The Republic of Rwanda
Water & Sanitation Corporation (WASAC)

Preparatory Survey for the Project for Strengthening Nzove-Ntora Principal Water Transmission Pipeline in Kigali City

Final Report

November 2018

Japan International Cooperation Agency (JICA)

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KYOWA ENGINEERING CONSULTANTS Co., Ltd.
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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to consist of Kokusai Kogyo Co., Ltd., KYOWA ENGINEERING CONSULTANTS Co., Ltd., and Yokohama Water Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of the Republic of Rwanda, and conducted a field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Rwanda for their close cooperation extended to the survey team.

November, 2018

Megumi MUTO

Director General,

Global Environment Department

Japan International Cooperation Agency

Summary

1. General Information of Republic of Rwanda

(1) Land, Nature

Republic of Rwanda (hereinafter referred to as “Rwanda”) has an area of 26,338 km2, is a land-located country bordering the Democratic Republic of the Congo (hereinafter referred to as “Congo”) in the west, Republic of Uganda (hereinafter referred to as “Uganda”) in the north, United Republic of Tanzania (hereinafter referred to as “Tanzania”) in the east, Republic of Burundi (hereinafter referred to as “Burundi”) in the south. The mountain ranges run from northwest to southeast, and the divide between Congo and Nile (altitude 2,740 m) runs north and south. The lower part of the western slope is a part of the African great groove zone. The eastern slope gently slopes and the altitude drops from the central highland to the plains, swampy lands, and lakes. In this way, since most of the lands are formed from valleys and hills and has a rich terrain, Rwanda is called "the country of a thousand hills".

(2) Situation of Social Economy

In 2000, Rwanda announced "VISION 2020", a mid-long-term national development plan. Rwanda aims for a transition to a middle-income country by 2020, and raises a knowledge intensive economy in VISION 2020. President Kagame puts emphasis on countering corruption. As a result, Rwanda’s fewer corruption and well-maintained public peace are noteworthy than other African countries. In Rwanda, the proportion of women in the national assembly is 57.5%, the largest in the world (as of October 2014), female occupies major positions such as senate vice chairman, key positions of lower house. The proportion of women cabinet member is about 26 % and women's social advancement is progressing.

In 2007, Rwanda announced the Second Economic Development and Poverty Reduction Strategy (EDPRS II), a growth strategy of Rwanda. In the recent national budget, budgets are allocated to areas such as economic structural reform, rural development, youth employment creation, public accountability responsibility. It especially puts on emphasis on economic structural reform as a most important field.

In December 2015, the constitution was revised after national referendum. Three presidential elections was maintained while presidential work term was shortened from seven years to five years. Under the revised Constitution, President Kagame can run for the presidential election scheduled to be implemented in 2017 and 2024. In the presidential election in August 2017, President Kagame ran for election, with the support of 98.8%.

According to the census of 2012, the population of Rwanda is 10,515,973 people, the population density is 415 people/km2, and the population growth rate in the decade from 2002 was 2.6 %.

Rwanda has steadily continued to develop for 20 years until 1987 since the independence owing to the economic reconstruction plan that began in 1966. However, the civil war and genocide in 1994 diminished Rwanda’s economy. Economy improved steadily afterward with improvements in agricultural production, assistance from donor countries, sound economic policies and GDP recovered to the level before the civil war in 1999.

As shown below, the economy of Rwanda is the primary industry structure centered on

agricultural industry. According to the sectoral ratio of GDP in 2016, the agriculture, forestry and fishery industry accounts for 31%, the manufacturing industry is 16%, the service industry is 47%. The main agricultural crops are coffee and tea. Agricultural crops occupies 20% in the agriculture, forestry and fishery industry, and export crops accounts for only 5%. In the past five years, this ratio has hardly changed and there is no major change in the industrial structure. Although the trade balance has a deficit, GDP, exports and imports are on an increasing trend, indicating the remarkable growth of Rwanda's economy. However, although GNI per capita is rising, it is still around 700 US dollars and remains at the level of low income countries.

Table 1 Major economic indicator in Rwanda

Item	Actual performance				
	2012	2013	2014	2015	2016
GDP (million USD)	7,315	7,622	8,016	8,261	8,376
GDP growth rate (%)	8.84	4.70	7.62	8.87	5.93
GNI/capital (USD)	650	680	700	710	700
Population (million)	10.7	11.0	11.3	11.6	11.9
Sectoral ratio of GDP (%)					
agriculture, forestry and fishery industry	29	29	28	28	31
manufacturing industry	17	17	17	17	16
Service industry	47	48	48	47	47

Source: World bank, NISR

2. Background、context and outline of the Project

(1) Upper Level Plan

1) Vision 2020

In 2000, Rwanda formulated the long-term development plan "VISION 2020" that set the economic achievement target of 2020. In the VISION 2020, Rwanda aims to improve GDP per capita from 220 US dollars to 900 US dollars and achieves to convert to middle income country by achieving an economic growth rate of 7% or more, realizing the following development.

① Reconstruction of nation and social capital
② Effective and reliable national development under the authority of the law
③ Development of human resource toward Intellectual economic prosperity
④ Construction of basic infrastructures covering urban development
⑤ Cultivation of enterpriser and development in public sector
⑥ Modernization of agriculture and animal industryVISION 2020

The development target of the water sector in VISION 2020 states that "All populations can access safe drinking water by 2020". As a concrete action plan for the development target of VISION 2020, EDPRS II has been formulated.

2) National Water Supply Policy Implementation Strategy（NWSPIS）

In December 2016, the Ministry of Infrastructure (hereinafter referred to as “MININFRA”) formulated the NWSPIS in the water sector and sanitation sector respectively. NWSPIS shows the achievement status of the target, aiming increase the water supply rate of the urban area up to 100% by 2020, decrease of the non-revenue water rate to 20%.

Table 2 Goal of NWSPIS

Remarkable Goal	Indicator (Comparison to EDPRS II)	Target in EDPRS II	Baseline	Target Year				
				2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020
Water supply ratio in rural areas is improved to 100 %	Access ratio of rural household to improved source within 500 m	100%	79 % *1	85%	93%	100%	100%	100%
All population can access to safe water in urban areas	Access ratio of urban household to improved source within 200 m	100%	69 % *2	85%	93%	100%	100%	100%
	Ration of non-revenue water	-	35 % *3	32%	28%	24%	22%	20%

Resource: National Water Supply Policy Implementation Strategy

*1: Integrated Household Living Conditions Survey (EICV 4)

*2: Rwanda Demographic and health Survey (RDHS) 2014/2015

*3: Rwanda Utilities Regulatory Agency (RURA)-Key Statistics in Water and Sanitation Sector for the Period of July September 2015

(2) Current Situation and Challenge

Rwanda sets the national long-term development goal for its target in 2020, aims to make the water supply ratio nationwide 100% by 2020 setting the long-term development plan "VISON 2020" and EDPRS II. However, although the current water supply ratio has improved from about 50% in 2000, it is still only about 85% in 2015/2016.

Therefore, the government of Rwanda considers the construction and rehabilitation of basic infrastructure covering water and sanitation sector as the most important challenge for national development, and has plan to improve existing old water treatment plants, construct new water treatment plants, strengthen transmission pipeline networks, and improve water distribution pipes, since EDPRS which the predecessor of EDPRS II.

Water and Sanitation Corporation (hereinafter referred to as “WASAC”) which is under the jurisdiction of MININFRA, operates water supply and sewerage projects.

Water supply facilities in Kigali City, the target area of the Project, are under the jurisdiction of Urban Water and Sanitation Services Directorate (hereinafter referred to as “UWSS”) and Commercial Services Directorate (hereinafter referred to as “CS”) of WASAC. Kigali city is supplying water with 23 sectors out of all 35 sectors in the city as its water supply area. However, the population of Rwanda continues to increase, especially in Kigali City, it is expected that the annual population growth rate until 2025 will be 4.1-5.8% (Kigali City Master Plan in 2013). Along with this rapid population increase, Kigali city suffers from short water supply time as short as 8 hours a day, due to water supply shortage, water discontinuation due to facility aging. Kigali city is enforced to constantly stop and straiten water supply per water supply area. Besides, since the water supply area of the three water treatment plants is fixed and the construction of the water distribution network which allows water shortage to be mutually compatible between each water treatment plant is delayed, water distribution cannot be designedly and efficiently carried out. Since many of the existing water distribution pipes were installed before the 1970s, water distribution facilities including water distribution pipes were aging and proper maintenance and control of the pipeline has not been implemented. Under this context, a ratio of non-revenue water is still high at 35.5 % in 2015/2016. In the field of water supply in the Rwanda, the government of Japan (hereinafter referred as to “GoJ”) has assisted it mainly in eastern province of Rwanda, where access rate to safe water is low.

In consideration of the situation of the water supply facilities in Kigali City in recent years, GoJ is also implementing a technical cooperation project "Project for Strengthening Non-Revenue Water Control in Kigali City Water Network" in urban water

sector. In this way, although GoJ is currently contributing to improving the soft area including improvements in operation and maintenance of water supply facilities in Kigali City, however, in order to achieve the goal of setting the water supply ratio to 100% by 2020, It is necessary to deal with not only the soft aspect but also the hardware aspect such as rehabilitation of facilities including the reconstruction of the water supply facilities. Therefore, It is an urgent matter for Rwanda to bring water supply ratio closer to the target by concurrently implementing countermeasures for both software and hardware aspects.

(3) Background, Context and Outline of Grant Aid Project

Rwanda aims to achieve 100% in water supply ratio nationwide by 2020, however, it is still only about 85% in 2015/2016. It is necessary to deal with not only the soft aspect but also the hardware aspect including the reconstruction of the water supply facilities in order to make water supply ratio 100 % by 2020. It is an urgent matter for Rwanda to bring water supply ratio closer to the target by concurrently implementing countermeasures for both software and hardware aspects.

Under this situation, Rwanda made the following request to GoJ. The contents of the request mainly focused on reinforcement of the transmission pipe of Nzove-Ntora, the improvement of facilities at the Nzove water treatment plant as the start point of the transmission pipe and the Ntora reservoir as the end point, and replacement work of a water distribution pipe supplying water from Ntora reservoir to the area receiving the water supply by direct branching from the existing transmission pipes.

1. Reinforcement of principal transmission pipeline of Nzove-Ntora
2. Replacement of water distribution pipe branching out from principal transmission pipeline of Nzove-Ntora
3. Development of water supply pumps at the Nzove water treatment plant
4. Expansion of the Ntora reservoir

3. Outline of survey result and Contents of the Project

(1) Dispatch Period of survey Team

The survey team conducted the survey in the following schedule.

- The first site survey （The first : 4th November, 2017-20th February, 2018）

In the first site survey, the survey team investigated the route laying transmission pipes, selected optimum rout of the transmission pipe from the seven plans and confirmed it with WASAC, concluding a minute and a technical note. The survey team started the field survey (location survey, ground survey, environmental and social consideration survey).

- The first site survey（The second : 22nd-28th February, 2018 ）

The survey team confirmed deliverables of the location survey and ground survey among the local subcontracting surveys. It also collected information relating tax exemption of Rwanda.

- The first site survey（The third : 16th-29th April, 2018）

The survey team confirmed the scope of the project (planned water supply volume, type of pipe, water supply pump equipment, other necessary instruments, etc.) with WASAC, concluding technical note. The survey team discussed the matter about crossing of the road on the transmission pipe and the crossing of the river with concerned organizations of Rwanda, and confirmed that there was no problem in the route of transmission pipe in the Project.

- The second site survey（26th August -5th September, 2018）

The survey team explained the project outline based on the Basic design study report (draft) to the Rwanda side and concluded minutes about matters to be borne by the Rwanda side, tax exemption etc.

(2) Review of Route of Transmission Pipe

The study team considered the seven plans of the route laying transmission after consultation with WASAC. In the regard of the route plan, the following criteria are used.

Table 3 Criteria for review of the plan of the route of laying transmission pipe

Criteria	
1	Pipe extension
2	Composition of laying route（Percentage of paved/unpaved roads）
3	Presence of narrow part
4	Countermeasure for river（Necessity for revetment maintenance）
5	Workability in wet areas
6	Necessity of river crossing
7	Constructability in steep gradient
8	Impact on transportation
9	Resident relocation
10	Land expropriation
11	Implementation period
12	Project cost

Source: Study Team

The survey team carefully consulted the following criteria out of the set twelve criteria with WASAC.

① Composition of road on the laying route（Percentage of paved/unpaved roads）

Since it is difficult to lay a transmission pipe under the paved road, five plans out of seven plans were left out.

② Presence of narrow part

For one of the remaining two plans, it is necessary to install a new transmission pipe in the vicinity of the bent pipe part of the existing transmission pipe. Since for construction close to the bent pipe part, earth pressure does not act on concrete protection against uneven force when excavating the pipe, the existing transmission pipe is at risk to move, detach its pipe and leak water. Therefore, in consideration of safety of construction, the proposal of approaching the bent stem of the existing transmission pipe was left out.

(3) Outline of Design

Since the transmission pipe to be renewed in the project is difficult to expand and review amoung the water facilities and it is an important infrastructure, it is necessary to plan with long-term plan in mind. In Japan's design guidelines of water supply facility, the standard planned target year for facility design is set from about 10 to 15 years from the time of planning. Therefore, the planned target year is set in 2030 in the project, based on Japan's standard.

The components of the Project are shown as below.

Table 4 Component of the Project

Items	Target		Specifications
Transmission Pipeline	Transmission Pipeline	Planned water supply volume	87,000 ㎥/day
		Diameter	900 mm
		Total length of pipe	9,400 m
		Pipe type	Steel pipe: 8,000 m (from Nzove WTP to the steep hill)
			Ductile iron pipe: 1,400 m (from the steep hill to Ntora Reservoir)
		River Crossing	6 places
			River crossing method: inverted siphon will be implemented in all six places
	Air valve		9 places
	drain valve		4 places
Nzove WTP	Installation of additional water pumps		Capacity: 22,000 ㎥/day Pump head: 240 m Pumping rate: 7.6 ㎥/min (11,000 ㎥/day) x 3 - 3 pumps (Two for operation and one for reserve)
	Compression tank		1 set
	Pump station		New water pump station for additional water pumps at Nzove WTP
	Meters and gauges		Two flowmeters One at conduit pipe of Nzove 1 WTP Another at inlet pipe of the new pump station
Ntora Reservoir	Ntora Reservoir		Restructure of two outflow pipes from Ntora Reservoir Installation of new ventilation holes at Ntora Reservoir
	Elevated water tank		Volume: 200 ㎥ (10m x 10m x 2.5m) Height: 10 m Material: Steel Frame: RC

Items	Target	Specifications
	Lifting pump	Capacity:576㎥/day Pump head: 20m Pumping rate: 0.4 ㎥/min (576 ㎥/day) x 2 -Two pumps (one for operation and another for reserve)
	Meters and gauges	Three flowmeters One for inlet pipe of Ntora Reservoir One for an outflow pipe to Kacyiru area One for a transmission pipeline (to Fawe Girls School Reservoir) Four water level gauges Two for each tank (double tank type) of Ntora Reservoir Two for each elevated tank (double tank type)

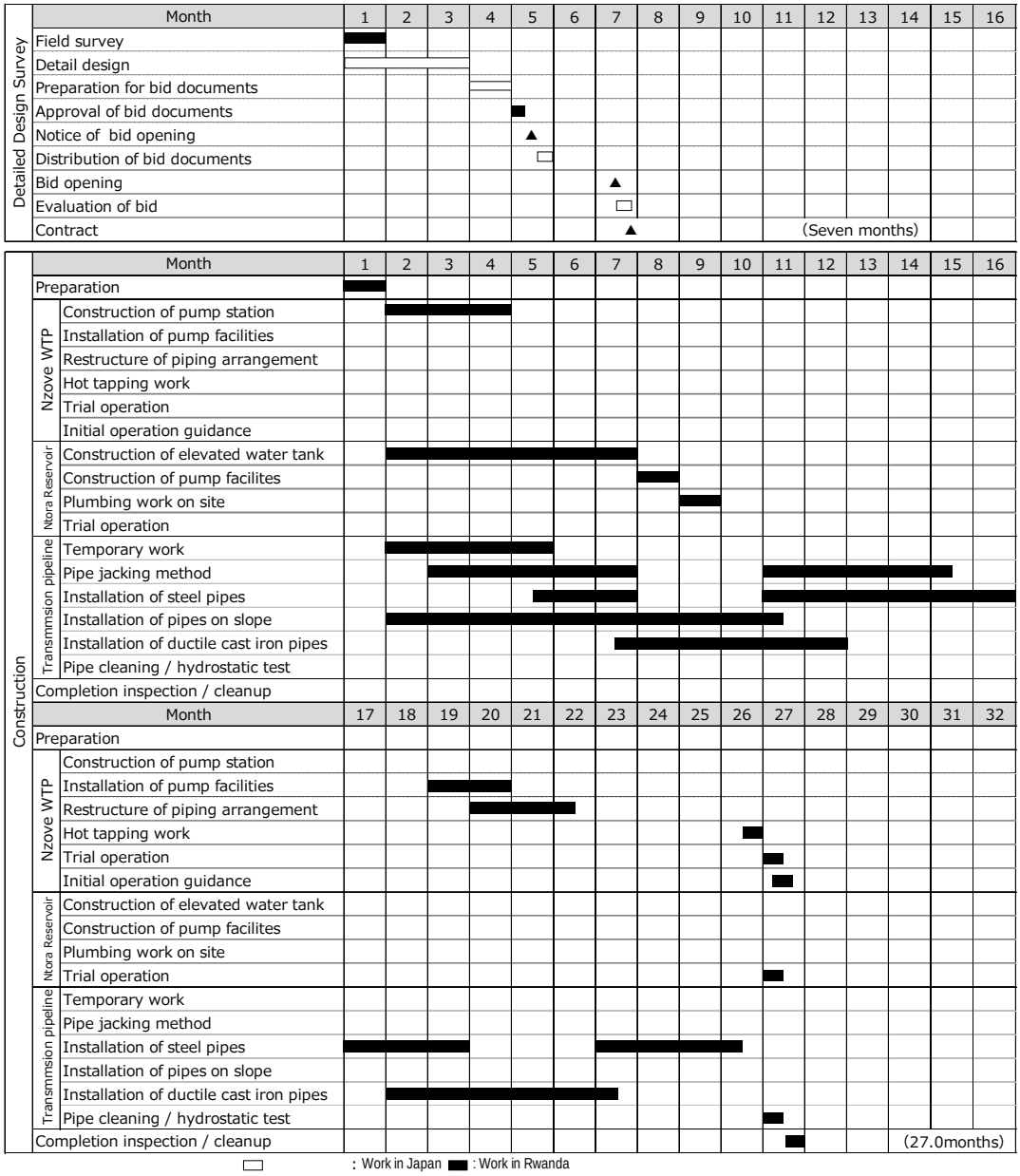
Source: Study Team

4. Implementation Schedule and Outline Cost of the Project

(1) Implementation Schedule

E/N will be concluded after the approval of the Project by Japanese Government, and the Project will commence based on the Japanese Grant Aid Policy. The Project includes three stages: actual design; selection of contractor (preparation of bid documents, announcement of the bid, evaluation of the bid); and construction of facilities. The following table shows the Project schedule.

Table 5 Implementation Schedule



Source: Study Team

(2) Estimated Project Cost

The cost borne by the Rwanda side is as follows.

Table 7 The cost born by the Rwanda side

The cost born by the Rwanda side : 291.98 million Japanese Yen

Item	Estimated cost (million RWF)	Estimated cost (Million yen)
Land acquisition	165.50	21.52
Construction of box culvert	55.00	7.15
Construction of distribution pipe around Ntora reservoir	39.00	5.07
Implementation of environmental	4.20	0.55

Item	Estimated cost (million RWF)	Estimated cost (Million yen)
Management Plan (EMP) and Environmental Monitoring Plan (EMoP)		
Cost for tax exemption	1,958.00	254.54
Charge for banking agreement (estimation)	24.26	3.15
Total	2,245.96	291.98

Source: Study Team

5. Project Evaluation

(1) Relevance

The Project is evaluated to be relevant to be implemented under the Grant Aid Scheme, based on the following reasons.

1) Relevance in terms of the scale of recipients

The Ntora pipe-system in the Project is an important principal transmission pipeline which supports the water supply of about 550,000 citizens of 1,130,000 citizens of Kigali (as of 2012). With the implementation of the Project, it is possible to safely and steadily supply water of 87,000 ㎥/day, which is scheduled to be increased in Nzove WTP by 2024.

2) Consistency with Policies in Rwanda

In the National Water Policy of Rwanda, one of the policy objectives is that citizens of all urban areas are given safe, reliable and economical water supply service by 2018.

Furthermore, “Vision 2020”, a long-term national development plan aims to achieve a safe water with 100% access rate by 2020; and building infrastructures including water supply facilities as one of the top priorities. Main purpose of the Project is the improvement of the necessary principal transmission pipeline for safe water supply to the citizens in the capital city of Kigali, which is consistent with the development plan in Rwanda.

3) Consistency with Japan's Grant Aid Policy

In the Japanese Government’s Assistance Policy for Rwanda Country (April 2012), safe water supply is set as a principal development subject in the priority area of improvement of social services. The Project is consistent with Japan’s ODA policy for Rwanda.

4) Consistency with global development goals

The Project contributes to the improvement of the living conditions of the residents by increasing the access rate to safe water and the provision of stable water supply service through the implementation of transmission pipeline as the key facility of Kigali City. The Project is consistent with SDGs’ Goal 3 of "Ensure healthy lives and promote well-being for all at all ages" and Goal 6 of “Ensure access to water and sanitation for all".

(2) Effectiveness

The quantitative and qualitative impacts to be expected by the Project is shown as follows. This Project is evaluated to be effective.

