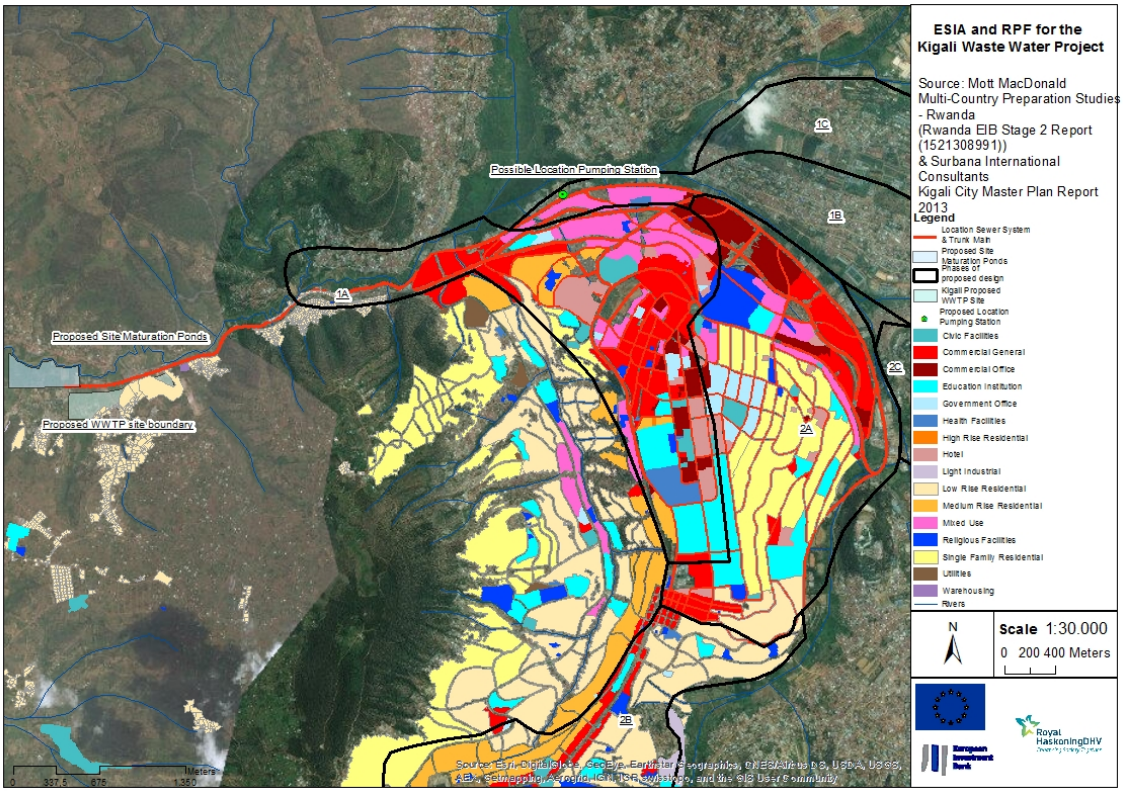

Figure 44 – Urban Master Plan for the Kigali Wastewater Project Region

The sewer network area includes distinct areas for governmental offices, educational facilities, low rise residential areas, single family residential areas and commercial offices, while the trunk main and wastewater treatment plants are along dedicated single family residential areas, agriculture and forest areas. Overall, the current wastewater treatment project seems in line with the Urban Master Plan, see also figure 16 before. An exception is the western part of the WWTP area and maturation ponds, located in dedicated wetland areas. This requires change of land use permissions from the responsible authorities, as well as following specific wetland protection measures including related zoning requirements.

6 INSTITUTIONAL SETTING, POLICIES AND STANDARDS

6.1 Institutional Setting

The Republic of Rwanda is divided into Provinces, Districts, Sectors and Cells. Rwanda is divided into five provinces with a total of 30 districts. The District is the basic political-administrative unit of the country. Each District is divided into a number of sectors, which are the political organs for policy-making decisions. The Sector Council's functions include approval of Sector action plans and programs and ensuring the follow-up of their implementation. One sector includes a series of cells, or villages in the urban and rural areas, managed by the Cell Council. All citizens resident in the Cell of or above the age of 18 are members of the Cell Council. The Cell Council mobilizes the residents of the Cell, identifies, discusses and prioritizes the problems of the Cell, and takes decisions for their resolution.

The Kigali Wastewater Projects is situated in the Nyarugenge District within the Kigali Province. This district contains 10 sectors, including Gitega, Kanyinya, Kigali, Kimisagara, Mageragere, Muhima, Nyakabanda, Nyamirambo, Nyarugenge and Rwezamenyo. The sectors relevant for the Kigali Wastewater Project are presented in below map.

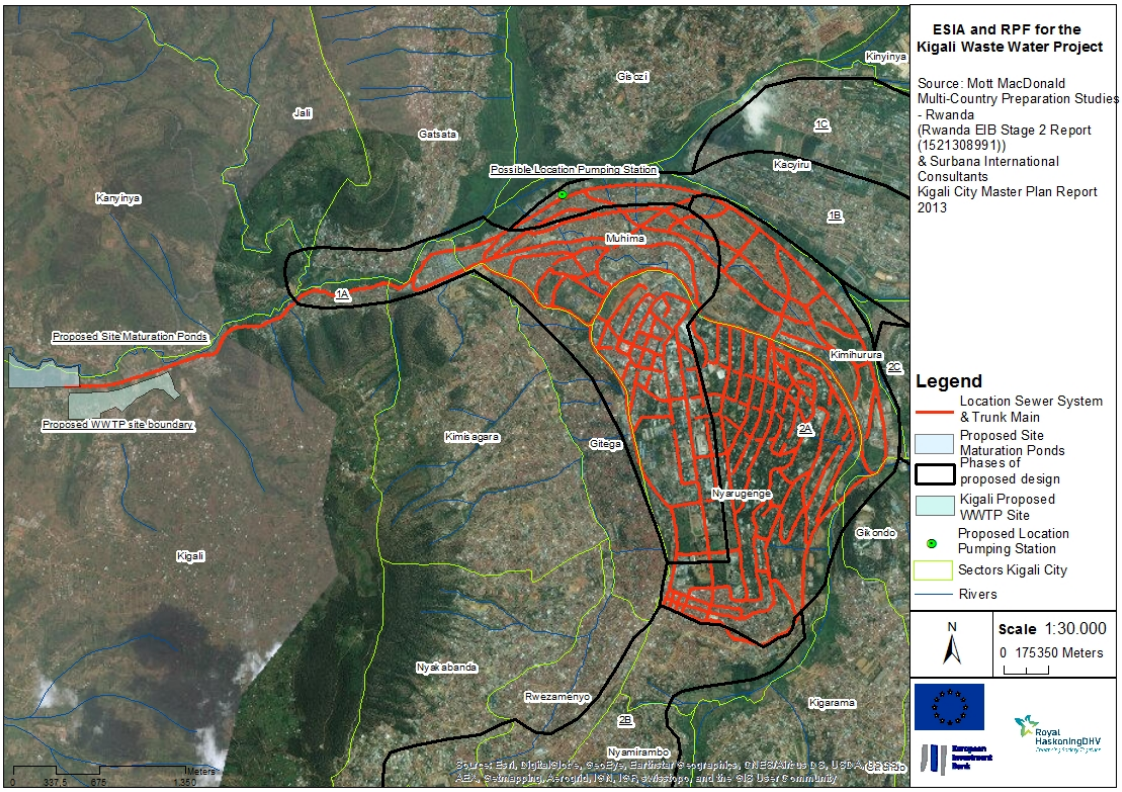

Figure 45 – Relevant Sectors for the Kigali Wastewater Project

The boundaries of the Cells within these districts are presented below.

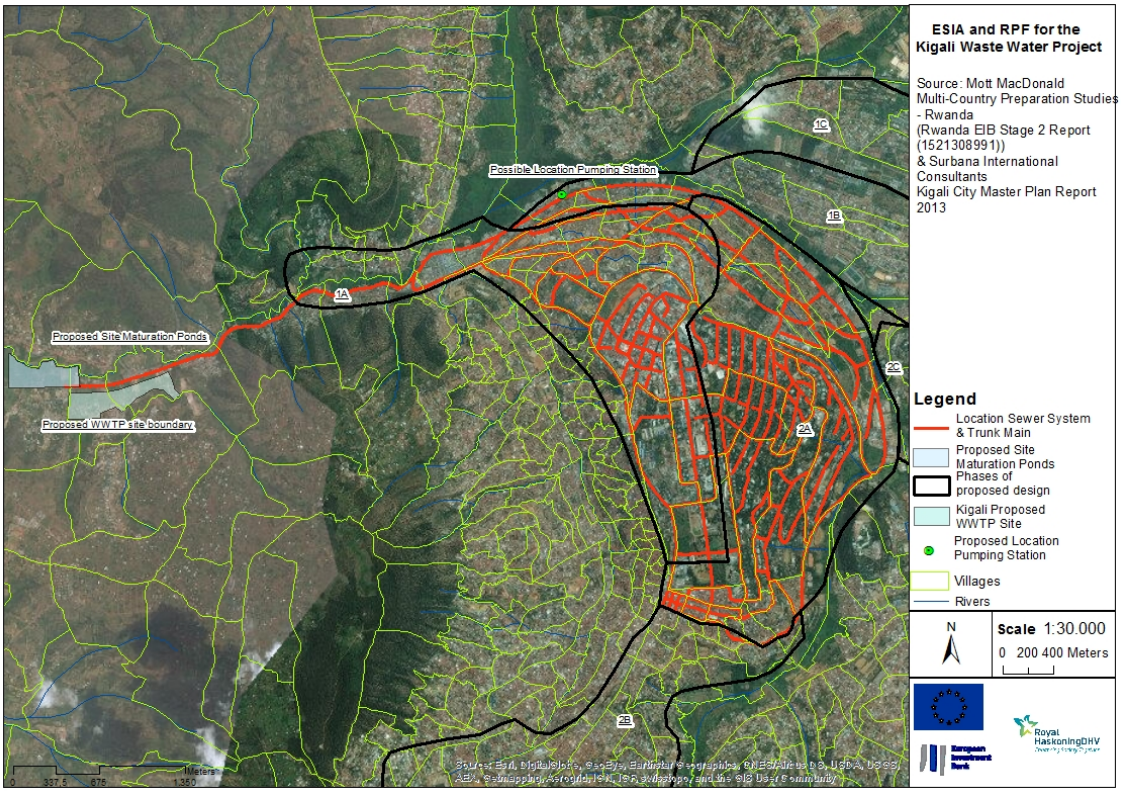

Figure 46 – Cell Boundaries in the Project Area

Other institutional Governmental and Non-Governmental stakeholders relevant for this project are the following:

Promoter

The *Water and Sanitation Corporation Limited WASAC LTD* is promoter of the Kigali Wastewater Project. It is the public company providing water supply and wastewater collection services to the people of Kigali and other areas in Rwanda. It has been established in 2014 as the result of a division of the previous Energy, Water and Sanitation Authority (EWSA) into a water service provider (WASAC LTD) and a separate energy service provider (REG). WASAC LTD falls under the responsibility of the Minister of Infrastructure (MININFRA). WASAC LTD will be the owner and operator of the wastewater facilities under the current Kigali Wastewater Project. The wastewater management related activities and ambitions of WASAC LTD are largely steered by the Kigali Storm Water and Wastewater Master Plan, issued in 2009.

Steering Committee

A Steering Committee has been established for the Kigali Wastewater Project, including representatives of CoK, WASAC LTD, MINECOFIN, REMA and MININFRA. The Permanent Secretary in MININFRA is the chair person and CEO of WASAC LTD is the deputy chair person. The committee members meet on regular basis to oversee implementation of the WWTP, including preparation of this ESIA.

MININFRA

The Ministry of Infrastructure (*MININFRA*) is responsible for developing policies and laws of water/sanitation, energy, transport development, housing and meteorology. MININFRA supervises the functioning of a number of public agencies, including WASAC LTD. MININFRA promotes the Kigali

Wastewater Project as part of their policy objectives. MININFRA is Chair of the Steering Committee of the project.

Local Administration
The capital of Rwanda, Kigali, is governed by the Council of the *City of Kigali (CoK).* The City of Kigali is divided in three districts and 35 admistrative sectors. It is responsible for planning and management of the city's development and providing municipal services to its population. The city has today a population of about 1.2 Million and is expanding rapidly. Consequently the CoK has identified a series of development objectives in its Vision 2020 City Development Plan. The urban development of the CoK is largely steered by the Kigali Urban Master Plan (2013). In terms of water and sanitation the objectives are to provide fully wastewater collection and treatment services throughout the city, to protect the environment; improve public health; and to facilitate private investments in the city's economy. The CoK takes a leading role in communication with the affected communities and the expropriation and compensation process. CoK is an important member of the Steering Committee for the Kigali Wastewater Project.

Nyarugenge District is the district, in which the main components of the project are located. The district Land Bureau is supporting the expropriation by managing cadastrial and the land ownership data, providing an overview of the sectors affected by the project, these are: Kigali, Kimisagara, Muhima and Nyarugenge.

RDB
The *Rwanda Development Board (RDB)* provides support to the development of the private sector, and aims to stimulate business development, investments and innovation in the national economy. Since recent, the issuance of the Environmental Impact Assessment Certificate is done by the RDB as part of the One-Stop-Centre for investors. It was recently suggested they will become part of the Steering Committee.

REMA
The *Rwanda Environmental Management Authority (REMA)* is mandated to facilitate coordination and oversight of the implementation of national environmental policy and legislation. It plays a key role in reaching the sustainable development goals as set in out in the Rwanda Development Vision 2020, particularly in terms of addressing urgent environmental issues such as pollution control and preservation of natural resources in sectors and domains such as agriculture, water, mining, forestry, waste and wastewater management. REMA used to be the Authority, who reviews and approves the ESIAs and issued the ESIA Clearance Certificate. However, this is now incorporated in the One-Stop-Centre of the RDB. REMA still supports the RDB in their review of ESIAs. REMA is member of the Steering Committee of the project.

MINECOFIN
The *Ministry of Finance and Economic Planning (MINECOFIN)* was formed in March 1997 from the joining of the Ministry of Finance and the Ministry of Planning, to better co-ordination between finance and planning. MINECOFIN is the author of the Vision2020. The Ministry will act as direct counterpart to the European Investment Bank (EIB) within the scope of the Kigali Wastewater Loan Agreement, and is therefore an important member of the current Steering Committee.

RNRA
Rwanda Natural Resources Authority (RNRA) under the Ministry of Natural Resources (MINIRENA) created in 2011 by merging the Rwanda Geology and Mines Authority (OGMR), National Land Centre, National Forestry Authority and the department of Integrated Water Resources Management (IWRM). This agency keeps all data and documentations related to the above mentioned resources. Also cadastral information is held by RNRA. It was recently suggested they will become part of the Steering Committee.

RURA
The *Rwanda Utilities Regulation Agency (RURA)* was established in 2001. It regulates public utilities including telecommunications and ITC; postal services; energy storage, transport and supply; and water and sanitation. This task includes setting up guidelines; licensing; ensuring compliance with laws and regulations and protecting the consumers' interests. RURA will also be the regulator of the Kigali Wastewater management operations.

RSB
The *Rwanda Standards Board (RSB)*, a public institution is responsible for the development of Standards, Conformity Assessment and Metrology and providing related services. It issues a wide variety of standards. Those relevant for the Kigali Wastewater Project include water quality standards; wastewater treatment standards; waste disposal standards; occupational health and safety standards; acoustic, vibrations and air quality standards. These standards have been obtained and will be applied in the current environmental and social impacts assessment.

RTDA
The Rwanda Transport Development Agency (RTDA) is a public institution, under the Ministry of Infrastructure (MININFRA), responsible for managing all day-to-day aspects of the transport sector in Rwanda.

FONERWA
The Environment and Climate Change Fund is a cross-sectoral financing mechanism to achieve development objectives of environmentally sustainable, climate resilient and green economic growth it is supervised by MINIRENA

MINAGRI
The Ministry of Agriculture is responsible for agriculture, soil management, irrigation, animal husbandry, as well rural water resources and land management, mining and geological exploration

RPSF
The Rwanda Private Sector Federation (RPSF) promotes and represents the interests of the Rwandan business community

Ministry of Local Government
The Ministry of Local Government connects other ministries and government agencies with administrative entities such as provinces, districts and sectors

MINISANTE
The Ministry of Health (MINISANTE) aims at improving the health of the people of Rwanda, through coordinated interventions by all stakeholders at all levels, thereby enhancing the general well-being of the population and contributing to the reduction of poverty.
RTDA
The Rwanda Transport Development Agency (RTDA) manages all aspects of the transport sector in Rwanda.

RHA
The Rwanda Housing Authority manages rural and urban planning, housing and infrastructure development.

Vulnerable People's Governmental Organisations

To ensure that the perspective and needs of vulnerable people is incorporated in the design and implementation of the project, organisations representing and advocating the perspective of vulnerable people have been identified.

NCPD

The *Governmental National Council of Persons with Disabilities (NCPD)* is a forum for advocacy and social mobilization on issues affecting persons with disabilities in order to build their capacity and ensure their participation in national development. The Council assists the Government to implement programs and policies that benefit persons with disabilities: **(http://www.ncpd.gov.rw/index.php?id=23&no_cache=1).**

NAWOCO

The *National Women's Council (NAWOCO)* (http://www.migeprof.gov.rw/index.php?id=194) is a social forum where girls and women pool their ideas in order to solve their own problems and to participate in the development of the country. The Council resides under the Ministry Of Gender And Family Promotion and has Councils at District Level.

Non-Governmental Organisations (NGOs)

The NGO sector in Rwanda is not very well developed. NGOs established by Rwandan people are limited in number, members and influence. NGOs need to be registered by the Government to be able to manage funds and implement projects. In practice activities are implemented through Governmental Institutions, with support of NGOs in some cases. NGOs targeting at water and sanitation issues are rare.

NUDOR

For this project the NGO *National Union of Disabilities' Organisations of Rwanda (NUDOR)* (http://nudor.org/), has been identified, to secure input from the perspective of vulnerable people with disabilities. NUDOR exists to strengthen the voice of the disability movement in Rwanda. It is an umbrella organisation established in 2010 by eight organisations of persons with disabilities. Together NUDOR and its nine members are working so that persons with disabilities can enjoy the equal rights to which they are entitled.

Consultants

Next to *HaskoningDHV Nederland B.V.*, the EIB assigned *Mott MacDonald (MMD)* for the design of the WWTP and collection system. They are involved since 2013 and have prepared several reports. It is foreseen that the detailed design will be completed by March 2016. *Atkins* is currently preparing a feasibility study, looking at the institutional, legal, financial and economic aspects of the Kigali Wastewater Project.

6.2 National Strategies, Regulations and Standards

6.2.1 Economic Development Strategy

The Rwandese water sector is guided by two main economic development strategy documents: Rwanda's overall development strategies of Vision 2020 and the Economic Development Plan EDPRS. These strategies contain also generic objectives for the water sector. The EDPRS 2 which runs from 2012/13-2017/18 has set targets for the water supply and sanitation sector, aiming to reach 100% coverage rate for water supply by 2017. This target is a revision of the targets set in Vision 2020, which aimed to reach this coverage level by 2020.

The EDPRS 2 has prioritized water supply and sanitation services as a critical thematic service that will contribute significantly to attainment of the social and economic growth needed for Rwanda during the next five years. It is from this perspective that WASAC LTD needs to ensure effective delivery of adequate, reliable, and sustainable services.

Besides the two development strategic plans mentioned above, the Millennium Development Goals have also influenced the targets for water and sanitation coverage. The sector policy that is defined in the National Water & Sanitation Policy (2010) translates these general development objectives into policy statements per sector.

The Water and Sanitation Sector Strategic Plan 2013/14 - 2017/18 is a thorough and detailed Plan designed to assist implementation of the main strategic documents. It also provides an implementation and financial framework for different regions, including Kigali City, and the northern, western, southern and eastern districts.

Targets include 100% rural water supply by 2018, 100% safe, reliable and affordable urban water supply by 2018 and strengthening of related water service providers; improved sanitation services, including 100% coverage for schools, health facilities and other public institutions by 2018, and development of safe, well-regulated and affordable facilities for wastewater management, including sewerage, treatment and reuse / disposal for densely populated areas by 2018.

6.2.2 National Regulations

Environmental Legislation and Regulations

This section provides an overview of the legal and institutional framework which encompasses the Rwandese regulations and international conventions, treaties and standards to be followed in implementation of Kigali Wastewater Project.

The constitution of Rwanda of 4th June 2003 and amendments addresses environmental issues and ensures the protection and sustainable management of the Rwanda environment and encourages rational use of environmental resources. In the constitution article 49 states that every citizen is entitled to a healthy and satisfying environment. Every person has the duty to protect, safeguard and promote the environment. The state shall protect the environment. The law determines the modalities for protecting, safeguarding and promoting the environment. Furthermore, the Government of Rwanda has signed and ratified several international conventions and treaties for the protection and conservation of environment (Table 1).

Vision 2020 and EDPRS1/2

In the economic development poverty reduction strategies covering the period 2008-2012 (EDPRS1), and next for the period 2013-2018 (EDPRS2), the Government of Rwanda presents a mid-term programme and pillars to achieving the vision 2020 aspirations consider environment protection as cross cutting issue.

In terms of water and sanitation, the government aims at having by 2020 full water supply and sanitation for all rural and urban areas. Each town will be endowed with an adequate unit for treating and compressing solid wastes for disposal. This includes development of safe, well-regulated and affordable off-site sanitation services (sewerage and sludge collection, treatment and reuse/disposal) for densely populated areas. The 100% coverage targets for schools, health facilities and other public institutions and locations are set for 2017/18.

The Government of Rwanda has furthermore rectified the following international treaties and conventions.

Table 15 - Conventions and Treaties ratified by the Government of Rwanda

Conventions and treaties	Date of signature	Approval by GoR
International convention on biological diversity and its habitat signed in RIO DE JANEIRO in BRAZIL	5 /06/ 1992	18 /03/ 1995
United Nations framework convention on climate change signed in RIO DE JANEIRO in BRAZIL	5 /06/ 1992	30 /05/ 1995,
STOCKHOLM convention on persistent organic pollutants	22/05/ 2001	08 /07/2002,
BASEL convention on the control of transboundary movements of hazardous wastes and their disposal	22/03/1989	24/08/2003
ROTTERDAM international convention on the establishment of international procedures agreed by states on commercial transactions of agricultural pesticides and other poisonous products	11/09/1998	24/08/2003
MONTREAL international convention on depletion of the ozone layer	1997	24/08/2003
CARTAGENA protocol on biosafety to the convention of biological biodiversity	15-26/05/2000	29/12/2003
KYOTO protocol to the framework convention on climate change	06/03/1998	29/12/2003
RAMSAR international convention on wetlands of international importance, especially as waterfowl habitats	2/02/1971	29/12/2003
BONN Convention on conservation of migratory species of wild animals	23/06/1979	29/12/2003
Washington agreement on international trade in endangered species of wild flora and fauna	03/03/1973	25/06/1980

However, the ratification and implementation of the above treaties and policies were very limited up to 2003, as the environment sector was controlled by the Ministry of Agriculture (MINAGRI) like in many other African countries. In 2003 environmental issues were transferred to the Ministry of Natural Resources (MINIRENA) and the establishment of the Rwanda Environment Management Authority (REMA) took place in 2005.

The Organic Law N^{o} 04/2005 of 08/04/2005 was promulgated with the goal of determining the modalities of protection, conservation and promotion of the environment in Rwanda. Article 5 shows the responsibilities of the GoR to establish a national policy of protection, conservation and promotion of the environment, to develop strategies and plans and additional programs aiming at ensuring the conservation and effective use of the environment. Article 6 of the same law states the fundamental right of every person in Rwanda to live in a healthy and balanced environment and the obligations to contribute individually or collectively to the conservation of natural heritage, historical and socio-cultural activities. Articles 85 to 113 of this law

determine preventive provisions and punitive sanctions of individuals or groups of people who do not comply with this law. This law (articles 65, 67 and 68) established the Rwanda Environment Management Authority (REMA) as an implementing agency of this law. REMA was created by the Act N^{o} 16/2006 of 03/04/2006 determining the organization, functioning and responsibility of REMA (Republic of Rwanda, 2005).

The proposed WWTP and related maturation ponds are located in dedicated wetlands areas according the Organic Law of Rwanda No 04/2005 of 08/04/2005. In line with the legal requirements under this Law, particularly article 87 related to construction of wastewater treatment plants in wetlands (rivers, lakes and big or small swamps), a Permit request for construction of this WWTP and maturation ponds have been issued by WASAC LTD to the Ministry of Natural Resources (MINIRENA) in June 2016.

The proposed project is consistent with Article 83 of the Organic Law N° 04/2005 of 08/04/2005, which "prohibits dumping wastewater into wetlands, except after treatment in accordance with instructions that govern it".

Other Rwandese policies and laws dealing with environmental protection for sustainable development are:

1. The law on land use and management, (Organic law N° 08/2005 of 14/07/2005)
2. The law on forestry, No 47/1988 of 5 December 1988.
3. The water law, (Law N°62/2008 of 10/09/2008)
4. The land title and registration law, (Ministerial order N°002/2008 of 01/4/2008)
5. Ministerial order establishing the list of protected animal and plant species (Ministerial order No 007/2008 of 15/08/2008)
6. Ministerial order relating to the requirements and procedure for environmental impact assessment(ministerial order n° 003/2008 of 15/08/2008)
7. Ministerial Order determining modalities of establishing and functioning of occupational health and safety committees (Ministerial Order N°01 du 17/05/2012)
8. National Strategy on Climate Change and Low Carbon Development for Rwanda , DOI 10.4210/SSEE.PBS.2011.0002
9. the national land policy, 2004
10. the water and sanitation policy, 2004
11. the five year strategic plan for the environment and natural resources, 2009-2013, developed in 2009.
12. the mines and geology policy,2004.
13. National Forestry policy, May 2010
14. The ministerial order no. 004/2008 of 15/08/2008 establishing the list of works; activities and projects that have to undertake an environmental impact assessment
15. RURA, 2009: Standards on the Management of Waste Disposal Site (Landfill). The location and substances not to dump in a land fill
16. Ministerial Order N°004/2008 Of 15/08/2008 Establishing The List Of Works, Activities And Projects That Have To Undertake An Environment Impact Assessment
17. Law N°10/2012 Of 02/05/2012 Governing Urban Planning and Building In Rwanda
    Article 27: Hygiene and sanitation in buildings intended for public use Buildings intended for public use shall be built in accordance with hygiene and sanitation rules
    enacted by an Order of the Minister in charge of urban planning and building
18. Ministry of Lands, Environment Forests, Water and Natural Resources 2004: Sectorial Policy On Water And Sanitation
19. Organic Law N° 04/2005 Of 08/04/2005 Determining The Modalities Of Protection, Conservation And Promotion Of Environment In Rwanda
20. Law Nº16/2012 Of 22/05/2012 Determining The Organization, Functioning And Mission Of The

National Fund For Environment(FONERWA)

21. Ministerial Order determining the list of prohibited plains to constructions N°005/16.01 of 15/07/2010 (Nyabugogo and Nyabarongo) plains are included
22. Ministerial Order N°006/16.01 of 15/07/2010 establishing special regulations relating to burying toxic wastes
23. 2009: RURA: Directives On Minimum Requirements For Liquid Wastes Disposal And Treatment
24. Ministerial Order preventing activities that pollute the atmosphere N°003/16.01 of 15/07/2010 List gas polluting emissions are mentioned
25. Ministerial Order N0 007/2008 Of 15/08/2008 Establishing The List Of Protected Animal And Plant Species hippopotamuses and crocodiles found in Nyabarongo River included
26. Law governing land in Rwanda N° 43/2013 of 16/06/2013
27. Law No 46/2013 Of 16/06/2013 establishing the Rwanda Development Board (RDB) and determining Its Mission, Organisation and Functioning in its article 4 of and helping investors to meet environment standards.
28. Law N°24/2012 of 15/06/2012 relating to the planning of land use and development in Rwanda
29. Law putting in place the use, conservation, protection and management of water resources Regulations N°62/2008 of 10/09/2008
30. Law N° 32/2015 of 11/06/2015 Relating to Expropriation in the Public Interest replacing 2007 expropriation law

Environmental Management

The Ministry of Natural Resources (MINIRENA) was established to ensure sustainable environmental management and rational use of natural resources. All environmental matters in Rwanda are the responsibilities of the MINIRENA with the main role of preparing and ensuring the follow up and evaluation of policies and strategies related to natural resources protection and management. The institutional framework for environmental management is set out in the Organic Law determining the modalities of protection, conservation and promotion of the environment in Rwanda, published in the Official Gazette RWA Nº 9 of the 1st May 2005, particularly in Chapter III relating to the establishment of the institutions.