1) Quantitative Impact

Table 8　Quantitative impact after the implementation of the Project

Output indicator		Reference value (Actual values in 2017)	Target value (2024) (After three years of the Project completion)
Average amount of water supply in Ntora pipe-system（m³/day）	㎥/day	35,750	52,800[1)]
Number of accidents in the transmission pipeline of Ntora pipe-system) [2]	Number of accidents /100km/year	6.8	0.7
Number of days of water supply restrictions in the area surrounding the Ntora Reservoir	day/week	3～4	0
(Reference value) Number of recipients for the average water supply volume of the Ntora pipe-systemm[3)]	Number of person	298,000	440,000

Source:Study Team

1) 62,000×（35,750/42,000）≒52,800

2) Reference value: The accident records of the existing transmission pipeline were converted according to the calculation method of average accidents number of ductile iron pipes in Japan. The length of the existing transmission pipeline is 8.85 km and 6 accidents occurred in the past 10 years. 6/ (8.85/100)/10≒6.8

Target value: The average number of accidents on ductile iron pipes in Japan was adopted (Source: Ministry of Health, Labor and Welfare: 2012)

3) The value obtained by dividing the average water supply amount by the unit water supply rate (120 ℓ/person/day, from Kigali City Master Plan 2013)

2) Qualitative Impact

Qualitative Impact to be expected by the Project is described below.

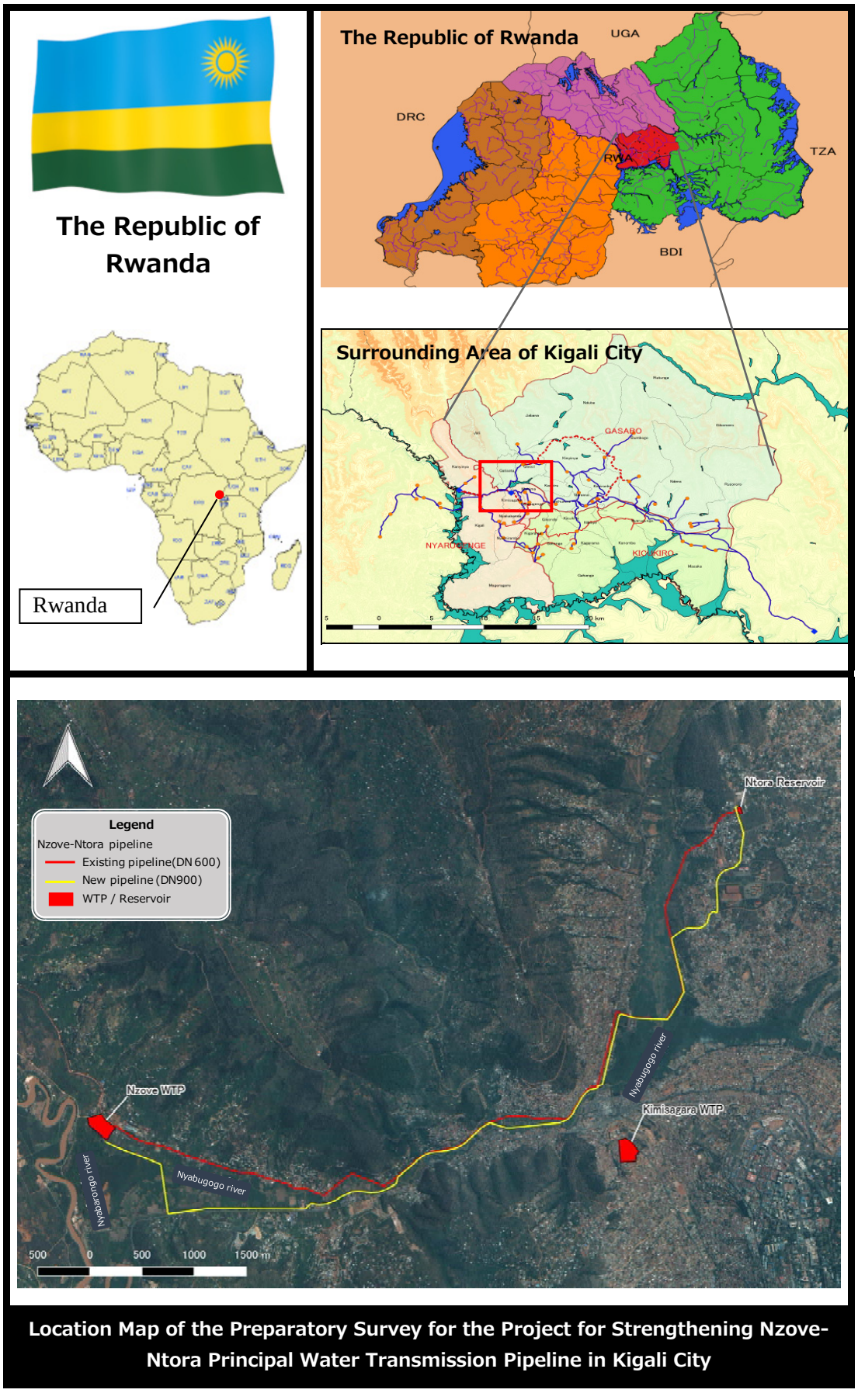
1. The operation and maintenance of the Ntora reservoir is improved and the suspension period of water supply from the reservoir No.1 decreases.
2. Water distribution status after passing through Ntora Reservoir improves.

The Republic of Rwanda

Preparatory Survey for the Project for Strengthening of Nzove-Ntora Principal Transmission Pipeline in Kigali City

Final Report

Table of Contents

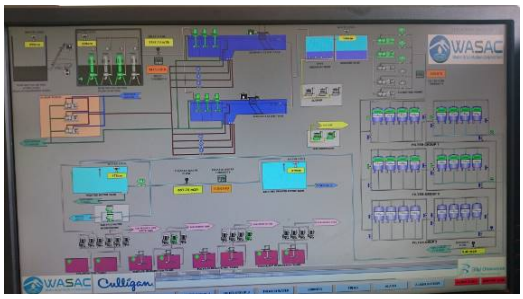


Location Map of the Preparatory Survey for the Project for Strengthening Nzove-Ntora Principal Water Transmission Pipeline in Kigali City

Perspective

Photos

	
Courtesy to WASAC	Courtesy to WASAC
	
Courtesy to MININFRA	Site visit (Nzove WTP)
	
Discussion on new pipeline route	Site visit (Existing pipeline)
	
Site visit with RNRA (River area)	Geological survey at Ntora Reservoir

	
Site visit near Ntora Reservoir	Site visit near Ntora Reservoir
	
Nzove WTP (SCADA system)	Nzove WTP (Intake of water source)
	
Nzove I WTP (Filtration system)	Detection of existing pipeline position
	
Water meter on the site of construction	Water quality analysis
	
Water use situation	Water flow meter

	
Water pump at Nzove WTP	Compression tank at Nzove WTP
	
Ntora Reservoir	Existing pipeline (Fist water pipe bridge)
	
Detection of existing pipeline position	Existing pipeline (Exposed part of pipeline)
	
Existing pipeline (Air valve)	Detection of existing pipeline position

List of Tables and Figures

Abbreviations

AfDB	Africa Development Bank
ARAP	Abbreviated Resettlement Action Plan
BOD	Biochemical Oxygen Demand
BoQ	Bill of Quantities
BOT	Build-Operate-Transfer
CBEHPP	Community-Based Environmental Health Promotion Program
COD	Chemical Oxygen Demand
CS	Commercial Services
DIP	Ductile Iron Pipe
DMA	District Metered Area
EAIF	Emerging Africa Infrastructure Fund
EDPRS	Economic Development and Poverty Reduction Strategy
EIA	Environmental impact assessment
EICV 4	Integrated Household Living Conditions Survey 4
E/N	Exchange of Note
EWSA	Energy Water and Sanitation Authority
F/S	Feasibility Survey
G/A	Grant Agreement
GDP	Gross Domestic Product
GIS	Geographic Information System
GL	Ground Line
GNI	Gross National Income
HWL	High Water Level
IC/R	Inception Report
IFC	International Finance Corporation
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicators
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MINECOFIN	Ministry of Finance and Economic Planning
MININFRA	Ministry of Infrastructure
MINILAF	Ministry of Lands and Forestry
MLFM	Movimento Lotta Fame nel Mondo (Movement for the Fight Against Hunger)
Mpa	Mega Pascal
NGO	Non-Governmental Organization
NISR	National Institute of Statistics of Rwanda
NRW	Non-Revenue Water
NTU	Nephelometric Turbidity Unit

NWRMP	Rwanda National Water Resources Master Plan
NWSPIS	National Water Supply Policy Implementation Strategy
NWSPS	National Water Supply Policy and Strategy
OHSAS	Occupational Health and Safety Assessment Series
PAH	Project Affected Household
PAP	Project Affected Person
PGA	Peak Ground Acceleration
PPP	Public–Private Partnership
PRSP	Poverty Reduction Strategy Paper
PVC	Polyvinyl Chloride
RAP	Resettlement Action Plan
RDB	Rwanda Development Board
REG	Rwanda Energy Group
REMA	Rwanda Environment Management Authority
RLMUA	Rwanda Land Management and Use Authority
RWF	Rwandan franc
RRA	Rwanda Revenue Authority
RSB	Rwanda Standards Board
RTDA	Rwanda Transport Development Agency
RURA	Rwanda Utilities Regulatory Authority
RWF	Rwandan franc
RWSS	Rural Water and Sanitation Services
SCADA	Supervisory Control And Data Acquisition
SDC	Swiss Agency for Development and Cooperation
STW	Steel Tube Water
SusWAS	Sustainable Water Services
SWAp	Sector Wide Approach
UNICEF	United Nations Children's Fund
UWSS	Urban Water and Sanitation Services Directorate
VAT	Value-added tax
WASAC	Water and Sanitation Corporation
WHO	World Health Organization
WSDS	Water and Sanitation Development Services
WTP	Water Treatment Plant

Chapter 1 Background of the Project

1-1 Background of Grant Aid

The Republic of Rwanda (hereinafter referred to as “Rwanda”) has set the goal of 100% access to safe drinking water throughout the country by 2020. To achieve this goal, the government of Rwanda is facing many challenges not only soft aspects but hardware aspects such as the review of all water supply facilities. It is an urgent task for Rwanda to achieve the goal of 100% access to safe drinking water by conducting countermeasures for both software and hardware in parallel. Under such circumstances, Rwanda requested grant aid to Japan.

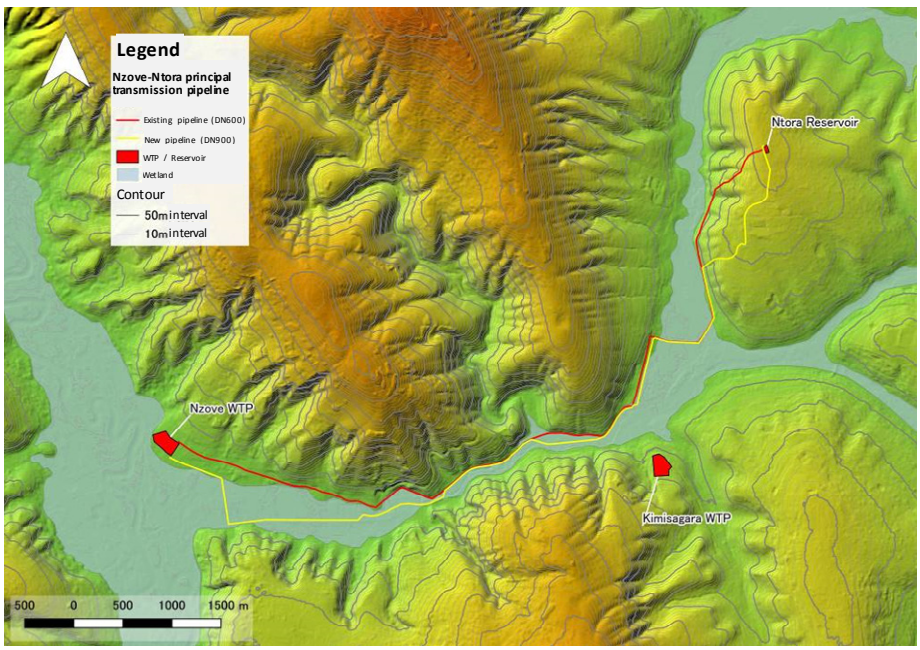
Contents of grant aid are as follows. Main component is to enhancement Nzove - Ntora Principal Water Transmission Pipeline. The grant aid also includes improvement of Nzove water treatment plant and Ntora reservoir.

1) Enhancement of Nzove - Ntora Principal Transmission Pipeline
2) Replacement of the water distribution pipes branching from the Principal Pipeline
3) Improvement of water supply pump equipment of Nzove WTP
4) Expansion of the Ntora reservoir

1-2 Natural Condition

1-2-1 Topography

Rwanda has an area of 26,338 km2, is a land-located country bordering Congo in the west, Uganda in the north, Tanzania in the east, Burundi in the south. The mountain ranges run from northwest to southeast, and the divide between Congo and Nile runs north and south. Since most of the lands are formed from valleys and hills and has a rich terrain, Rwanda is called "the country of a thousand hills".



Source: Study Team

Figure 1-1 Topographic chart around the project site

Kigali City is located approximately in the center of Rwanda and has an area of 730 km2 with its altitude of 1,433 to 1,645 in the highlands and several hills.

Topography around the project site has only 20 m of difference of elevation on 8 km range from the Nzove water treatment plant which is in the route of the transmission pipe planned in the Project, and 200 m of straight difference of elevation after hills from the said area 8 km from the Nzove water treatment plant.

1-2-2 Geological Condition

In Rwanda, there are widely basement rocks composed of granitic rocks and metamorphic rocks belonging to the Precambrian era distributed. The granitic rocks are mainly composed of intrusive rocks and metamorphic rocks are mainly composed of schists which were metamorphosed by penetration of granite. After the Cenozoic era, activities of the African great groove zone became active and groove zone was covered with volcanic ejecta by volcanic activity. After that, volcanic sediments were gradually dissected, and the sediments carried from the cliff top layer on the hillside slope and upstream river was heaped up, forming alluvial lowlands and wetlands along the valley. As the geologic structure, the metamorphic rocks are distributed into strips in the north and south and many faults of the same running are observed, since they are pushed from the east-west direction by the activity pressure of the rupture zone.

Kigali city is also based on granitic and metamorphic rocks, which include schist, sandstone and mudstone. Hill areas covering hills and ridges have many sludge soils containing aluminum and iron, where alluvial soils and organic soils are found in lowlands and wetlands. In Kigali City, the fertility of the soil has been lost in places where the soil runoff on the slope of the hilly area. While, it has a problem that the habitat of the creatures decreases due to the accumulation of heavy mud in wetlands occupying 12.5% of the area of lowlands and Kigali City.

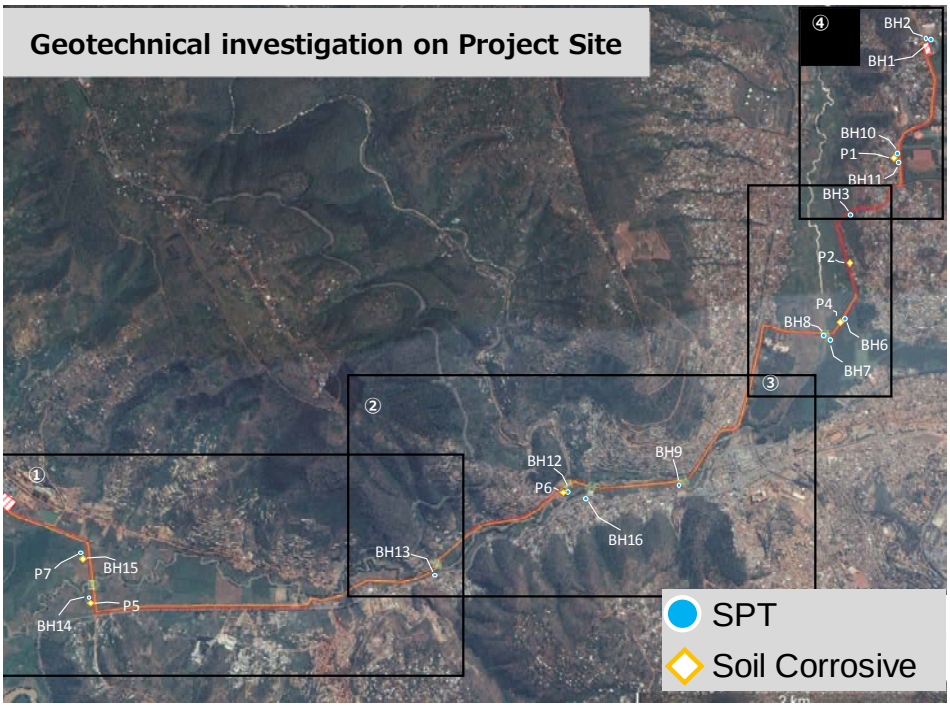
In this survey, corrosion survey (6 points) and standard penetration test (14 points) were carried out by the subcontractor.

The following table shows the N value at 14 points and the groundwater level near the river where the standard penetration test was carried out.

Table 1-1 The N value at 14 points and the groundwater level in the project site

Depth(m)	BH15	BH14	BH13	BH12	BH16	BH9	BH8	BH7	BH6	BH3	BH11	BH10	BH1	BH2
Groundwater level	0.65m	1.06m	1.57m	2.5m	1.0m	4.55m	2.19m	1.2m	0.6m	-	-	-	-	-
1	15	1	3	3	2	17	8	1	2	-	13	3	67	94
1.5														
2	13	1	2	2	4	43	2	1	1	-	10	29	77	90
2.5														
3	4	2	2	3	4	72	1	2	6	-	15	95	92	93
3.5														
4	4	1	3	2	7	79	1	1	6	-	12	93	53	97
4.5														
5	7	1	2	4	12	91	2	2	6	-	99	100	100	92
5.5														
6	6	1	4	4	1	97	1	2	8	-	25	103	64	102
6.5														
7	16	19	14	3	2	101	2	2	1	-	80	90	91	108
7.5														
8	17	16	100	5	3	91	2	1	1	-	88	94	94	93
8.5														
9	14	4	100	9	6	110	3	2	1	-	90	95	92	106
9.5														
10	13	3	100	7	6	112	2	3	1	-	100	99	91	112
10.5														
11		2	100	9		113	3	5						
11.5														
12		2	100	11		115	6	7						
12.5														
13		3	100	7		120	4	8						
13.5														
14		3		6			16	60						
14.5														
15		1		4			41	73						
15.5														
16		2		5			93	80						
16.5														
17		1		5			98	94						
17.5														
18		2		4			84	98						
18.5														
19		1		6			102	98						
19.5														
20		2		6			101	100						

Source: Study Team



Source: Study Team

Figure 1-2 A entire map of the survey carried by subcontractor

Source: Study Team

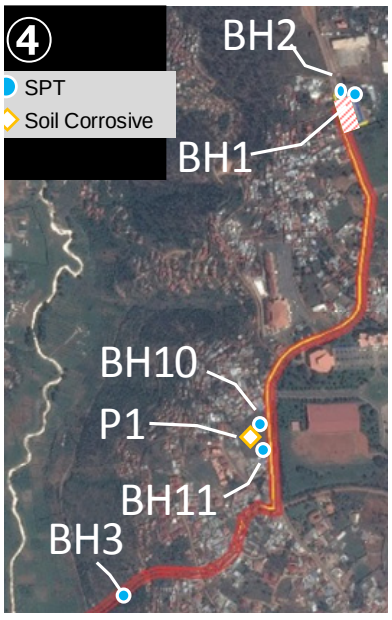
Figure 1-3 Survey point No.1 carried by subcontractor

Source: Study Team

Figure 1-4 Survey point No.2 carried by subcontractor

Source: Study Team

Figure 1-5 Survey point No.3 carried by subcontractor



Source: Study Team

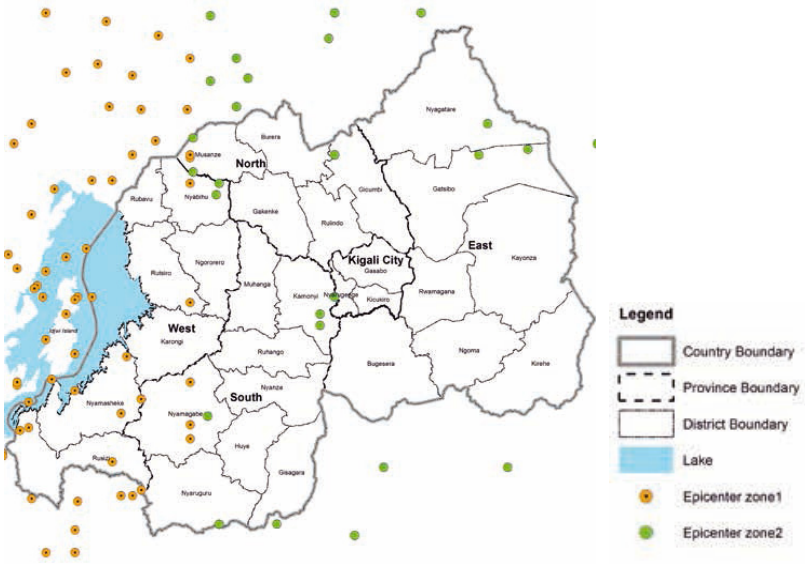
Figure 1-6 Survey point No.4 carried by subcontractor

The results of the standard penetration test found that the project target area is soft ground. Even though pile foundation (pile length 24 m) has been constructed at two water pipe bridges (BH 8, 7 and BH 12) on the existing route of the transmission pipe, the pile foundation on soft ground may not be functioning sufficiently, such as that water leakage occurred in both water pipe bridges (one bridge was repaired), and the foundation descends.

Furthermore, the corrosion investigation found that it is slight corrosive soil at all the survey points. Therefore, the Project considers causticity as well for the transmission pipe. In the plan of the water supply pipes planned in this case, it is necessary to consider causticity as well.