Article 65 of the Organic Law establishes the Rwanda Environment Management Authority (REMA) as being responsible for managing environmental issues in Rwanda with a duty to implement policies and laws related to the environment. REMA was established under the Organic Law (No. 04/2005 of 08/04/2005) and given responsibility to oversee, co-ordinate and supervise the Environmental Impact Assessment (EIA) process, compliance and monitoring in Rwanda.

REMA is an agency affiliated to MINIRENA with a mandate of supervision, following and ensuring that issues relating to the environment receive attention at all levels and has the duty of implementing policies and laws related to the environment. Even though the agency is under the ministry it has a legal status of financial and administrative autonomy.

However, the responsibilities for EIA review and approval have recently been transferred from the REMA to the Department of Environmental Compliance of the Rwanda Development Board (RDB) in order to help and facilitate investors to meet environmental standards.

Environmental Impact Assessments

The EIA process in Rwanda provides a justification and a basis for future international cooperation and also aids in conflict resolution concerning environmental impacts at a regional level. The Organic Law n°004/2008 of 15/08/2008 establishes the list of works; activities and projects that have to undertake an EIA (see below table). They are classified into 4 categories: infrastructure, agriculture, works in park and in

its buffer zones and mine extraction (Republic of Rwanda, 2008). According to that law, the Kigali Wastewater Project falls in categories I for infrastructure of water distribution and sanitation network.

Table 16 - List of projects, activities subject to EIA study in Rwanda

Infrastructure (I)	Agriculture (II)	Parks (III)	Mining (IV)
Construction and repair of international roads, national roads, district roads and repair of large bridges; Construction of industries, factories and activities carried out in those industries; Construction of hydro- dams and electrical lines; public dams for water conservation, rain water harvesting for agricultural activities and artificial lakes; Construction of oil pipelines and its products, gases and storage tanks; terminal ports, airports, railways, car parks; hotels, large public buildings, water distribution network , sanitation; public land fills; slaughter houses; hospitals;, stadiums, large markets and initial installation of communication Infrastructures.	Agricultural and breeding activities which use chemical fertilizers and pesticides in wetlands and large scale monoculture Agricultural practices such as tea, coffee, flowers and pyrethrum, etc. Works and activities that use bio-technology to modify seeds and animals	Works in parks and in its buffer zone	Work of mines extraction

EIA Procedure

The EIA procedure in Rwanda includes 5 steps: (1) project application and registration, (2) screening, scoping and terms of reference, (3) EIA study and report, (4) submission of an EIA report and finally (5) decision making. They are explained in below table.

Table 17 – EIA Stages and Procedures

Stage	Procedure
1. Project application and registration	The developer submits a project registration and application to RDB including a brief description of the project applying for EIA Clearance Certificate.
2. Screening, scoping and terms of reference	The screening process consists of evaluation and analysis of the project description with the outcome of informing the developer whether the project requires some further environmental analysis or not or if the project requires a full EIA. The Project will be categorised by RDB to determine the level of EIA required. Scoping involves input of relevant lead agencies, stakeholders and the developer. The scoping report is also used to provide information to communities in areas affected by the Project. The scoping report is submitted to RDB for review and incorporated in the terms of reference for serving as authorisation for the developer to start an EIA study. The terms of reference should include the issues that need to be assessed during the impact study.

Stage	Procedure
3. EIA study and report	In this step EIA experts produce an EIA Report which includes development of an environmental management plan (EMP). The developer submits the EIA Report and a written addendum, both documents signed by the EIA project leader. The RDB organises a public hearing during which the developer presents the project before issuing an EIA certificate of authorisation (EIACA). If the project is rejected the developer addresses his appeal to the MINIRENA. Upon project completion or relocation, the developer prepares a decommissioning plan to submit to the RDB.
4. Submission of an EIA report	The developer submits the EIA and a written addendum to the RDB.
5. Decision making	The RDB organises a public hearing during which the developer presents the project before issuing an EIA certificate of authorisation (EIACA). Upon project completion or relocation, the developer prepares a decommissioning plan to submit to the RDB. This plan must include a description of the existing environmental conditions and proposed restoration measures.

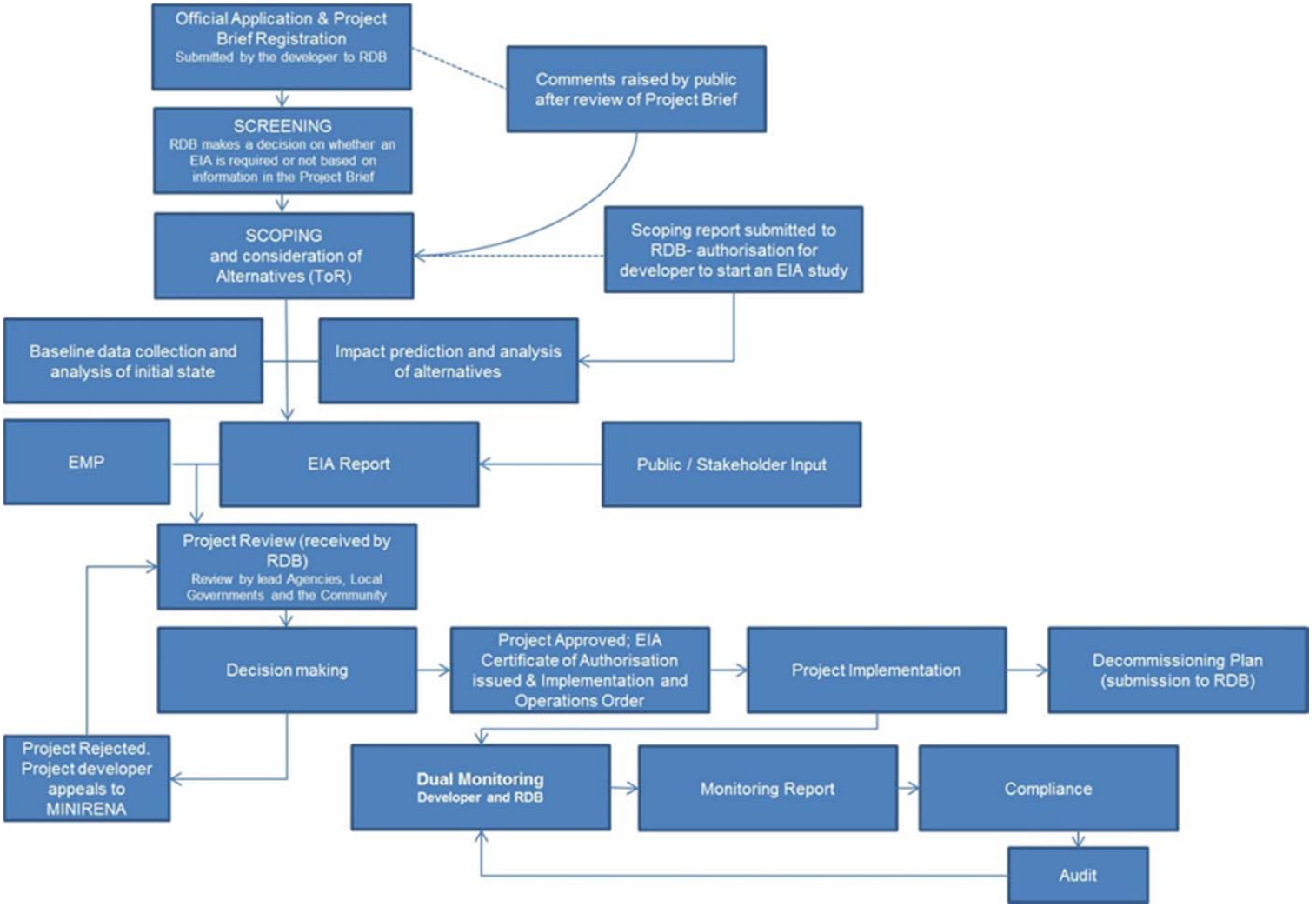

Figure 47 – EIA Procedural Flow Chart (REMA, 2006)

Once the Draft EIA and related Environmental Management Plan (EMP) have been prepared the developer signs and submits these reports to the RDB, who next organises a public hearing, during which the developer presents the project. Once the EIA and EMP have been finalized and approved, the RDB will issue an EIA Certificate of Authorization (EIACA). RDB is need a maximum of 22 days between submission of the EIA and EMP, and issuing the EIACA.

If the EIA would be rejected by RDB, the developer may address his appeal to the MINIRENA. If on the other hand the EIACA has been provided, the developer shall also prepare and submit a decommissioning plan to the RDB. This plan shall include a description of the current existing environmental conditions and proposed restoration measures after decommissioning of the project. Finally, the developer shall also to submit an annual environmental monitoring report and an environmental auditing report to RDB, as demanded by REMA (REMA, 2006).

Relevant national environmental publications in this respect are the following:

- MINECOFIN, 2000: *Rwanda vision 2020*. MINECOFIN-Ministry of Finance and Economic Planning, Kigali, Rwanda, 29 pp.
- MINECOFIN, 2007: *Economic development & poverty reduction strategy (EDPRS) 2008 – 2012.* Ministry of Finance and Economic Planning, Kigali, Rwanda, 166 pp.
- REMA, 2006: *General guidelines and procedures for environmental impact assessment.* Rwanda Environmental Management Authority, Kigali, Rwanda, 52 pp.
- Republic of Rwanda, 2005: Organic Law no. 04/2005 of 08/04/2005 determining the modalities of protection, conservation and promotion of environment in Rwanda. Official Gazette of the Republic of Rwanda.
- Republic of Rwanda, 2008: The ministerial order no. 004/2008 of 15/08/2008 establishing the list of works; activities and projects that have to undertake an environmental impact assessment. Official Gazette of the Republic of Rwanda.
- Republic of Rwanda, 2010: Government program 2010-2017. Republic of Rwanda, Kigali, Rwanda, 64 pp.

6.2.3 National Environmental Permits and Standards

The following table provides an overview of the national permits required for the construction, operation and decommissioning of the WWTP.

Table 18 – Required Permits related to the WWTP

General Construction Permits Required	Issuing Authority	Reference	Current Status
Application for authorisation for EIA study	Rwanda Development Board (RDB)/ Rwanda Environment Management Authority (REMA) by the law	EIA general guideline (2006) Ministerial Order N° 003/2008 of 15/08/2008 relating to the requirements and procedure for EIA study	Obtained in November 2015
Approval on terms of references for EIA study	Rwanda Development Board (RDB)/ Rwanda Environment Management Authority (REMA) by the law	EIA general guideline (2006) Ministerial Order N° 003/2008 of 15/08/2008 relating to the requirements and procedure for EIA study	Obtained in November 2015
EIA certificate of Authorisation (EIACA)	Rwanda Development Board (RDB)/ Rwanda Environment Management Authority (REMA) by the law)	Environmental organic law (2005) and EIA general guidelines (2006) Ministerial Order N° 003/2008 of 15/08/2008 relating to the requirements and procedure for EIA study	After EIA report submission and approval by RDB/REMA
Permit for construction of a waste water treatment plant in wetlands (rivers, lakes and big or small swamps)	Ministry of Natural Resources (MINIRENA)/Rwanda Natural Resources Authority (RNRA)	Environmental organic law (2005)	Before construction activities commence
Building Permit	District level approval required.	Law governing urban planning and building in Rwanda (2012)	Before construction activities commence
Occupancy permit	District level approval required.	Law governing urban planning and building in Rwanda (2012)	After WwTP commissioning
Demolition permit	Rwanda Housing Authority	Law governing urban planning and building in Rwanda (2012)	After the life of the WwTP
Permit of provision of liquid waste management services	Rwanda Utilities Regulatory Agency (RURA)	Required under the law ° 39/2001 establishing RURA and the Directives on minimum requirements for liquid wastes disposal and treatment (2009)	During operation of the plant
Transportation and collection of liquid waste permit	Rwanda Utilities Regulatory Agency (RURA)	Required under the law ° 39/2001 establishing RURA and the Directive on minimum requirements for liquid wastes disposal and treatment (2009)	During operation of the plant
Management of waste disposal site	Rwanda Utilities Regulatory Agency (RURA)	Standards On The Management Of Waste Disposal Site (2009)	During operation of the plant

In addition, the following standards issued by the Rwanda Standards Board have been assessed against the proposed Kigali wastewater project

RS 109 2009 Water Quality – tolerance limits of industrial wastewater discharge

These sets of standards prescribe, among others, the effluent standards related to wastewater or effluent from the last stage of a wastewater treatment plant as follows:

Table 19 – Effluent Standards for treated domestic wastewater (RS 109 2009)

S/N	Parameter	Limits	Test methods
		Treated	
1	TDS mg/l	<1500	ISO 6107-2
2	TSS mg/l	<50	ISO 11923
3	pH	5-9	ISO 10523
4	Nitrates mg/l	<20	ISO 5663
	Nitrites mg/l	<2	ISO 6777
	Total Nitrogen	<30	ISO 11905
5	Total Phosphorus mg/l	<5	ISO 6878
6	Temperature variation of treated water compare to ambient temperature of water °C	<3	Thermometer[1]
7	BOD5 mg/l	<50	ISO 5815-2
8	8 COD mg/l	<250	ISO 6060
9	Faecal Coliforms /100ml	<400	ISO 4831
10	Oil and grease mg/l	<10	ISO 9377-2
11	Chlorine mg/l	<2	ISO 7393
12	Sulphate mg/l	<500	ISO 22743
13	Color Pt-Co	<200	ISO 7887

The Design Criteria Report for the proposed WWTP (2013) speaks about the effluent quality as follows: “the approach to effluent quality for stage 1 will be to achieve the best results it can within the limits of the defined process. During stage 1 a fully activated sludge treatment step will be included, treating 100% of the wastewater against the following effluent criteria:

- BOD - <25mg/L
- Ammonia <5 mg/L
- SS <50 mg/L

It may be concluded that the effluent of the WWTP will likely meet the national effluent standards. However, monitoring of the effluent quality will be an important aspect during the operations.

RS 126 1 to 4 Wastewater construction and safety principles

The regulation prescribed a series of requirements and standards in terms of design , structural and equipment components of wastewater treatment installations, which shall be fully met. The general standards include aspects related to:

- Discharge limits
- Capability to treat full range of flows and loads
- Personal safety
- Nuisance, odor, noise, toxicity, aerosols and foam emission limitations
- Provisions for operation and maintenance
- Cost efficiencies (OPEX and CAPEX)
- Energy consumption
- Waste production

Design criteria include, for instance, the need for:

- Sufficient stand-by capacities
- For maintenance purposes, possibility of bypassing every unit
- Emergency power generation
- Chemical storage
- Leak prevention

In addition, this regulation prescribes that where significant emission to the environment is likely as a result of the operation of a wastewater treatment plant, such emission shall be abated by special measures relating to structures, equipment and methods of operation, due consideration being given to the distance of the area to be protected from the treatment plant. Emission of odor, noise and pollutants (e.g. oil and grease) shall be prevented by means of suitable structures, equipment and mode of operation.

RS 180 and 181 2013 Solid waste disposal - Code of practice

Regulation RS 180 specifies that guidelines for safe disposal of solid waste, including soil, surface water and groundwater protection and vector risks: living animals including insect or other arthropod which are capable of transmitting an infectious disease from one organism to another, air quality and management of explosive gases. It further regulates licenses required for waste disposal and daily operational safety requirements.

This regulation is relevant for the WWTP where is concerns on site storage of waste, generated by the plan operations, as well as the requirements for the sludge drying beds, particularly in terms of prevention of emissions to soil and water, and related to odor emissions.

RS 183 2013 Occupational Health and Safety requirements

The RS 183 Occupation Health and Safety (OHSAS) Standards are intended to provide organizations with the elements of an effective OH&S management system that can be integrated with other management requirements and help organizations achieve OH&S and economic objectives. It refers to the following international standards:

- RS ISO 19011 *Auditing quality management systems*
- RS ISO 9000, *Quality management systems -- Fundamentals and vocabulary*
- RS ISO 14001 *Environmental management Systems*

It does not state specific OH&S performance criteria. In the context of the current Kigali Wastewater Project however it is advised to follow these OH&S principles, such as during:

a. routine and non-routine activities;
b. activities of all persons having access to the workplace (including contractors and visitors);
c. workplace human behavior, capabilities and other human factors;
d. hazards originating outside the workplace capable of adversely affecting the health and safety of persons under the control of the organization within the workplace;
e. hazards created in the vicinity of the workplace by work-related activities under the control of the organization;
f. infrastructure, equipment and materials at the workplace, whether provided by the organization or others;
g. changes or proposed changes in the organization, its activities, or materials;
h. modifications to the OH&S management system, including temporary changes, and their impacts on operations, processes, and activities;
i. any applicable legal obligations relating to risk assessment and implementation of necessary controls (see also the NOTE to 3.12);
j. design of work areas, processes, installations, machinery/equipment, operating procedures and work organization, including their adaptation to human capabilities.

RS 236 2014 Acoustics and Noise Pollution Tolerance limits

This Standard prescribes maximum allowable noise limits in industrial, commercial, residential and silence zone areas in respect to human beings. It also lay down sound level requirements for indoors of non-industrial buildings.

The following limits have been set:

Table 20 – Rwandese Ambient Noise Emission Standards

Area Code	Category of area	Limit in dB, Max.	
		Day time	Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential area	55	45
D	Silence Zone	50	40

The noisiest phase is expected during the project's construction phase as result of trucks, unloading of materials and during construction works. Specific attention will be required to minimize noise nuisance during construction, particularly for the living area directly south of the WWTP.

During operations however, wastewater treatment plants generally generate noise levels not above 20 Decibels (dB), well below the above day time national threshold of 50 dB set for residential areas.

RS 237 2014 Vibration Tolerance Limits

This standard specifies limits for general vibration including occupational environment and air overpressure. It states that any land within 10 m of a residence, in which people could reasonably expect to be free from

undue annoyance and nuisance caused by vibration. The 10 m will be measured from the boundaries of the property.

Some vibrations may be expected during the project's construction phase as result of ground and construction works. However, during operations, wastewater treatment plants do not generate vibrations that create annoyance or nuisance.

RS EAS 751 and 752, Air Quality Tolerance Limits

These standards provide guidelines as well as air quality limit levels. The limit levels are the binding and shall be used for regulatory purposes. The guidelines are based on studies that indicate safe levels averaged over relatively longer periods and mostly, they are derived from WHO Guidelines.

The following ambient air immission standards have been set.

Table 21 – Rwandese Ambient Air Quality Standards

	Pollutant	Time weighted Average				Test methods
			Industrial area	Residential, Rural & Other area	Controlled areas***	
1.	Sulphur oxides (SO_X);	Annual Average*	80 μg/m^3	60 μg/m^3	15 μg/m^3	IS0 4221-1980
		24 hours**	125 μg/m^3	80 μg/m^3	30 μg/m^3	
		Annual Average		0.019 ppm/50μg/m^3		
		Month Average				
		24 Hours		0.048ppm /125μg/m^3		
		One Hour				
		Instant Peak		500 μg/m^3		
		Instant Peak (10 min)		0.191 ppm		
2.	Oxides of Nitrogen (NO_X);	Annual Average*	80 μg/m^3	60 μg/m^3	15 μg/m^3	ISO7996: 1985
		24 hours**	150 μg/m^3	80 μg/m^3	30 μg/m^3	
		8 hours				
		Annual Average		0.2 ppm		
		Month Average		0.3 ppm		
		24 Hours		0.4 ppm		
		One Hour		0.8 ppm		
		Instant Peak		1.4 ppm		
3.	Nitrogen Dioxide	Annual Average	150 μg/m^3	0.05 ppm		IS0 6768:1998

	Pollutant	Time weighted Average				Test methods
			Industrial area	Residential, Rural & Other area	Controlled areas***	
		Month Average		0.08 ppm		
		24 Hours	100 μg/m^3	0.1 ppm		
		One Hour		0.2 ppm		
		Instant Peak		0.5 ppm		
4.	Suspended particulate matter (SPM)	Annual Average*	360 μg/m^3	140 μg/m^3	70 μg/m^3	ISO 9835:1993
		24 hours**	500 μg/m^3	200 μg/m^3	100 μg/m^3	
			Industrial area	**Residential, rural & other area**	**Controlled areas*** **	
		mg/Kg				
		Annual Average****		100 μg/m^3		
		24 hours***		180 μg/m^3		
5.	Res-pirable particu-late	Annual Average*	70 μg/m^3	50 μg/m^3	50 μg/m^3	ISO 9835:1993
		24 hours**	150 μg/Nm^3	100 μg/Nm^3	75 μg/Nm^3	
6.	$PM_{2.5}$	Annual Average	35 μg/m^3			ISO 9835:1993
		24 hours	75 μg/m^3			
7.	Lead (Pb)	Annual Average*	1.0 μg/Nm^3	0.75 μg/Nm^3	0.50 μg/m^3	ISO 9855:1993
		24 hours**	1.5 μg/m^3	1.00 μg/m^3	0.75 μg/m^3	
		Month Average		2.5		
8.	Carbon monoxide (CO)/ carbon dioxide (CO_2)	8 hours**	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3	ISO 4224:2000
		1 hour	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3	
		mg/Kg				
		24 hours**				
9.	Non-methane hydrocarbons					
		instant Peak	700ppb			
10.	Total VOC	6 mg/m^3				ISO16000-6
11.	Ozone	1-Hour	200 μg/m^3	0.12 ppm		ISO 13964
		8 hour (instant Peak)	120 μg/m^3	1.25 ppm		

In addition, these regulations prescribe emission limits, particularly for Sulphur oxides, carbon monoxide, total organic carbon, dust, Nitrogen oxides and lead.

At the Kigali WWTP, contaminants such as pathogens, Nitrogen oxides and volatile organic compounds can become airborne in the process of treating the water, especially at sites of gaseous releases or mechanical agitation, such as aeration, or mechanical oxidation. Another common site of high airborne emissions can be at the exit of the trunk main towards the WWTP.

Confined spaces are especially important for WWTP employees if they receive minimal ventilation. This would allow emissions to accumulate in these places at unusually high concentrations.

The currently available design documents do however not predict emission level for various stages of the wastewater treatment plant. And considering the proximity of living areas at the WWTP is it advised to assess these emission levels during the design phase and evaluate them against the standards provided in this regulation. In case of exceeding air quality standards, measures are proposed similar to the proposed mitigation of smell nuisance.

In addition it is advised to include sufficient ventilation in the design at all confined spaces at the WWTP and pumping station.

6.2.4 Related Sector Policies

Health Sector Policy

The 2015 Health Sector Policy of the Ministry of Health confirms that infectious diseases are the primary cause of outpatient morbidity in health centers. Acute Respiratory infections and malaria account for well over half of the outpatient morbidity (61.9%). This highlights the importance of introducing wastewater treatment in the country, reducing diseases related to poor sanitation and wastewater disposal. The policy also emphasizes on the role of environmental and health promotion activities in most of the villages in the country conducted by hygienic clubs. These clubs are responsible for promoting hand washing, introduction of improved latrines and other behavior change.

Agricultural Policy

The absence of sufficient minerals and other natural resources, low purchasing power of the population and low level of industrialization in a landlocked country like Rwanda explains why agricultural sector is among the key drivers of economic growth and sustained development of achieving EDPRS I and II as well as Vision 2020. Ministry of Agriculture shares responsibilities with MINIRENA related to land, water and environment management and with MININFRA for the responsibilities related to road infrastructure and energy which facilitate intensification and modernization of agriculture in the country. The fact that the WWTP is partly located in agricultural productive area (rice and sugar cane cultivation) and a flood-prone area makes it an inter-ministerial project. And as the project is located in marshland, the policy states that any big marshland development activities is subject to environmental impact assessment.

Land Use Policy

Rapid population growth, reduction in availability of farm land, excessive cultivation of high slopes land make Rwanda’s soil susceptible to continuous and excessive degradation. The loss of land is considerable and they were estimated between 0 and 557 tons / ha per year. The sediment load transported in the Nyabarongo River was estimated between 51 kg/s and 44kg/at Kigali and Kanzenze respectively and this sediment load goes down to 26 kg/s for Akagera River at Rusumo. The range of variation of these losses is from 33 to 288 kg of total suspended solids per second. Inadequate management of natural resources leads to land degradation by the aggressiveness of rainfall and slope of hills exploited. This environmental degradation is manifested in a way marked by water erosion that strips a significant portion of cultivated land. Water erosion is estimated to decrease the country's capacity to feed 40,000 people a year and in addition it brings the total annual losses due to poor soil conservation estimated at 945 200 tonnes of organic materials, 41,210 tons of nitrogen, 280 tons phosphorus and potassium 3055 tons for the whole country. It is expected that the Kigali Wastewater Project will contribute to the reduction of sediment load in the catchment and organic and inorganic pollution level in Nyabugogo and Nyabarongo Rivers.

National Water Resources Management Policy

The policy indicates a need to develop and implement guidelines for the issuance of permits for water abstractions and wastewater discharges and for compliance monitoring and penalties for non-compliance. This policy shows that pollution from point and non-point sources, including agricultural chemicals, inappropriate human settlements and poor urban and industrial waste management are the major issues of resources management in Rwanda.

Labor Legislation

Law N° 13/2009 of 27/05/2009 regulates labor in Rwanda, like labor relations between workers and employers [18]. The labor law includes requirements for leave, agreements, wages and additional compensation, working hours, work injury benefits, fair and equal treatment, family responsibilities, maternity conditions, health and safety, sick leave, social security and the freedom to join and form a Union, collective bargaining and the right to strike.

The official minimum working age in Rwanda is sixteen years old. A child aged between sixteen (16) and eighteen (18) may be employed under certain conditions that the daily rest period for a child worker must be at least 12 consecutive hours. A child has to be employed in work which is proportionate to his/her capacity. A child cannot be employed in the nocturnal, laborious, unsanitary or dangerous services for his/her health as well as his/her education and morality.

There are no regulations in Rwanda to promote recruitment of Rwandese staff, by setting a certain share of Rwandese staff in organizations or contractors of foreign origin.

Gender Issues

The fundamental principles article 9 of the chapter 2 of the Rwanda Constitution of 2003 states that building a state governed by the rule of law, a pluralistic democratic government, equality of all Rwandans and between women and men reflected by ensuring that women are granted at least 30% of posts in decision making organs.

Law Determining The Mission, Organization And Functioning Of The National Women's Council[19] and has two main responsibilities to build women's capacity and to conduct advocacy on serious issues affecting the development and the rights of women (article 5).

Law N°59/2008 of 10/09/2008 on prevention and punishment of gender- based violence. In its article 4: It is forbidden to harass to deprive one's spouse of the right to property and to employment.

Law N° 51/2007 of 20/09/2007 determines the responsibilities, organisation and functioning of the gender monitoring office in Rwanda. One of the specific responsibilities is to monitor how fundamental principles of gender are respected in all organs at governmental, private, non- governmental and religious levels.

Occupational health and safety

The Labor Law contains clauses on the responsibility of the employer to provide healthy and safe working conditions, protective equipment, emergency response, training and free access for labour inspections.

Ministerial Order N°02 of 17/05/2012, determines 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. Also it states the modalities of establishing and functioning of occupational health and safety committees for any institution or company employing at least twenty (20) workers and operating in the industrial sector, public works and construction or engaged in mechanical works or mining. This order also provides a list of occupational and health safety equipment and first aid training to accomplish their tasks as well as their mode of monitoring and reporting.

6.3 International ESIA Policies and Standards

6.3.1 EIB / EU

Environmental Impact Assessment (EIA) is a key instrument of European Union environmental policy. Since passage of the first EIA Directive in 1985 (Directive 85/337/EEC) both the law and the practice of EIA have evolved. An amending Directive was published in 1997 (Directive 97/11/EC) and the European Commission published guidance documents reflecting current EU legislation and the current state of good practice. In 2014 this directive was again amended with the Directive 2014/52/EU, particularly on the assessment of the effects of certain public and private projects on the environment.

The EIB Statement of Environmental and Social Principles and Standards and the EIB Environmental and Social Practices Handbook are consistent this EU environmental policy. In line with these guidelines, the EIB requires that all promoters apply good international practices in these respects. The relevant standards are identified in discussions between the Bank and the promoter during project preparation, appraisal and negotiation and shall be applied by the promoter during project implementation and operation.

According to these guidelines, EIB-financed projects should include measures to prevent, reduce or eliminate pollution that arises directly or indirectly from their activities. The Bank requires its promoters to apply point source-specific emission standards according to the IPPC Directive (primarily targeting the industrial sector) and sector-specific Directives, e.g. the Water Framework Directive31. The IPPC a approach is based on “best available technology” (BAT), which among other things requires a rational approach to resource use, including best practice measures in the field of energy efficiency.

According to the EIB guidelines, ambient standards that relate to accumulated pollution in air, water and soils are also determined by the requirements of EU Directives, and projects financed by the EIB are required to contribute to ensuring the relevant ambient standard is met.

For projects in countries outside the EU, such as Rwanda, the EIB requires that all projects comply with national legislation, including international conventions ratified by the host country, as well as EU standards. Where EU standards are more stringent than national standards, the higher EU standards are required, if practical and feasible.

The social standards of the EIB are intended to promote outcomes to the benefit of individual well-being, social inclusion and sustainable communities. Outside the EU and enlargement countries, the approach of the EIB to social matters is based on the rights-based approach mainstreaming the principles of human rights law into practices through the application of its Social Assessment Guidelines. Specific social standards relevant for this ESIA are:

5. Cultural heritage
6. Involuntary Resettlement

7. Rights and Interests of Vulnerable Groups
8. Labor Standards
9. Occupational and Public Health and Safety
10. Stakeholder engagement (see also the separate Stakeholder Engagement Plan)

In the context of the Kigali Wastewater Project, this ESIA has been prepared to be consistent with these EIB guidelines. This ESIA furthermore advises that the national Rwandese standards with regard to emissions and ambient environmental quality, are sufficient and in line with the guidelines for EIB-financed projects in Rwanda.

6.3.2 World Bank

The World Bank has developed a series of environmental assessment policies and guidelines, including the Environmental Assessment Sourcebook; the Operational Policy OP 4.01 for Environmental Assessments, and the related Bank Procedures 4.01 for Environmental Assessments.

The Environmental Assessment Sourcebook is designed to assist all those involved in environmental assessment (EA), Its aim is that sustainable development is achieved most efficiently, and that negative environmental impacts are identified and addressed at the earliest possible planning stage. The Sourcebook provides practical guidance for designing sustainable projects assisted by the World Bank.

The sourcebook includes a series of guidelines related to performance of the EIA, including a prescription of the review process, guides for addressing global and cross sectoring issues; inclusion of social and cultural issues and strengthening of local capacities and institutional during the monitoring and implementation of environmental actions. The World Bank is keen on ensuring that the project affected people, the community and local NGO's are involved in the EIA process as well.

This ESIA, including the separately issued Stakeholder Engagement Plan and Resettlement Policy Framework have been performed and drafted in line with these World Bank policies and guidelines.

7 ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Introduction

This section provides the Environmental Impact Assessment, based on the national Rwandan ESIA and international frameworks and taking stock of the ESIA already prepared in 2009. The Consultant has reviewed the site selection process, existing environmental and social documentation, expropriation plans, technical design documentations and other relevant Project documentation prepared under various stages of the Project planning. The work furthermore included assessment of project development and permitting issues as well as other project preparation activities undertaken to date.

7.2 Area of Influence

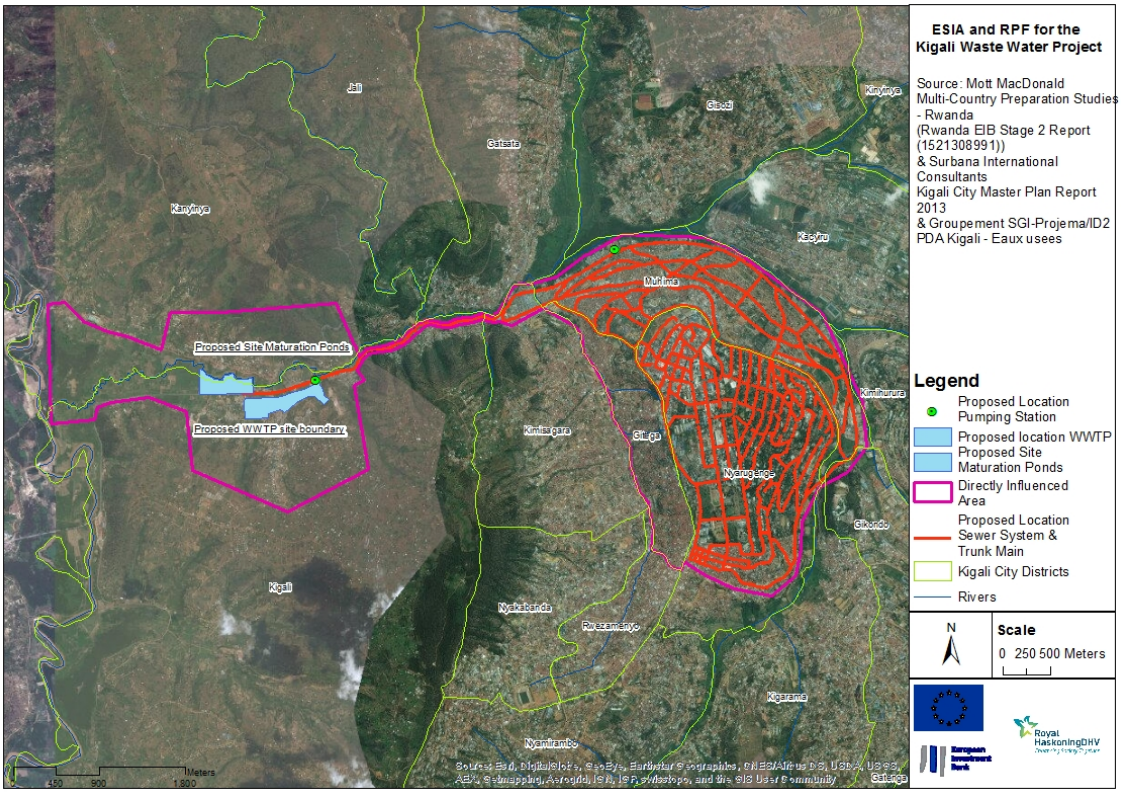

Figure 48 – Area of Influence

The Kigali Wastewater Project has an impact directly on those areas that will be used for constructing the various project components, including the resettlement related impacts. In addition, it will have a direct influence on a wider region around these areas, as shown on above map.

The sewer collection areas 1a and 2a are located on a hill. See also figure 3 Topography. Rainwater and collected wastewater currently drains down to the valley surrounding this hill, as indicated by the purple boundary around these areas in above figure. From here the water flows mainly towards the Nyabugogo River. As the project will manage these wastewater flows, its area of influence corresponds to this boundary.

The area around the wastewater treatment plant and maturation ponds will be influenced by the project in terms of surface water quality impacts in the Nyabugogo River, and noise and air quality emissions. This area of influence surrounds the plant and ponds as indicated above. During later stages the project will also influence wider regions, such as the water quality in the Nyabarongo River downstream of the Nyabugogo River, and additional wastewater collection areas that will be connected to the sewer system. However, this goes beyond the area of influence during the current stage 1.

7.3 Environmental Impacts

Overviews of all environmental impacts that have been identified are described in the following impact table. The individual impacts have been numbered for reference with the description of the significant environmental impacts in the next section, and the environmental and social management plans following afterwards.

This Impact table provides characteristics of each impact, including its relative significance. It contains the following information:

1. Project phase related activity, as described in section 4.3
2. Receptor of the potential impacts in terms, like the communities, the ecosystem, air, soil, groundwater, river system;
3. Description of the nature of the impact;
4. Direction of the impact: positive or negative direction;
5. Severity of the impact: degree of effect on the physical, ecological or social functions or process in minor, moderate or major terms;
6. Duration of the impact: temporary or permanent;
7. Scale of the impact: the geographical extent, that the impact can be encountered in local, regional and global extent;
8. Likelihood that the impact will occur: unlikely, possible and likely; and
9. Significance of the impact indicates the relative importance of the impact, based on a combination of the severity, duration, scale and likelihood (numbers 5, 6, 7 and 8 above) of the impact, as given in the columns before. In the table the significance is indicated in major, moderate and minor.

The significance of the impacts is expressed as follows:

Table 22 – Definition of Significance Classification in Annex 1

Nature	Significance	Description
Positive	Major	Very substantial improvement to existing resources
Positive	Moderate	Appreciable improvements or will sustain resources
Positive	Minor	Some benefits
Negative	Minor	Acceptable negative effects
Negative	Moderate	Effects cause serious concerns. Mitigation measures should be considered.
Negative	Major	Unacceptable effects. The project should not proceed unless design and/or management of the project is changed so that the significance of this impact is reduced to acceptable levels

Table 23 – Environmental and Social Impact Table

No	Activity	Resources use	Emissions	Impacts and risks	Receptor	Direction	Magnitude	Duration	Scale	Likelihood	Significance
						Positive	*small*	*Temporary*	*Local*	*Likely*	*Minor*
						Negative	*medium*	*Permanent*	*Regional*	*Possible*	*Moderate*
						Neutral	*high*		*Global*	*Unlikely*	*Major*
	Overall										
A1	The proposed Kigali Wastewater Project aims at collecting and treating wastewater generated in parts of the Kigali, the capital of Rwanda. The project includes the realization of a sewer network covering the Nyarugenge and Muhima areas of Kigali, a trunk main crossing Kimisagara and Kigali sectors and a wastewater treatment plant with related sludge processing facilities and maturation ponds	See below	See below	Improved public health conditions and environmental conditions in and around Kigali due to prevented inflow of raw sewage in open drainage and surface water, reducing water-borne diseases and pollution	Local residents, employees and visiters, Surface and groundwater, environment	+	*High*	*Permanent*	*Regional*	*Likely*	*Major*
				Enhancement of programmes for health improvement programmes	Residents of Kigali City	+	*Medium*	*Permanent*	*Regional*	*Likely*	*Moderate*
				Improved economic development perspectives for the CoK, specifically the business centre, due to good sanitation facilities	Residents of Kigali City and possibly extending to nation-wide	+	*Medium*	*Permanent*	*Regional*	*Likely*	*Moderate*
			Culumative Impacts	Cumulative impacts of disturbance of construction works of traffic congestion, dust, noise	Local residents, environmental resources	-	*Medium*	*Temporary*	*Regional*	*Possible*	*Moderate*
	Preparation Phase										
P1	Surveys and field investigations	Transport means, field equipment	Dust, noise, fume, soil distortion, nature distortion	Minor distortion of land and narure during sampling and test drilling	project area, including wetland	-	*small*	*Temporary*	*Local*	*Likely*	*Minor*
				Risk of creating unrest with local residents and businesses as result of surveys	local residents	-	*medium*	*Temporary*	*Local*	*Possible*	*Minor*
P2	Site Selection and buffer zones	site selection	site selection	Site Selection / Location alternatives for WWTP and trunk main: what argumentation and considerations have been put forwards to select the proposed sites?	project area, including wetland	+	*High*	*Permanent*	*Regional*	*Likely*	*Major*
		buffer zone	within buffer zone	land use restrictions will apply directly above and around the trunk main and also above and around the WWTP footprint (Zone A). For safety and security of the local communities and the environment, the National Legislation provides that a safety zone of at least 20 m should be assigned and maintained , thus being an Indirect Area of Influence or Zone B	Buffer zone around project area	+	*High*	*Permanent*	*Regional*	*Likely*	*Major*

No	Activity	Resources use	Emissions	Impacts and risks	Receptor	Direction	Magnitude	Duration	Scale	Likelihood	Significance
						Positive	*small*	*Temporary*	*Local*	*Likely*	*Minor*
						Negative	*medium*	*Permanent*	*Regional*	*Possible*	*Moderate*
						Neutral	*high*		*Global*	*Unlikely*	*Major*
	Preparation of detailed design										
P3	Design WWTP and Maturation Ponds	energy	climate	Confirm why 4 sedimentation tanks are required instead of 2 in the water line	Climate	0	*small*	*Permanent*	*Local*	*Possible*	*Moderate*
P4		energy	climate	Confirm that Digester is designed optimally, considering one single digestor through the use of boiler to create optimized temp of 30 degrees C.	Climate	0	*small*	*Permanent*	*Local*	*Possible*	*Moderate*
P5		energy	power supply	Reliability of Power Supply	Environment	-	*high*	*Permanent*	*Regional*	*Unlikely*	*Moderate*
P6		Design Effluent	water pollution	Design Effluent quality shall be confirmed	Surface water	+	*high*	*Permanent*	*Regional*	*Likely*	*Moderate*
P7											
P8		WWTP and Maturation Ponds	flooding risks	Are WWTP and maturation ponds well designed to address potential flood risks?	Surface water, wetland	-	*high*	*Temporary*	*Local*	*Likely*	*Moderate*
P9		WWTP and Maturation Pond	loss of wetland and biodiverisity	Is there a need for offsetting loss of wetland or biodiversity due to construction of the WWTP and maturation pond in dedicated wetlands?	wetland / ecosystems	-	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
P10		WWTP	Odour	Ensure that the applied wastewater and sludge management technologies doe not have a negative impact in terms of odour on the surrounding inhabitants	Affected People	-	*high*	*Permanent*	*Local*	*Likely*	*Major*
P11		WWTP	GHG Emissions	Gas emissions from WWTP	Climate	-	*medium*	*Permanent*	*Regional*	*Likely*	*Minor*
P12		WWTP	Footprint	Land use and Expropriation cost	Economy	-	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
P13		WWTP	Access Road to Hinterland	Mobility of Project Affected People	PAP	-	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
P14		WWTP	Local Water Supply	Project Affected People	PAP	-	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
P15		WWTP	Water Quality Monitoring	Environment	Environment	-	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*

No	Activity	Resources use	Emissions	Impacts and risks	Receptor	Direction	Magnitude	Duration	Scale	Likelihood	Significance
						Positive	*small*	*Temporary*	*Local*	*Likely*	*Minor*
						Negative	*medium*	*Permanent*	*Regional*	*Possible*	*Moderate*
						Neutral	*high*		*Global*	*Unlikely*	*Major*
P16		WWTP	Sludge Management	Enable reuse of sludge for agricultural purposes	Agriculture	+	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
P17		WWTP	Wastewater Reuse Options	Agriculture, water management	Agriculture	+	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
P18		Maturation Ponds	Malaria risks	Increased malaria risks due to open surface water of maturation ponds	Affected People	-	*medium*	*Permanent*	*Local*	*Likely*	*Moderate*
P19		Maturation Ponds	Local Football Field	Project Affected People	PAP	-	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
P20	Trunk Main	Resettlement	Social	Current proposed trunk main crosses through existing houses north of main road, resulting in resettlement requirements	Affected People	-	*high*	*Permanent*	*Regional*	*Likely*	*Major*
P21		Road Expansion	Government	Planning of Construction Planning of Trunk Main route vs Road Expansion Plans.	Affected People		*medium*	*Temporary*	*Local*	*Likely*	*Moderate*
P22	Sewer Connections	Sewer	PAP	Risk that households do not get connected	Households in sewer network area	-	*Medium*	*Temporary*	*Local*	*Likely*	*Moderate*
P23		Sewer	PAP	Sanitation services of Project Affected People	Households along Trunk Main	-	*Medium*	*Temporary*	*Local*	*Likely*	*Moderate*
	Completion FS Finance, Institutional, Legal issues	none	none								
P24	Completion of RPF, RAP and Land Acquisition Plans (RAP and LAP are not part of this assignment)	Project at large	Houses and Livelihood of people using the land of the area of the WWTP and maturation ponds (sugar cane, other) may be affected.	Identification and compensation of affected people, according compensation principles and resettlement process	Affected People	-	*high*	*Permanent*	*Regional*	*Likely*	*Major*
P25	Preparation and implementation of SEP	Social	PAP	Opportuninities for stakeholders to be involved in the project preparation process resulting in a more widely supported and better project	all stakeholders	+	*mediuim*	*Permanent*	*Regional*	*likely*	*Major*
	Final Decision Loan Agreement EIB	none	none								
	Preparing Construction Tender Documents	none	none								
	Permits to Construct and Operate	none	none								
	Tendering, tender evaluation and contract awarding of Construction Works	none	none								

No	Activity	Resources use	Emissions	Impacts and risks	Receptor	Direction	Magnitude	Duration	Scale	Likelihood	Significance
						Positive	*small*	*Temporary*	*Local*	*Likely*	*Minor*
						Negative	*medium*	*Permanent*	*Regional*	*Possible*	*Moderate*
						Neutral	*high*		*Global*	*Unlikely*	*Major*

	Construction Phase										
C1	Fields Surveys and Final Construction Designs by Selected Contractor	Transport means, field equipment	Dust, noise, fume, soil distortion, nature distortion	Minor distortion of land and narure during sampling and test drilling	project area, including wetland	-	small	Temporary	Local	Likely	Minor
C2	Sub-surface infrastructure		Sub-surface infrastructure protection	Ensure that existing sub-surface infrastructure (power lines, water supply, fibre cables, sewer lines) is not affected by the project	Sub-surface infrastructure	-	*medium*	*Permanent*	*Local*	*Possible*	*Moderate*
C3	Preparing / Implementation of Construction Environmental Management Plan by Contractor		Environmental and Social Issues	Implementing the CEMP will mitigate the identified environmental impacts during construction works	Project area, Affected people,	+	*High*	*Temporary*	*Regional*	*Likely*	*Major*
	Operational Phase										
OP1	Ensure that ESMP is implemented			Implementing the ESMP will mitigate the identified environmental impacts during the operations	Project area, Affected people,	+	*High*	*Permanent*	*Regional*	*Likely*	*Major*
	Decommissioning (if any, at least >> 50 years?)										
DC1	Decommissioning of wastewater treatment and collection components			Loss of jobs in treatment plant operation & maintenance	Employees in WWTP operation & maintenance	-	*Medium*	*Permanent*	*Local*	*Likely*	*Moderate*
DC1	Remaining soil, waste and groundwater related pollution problems, if any, after decommissioning	transportation, temporary material storage	Dust, noise, exhaust fume, risk of fuel spill, GHG, traffic congestions and safety issues	depending of origin of materials, transport logistics and related traffic safety issues are to be considered. Also on site storage issues are to be considered	Traffic	-	*medium*	*Temporary*	*Locally*	*Likely*	*Moderate*
DC3	Land use Functions after decommissioning	soil, groundwater, transportation	pollution risks	Any soil or groundwater pollution shall be rehablitated after decommissioning of the Plant	soil, groundwater, waste	-	*medium*	*Permanent*	*Local*	*Likely*	*Minor*
DC4	Transfer of land ownership	Land Use	Land Use	Land becomes available for other purposes	CoK	+	*Medium*	*Permanent*	*Regional*	*Likely*	*Moderate*
		soil, groundwater, vegetation, social issues	soil, water quality, ecology	Landscaping and replanting will be required after decommissioning	Project area	-	*medium*	*Permanent*	*Local*	*Likely*	*Moderate*

7.4 Review of Project Design Documents

7.4.1 Review of Wastewater Treatment Plant Design

Within the framework of the ESIA, the current design documents have been assessed against potential environmental impacts. Below table provides the design flows and loads for the WWTP..

Table 24 – WWTP Design flows and loads (2014)*

Parameter	unit	value
Flows		
dry weather flow	m3/h	481
peak factor	–	2
maximum flow	m3/h	961
total flow	m3/d	11 532*
Loads		
BOD	kg/d	6 158
NH4-N	kg/d	924
TP	kg/d	*154*

*** The latest 2016 calculation of Mott McDonald foresee in an average treated effluent flow of 6,800 m3 / day in 2020**

It is noted that the available information provides only a value for the Ammonia – Nitrogen (NH4-N) concentration, whereas Kjeldahl Nitrogen would be a more correct measure. Normally, some 70-80 % of the nitrogen in wastewater is in the form of ammonia, which will be present in organic compounds as well. The latter will give rise to more ammonia generation during degradation. We conclude that the design of the aeration capacity, the design value for ammonia nitrogen may need to be 25% higher.

For the design a temperature of 20 °C has been used. From data available through the internet it seems that water temperature may be expected to vary between 20 and 26 °C, which is well within the range.

Effluent standards
Clear effluent standards for the plant as a whole have not been presented. The activated sludge process, which will cater for only 25% of the flow, will comply with the following standards:

- BOD_5 < 25 mg/L
- Ammonia < 5 mg/L
- SS < 50 mg/L

Evaluations of the other design components are presented in below tables. These tables provide a comparison between the provided design and a set of parallel calculations performed by the ESIA team. Separate tables are presented for the water line, the maturation ponds and the sludge line.

Table 25 – Assessment of the Water Line

Parameter	Unit	provided	ESIA review	comment	OK?
primary sedimentation					
Diameter	M	13	12.40	See above	
Selector					
Volume	m3	178	178	The provided volume seems to be in accordance with design criteria on contact time , BOD loading rate and COD flow loading.	OK
biological volume					
MLSS	g/l	2.5	–	Apparently, English speaking countries have the habit to adopt rather low values for the design MLSS. Calculation of the optimum sludge concentration results in a higher value of MLSS, of 3.6 g/l. It may be commented that the difference (in investments costs) between the two is very low, less than 2%.	OK
SVI	ml/g	–	150	Design value for the (stirred) sludge volume index has not been presented. According to Dutch guidelines[25], a value of 225 ml/g would lead to the adopted surface loading rate of 0.65 $m^3.m^{-2}.h^{-1}$., at MLSS = 2.46 g/l. Normally a SVI of 150 ml/g would be adopted. In this respect, the design is very conservative.	OK
SRT	D	7.02	4.0	It is not quite clear how the SRT of 7.02 days for full nitrification has been arrived at. German guidelines[26] would give a much lower value, of 4 d at 20 °C. A 4-day SRT would lead to a much smaller biological volume: according to the reviewer's calculations a volume of 950 m3 would be sufficient for nitrification. The volume provided will	OK

[25] Ekama G A, J L Barnard, F W Günthert, P Krebs, J A McCorqoudale, D S Parker & E J Wahlberg 1997. Secondary settling tanks - Theory, modelling, design and operation. IAWQ Scientific and technical report no. 6. IAWQ, England, 1997.

[26] Wiedenhöft C (ed) 2005. Merkblätter band 53. Bemessubng Kommunaler Abwasserreinigungen - Hinweise für die Bemessung von Belebungsanlagen mit dem Programm ARA-BER version 5. Landesumweltamt Nordrhein-Westfalen, Essen, Duitsland.

Parameter	Unit	provided	ESIA review	comment	OK?
				certainly be sufficient.	
Volume	m3	1 738	–	The volume provided may be sufficient for significant denitrification, which will improve effluent quality, and also lower the risk on rising sludge (due to gas evolution as a result of denitrification) in the final sedimentation tanks.	OK
aeration capacity					
Number	–			Although surface aeration is preferred, the values presented refer to fine bubble aeration. I would calculate 2 x 80 kW surface aerators, with provisions (such as draft tubes) to cater for the relatively large water depth of 5.75 m.	
Capacity	–				
final sedimentation					
Number	#	1	1		
side wall depth	M	3	2.5		OK
Volume	m dia	22	21.70		OK

The main conclusions of this evaluation are that four primary sedimentation tanks are envisaged, whereas two or even one seems more reasonable; the surface aeration apparently is preferred, but the figures provided pertain to fine bubble aeration. However, in general the provided technological design of the water line may be considered safe.

Table 26 – Assessment of the Maturation Pond

Parameter	Unit	provided	ESIA review	Comment	OK?
maturation pond					
Number	#	1		BOD removal down to 25 mg/l requires a set of ponds in series.	OK
surface area	Ha	10.3	11.2	The reviewer's calculation is based on two lagoons in series, rather than one large lagoon.	OK

This evaluation concludes under the current design including full scale activated sludge treatment and the use of the maturation ponds that the first stage of the project the effluent standards of 25 mg / l BOD will likely be complied with.

With regard to the sludge line, input data, such as production of primary and secondary sludge, are not explicitly given. Picket fence thickeners are not described, thickeners for secondary sludge are not planned, which seems a little bit overoptimistic. Furthermore, sludge degradation and final sludge production are not explicitly estimated. The available design data are further commented in below table.

Table 27 – Assessment of the Sludge Line

Parameter	Unit	provided	ESIA review	comment	OK?
sludge production					
Primary	kg ds/d	*6 948*	6 948	Based on 80% efficiency for TSS, which may be considered high, but not unrealistic.	OK
secondary	kg ds/d	*1 133*	c. 535	Yield value of 0.75 kg ds/kg BOD pertains to wastewater with higher TSS content.	OK
picket fence thickeners					
number	#	1	1		
diameter	m		18.80	Based on solids loading rate of 25 kg.m-2.d-1. For primary solids, sometimes a higher value is adopted. One may wonder why secondary sludge is not envisaged to thicken along with the primary sludge, especially in stage 1	OK
sludge production	m3/d	*172*	174	Concentration of 4 % has been assumed.	OK
digesters					
number	#	2			
volume	m3	4 835		The volume is huge. This is because	OK?

Parameter	Unit	provided	ESIA review	comment	OK?
				the digesters are not heated. This will require a long HRT for stabilization: 56 days is reasonable at 20°C. Since most biogas will be produced by the primary sludge and digesters are expensive, one may consider operating the digesters at 30°C by installing a boiler (rather than a CHP) during the first stage. It will result in a single digester being sufficiently large to arrive at the required degree of stabilization (HRT 28 d).	
solids degradation	%	–	44	Strongly dependent on assumed chemical dosage. Reduction of organics estimated at 58%. Due to climate conditions, reviewer's estimate may be too optimistic.	OK
biogas production	Nm3/d	2 291	2 940	Biogas estimated at 65% methane. Due to climate conditions, reviewer's estimate may be too optimistic.	OK

7.4.2 Review of Wastewater Treatment Operations

Pre-treatment of industrial waste water

The baseline information indicates that the current collection area 1a /2a do not include industries. However, it is important that for any industrial activity in the collection areas, now or in the future, pre-treatment facilities will be mandatory in order to protect the sewer system and the biological part of the treatment plant against non-organic and hazardous pollution.

Pre-treatment of industrial produced wastewater at source will results in a better operating results of the central wastewater treatment system. In addition, treatment at the source (the industrial production process) is less costly than a combined household and industrial treatment system in the public waste water treatment plant, because at the source, dilution can be prevented and a more focused and appropriate treatment system can be designed and operated.