1-2-3 Earthquake

Since Rwanda forms part of the African great groove zone, the western part of Rwanda has a risk of earthquake, while Kigali City and the eastern part of Rwanda rarely have a risk of earthquakes according to a report published by Ministry of Disaster Management and Refugee Affairs：MIDIMAR.



Source: THE NATIONAL RISK ATLAS OF RWANDA, pp.71, MIDIMAR, 2015

Figure 1-7 Earthquake disaster distribution map of Rwanda

Since the surface maximum acceleration (PGA) of the earthquake that occurred in the past 475 years is 0.1 g or more in the southwestern area where Neogenane volcano is located, it is recommended that the facilities should be designed with horizontal seismic intensity of 0.05. While, it is recommended that the facilities should be designed with horizontal in Kigali City and areas with low risk of earthquake.

1-3 Environmental and Social Consideration

1-3-1 Environmental Impact Assessment

1-3-1-1 Outline of Project Components that have Environmental and Social Impacts

(1) Project Components

The outline of the Project component is shown below. One of the main outcomes of the Project is replacement of the transmission pipeline from Nzove WTP to Ntora Reservoir, along with rehabilitation works at these two facilities.

Items		Specification
Transmission pipeline	Planned water supply volume	87,000 ㎥/day
	Diameter	900 mm
	Total length of pipe	9,400 m
	Pipe Type	Steel pipe: 8,000 m (from Nzove WTP to the steep hill)
		Ductile iron pipe: 1,400 m (from the steep hill to Ntora Reservoir)
	River crossing	6 places
		River crossing method: inverted siphon at all the six places
	Air valve	9 places
	Drain valve	4 places
Nzove WTP	Installation of additional water pumps	Capacity: 22,000 ㎥/day - 3 pumps (Two for operation and one for reserve) Pump head: 240 m Pumping rate: 7.6 ㎥/min (11,000㎥/day) x 2
	Compression tank	1 set
	Pump station	New pump station for additional water pumps at Nzove WTP
	Meters and gauges	Two flowmeters One at conducting pipe of Nzove 1 WTP Another at inlet pipe of the new pump station
Ntora Reservoir	Outflow pipe	Two outflow pipes from Ntora Reservoir in direction to Kacyiru area a transmission pipeline (in direction to Fawe Girls School Reservoir)
	Elevated water tank	Volume: 200 ㎥ (10m x 10m x 2.5m) Height: 10 m Material: Steel Frame: RC
	Lifting pump	Capacity:576㎥/day Two pumps (one for operation and another for reserve) Pump head: 20m Pumping rate: 24㎥/hour
	Meters and gauges	Three flowmeters at an inlet pipe of Ntora Reservoir at an outflow pipe in direction to Kacyiru area at a transmission pipeline (in direction to Fawe Girls School Reservoir) Four water level gauges 2 at each tank (double tank type) of Ntora Reservoir 2 at each elevated tank (double tank type)

Source: Study Team

The following project components could have adverse environmental and social impacts on the Project area.

- Nzove WTP
- Transmission pipeline from Nzove WTP to Ntora Reservoir

(2) Project Target Area

The project target area covers seven Cells in 5 Sectors and 2 Districts, as shown in Figure 1-8

(3) Scope of Environmental Impact Assessment

The scope of the environmental impact assessment is shown below.

- Nzove WTP
  - Construction of the new pump station
  - Installation of new water supply pumps
- Transmission pipeline from Nzove WTP to Ntora Reservoir

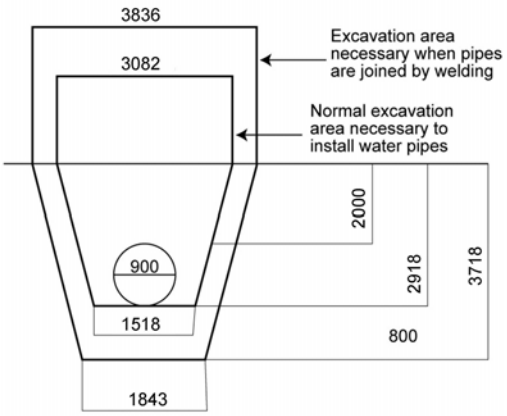
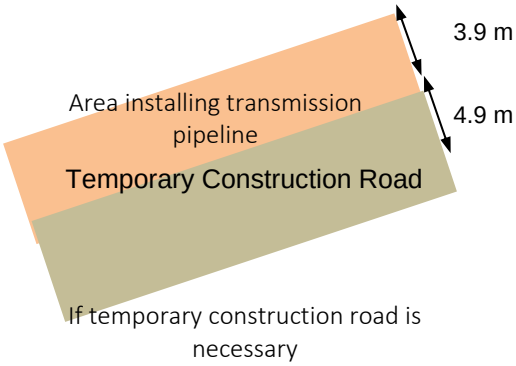
The area of the land necessary to install the transmission pipeline are shown below by the type of the land. The pipeline, from Nzove WTP to the steep slope, runs through the marshland and the rest of the route pass the residential areas.

At the marshland, 900 mm diameter steel pipes are planned to be installed, while 900 mm diameter ductile iron pipes will be installed at the residential areas.

<u>Marshland</u>

The excavation area necessary to bury steel pipes is 3.9 m in width, wider than the area necessary to install ductile iron pipes, since steel pipes require welding work at the construction site when they are joined.

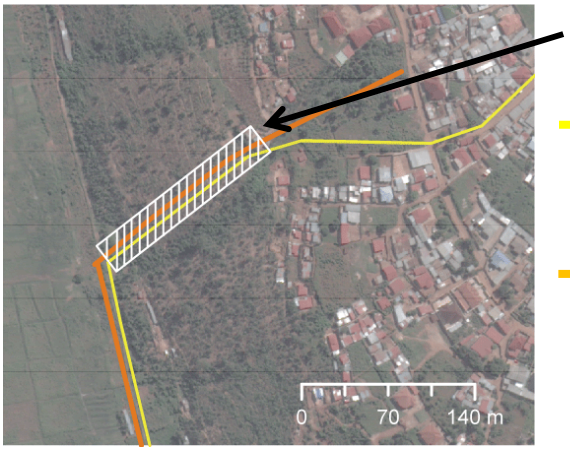
In addition, it is necessary to prepare temporary construction roads of 4.9 m in width along the pipeline installation route, if there are no roads or maintenance roads for the existing transmission pipeline near the planned route.

<table>
<tr>
<td>900mm Diameter Pipe
 
</td>
<td> 
</td>
</tr>
<tr>
<td>Cross-section view of excavation area to install transmission pipeline at marshland</td>
<td>Area of temporary construction road</td>
</tr>
</table>

Out of the excavation area of 3.9 m in width, WASAC needs to acquire the area of 3.0 m in width in order to maintain the transmission pipeline. The rest of the excavation area along with the temporary construction road will be returned to the owners/users of the land after rehabilitation work.

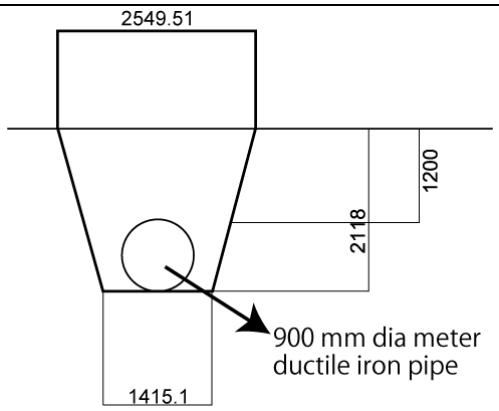
Steep Slope

The transmission pipeline will be installed at the steep slope in Ruhango Cell, hanging pipes down with a monorail, installed at the shaded area. Excavation work will be done manually.

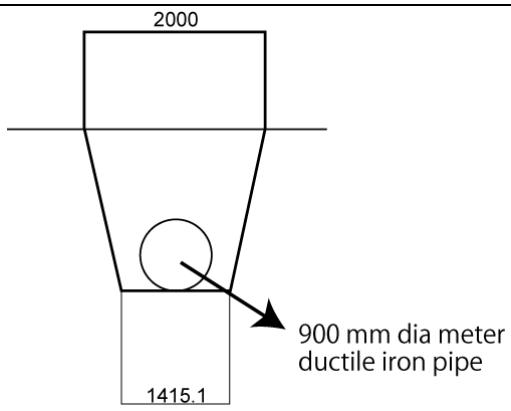


Residential Area

At the residential areas, ductile iron pipes, which can be joined without welding, are planned to be installed. Along the paved road, ductile iron pipes will be installed under the curbside and road reserve; however, many of premises along the road are partly located within the road reserve. As a result, a dozen of land plots are identified as the targets of partial land expropriation. In order to minimize the number of land plots to be partly expropriated, the Study Team decided to narrow the width of the excavation area fro ㎡ 70 mm to 200 mm, since the ground on site is relatively hard and this could make the excavation slope steeper.



Excavation area necessary to install 900mm diameter ductile iron pipe



Excavation area necessary to install 900mm diameter ductile iron pipe along the paved road

(4) Current Social Environment

3) Target Administrative Areas

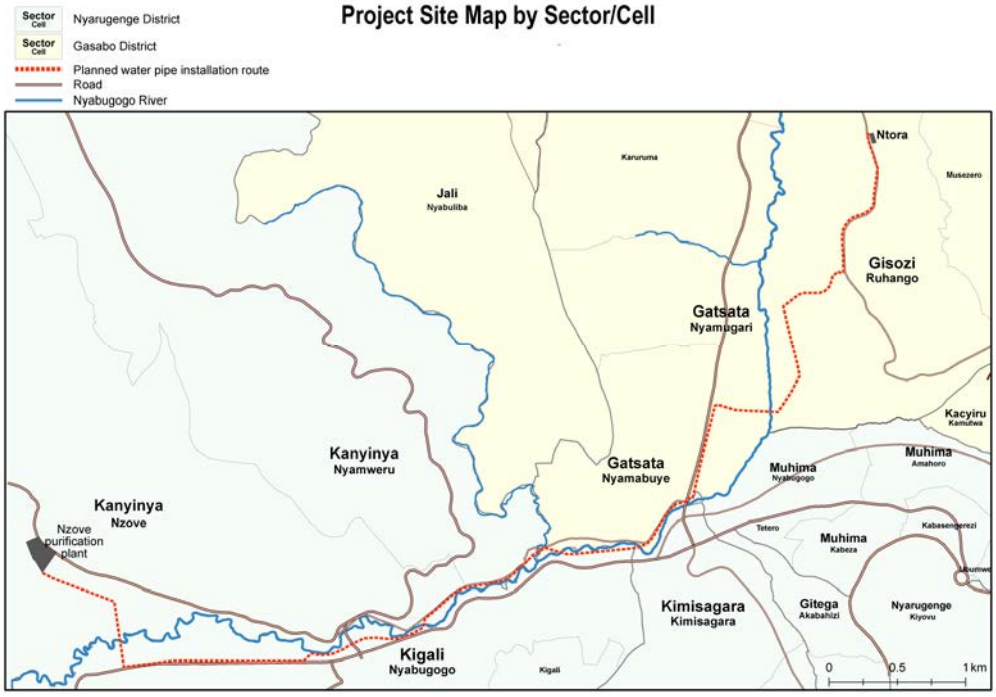
As shown in Table 1-2 and Figure 1-8, the planned transmission pipeline pass through the following 2 Districts, 5 Sectors and 7 Cells. (Only a few land plots are targeted in the Kimisagara Cell)

Table 1-2 Project Target Area by District, Sector and Cell

	District	Sector	Cell
1	Nyarugenge	Kanyinya	Nzove
2			Nyamweru
3		Kigali	Nyabugogo
4		Kimisagara	Kimisagara
5	Gasabo	Gatsata	Nyamabuye

	District	Sector	Cell
6			Nyamugari
7		Gisozi	Ruhango

Source: Study Team



Source: Study Team

Figure 1-8 Project Site Map by Sector and Cell

4) Population in the Project area

The population and population density by Sector in the Project area is summarized in the table below. As a reference, the population and population density of the whole Rwanda and Kigali City is shown. The Kanyinya Sector, where Nzove WTP is located, is classified as "rural" and has the low density, while two sectors in Gasabo District area classified as "urban" and have higher density.

Table 1-3 Population, Household Number and Population Density

	Sector	Urban area/Rural area			Private Households	Density (person/km²)
		Total	Urban	Rural		
RWANDA		10,515,973	1,737,684	8,778,289	2,424,898	415
Kigali City		1,132,686	859,332	273,354		1,552
Nyarugenge District		284,561	214,020	70,541	72,280	2,149
	Kanyinya	21,859	0	21,859	5,760	904
	Kigali	30,023	4,748	25,275	8,116	1,022
	Kimisagara	46,753	46,753	0	11,648	14,116
Gasabo District		529,561	365,371	164,190	137,146	1,234
	Gatsata	37,110	37,110	0	10,035	6,163
	Gisozi	44,003	44,003	0	12,199	5,300

Source: The Fourth Rwanda Population and Housing Census (RPHC4) 2013/2014

5) Economic Activities

GDP, GDP growth rate, GDP per capita, and GDP by industry in Rwanda since 2011, based on the year 2014, are summarized in the table below.

Table 1-4 GDP by Industry, GDP Growth Rate, and GDP per Capita

	2011	2012	2013	2014	2015	2016
GDP at constant 2014 prices (Rwf billions)	4,459	4,852	5,079	5,466	5,951	6,304
Growth rate	*7.8%*	*8.8%*	*4.7%*	*7.6%*	*8.9%*	*5.9%*
GDP per head (in '000 Rwf)	381	429	459	497	529	574
GDP per head (in current US dollars)	635	698	710	728	735	729
Proportion						
Agriculture, Forestry and Fishing	28%	29%	29%	29%	28%	30%
Industry	17%	17%	17%	17%	17%	17%
Construction	7%	7%	7%	7%	7%	7%
Electricity, Water & Waste	1%	1%	2%	2%	2%	2%
Manufacturing	6%	6%	6%	6%	6%	6%
Mining & Quarrying	3%	2%	3%	3%	2%	2%
Services	48%	48%	48%	47%	48%	48%
Administration, Defense & Social Security	8%	8%	8%	9%	9%	9%
Financial & Real estate services	13%	12%	12%	11%	11%	11%
Information & Communication	2%	2%	2%	2%	2%	1%
Hotels & Restaurants	2%	2%	2%	2%	2%	2%
Trade & Transportation	12%	12%	12%	12%	12%	12%
Others	12%	12%	13%	13%	13%	13%
Adjustments	8%	7%	6%	7%	7%	6%

Sources: National Statistics Institute Rwanda (NSIR), GDP National Accounts 2016

Due to the price decline of metals, which is one of the main exporting items along with tea and coffee, the GDP growth rate was slowed in 2016; however Rwanda kept the average growth rate of more than 7% since 2011. Even though the GDP per capita has not reached US$ 800 yet and the unemployment rate is still high, as shown in Table 1-5. Rwanda reduced the total and extreme poverty rate fro ㎡ 010/2011 to 2013/2014, while keeping the economic growth.

Table 1-5 Labor Participation Rate and Unemployment Rate in Rwanda and Kigali

	Rwanda			Kigali			
	Total	Urban	Rural	Total	Nyarugenge	Gasabo	Kicukiro
Labor participation rate (16 years old and over)	54.0%	64.5%	50.8%	52.4%	65.6%	66.7%	66.3%
Unemployment rate	16.7%	18.1%	16.2%	17.7%	22.5%	17.6%	15.9%
Youth unemployment rate	21.0%	21.0%	20.9%				

Source: 1National Institute of Statistics Rwanda, Labor Force Survey 2017

Table 1-6 Trend of Total Poverty and Extreme Poverty (2010/11－2013/14)

	Total Poverty (Percentage)			Extreme Poverty (Percentage)		
	2010/11 (EICV3)	2013/14 (EICV4)	Change	2010/11 (EICV3)	2013/14 (EICV4)	Change
Nationally						
Rwanda	46.0	39.1	-6.9*	21.8	16.3	-5.5
Area of Residence						

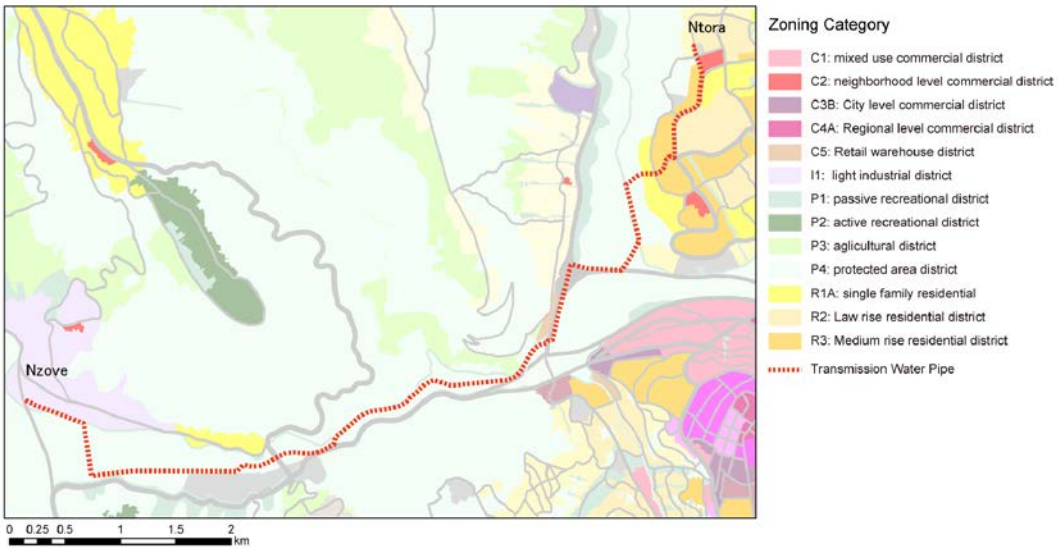
	Total Poverty (Percentage)			Extreme Poverty (Percentage)		
	2010/11 (EICV3)	2013/14 (EICV4)	Change	2010/11 (EICV3)	2013/14 (EICV4)	Change
Urban	17.7	15.9	-1.9	6.6	5.45	-1.1
Rural	51.0	43.7	-7.3	24.5	18.5	-6.0
Province						
Kigali City	27.5	20.9	-6.6	13.7	9.4	-4.2

Source: National Statistics Institute Rwanda (NSIR), Poverty Trend Analysis Report 2010/11-2013/14 (2016)

6) Land Use

Kigali City consists of a dozen of hills, and the marshlands are stretching between hills and valleys. According to the Kigali Master Plan 2013, marshlands and hilly land that is steeper than 20 degrees account for 14% and 35% of the whole city area respectively.

As shown in Figure 1-9, around 70% of the planned transmission pipeline route passes through the marshland, which is categorized as P4 “Protected Area” under the Kigali Master Plan 2013. Developments in P4 zone require approval by review panel.



Source: the Kigali City Master Plan 2013

Figure 1-9 Zoning Map around the Planned Route of Transmission pipeline

7) Social Infrastructure

The result of the census survey in 2012 shows the source of drinking water and energy by Sector.

Table 1-7 Sources of Drinking Water by Sector

Sector of residence	Improved water source					Unimproved water source						
	Internal pipe-borne water	Pipe-borne water in the compound	Public tap out of the compound	Protected spring/ well	Rain water	Unprotected spring/ well	River	Lake/stream/ pond/surface water	Other	Not stated	Total	Count
Rwanda	0.5%	7.1%	27.7%	37.0%	0.7%	13.0%	6.4%	6.4%	0.2%	1.1%	100%	2,424,898
Nyarugenge District												
Kanyinya	0.1%	5.0%	41.2%	11.8%	0.2%	18.6%	18.8 %	3.4%	0.2%	0.8%	100%	5,760
Kigali	0.1%	7.2%	58.5%	12.1%	0.1%	7.9%	1.8%	11.2%	0.0%	1.2%	100%	8,116
Kimisagara	0.6%	45.8%	48.7%	2.4%	0.1%	1.0%	0.0%	0.0%	0.0%	1.3%	100%	11,648

Sector of residence	Improved water source					Unimproved water source						
	Internal pipe-borne water	Pipe-borne water in the compound	Public tap out of the compound	Protected spring/ well	Rain water	Unprotected spring/ well	River	Lake/ stream/ pond/ surface water	Other	Not stated	Total	Count
Gasabo District												
Gatsata	0.6%	26.1%	46.6%	11.8%	0.1%	11.5%	1.9%	0.0%	0.0%	1.5%	100%	10,035
Gisozi	2.3%	40.5%	49.9%	3.3%	0.0%	1.9%	0.8%	0.0%	0.0%	1.3%	100%	12,199

Source: Fourth Rwanda Population and Housing Census.