This requires the development of a separate system of regulating, monitoring and enforcement of pre-treating industrial wastewater within the city collection areas.

Bypass of Untreated Influent

The current operational plans for the wastewater treatment plant foresee a bypass of untreated influent into the river during periods of high water levels and flooding events. The untreated influent will then

directly be discharged into the river, next to the maturation ponds. The justification provided is that during high water levels, the mixture of untreated influent with the river water will still be less polluted that the current river water at normal or low flow conditions. The underlying reason is that this will save WWTP operating costs during these bypass periods.

This ESIA concludes that this bypass feature is not advisable, for the following reasons:

1. It may be expected that discharge of untreated wastewater will happen twice a year during both rainy seasons, or about 4 – 5 weeks per year in total. To compare, in Europe untreated influent is only discharged during periods of floods when the sewer collection systems are overloaded; about 1 % of the time per years or less.
2. The Kigali sewer and main trunk systems are not connected to surface water drains, and will therefore not be affected during periods of rain
3. During high water levels, the discharge of untreated influent into the river would cause high concentration of pathogens, particularly close to the point of discharge, causing substantial public health risks at that point and beyond
4. Specifically at the point of discharge, the smell nuisance shall be considerable
5. This practice would not correspond to the often maintained principle of: “dilution is no solution for pollution”
6. Bypassing untreated wastewater in the manner will only save about 8 – 10% of the annual operating costs

Consequently, it is highly recommended to treat the influent wastewater at the WWTP at all times, also during periods of high river water levels and floods.

If, during times of emergencies such as power failure and backup power failure, bypassing the influent around the WWTP cannot be avoided, it is recommended to use an outflow that minimizes the risk for exposure and smell at its outlet. This may include discharge well below the river surface level, and using different discharge points to reduce the individual influent flows into the river. It should however be noted that during low river flows, this bypass of untreated wastewater may lead to high concentrations of pollutants in the river. At that stage adequate information to the surrounding population shall be provided to avoid any direct contact with the river segment downstream of the wastewater treatment plant. In addition, prevention of direct contact shall further be enforced by clear information signs and surveillance along the river.

Reuse of Sludge

The operational plans speak of reusing the processed sludge for agricultural purposes. In this respect it is worthwhile to know the EU limit values for sludge reused in the agriculture, as shown in the following table. In the USA a different approach has been adopted by the Environmental Protection Agency (EPA). Sludge loading rates to be applied are usually limited by the levels of heavy metal contamination. In general, these limits are to be based on the cat-ion exchange capacity (CEC) of the soil as an indicator of the relationship between total metal addition and the soil's ability to control metal uptake in plants.

Table 28 – EU Limit Values for Sludge being reused in Agriculture

EU Limit values in sludge reuse in Agriculture	Limit value in mg/kg dry solids
Zinc (Zn)	2500 to 4000
Copper (Cu)	1000 to 1700
Lead (Pb)	750 to 1200
Chromium (Cr)	-
Nickel (Ni)	300 to 400
Cadmium (Cd)	20 to 40
Mercury (Hg)	16 to 25
Arsenic (As)	-

Chemical Testing shall be required before the sludge will be offered to the agricultural sector. Related provision of information and support to the sector needs to be organized. If the sludge quality will not reach the standards for agricultural reuse, final disposal at sanitary conditions are to be recommended.

Wastewater Reuse

The current plans do not foresee in reusing the treated wastewater. However, wastewater reuse is an environmentally sound and common practice in many developing countries, particular in water scarce regions. Particularly reusing wastewater in agriculture is increasing around the world, and reuse water quality standards have been developed for various alternative applications. Generally, agriculture that implies direct contact between crops and irrigation water, such as vegetables, requires much stricter reuse quality standards than crops that have no direct contact with the irrigation water, like fruit trees, or crops that are used to feet animals only (fodder crops). Other types of reuse application are watering gardens, trees, public parks or greeneries.

The current design of the Kigali Wastewater Plan does not foresee in the reuse of its treated effluent, since most agriculture in the valley of the WWTP apply water from the Nyabugogo River. Meanwhile some of the decentralized wastewater treatment systems that are currently in operation reuse the treated wastewater in their nearby gardens or greeneries. This type of reuse will be terminated once these buildings are connected to the new main sewer system.

It is advised therefore to study options for the reuse of the effluent near the treatment plant in more detail, either as part of the current design phase, or otherwise once the plant is in operations and reliable data is available in terms of the total flow and quality of both its influent and its effluent.

7.4.3 Review of Sewer Connections

The success of the Kigali Wastewater Project will depend, among others, on full connection of all building in the sewer collection areas 1A and 2A, based on a new water and sanitation policy. New buildings will be obliged to connect to the sewer in accordance with the building regulations, to be enforced with sanctions. Existing buildings will have the obligation in the water law to connect within two years. This policy shall include arrangements to finance and construct these connections, and may include co-financing by the owners of the buildings through their collection fees. In any case, it is crucial that the connections will be completed and in operation prior to start-up of the WWTP. However, subordinate legislation will be

required to be effective, and implement this required legislation in advance of commencement of this project will be required.

On the 30th of June 2016 the Steering Committee decided to adopt a Design, Build, Operate and Transfer (DBOT) contract format for the realization of the project, where the operations will be transfer to WASAC LTD after two years. One option to effectively ensure that connections, sewers and treatment plant will be managed adequately is to bring together all constructions and operation components under this DBOT contract, so that one contractor / operator will be responsible for construction and operation of all project components in an integrated manner.

7.4.4 Review of the Trunk Main

The current plans for the lining of the Trunk Main are in accordance with the CGI outline designs of 2008, and the related resettlement assessments have been performed based on this outline. See figures 25, 36 and 37 above.

However, as will be described in section 9.3, it is preferred that the trunk main will be aligned with the plans for the new highway between the central bus station and the treatment plant.

The best option is to put the trunk main in the median, between the two tracks of the new high way. This requires joined planning of the high way and the trunk main: the final lay out of the high way shall be available before completion the final design of the trunk main. This particularly requires coordination between the City of Kigali, WASAC LTD and the Rwanda Transport Development Agency, both under this Ministry of Infrastructure, prior to completion of the design and tender documents for the Trunk main.

7.4.5 Risks related to Extension Stages 2 and 3

Extending the sewerage collection project beyond areas 1a and 2a, will imply that first the newly collected areas will need adequate water supply and flushing toilet systems. Since today on overage only 7.5 % – 10% of the remainder of the city has flushing watered systems and more than 90% uses septic tanks, this requires substantial efforts and investments. It also requires generating sufficient additional water resources.

7.5 Significant Environmental Impacts

7.5.1 Introduction

The most significant environmental impacts related to Kigali Wastewater Project are described in more detail in this section. For each, a reference is made to the impact numbers listed in the Impact Table above.

7.5.2 Buffer Zone and Visual Impacts

Reference Impact Table: P2

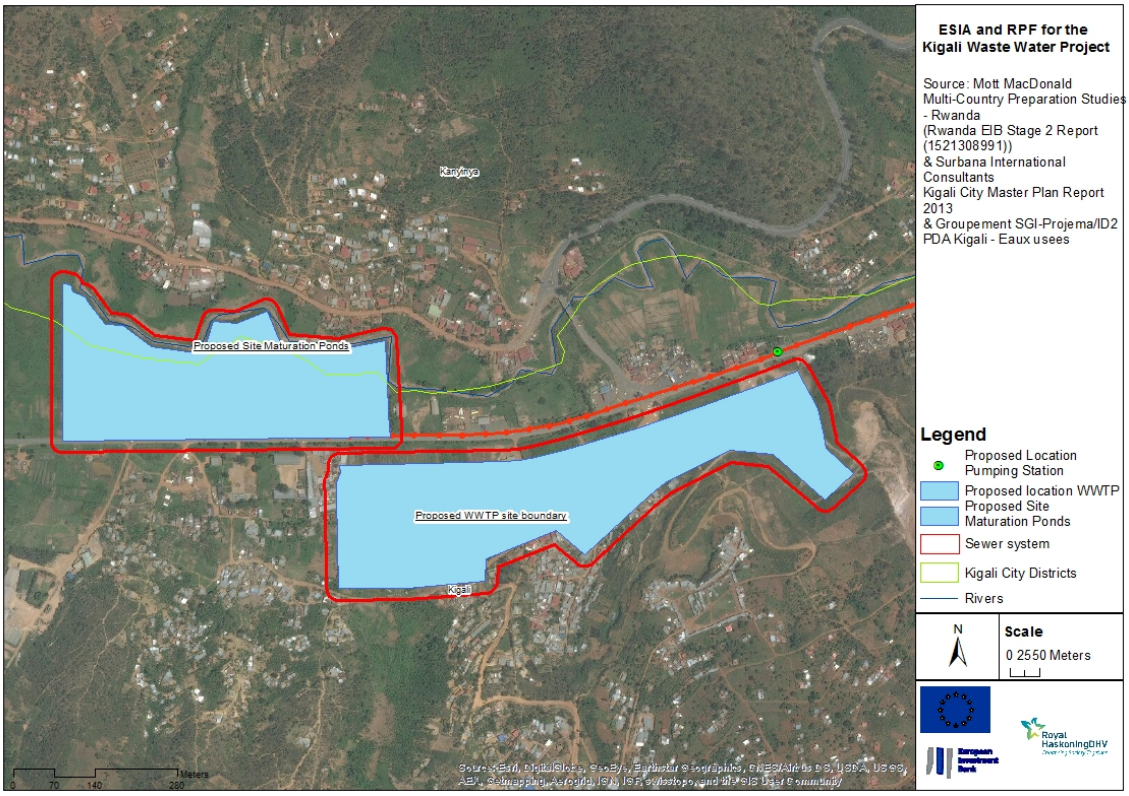

Figure 49 – Map of Indirect Area of Influence including the Buffer Zone (20m), also called Zone B

Based on Rwandese legislation, land use restrictions will apply directly above and around the trunk main and also above and around the WWTP footprint. This zone of direct influence (Zone A) will carry restrictions to land use and cultivations in the future, to protect the integrity of the scheme's facilities. Zone A also restricts the presence of any structures, residential or of any other nature.

For safety and security of the local communities and the environment, the National Legislation provides that in relation to a sewerage facility, a safety zone of at least 20 m should be assigned and maintained[27], thus being an Indirect Area of Influence or Zone B. In addition, Law No. 55 of 2011 Governing Roads in Rwanda also states that the minimum width of the City of Kigali roads in the urban areas should be 6m.

[27] Organic law No.4 of 2005

Although not explicitly described in the available design documents, it will be crucial that this zoning is respected in the final designs. In addition, to break the visual distortion of the WWTP from the main road, it is recommended to plant sufficiently high trees in the buffer zone around the wastewater treatment plant.

Finally, to prevent an increase in population density around the WWTP and maturation ponds a spatial planning order of the City of Kigali or the District of Nyarugenge could be developed limiting new developments of housing in the area of influence around the WWTP.

7.5.3 Impacts of Flooding Risks

Reference Impact Table: P8

The maturation ponds are positioned in the wetlands of the Nyabugogo River between the river and the main road. The WWTP area is located on the opposite, southern part of the road. This land is below the level of the road. Also the western portion of the WWTP area is a dedicated wetland area.

The wetlands between the river and the main road tend to be flooded annually. Although detailed information about flood events and river water levels are not available for this river section, reports from local residents say that floods overflowing the road occur every now and then. Lastly such an event was reported in 2002, when concomitant floods occurred in both the Nyabugogo and the Nyabarongo rivers. Reduced discharge capacities of the Nyabugogo River into the Nyabarongo during times of high water levels in the Nyabarongo could result in backwater impacts upstream the Nyabugogo, with accumulating flood risks.

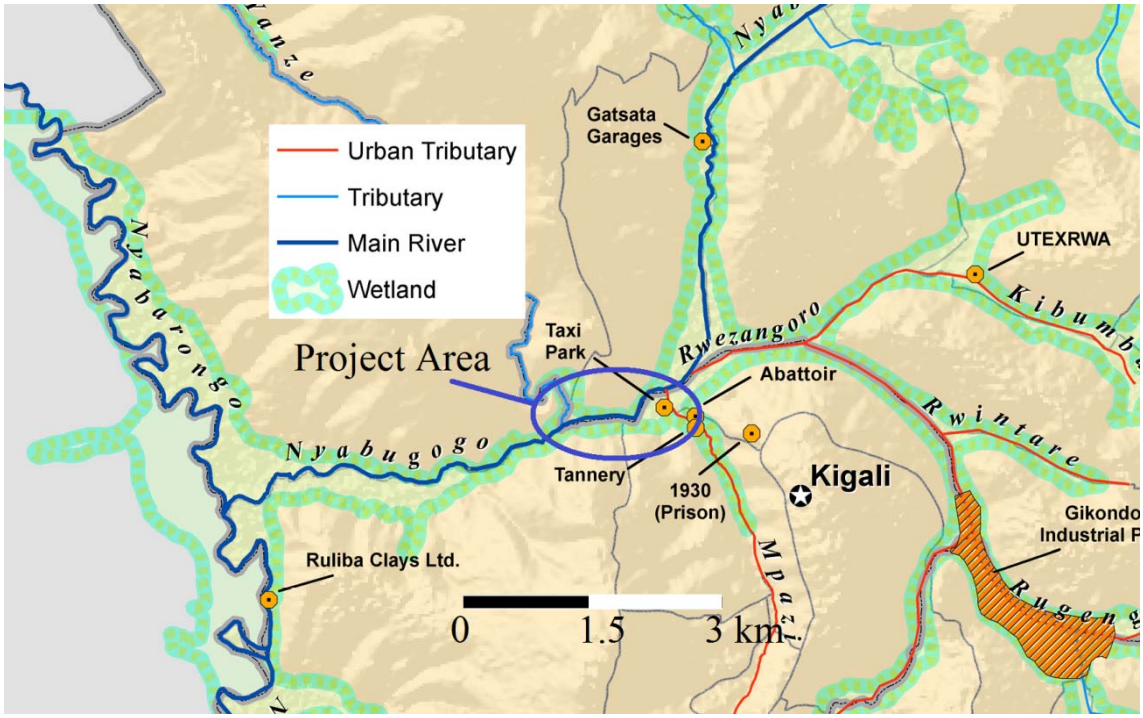

Figure 50 – Flood Prone Areas along the Nyabugogo and the Nyabarongo rivers

When this would happen again, the WWTP area will likely be flooded, specifically the western part of the area. This may seriously hamper the operations of the WWTP.

Consequently it is proposed to take adequate flood preventive measures, such as construction of a dyke or flood retention wall north of the main road along the western side of the WWTP, and prepare for some additional surface drainage facilities on the western part of the WWTP site in case of flood emergencies. As studies are underway to construct a four to six lane highway over the current main road, such flood protection measures could be easily incorporated in the designs of this High Way.

7.5.4 Loss of Wetland and Biodiversity

Reference Impact Table: P9

Both the foreseen wastewater treatment and the maturation ponds are located in a dedicated wetland area in accordance with the Organic Law N° 04/2005 of 08/04/2005. This Law determines the modalities of protection, conservation and promotion of environment in Rwanda, specifically in its article 87 related to construction of wastewater treatment plants in wetlands (rivers, lakes and big or small swamps), considering that the EIACA for the Kigali Wastewater Treatment Plant and associated wastewater maturation ponds shall not be issued without obtaining the construction permit in the wetland.

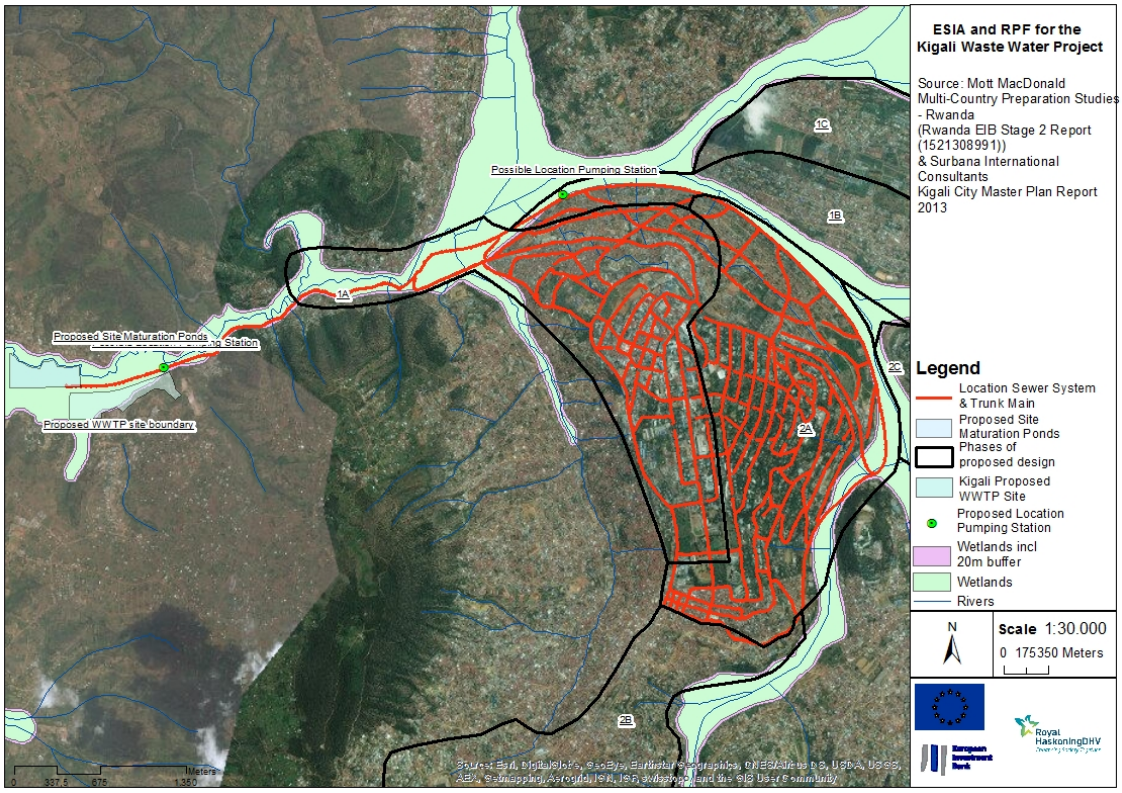

Figure 51 – Dedicated Wetlands in the Project Area

The proposed site for the WWTP south of the road is currently used by various workshops and small industries; the proposed location of the maturation ponds north of the road and along the river is currently in use as a football field and for growing sugar canes.

The following impacts of the construction the WWTP and maturation ponds in these wetlands have been identified:

- Change of land use WWTP: the current workshops and small industries on the new WWTP will disappear. This will not have an impact in terms of wetland preservation during normal operations of the new wastewater treatment plant. However, when this area would be flooded, polluted wastewater may come into direct contact with surface water. As it is recommended to realize flood protection measures along the main road, between the river and the WWTP area, this would prevent direct contact during these high floods:

- Failure of the WWTP system, for instance due to power failure or other disturbances. In these cases it is foreseen to bypass the untreated wastewater through the maturation ponds directly into the river system. This will likely have a serious impact on the aquatic ecosystems in the river, be it the current water in the river is today heavily polluted due the bad sanitation status of the city of Kigali, as indicated earlier in this report. Furthermore, this situation would be non-conforming Article 83 of the Organic Law N° 04/2005 of 08/04/2005, which “prohibits dumping wastewater into wetlands, except after treatment in accordance with instructions that govern it”. It is recommended that the discharge be distributed over different points along the river to dilute the untreated effluent as much as possible, and to enforce a public information and support plan to prevent direct contact of the public with the untreated effluent during these occurrences. However, temporary disruption of local ecosystems in and around the related river segments may not be prevented during these times of WWTP Failure:

- Change of land use at the maturation pond. As the current land use includes a football field and sugar cane fields, this will likely not have a direct impact on the local ecosystems. In addition, the maturation ponds have been designed to deal with the annual flooding in this section of the wetland, including the use of natural, non-polluting construction materials. The maturation ponds furthermore foreseen in dilution of the treated effluent from the WWTP during times of floods, leading to water quality below the surface water discharge standards;

- Open water in the Maturation Ponds: this will likely increase locally the occurrence of mosquitos as described in below section 7.5.6

7.5.5 Water Quality Impacts

Reference Impact Table: A1 and P15

The immediate and one of the most beneficial impacts of the Kigali Wastewater Project will be the cessation of the discharge of untreated sewerage in the environment and the Nyabugogo River. It can be expected to result in an increase in dissolved oxygen levels in the river, particularly during the dry summer months. It may also be expected that the sediments in the river will become more aerobic as result of the increased oxygen levels, leading to more favorable conditions for fish populations, aquatic ecosystems and local people.

In addition, the project will lead to reductions in nutrient loads from untreated sewage. This may lead to conversion of nitrogen-ammonia into nitrates, leading to reduced ammonia concentrations, which is beneficial for the aquatic ecosystems as well.

The project will also lead to a reduction in fecal coliform concentrations in the surface water. However, the Nyabugogo River will remain to receive untreated wastewater from other parts of the City of Kigali and therefore remains a risk in terms of infectious diseases through the exposure to coliform bacteria's in the river.

However, in order to better understand the water quality development of the Nyabugogo River, it is recommended to establish a WQ monitoring program both upstream and downstream of the proposed WWTP effluent point, particularly focusing on BOD, coliform, Ammonia, Suspended Solids and occasionally for inorganic components.

7.5.6 Malaria related Risks

Reference Impact Table: P18

The occurrence of Malaria in Rwanda is increasing again. The Rwanda public health authorities believe this may relate to climate change and more extreme weather conditions, and increasing resistance of mosquito's to malaria medicines. Malaria occurs more often in the wetland areas then in the city, due to the more abundant open surface water and vegetation in the wetland areas.

This ESIA assumes that the density of malaria mosquitos may increase substantially in the wetlands around the new maturation ponds. This will impact all people working of living within close range of the maturation ponds. It is advised to minimize these negative impact through applying both preventive and control measures.

Biological prevention measures in the maturation ponds may be used, such as introduction of predatory fish that feed on mosquito larvae, or otherwise Carps or Minnows. Other mosquito predators include the Dragon Fly, which consumes both mosquito larvae in the breeding waters and adult mosquitoes. However, the appropriate measure shall be selected carefully, in order not to impact the natural fauna and ecosystems in the river, and not to impact the quality of the treated water effluent.

In addition it is proposed to provide mosquito nets to the inhabitants within the vicinity of the plant on a regular basis, and monitor Malaria occurrences in the project area, particularly during the first years of operations, with assistance from the Muhima and Kimisigara Health Centres, which are nearest to the WWTP.

7.5.7 Odor and Air Pollution

Reference Impact Table: P10

During operations, the wastewater treatment plant will like generate odor due to hydrogen sulfide emissions and other volatile components. Odor emissions from the foreseen wastewater treatment plant will be largest from the elements preceding aeration and from the places were sludge is exposed to air for sustained periods of time:

- inlet works
- primary sedimentation

- division works
- picket fence thickeners
- digester feed tanks
- sludge drying beds.

Odor emissions depend on the quantities and composition of influent, and may still be limited upon start of the operations of the WWTP. However, when the plant is operating under full capacity, these emissions will likely be substantial.

No specific wind values are available at the site of the proposed Kigali WWTP. However, due to the east topographic characteristics it may be expected that west- and east-ward wind directions here be more frequent.

An indicative odor boundary map based on the current design information has been composed below.

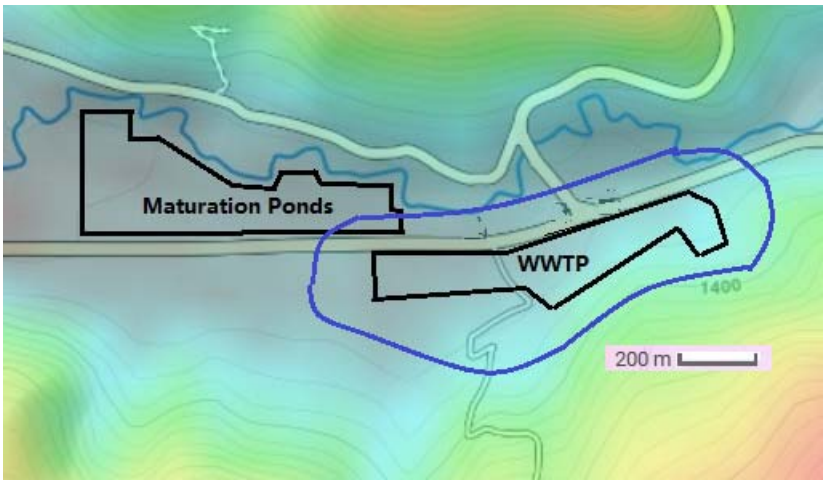

Figure 52 – Indicative Contour of around 1 Odor Unit / m3

The estimated 1 odor unit contour would be the contour where 50% of the people would still smell the odor generated by the plant, also referred to as the Odor Perception Threshold. This estimation is based on similar measurements around other wastewater treatment plants, and can only be determined in reality at the WWTP during operations of the plant using odor tests by a panel of trained people.

The people mostly affected will be those along the borders of the WWTP, particularly the village directly south of the plant. The volatile components that usually generate the smell nuisance are usually highly degradable from a biological point of view, leading likely to no additional air pollution problems.

When normal odor control measures are applied, the following minimum distances usually keep nuisance for residents at an acceptable minimum:

- 250 m for plants with a capacity until 20,000 person equivalent
- 250 to 500 m for plants with a capacity from 20,000 person equivalent to 100,000 person equivalent
- 500 m for plants with a capacity of more than 100,000 person equivalent

In locations where residents are living closer to the WWTP, additional odor containment and treatment may be the only option. With regard to the Kigali WWTP it is proposed to manage and mitigate the odor risks through the following sequence of steps:

1. an effective odor monitoring program on and around the plant right from the start of operations, with participation from the neighboring population
2. Prepare for on-site mitigation measures, including:
   * applying a mechanical sludge system (Belt Filter Press), instead of open sludge drying beds. This will substantially reduce odor emissions and will require a substantially smaller footprint. This system can also operate during rainy periods, contrary to the open drying beds. It is noted that the design update of September 2016 has meanwhile adopted this recommendation. See also: https://www.youtube.com/watch?v=iQAxVqCL2rk.
   * Prepare for covering up other places within the WWTP were sludge is exposed to air, and filtering the air for instance with use of active carbon. These places include the inlet works; primary sedimentation; division works; picket fence thickeners; and the digester feed tanks;
3. Implementation of these measures immediately when the monitored odor emissions exceed acceptable levels, until the level that these emissions have been effectively mitigated.

Odor Panel

In order to monitor any potential odor nuisance around the site it may be considered inviting about 15 people inhabitants from directly around the WWTP plant to participate in an Odor Panel, starting with the operations of the plans. The Panel will preferably be coordinated by an independent expert from for instance REMA. These people would next be invited to report on paper when a specific odor from the treatment plant is noticed, including date, time and level of odor. In addition, they might file any odor complaint from the other inhabitants around the plant.

In parallel, the operator of the plant would be invited to keep record of the timing of specific wastewater and sludge handling processes on the plant. This would allow linking certain obvious odor events with specific activities on the plant, and taking adequate measures. In addition, the Plant Operator may install a weather vane, to monitor dominant wind directions and speed.

For an initial period of a couple of months both records shall be evaluated by the coordinating expert on for instance a weekly basis, and be reported back to both the Odor Panel as well as the Plant operator.

If periods of structural odor nuisance will be noticed, the plant operator shall be invited to take adequate measures, such as the ones proposed above, to mitigate the odor emissions. After a certain period of time, once the nuisance has disappeared, a less intensive monitoring system may be established, such as a central point of contact at the WWTP where surrounding residents can file their odor related complaints.

Resettlement

Alternatively, if may be decided to resettle and expropriate the living areas directly around the WWTP who are mostly affected by the odor emissions, particularly the village directly south of the WWTP. As indicated in the RPF Report, such intervention shall be appropriately managed as part of the Resettlement Action Plan.

7.5.8 Greenhouse Gas Emissions

Reference Impact Table: P11

Emissions

Emission of greenhouse gasses will occur both during the construction and operational phases of the Kigali Wastewater Project. Typical GHG emissions associated with wastewater treatment plants include carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), and are generated through the degradation of the organic compounds in the wastewater. Their impact on the greenhouse effect is typically expressed by their Global Warming Potentials (GWP), or CO2 emission equivalent. One ton emission of N2O has about 300 times higher greenhouse effect that the emission of one ton of CO2, and one ton emission of CH4 about 25 times higher.

Worldwide wastewater contributes to about 9% of the total global CH4 emissions and about 3% of all N2O emissions, and this will likely increase during the next decades. Direct CO2 emissions associated with wastewater contribute to less than 1% of the global CO2 emissions (ref: Greenhouse Gas Emissions from WWTPs, Diksha Gupta et al, 2012)

In the aerobic wastewater treatment process of the proposed Kigali WWTP, CO2 will be produced through the breakdown of BOD in activated sludge. In the anaerobic sludge digester the BOD in the sludge is further converted to CO2 and CH4. The maturation ponds will further degrade remaining organic compounds, but will also play a role in breaking down nitrogen components in the wastewater leading to emission of N2O. Diesel generators and energy consumption in general contribute to the largest portion of total CO2 equivalent emissions.

Although influent flows and loads cannot be predicted at present for the current WWTP, it may be assumed that the 120,000 connected people during stage 1 of the Kigali Wastewater Project will generate around 12 kg BOD per person per year, or in total about 1,440 tons BOD per year. Generally, this may lead to a total methane emission of about 1,200 kg CH4 / yr, which is a GWP equivalent of about 30,000 kg CO2 / yr. In addition, this may lead to an emission of about 1.5 kg N2O per year, which is a GWP equivalent of about 450 kg CO2 / yr.

It should be noted that if the current Kigali Wastewater Project would not be implemented, this would lead to a natural decomposition of the same BOD loads in current cesspits and in the open surface waters in which the untreated wastewater ends up today. Related CO2 equivalent emissions depends whether this natural decomposition takes place in an aerobic or anaerobic manner, however it may be expected that the WWTP itself will generally not worsen the CO2 balance when it comes to these BOD emissions.

The total annual energy consumption of the Kigali Wastewater Project cannot yet be predicted either. But it may be reasonable to assume that an equivalent of around 600 MWH of energy will be required per year, leading to a GWP emission equivalent of about 550 ton CO2 / yr. The total CO2 equivalent GHG emission during the operations of the WWTP would thus be around 580 ton CO2 / yr, with energy consumption being responsible for about 95% of the emissions and CH4 emissions for about 5%.

Mitigating Measures

The current project design foresees in flaring the CH4 emission generated by the WWTP. If, instead this biogas would be reused for power generation this would result in a direct reduction of about 5% of the operational GHG emissions of the project, or a reduction of about 30 ton CO2 equivalent / yr.

Additional climate mitigation achievement may be obtained during the construction phase. Although quantitative estimates for the construction related emissions cannot be made at this point, generally these GHG emissions could reach up to 800 ton CO2 equivalents for major projects such as this one, where transport related emission would count for around one-third, and material related emission for about two-third of the total.

Consequently, measures to reduce GHG related emissions during construction might include minimization of road transport requirements and related diesel consumption; and minimized use of construction materials, particularly the use of cement, as one ton of cement production generates about 900 kg equivalent CO2 emission.

Additional GHG benefits can be obtained by recycling construction materials after their lifetimes. For instance demolition concrete, asphalt and stone materials may be crushed and reused in the construction sector again.

7.6 Cumulative Impacts

Cumulative impacts may appear if the expansion of the Kigali-Muhanga highway would be executed in parallel to the trunk main construction works along the same route. Specifically in terms of social and resettlement issues this would be beneficial, since this would allow the trunk main to be aligned with the position of the new high way, preferably in the central reserve between both high way directions, and to execute all resettlement related issues under one program.

Negative cumulative impacts may arise when both the high way construction and construction of the wastewater treatment plant would occur at the same time, as the transport of construction materials passing this road section towards the treatment plant may be hampered. These cumulative impacts may relate to noise, air emissions, road safety issues and congestion problems and socio-economic disruption issues.

No other projects, nor related negative cumulative impacts, are foreseen in the direct vicinity of the Kigali Wastewater Project.

8 SOCIAL IMPACT ASSESSMENT

8.1 Introduction

This section presents the potential social impacts that have been identified, based on the baseline data described in Chapter 3 and the project description in Chapter 4. The potential socio-economic impacts and risks are described separately for the pre-construction, construction, operation and decommissioning phase respectively.

The following sources and methods have been used to identify and assess the significance of the potential environmental and social impacts:

- Discussions with the project promoter WASAC LTD, the City of Kigali and the other members of the Steering Committee;
- Information and opinions of key informants and other relevant stakeholders;
- Issues raised in the community engagement;
- Review of the design documents
- Assessment of Odor impacts
- Estimation of job opportunities in the construction and operation phase of the project;
- Estimation of use of resources in the construction and operation phase;
- Estimation of emissions from the construction and operation phase.

The foreseen social impacts during the various phases of the project, listed in section 4.3, are summarized in annex 1. Below sections provide a description of the significant impacts.

8.2 Social Impacts during Pre-construction Phase

8.2.1 Land Acquisition and Resettlement Action Planning

Reference Impact Table: P24

Resettlement and expropriation of land and assets is an important aspect during the pre-construction phase of the project with far reaching social and economic consequences for the people involved. These aspects have been studied and reported in a separate Resettlement Policy Framework (RPF) report.

The purpose of this RPF is to guide the future Resettlement Action Plan (“RAP”) preparation and implementation. The RPF is based on the strategies of the Government of Rwanda, the EIB Standard 6 requirements and the World Bank Operational Policy 4.12 (WB OP4.12). The RPF addresses the scale and responsibilities for remedying all adverse impacts of resettlement, in order to maintain and improve the living standards of those affected by land acquisition and any other resettlement impacts of the project. The RPF also suggests a method of setting up a future cut-off date for the most critical sites, namely the future wastewater treatment plant (WWTP) and the foreseen trunk main route.

8.2.2 Stakeholder Engagement Planning

Reference Impact Table: P25

Identification and involvement of the key stakeholders in the pre-construction phase of the project is an essential element of the Rwandese and EIB standards for project preparation and implementation. This aspect has been studies and reports in a separate Stakeholder Engagement Plan (SEP) report.

The purpose of this SEP is to design a Stakeholder Engagement Framework for the different phases of the Project; provide a summary of all public consultation and information disclosure activities to date; provide an inventory of key stakeholder groups who will be informed and consulted about the project; describe the legal requirements for consultation and disclosure; draft a public consultation and disclosure program and schedules against the different stages of the project; and indicate related budgets and management staffing requirements.

The Stakeholder Engagement Plan (SEP) of this project includes a detailed stakeholder analysis. A distinction is made between the affected communities, who will experience the direct and indirect impacts of the project and the institutional stakeholders, who have a role in the management and approval of the project. It provides a description of the affected communities and lists the institutions and their role and responsibility for the planning, approval and implementation of the project.

Several stakeholder engagement activities have been performed till today, including Steering Committee meetings, public hearings, bilateral meetings with institutional stakeholders and surveys.

Steering Committee
Since July 2012 a cross-institutional Kigali City Wastewater Steering Committee (SC) has been established (MMD, 2012). The Committee consists currently of the following member organisations:

- Ministry of Infrastructure (Chair)
- Water and Sanitation Corporation Limited (WASAC LTD)
- City of Kigali (CoK)
- Rwanda Environmental Management Authority (REMA)
- Ministry of Finance and Planning (MINECOFIN)

Recently a suggestion was made to include also the Rwanda Development Board (RDB) and Rwanda Natural Resources Authority (RNRA). The SC meets regularly to coordinate the preparation of the Kigali wastewater project.

Public hearings
In 2014 two public hearings were held, one with the population of Nyabugogo and Gitikinyoni villages, where the WWTP is planned to be constructed and one with the District land commission, Land bureau in Nyarugenge district and three landowners of the site, proposed for the WWTP. As part of the scoping phase of the ESIA and the RPF on 3 September 2015 a project information meeting was organized for local communities at the proposed locations for the WWTP and trunk main. On 18 and 19 September 2015 two public meetings were organized in the sectors of Nyarugenge and Muhima in the centre of town, where the sewer network and collection system will be developed.

The main concerns raised at these meetings were related to:

- compensation for resettlement and land acquisition, related to eligibility and land titles, timing, and rate of the compensation package;
- adverse effects of wastewater on people's health and assets;
- WWTP at this location at the entrance of the City is not a promotion of Kigali;

- timing of the start of the project;
- household connections for pit latrines not possible;
- Who pays for household connections?;
- What are the tariffs for wastewater treatment?
- How will the water supply demand be met? And
- Job opportunities for local people

Bilateral meetings with institutional stakeholders

As part of the ESIA, RPF and SEP preparation various bilateral meetings were held with different institutional stakeholders between August and December 2015.

The main issues raised in these meetings were:

- Justification for the selection of the site for the WWTP and maturation ponds is required;
- Reuse of wastewater should be considered;
- Interaction between the alignment of the trunk main and the road extension needs to be considered;
- Part of the WWTP and maturation ponds is located in the wetland area. Special permission is requested from MININRENA.
- The CoK has a grievance mechanism under the department 'good governance', where people can provide feedback to the city;
- Smell is a big concern as the plant is proposed close to the road, which is the gateway to Kigali;
- When the site will be flooded the WWTP operations will be stopped and the sewage will be bypassed to the maturation ponds (which is located in the flood plain). This is expected to happen once or twice every year for a few days in a row.
- During construction works in the Town accessibility for handicapped people will be hampered even more than today;
- When during construction works remains of bodies from the genocide are found, the head of village should be informed. Each village administration is a representative of the survivors of genocide, and they will perform the necessary steps to salvage the remains;
- Positive discrimination for women in job opportunities should be considered.

Surveys

The people in the area of influence have been approached with questionnaires for a number of surveys. The survey results are reported in the ESIA and RPF.

In January 2015 an inventory survey was initiated at the proposed WWTP site to identify the ownership and assets of inhabitants of the site. However, this survey was not completed and results are not available. A socio-economic survey was performed early September 2015 at the WWTP and trunk main areas. In November 2015 a survey was held with the households living just south of the proposed WWTP plot. A survey on affordability of the Kigali Wastewater Project has been performed by Atkins as part of their non-technical Feasibility Study in the poorer neighborhoods of the sewer network area in September 2015.

Identification and involvement of the key stakeholders in the pre-construction phase of the project is an essential element of the Rwandese and EIB standards for project preparation and implementation. This aspect has been studies and reports in the separate Stakeholder Engagement Plan (SEP) report.

The SEP report provides guidance for the engagement and disclosure activities for the future project stages, starting from the moment of writing the SEP in the preparatory stage till and including the actual operation of the wastewater project. It covers the stakeholder engagement of the stages of preparation (design, ESIA, RPF, setting of a cut-off date, Resettlement Action Plan (RAP) and resettlement

implementation), the construction of all components of the project and the operation and maintenance of the project.

The SEP contains guidance on the methods for Public Consultation:

- Bilateral meetings between institutional stakeholders or with representatives of the communities. These take place during the whole project, including the operation stage. WASAC LTD and/or CoK are the lead parties in this.
- Steering Committee meetings: Representatives of all major institutional stakeholders, united in the Steering Committee (SC), collaborate in order to find integral solutions.
- Public hearings: Open public meetings organised by CoK to inform local residents, local government and NGOs about the progress of the project, details on impacts, mitigation measures and problems raised. The public can express comments and queries verbally at meeting.
- Public Disclosure of information: Documents will be disclosed via the websites of different organizations in Rwanda and the EIB.
- Brochure with information on resettlement compensation principles and grievance mechanism
- Non-Technical Summary (NTS) of the ESIA in English and Kinyarwanda and will be available in hard copy at the public hearings and other meetings, and will be published in the website of the CoK and the EIB.
- Bill boards on construction works and progress
- Project Council with representatives of local residents, local government, vulnerable groups and women is a platform for a continuous dialogue between the CoK and WASAC LTD (and the Steering Committee) and the representatives.
- Grievance mechanism assures that issues raised are consistently dealt with and solutions are found and implemented between the different stakeholders.

In the SEP it is advised that the City of Kigali (CoK) is the owner and main responsible organization for the planning and implementation of the activities of this Stakeholder Engagement Plan (SEP), including the grievance mechanism. WASAC LTD shall be closely involved in the SEP implementation, as they are the operator and promoter of the wastewater project. In the operational phase WASAC LTD will take the lead in the implementation of stakeholder engagement with support of the CoK.

8.3 Social Impacts during Construction Phase

8.3.1 Definition

The construction phase is defined as the phase in which the contractor is engaged in the construction works. This covers the time between contract award until completion of the works and the start of the operation of the wastewater treatment plant. The social impacts during the construction phase have been included in section 7.4 – Construction Environmental and Social Impacts.

8.3.2 Land use and retouring Access road to hinterland, south of WWTP

Reference Impact Table: P13

The current area of the WWTP includes an unpaved side road, running southwards from the main road to the hinterland. It connects the main road to a large number of houses and various communities in the hills south of the WWTP. Many inhabitants use this unpaved road to walk towards the main road.

The access road will have to be rerouted prior to the construction of the WWTP. If rerouting would be done around the eastern side of the treatment plant, this will lengthen the access road considerable, around 1 km. It would be more convenient for the pedestrians to go around the western part of the WWTP area. This is considerably shorter. If the footprint of the WWTP could be further reduced due to the use of mechanical sludge drying, this bypass can be further shortened.

Figure 53 – Unpaved road crossing the proposed WWTP site (viewing direction to the south)

8.3.3 Local Water Supply

Reference Impact Table: P14

On the southern borders of the WWTP area, close to the unpaved road, there is a communal water well used by people in the direct surroundings (see below picture). It will be required that WASAC LTD replaces this well in time and provides an alternative and reliable water source, before the WWTP is constructed.

Figure 54 – Communal Well directly south of proposed WWTP site

8.3.4 Leisure

Reference Impact Table: P19

The western part of the proposed Maturation Ponds is currently used as football field (see picture below), which is an important leisure and gathering place for the local youth. It is advised to see if an alternative field can be established in the neighborhood before the maturation ponds are constructed.

Figure 55 - Football field on proposed area of maturation ponds

8.3.5 Traffic Management

Reference Impact Table: C3

The construction works, especially of the sewer network and the trunk main will likely impact the traffic in the involved streets. Traffic congestion may hamper the flow of vehicles through the city and especially near the Central bus station near the Nyabugogo Boulevard, which is one of the main access roads to town, including emergency services as police, ambulances and fire brigades.

The transportation and use of construction equipment and material by heavy vehicles over local public roads creates health & safety risks for the communities. The risk of traffic accidents between construction vehicles and local pedestrians and traffic is quite substantial. The construction works, especially of the sewers and trunk main takes place in the open space and will temporarily change the local traffic situation increasing a risk of traffic accidents, as people are not familiar with the changed situation.

In addition, during construction works the accessibility of public buildings, businesses and offices maybe temporarily reduced. Social services like hospitals, schools, universities, public administration may be hampered if their access may be reduced.

As mentioned in section 7.4, table 26, it will be required that the contractor will develops an adequate traffic management plan, dealing with these issues, which will likely have to be approved by the City of Kigali.

8.3.6 Noise

Reference Impact Table: C3

The noisiest project phase is expected during the project's construction phase as result of trucks, unloading of materials and during construction works. Specific attention will be required to minimize noise nuisance during construction, particularly for the living area directly south of the WWTP.

During operations however, wastewater treatment plants generally generate noise levels not above 20 Decibels (dB), well below the above day time national threshold of 50 dB set for residential areas.

8.3.7 Labor Opportunities

Reference Impact Table: C3

The construction activities will likely require a labor force of about 30 to 40 people, which might create an opportunity for local people to find temporarily employment in the construction works. However, the number required is limited and it is expected that the majority of the staff should be skilled in the operation of construction equipment, resulting in only a limited number of un-skilled labor to be recruited. Considering the relative small number of workers involved it is recommended to house them in existing accommodation in the neighborhood instead of establishing a separate labor camp.

8.3.8 Occupational Health and Safety

Reference Impact Table: C3

Throughout the construction phase there are important health & safety risks for the workers, as mentioned in table 26, such as risk in the use of heavy equipment for digging, lifting or transportation, and related accidents. Transportation of construction material and equipment poses another risk. Part of the works take place in the public space, where normal vehicles pass by and where risks of accidents arise.

8.3.9 Public Health and Safety

Reference Impact Table: C3

Part of the construction works will take place in the public space, especially the construction of the sewer network and the trunk main. The areas of the WWTP, maturation ponds and pumping stations will need to be fenced off from public access to avoid people falling into holes, pools or ditches or face collisions with construction equipment.

8.4 Social Impacts during the Operational Phase

Reference Impact Table: OP1

The operational phase will start when the contractor has completed the works and the sewers, trunk main and wastewater treatment plant will become operational. It is expected that this will start in the middle of 2018. The activities of the operation phase are detailed in Section 4.3.3. Annex 1 provides an overview of all environmental and social impacts and risks in this phase.

8.4.1 Inequality Compensation

Although the overall objectives of the Kigali Wastewater Project clearly benefits the environment and all people of the city, the current phase 1 and 2 project design creates to some extend an inequality issue in the sense that pilot wastewater from the “Rich areas” 1a and 2a will be collected and treated in the “Poor area” of the treatment plant, where related project impacts and nuisance will be mostly concentrated.

To compensate for this inequality issue, it may be considered to for instance provide piped water supply and free of charge sanitation services to those affected along the trunk main and directly around the WWTP area. Also other measures benefiting the project affected people may be considered.

In addition, the low-income consumers resident in sewer areas 1a and 2a proposed to be served in the initial phases of the sewerage program do not at present receive sufficient water at the house to enable connection to the new network. This therefore limits the pro-poor benefits from the planned investments in the sewerage areas.

8.4.2 Electricity Supply

The WWTP and pumping stations will require substantial daily energy, which will be principally provided by the city's electricity net. Although detailed energy requirements have not been presented in the available design documents, it may be expected roughly that around 600 MWH of energy will be required per year.

It will be required to confirm that this energy can indeed be provided by the central network, without harming the interests of the co-users of the electricity network.

8.4.3 Labor Opportunities

The operation and maintenance of the wastewater treatment system offers limited job opportunities for the local population. It is expected that about 30 people may find a job in this stage, about half in the treatment plant and half in the maintenance of the sewer network, the majority of which need specific education and skills. The job opportunities for the local residents may be limited to security, maintenance and cleaning of the buildings and support in the sewerage maintenance. Potentially experienced staff from the current individual wastewater treatment plants may find a job here.

The current decentralized treatment plants at offices, hotels and other large building will not be operational anymore and some of them may be decommissioned. However, others are expected to remain as a back-up system. However, people working in these decentralized plants, usually one or two staff per plant (an estimated 30 people in total) will lose their job.

8.4.4 Occupational Health and Safety

The operation and maintenance of the wastewater treatment system pose will require adequate Occupational Health and Safety regulations and enforcement, dealing with aspects of equipment use, use of chemicals and nuisance related to smell, noise, as well as potential malaria risks surrounding the treatment plant and maturation ponds.

8.4.5 Public Health and Safety

Health benefits

The following table provides an overview of health risks normally associated to exposure to waste water and sludge.

Table 29 – Health Risks associated to exposure to untreated wastewater

Potential Illness	Risk
Hepatitis A infection	Some evidence of increases risk associated with contact to raw waste water and primary sludge
Other viral infections	Some indication of infection among highly exposed people
Leptospirosis	Risk now seems minimal, but formerly considered to be a major problem among sewer workers
Parasite infestation	Exposed people incur some increased risk
Gastrointestinal illness	Increased illness rates, especially among sewer workers in first years of employment
Compost-related factor(s)a	Excess of nasal, ear, and skin abnormalities in compost-exposed people determined by physical examination. Increased symptoms of burning eyes and skin diseases have been reported.

One of the clear main benefits of the Kigali Wastewater Project is improvement of the health situation, related to reduced discharge of and exposure to untreated wastewater. Also for the residents of the areas along the Nyabugogo River downstream of the planned sewer network in the Centre of town, health conditions may improve due to an improvement of the water quality in the river.

Local residents make use of the river for swimming, bathing, laundry, small-scale irrigation in the dry season and drinking for livestock.

Mosquito-borne diseases

Reference Impact Table: P18

As mentioned in section 7.3, there is a risk that around the maturation ponds health risks may increase, since these ponds may provide habitat for mosquitoes that can be nuisance pests and transmit pathogens such as arbo-viruses and malaria, due an increase in the surface with stagnant water.

Disease transmission depends on mosquito species and abundance, and extent of contact with humans; the characteristics and siting of wetlands determine hazards, and indicate risks for nuisance or disease. Compared to the current situation, mainly in the dry season, there is a risk of an increase in mosquito-borne diseases (dengue and malaria) for the people living and working close to this area.

Biological prevention measures in the maturation ponds may be used to mitigate this risk, such as introduction of predatory fish that feed on mosquito larvae, or otherwise Carps or Minnows. In addition it is proposed to provide mosquito nets to the inhabitants within the vicinity of the plant on a regular basis, and monitor Malaria occurrences in the project area, particularly during the first years of operations, with assistance from the Muhima and Kimisigara Health Centres, which are nearest to the WWTP.

Effluent Discharge

As mentioned in section 7.2, there might be an additional public health risk if current operational plans for the wastewater treatment plant would foresee in a bypass of untreated influent into the river during periods of high water levels and flooding events for operating cost saving reasons.

It is advised not to follow this approach, but to treat the influent wastewater at the WWTP at all times, also during periods of high river water levels and floods. This, because the Kigali sewer and main trunk systems will not connected to surface (rain) water drains, and that there are no technical reasons not to treat the water; that discharge of untreated influent into the river would cause high concentration of pathogens, particularly close to the point of discharge, causing substantial public health risks at that point and beyond; and that bypassing untreated wastewater in the proposed manner will only save about 8 – 10% of the annual operating costs.

If, during times of emergencies such as power failure and backup power failure, bypassing the influent around the WWTP cannot be avoided, it is recommended to use an outflow that minimizing the risk for exposure and smell at its outlet. This may include discharge well below the river surface level, and using different discharge points to reduce the individual influent flows into the river. It should however be noted that during low river flows, this bypass will lead to high concentrations of pollutants in the river. At that stage adequate information to the surrounding population shall be provided to avoid any direct contact with the river segment downstream of the wastewater treatment plant. In addition, prevention of direct contact shall further be enforced by clear information and surveillance along the river.

Reuse of Sludge

As mentioned in section 7.2, the operational plans speak of reusing the processed sludge for agricultural purposes. In this respect it is important that chemical testing shall be performed before the sludge will be offered to the agricultural sector to make sure that national and international standards are met, and that related provision of information and support to the sector needs to be provided. If the sludge quality will not reach the standards for agricultural reuse, final disposal at sanitary conditions is to be recommended.

8.4.6 Wastewater Reuse

Reference Impact Table: P17

As mentioned in section 7.2, the current operating plans do not foresee in reusing the treated wastewater. Meanwhile some of the decentralized wastewater treatment systems that are currently in operation reuse the treated wastewater in their nearby gardens or greeneries. This type of reuse will be terminated once these buildings are connected to the new main sewer system.

It is advised therefore to study options for the reuse of the effluent near the treatment plant in more detail, either as part of the current design phase, or otherwise once the plant is in operations and reliable data is available in terms of the total flow and quality of both its influent and its effluent.

8.4.7 Wastewater Treatment Fees

The level of wastewater treatment fees have not been decided yet. The impact of having this additional spending on household budget is currently being studied by Atkins as part of a non-technical Feasibility Study for the Kigali Wastewater Project.

9 ANALYSIS OF ALTERNATIVE LOCATIONS

9.1 General

During preparation of the Sanitation Master Plan for the city of Kigali (SGI, March 2008) various alternative schemes have been proposed and evaluated for the collection and centralized treatment of the wastewater.

Option A (see figure 25) included collective waste water drainage system in the Nyarugenge area, serving about 94,000 people, while the rest of the city would remain served through decentralized sanitation services. This options included two alternative locations for the centralized wastewater treatment plant: site 1 at Gitikinyoni (the site currently adopted in this ESIA), and the other at Muhima (the site where the current sewer pumping station is located, east of the central bus station). See map below.

Option B (see figure 26) included collective waste water drainage in a wider area, including Kiyovu, Kimihurura and Kacyirum allowing to the design the main sewer along the valley of the down town area and again concentrating all the wastewater in a single treatment site in either Muhima or again Gitinyoni.

Option C (see figure 27) encompasses collective waste water drainage in accordance with option B, including a separate areas north of the Kanombe Airport. This would allow a separate second centralized treatment system near the airport at Nyandungu, or further to the east at Mulindi. In addition, within this option a centralized treatment plant covering all selected areas further south east of the city was suggested (at Busanza).

Next, during the evaluation of this SGI Master Plan by Mott MacDonald in 2012, a phased implementation of a networked sewer system was proposed, including a wastewater treatment plant located at Gitikinyoni, either fully located in the wetlands (at the current proposed site for the maturation pond), or at the southern part of the road (currently proposed WWTP site). The selection of this site was based on considerations of available space, free flow of collected wastewater and costs.

The proposed network would cater for full flows at saturation levels in areas 1a and 2a as earlier identified by SGI, covering Kiyovu-Rugenge, Nyarugenge, Gitega and Muhima. During a next stage it would also include Gisozi (20,000 p.e.), Gacuriro (3,000 p.e.) and part of the district of Gikondo (20,000 p.e.), and eventually serving a population of 550,000

An alternative location (Ruliba) for the WWTP was also suggested by REMA, located further to the west in rural a wetland area close to the inflow of the Nyabugogo into the Nyabarongo. This area has also been mentioned to host the future centralized sanitary landfill for the city of Kigali.

Although the site selection process for the wastewater treatment plant followed the reasoning of the CGI Master Plan of 2008 and its further evaluation in 2012 by Mott McDonald, it was conducted implicitly without using a multi-criteria site selection process. The aim of this current section is to present such a multi-criteria analysis for the wastewater treatment site.