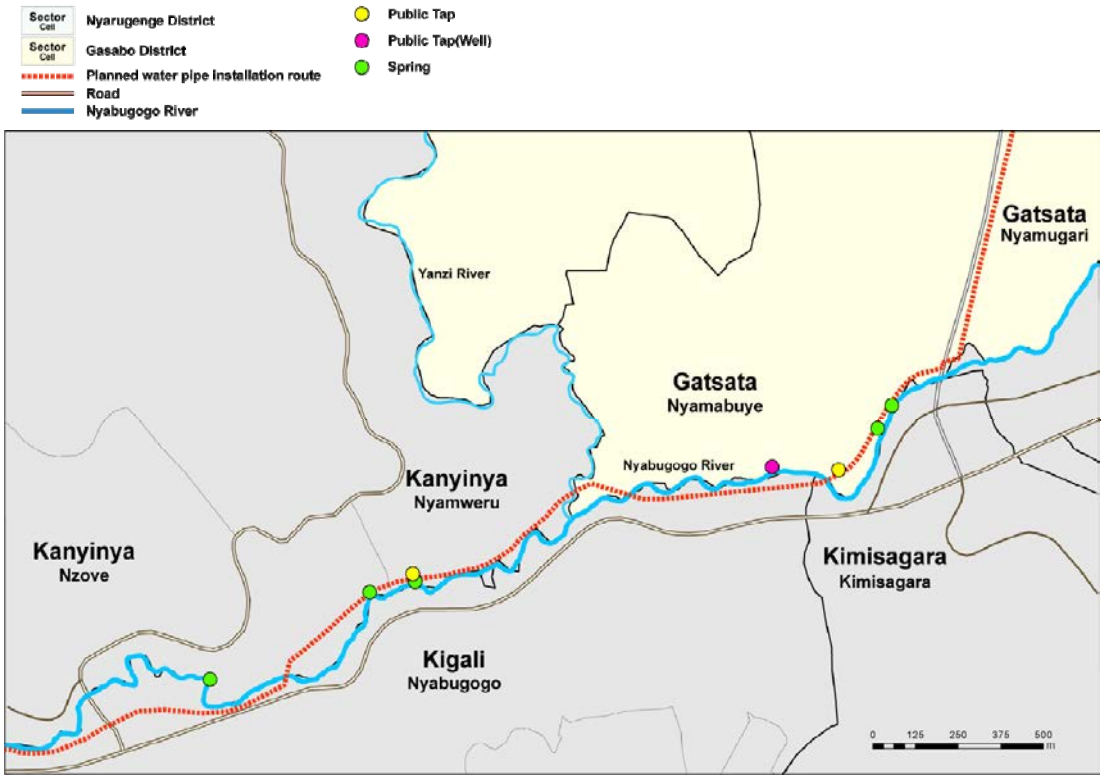
Table 1-8 Main Source of Energy Water by Sector

Sector of residence	Main source of energy for lighting								Percent	Count
	Electricity *	Kerosene lamp	Paraffin	Biogas	Candle	Firewood	Other	Not stated		
Rwanda	17.4%	39.6%	1.3%	0.0%	9.7%	7.9%	23.6%	0.5%	100%	2,424,898
Nyarugenge District										
Kanyinya	33.0%	27.2%	0.1%	0.0%	29.1%	0.6%	9.2%	0.8%	100%	5,760
Kigali	52.1%	28.5%	0.2%	0.0%	16.9%	0.3%	1.6%	0.4%	100%	8,116
Kimisagara	87.3%	4.2%	0.1%	0.0%	7.6%	0.0%	0.2%	0.6%	100%	11,648
Gasabo District										
Gatsata	87.2%	3.1%	0.0%	0.0%	8.7%	0.0%	0.5%	0.5%	100%	10,035
Gisozi	81.2%	5.4%	0.0%	0.0%	12.4%	0.1%	0.4%	0.5%	100%	12,199

Source: Fourth Rwanda Population and Housing Census.

Notes: (1) * Electricity = Electricity by EWSA + Hydro-electric source + Solar power + Generator.

Along the local road in Nyamweru Cell and Nyamabuye Cell, a part of the planned transmission pipeline route, many of residents still use wells and springs as main sources of drinking and domestic water.



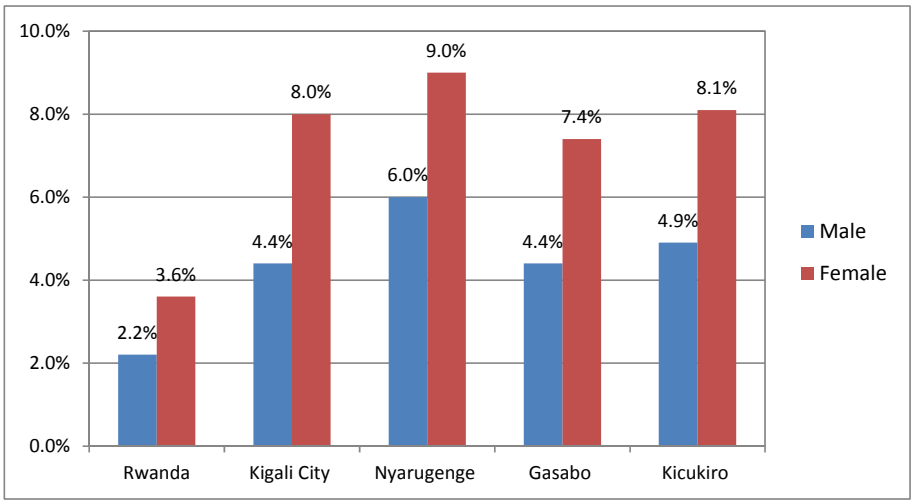
Source: Study Team

Figure 1-10 Location of Public Tap, Well, and Springs

8) Current Situations of HIV/AIDS

Rwanda Demographic and Health Survey (RDHS) 2014-15 investigated the level of comprehensive knowledge about HIV/AIDS among women and men age 15-49.

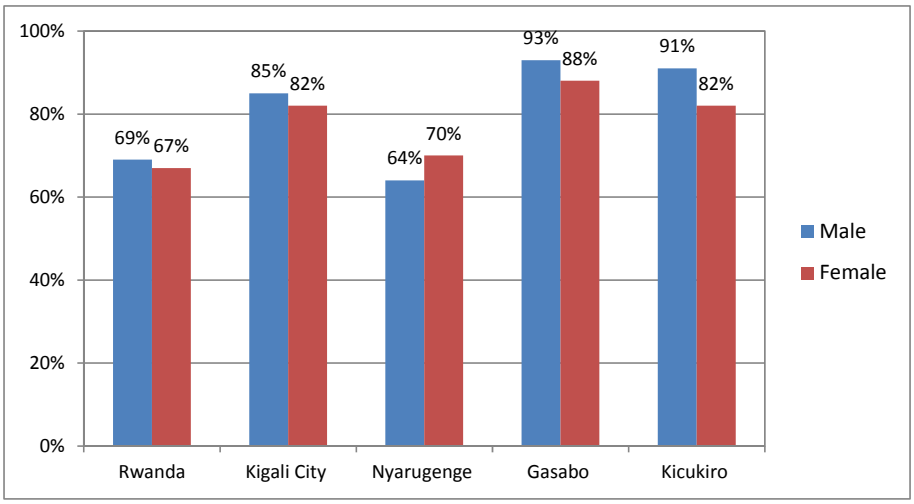
First of all, the HIV prevalence among women and men age 15-49 is shown. The Nyarugenge District shows the highest prevalence rate in Rwanda.



Source: Demographic and Health Survey (RDHS), 2014-15

Figure 1-11 HIV prevalence among women and men age 15-49

The share of women and men who were evaluated to have comprehensive knowledge by District is shown below. The share of the Nyarugenge District is lower than that of the other 2 Districts.



Source: Demographic and Health Survey (RDHS), 2014-15

Figure 1-12 Percentage of women and men age 15-49 with comprehensive knowledge on HIV

(5) Policy, Legal, and Administrative Framework of Environmental and Social Consideration

1) Laws and Regulations related to Environmental Consideration

Constitution of the Republic of Rwanda

The Constitution of Rwanda was established in 2003 and revised in 2015. Article 22 states that everyone has the right to live in a clean and healthy environment.

Article 53 states that everyone has the duty to protect, safeguard, and promote the environment and the State ensures the protection of the environment.

Rwanda Vision 2020

Rwanda Vision 2020 was formulated in 2000 as the government development program. The program consists of the following 6 goals, good governance, an efficient state, skilled human capital, including education, health and information technology, a vibrant private sector, a world-class physical infrastructure, and modern agriculture and livestock, while sustainable environmental and natural resource management is selected as one of three cross-cutting issues.

Rwanda National Environmental Policy (approved by Cabinet in November, 2003)

The overall objective of the Environment Policy is the improvement of man's well-being, the judicious utilization of natural resources and the protection and rational management of ecosystems for sustainable and fair development.

In addition, the policy states fundamental principles for improved management of the environment, both at the central and local level, in accordance with the country's current policy of decentralization and good governance.

N° 04/2005 of 08/04/2005 Organic Law determining the modalities of protection, conservation and promotion of environment in Rwanda

The organic law determines the modalities of protecting, conserving and promoting the environment in Rwanda. Article 17 states that any acts concerned with water resources like watering plants, the use of swamps and wetlands and others, shall always be subject to prior environmental impact assessment.

The chapter 3 "Environmental Impact Assessment" requires every project to assess environmental impact to obtain authorization for its implementation (Article 67), indicates the necessary items of the Environmental Impact Assessment (Article 68), and sates the authorities who examine and approve the survey (Article 69). The detailed procedures of the EIA implementation and approval are shown in the EIA guideline, which were formulated in 2006.

In order to conserve the marshland, agricultural activities and pastoral activities that require agricultural activities are not permitted without respecting a distance of 10 meters away from the banks of rivers (Article 85). All buildings shall be constructed in a distance of at least 20 meters away from the bank of the swamp (Article 87).

Any one or association that does not carry out environmental impact assessment prior to launching any project that may have harmful effects on the environment is punished by

suspension of his or her activities and closure of his or her association and without prejudice to be ordered to rehabilitate the damaged property, the environment, people and the property (Article 95).

Ministerial Order N° 003/2008 of 15/08/2008 Relating to the Requirements and Procedure for Environmental Impact Assessment)

The Ministerial Order summarizes the requirements and procedures of the EIA. The details of the EIA systems are shown in the EIA guidelines, which are edited by type of the Project.

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

Article 2 and the appendix table specify the works, activities and projects that have to undertake an environmental impact assessment before being granted permission to commence. The present project is classified among Infrastructure: water distribution activities and sanitation.

Ministerial Order for Establishing the List of Protected Animals and Plant Species in Rwanda, Order N° 007/2008 of 15/08/2008

This Ministerial Order shows the list of protected animal and plant species in Rwanda. The list of animals that include Mammals, Birds and Reptiles is shown under Appendix I while the protected plant species is shown under Appendix II of the Order document.

There are no habitats of fauna and flora requiring special protection measures; however, necessary measures, such as conserving top soil and protecting animals/birds during the site-clearance, will be taken.

2) Organizations Related to Environmental and Social Considerations in Rwanda

Ministry of Environment, MOE

The MOE was reorganized from Ministry of Natural Resources in 2017, with jurisdiction over Environment Conservation including Climate Change and Water Resources, while the Ministry of Lands and Forestry was created to take a responsibility for land and forest management. The Ministry is in charge of formulating policies, laws and regulations, and coordinating various activities among other organizations.

In the process of the EIA approval, MOE participates in the screening process as one of leading organizations based on the request from RDB, open the list of EIS consultants, evaluate the project briefings, submitted by developers, gives RDB advice on TOR, and evaluate EIA reports.

Ministry of Infrastructure, MININFRA

MININFRA formulates policies of national transportation infrastructure networks such as roads, bridges, airports, and railway, as well as water supply and sewerage systems and energy. In the field of water supply and sewerage systems, the Ministry gives guidance and supervises WASAC as a supervisory authority.

Water and Sanitation Corporation Ltd, WASAC

WASAC, the executing agency of the Project, is a 100% government owned public

corporation, established based on the law Nº 87/03 of 16/08/2014, in order to manage the water and sanitation services in Rwanda.

The Urban Water and Sanitation Services Directorate, UWSS, is responsible for water supply in the urban areas, planning and managing the water distribution network as well as managing the data on the customers and facilities.

Rwanda Environment Management Authority (REMA)

The REMA was established based on the Organic Law in order to implement environment related policies and laws under the Ministry of Natural Resources.

Its main roles and responsibilities are to implement environment policies, giving advice to the government, conduct environmental audits, carry out various surveys, prepare for environmental reports such as Sate of Environment, monitor and supervise environment assessment, and so on.

Rwanda Development Board, RDB

The RDB was established based on the Organic Law N° 53/2008 of 02/09/2008, in order to promote direct investments in Rwanda. REMA used to be responsible organization of the EIA approval; however, the functions and authorities were transferred to RDB in 2009.

The EIA Support Desk at the One Stop Center, which is operated by the Investment Promotion Division of RDB with the purpose of providing facilities for investors, receive project briefs, formulate the ToR after field visit, examines the EIA reports, and issues approval certificates.

Rwanda Water and Forestry Authority

The RWFA was reorganized from the Rwanda Natural Resources Authority in 2017 based on the Law no. 06/2017 of 03/02/2017, as a responsible organization of water and forest resource management. Its roles and responsibilities are to implement policies, laws & regulations, and strategies in the fields of water and forest resources management.

The RWFA is responsible for river water quality monitoring and river basin management plans.

Local Governments

The Constitution of Rwanda states that Public powers are decentralized at local administrative entities in accordance with provisions of law. According to the Article 61 of the Environmental Organic Law, decentralized entities are particularly responsible for ensuring the appropriate land management, forest conservation, water resource management, and effective use of marshland, and protection and management of endangered animal and plant species.

Districts are usually responsible organizations in the process of land expropriation; however, the Project covers 2 districts, so the City of Kigali is responsible for land expropriation and land use.

3) EIA Approval Process

The detailed approval process of the EIA is shown in the General Guidelines and Procedure for Environmental Impact Assessment for Rwanda, 2006. Regarding the water resources

management related projects, the EIA Guidelines for Water Resources Management was formulated in 2009.

The EIA procedure in Rwanda is shown in the figure below. According to the guideline, the RDB takes a responsibility for scoping; however, there are some cases, in which developers conduct scoping and formulate the ToR by themselves.

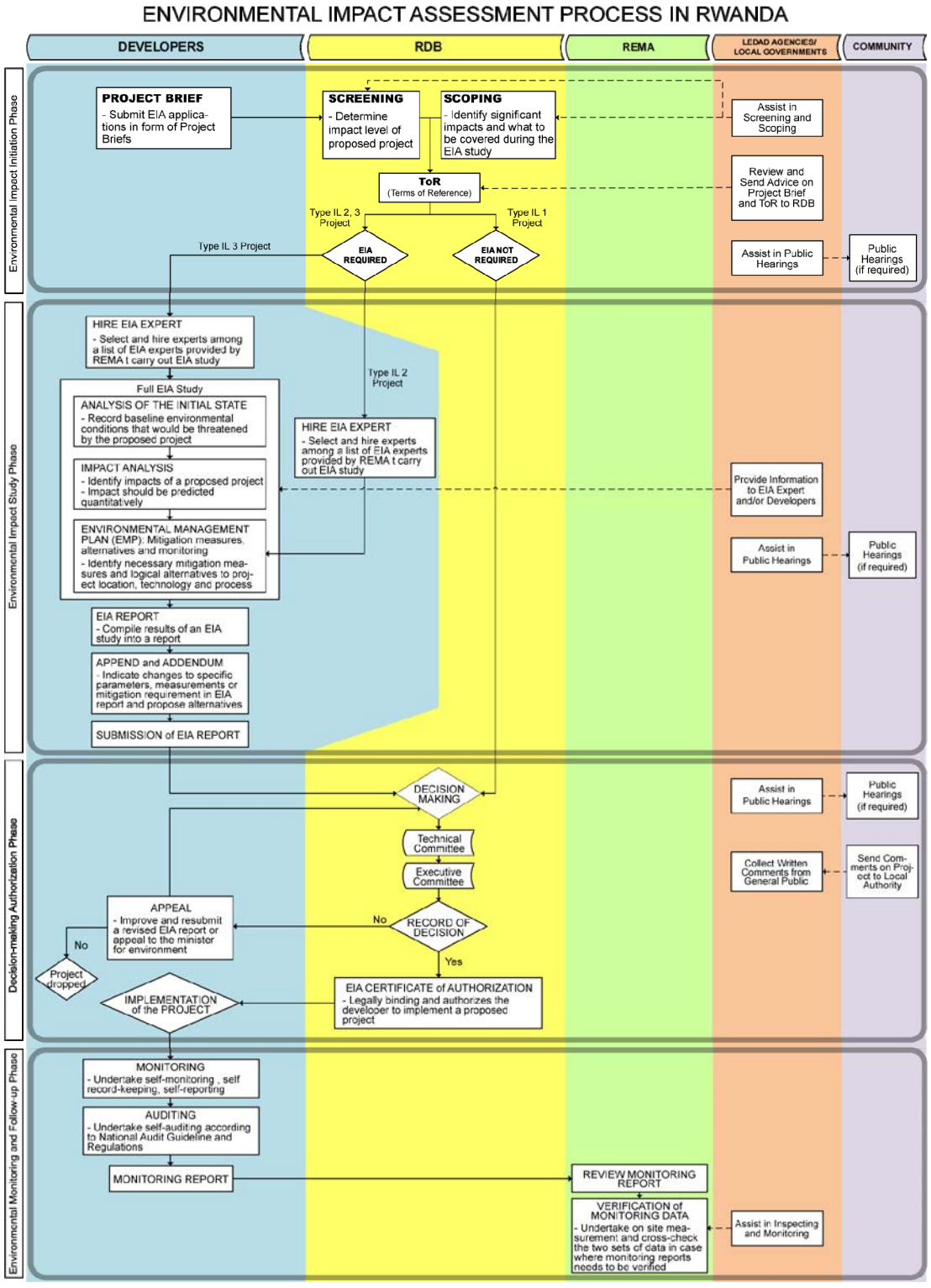


Figure 1-13 EIA Approval Process

(6) Alternative Analysis including Zero Option

An alternative analysis was conducted, in a comprehensive way, considering such items as technical aspects, economic effects, impacts of the natural and social environment, construction period, construction cost, and so on.

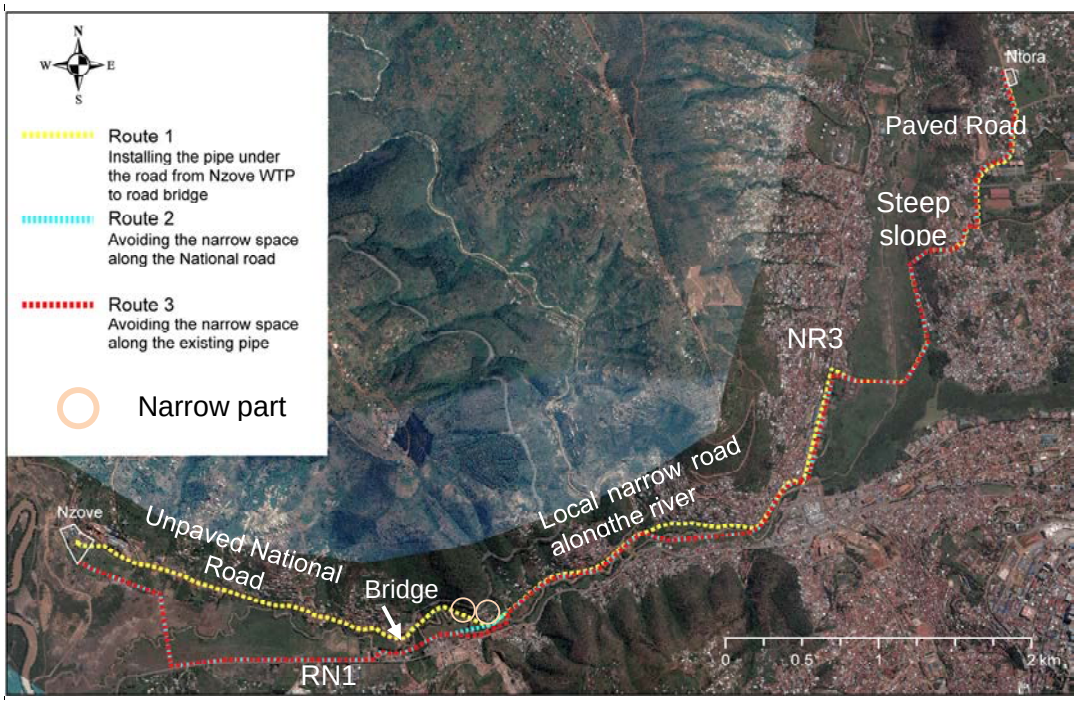
4) Zero Option

In Kigali, the demand for water increases as the population increases. In Ntora, water supply is often cut due to the water shortage, and this was expressed as one of major problems at consultation meetings in Ruhango. For WASAC, it is one of the most important issues to increase the water supply volume from Nzove WTP that has the water treatment capacity improved by rehabilitation work.

On the other hand, the existing transmission pipeline from Nzove WTP to Ntora Reservoir has serious problems such as water leakage since the start of the service; and the new transmission pipeline is required immediately. Therefore, the installation of the new transmission pipeline is necessary.

5) Alternative Analysis: Route Selection

The following 3 routes were compared.



Source: Study Team

Figure 1-14 Transmission pipeline Installation Routes for comparison

- Route 1

  The transmission pipeline runs along the existing transmission pipeline until the steep slope, under the unpaved National Road from Nzove WTP to the first bridge, and then under the local narrow road. There are various problems, such as limited space for pipe installation, due to the existing pipeline.

  Along the unpaved National Road, a part of transmission pipeline is needed to be installed

outside the road, due to the existing pipeline, and this would result in the land expropriation and resettlement of some houses and restaurants.

Local narrow road comes very close to Nyabugogo River at several places, and the pipe installation work at these places have negative impact on river banks and slopes just below the road. Bank protection work is necessary.

It is difficult for Rwanda Transport Development Agency (RTDA) to allow WASAC to install the transmission pipeline under the unpaved National Road, because they plan to have a project of road-widening work.

- Route 2

  From Nzove WTP, the transmission pipeline heads to the south to RN1, passing through the wetland along the existing transmission pipeline to Mount Kigali (there is the first river crossing point).

  The pipeline runs at the wetland along the RN1 and it runs along the right side of the river after passing the first bridge. Along the local narrow road, there is a one place where river bank protection work is necessary.

  There are 6 river crossing places.

- Route 3

  The route 3 is almost the same as the route 2. The pipeline runs along the right side of the river after the narrow parts (No bank protection work is necessary). There are 6 river crossing places.

The result of the alternative analysis of installation routes for the transmission pipeline is shown in the table below. The route 3 was selected as the most appropriate route.

Table 1-9 Result of Alternative Analysis of Transmission pipeline Installation Route

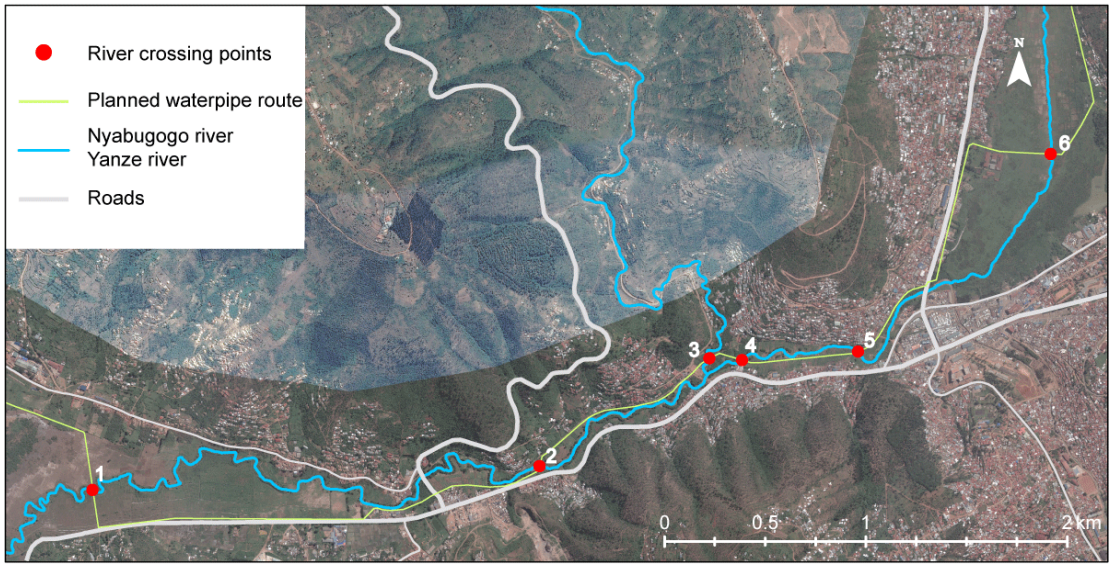
	Route 1	Route 2	Route 3
Total length of pipe	9.1km	9.4km	9.4km
Route composition	Paved: 1.15km Unpaved (including marshland): 7.95km	Paved: 1.15km Unpaved (including marshland): 8.25km	Paved: 1.15km Unpaved (including marshland): 8.25km
Presence of narrow road very near from the river	△	△	○
Measures of river bank protection	△	○	○
Measures to protect wet land	△	△	△
River-crossing measures	○	△	△
Construction at steep slope	△	△	△
Impact on traffic	△	○	○
Involuntary resettlement	△	△	△
Land expropriation	△	△	○
Construction period	○	○	○

	Route 1	Route 2	Route 3
Project cost	○	△	△
Overall evaluation			◎ most appropriate
Remarks	There will be road widening work from Nzove WPT to road bridge, and RTDA and other organizations concerned will not allow transmission pipelines to be installed under the National Road	Need to consider the impact of the new transmission pipeline on the existing one at one location near the river.	The detail design of sewerage pipe will be started, and the exact location of sewerage pipe must be confirmed.

○: Appropriate, △: A little problem, x: Not appropriate, - : no impact
Source: Study Team

6) Alternative Analysis: River Crossing Methods

The Route 3 has 6 river crossing places, as shown in the figure below.



Source: Study Team

Figure 1-15 River Crossing Places

The following 3 methods, open-cut method, pipe jacking method and water pipe bridge, are compared.

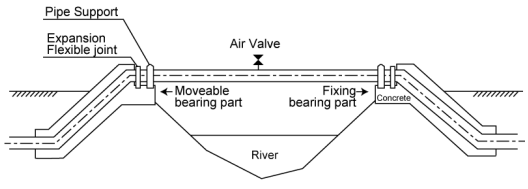
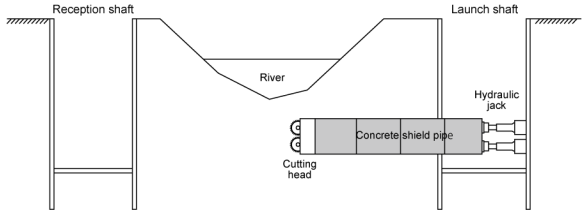
Table 1-10 Evaluation of impact of each river crossing method

	Hard Ground						Soft Ground					
	Open Cut Method (Underneath a river)		Pipe Jacking Method (Tunnel)		Pipe Beam Bridge		Open Cut Method (Underneath a river)		Pipe Jacking Method (Tunnel)		Pipe Beam Bridge	
	Under construction	In operation	Under construction	In operation	Under construction	In operation	Under construction	In operation	Under construction	In operation	Under construction	In operation
Land use	△	○	△	○	△	△	△	○	△	○	△	△
Landscape	○		○		△		○		○		△	
Approval	○		○		○		○		○		○	
Impact on the river (Water quality)	△	○	○	○	○	○	△	○	○	○	○	○
Impact on the river (Hydrology)	△	○	○	○	○	○	△	○	○	○	○	○
Construction cost	○		△		△		○		△		△	
Construction period	△		△		△		○		○		△	
Maintenance cost	○		○		△		○		○		△	
Safety	○	○	△	○	△	○	○	○	△	○	△	○
Resettlement	-		-		-		-		-		-	
Result of analysis	○		△		△		△		○		△	
Main elements for the analysis	Construction cost is relatively low		Construction cost is high		Construction cost is high		Construction cost is relatively low, easy to maintain, construction period is short, impact on the river bank is big		Construction cost is relatively low, easy to maintain, impact on the river bank is small		Construction cost is high and difficult to maintain	

○: appropriate, △: a bit of a problem, x: not appropriate, - : no impact

Source: Study Team

Table 1-11 River Crossing Methods

Pipe beam bridge	Lead-pipe jacking method
	
• The height of the water pipe bridges is higher than design flood level stipulated in the Rwandan regulation or the equivalent regulation. • After constructing abutments on both the river sides, installing the pipes by the rough terrain crane • Construction period: during the dry season • Construction cost at the soft ground such as wetland is high, in order to take measures to	• After preparing for the launch and reception shafts, centrifugal reinforced concrete pipes are inserted into the ground as pipe sleeves by hydraulic jacks. • The soils inside the pipes are excavated by hand. If the ground conditions are not good, the soils are excavated using a high-pressure jet, and this makes it possible assure the safety by keeping a certain distance between workers and cutting head. • After installing pipe sleeves, the transmission pipes are inserted inside them, and aerated light-weight concrete is

Pipe beam bridge	Lead-pipe jacking method
prevent differential settlement. • Pipe beam bridge has a load on river bank with the soft ground	filled up between the pipe sleeves and transmission pipes in order to fix the transmission pipeline in concrete. • Construction period: during the dry season • At the place where groundwater level is high, it is necessary to take a measure to drain water • Its impact on river bank is limited • There is a little impact on water pollution

Source: Study Team

River crossing methods at each place was examined, based on the result of the ground and soil survey. The result of these examinations is shown below. Considering the construction cost and difficulty of maintenance work of the pipe beam bridge, pipe jacking method is selected at the all river crossing places.

Table 1-12 River Crossing Method

Planned location	Location		Result of ground/soil survey		River-crossing method
	latitude	longitude	N-value	Soil type	
1	1°56'53.59"S	30° 0'23.70"E	1～2	Dark brown soft clay, with a medium compactness, fine to medium grained size, with a closely spaced discontinuity	Pipe Jacking Method
2	1°56'49.57"S	30° 1'36.01"E	2～4	Dark brownish and brown clay, fine to medium grained size, compact, less homogenous and less spaced discontinuity	Pipe Jacking Method
3	1°56'31.90"S	30° 2'2.63"E	3～4	Brown compact clay and silty clay, closely spaced di	Pipe Jacking Method
4	1°56'33.08"S	30° 2'5.17"	1～12	Dark brown clayey sand, medium grained, poorly graded, with a surrounded shape, loose compactness and no homogeneity.	Pipe Jacking Method
5	1°56'31.37"S	30° 2'26.70"E	No data at the exact location. It's estimated at 1-15, based on the value near the location.	Beige, mauve weathered schists, medium to coarse grained size, with less spaced joints	Pipe Jacking Method
6	1°55'59.26"S	30° 2'57.58"E	1～8	Grey brownish clay, with a dense compactness and a homogenous grading, and a closely discontinuity, fine to medium grained size	Pipe Jacking Method

Source: Study Team

In order to implement pipe jacking method safely at the soft ground with high underground water level, it is important to follow the international standards such as OHSAS.

(7) Scoping

Under the Rwandan EIA Procedures, RDB conducts scoping based on the comments from organizations concerned and local government and result of the field visits and decides the ToR.

The JICA study team also conducted scoping in cooperating with WASAC and EIA consultant team, and the opinions and comments from residents and local governments at the first consultation meetings was reflected in the finalized scoping.

Category	No.	Items	Evaluation		Reason
			Before/ During Construction	Operation	
Anti-pollution measures	1	Air pollution	B-	D	[During Construction] Emission gas and dust will be generated; however, their impact on ambient air quality is expected to be limited, due to the limited number of heavy vehicles & trucks and limited period of construction work at each place. [Operation] Newly installed pumps are electric pumps and have little impact on ambient air
	2	Water pollution	B-	D	[During Construction] There are six (6) river-crossing points and construction methods at each point would determine the level of water pollution.
	3	Soil pollution	D	D	[During Construction] There could be oil contamination during the maintenance work of heavy vehicles and trucks; however, its impact would be limited.
	4	Waste Municipal solid waste (MSW) Construction waste (CW)	B-	D	[During Construction] It is likely that workers are recruited locally and accommodations and camps for workers would not be prepared. Therefore MSW would not cause a serious problem. [During Construction] Construction waste such as excavated soil and concrete debris will be generated. Some of them can be reused as road construction materials. It is necessary to formulate a waste management plan.
	5	Noise and Vibrations	B-	C	[During Construction] There will be temporary problems of noise and vibrations due to the construction work of the new pump station and transmission pipeline installation work [Operation] Since the new pump station is far away from the nearest houses and new pumps are installed inside the concrete building, there would be no serious noise and vibration problems.
	6	Ground subsidence	D	D	Design based on the boring survey can prevent ground subsidence
	7	Odor	D	D	Problems of odor are not expected
	8	Bottom sediment	D	D	It is up to river-crossing method. Pipe jacking method has little impact on bottom sediment.
Natural Environment	9	Protection area	D	D	There are no protection area such as national park inside the Project area; however, the EIA survey will check it
	10	Biota and ecosystems	B-	D	EIA survey will study the fauna and flora at the marshland, which account for 70% of the construction area

Category	No.	Items	Evaluation		Reason
			Before/ During Construction	Operation	
	11	Hydrology	B-	C-	There are 6 river crossing places at the marshland, which ground is soft. It is up to the route and river crossing method, which could affect the river bank.
	12	Geographical features/Soil erosion	B-	C	[During construction] Soil along Nyabugogo river tends to be friable when it becomes wet. The construction work of water beam bridges and transmission pipeline installation work at steep slope could cause soil erosion. [Operation] Installation work of transmission pipelines at steep slope could affect the soil after construction work finishes
Social Environment	13	Resettlement	B-	D	2 households are needed to be resettled
	14	Land acquisition	B-	D	[Before construction] There are households and corporations, whose land plots are the targets of partial land expropriation. Compensations for structures, trees and crops are necessary
	15	Vulnerable groups	B-	D	Based on the result of the socio economic survey, support for vulnerable groups will be considered, if any.
	16	Local economy such as employment and livelihood	B+/-	C	[During Construction] The project would create jobs and this could have positive impact on the local economy. [Operation] There are households who would lose a part of farming land. Based on the result of socio-environmental survey, support measures would be examined, if necessary.
	17	Utilization of land and local resources	B-	D	[During Construction] A part of farming land and shops cannot be used.
	18	Water use Water for drinking and domestic use	B-	D	[During Construction] There is a possibility that construction work could have an impact on wells and springs along the local narrow road (judging from the construction work of the existing transmission pipeline, it is less likely)
		Water for agriculture	D	D	There is no water inlet for irrigation near the construction area
		Fishery	D	D	There are fishing activities at the swamps of the marsh land, not at Nyabugogo river.
	19	Existing social infrastructures and services	B-	B+	[During Construction] Traffic congestions would be expected along the RN1 and paved road in Ruhango Cell. [Operation] The network of transmission pipelines will be improved
	20	social institutions such as social infrastructure and local decision-making institutions	D	D	There will be little impact on social infrastructure and local decision-making institutions

Category	No.	Items	Evaluation		Reason
			Before/ During Construction	Operation	
	21	Misdistribution of benefits and damages	B-	D	[During Construction] The number of jobs is limited, and this would create gaps between those who get jobs and not get jobs. Those who live along the planned pipeline in Nyarugenge district would suffer from problems such as noise and vibrations but are not direct beneficiaries of the Project
	22	local conflict of interests	C-	D	[During Construction] There could be conflict between those who get jobs and not get jobs
	23	Cultural heritage	D	D	No cultural heritages are not identified
	24	Landscape	D	D	The project could not change the landscape significantly; however, cutting some bamboos along the river might change the landscape a little bit.
	25	Gender	C	D	[During Construction] The negative impact on gender issues is not expected; however, socio-economic survey will check the economic situations of female headed household, and supporting measure will be considered, if necessary.
	26	Children's rights	C	D	The negative impact on Children's right is not expected; however, if socio-economic survey identifies problems related to children, supporting measures will be considered.
	27	infectious diseases such as HIV/AIDS	B-	D	Workers will be employed locally and it is unlikely that the Project would spread infectious diseases such as HIV/AIDS; however, HIV/AIDS issue is one of concerns in Rwanda, and it is important to promote awareness about HIV/AIDS for not only workers but also local people in order to prevent further infection.
	28	Work Conditions including Work Safety	B-	D	There would be a possibility of accidents, injuries, and diseases at the construction site. Contractor will be required to follow Rwandan laws and international rules such as OHSAS in order to make sure of work safety.
	29	Accidents	B-	D	There would be a possibility of traffic accident during the construction work.
	30	Global warming	B-	D	Due to the operation of heavy vehicles and trucks generates greenhouse gas; however, the impact is limited.

Rating: A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C: Extent of positive/negative impact is unknown (Examination is needed. Impacts may become clear as study progresses.)
D: No impact is expected

Source: Study Team

(8) ToR of the Environmental and Social Consideration Survey

Based on the ToR made by RDB and the result of scoping, the ToR of the Environmental and Social Consideration Survey was made.

Table 1-13 ToR of the Environmental and Social Consideration Survey

Items of Impact	Survey Items	Survey method
1. Air pollution	(1) Environmental standard, current situations of ambient air (2) Impact of construction work	(1) literature survey (environmental standard, measuring method) (2) project components, construction method, construction schedule, heavy vehicles/trucks, construction area, and so on (from JICA study team)
2. Water pollution	(1) Environmental standard, current situations of water quality (2) Impact of construction work	(1) literature survey (environmental standard, measuring method, monitoring data) (2) project components, construction method, construction schedule, construction area, and so on (from JICA study team) (3) Baseline data survey (4) Result of soil and ground survey (from JICA study team)
4. Waste	(1) Laws and regulations (2) Impact of construction work	(1) literature survey (Solid management systems in Kigali) (2) project components, construction method, construction schedule, construction area, and so on (from JICA study team)
5. Noise and vibrations	(1) Environmental standard, current situations of ambient noise (2) Impact of construction work	(1) literature survey (environmental standard, measuring method) (2) project components, construction method, construction schedule, heavy vehicles/trucks, construction area, and so on (from JICA study team) (3) Baseline data survey
10. Biota and ecosystems	(1) data on fauna and flora (in particular endangered species) (2) Impact of construction work	(1) literature survey (reports on fauna and flora at wetland) (2) project components, construction method, construction schedule, construction area, and so on (from JICA study team) (3) Targets of bamboos and trees for cutting at the wetland
11. Hydrology	(1) current situations (2) Impact of construction work	(1) literature survey (reports of similar projects) (2) project components, construction method, construction schedule, construction area, and so on (from JICA study team) (3) Result of soil and ground survey (from JICA study team)
12. Geographical features/Soil erosion	(1) Impact of construction work	(1) literature survey related to soil survey (2) project components, construction method, construction schedule, construction area, and so on (from JICA study team) (3) Result of soil and ground survey (from JICA study team)
13. Resettlement	(1) legal framework related to resettlement (2) households needed to be resettled (3) compensation policies	(1) literature survey (legal framework, reports of other projects) (2) project components, construction method, construction schedule, construction area, and so on (from JICA study team) (3) Socio-economic survey, Inventory survey, consultation meetings
14.Land	(1) legal framework	(1) literature survey (legal framework, reports of other

Items of Impact	Survey Items	Survey method
acquisition	related to land acquisition (2) land needed to be expropriated (3) compensation policies	projects) (2) project components, construction method, construction schedule, construction area, and so on (from JICA study team) (3) Socio-economic survey, Inventory survey, consultation meetings
15. Vulnerable groups	(1) Current situations	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) Socio-economic (RAP) survey and consultation meetings
16. Local economy such as employment and livelihood	(1) Impact of construction work	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) Socio-economic (RAP) survey and consultation meetings
17. Utilization of land and local resources	(1) Impact of construction work	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) Socio-economic (RAP) survey and consultation meetings
18. Water use (drinking water)	(1) Impact of construction work (during and after the construction work)	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) Socio-economic (RAP) survey and consultation meetings
19. Existing social infrastructures and services	(1) Impact of construction work	(1) literature survey (EIA reports of other projects) (2) Consultation meetings
21. Misdistribution of benefits and damages	(1) Impact of construction work	(1) literature survey (EIA reports of other projects) (2) Socio-economic (RAP) survey and consultation meetings
22. local conflict of interests	(1) Impact of construction work	(1) literature survey (EIA reports of other projects) (2) Consultation meetings
24. Landscape	(1) Impact of construction work	(1) literature survey (EIA reports of other projects) (2) Consultation meetings
25. Gender	(1) Impact of construction work	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) Socio-economic (RAP) survey and consultation meetings
26. Children's rights	(1) Impact of construction work	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) Socio-economic (RAP) survey and consultation meetings
27. Infectious diseases such as HIV/AIDS	(1) Impact of construction work	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) interview survey with organizations concerned
28. Work Conditions including Work Safety	(1) Impact of construction work	(1) literature survey (reports of NISR, UN, WB, other projects and so on) (2) interview survey with organizations concerned
29. Accidents	(1) Impact of construction	(1) literature survey (EIA reports of other projects)

Items of Impact	Survey Items	Survey method
	work	(2) interview survey with organizations concerned
30. Global warming	(1) Impact of construction work	(1) literature survey (reports of UN, WB, other projects and so on)

Source: Study Team

(9) Result of Environmental and Social Consideration Survey including prediction result

Table 1-14 Result of Environmental and Social Consideration Survey

<table>
<tr><th></th><th>Evaluation Items</th><th>Result of the survey</th></tr>
<tr><td>1</td><td>Air pollution</td><td>[During Construction]
Emission gas from heavy vehicles and trucks and dust from constructing work could cause air pollution
Mitigation measures such as using certified heavy vehicles and trucks, daily check of vehicles, regular watering at the construction site and storage place, washing tires of the trucks, and covering the truck box with a sheet could reduce negative impacts</td></tr>
<tr><td>2</td><td>Water pollution</td><td>Result of the baseline survey
<table>
<tr><th></th><th>Unit</th><th>Down-stream</th><th>Main point</th><th>Up-stream</th><th>National permissible limit[1]</th><th>Reference national Standards</th></tr>
<tr><td>temperature</td><td>ºC</td><td>20.5</td><td>20.2</td><td>20.4</td><td><3</td><td>RS 109 (discharged industrial wastewater)</td></tr>
<tr><td>pH</td><td>-</td><td>6.63</td><td>6.86</td><td>6.84</td><td>6.5-85</td><td>RS546 (Drinking water</td></tr>
<tr><td>Turbidity</td><td>NTU</td><td>723</td><td>702</td><td>688</td><td>5</td><td>RS546 (Drinking water</td></tr>
<tr><td>TSS</td><td>(mg/l)</td><td>282</td><td>280</td><td>276</td><td>50</td><td>RS 109 (discharged industrial wastewater)</td></tr>
</table>
Source: UR/College of Applied Science and Technology, Feb 2018

[During Construction]
Pipe-jacking method will be applied at all the river crossing places. This would not cause water pollution problems.
Construction work near Nyabugogo River could cause a problem of soil erosion, since the ground is very soft. It is necessary to implement construction work in dry season.
There is a possibility of water pollution caused by the construction of temporary bridges, though the impact is limited. If necessary, countermeasures such as sediment pond or silt fence will be taken.
After watering and washing tires, it is necessary to prevent sediment from flowing out to the river directly.</td></tr>
<tr><td>3</td><td>Soil pollution</td><td>There is a possibility of soil pollution caused by oil and lubricant, though its impact is limited. The use of oil tray and proper storage management could prevent problems.</td></tr>
<tr><td>4</td><td>Waste Construction</td><td>Excavated soil and concrete debris will be generated, though its amount is limited. It is necessary to prepare for temporary storage place.</td></tr>
</table>

[1] Rwanda does not have specific standards for surface water or ground water. Water assessment results were compared either with drink water (RS 546) or industrial wastewater discharge (RS 109).