9.2 Alternative Siting of the WWTP

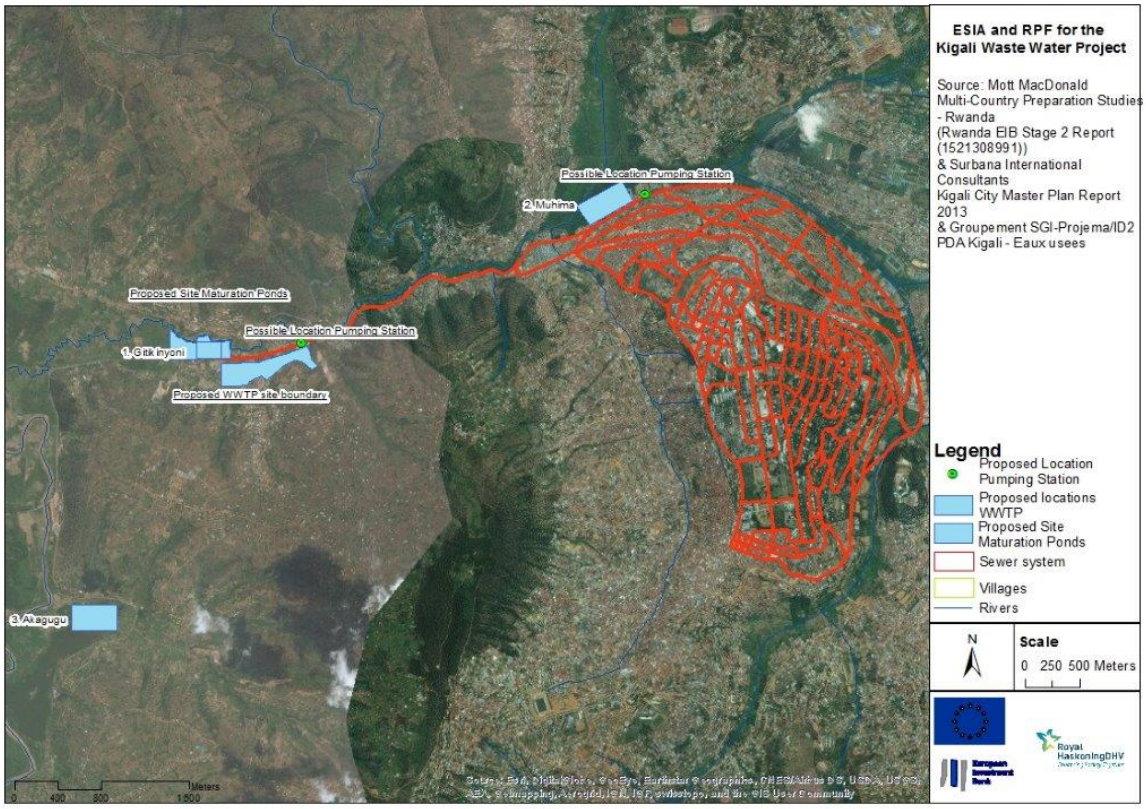

Figure 56 – Alternative locations for the WWTP

In line with the previous considerations, this multi-criteria analysis (MCA) has considered the following four alternative sites for the wastewater treatment plant:

1. Currently selected site at Gitikinyoni, with WWTP south of main road
2. Alternative site at Gitikinyoni, with WWTP and maturation ponds both in the wetland, north of the main road.
3. Muhami, located near the current pumping station 4 km south east of current site, in a rural wetland area owned by the CoK, close to the inflow of the Nyabugogo into the Nyabarongo.
4. Ruliba site at Akagugu, a rural wetland area located further south west of the Gitikinyoni site, located in the flood plain of the Nyabarongo river.

9.3 Evaluation Criteria

Different criteria have been considered and scored, whereas a score of 3 represent the best score, 2 represents a medium score; and 1 represents the worst score.

The following criteria have been considered:

Social and Resettlement Issues
For each site the social issues and required resettlement have been been assessed. The less people will be affected and resettlement or expropriated, the higher the score under this criteria will be.

Ecological Impacts
For each site an estimate has been made of the ecological impacts as stake. The smaller these impacts are, the higher the score under this criteria will be.

Visual Impacts
For each site the visual impacts have been assessed in terms of distortion of the view from the surrounding due to the wastewater treatment plant. The smaller the visual impact will be, the higher the score under this criterion will be.

Smell Nuisance
For each site the smell nuisance has been assessed in terms of potentially affected people within a radius of 200 meter around the wastewater treatment plant. The smaller the smell nuisance will be, the higher the score under this criterion will be.

Flooding risks
For each site the flooding risks have been assessed. The smaller these risks, the higher the score under this criterion will be.

Volume of wastewater collected
For each site an assessment has been made of the volume of wastewater that can be collected and discharged towards this site. The higher the volume of wastewater, the higher the score under this criterion will be.

Capital Expenditures
For each site an estimate of the total capital expenditures for the Kigali Wastewater Project has been made. The lower these expenditures the higher the score under this criterion will be.

Operational Expenditures
For each site an estimate has been made of the total operational expenditures. The lower these expenditures, the higher the score under this criterion will be.

Weighing of the criteria
Not all criteria have been considered equally important. The most important criteria in the comparison of the alternative sites have been the resettlement issues; the flooding risks and capital expenditures and the operational expenditures. Each of these criteria received a weighing factor of 0.15.

The ecological impacts, visual impacts, smell nuisance and volumes of wastewater collected are considered somewhat less important than the above list. However, their importance is still substantial, and each of these criteria received a weighing factor of 0.10.

The Multi-criteria analysis has been concluded by multiplying the scores under each criteria with its weighing factor, and next adding up the totals for each alternative site. The site receiving the highest score would then represent the preferred site under this analysis.

9.4 Analysis of Alternative Sites

9.4.1 Gitikinyoni, South of Main Road

The impacts related to the currently selected site at Gitikinyoni, with its WWTP south of main road, have been described in depth in the previous chapters of this ESIA report. Summarizing the impacts, the following can be concluded:

Social and Resettlement Impacts
The social impacts have been described earlier in this ESIA. The resettlement related impacts of the current site have been described in the Resettlement Policy Framework Report. The proposed WWTP would require expropriation of land and resettlement of the business activities on the proposed WWTP site, south of the main road. However, there are no residential homes to be resettled on the site here. If the proposed odor prevention measures for the WWTP will be implemented, and the residential areas directly south of the proposed WWTP will be protected against odor impacts accordingly, this would not require additional resettlement actions here. For the sake of this MCA the level of the impact has been qualified as Medium (score 2).

Ecological Impacts
The ecological impacts of constructing the WWTP at this site mainly relate to the development of the wetland area north of the main road into a maturation pond, requiring removal of the vegetation currently present here. The impacts of the river water quality and related aquatic eco-systems are expected to be positive as the overall water quality is expected to improve, however this requires continuous operations of the plant throughout the year as stipulated earlier in this report. For the sake of this MCA the level of the impact has been qualified as small (score 3).

Visual Impacts
The view from the surrounding of the WWTP will be impacted by the plant, particularly along the Kigali-Muhanga highway and along the highway to Musange close to the junction of both roads. However, these visual impacts would be reduced when the buffer zone around the WWTP will be planted with trees, as foreseen in the plans. For the sake of this MCA the level of the impact has been qualified as Medium (score 2).

Smell Nuisance
The smell impacts of the WWTP located here have been described in the above sections of this ESIA. If no additional smell reduction measures would be realized, this might lead to a zone of influence of approximately 200 m around the WWTP. This will particularly impact the highway north of the plant and the residential houses directly south of the site. This ESIA recommends however a series of smell reduction measures, including mechanical sludge drying systems instead of open drying beds, and additional covering up of critical sites at the WWTP when required on the basis on a proposed odor monitoring program. For the sake of this MCA the level of the impact has been qualified as Medium (score 2).

Flooding risks
The flooding risks of the WWTP and maturation ponds located here have been described above. Particularly the western part of the WWTP may be flooded once every few years. In addition the maturation ponds north of the highway will be flooded more annually, however the concept of the designed ponds are based regular flooding here, with very small impacts in terms of surface water quality. This ESIA recommends however flood prevention measures for the WWTP itself, including a flood retaining wall along the high way and additional surface drainage facilities in the site. However, compared to the other sites, the current site scores best when it comes to flooding risks, therefore is has received a score of 3.

Volume of wastewater collected
The volume of wastewater that can be collected when the WWTP is to be located at this site has been described in the Design Reports. Upon the final stage 3 of the project, the treatment plant will be able to receive 24,000 m3 / day to cater for a connected population of 240,000. For the sake of this MCA the level of the impact has been qualified as Medium (score 2).

Capital Expenditures
The total capital expenditures for the Kigali Wastewater project have been estimated in the Design Report at around 70 M€ excluding resettlement and household connections costs. As will be shown below with the description of the other sites, this turns out to be the second cheapest of all alternative sites, and consequently the level of this impact has been qualified as medium (score 2).

Operational Expenditures
The total operational expenses according to the design reports for the proposed WWTP site will be around € 500,000 per year. These costs will be increased with operational costs of the proposed flood (€ 5000 per year) and odor mitigation measures (€ 5000 per year), leading to a total of € 510,000 per year. As will be shown below with the description of the other sites, this turns out to be the second cheapest of the alternative sites, and consequently the level of this impact has been qualified as medium (score 2).

9.4.2 Gitikinyoni, North of Main Road

The impacts and related scores of the alternative site at Gitikinyoni with the WWTP situated north of main road in the wetland area are summarized below.

Social and Resettlement Impacts
The related impacts of this site are smaller than for the proposed site south of at Gitikinyoni, since this site is located fully in the wetland area, currently used mainly for growing sugar canes. The current farmers in the dedicated wetland area need to be compensated, however resettlement of other business activities are not required. In addition, this site is further away from the residential homes directly south of the originally proposed site. It will likely have no impact there in terms of odor and therefore no resettlement issues are at stake. The level of this impact has therefore been qualified as medium (score 2).

Ecological Impacts
The ecological impacts of constructing the WWTP at the site north of the main road are higher than for the site south of the road, since it requires development of a larger wetland area into both a WWTP and a maturation pond, requiring removal of more vegetation currently present here. The impacts of the river water quality and related aquatic eco-systems are expected to be positive as the overall water quality is expected to improve, however this requires more expensive flood protection measures throughout the year for the WWTP. The level of this impact has therefore been qualified as high (score 1).

Visual Impacts
The view from the surrounding of the WWTP will be impacted by the plant, again particularly along the Kigali-Muhanga highway, but to a lesser extent along the highway to Musange close to the junction of both roads. However, residents living north of the main road will be more impacted visually. Again, these visual impacts can be reduced when the buffer zone around the WWTP will be planted with trees, as foreseen in the plans. Overall, the level of this impact has been qualified as medium (score 2).

Smell Nuisance

If no additional smell reduction measures would be realized for the site north of the highway, this might again lead to a zone of influence of approximately 200 m around the WWTP. This will again impact the highway south of this site, but it will not generate impacts for the residential houses directly south of the original site south of the road. However, residents living north of the highway will be impacted. The earlier proposed smell reduction measures may again be considered for this site. Overall, the level of this impact has been qualified as medium (score 2).

Flooding risks

The flooding risks of WWTP and maturation ponds all located in the wetlands north of the highway are substantially higher compared to the site south of the high way. Particularly the WWTP site as a whole needs to be protected here against annual floods. Also the maturation ponds north of the highway will be flooded annually, however the concept of the designed ponds are based on regular flooding here, with very small impacts in terms of surface water quality. Flood prevention measures will be required all around the WWTP, including for instance a flood retaining dam around the site and high capacity surface drainage facilities all over the WWTP site. The level of this impact has been qualified as high (score 1).

Volume of wastewater collected

The volume of wastewater that can be collected here is the same as for the site north of the high way. Upon the final stage 3 of the project, this site will also be able to receive 24,000 m3 / day to cater for a connected population of 240,000. The level of this impact has been qualified as Medium (score 2).

Capital Expenditures

The total capital expenditures for the WWTP south of the high way have been estimated at about 70 M€. If the WWTP would be located north of the highway, this requires additional flood prevention investments, including approximately 1000 m of flood retaining dams and high capacity drainage systems and related pumps, which may cost together up to 1 million euro extra. On the otThe level of this impact has been qualified as Medium (score 2).

Operational Expenditures

The total operational expenses according to the design reports for the proposed WWTP site will be about € 500,000 per year. If the WWTP would be located north of the highway, these costs will be increased with additional operational costs of the proposed flood prevention measures (about € 25,000 per year), as well as odor mitigation measures (€ 5000 per year). On the other hand, the purchase of land required for the WWTP in the wetland area might be less that the price of land south of the main road. The level of this impact has been qualified as Medium (score 2).

9.4.3 Muhima

The alternative Muhima site is located near the current pumping station 4 km south east of current site, in a the Nyabugogo flood plain area currently owned by the CoK, close to the inflow of the Nyabugogo into the Nyabarongo. The area is undeveloped and contains low vegetation and wetland depending flora and fauna. The location of the site and a picture are presented below.

Figure 57 – Muhima site as alternative location for the WWTP

Figure 58 – Pictures of the Muhima Site

The impacts and related scores of the alternative Muhima site are summarized below.

Social and Resettlement Impacts
The related impacts of this site are smaller than for the proposed site south of at Gitikinyoni, since this site is located fully in a wetland area, currently covered by low vegetation. As the land is currently owned by the City of Kigali there are no external parties to be compensated. In addition, this site does not require the trunk main needed for the other sites, reducing the required resettlement actions and related costs substantially. On the other hand, this ESIA recommends to construct the trunk main in line with the new high way expansion project, which would also deduct the related trunk main resettlement costs for the two Gitikinyoni sites. Overall, the level of this impact has therefore been qualified as small (score 3).

Ecological Impacts
The ecological impacts of constructing the WWTP in a rural wetland area, currently accommodating wetland related flora and fauna, are high. The impacts of the river water quality and related aquatic eco-systems are expected to be positive as the overall water quality is expected to improve, however this requires expensive flood protection measures throughout the year for the WWTP. The level of this impact has therefore been qualified as high (score 1).

Visual Impacts
The view from the surrounding of the WWTP will be impacted by the plant, particularly from the south along KN 7 road, but possibly more importantly also from the Kigali Genocide Memorial, located north east of this location. Again, these visual impacts may be reduced somewhat when the buffer zone around the WWTP will be planted with trees, as foreseen in the plans. Overall, the level of this impact has been qualified as high (score 1).

Smell Nuisance
If no additional smell reduction measures would be realized for the site north of the highway, this might again lead to a zone of influence of approximately 200 m around the WWTP. This will impact the road south of this site and possibly a stretch of urban area more southwards towards the direction of the city center. The earlier proposed smell reduction measures may again be considered for this site. However, this impact has been qualified as high (score 1).

Flooding risks
The flooding risks of WWTP and maturation ponds all located in the wetlands of the Nyabugogo flood plain are extremely high. The site has a low altitude compared to the surrounding areas, with only a short distance from the river. This probable leads to annual flooding of certain magnitude. Substantial flood prevention measures will be required all around the WWTP, including for instance a robust flood retaining dam around the site and high capacity surface drainage facilities all over the WWTP site. The level of this impact has been qualified as (very) high (score 1).

Volume of wastewater collected
The volume of wastewater that can be collected here is the same as for the Gitikinyoni site. Upon the final stage 3 of the project, this site will also be able to receive 24,000 m3 / day to cater for a connected population of 240,000. The level of this impact has been qualified as Medium (score 2).

Capital Expenditures
The total capital expenditures for this WWTP site compared to the Gitikinyoni site are influenced by two factors. First, as a trunk main will not be required, the costs related to this trunk main can be saved. Secondly, the site would require substantial flood prevention investments, including approximately 1000 m of flood retaining dams and high capacity drainage systems and related pumps, which may cost together

over 1 million euro extra. Overall however, this site may be cheaper than the Gitikinyoni site, and therefore receives a score of 1.

Operational Expenditures
The total operational expenses according to the design reports for the proposed Gitikinyoni WWTP site will be around € 500,000 per year. If the WWTP would be located in the Nyabugogo flood plain, these costs will be increased with additional operational costs related to the required flood prevention measures (about € 30,000 per year), as well as odor mitigation measures (€ 5000 per year). The level of this impact has been qualified as Medium (score 2).

9.4.4 Ruliba

The Ruliba site is located in a rural wetland area further south west of the Gitikinyoni site, in the flood plain of the Nyabarongo river. Contrary to the other sites it is not surrounded by urbanized areas. However, due to its longer distance from the city, it required a longer trunk main to reach it. The area contains low vegetation and wetland depending flora and fauna. The location of the site and a picture are presented below.

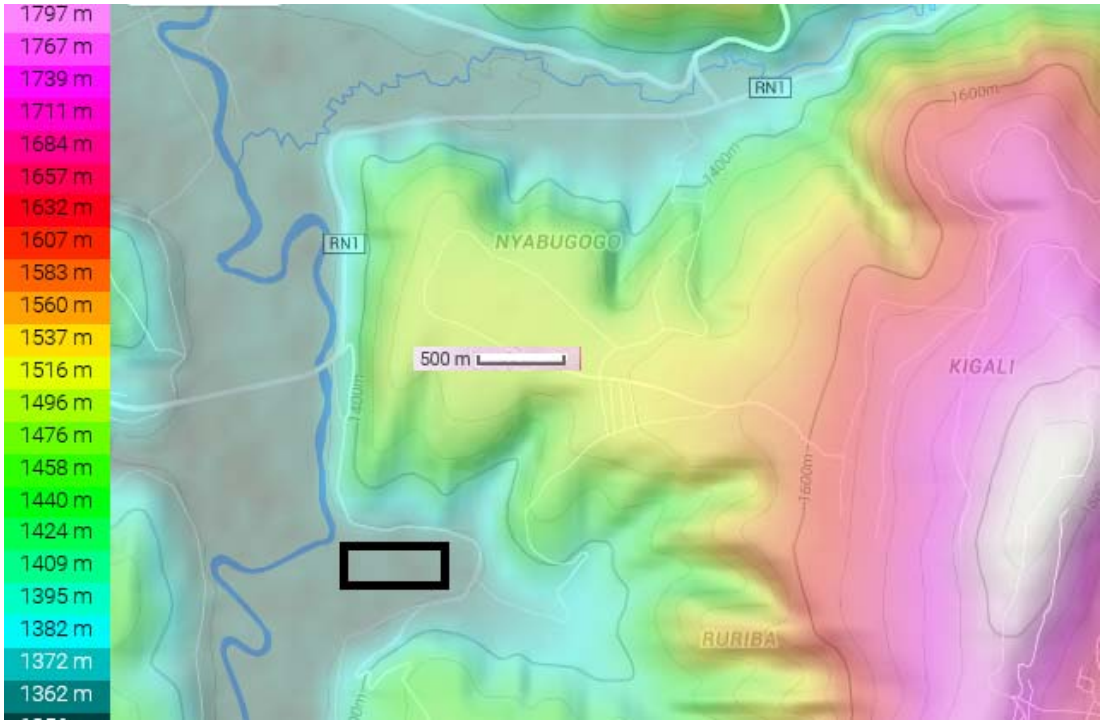

Figure 59 – Ruliba site as alternative location for the WWTP

Figure 60 – Pictures of the Rubila Site

The impacts and related scores of the alternative Ruliba site are summarized below.

Social and Resettlement Impacts
The related impacts of this site are smaller than for the proposed site south of at Gitikinyoni where it comes to the WWTP area, since this site is located fully in a wetland area, mainly covered by low vegetation and some agricultural plots (see photo's above). As the land is currently owned by the government there are likely no external parties to be compensated. On the other hand however, this site requires a longer trunk main along the Kigali-Muhanga highway to the west, and next cutting through the rural areas towards the south to reach this location. In total this will require substantially more resettlement and expropriation efforts compared to the other alternative sites. Overall, the level of this impact has therefore been qualified as large (score 1).

Ecological Impacts
The ecological impacts of constructing the WWTP in this rural wetland area, currently accommodating wetland related flora and fauna are high. The impacts of the river water quality and related aquatic eco-systems are expected to be positive as the overall water quality is expected to improve, however this again requires expensive flood protection measures throughout the year for the WWTP. The level of this impact has therefore been qualified as high (score 1).

Visual Impacts
The view from the surrounding of the WWTP will be impacted by the plant. However, the population density in the vicinity of this site is very low. In addition, these visual impacts may be reduced somewhat when the buffer zone around the WWTP will be planted with trees. Overall, the level of this impact has been qualified as low (score 3).

Smell Nuisance
If no additional smell reduction measures would be realized for the site north of the highway, this might again lead to a zone of influence of approximately 200 m around the WWTP. However, the population density in the vicinity of this site is very low. In addition, these odor impacts may be reduced with the measures also proposed for the other sites. Overall, the level of this impact has been qualified as low (score 3).

Flooding risks
The flooding risks of WWTP and maturation ponds all located in the wetlands of the Nyabarongo flood plain are high. The site has a low altitude compared to the surrounding areas, with only a short distance from the river. This probable leads to annual flooding of certain magnitude, although likely not as severe as for the Muhima site. Nevertheless, appropriate flood prevention measures will be required all around the WWTP, including for instance a flood retaining dam around the site and high capacity surface drainage facilities all over the WWTP site. The level of this impact has been qualified as medium (score 2).

Volume of wastewater collected
The volume of wastewater that can be collected here is the same, or even more than the Gitikinyoni site, since some residential areas between this site and the Gitikinyoni site may also be connected, if desirable. Upon the final stage 3 of the project, this site will therefore cater for a connected population of over 240,000. The level of this impact has been qualified with a score 3.

Capital Expenditures
The total capital expenditures for this WWTP site compared to the Gitikinyoni site are influenced by two factors. First, as a much longer trunk main will be required, about 3 km. Secondly, the site would again require substantial flood prevention investments, including approximately 1000 m of flood retaining dams and high capacity drainage systems and related pumps, which may cost together close to 1 million euro

extra. Overall however, this site will be more expensive than the Gitikinyoni site, and therefore receives a score of 1.

Operational Expenditures
The total operational expenses according to the design reports for the originally proposed WWTP site will be € 500,000 per year. If the WWTP would be located in the Nyabarongo flood plain, these costs will be increased with additional operational costs related to operation and maintenance of a much longer trunk main, and the required flood prevention measures (about € 30,000 per year). The level of this impact has been qualified as High (score 1).

9.5 Conclusion of the WWTP Site Selection Analysis

Below table provides the scores as described and presented above. The total score for each site in provided in the right-hand column. The total scores are obtained by multiplying the scores under each criterion with its weighing factor, and next adding up the totals for each alternative site.

Table 30 – Multi-criteria Analysis for the WWTP Location

Multi-criteria analyse WWTP sites	Criteria								
Options	Social and Resettlement	Ecological impacts	Visual impacts	Smell nuisance	Flooding risks	Volume sewage collected	CAPEX	OPEX	Total score
Weighing factors	0,15	0,10	0,10	0,10	0,15	0,10	0,15	0,15	1
1. Gitikinyoni (south of road)	2	3	2	2	3	2	2	3	2,4
2. Gitikinyoni (north of road)	2	1	2	2	1	2	2	2	1,75
3. Muhima	3	1	1	1	1	2	3	2	1,85
4. Ruliba	1	1	3	3	2	3	1	1	1,75

The WWTP site receiving the highest score under this Multi-criteria analysis (2.4) is the site of Gitikinyoni, south the main road. However, this preference remains subject to mitigating the related negative impacts as described in the ESIA.

9.6 Routing of the Trunk Main

The current design documents assume routing of the trunk main as proposed in the CGI Master Plan (2008). See figures 35, 36 and 37 above. This route originates at the Central Bus Station in the east and next runs north of the current main road towards the proposed WWTP site at Gitikinyoni.

According to this outline, the trunk main first runs through the wetland and then passes along the northern backside of the houses located along the road (figure 35). However, in the middle section (figures 36) it cuts through the houses north of the main road and finally follows the northern boundaries of the main road (figure 36) down to the treatment plant.

Information from the design engineer revealed however that there are no technical constraints for altering the route of the main trunk, either more to the north into the valley, or more to the south along the main road.

As the City Master Plan for Kigali foresees in the planning of a new High Way along this route, possible with up to three lanes in both directions, the best option seems to be to put the trunk main in the median, between the two directions of the new high way. This will enable easy access to the trunk sewer for

maintenance and repair reasons, it will enable one combined action in terms of land expropriation and resettlement, it will reduce the combined investment costs, and finally it will limit the construction related nuisance for the project affected people.

However, this would require joined planning and coordination of the high way and the trunk main: the final lay out of the high way shall be available before completion the final design of the trunk main. This particularly requires coordination between the City of Kigali, WASAC LTD and the Rwanda Transport Development Agency, both under this Ministry of Infrastructure, prior to completion of the design and tender documents for the Trunk main.

9.7 Preferred Alternative

Based on above considerations, this ESIA concludes that the preferred alternative is the design as proposed by the project promoter WASAC LTD and presented by Mott Macdonald, with the exception of the trunk main, which is preferably be rerouted in accordance with the recommendations presented in section 9.3 above.

It is recommended furthermore to also include the recommendations and mitigating activities presented in this ESIA, both in the design and during the operations of the Kigali Wastewater Project.

10 ENVIRONMENT AND SOCIAL MANAGEMENT PLAN

10.1 Introduction

This section presents the Environmental and Social Management Plan (ESMP). It is based on the findings of the ESIA study, and includes a set of recommendations and mitigation and enhancement measures. These measures aim to reduce potentially significant adverse impacts to acceptable levels, including traffic, dust, odor, waste, flooding risks, and compensate residual effects. The plan includes prevention or minimization of any potential adverse environmental and social impacts of the Project that have not already been identified, e.g. actions for labor management, contractor management and performance in accordance with good international construction practices. This ESMP together with the separately issued Resettlement Policy Framework (RPF) aims to define certain aspects of the Tender Documents to be prepared for realization of the Kigali Wastewater Project. The proposed measures of this ESMP are differentiated for the pre-construction, construction and operation phases for the Project to achieve compliance with all relevant EIB requirements.

This ESMP includes a monitoring program to provide information on the environmental and socio-economic impacts of the project during implementation and on the effectiveness of mitigation and enhancement measures. The latter intended to allow corrective responses where results are insufficient. This ESMP also includes an organization structure and a framework for associated operational policies, procedures and practices, including agencies that are responsible for operation, supervision, monitoring and enforcement, remedial action, financing, reporting and capacity-building. Finally, this ESMP includes an estimate of the required costs and funding sources.

10.2 Pre-construction Mitigation Measures

Below table presents measures required to mitigate the identified negative environmental and social impacts, some of which already have been mentioned before. This table focuses on the mitigation and enhancement measures during the design and pre-construction phase.

Table 31 - Mitigation Measures during Design and Pre-construction Phase

No	Activity	Impacts and risks	Mitigation Actions
	Overall		
A1	The proposed Kigali Wastewater Project aims at collecting and treating wastewater generated in parts of the Kigali, the capital of Rwanda. The project includes the realization of a sewer network covering the Nyarugenge and Muhima areas of Kigali, a trunk main crossing Kimisagara and Kigali sectors and a wastewater treatment plant with related sludge processing facilities and	Improved public health conditions and environmental conditions in and around Kigali due to prevented inflow of raw sewage in open drainage and surface water, reducing	Project Implemented as planned according to design an ESIA documents
		Enhancement of programmes for health improvement programmes	Project Implemented as planned according to design an ESIA documents
		Improved economic development perspectives for the CoK, specifically the business centre, due to good	Project Implemented as planned according to design an ESIA documents
		Cumulative impacts of disturbance of construction works of traffic congestion, dust, noise	Implement CESMP as planned
	Preparation Phase		
P1	Surveys and field investigations	Minor distortion of land and narure during sampling and test drilling	Carefull field sampling and test drilling, with restoration, cleaning up afterwards
		Risk of creating unrest with local residents and businesses as result of surveys	Public information prior to implementing surveys and field investigations
P2	Site Selection and buffer zones	Site Selection / Location alternatives for WWTP and trunk main: what argumentation and considerations have been put forwards to select the proposed sites?	See Multi Criteria Analysis for Site Selection
		land use restrictions will apply directly above and around the trunk main and also above and around the WWTP footprint (Zone A). For safety and security of the local communities and the environment, the National Legislation	Confirm that buffer zone and trees are included in final design of WWTP; To prevent an increase in population density around the WWTP and maturation ponds a spatial planning order of the City of Kigali or the District of Nyarugenge could be developed limiting new developments of housing in the area of influence around the WWTP
	Preparation of detailed design		
P3	Design WWTP and Maturation Ponds	Confirm why 4 sedimentation tanks are required instead of 2 in the water line	The logics of applying 4 sedimentation tanks in stead of 2 is requested to be clarified in the design documents
P4		Confirm that Digester is designed optimally, considering one single digestor through the use of boiler to create optimized temp of 30 degrees C.	The logics of the proposed Digested is requested, considering the use of a boiler to create optimized temperature of 30 degrees C in teh design documents

No	Activity	Impacts and risks	Mitigation Actions
P5		Reliability of Power Supply	(1) Confirm capacity of central electricity net, to supply sufficient energy to WWTP, pumping stations and to other consumers of the electricity net; (2) confirm sufficient stand alone back up energy capacity for WWTP and pumping station
P6		Design Effluent quality shall be confirmed	Confirm that the designed WWTP and maturation ponds reach effluent standard of 25 mg/l, possibly splitting up maturation ponds in 2 to better reach these standards
P7			Design effluent discharge well below river surface level and optimize dilution with river water flow
P8		Are WWTP and maturation ponds well designed to address potential flood risks?	Confirm that WWTP design and related pumping stations are robust enough to maintain influent treatment during period of high water / flooding
			Confirm that adequate flood protection measures (such as dam or flood retention wall, and additional surface water drainage) are included in design for western part of WWTP
P9		Is there a need for offsetting loss of wetland or biodiversity due to construction of the WWTP and maturation pond in dedicated wetlands?	realize flood protection measures along the main road, between the river and the WWTP area, this would prevent direct contact during these high floods; manage discharge of untreated effluent during failure of WWTP; (see also section 7.5.4)
P10		Ensure that the applied wastewater and sludge management technologies doe not have a negative impact in terms of odour on the surrounding inhabitants	Prepare for Odor Mitigation Measures during design phase: (1) belt filter press; (2) enabling covering up and air filtering of critical odor areas in WWTP design; (3) prepare design for a basic weather station for recording wind speed, direction, humidity and rainfall at the WWTP. This may reduce the footprint of the WWTP with about 2 ha
P11		Gas emissions from WWTP	Enable gas emission reuse for power generation in design of WWTP; Apply reusable building materials where possible
P12		Land use and Expropriation cost	If still opted for open drying beds, confirm that surface area of 2.4 ha is sufficient (ESIA review estimates that 3.17 ha would be required for open drying beds). If opted for mechanical sludge drying instead, as recommended in this ESIA, the overall footprint of the WWTP area can be reduced with 2 ha.

No	Activity	Impacts and risks	Mitigation Actions
P13		Mobility of Project Affected People	Re-route and design a new Access Road, currently running through the WWTP area from north to south
P14		Project Affected People	Plan and design alternative water source or well near WWTP for local communities, and provide adequate water supply for project affected people along trunk main and WWTP as an equitability compensation measure
P15		Environment	Design a chemical and biological laboratory on the site of the WWTP for weekly analysis of influent, effluent and ambient water quality (COD, TSS, total Nitrate, Phosphate and pH)
P16		Enable reuse of sludge for agricultural purposes	Perform chemical testing of procesed sludge prior to agricultural use, to ensure meeting sludge reuse standards
P17		Agriculture, water management	Study reuse options of the treated wastewater
P18		Increased malaria risks due to open surface water of maturation ponds	Include biological prevention measures into the design of the maturation ponds, to prevent malaria
P19		Project Affected People	Plan and design alternative football field near maturation ponds for local communities
P20	Trunk Main	Current proposed trunk main crosses through existing houses north of main road, resulting in resettlement requirements	Prior to detailed design of the project components an assessment shall be made of existing subsurface infrastructure, to ensure that this infrastructure (power lines, water supply, fibre cables, sewer lines) is not affected by the project
P21		Planning of Construction Planning of Trunk Main route vs Road Expansion Plans.	Ensure that coordination with CoK, WASAC and Rwanda Transport Development Agency is performed, to integrate the design of new high way with routing Trunk Main (along median of new high way)
			If agreed, prepare and implement RAP for Trunk Main in coordination with RAP for new High Way
P22	Sewer Connections	Risk that households do not get connected	Ensure connection of all buildings; ensure that connected houses have flush toilets in 1A / 2A areas to sewer system, possibly as part of one overall BOT package.
P23		Sanitation services of Project Affected People	Provide adequate sanitation services to Project Affected People along trunk main and around WWTP
P24	Completion of RPF, RAP and Land Acquisition Plans (RAP and LAP are not part of this assignment)	Identification and compensation of affected people, according compensation principles and resettlement process	Develop and implement Resettlement Action Plan, based on the Resettlement Policy Framework (issued separately)
P25	Preparation and implementation of SEP	Opportuninities for stakeholders to be involved in the project preparation process resulting in a more widely supported and better project	Implement Stakeholder Engagement Plan (issued separately)

10.3 Construction Environmental and Social Management Plan

This section focuses on environmental and social impacts and proposed mitigation and enhancement measures throughout the construction and immediate post-construction phase of the proposed Kigali Wastewater Project. Specifically, this section focuses on construction activities that might have detrimental impacts on the environment and society, and related mitigation measures.

The successful implementation of the CESMP is dependent on the effective management of the environmental aspects and impacts associated with the construction works. It is recommended that the Employer and their Contractors move towards implementing an Environmental Management System (EMS) that is, or comparable to, the ISO 14001 standard. The ISO 14001 standard allows for environmental performance to be continuously monitored and audited, thereby identifying areas that require improvement. The ISO 14001 standard requires the adoption and implementation of a range of environmental management techniques in a systematic manner that can contribute to optimal outcomes for all interested parties. An Employer, or Contractor, is ultimately also required to develop an environmental policy, if there is none in existence. The policy defines how the environmental objectives set for the organization are managed and monitored. The policy should be seen as the vehicle for the implementation of guiding principles regarding the environment that are specified in the policy. The ISO 14001 standard is based on the methodology known as “Plan-Do-Check-Act” (PDCA).

The CESMP provides mitigation and management measures as shown in below table. This CEMP shall be a dynamic document which can be updated as required on a continuous basis by the Contractor to ensure environmental best practice. Any amendments made, must be submitted to the Independent Engineer/Employer/relevant Authorities for approval prior to the amendments being implemented.

The Contractor shall detail the measures mentioned below in a Construction Environmental and Social Management Plan (CESMP) for all activities and locations (including transportation routes) into practical rules, responsibilities, timelines, training and awareness raising, communication, costs and supervision. The plan needs approval from WASAC LTD.

The following construction environmental and social impacts and related mitigation measures have been identified for the Kigali Wastewater Project.

Table 32 – Construction Environmental and Social Impacts and Mitigation Measures

No	Impact	Source / Subject	Mitigation Measures
CE	Disturbance to local residents during construction works	Location of construction works close to neighboring living areas	Contractor shall submit construction yard logistics to Client, including means of separation from living areas
	Disturbance to local residents	Location of maturation ponds	Construct alternative football field near maturation ponds for local communities
	Impact on existing sub-surface infrastructure	Existing sub-surface infrastructure (power lines, water supply, fiber cables, sewer lines) is not affected by the project	It is required to investigate the presence of existing subsurface infrastructure (power lines, water supply, fiber cables, sewer lines) and to ensure that during the construction works these will not be affected
	Traffic Management Plan	Construction Vehicles and traffic management	The Contractor shall elaborate a Traffic Management Plan, which shall be coordinated with the Client, the CoK and the relevant traffic authorities and the police. This plan shall be approved prior to the start of the construction works, and will include: • Traffic routes for construction equipment and building materials, including foreseen timing and frequency of traffic movements • Identify critical traffic safety and accident risk locations along the route, and propose related mitigation measures, including speed control and road signs • Timing and access of construction material delivery vehicles to site should be strictly controlled to avoid the disturbances to the local community. • Timing of construction of sewer network and trunk main to limit risks of traffic accidents, traffic jams and nuisance. • Appropriate traffic signage must be erected on site by the Contractor to alert other road users to construction activities. • The Contractor should strategically position the site entry and exit points to ensure that there is minimum impact to the traffic flow on neighbouring areas • A low speed limit shall be adhered to on site. • Construction vehicles must utilise existing main road and access roads and not create new unauthorised access roads. • The Contractor must ensure that local access roads are not damaged by

No	Impact	Source / Subject	Mitigation Measures
			construction vehicles. If damage does occur, it needs to be attended to immediately to avoid long term problems. • Lighting used to facilitate construction at night should not disturb neighbouring residents. Down lighting should be employed where practicable. • Accessibility of public buildings (among others offices, hospitals, schools, universities, businesses and culturally important sites) needs to be guaranteed during normal working hours. Specific attention shall be given to accessibility for people with disabilities
	Storm water discharge to neighboring residents	Storm water and drainage at construction site	Contractor shall attend storm water drainage on construction site, to prevent soil erosion and flooding
	Unauthorized access to site camp	Access points	The site yard must be secure at all times to prevent unauthorized access at the construction site. The Contractor must ensure that construction trenches and material storage areas are sealed off with barrier tape/fences. There must be security at the entrance gate controlling access to the site.
	Site contamination	Storage and use of equipment and hazardous substances	Hazardous substances need to be kept in a secured storage area which is bunded and/or has an impermeable floor layer that is able to contain spillages. The hazardous substance storage area needs to be locked at all times. Spill kits must be kept at the hazardous substance storage facility to treat and manage any spills immediately. All contaminated soil/clothing/material must be disposed of at a licensed or approved hazardous landfill site. The hazardous material storage facility should be sited away from storm water drainage lines. Clear warning signage must be placed at all storage areas containing hazardous substances / materials. Staff dealing with these materials / substances must be aware of their potential hazard and follow the appropriate safety measures.
	Site contamination	Solid waste handling	Sufficient waste bins shall be provided on site to encourage waste separation and for recycling purposes, if such systems are available. Refuse bins shall be placed at strategic positions to ensure that litter does not accumulate on site. Construction workers need to be encouraged to use the waste bins provided at all times, and littering should be prohibited. The Contractor must engage with the local authorities or a private waste service provider with regards to the provision of waste skips. Skip waste containers should be kept on site to dispose of construction rubble.

No	Impact	Source / Subject	Mitigation Measures
			Containers must be removed when they fill up to maintain a clean site. Waste must be disposed of at the official landfill, approved by the authorities. If the waste disposal facility does not issue a record of the waste disposed, it is recommended that the Contractor keep a record at the construction site of the volumes of waste taken to the facility. Burning of waste on site or in waste containers is prohibited. Hazardous waste may not be stored on site in excess of a 90 calendar day period.
	Site contamination	Sanitation	The Contractor shall install mobile chemical toilets on the site and place them in a bunded area. The Contractor need to establish hand washing facilities and soap to maintain good hygiene on site. Staff shall be sensitized to use these facilities at all times. Ablution facilities shall be within 100m from workplaces. The Contractor should arrange that the toilets are serviced regularly by the service provider.
	Air and soil pollution	Handling of cement, asphalt, fuel, paints and other chemicals	Cement or asphalt mixing must take place on impermeable/ protected surfaces. Use of ready mixed cement/asphalt will require the establishment by the Contractor of proper truck and equipment wash bays with an impermeable floor layer. Used paint tins/brushes must be disposed of as hazardous waste and paint washings collected in receptacles for later safe disposal. Paint must not be washed into stormwater drains on site.
	GHG Emissions	Air emissions	Purchase reusable building materials where possible; minimize construction transport distances and related transport air pollution
	Noise	construction noise	Construction works related noise levels must be kept within acceptable limits. The noise and sound generated shall adhere to the Rwanda noise standard specifications and take account of nearby residents when work is performed at night. No sirens and hooters may be utilized except where required or in emergencies. The playing of loud music at the construction yard is prohibited. The Contractor should keep the local community informed of unavoidable noisy activities and their duration.
	Soil Erosion	Topsoil erosion risks	Topsoil removed from the construction footprint should be stored separately for usage during the rehabilitation process. The topsoil stockpiles shall be stored, shaped and sited in such a way that they do not interfere with the flow of stormwater and cause soil erosion.

No	Impact	Source / Subject	Mitigation Measures
			Stockpiles of topsoil shall not exceed a height of 2 meters. Areas not forming part of the construction footprint should not be disturbed by the Contractor. Soils compacted during construction work should be deeply ripped to loosen compacted layers and be re-graded to even levels and then re-vegetated upon completion of construction activities. Wind screening and stormwater control should be undertaken to prevent soil loss from the site by the installation of diversion berms, sandbags and silt traps, where necessary. The use of a geotextile cover is particularly important where there is a slope, or where the soils are likely to remain exposed for any period of time while the new vegetation establishes itself. Site clearance must be undertaken in a phased manner to minimize the amount of exposed soil.
	Dust generation	Duct from excavations, cement and construction materials	Excavations and other site clearing activities shall only be undertaken during agreed working times to avoid the spreading of sand and dust into neighbouring areas. The Contractor shall be responsible for dust control (water spraying) on site to ensure no nuisance is caused to the neighbouring landowners and the local community. A speed of 20 km/h shall not be exceeded on site. The Contractor must attend to complaints resulting from dust generation immediately. The Contractor should commence with rehabilitation of exposed soil surfaces as soon as practically possible after completion of earthworks. All material resulting from excavation must be put in a location protected from wind and regularly sprinkled with water until reused for fill Dust suppression measures must be implemented where required.
	Fire risks	Potential fires	The Contractor shall have operational fire-fighting equipment available on site at all times. The level and capacities shall be sufficient to address any major firs outbreak Open fires shall be prohibited on the site
	Surface Water pollution	Chemical and hazardous	All hazardous materials shall be placed in bunded containment areas on sealed

No	Impact	Source / Subject	Mitigation Measures
		materials	floor surfaces and 100m away from any water bodies. The Contractor must remove contaminated wastewater resulting from construction activities and dispose of it at a licensed commercial wastewater treatment facility. Temporary cut-off drains and berms must be erected in order to capture surplus storm water and promote infiltration. Used oil on site must either be collected by a registered waste oil collector or disposed of to a registered processing or disposal facility. Manual cement/asphalt mixing activities must take place in a bunded/lined area to prevent runoff from the area entering the storm water drainage system. It is recommended that ready mixed cement/asphalt be utilised to prevent onsite water pollution and impacts on surrounding areas, where possible. A designated, properly designed impermeable washing area for vehicle and construction equipment must be established by the Contractor if this cannot be undertaken off-site. Any accidental spillages that occur on site must be contained and remediated as soon as possible. On site ablution facilities need to be serviced regularly and placed in a bunded area. Storm water needs to be managed especially during the wet season. It should not be allowed to drain into trenches nor should it be allowed to flood areas where construction materials or equipment are stored. A storm water management plan must be prepared by the Contractor and approved by the ESO, ECO and /or the Independent Engineer. Water pumped from any excavations/trenches must be safely disposed of and be free from silt and sediments. This can be achieved by installing silt traps (e.g. sandbags) to separate silt and water.
	Safe water use	Leakage and wasting	The contractor need to provide safe drinking water to its employees, meanwhile avoiding wastage and timely repaid of leakages
	Local Water Supply	Water Supply	Construct alternative water source near WWTP for local communities
	Disturbance of wetland ecology	During construction maturation ponds	Construction work site shall be physically separated from surrounding wetlands Nuisance and pollution of the surrounding wetlands shall be fully prevented, including dust, noise, wastewater emissions, and particularly waste generation and

No	Impact	Source / Subject	Mitigation Measures
			disposal The contractor shall prevent that animals, fishes and other fauna will be disturbed, trapped, hunted or killed by the workers and staff involved in the construction works In case of emergencies accidents with impacts on the wetland ecology beyond the boundaries of the construction site, the relevant authorities including REMA shall be informed immediately, and related mitigation measures shall be prepared and implemented as soon as possible
	Occupational Health and Safety Impacts	Workers and community safety	A health and safety plan shall be drawn up by the Contractor to ensure the safety of workers. Contractors shall ensure that all equipment is maintained in a safe operating condition. A record of health and safety incidents shall be kept on site. Any health and safety incidents shall be reported to the Employer immediately. First aid facilities shall be available on site at all times. Workers have the right to refuse work in unsafe conditions. Material stockpiles or stacks shall be stable and well secured to avoid collapse and possible injury to site workers.
	Occupational Health and Safety Impacts	Use of Protective gear	Personal Protective Equipment (PPE) shall be made available to all workers and use of PPE shall be made compulsory. The minimum PPE includes: • Hard hat • Safety shoes • Overalls • Gloves • Reflector vests • Certain operations may require additional PPE such as: • Earplugs • Eye protection glasses • Face masks etc. No person is to enter the construction site without the necessary PPE.

No	Impact	Source / Subject	Mitigation Measures
	Occupational Health and Safety Impacts	Site safety issues	The WWTP and maturation pond construction yard shall remain fenced at all times. Potentially hazardous areas such as trenches are to be demarcated and clearly marked. Adequate warning signs of hazardous working areas shall be erected in suitable locations. Emergency numbers for the local police, clinic/hospital and fire department shall be placed in a prominent area. Firefighting equipment shall be placed in prominent positions across the site where it is easily accessible. This includes fire extinguishers, a fire blanket as well as a water tank. Workers need to be trained on how to operate the firefighting equipment. All flammable substances shall be stored in safe areas which do not pose an ignition risk. Smoking may only be conducted in demarcated areas as agreed upon by the SHE officer and the Contractor. A speed limit of 20km/h shall be adhered to by all construction vehicles and machinery. The works that take place in the public space, especially the construction of the sewer network and the trunk main, need specific health & safety planning, traffic safety planning, and training of the construction workers to limit public the safety risks, such as falling into holes, pools or ditches or collisions with construction equipment.
	Stakeholder Engagement Planning	Stakeholders	Stakeholder engagement, as described in the Stakeholder Engagement Plan (SEP) should continue into the construction phase. Specific attention should be given to communication about public health & safety risks and measures to mitigate these. The project council (as introduced in the SEP) with representatives of the local residents should be in regular contact with CoK and WASAC LTD. A grievance mechanism (as described in the SEP) should be established and managed.
	Neighborhood accessibility	Community	Construct the rerouted Access Road around the WWTP area to the hinterland in the south

No	Impact	Source / Subject	Mitigation Measures
	Neighboring Community Impacts	Community relations	The Contractor must be courteous at all times when dealing with the neighboring community and their rights need to be respected at all times. A complaints register should be kept on site and the Contractor must attend to any public complaints as soon as possible. No interruptions other than those negotiated shall be allowed to any essential services, including acces to water sources and local infrastructure. Damage to local infrastructure shall not be tolerated and any damage shall be rectified immediately by the Contractor. A record of all damages and remedial actions shall be kept on site. Where possible, unskilled job opportunities should be afforded to local community members in order to transfer employment skills. The Contractor will need to engage with the municipal local Councillors or other community leaders to assist with the recruitment of the local unskilled labour when required.
	Neighboring Community Impacts	Infection risks from HIV / AIDS. Ebola and other diseases	The Contractor must coordinate and implement an awareness campaign on HIV and Aids, Ebola and other potential sicknesses within Kigali and Rwanda. The campaign must aim at sensitizing the employees and neighboring communities to potential health risks and regulating behavior.
	Neighboring Community Impacts	Alcohol and drug abuse	The consumption of alcohol and drugs by employees must be prohibited on and surrounding the construction area
	Disruption of cultural heritage	Uncovering of heritage artifacts or human remains during ground works	If heritage artifacts or human remains are uncovered on site, work in the immediate vicinity must be stopped immediately. The Contractor must take reasonable precautions to prevent any person from removing or damaging any such artifacts or human remains and must immediately, upon discovery thereof, inform the authorities of such discovery whom in turn must contact the authorities or a registered archaeologist. Work may only resume once clearance is given in writing by the archaeologist or relevant Authority.
	Employment opportunities	Labor recruitment	Where possible local residents, including women, shall be given the opportunity to apply for construction jobs and to supply materials, food and beverage.

Post-construction

Following the completion of the construction works, the following post-construction actions will be implemented by the Contractor:

- The construction yard is to be checked for spills of substances such as oil, paint, chemicals, other types of waste, and these shall be cleaned up.
- The Contractor must arrange for the cancellation of all temporary services, e.g. chemical toilets.
- All areas where temporary services were installed are to be rehabilitated to the satisfaction of the local authorities and the Independent Engineer, if assigned.
- Surfaces are to be checked for waste products from activities such as concreting/asphalting and cleared accordingly.
- All surfaces hardened due to construction activities are to be ripped and concrete/asphalt material removed.
- Topsoil must be replaced back to disturbed surfaces and used to re- vegetate disturbed areas.
- The use of a geotextile cover is particularly important where there is a slope, or where the soils are likely to remain exposed for any period of time while the new vegetation establishes itself.
- All construction waste and rubble is to be removed from the site and disposed of to the municipal or recognised/approved landfill site.
- The site is to be cleared of all litter and temporary cabins and structures should be dismantled.
- Fences, barriers and demarcations associated with the construction footprint are to be removed from the site.
- All residual stockpiles must be removed from the site.
- The Contractor must repair any damage that the construction works has caused to neighbouring properties
- Quarries used for sourcing construction material must be rehabilitated accordingly.

Public Information to prepare for Construction Works

The Project Affected People and general public shall be informed through the City of Kigali about the type and duration of the upcoming construction works, as well as during these works. This shall include information on the timing and planning of the construction works, the impacts on roads and traffic such as road closures and rerouting of vehicle and pedestrian traffic, potential temporary environmental nuisance and temporary traffic signs and warnings.

Contractor Management Process

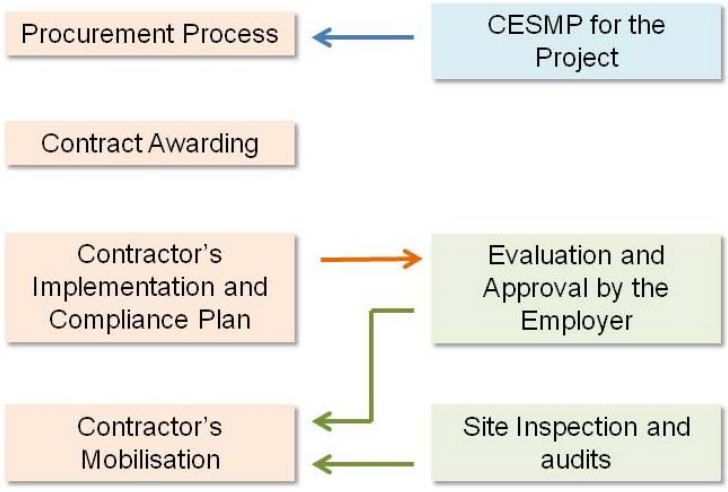

Figure 61 - Diagram Illustrating the Contractor Management Process

During the construction works procurement process an environmental and social briefing is required that alerts the Contractor to the environmental management expectations during the project, as illustrated above. Above table shall be provided to the Contractors who will be bidding for the construction work for the project. This is to ensure that the Contractors are made aware of the CESMP requirements and budget accordingly in their bids. The appointed Contractor is required to develop construction method statements indicating how he/she is going implement and ensure compliance with the conditions of the CESMP. The method statement documents must be approved by the Client and by relevant authorities before the Contractor mobilizes.

The following documentation must be kept on site by the Contractor in order to record compliance with the CESMP:

- An Environmental File including:
  - *Copy of the CESMP;*
  - *Copy of all other licenses/permits;*
  - *Copy of all rehabilitation plans;*
  - *Copy of the stormwater management plans;*

- Environmental Policy of the Contractor;
- Environmental Construction Method statements compiled by the Contractor;
- Non-conformance reports;

- Environmental register, which shall include:
  - *Communications register – including records of complaints, and, minutes and attendance registers of all environmental meetings.*
  - *Monitoring results – including environmental monitoring reports, register of audits, non-conformance reports (NCRs) etc.*
  - *Incident book – including copies of notification of emergencies and incidents and how these were closed out; this must be accompanied by a photographic record.*
  - *Safe disposal certificate for all types of waste disposed of site;*
  - *Environmental training records;*
  - *Waste disposal receipts or records;*
  - *Material Safety Data Sheets for all hazardous substances used and stored on site;*
  - *Dust suppression register;*
  - *Water quality monitoring reports;*
  - *Written corrective action instructions;*
  - *Construction Method Statements; and*
  - *Notification procedures and contact numbers for emergencies and incidents.*

When the construction activities have been completed, an independent environmental auditor is required to conduct a site inspection in order to sign off the site prior to the Contractor leaving the site.

Environmental Monitoring during Construction Works

A monitoring program should be in place not only to ensure compliance with the CESMP throughout the period of the construction activities, but also to monitor any environmental issues and impacts which may have not been accounted for in the CESMP that are, or could result in significant environmental or social impacts for which corrective action is required. A monitoring program should be implemented for the duration of the construction phase of the project.

This program may include:

- Daily site visits and monitoring must be conducted by the Contractor's Environmental Site Officer (ESO) to ensure daily implementation of the CESMP conditions and provide corrective actions where required. Monthly site audits must also be conducted by the ESA and monthly audit reports produced;
- Site audits, as agreed with the Client, must be conducted by an external independent Environmental auditor during the construction phase (it is proposed one in month 2 and one as construction ends), and be reported to REMA and the Client;
- Site audits by Client's representative; and
- Compilation of external independent environmental audit reports after the aforementioned site audits by the ECO that document findings and recommend any corrective actions to be taken. The final report will provide feedback on whether any previous non-conformances raised have been resolved, thereby ensuring continual improvement of the site's environmental performance.

In case of non-compliance by the Contractor, a Non-Conformance Report (NCR) will be issued to the Contractor as a final step towards rectifying a failure in complying with a requirement of the CESMP. This will be issued by the Client to the Contractor in writing. Preceding the issuing of an NCR, the Contractor must be given an opportunity to rectify the non-conformance issues. Should the Client assess an incident or issue and find it to be significant (e.g. non-repairable damage to the environment), it will be reported to the relevant Authorities and immediately escalated to the level of a NCR.

The following information should be recorded in the NCR:

- Details of non-conformance;
- Any plant or equipment involved;
- Any chemicals or hazardous substances involved;
- Work procedures not followed;
- Any other physical aspects;
- Nature of the risk;

Agreed timeframes by which the actions documented in the NCR must be carried out; and the Client should verify that the agreed actions have taken place through an independent environmental auditor by the agreed completion date; when completed satisfactorily; the auditor on behalf of the Client should sign the close-out portion of the non-conformance record and file it with the contract documentation.

10.4 Operational Environmental and Social Management Plan

Below table presents the measures required to mitigate the identified negative environmental and social impacts, some of which have already been mentioned before. This table focuses on the mitigation and enhancement measures during the operational phase.