<table>
<tr><th></th><th>Evaluation Items</th><th>Result of the survey</th></tr>
<tr><td></td><td>Waste</td><td>In Kigali, Sectors are responsible for collecting general waste, while Kigali City is responsible for disposal site management. There are around 20 companies with license of waste collection and transportation.
Kigali City operates a disposal site at Nduba Cell, Gasabo District. It accepts construction waste. Tipping fee are shown below
General waste: F 3,000/5t、F 5,000/10t
Industrial waste: F 20,000/vehicle
According to the Kigali City officer in charge of waste management, construction waste can be reused as roadbed material, if construction companies have an evidence to show where they get the materials. Construction waste will be reused if proper users can be found through proper procedures. If not, construction waste will be disposed of at the Nduba disposal site.</td></tr>
<tr><td>5</td><td>Noise and Vibration</td><td>Result of baseline survey
<table>
<tr><th>Location</th><th>Maximum dB(A)</th><th>Minimum dB(A)</th><th>Average dB(A)</th><th>Maximum vibration (VdB)</th><th>Minimum vibration (VdB)</th><th>Average (VdB)</th></tr>
<tr><td>Trinity Nursery school</td><td>66.4</td><td>48.6</td><td>55.4</td><td>3.5</td><td>0.4</td><td>2.3</td></tr>
<tr><td>Gatsata near Nyamabuye cell</td><td>64.7</td><td>42.5</td><td>51.6</td><td>2.3</td><td>0.2</td><td>1.8</td></tr>
</table>
Ambient noise standards
<table>
<tr><th>No</th><th>Area</th><th>Time During Day (hours)</th><th>Limits, dB(a)</th></tr>
<tr><td>1.</td><td>Industrial Noise</td><td>07:00-21:00
21:00-07:00</td><td>60.0
55.0</td></tr>
<tr><td>2.</td><td>Neighborhood Noise</td><td>07:00-18:00
18:00-21:00
21:00-07:00</td><td>60.0
55.0
50.0</td></tr>
</table>
[During Construction]
Construction work of new pump station and transmission pipeline installation would cause problems of noise and vibrations
Construction period of transmission pipeline installation at each place is limited. If the information on construction schedule is disseminated beforehand and the construction work which generate noise and vibrations is done during the daytime as much as possible, this could mitigate problems.
Regular monitoring of noise and vibrations will be done during the construction period.
[Operation]
Since the new pump station is far away from the nearest houses and new pumps are installed inside the concrete building, there would be no serious noise and vibration problems.</td></tr>
<tr><td>10</td><td>Biota and ecosystems</td><td>[Before construction]
Site clearance at the wetland could disturb habitats of wildlife. According to the result of the baseline survey, 13 species of birds are observed. It is necessary to pay attentions to habitats, in particular during the breeding period.
Keep the wetland outside the construction area untouched as much as possible.
In order to conserve vegetation at the wetland, before construction work, top soil and wetland soils are stripped and stockpiled for restoration. Once construction work finishes, the surface will be restored with soils.</td></tr>
</table>

	Evaluation Items	Result of the survey
		Some bamboos and trees are needed to be cut. Once the construction work finishes, bamboos along the river and street trees are planted.
11	Hydrology	There would be no negative impact on river bank, with the selection of pipe-jacking method. Storage places of materials and temporary storage place of waste should be prepared, keeping a certain distance from the river.
12	Geographical features/Soil erosion	[During Construction] Pipe installation work at steep slope could cause soil erosion. Pipes will be hanged from the top using mono rail and excavation work will be done manually. As a similar installation work near the driving school shows, proper construction work could prevent problems of soil erosion. There would be no soil problems at river crossing places, since pipe-jacking method will be applied.
13	Resettlement	2 households have to be resettled. The details are shown in Land Expropriation and Resettlement.
14	Land acquisition	For installation of transmission pipelines, land expropriation is necessary. The details are explained in Land Expropriation and Resettlement.
15	Vulnerable groups	Vulnerable groups are identified at the socio-economic survey, and support measures were examined. The details are explained in Land Expropriation and Resettlement.
16	Local economy such as employment and livelihood	The Project could create jobs such as construction works, and this could results in the increase in sales of shops and street vendors. There is a positive impact on the local economy. There are 2 households, who depend on the income from farming activities at government land. They would lose about 30 % of the farming land. For households who would suffer most from the loss of land/income, priority in employment was considered. The details are explained in Land Expropriation and Resettlement.
17	Utilization of land and local resources	A part of farming land is needed to be temporarily or permanently expropriated. It is necessary to consider appropriate compensation under RAP. Only licensed quarrying operations are to be used for material sources.
18	Water use Water for drinking and domestic use	Along the planned transmission pipeline, there are two springs. It is necessary to pay an attention not to fill the surrounding areas of spring while regular monitoring will be conducted.
19	Existing social infrastructures and services	There would be traffic congestion along the RN1 and local paved road in Ruhango cell. The traffic management plan will be prepared, assigning a person who guides traffic and installing signboards.
21	Misdistribution of benefits and damages	The number of jobs is limited and not all the person could get job. It is preferable that those who would suffer most from the Project and vulnerable groups are given a priority in employment. Residents along the narrow local road in Nyarugenge District would suffer from problems such as noise and vibrations and inconvenience such as traffic congestions; however, are not the direct beneficiaries. It is important to consider improving convenience, such as road improvement and continuous use of temporary bridges.
22	local conflict of interests	The number of jobs is limited and not all the person could get job. It is preferable that those who would suffer most from the Project and vulnerable groups are given a priority in employment.
24	Landscape	Cutting bamboos along the river and trees along the National Road could

	Evaluation Items	Result of the survey
		change landscape locally a little bit. After the construction work finishes, bamboos and trees would be replanted.
25	Gender	When construction workers are employed, contractor is required to consider gender balance and to promoted awareness about Gender Based Violence, as well as code of conduct, in order to prevent GBV at and around the construction sites.
26	Children's rights	Children could come to the construction site, looking for jobs. Contractor and sub-contractors will be required to confirm the age of the workers.
27	infectious diseases such as HIV/AIDS	Construction workers would be employed locally and it is unlikely that migrant workers would spread infectious diseases such as HIV/AIDS In Kigali, each District health centers and health workers are assigned to provide training programs for local people Contractor will be requested to provide training of health and hygiene as well as HIV/AIDS for all the workers, in cooperation with health center. Local people will be allowed to participate in the program.
28	Work Conditions including Work Safety	Working conditions could be worsened by dust, noise and vibrations and there would be accidents and injuries at the construction site. Contractor will be required to prepare for work safety plan based on the Rwandan laws such as Law regulating labor in Rwanda、N°13/2009 of 27/05/2009 and international standards such as OHSAS, to provide protection goods such as masks and globs, in order to prevent diseases and injuries. Contractor will be also required to provide training programs for workers, in cooperation with District Labor Inspector, as well as regular meetings, in order to promote awareness of work safety.
29	Accidents	Local people could be involved in accidents at the construction site. Contractor will be required to take measures such as dissemination of information on construction work, installation of fences, and assignment of trained guards at the construction site, in order to prevent accidents involving local people. There would be a traffic accident, involving trucks transporting construction materials and private passenger vehicle. It is necessary for Contractor to assign a guard who guides traffic and install signboards and fences, in order to prevent accidents.
30	Global warming	Number and operation hours of heavy vehicles and trucks used for the construction work 4 backhoes 0.8㎥ (operation hours 8h/day, in total 10,016 h) 6 rough terrain cranes 5t (operation hours 8h/day, in total31,816 h) 1 Crawler cranes 50t (operation hours 8h/day, in total 16 h) 4 backhoes 0.8㎥ + vibration Hammer (operation hours 8hday, in total 2,845 ha9 2 Dump trucks 10t (11 trips/day total travel distance 60 km/day) CO2 emission amount: 675 ton

Source: Study Team

(10) Impact Assessment

Result of the impact assessment is shown below.

Category		Items	Scoping		Impact assessment		Reasons
			Before/ During Construction	Operation	Before/ During Construction	Operation	
Anti-pollution measures	1	Ari pollution	B-	D	B-	D	[During Construction] Emission gas and dust will be generated; however, their impact on ambient air quality is expected to be limited, due to the limited number of heavy vehicles & trucks and limited period of construction work at each place. [Operation] Newly installed pumps are electric pumps and have little impact on ambient air
	2	Water pollution	B-	D	B-	D	[During Construction] There are six (6) river-crossing points and selecting pipe-jacking method could prevent water pollution. Construction work near the river and construction of temporary bridges could cause water pollution, though the impact is limited. [Operation] Pipe jacking method has little negative impact on river bank after construction work finishes
	3	Soil pollution	D	D	D	D	[During Construction] There could be oil contamination during the maintenance work of heavy vehicles and trucks; however, this could be prevented using oil trey and proper oil storage management.
	4	Waste Municipal Solid Waste Construction waste	B-	D	D	D	[During Construction] It is likely that workers are recruited locally and accommodations and camps for workers would not be prepared. Therefore MSW would not cause a serious problem.
					B-	D	[During Construction] Construction waste such as excavated soil and concrete debris will be generated. It is necessary to manage waste properly, preparing temporary storage place and sorting. Construction waste will be reused if proper users can be found through proper procedures. If not, construction waste will be disposed of at the Nduba disposal site [Operation] No waste will be generated.
	5	Noise and Vibrations	B-	D	B-	D	[During Construction] There will be temporary problems of noise and vibrations due to the construction work of the new pump station and transmission pipeline installation work [Operation] Since the new pump station is far away from the nearest houses and new pumps are installed inside the concrete building, there would be no serious noise and vibration problems.
	6	Ground subsidence	D	D	D	D	Design based on the boring survey can prevent ground subsidence
	7	Odor	D	D	N/A	N/A	Problems of odor are not expected
	8	Bottom sediment	D	D	N/A	N/A	It is up to river-crossing method. Pipe jacking method has little impact on bottom sediment.
Natural	9	Protection area	D	D	D	D	At the wetland along the Nyabugogo river, a lot of birds inhabit but there is no protection area

Category		Items	Scoping		Impact assessment		Reasons
			Before/ During Construction	Operation	Before/ During Construction	Operation	
Environment	10	Biota and ecosystems	C-	D	D	D	[Before construction] Site clearance at the wetland could disturb habitats of wildlife. According to the result of the baseline survey, 13 species of birds are observed. It is necessary to pay attentions to habitats, in particular during the breeding period. Keep the wetland outside the construction area untouched as much as possible [During Construction] top soil and wetland soils are stripped and stockpiled for restoration. Once construction work finishes, the surface will be restored with soils.
	11	Hydrology	B-	C	D	D	Selection of pipe jacking method would minimize the impact on river bank.
	12	Geographical features/Soil erosion	B-	C	B-	D	[During construction] Soil along Nyabugogo river tends to be friable when it becomes wet. The transmission pipeline installation work at steep slope could cause soil erosion; however, implementing construction work in dry season could minimize this problem. [Operation] As a similar installation work near the driving school shows, proper construction work could prevent problems of soil erosion.
Environment	13	Resettlement	B-	D	B-	D	[Before construction] 2 households are needed to be resettled
	14	Land acquisition	B-	D	B-	D	[Before construction] There are households and corporations, whose land plots are the targets of partial land expropriation. Structures such as fence and gate, which are construction above road reserve, are the targets of partial expropriation in Ruhango Cell Some land plots will be Temporarily expropriated used as temporary construction road at the marshland
	15	Vulnerable groups	B-	D	B-	D	[Before/During Construction] Based on the result of the socio economic survey, 7 households will be provided support
	16	Local economy such as employment and livelihood	B+/-	D	B+/-	B+/-	[During Construction] The Project would create jobs and this could have positive impact on the local economy. A part of PAHs will lose a part of income opportunity for one season, due to the partial/ temporary land expropriation. [Operation] There would be no cut in water supply in Ruhango Cell, and this might have positive impact on local economy. There are households who would lose a part of farming land. Based on the result of socio-environmental survey, support measures would be examined (RAP)
	17	Utilization of land and local resources	B-	D	B-	D	[During Construction] A part of farming land will be temporarily expropriated, used as temporary construction road. Top soils should be kept and once construction work finishes, the surface of land should be rehabilitated with top soil and returned to owners/uses as soon as possible.
	18	Water use Water for drinking and domestic use	B-	D	B-	D	[During Construction] Along the planned transmission pipeline, there are two springs. It is necessary to pay an attention not to fill the surrounding areas of spring while regular monitoring will be conducted.

Category		Items	Scoping		Impact assessment		Reasons
			Before/ During Construction	Operation	Before/ During Construction	Operation	
	19	Existing social infrastructures and services	B-	B+	B-	B+	[During Construction] Traffic congestions would be expected along the RN1 and paved road in Ruhango Cell. [Operation] The network of transmission pipelines will be improved.
	20	social institutions such as social infrastructure and local decision-making institutions	D	D	N/A	N/A	There will be little impact on social infrastructure and local decision-making institutions
	21	Misdistribution of benefits and damages	B-	D	B-	B+	[During Construction] The number of jobs is limited and not all the person could get job. It is preferable that those who would suffer most from the Project and vulnerable groups are given a priority in employment. Residents along the narrow local road in Nyarugenge District would suffer from problems such as noise and vibrations and inconvenience such as traffic congestions; however, are not the direct beneficiaries. [Operation] There will be some benefit for people living along the local narrow road in Nyabugogo District, such as improvement of road and continuous use of temporary bridges.
	22	local conflict of interests	B-	D	B-	D	[During Construction] The number of jobs is limited and not all the person could get job. It is preferable that those who would suffer most from the Project and vulnerable groups are given a priority in employment.
	23	Cultural heritage	D	D	D	D	No cultural heritages are not identified
	24	Landscape	D	D	D	D	[During Construction] The project could not change the landscape significantly; however, cutting some bamboos along the river and trees along the National Road might change the landscape a little bit. After the construction work finishes, bamboos and trees would be replanted
	25	Gender	C	D	D	B+	[Before/During Construction] The negative impact on gender issues is not expected; however, when construction workers are employed, contractor is required to consider gender balance and to promoted awareness about Gender Based Violence, in order to prevent GBV at and around the construction sites. [Operation] The number of women and children, who are freed from water drawing labor will increase in Gasabo district.
	26	Children's rights	C	D	C	D	[Before/During Construction] Children could come to the construction site, looking for jobs. Contractor and sub-contractors will be required to confirm the age of the workers.
	27	infectious diseases such as HIV/AIDS	B-	D	B-	D	[Before/During Construction] Construction workers would be employed locally and it is unlikely that migrant workers would spread infectious diseases such as HIV/AIDS Contractor will be requested to provide training of health and hygiene as well as HIV/AIDS for all the workers and local people, in cooperation with health center (including voluntary counseling and test).

Category		Items	Scoping		Impact assessment		Reasons
			Before/ During Construction	Operation	Before/ During Construction	Operation	
	28	Work Conditions including Work Safety	B-	D	B-	D	[During Construction] Working conditions could be worsened by dust, noise and vibrations and there would be accidents and injuries at the construction site. Contractor will be required to prepare for work safety plan based on the Rwandan law and OHSAS, as well as regular meetings, in order to prevent diseases and injuries and promote awareness of work safety.
	29	Accidents	B-	D	B-	D	[During Construction] There would be a possibility of traffic accident during the construction work.
	30	Global warming	B-	D	B-	D	[During Construction] Due to the operation of heavy vehicles and trucks generates greenhouse gas; however, the impact is limited.

Source: Study Team

(11) Mitigation Measures and Cost to implement Mitigation Measures

Proposed mitigation measures and the cost to implement these measures are summarized below.

Table 1-15 Mitigation Measures against Expected Concerns and Cost to implement measures

No	Environmental Concern	Suggested Mitigation Measures	Implementing agencies	Responsible organizations	Cost (USD)
Before Construction					
10	Biota and ecosystems	• Site clearance at the wetland could disturb habitats of wildlife. It is necessary to pay attentions to habitats, in particular during the breeding period. • Keep the wetland outside the construction area untouched as much as possible.	Contractor	REMA/ WASAC	Included in BoQ
13	Resettlement	• Land expropriation, arrangement of compensation, and supporting measures based on RAP	WASAC, Local government、resettlement committee	WASAC	RAP cost
14	Land acquisition	• ditto	ditto	WASAC	RAP cost
15	Vulnerable groups	• ditto (including priority in employment)	ditto＋ Contractor	WASAC	RAP Cost/ Included in BoQ
16	Local economy such as employment and livelihood	• For households whose income would be affected, supporting measures would be considered (priority in employment) (RAP)	WASAC, Local governments, Contractor	WASAC	Included in BoQ
		• Employ as construction workers	Contractor	Local Authority/	Included in BoQ

No	Environmental Concern	Suggested Mitigation Measures	Implementing agencies	Responsible organizations	Cost (USD)
				WASAC	
During Construction					
1	Air pollution	Watering at storage place and construction site and washing tires of trucks No idling of all vehicles Using sheet to cover truck box	Contractor	REMA/ WASAC	Included in BoQ
2	Water pollution	• Construction work near the river will be done in dry season • After watering and washing tires, a countermeasure, such as sedimentation tank will be taken in order to prevent sediment from flowing out to the river directly. • If construction of temporary bridges cause soil erosion, a countermeasure such as sedimentation pond or silt fence, will be taken to prevent soil from flowing out to the river.	Contractor	REMA/ WASAC	Included in BoQ
3	Waste	• Prepare for temporary storage place, away from the river, and separate and store waste • Reuse construction waste as roadbed materials as much as possible, according to regulations of Kigali City • Disposed of the rest of waste at Nduba disposal site. If transportation work is contracted out to private company, use the company with license	Contractor	REMA/ WASAC	Included in BoQ
4	Soil pollution	• Use oil trey at the time of maintenance work in order to prevent soil contamination.	Contractor	REMA/ WASAC	Included in BoQ
5	Noise and Vibrations	• Regular maintenance will be implemented in order to prevent abnormal sound and vibrations • Safety goods are provided for workers who work near the machine, which causes noise and vibrations	Contractor	REMA/ WASAC/ Local Authority	Included in BoQ
6	Soil erosion	• Construction work near the river will be done in dry season	Contractor	WASAC/ REMA/ RWFA	Included in BoQ
10	Biota and ecosystems	• Top soil and wetland soils are stripped and stockpiled for	Contractor	REMA/ WASAC	Included in BoQ

No	Environmental Concern	Suggested Mitigation Measures	Implementing agencies	Responsible organizations	Cost (USD)
		restoration. Once construction work finishes, the surface will be restored with soils. • Some bamboos and trees are needed to be cut. Once the construction work finishes, bamboos along the river and street trees are planted.			
17	Utilization of land and local resources	• When temporary construction road is returned to owners or users, the surface of land should be rehabilitated with top soil, which is separately stored.	Contractor	WASAC	Included in BoQ
18	Water use	At the construction work neat springs, it is necessary to pay an attention not to fill the surrounding areas of spring. Regular monitoring will be conducted. If necessary, another water source will be examined	Contractor /WASAC	WASAC	Included in BoQ
19	Existing social infrastructures and services	Prepare for traffic management plan Assign a person who guides traffic and install signboards	Contractor	Local Authority/ WASAC	Included in BoQ
21	Misdistribution of benefits and damages	For households whose income would be affected, supporting measures would be considered (priority in employment) (RAP)	WASAC, Local Governments、Contractor	Local Authority/ WASAC	Included in BoQ
		For local people who are not the direct beneficiaries in Nyarugenge district, improvement of road and continuous temporary bridge will be considered	Contractor	Local Authority/ WASAC	Included in BoQ
22	local conflict of interests	Employ as construction workers	Contractor	Local Authority/ WASAC	Included in BoQ
25	Gender	Prepare for code of conduct Promote awareness Gender based violence and sexual Exploitation and Abuse(GBV/SEA) for workers	Contractor	Local Authority/ WASAC	Included in BoQ
26	Children's rights	Follow Rwandan laws, ILO, and the Convention on the Rights of the Child, UNICEF	Contractor	REMA/ WASAC/ Districts	Included in BoQ
27	infectious diseases such	Provide training program of infectious diseases and health	Contractor	Ministry of Health/Local	Included in BoQ

No	Environmental Concern	Suggested Mitigation Measures	Implementing agencies	Responsible organizations	Cost (USD)
	as HIV/AIDS	and hygiene, for all the workers and local people, in cooperation with Health Center Provide voluntary counseling and HIV test		Authority	
28	Work Conditions including Work Safety	Prepare for Work Safe Plan based on the Rwandan laws and international standards such as OHSAS Provide safe goods such as masks and globes for workers Provide training programs of work safety in cooperation of District labor inspector, and organize regular meetings with workers in order to promote awareness of work safety	Contractor	REMA/ WASAC/ Districts	Included in BoQ
29	Accidents	Take countermeasures such as Disseminating information on constructing work schedule, installing fences between construction site and houses, and assigning a trained guard, in order to prevent accidents Assign a guard to guide traffic and install signboards, in order to prevent accidents between trucks and private passenger vehicle	Contractor	REMA/ WASAC/ Districts	Included in BoQ
30	Global warming	Conduct regular maintenance of heavy vehicles and trucks Prevent unnecessary idling of engine	Contractor	REMA/ WASAC	Included in BoQ

Source: Study Team

(12) Environmental Management and Monitoring Plan (implementation system, Methods, and Cost)

The following Environmental Management Plan and Environmental Monitoring Plan will be implemented in order to monitor mitigation measures before/during construction and during operation.

Table 1-16 Environmental Management (EMP)

Environmental concerns	Suggested mitigation measures	Responsible	Monitoring	Estimated Cost(US$)
CONSTRUCTION, OPERATION PHASES AND DECOMMISSIONING PHASES				
- Overall environmental management	- Designated an Environmental Supervisor to oversee environmental management, environmental training, and the implementation of environmental policies; - Appoint ESHS Manager in EPC contractor team to assist with sampling, monitoring and daily environmental compliance; - Provide environmental training to all employees.	WASAC Ltd Contractor	REMA/WASAC	Included in BoQ (15,000)
- Occupational health and Safety (OHS)	- The safety and sanitation plan is formulated and safety trainings are provided for workers - Ensure all employees have health insurance; - Provide workers and visitors with the necessary personal protective equipment (PPE); - First aid Kits	Contractor	REMA/WASAC/Districts	Included in BoQ (4,500)
- Child labour, forced labour and discrimination	– Protect workers' rights; – Establish, maintain, and improve the employee–employer relationship; – Promote compliance with national legal requirements and provide supplemental due diligence requirements where national laws are silent; – Comply with international Labour Organization, and the UNICEF Convention on the Rights of the Child, where national laws do not provide equivalent protection; – Protect the workforce from inequality, social exclusion, child labour, and forced labour;	Contractor	REMA/WASAC/Districts	NA
- High expectation of the local communities in relation to job posts	- Disclosure the exact number of jobs available, the applicable period and the remuneration to be allocated for each type of work; - Involvement of local leaders; - In the event there are local expectations for employment that cannot be met by the project, the limited availability of places should be made known to the interested parties through local authorities	Contractor	Local authorities WASAC	NA
- High expectations of getting great compensation in cases of resettlement	- Expropriation and compensation mechanisms should be implemented in all justifiable cases	WASAC Ltd	- WASAC - MININFRA, - Local authorities	RAP budget
- Conflicts among workers and the local population in the project area	- Keeping a good relationship with local communities - Establishment and implementation of set of rules for the workplace	Contractor and WASAC	Local authorities	Operational Cost
- Impacts on public utilities such as spring water/wells or water supply pipe and electrical cables	- Rehabilitation of affected structures and infrastructures; - Identification of new water source and construct alternative water spring.	Contractor and WASAC		Construction cost
- Risk of destruction or disruption of infrastructure and social and economic loss infrastructure	- Minimize the affected population by occasional changes in the route of pipelines; - Providing a due compensation in coordination with local authorities and project proponent;	WASAC Ltd	- Local authorities	Budget provided in RAP

Environmental concerns	Suggested mitigation measures	Responsible	Monitoring	Estimated Cost(US$)
- Health related issues due to dust emissions	- Use of wet processes; - Use of Personal Protective Equipment	Contractor	WASAC/Local authority	-
- Risk of increase of HIV/AIDS and other Sexually Transmitted Diseases	- Providing surveillance and active screening and treatment of workers - Providing health and hygiene training - Preventing illness among workers in local communities - Providing health services	Contractor	Ministry of Health/Local Authority	Included in BoQ (4,000)
- Gender based violence and sexual Exploitation and Abuse(GBV/SEA	- Preparation and implementation workers Code of conduct - Conduct GBV/SEA awareness	Contractor	WASAC/Local authority	Included in BoQ (3,000)
- Safety and security	- Install safety and warning signage as appropriate - Provide safety training to all workers	Contractor	WASAC, / Local Authority	Included in BoQ (2000)
- Soils erosion and compaction	- Restrict the activities to the minimum possible; - Use appropriate machinery and/or protective boarding during soil stripping; - Remove and stockpile topsoil, sub-soils and any parent material separately;	Contractor	REMA/WASAC	Construction cost
- Changes of landscape - Visual impact	- Rehabilitate working area with trees and grasses	Contractor	REMA/WASAC	Included in BoQ (2,000)
- Noise and vibration emissions management	- Restrict construction and operation of heavy machines to daylight; - Ensure noise emissions are kept within the Rwanda standards; - Reduce needed truck movements by careful planning of needs of construction material; - Regular and effective equipment maintenance in order to ensure all machinery is in good working order and use does not generate excess noise/vibration.	Contractor	- REMA; - WASAC, - Local authority	Operational cost
- Risk of Alteration of hydrology and wetland	- Watercourse crossing must be designed to avoid affecting the stability and long-term performance of riverbanks and flood defenses; - Consider the seasonal sensitivity of ecological resources when planning river crossings; etc.	Contractor	- REMA, - RWFA, - Local authority	Construction budget
- Disturbance of wildlife by noise	- Restrict construction activities and operation of heavy machines to daylight, when most wildlife is active and can react to noise.	Contractor	- REMA, - district	-
- Loss of vegetation cover and plant diversity	- Align the excavations to follow existing parallel water pipeline in order to minimize the loss of vegetation cover; - In areas of dense vegetation cover, the removal of vegetation must be restricted to the minimum necessary width; etc.	Contractor	REMA,/WASAC	-
- Disturbance and mortality of terrestrial fauna	- Restrict construction activities do the daylight; - Inspect the area to be cleared for any terrestrial fauna before bush clearing and digging; - Protect any trench left overnight with a net fence to block fauna from being trapped inside; - Capture and release fauna away from the direct influence zone (including species trapped in the trenches);	Contractor	- REMA, - Self-monitoring by WASAC	-
- Disturbance of ground Water Quality	- Consider measures to prevent pollution of ground water while designing the sludge storage site; - Storage site shall follow the appropriate regulation of Waste Management	Contractor	- REMA, - WASAC	-

Environmental concerns	Suggested mitigation measures	Responsible	Monitoring	Estimated Cost(US$)
Air Quality Management	- Minimizing dust from open area sources, including storage piles; - Managing emissions from mobile sources,	Contractor	- REMA, - WASAC	-
	- Dust suppression techniques should be implemented, such as applying water or non- toxic chemicals to minimize dust from vehicle movements,	Contractor	- REMA, WASAC	Included in BoQ (3,000)
	- Avoiding open burning of solid.	Contractor	REMA, WASAC	-
- Solid wastes management	- All the solid waste should be collected; the biodegradable organic material composted properly on site for manure production and the non-biodegradable disposed of in a public landfill; etc.	Contractor	REMA, WASAC	Included in BoQ (2,500)
- Management of Hazardous Materials and Oils	- Waste separation must be conducted on site; - Maintenance of trucks and machines should be done far from water sources	Contractor and WASAC	- REMA, - WASAC	-
Total estimated Cost				36,000

Source: Study Team

Table 1-17 Environmental Monitoring Plan (EMoP)

Environmental items	Monitoring item	Parameter /Indicator	Location	Frequency	Responsible	Budget
Pre-construction and site mobilization phase						
Land expropriation, compensation payment and other support	Compensation for land and houses lost	Number of houses expropriated Area of land expropriated	Project area	Once before construction	WASAC Ltd	RAP monitoring
	Priority in employment	Number of PAPs who receive support such as priority in employment	Project area		WASAC/ local government	RAP monitoring
	Complaints resolutions	GRM log book	Project area		Districts/GRM Committees	RAP monitoring
Air pollution	Equipment and automobiles in good shape	Number of Automobiles with certification on site		As appropriate	Contractor	No cost applicable to monitor.
Water pollution	Surface water quality	(temperature, pH, TSS, Turbidity)	Upper site/ lower site of the river	Once	Contractor	Included in BoQ (500US$)
Noise and vibrations	Noise and vibrations		WPT and 8 construction sites	Once	Contractor	Included in BoQ (1000US$)
Construction phase						
Accident and incident	Complaint (in general such as noise, traffic jam, and accidents)	Records of complaints	Project area		Contractor WASAC	Operational Cost
Air Pollution	Equipment and automobiles in good shape	Regular inspection and maintenance	WPT and 8 construction sites	Daily	Contractor	No cost applicable to monitor.
	Spraying of water to reduce dust.	Records on water spay Level of dust	WPT and 8 construc	Daily	Contractor	Operational cost

Environmental items	Monitoring item	Parameter /Indicator	Location	Frequency	Responsible	Budget
		(observation)	tion sites			
	Regular inspection of electrical installations, Fire extinguishers, water tanks	Number of fire extinguishers and water tanks Records of inspection	WPT and 8 construction sites	Quarterly through the construction phase	EPC contractor	Included in BoQ (150US$ / trip to inspection)
Water pollution	Surface water quality	temperature, pH, TSS, Turbidity	Upper site/ lower site of the river	Quarterly	Contractor	Included in BoQ (3,500)
Noise and vibrations	Restriction of noise/vibration emitting activities to working hours.	Noise level Vibration level	WPT and 8 construction sites	At the time of earth works or concrete vibrations.	Contractor	Cost of a sound meter level is about 350 US$. Vibration meter 500US$ (Included in BoQ)
Soil pollution	Check prevention measures of oil contamination	Keep records or not	WPT and 8 construction sites	Monthly	Contractor	Operational Cost
Soil erosion	Check the conditions of river bank and steep slope along the pipeline route	Keep records of conditions	Steep slopes 6 river crossing places	Monthly	Contractor	Operational Cost
Waste	Management of excavated soil Management of concrete debris and others	Reuse or not Proper management or not	WPT and 8 construction sites	Monthly	Contractor	Operational Cost
Ecosystem	Reforestation to offset lost grasses and trees Management of top soil	Number of planted hectares (ha) Number of trees planted	WPT and 8 construction sites	Every quarter of a year	Communities/Districts/ Contractor	Operational Cost
Work conditions	Occupational Safety and Health plan	Availability of OHS Plan		Quarterly through the construction phase.	Contractor	Operational Cost
	Meetings and trainings	Number of meetings and trainings				
	Safety gear for workers	Number of workers with safety gear	WPT and 8 construction sites			
	Noise and vibrations	(from noise and vibrations)	WPT and 8 construction sites	(from noise and vibrations)		
	Occurrence of accidents and injuries	Records of accident and injuries	Project area	Monthly		
Accident/ Traffic congestions	Traffic management Plan and traffic signage	Availability of TMP Number of	Project area	Monthly	Contractor	Operational Cost

Environmental items	Monitoring item	Parameter /Indicator	Location	Frequency	Responsible	Budget
		traffic signage				
HIV and other diseases	Health and sanitation for labor workers	Number of trainings		Quarterly through the construction phase.	Contractor	Operational Cost
Water use	Check springs and well along the construction route	Conditions of springs and wells	Targets springs and wells	Quarterly through the construction phase.	Contractor Community/ Local government	Operational Wells
Gender	Preparation and implementation workers Code of conduct	Availability of code of conduct	Project area	Quarterly through the construction phase.	Contractor	Operational Cost
	Conduct GBV/SEA awareness	Number of events		Quarterly through the construction phase.	Contractor	Operational Cost
Child and forced labour	Minimum working age and working condition	Employment record by age	Construction areas	Monthly	Contractor /Local government	Operational Cost
Operation phase						
Noise and vibrations	Noise/vibrations	Noise and Vibration level records	WPT	Once/year	WASAC	Operational cost
	Total cost for monitoring					5,850 US$

Source: Study Team

(13) Stakeholder Meetings

Stakeholder meetings were organized three times, (a) at the time of scoping, (b) before socio-economic and inventory survey started, and (c) after Draft of EIA report/RAP was prepared.

(a) Scoping

The EIA/RAP survey team visited the following organizations concerned in order to explain the Project, while collecting necessary information and data.

- Ministry of Environment,
- Ministry of Land and Forestry
- Rwanda Land Management and Use Authority
- Rwanda Water and Forestry Authority;
- Rwanda Environment Management Authority (REMA)
- Rwanda Development Board RDB
- Water and Sanitation Corporation (WASAC)
- Kigali City Council
- Gasabo District and Nyarugenge District

Before public consultation meetings, the survey team visited Sectors and Cells concerned in order to explain the outline of the Project, EIA/RAP survey, schedule, and public consultation meetings.

Public consultation meetings were organized by WASAC at each Sector. The date and venue of the meetings were arranged, according to the schedule of community meetings (Tuesday afternoon) as much as possible, based on the advice of Sectors/Cells. The information on the Project and consultation meetings were disseminated by community leaders and through monthly community activities.

The main agenda of the first consultation meetings were (a) project outline, (b) outline of EIA and RAP survey and its schedule, (3) future plan including cut-off date. The outline of the first consultation meetings are summarized below.

Table 1-18 Outline of First Consultation Meetings

Dates	Sector	Venue	Number of participants	Category of Participants
Tuesday January 9th, 2018	Gatsata	Nyamabuye cell	82	WASAC Representative Nyamabuye Cell local Leaders Nyamabuye local community
	Kigali	Nyabugogo Cell	41	WASAC Representative Nyabugogo Cell local Leaders Nyabugogo local community
Tuesday January 16th, 2018	Kanyinya	Nyamweru Cell	90	WASAC Representative Nyamweru Cell local Leaders Nyamweru local community
Saturday January 27 th,2018	Gisozi	Ntora Cell	92	Representative of Ruhango cell-Leaders of four villages Community of four villages

Source: Study Team

Questions and Answers at the meetings are summarized below.

Table 1-19 Questions and Answers

No	Names	Questions/Suggestions	Responses
Nyamabuye cell in Gatsata sector, Tuesday January 9th, 2018			
1	- How many sectors will the pipeline cross?		-The proposed pipeline will be installed in four sectors, Kanyinya and Kigali in Nyarugenge, Gatsata and Gisozi in Gasabo District.
2	-Will the pipeline cross through private properties? If so, is there compensation planned for?		- The project is designed to avoid private houses but if structures will be affected, adequate compensation will be provided
3	- It seems that there are many organizations involved in the Project, and which organization is responsible for compensation issues? To witch institution shall we send our complaints?		-WASAC Ltd is the implementing agency and will be responsible institution to provide compensation but will work with district, sector, cells and resettlement committees.
	- When assets valuation will start		- There will be a cut-off date that will be agreed on and announced to the population properly. This means that every asset putted after the cut-off date will not be considered.
4	During the previous projects, our land was valued and was marked at zero (0) on the certificate, and we couldn't get compensation for lost land. How the Project will value the land?		The consultant explained that the 0frw marked to land titles is related to Taxes but in Compensation the value of land is calculated based on the full replacement cost of market value. Anyone who owns a land which does not have up to one ha (1ha) and is for agriculture does not pay taxes but when the land is affected the person receives compensation.
5	-There is a pipeline from Yanze river that have exploded and the water destroyed the bridge		- WASAC Ltd Representative promised to check the issue and work with the maintenance department to address the

No	Names	Questions/Suggestions	Responses
			problem.
Nyabugogo cell in Kigali sector, Tuesday January 9th, 2018			
1	-We are currently working on government land, and what will happen during the valuation?		-During Valuation people will have to provide evidences of assets ownership. It is necessary to search for documents before.
2	- Have you already planned where people will relocate after the expropriation?		- The installation route will be finalized, avoiding expropriation as much as possible, thus not many people will be expropriated
3	- After the construction works will people continue to use their land?		- The consultant replied that during construction works, they will need buffer zone but after the construction other works will continue as usual.
4	- Some have assets on the land which they lease, and they don't have ownership certificate what laws says about it?		- Land law says that in case of project implementation, assets on land are compensated to its owner.
5			- The consultant also mentioned that there is a cut-off date that will be announced, thus any assets that will be added after the cut-off date will not be evaluated. He mentioned also that everyone who has land must provide the proof of ownership
Nyamweru Cell, Kanyinya sector, Tuesday January 16th, 2018			
1.	We have a local market here, what about the pollution during the construction work?		Construction works could probably have impacts like pollution which will be analyzed during the studies that will be conducted.
	We are being asked taxes buy the owner of the plot and we wonder who will be compensated if the market is affected?		The compensation will be provided to land owners but if there an agreement with users then the compensation of assets will be provided to the person who owns these assets
2	We are renting the ground to use for driving exercises, is there any compensation provided?		During assets valuation, the income loss will be also considered.
Meeting with communities in Ruhango, Gisozi Sector , January 18, 2018			
1.	We think the other planned meetings should be done in each village, so that all people concerned could be aware of the Project.		The consultant agreed with that and he also mentioned that this was an introduction meeting and further meeting are planned.
2.	When do you think the Project should start?		WASAC representative said that the Project is planned to start in 2019. The consultant added also that survey and assets inventory should start as soon as possible on 1st February 2018

Source: Study Team

(b) Before Socio-Economic and Inventory Survey

Before the socio-economic and inventory survey, the second public consultation meetings were organized. The information on the public consultation meetings were disseminated through the census survey, conducted by the survey team and Cell, and monthly community activities.

Participants of the second public consultation meetings were Cell officers in charge, community leaders and project affected people. The main agenda of the meetings were the Project outline, the outline of socio-economic and inventory survey, future schedule and cut-off date.

The date and participants of the second public consultation meetings are summarized below.

Table 1-20 Public Consultation Meetings before socio-Economic and Inventory Survey

Dates	Sector	Venue	Number of participants	Category of Participants
Tuesday February 6th, 2018	GATSATA	NYAMABUYE cell	12	BESST LTD Team Nyamabuye Cell Leaders Nyamabuye local community
	KIGALI	Nyabugogo Cell	9	BESST LTD Team Nyabugogo Cell local Leaders Nyabugogo local community
Wednesday 7th, 2018	KANYINYA	Nzove & Nyamweru Cell	18	BESST LTD Team Nyamweru Cell local Leaders Nyamweru local community
Thursday 8th,2018	GISOZI	Ntora Cell	16	Representative of Ruhango cell-Leaders of four villages Community of four villages

Source: Study Team

Table 1-21 Questions and Answers

No	Question/comments	Answers provided by consultant
Consultative meeting in Nyamabuye Cell, Gatsata cell		
1	How are we going to know the value of our properties?	WASAC will hire an independent valuer who will agree with assets owner the compensation value.
2	When the Project implementation will start so that we can plan for our agriculture activities?	It is expected that construction will start in 2019; however, upon the completion of final design studies, farmers will be informed of the construction schedule.
3	Will the Project gives us the jobs or it will use machines?	Though some activities will require the use of machines, other works will be done by workers and affected people will be given priority.
4	How you can make sure that locals are provided with jobs?	First of all, locals will be provided with information on employment, and then during the preparation of construction contract WASAC shall emphasize priority for employment to local residents/communities.
Consultative meeting in Nyabugogo Cell, Kigali Sector		
1	Sometimes the compensation amount for lost land is not enough to buy another land. What are you planning to address this issue?	There will be compensation for land owners and a special attention will be paid to those who are going to lose government land. For the person who disagrees with the value assignment to his/her property, a grievance mechanism will be prepared.
2	When are we going to get results of your data collection?	This exercise is the initial identification of assets and PAPs and results will be included in RAP report which will be made public. However a final asset valuation will be conducted and every PAP will sign on the valuation form after verification of his attest and its value
3	The land where beacons have been installed is the targets of land acquisition?	Beacons were used for land survey and will be used for assets inventory.
4	Will farmers allowed to continue to use the land after pipe installation.	Yes; however, the land will be used under conditions and no permanent structure may be allowed. Again the land above the pipe is not allowed to conduct activities but other areas can be used.
5	What about the water point	The installation of transmission pipeline will not affect the water

No	Question/comments	Answers provided by consultant
	(springs?). They may be affected?	resources because even the first pipe did not affect then. However, the final design will consider the location of water source.
6	One PAPs wanted to know the size of his land that will be taken.	All affected land plots will be measures and communicated to land owners but in general land with 9m in width will be required during contraction for excavation but also access roads.
Consultative Nzove and Nyamweru Kanyinya sector		
1	Will our land be taken without compensation?	Private land will be compensated and care will be taken to the ones who will lose government land.
2.	What kind of compensation will be provided for us?	Compensation measures will be provided based on eligibility criteria and the nature of impact and the compensation may include land for land compensation or monetary compensation. Especially for crops and trees.
3	When shall the construction start?	The final date for construction is not yet fixed but construction works are expected to start in 2019. Farmers will be informed about construction schedule in due time.
4	If one people has two plots in targeted area marshland will be counted two times?	If the land is for the same use and fall in the same category these areas are to be summed up in order to avoid double counting.
5	We cannot be against public interest; however, what support are we going to receive from the government?	Compensation will be provided for the affected people and job opportunities will be provided during construction.
Consultative meeting at Ntora, Gisozi Sector		
1	We were living on our land. What support do you provide for us when the Project starts?	Owners of private land will be compensated for the loss of land and their assets. Those who live by cultivating government land in the affected areas will be considered for different supports and follow up their living conditions
2	If 9m will be required it's likely that some structures will be affected. If that is the case, what compensations will be provided?	The assets inventory survey will identify both land, crops, trees but also structures that will be affected and adequate compensation will be provided in accordance with laws.
3	The land of Road reserve has been regarded as government land but we have not received any compensation. What will happen to this portion of land when the Project starts?	The land law is clear that any land to be transferred from private to public land should be compensated. What is required is to present ownership documents.

Source: Study Team

(c) After Draft /RAP prepared

The third consultation meetings were organized at 4 Sectors. Through socio-economic and inventory survey and monthly community meetings, the information on the third consultation meetings was disseminated.

The main agenda was the result of EIA and RAP survey, eligibility and calculation methods of compensations, proposed grievance redress mechanism, and future plan. The outline of the third consultation meetings were summarized below.