Table 33 - Mitigation Measures during Operational Phase

OP1	Impact	Ref.	Mitigation Measures
1	Effluent water quality	6.2.3 8.4.5	Establish effluent monitoring program in line with RS 109 2009 Water Quality, and optionally with EU Directive 91/271/EEC and amendment 98/15/EEC, particularly for BOD, Ammonia and SS and occasionally for non-typical components
2	Monitoring and reporting	6.2.3 8.4.5	The operator should maintain records of air emissions, effluents, and hazardous wastes sent off site, as well as significant environmental events such as spills, fires, and other emergencies that may have an impact on the environment. The information should be reviewed and evaluated to improve the effectiveness of the ESMP. It should further include procedures for handling of accidents and disaster preparedness.
3	Occupational Health and Safety during operations (management system)	6.2.3 8.4.5	Establish an OH&S management system in line with RS 183 2013. Supervisors must first have the proper attitude and interest in OH&S, and shall gain a full working knowledge and understanding of the many ways in which they can prevent accidents and occupational illness.
4	Occupational Health and Safety during operations (chemical handling)	6.2.3 8.4.5	Many of the materials and chemicals used in the waste water treatment are corrosive, poisonous, explosive, or flammable. Handling of these materials requires proper precautions.
5	Occupational Health and Safety during operations (ventilation)	6.2.3 8.4.5	Wastewater treatment plants require careful analysis of and provision for ventilation needs, because plant ventilation prevents dangerous gas mixtures, and helps to maintain safe working conditions.
6	Occupational Health and Safety during operations (fire prevention)	6.2.3 8.4.5	All equipment, buildings and fire alarm systems should comply with local, state, and national fire codes and standards
7	Occupational Health and Safety during operations (electrical hazards)	6.2.3 8.4.5	Most of the equipment in the waste water plant uses electricity as the primary power source. Maintenance of the equipment requires strict safety measures against exposure to electrical hazards that may result in shock or death.
8	Noise	6.2.3	Confirm that WWTP operations with meet the ambient noise standards according to RS 236 2014
9	Air Quality	6.2.3	Confirm that WWTP operations with meet the air quality standards according to RS EAS 751 and 752
10	Influent Water Quality	7.2.2	Establish influent monitoring to confirm that the influent is not mixed with industrial produced wastewater
11	Prevention of Bypassing influent (operations)	7.2.2	Confirm that Operations of WWTP and treatment of influent continues during periods of high water / flooding
12	Emergency bypassing during failure of WWTP		Bypassing untreated influent from sewre system, pumping station and WWTP to the maturation ponds during failure of

OP1	Impact	Ref.	Mitigation Measures
			the WWTP: During low river flows, this bypass will lead to hig14h concentrations of pollutants in the river. At that stage adequate information to the surrounding population shall be provided to avoid any direct contact with the untreated wastewater and the river segment downstream of the discharge. In addition, prevention of direct contact shall further be enforced by clear information and surveillance along the river.
13	Sludge Quality	7.2.2	Analysis of Final Sludge Quality, and evaluate against EU limit values for reuse in agriculture
14	Sludge Reuse	7.2.2 8.4.5	Provision of training and support to agricultural sector, if sludge reuse standards are met and sludge is provided to agricultural sector
15	Sludge final disposal	7.2.2	Sanitary disposal of sludge, if sludge reuse standards are not met
16	Wastewater Reuse	7.2.2 8.4.6	Study options for wastewater reuse near WWTP, based on total flow, effluent quality, and local (agricultural) market options.
17	Wastewater Treatment Fees	8.4.6	Ensure financial sustainable operations, including effective and adequate fee collection system and adequate pro-poor provisions
18	Prepare for expansion of stage 1 Kigali Wastewater Project	7.2.5	Ensure all water management related issues before expanding to stages 2 – 4 of Kigali Wastewater project (including additional water resources, sufficient water supply and full introduction of flushing toilets)
19	Buffer Zone and Visual Impacts	7.3.1	Maintain buffer zone and trees in this zone, including water supply, and maintain spatial plan around the project area. Enforcement of spatial planning around the WWTP and maturation ponds limiting new developments of housing in the area of influence around the WWTP
20	Flooding Risks	7.3.2	Main flood protection measures (dam and surface water drainage) and operate them during periods of high water level and floods for the western part of WWTP
21	Water Quality Monitoring	7.3.3	Establish Nyabugogo WQ monitoring program, upstream + downstream of WWTP effluent point, particularly for BOD, coliform, Ammonia and SS and occasionally for non-typical components.
22	Water Quality Analysis	7.3.3	Operate the chemical and biological laboratory on the site of the WWTP on a weekly basis for analysis of influent, effluent and ambient water quality (COD, TSS, total Nitrate, Phosphate and pH)
23	Malaria Risks (Operations)	7.3.4 8.4.5	(1) Operate and maintain biological malaria prevention measures during operations of maturation ponds, (2) ensure regular distribution of malaria nets to inhabitants; (3) monitoring malaria occurrence in surroundings of maturation ponds in co-operation with Health Centers
24	Odor emissions (monitoring)	7.3.5	(1) Set up effective odor monitoring program with participation from neighboring population; (2) operate the basic weather

OP1	Impact	Ref.	Mitigation Measures
			station for recording wind speed, direction, humidity and rainfall at the WWTP.
25	Odor emissions (operations)	7.3.5	Implement odor reduction measures (covering up and air filtering) if monitoring program measure structural odor nuisance
26	GHG emissions (Operations)	7.3.6	Implement gas emission reuse for power generation once this is possible financially and market / demand wise.
27	Implement Stakeholder Engagement Plan	8.2.2	Implement SEP during operational phase (see SEP report)
28	Inequality Compensation	8.4.1	Provide piped water supply and sanitation services for project affected people
29	Electricity Supply	8.4.2	(1) Confirm capacity of central electricity net, to supply sufficient energy to WWTP, pumping stations throughout operations and (2) operate and maintain stand alone back up energy capacity for WWTP and pumping station
30	Labor Opportunities	8.4.3	Assess operational job opportunities for local residents

10.5 Training and Capacity Development

It is important to ensure that all parties involved in the construction and operation of the project, including the Promoter and contractor, has the appropriate human capacity and level of environmental and social awareness and competence to ensure continued environmental due diligence and on-going minimization of environmental and social harm. Training needs should be identified based on the available and existing capacity of involved personnel to undertake the required ESMP and the CESMP management actions and monitoring activities. It is vital that all relevant staff is adequately trained to perform their designated tasks to an acceptable standard. The environmental training may be aimed at:

- Promoting environmental awareness;
- Informing about all environmental and social management procedures, policies and programs applicable;
- Providing generic training on the implementation of environmental management specifications; and
- Providing job-specific training in order to understand the key environmental and social features of the project site and the surroundings.

10.6 Public Information and Complaints Register

10.6.1 Public Information

As part of this ESMP it is proposed to set up a public information campaign to inform and instruct the involved population about the benefits of the Kigali Wastewater Project, and their roles and responsibilities.

The proposed public education and /communication programs include public awareness campaigns and educational programs designed to raise awareness about water and sanitation issues and to implement good water conservation and protection practices. Increased public awareness will also generate demand

and public support for further efforts to expand the sanitation services beyond stage 1. Communication and education techniques can enhance the effectiveness of people or groups seeking to participate.

As mentioned under the CESMP, the Project Affected People and general public shall also be informed through the City of Kigali about the type and during of the upcoming construction works, as well as during these works. This shall include information on the timing and planning of the construction works, the impacts on roads and traffic such as road closures and rerouting of vehicle and pedestrian traffic, potential temporary environmental nuisance and temporary traffic signs and warnings.

10.6.2 Public Complaints Register

It is proposed that the City of Kigali organizes a public desk for the Kigali Wastewater Project as part of their overall Public Information organization. The desk shall receive complaints and correspondence from the public, and register them in accordance to:

- Nature of complaint;
- Cause of complaint;
- Party/parties responsible for addressing complaint;
- Immediate actions undertaken to stop/reduce/contain the causes of the complaint;
- Additional corrective or remedial action taken and/or to be taken to address and to prevent reoccurrence of the complaint;
- Timeframes and the parties responsible for the implementation of the corrective or remedial actions.
- Procedures to be undertaken and/or penalties to be applied if corrective or remedial actions are not implemented; and
- Copies of all correspondence received regarding complaints/incidents.

This registration shall preferably be web-based with on-line access options for the public to key issues in terms of complaint registration and follow-up actions.

10.7 Monitoring Program

This section summarizes the specific environmental and social monitoring program required to support this ESMP. The monitoring components are divided over the different environmental and social domains.

10.7.1 Air and Odor Monitoring

In order to monitor any potential odor nuisance around the site it is proposed inviting about 15 people inhabitants from directly around the WWTP plant to participate in an Odor Panel, starting with the operations of the plans. The Panel will be coordinated by an independent expert from REMA. These people would be directly invited to report on paper when a specific odor from the treatment plant is noticed, including date, time and level of odor. In addition, they will file any odor complaint from the other inhabitants around the plant.

In parallel, the operator of the plant will keep record of the timing of specific wastewater and sludge handling processes on the plant. This would allow linking certain obvious odor events with specific activities on the plant, and taking adequate measures. In addition, the Plant Operator may install a weather vane, to monitor dominant wind directions and speed.

For an initial three months both these records shall next be evaluated by the coordinating expert on a weekly basis, and be reported back to both the Odor Panel as well as the Plant operator. In addition it is recommended to establish a basic weather station for recording wind speed, direction, humidity and rainfall at the WWTP. If periods of structural odor nuisance will be noticed, the plant operator shall be obliged to take adequate odor mitigation actions.

After the three month period, or once the nuisance has disappeared, a less intensive monitoring system shall be established, including a central point of contact at the WWTP where surrounding residents can file their odor related complaints.

10.7.2 Noise Monitoring

It is not likely that noise emissions will lead to nuisance during the operations. However, in case of complaints from neighboring villages, noise levels should be identified. If these measurements prove impacts on settlements, measures for noise abatement may have to be elaborated. Nevertheless, no specific acoustic measures are required for the WWTP.

10.7.3 Influent and Effluent Monitoring

It is advised to sample and analyse both influent and effluent water samples on the same day every six days. This results of a weekly shift of one day, so that after 7 rounds of analysis all days of the week have been covered.

The following analyses are proposed for both influent and effluent data every six days:

- Total Chemical Oxiden Demand
- Total Suspended Solids
- Total Nitrate
- Total Phosphate
- pH

The analyses are to be performed by a qualified laboratory and checked against the design influent and effluent parameters. If important discrepancies will occur, adequate operational interventions shall be developed.

In addition it is proposed to analyze heavy metals, particularly Lead, Nickel and Copper and Oil, on a monthly basis, in order to assess whether industrial wastewater might have been discharged as well.

These concentrations shall be evaluated and tested against national WQ standards RS109 2009, and reported to the operator and REMA.

10.7.4 Water Quality Monitoring

The water quality of the Nyabugogo River is to be analyzed every 3 months for the first 3 years of operations of the WWTP, both directly downstream as well as upstream of the point of effluent discharge. The sampling of both samples shall be done on the same time, and analysis shall include the following concentrations:

- Total Chemical Oxiden Demand
- Total Suspended Solids

- Total Nitrate
- Total Phosphate
- Total Coliform and related Pathogenic organisms
- pH

These concentrations shall be evaluated and tested against national WQ standards RS109 2009, and reported to the operator and REMA.

10.7.5 Malaria Monitoring

During the first five years of operations a malaria monitoring program shall be set up, in co-operation with the Muhima and Kimisagara Health Centers, near to the maturation ponds, to assess the number of annual malaria diseases in the project area, compared to the pre-project period. In case number of on the rise additional measures shall be considered, prepared and implemented.

10.7.6 HSE Monitoring

In accordance with the RS 183 Occupation Health and Safety (OHSAS) Standards, the HSE aspects shall be integrated with the overall management of the WWTP into a separate Occupational Health and Safety Management System (OH&M). This system shall be elaborated by the operator, and shall focus on all relevant impacts on health and safety during the operations of the plans, including:

- Relevant routine and non-routine activities;
- All persons on the workplace (including contractors and visitors);
- hazards created in the vicinity of the workplace by work-related activities under the control of the organization;
- infrastructure, equipment and materials at the workplace, whether provided by the organization or others;
- OH&S organization, its activities, or materials;
- Any modification to the OH&S management system, including temporary changes, and their impacts on operations, processes, and activities;
- Legal obligations relating to risk assessment and implementation of necessary controls
- Design of work areas, processes, installations, machinery/equipment, operating procedures and work organization, including their adaptation to human capabilities.

10.7.7 Public Health Monitoring

Monthly data of the two health centers in the WWTP region should be analyzed in detail on developments in water-borne diseases to assess the health impacts benefits of the wastewater project.

10.8 Organization Structure of this ESMP

This section provides a description of institutional arrangements in terms of who should be responsible and when, for carrying out the mitigation and monitoring measures.

The WWTP operator shall assign an Environmental and Social Officer (ESO) at the Plant, who shall be responsible for implement this ESMP, including the monitoring program, monthly reporting to the Operator and REMA, and running the environmental laboratory at the WWTP site.

REMA will be the environmental authority responsible for environmental issues. It shall be responsible for overseeing the environmental and social monitoring activities and evaluating the environmental monitoring reports that shall be issued on a monthly basis by the Environmental and Social Officer.

WASAC LTD is responsible for the operational activities of the Kigali Wastewater Treatment Plant, and shall be responsible for managing and monitoring all financing aspects of the ESMP as part of the operational financial budget for the project. However, WASAC LTD will most likely need additional financial subsidies from the Ministry of Finance, or through cross subsidies from energy to water, to balance their operational expenditures with their wastewater related revenues.

The City of Kigali will be responsible for overseeing all communication with the stakeholders and manage the complaints filing unit for the project as part of their overall Public Relations department. Next, the Health Centers will play a role in monitoring any malaria related impact of the project, together with the ESO. These centers fall under the responsibility of the Ministry of Health.

Finally it is suggested that a specialized independent environmental auditor will carry out annual audits and review of compliance of the activities and monitoring results with the provisions of this ESMP.

10.9 Operational Procedures and Practices.

Operational procedures and practices for this EMSP are described in ISO 14001, an internationally agreed standard that sets out the requirements for an environmental management system. It helps organizations improve their environmental performance through more efficient use of resources and reduction of waste, gaining a competitive advantage and the trust of stakeholders.

According to ISO 14001, an environmental management system helps organizations identify, manage, monitor and control their environmental issues in a holistic manner, using a High-Level Structure. This means it can be integrated easily into any existing management systems. It also includes the need for continual improvement of an organization’s systems and approach to environmental concerns. ISO 14001 is suitable for organizations of all types and sizes, including the operations of Wastewater Treatment Plants.

The standard reuiqres that the WWTP management includes all environmental issues relevant to its daily operations, including odor an air pollution, water and sewage issues, waste management, soil contamination, climate change mitigation and adaptation, and resource use and efficiency. It furthermore assumes environmental management within the organization’s strategic planning processes; strong input leadership involvement and engagement of all employees.

Other relevant policies, principles and guidelines for implementing this ESMP are: the RS 126 1 to 4 Wastewater construction and safety principles, prescribing a series of requirements and standards in terms of design , structural and equipment components of wastewater treatment installations, which shall be fully met; the RS 180 and 181 2013 Solid waste disposal - Code of practice, specifying that guidelines for safe disposal of solid waste, including soil, surface water and groundwater protection and vector risks; and the RS 183 2013 Occupational Health and Safety requirements, intended to provide organizations with the elements of an effective OH&S management system that can be integrated with other management requirements and help organizations achieve OH&S and economic objectives

Finally, the 2015 Health Sector Policy of the Ministry of Health confirms that infectious diseases are the primary cause of outpatient morbidity in health centers. The policy emphasizes on the role of environmental and health promotion activities in most of the villages in the country conducted by hygienic clubs. These clubs are responsible for promoting hand washing, introduction of improved latrines and other behavior change.

10.10 Costs and funding sources

The following table provides an estimate of the annual costs for implementing this ESIA and ESMP.

Table 34 – Cost and Saving Estimates for implementing the ESIA and ESMP

No	Recommendation	Savings in CAPEX	Additional preparation costs and CAPEX	Additional OPEX
P3	2 instead of 4 primary sedimentation tanks may be considered	Based on pre-design Mott		
P4	Single Digester with 30^0 C heater may be considered	Based on pre-design Mott		
P6	Split up maturation ponds in 2, to better reach 25 mg / BOD effluent standard?		To be included in Contractors' bid	
P8	Continue operations of WWTP also during times of flood			+10% operating costs. Check annual WWTP operating costs of Mott
P16	Chemical testing of processed sludge prior to agricultural reuse			€ 5000 / yr
P17	Study reuse options for treated wastewater		Study costs: € 10,000	
P21	Align Trunk Main with plans Highway Extension	Saving resettlement and compensation costs Trunk Main in Kigali WW Project: € 1,633,114	To be included in Contractors' bid	
P2	Safety zone of 20 m around WWTP, including trees			
P8	Flood prevention at western part of WWTP		500 m Flood Retaining Wall: € 100,000 Additional drainage on site: € 100,000	Maintenance: € 5,000 / yr
P15	River WQ Monitoring at WWTP			€ 10,000 / yr (for 3 years)
P18	Malaria Prevention		Biological Prevention in maturation	€ 5000 / yr

No	Recommendation	Savings in CAPEX	Additional preparation costs and CAPEX	Additional OPEX
			ponds: € 5,000 Distribution of Malaria nets: € 4,000	
P10	Odor Prevention		If required: covering up / active carbon air filters: € 100,000 Applying a mechanical sludge system (Belt Filter Press), instead of open sludge drying beds: € 150,000	Odor monitoring: € 5000 / yr Active carbon: € 2000 / yr Operations: € 12,000 per year
P11	Biogas power generation		Based on BoQ Mott	Energy saving
P13	Rerouting unpaved road across WWTP site		€ 200,000	
P14	Re-arranging local water supply well near WWTP		€ 10,000	
P19	Relocating local football field		€ 10,000	
P23	Inequality Compensation		Piped water supply and sanitation for PAP's € 100,000	€ 5,000 / yr
C3	Construction Environmental and Social Management Plan	Included in Construction Costs		
OP1	Environmental and Social Management Plan		€ 30,000	€ 10,000 / yr
TOTAL Addition Cost and Savings ESIA and ESMP *		**€ 2,273,144 excluding estimates based on BoQ Mott**	**€819,000, excluding estimates based on pre-design Mott**	**€ 52,000 / yr excluding estimates based on operating costs Mott**

* The Contractor shall fulfil all duties and responsibilities stated in this ESIA and Environmental and Social Management Plan

If the recommendations of this ESIA and ESMP would be implemented, this will lead to an addition CAPEX of € 819,000 and an additional annual WWTP operating cost of € 52,000. These figures are excluding estimates to be made on the basis of the design and WWTP operating costs to be elaborated by the BOT Contractor.

11 LIMITATIONS AND CONCLUSIONS

This section summarizes the conclusions of the Environmental and Social Impact Assessment (ESIA) for the Kigali Wastewater Project, situated in Kigali, Rwanda. The *Water and Sanitation Corporation Limited* (WASAC LTD) is promoter of this. WASAC LTD is the public company providing water supply and wastewater collection services to the people of Kigali and other areas in Rwanda.

The overall objective of the Project is to protect the environment of Kigali water catchments and the Nyabarongo River, which is discharging to the Kagera River and further to Lake Victoria, through wastewater treatment and to improve water and sanitation services within the city of Kigali. The purpose of this ESIA is to ensure that the European Investment Bank's and the national Rwandese environmental and social standards are met for the preparation and appraisal of the Kigali Wastewater Project.

Chapter 1 of this ESIA presents an introduction to the Kigali Wastewater Project and confirms that purpose of this ESIA. Chapter 2 provides the context and the history of the project. It demonstrates the importance of the Kigali Wastewater Project in terms of mitigation the environmental and public health risks associated with the current wastewater and sanitation status. The Nyarugenge district, to be connected to the new sewer system, is the second wealthiest district in Kigali. Comparing with the national poverty level (44.9% and 24.1% of the population identified as poor and extremely poor), this district has 16.8% poor people and 7.8% extremely poor. This ESIA concludes that the project provides an excellent opportunity for the city of Kigali to reach eventually a sustainable situation regarding sanitation and public health that will benefit its environment and its socio-economic development perspectives.

Chapter 3 provides the environmental and socio-economic baseline of the project. The project is located in the area where three rivers flow into the Nyabugogo River and its surrounding wetlands. Flooding events occur up to three times per year in the Nyabugogo wetlands and affect the wetlands along the proposed trunk main and the area of the maturation ponds. The trunk main will be located along the Kigali-Muhanga highway from the Nyabugogo Central Bus Terminal to the junction with the highway to Musange. This is the main thoroughfare used intensively by cars, motorcycles, busses, trucks, bicycles and pedestrians entering and leaving Kigali.

Today about 65,000 m3 /.day is produced by WASAC LTD in existing water plants and provided to the city as piped water. Considering a projected population of 1.33 Million with a total water demand of about 100,000 m3 / day or more, this ESIA concludes that there is still a considerable gap between water demands and piped water supply. The City of Kigali does not have a centralized wastewater collection and treatment system yet. Individual household wastewater collection systems are used by 95% of the CoK population and include simple or aerated pit latrines and public latrines, which still largely flow untreated into the surrounding surface waters.

This ESIA concludes that the current situation inhibits the wetland from functioning properly, reducing its ability to filter water and provide a safe ecosystem for plants and animals. Water-borne diseases occur throughout the project area, between 3 and 7% of the patients registered at the health centers. However,

no specific information is available that links the current sanitation problems and river water pollution to public to public health data.

Chapter 4 provides a description of the foreseen Kigali Wastewater project, including its staged implementation framework. The Kigali Wastewater Project includes the construction of a sewerage collection system and pumping station, a trunk main, and a central wastewater treatment plant with maturation ponds. These project components are situated in five administrative sectors: the Gitega, Nyarugenge, Muhima, Kimisagara and Kigali sectors, all part of the Nyarugenge District. The sewerage collection area will be located in the first three sectors; the pumping station in the Muhima sector; the trunk main in the Kigali and Kimisagara sectors and the WWTP and maturation ponds in the Gitikinyoni the Kigali Sector (in the village of Nyabugogo Cell, which is part of the Kigali sector).

The Kigali Wastewater Project will be built in a modular fashion, with stages in line with the foreseen network expansion and as the population of Kigali grows. Since the current project is the first centralized wastewater treatment project in Rwanda, it is concluded that this approach will enable the responsible authorities and operators to get acquainted with all the practicalities of operations aspects (learning by doing), and to maintain sufficient flexibility to anticipate on future developments.

Chapter 5 describes other relevant developments in the area, including the new Nzove water supply treatment plant completed in 2009, and the decentralized treatment plants connected to new building projects. These decentralized systems are compulsory for project developers before their construction permits will be issued. Other relevant water and wastewater projects in Kigali include the preparation of an urban sludge management concept, including designs, for Kigali and other cities, that is underway with funding from the Government of Rwanda, and assistance to water and sanitation by the World Bank through the Lake Victoria Environmental Management Program.

Chapter 6 provides the institutional setting, relevant policies and standards. It explained that Rwanda is divided into five Provinces, 30 Districts, Sectors and Cells. The Kigali Wastewater Projects is situated in the Nyarugenge District within the Kigali Province containing 10 sectors. A Steering Committee has been established for the Kigali Wastewater Project, including representatives of the City of Kigali, WASAC LTD, the Ministry of Infrastructure (MININFRA), the Ministry of Finance and Economic Planning (MINECOFIN), and the Rwanda Environmental Management Authority (REMA). This section further explains that the EIA process in Rwanda is described in the Organic Law n°004/2008 of 15/08/2008, which establishes a list of works, activities and projects that have to undertake an EIA. Draft ESIA's and ESMP's are to be submitted to the Rwanda Development Board RDB, who next organizes a public hearing during which the Promoter presents the project. Once the ESIA and ESMP have been finalized and approved, the RDB will issue an EIA Certificate of Authorization (EIACA).

Chapter 7 provides the environmental impact assessment, including the area of influence, an assessment of the project design documents and a review of the significant and cumulative impacts. This environmental impact assessment is limited by the status of the current design activities: the final designs are foreseen to be completed early 2016.

The identified impacts are the following:

- The current operational plans for the wastewater treatment plant foresee in a bypass of untreated influent into the river during periods of high water levels and flooding events. However, it is recommended to treat the influent wastewater at the WWTP at all times, also during periods of high river water levels and floods.
- The trunk main can be best aligned with the foreseen new highway between the central bus station and the treatment plant.

- Extending the sewerage collection project beyond areas 1a and 2a will imply that first the newly collected areas will need adequate water supply and flushing toilet systems.
- A zoning is to be respected around the wastewater treatment plans, including sufficiently high trees to be planted here.
- Near the WWTP, the wetlands between the river and the main road tend to be flooded annually and local residents report that floods overflowing the WWTP area occur every now and then as well, lastly noticed in 2002. It is therefore proposed to take adequate flood preventive measures including a dyke or flood wall and additional drainage facilities on the site.
- The maturation ponds might pose increased malaria risks. It is proposed to use biological prevention measures and to provide mosquito nets to the inhabitants within the vicinity of the plant
- During operations, the wastewater treatment plant may generate some odor due to hydrogen sulfide emissions and other volatile components. It is proposed to set up an effective odor monitoring program. The earlier recommended mechanical sludge processing systems instead of open sludge drying beds have already been included in the latest design (September 2016). In addition it is recommended to prepare for covering up and filter the air at places within the WWTP were sludge is exposed to air
- Emission of greenhouse gasses will occur both during the construction and operational phases. It is proposed to minimize these emission by flaring the organic gas generated by the WWTP, minimizing energy use and consider the use of recyclable building materials where possible
- Negative cumulative impacts may arise when both the high way construction and construction of the wastewater treatment plant would occur at the same time, as the transport of construction materials passing this road section towards the treatment plant may be hampered. These cumulative impacts may relate to noise, air emissions, road safety issues and congestion problems and socio-economic disruption issues.

Chapter 8 provides the social impact assessment for the various phases of the project. It concludes that:

- The resettlement and expropriation of land and assets are important aspects during the pre-construction phase of the project with far reaching social and economic consequences for the people involved. These aspects have been studied and reported in a separate Resettlement Policy Framework (RPF) report.
- Identification and involvement of the key stakeholders of the project is an essential element of the Rwandese and EIB standards for project preparation and implementation. This aspect has been studies and reports in a separate Stakeholder Engagement Plan (SEP) report;
- The current area of the WWTP includes an unpaved side road, running southwards from the main road to the hinterland. It connects the main road to a large number of houses and various communities in the hills south of the WWTP. It is concluded that the access road will have to be rerouted prior to the construction of the WWTP
- On the southern borders of the WWTP area, close to the unpaved road, there is a water well used by people in the direct surroundings. It will be required that WASAC LTD replaces this well and provides an alternative and reliable water source, before the WWTP is constructed.
- The western part of the proposed Maturation Ponds is currently used as football field, which is an important leisure and gathering place for the local youth. It is advised to see if an alternative field can be established in the neighborhood before the maturation ponds are constructed.
- The project will likely provide some opportunity for local people to find employment or to supply goods to the project.
- the current phase 1 and 2 project design creates to some extend an inequality issue in the sense that pilot wastewater from the “Rich areas” 1a and 2a will be collected and treated in the “Poor area” of the treatment plant, where related project impacts and nuisance will be mostly concentrated. It is advised to consider providing piped water supply and sanitation services to

those affected along the trunk main and directly around the WWTP area to compensate for these inequality issues.

- The current plans do not foresee in reusing the treated wastewater. It is advised to study options for the reuse of the effluent for agricultural purposes near the treatment plant
- The level of wastewater treatment fees have not been decided yet. The impact of having this additional spending on household budget and the project financial sustainability is currently being studied.

Chapter 9 provides multi criteria analysis (MCA) for alternative locations of the wastewater treatment plant and discusses the routing of the trunk main. The MCA concludes that the current site at Gitikinyoni, south of the main road would indeed be preferred. However, this will require that the negative impacts as described in the ESIA will be mitigated adequately. It also concludes that the best option for the trunk main is to put it in the median between the two directions of the newly planned new high way.

Chapter 10 provides the Environmental and Social Management Plan (ESMP), including mitigation measures during the pre-construction, construction and operational phases of the project. It is proposed that the construction related mitigation measures will be used as input to detailed Construction Environmental and Social Management Plans, to be elaborated and implemented by the assigned contractor for this project. It is furthermore proposed that the City of Kigali sets up a public desk for the Kigali Wastewater Project as part of their overall Public Information organization, for receiving complaints and correspondence from the public related to the project.

The ESMP concludes that it is important to ensure that all parties involved in the project, including the Promoter and contractor, have the appropriate human capacity and level of environmental and social awareness and competence to ensure continued environmental due diligence and on-going minimization of environmental and social harm.

The total one-time expenditures of the ESMP are estimated as € 270,000, where the annual costs related to implementing this ESMP are estimated as € 70,000. These costs are to be financed through the operational budget of the Kigali Wastewater Project.

12 COLOPHON

Client	:	European Investment Bank
Project	:	ESIA and RPF for the Kigali Wastewater Project
Report	:	ESIA vs 2
File	:	BB8344-101-100
Length of report	:	187 pages
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Date	:	14 November 2016
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- RS 126-2 Wastewater treatment plant- construction principles
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