Table 1-22 Third Consultation Meetings

No.	Issues	Response
Meeting in Kigali sector, 17/04/2018		Number of participants: 27
1	In the past we have seen some problems of compensation that comes after valuation and are either related to construction activities or consequence of poor water drainage. Is there any mechanism to address these issues?	If there is a new compensation issue that were not identified before or any issue that is caused by projects after construction, the resettlement committee will work with local Authority and WASAC to address the issue.
2	When the construction works will start?	Construction works are expected to start in 2019 but people will be informed in due time.
3	-After assets inventory what are the next steps?	A final valuation will be done and compensation shall follow before and physical works
Meeting at Kanyinya Sector, April 24th, 2018		Number of participants: 31
1	Some people have the trees and crops in government land. How they will be compensated?	Trees and crops on government land will be compensated but the land is not compensated because in the government properties.
2	Is there any special attention to vulnerable people?	Vulnerable people identified by project will be given priority in employment and special follow up during compensation process.
3	What kind of compensation is provided for land?	The expropriation law provides both monetary and in kind compensation. However, due to the lack of free land in Kigali, the cash compensation is likely to be the only alternative.
Meeting in Gisozi Sector, April 28, 2018		Number of participants: 31
1	How about people who have assets in Government Land and who don't have its land title?	The land itself will not be compensated, and only assets on the land will be compensated to its owners.
2	What will be done if the access road destroys some infrastructures?	Infrastructures that will be affected will be compensated.
3	What will happen if the pipeline passes through someone plots and she/he cannot use the rest of the plots?	The pipeline line route was selected to minimise the affected areas as much as possible, especially in residential area. However if the installation of pipe affects the use of the entire plot of land, the whole plot will be compensated
4	How large is the protective strip, in case we would like to put some infrastructures near our home or in case there would be pipe leakage? I would like to know if there are no negative effects of the Project.	The size of the land that will be required for construction work is about 9m in width at the marshland without access roads; however, after construction land of about 2m in width will be required, where pipe is installed and used for maintenance purpose.
5	What will happen if crops that were identified in assets inventory are harvested before the final valuation?	The final valuation will be done on assets found on the land during valuation period. If crops are harvested before valuation, then there will be no impacts on these crops
6	What will happen if someone is not happy with the compensation cost?	Grievance redress mechanism will be established according to the expropriation law, and those who are not satisfied with the compensation amount can express his complaints and hire his own valuer.
7	What will happen to people who have not received land title?	People are encouraged to request land titles because all land in Kigali and elsewhere in the country have been registered and the compensation law requires land title or

No.	Issues	Response
		any other written documents issued by authority
Meeting in Gatsata sector, May 8, 2018		Number of participants: 42
1	What happen if people are not around during valuation?	If the land owner is not around during land valuation, the valuer carries out the valuation in the presence of local authorities.
2	What will happen to people who have not received land title?	People are encouraged to request land titles because all land in Kigali and elsewhere in the country have been registered and the compensation law requires land title or any other written documents issued by authority
3	What will happen to people who have not received land title?	People are encouraged to request land titles because all land in Kigali and elsewhere in the country have been registered and the compensation law requires land title or any other written documents issued by authority

Source: Study Team

1-3-1-2 Land Expropriation and Resettlement

(1) Necessity of Land Expropriation and Resettlement (Alternative Analysis)

(a) Project components which causes land acquisition

The following project components causes land acquisition and compensation for trees and crops.

- Installation of transmission pipeline from Nzove WTP to Ntora Reservoir
- Excavation for installing transmission pipelines (2.0 m to 4.0 m in width)
- Temporary construction road (4 m in width)

(b) Plan to minimize the area for land acquisition

As summarized in Table 1-9 Result of Alternative Analysis of Transmission pipeline Installation Route, land acquisition is one of items to be considered to select the most appropriate route. The selected route, which passes through the wetland, increases the area of land acquisition. However, the rate of the government land is large and this could keep the compensation amount inexpensive. However, farmers will lose a part of farmland, and this will affect their income from farming activities. One of the purposes of the socio-economic survey is to estimate the impact of the Project on the income of the farmers.

As mentioned before, the width of the excavation area along the paved road in Ruhango Cell was decreased fro ㎡.7 m to 2.0 m in order to minimize the area of the land acquisition.

(2) Legal and Institutional Framework

(a) Laws and Regulations related to land expropriation and resettlement

National Land Policy, 2004

Its main objective is to put in place and operationalize an efficient system of land administration and land management that secures land ownership, promotes investment in land for socio-economic development and poverty reduction.

According to the National Land Policy, all Rwandese enjoy the same rights of access to land,

without discrimination against women or any other vulnerable persons. All land must be registered for security. The National Land Policy specifies that marshlands are a special category of public land and their use, for those earmarked for it, must be done in the form of concession.

No. 03/2013/ Organic Law of 16/06/2013 Repealing No. 08/2005 Organic Law determining the Use and Management of Land in Rwanda

In 2013, it replaced No. 08/2005 Organic Law. The law states that the land is part of the public domain of all Rwandans. The State guarantees the right of people to own and use the land; however, also has the right to order expropriation in the public interest.

The law also categorizes the land by the type of use and ownership.

LAW No. 18/2007 Relating to Expropriation in the Public Interest

This law determines the procedures relating to expropriation of land in the interest of the public. The law stipulates that the government has the authority to carry out expropriation. However the Project, at any level, which intends to carry out acts of expropriation in public interest, shall provide funds for inventory of assets of the person to be expropriated.

The procedures of land expropriation stated in the law are shown below.

1. Prepare for application for expropriation which includes the following contents

- the description of the project proposal;
- the indication that the project is aimed at the public interest;
- the land master plan on which the project shall be carried out;
- the document indicating that the project does not degrade the environment;
- proof confirming the availability of payment of the compensation;
- the explanatory note to verify that such a land or place suits the project;
- The minutes indicating that the concerned population was sensitized about the importance of the project

2. Examine the proposal by relevant Land Commission
3. the relevant Land Commission shall request, in writing, the District authorities concerned to convene a consultative meeting (within 30 days)
4. The relevant Land Commission shall take a decision within a period of at least fifteen days
5. The decision the relevant Land Commission takes shall be open to public at offices where the land is located and by radio and newspaper (within 30 days)
6. the relevant commission shall publish and post an actual list of beneficiaries of the activities
7. Value the land and assets
8. Implement land expropriation

Law N°55/2011 of 14/12/2011 Governing Roads in Rwanda

The law stipulates the road reserve for National Roads, demarcated by two parallel lines at twenty 22 meters on both sides of the road from the median line. The road reserve for Districts and City of Kigali is delimited by two parallel lines at 12 meters on both sides of the road from the median line.

(b) Comparison between JICA Guideline and Rwandan Laws and Regulations

The result of the GAP analysis between the JICA Guideline and Rwandan laws and regulations is summarized in the table below.

Table 1-23 Comparison between JICA guideline and Rwandan Laws and Regulations

JICA Guideline/ Word Bank safeguard policy	Rwandan laws and regulations	Gaps	actions to be taken for filling the gap
After the disclosure of the scoping drafts, project proponents etc. conduct consultations with local stakeholders. JICA incorporates the results of such consultations into its TOR. The consultations cover the needs of projects and the analysis of alternatives. (JICA GL)	Under the process of scoping, local governments and community are requested to review Project Brief and send comments to RDB.	The Rwandan EIA guideline requires local governments and community only to review Project Brief and to comment on it.	According to the JICA guideline, local consultation meetings will be organized before finalizing the TOR.
Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Expropriation as provided for under this Law shall be carried out only in the public interest and with prior and fair compensation. (Chap1 Article 2)	No similar provisions in the expropriation law; however, under the Rwandan EIA guideline, alternatives area analyzes.	Alternatives are analyzes, regarding the involuntary resettlement and loss of means of livelihood
When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Expropriation as provided for under this Law shall be carried out only in the public interest and with prior and fair compensation. (Article 3)	In Rwanda loss of income and compensation of illegal occupants is not provided	Compensation for standing crops of illegal occupants shall be considered.
People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	Affected person receive fair and just compensation. However a ministerial order gives the value of land and crops. (Article 23)	In Rwanda loss of income is not provided.	Priority for job of construction work will be considered for those who will lose a part of income sources

JICA Guideline/ Word Bank safeguard policy	Rwandan laws and regulations	Gaps	actions to be taken for filling the gap
Compensation based on the full replacement cost must be provided as much as possible (JICA Guideline).	Compensation shall be calculated on the basis of their size, nature and location and the prevailing market rates. The compensation for disruption caused by expropriation to be paid to the expropriated person shall be equivalent to five percent (5%) of the total value of his/her property expropriated.	The Rwanda Expropriation law does not mention the replacement cost.	Compensation based on the market value such as materials and labor cost without depreciation, and disturbance allowances as 5% of market value were used. The proposed price for the real property will be made close or equal to replacement value, referring to the recent data of the transaction in land. Transaction tax and commission fee shall be added as compensation.
Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Rwanda expropriation law stipulates a timeframe upon when the property to be expropriated must be handed over which is 120 days after compensation has been paid. (Article 36)	JICA GL does not specify the period of payment and assistance.	Compensation and other kinds of assistance must be provided prior to displacement, as JICA GL states.
For projects that will result in large-scale involuntary resettlement, a Resettlement Action Plan (RAP) must be submitted and made available to the public. (JICA GL)	The necessary documents, which contain such information as the outline, environmental and socio-economic impact, and concerned people's understanding of the project, along with the application shall be submitted to the competent authority for approval the law. (Article 10)	The Rwandan laws do not stipulate the RAP; however, donor agencies in general recommend preparing for RAP.	ARAP will be prepared and open to public on the WASAC website and at offices of local governments.
In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL) When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	The relevant committee in charge of monitoring projects of expropriation in the public interest shall consider the relevance of the project within a period not exceeding thirty (30) days after receiving the request for expropriation and shall conduct a consultative meeting with the population living where the land is located concerning the relevance of the project of expropriation in the public interest. The committee shall inform them about the date, time and venue of that meeting. (Article 11)	Both JICA GL and Rwandan law require consultation with affected people with enough information	For the preparation of the RAP, consultation meetings will be organized and sufficient information will be provided in the local language.

JICA Guideline/ Word Bank safeguard policy	Rwandan laws and regulations	Gaps	actions to be taken for filling the gap
Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. (JICA GL)	Under the expropriation law, The relevant committee in charge of monitoring projects of expropriation shall conduct a consultative meeting with the affected population. (Article 11, 12, 13)	Under the expropriation law, consultative meeting shall be conducted; however, promoted in the beginning stage.	Consultation meetings will be organized in the planning process for RAP preparation.
Appropriate and accessible grievance mechanisms must be established for the affected people and their communities (JICA GL)	The expropriation law provides for rights of persons to be expropriated and stipulates the process for redress of problems with expropriation decision by the affected persons (Article 18, 19, 20 of Section 3) Article 18 also guarantees the right for appeal and provides for the mechanism for appeal for any person affected by the decision on expropriation in the public interest.. Any person to be expropriated who is not satisfied with the assessed land and property value shall indicate in writing grounds for his/her dissatisfaction with the valuation report. (Article 33 and 34)	No gap	Grievance Redress Mechanism will be established, according to the land expropriation l
Upon identification of the need for involuntary resettlement in a project, the census survey should be conducted, to determine who will be eligible for assistance, and to discourage inflow of people ineligible for assistance (WB OP4.12)	The census shall be conducted after the application is approved in the public interest. The census and asset inventory survey is implemented after the announcement of the decision.	The census and asset inventory survey shall be conducted after the application under the Rwanda Expropriation law.	Census survey shall be done upon identification of the need for involuntary resettlement in a project under the preparatory survey, and to be updated by final valuation stage.
The socio-economic studies should be implemented in the early stages of project preparation and with the involvement of potentially displaced people. (WB OP4.12)	The Rwandan expropriation law requires the census and asset inventory survey.	The census and asset inventory survey shall be conducted after the application for land expropriation is approved.	Socio-economic survey shall be done under the preparatory survey, and to be updated by final valuation stage.

JICA Guideline/ Word Bank safeguard policy	Rwandan laws and regulations	Gaps	actions to be taken for filling the gap
Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12)	Under the Rwanda Expropriation law compensation is limited only those land titles and or recognizable customary or written evidence of land ownership, persons recognized as legal occupants and owners of the expropriated land and property.	The World Bank OP4.12 policy is much broader and includes both legal and illegal occupants of the land.	Compensation for structures, trees, perennial crops, and standing crops of illegal occupants shall be considered.
Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Fair compensation can be paid in monetary form in the Rwandan currency or in any other form mutually agreed upon by the expropriator and the person to be expropriated. (Article 35)	The Rwanda Expropriation law confirms Land for land compensation.	In Kigali, where land is a limited resource, it is very difficult to implement land for land compensation, so compensation will be paid in cash.
Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	There are no explicit support for transition period and livelihood restoration	There are no explicit supports for transition period and livelihood restoration.	Compensation for one year crop will be paid as a compensation for loss of income for one season. For some farmers who lose a part of income, priority for job will be provided.
Special attentions must be given to the vulnerable social groups including women, indigenous peoples, persons with disabilities, and minorities when implementing cooperation projects (JICA Guideline)	No mention	There could be vulnerable groups in the project area	Special attention will be paid to vulnerable groups.

Source: Study Team

Under the Rwandan laws and regulations, compensation for loss of income is not mentioned, when the farmland owned by the government is the target of the land acquisition, even though farmers can receive compensation for trees and perennial crops. If the result of the socio-economic survey reveals that there are PAHs whose income from farming activities is seriously affected, supporting measures would be examined.

(3) Scale and Scope of Land Acquisition and Resettlement (including the result of Census, Socio-economic, and Inventory Survey)

1) Result of Socio-Economic Survey

Project Affected Households and People

The census survey was conducted on the latter half of January, 2018, based on the discussion

with Sectors and Cells concerned, in order to identify PAHs. After the socio-economic survey, some households fell outside the scope of the Project based on the second land measurement, while additional households and corporations were identified as PAHs late in the survey period. These Households and corporations were not the targets of the socio-economic survey. The number of households and corporations, who are affected by the Project, were shown by Cell in the table below.

Table 1-24 Project Affected Households, People and Corporations by Cell

PAHs

District	Sector	Cell	Identified before Socio-economic survey		Identified later in the survey (no Socio economic survey)		total
			Own a part or whole land plots	Cultivate government owned land	Own a part or whole land plots	Cultivate government owned land	
Nyarugenge	Kanyinya	Nzove	6		1		7
		Nyamweru	5		1		6
	Kigali	Nyabugogo	10	1	3	3	17
Gasabo	Gatsata	Nyamabuye	2		4		6
		Nyamugali	0	5	8		13
	Gisozi	Ruhango	29		5	1	35
total			52	6	22	4	84

Source: Study Team

PAP

District	Sector	Cell	Identified before Socio-economic survey		total
			Own a part or whole land plots	Cultivate government owned land	
Nyarugenge	Kanyinya	Nzove	20		20
		Nyamweru	23		23
	Kigali	Nyabugogo	37	9	46
Gasabo	Gatsata	Nyamabuye	14		14
		Nyamugali		23	23
	Gisozi	Ruhango	164		164
total			258	32	290

Source: Study Team

Corporations

District	Sector	Cell	Identified before Socio-economic survey		Identified later in the survey	total
			Target of socio-economic survey	Rejected the survey		
Nyarugenge	Kanyinya	Nzove	1		1	2
		Nyamweru		1		1

District	Sector	Cell	Identified before Socio-economic survey		Identified later in the survey	total
			Target of socio-economic survey	Rejected the survey		
	Kigali	Nyabugogo	1		1	2
Gasabo	Gatsata	Nyamabuye				
		Nyamugali				
	Gisozi	Ruhango	4	1	1	6
		total	6	2	3	11

Source: Study Team

Economic Activities and Expenditure

Family members who earn incomes were asked about the income and income sources (if they have plural income sources, the highest and second highest income sources were mentioned). Some or respondents rejected to answer. The result is shown in the table below.

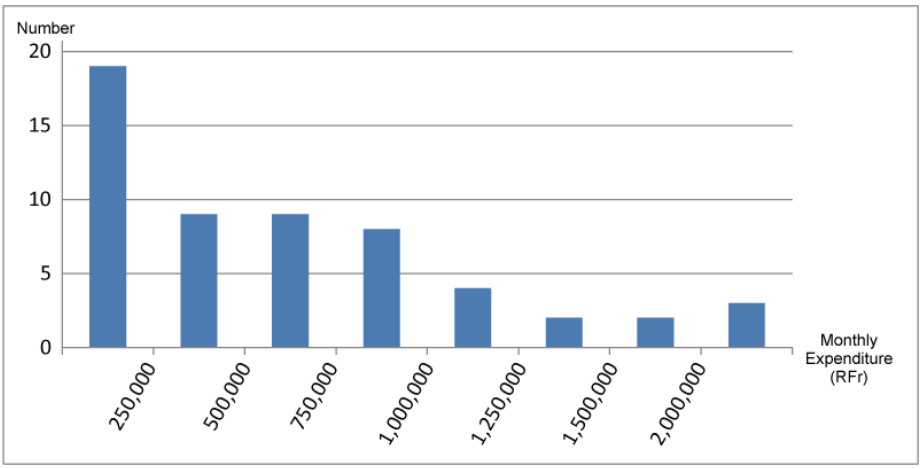
Table 1-25 Main income sources by Sector

Level of the activities	Number of family members	Percentage
Agriculture	20	18%
Livestock	8	7%
Construction	1	1%
Manufacturing	1	1%
Commercial	33	29%
Trading	1	1%
Financial	5	4%
Transportation	3	3%
Government	11	10%
Education	1	1%
Professional	9	8%
Others	21	18%
Total	114	100%

Source: Study Team

The number of households who depend on the income from agriculture is 10. The income level varies. Some household manage a large scale farmland, others cultivate a small farming plots.

In Rwanda, household expenditure is used as an indicator showing household income level. The distribution of the monthly household expenditure of 52 households is shown below. The median household expenditure is RF 505,175.



Source: Study Team

Figure 1-16 Distribution of Monthly Household Expenditure

2) Cut-off Date

The cut-off date is the date on which assets inventory starts and for the Project the provisional date was fixed on February 1st, 2018 the date on which field survey started.

However, this date is provisional and may be revised depending on the progress of the Project and a new date will be required if the Projects delayed.

(4) Compensation and Support Policies (including eligibilities and calculation methods)

The targets of compensations are categorized, as shown below.

1) Permanent Loss of Land

- Private land with land registration

The target land plots for land expropriation are categorized into 2 groups, permanent loss of land and temporary loss of land. The plots of land where the transmission pipeline will be installed are permanently expropriated. The area is 3.0 m in width at the wetland and 2.0 m in width in the residential area in Ruhango Cell.

According to the land expropriation law in Rwanda, market value plus 5% of disturbance allowances will be arranged as compensation for the loss of registered land. The asset valuation methodology, whereby the proposed price for the real property is close or equal to replacement value including the tax and registration fee, was used, referring to the recent actual price data. For those who use plural plots of land, compensation for the loss of only registered land will be arranged.

- Government owned farmland

There are 9 households who cultivate government owned farmland. They are allowed to use government owned land, on the conditions that they have to return to the state when the land is the target of land expropriation by public project. They cannot get the compensation for the loss of the land; however, compensation for trees and perennial crops will be arranged.

2) Temporary Loss of Land

The targets of the temporary loss of land will be used as temporary construction road and are mainly located in the wetland and steep slope. The area of the land is about 5.0 m in width. The temporary loss of the land is not the target of compensation under the Project by WASAC.

The whole project schedule is about two years and three months; however, the schedule of construction work at each site is about 3 months and farmers would lose the income opportunity for one season. For the temporary loss of the land, compensation for annual crops as the compensation for income loss (compensation for trees and perennial crops are arranged in general as the compensation for loss of assets).

The number of land plots, which are the targets of land expropriation, is 147 in total. All the plots are registered. The number of targets land plots is shown, according to their locations and purpose of use. The left end column shows the area of the affected land.

Table 1-26 Number and Area of Targeted Land Plots for Land Acquisition by Location and Purpose of Use

DISTRICT	SECTOR	CELL	Number of HHs	Number of plots affected		Size of affected land (㎡)
Gasabo	Gatsata	Nyamabuye	6	Cultivate land	7	1,841
				Business/commercial	2	1,323
		Nyamugari	8	Cultivate land	22	6,174
	Gisozi	Ruhango	46	Cultivate land	26	7,585
				Housing plot	21	373
				Business/commercial	6	144
Nyarugenge	Kanyinya	Nyamweru	7	Cultivate land	6	1,621
				Housing plot	3	116
				Business/commercial	1	378
		Nzove	9	Cultivate land	14	6,397
				Housing plot	0	0
	Kigali	Nyabugogo	19	Cultivate land	28	10,936
				Housing plot	5	3,061
				Business/commercial	6	437
	Kimisagara	Kimisagara	*0	Cultivate land	1	280
Grand Total			**95**		**148**	40,665

*: User of the land is counted at Nyamweru Cell, because they do business there
The targeted land plots are summarized according to the ownerships. The left end column shows the total area of the permanently lost land.

Source: Study Team

Table 1-27 Targeted Land Plots by Ownership

District	Sector	Cell	Size of affected land (㎡)			Permanently affected land (only private land) ㎡
			Government land (㎡)	Private land (㎡)	Total	
Gasabo	Gatsata	Nyamabuye	2,680	484	3,164	157
		Nyamugali	3,933	2,242	6,174	445
	Gisozi	Ruhango	2,563	5,539	8,102	2,392
Nyarugenge	Kanyinya	Nzove	864	5,533	6,397	718
		Nyamweru	98	2,016	2,114	723

District	Sector	Cell	Size of affected land (㎡)			Permanently affected land (only private land) ㎡
			Government land (㎡)	Private land (㎡)	Total	
	Kigali	Nyabugogo	11,769	2,664	14,433	1,510
	Kimisagara	Kimisagara	280		280	-
Total			22,187	18,478	40,665	5,946

Source: Study Team

The number of PAHs, land plots and area of permanent and temporary loss of private land is summarized below.

Table 1-28 Permanent Loss of Private Land

District	Sector	Cell	Affected HHs	Number of plots affected	Size of land affected (㎡)
Gasabo	Gatsata	Nyamabuye	5	5	157
		Nyamugari	5	7	445
	Gisozi	Ruhango	40	47	2,392
Nyarugenge	Kanyinya	Nyamweru	7	8	718
		Nzove	9	12	723
	Kigali	Nyabugogo	14	21	1,510
Grand Total			80	100	5,946

Source: Study Team

Table 1-29 Temporary Loss of Private Land

District	Sector	Cell	Affected HHs	Number of plots affected	Total size of land affected(㎡)
Gasabo	Gatsata	Nyamabuye	6	6	327
		Nyamugari	8	10	1,797
	Gisozi	Ruhango	40	47	3,147
Nyarugenge	Kanyinya	Nyamweru	7	8	4,815
		Nzove	9	12	1,293
	Kigali	Nyabugogo	14	21	1,477
Grand Total			84	104	12,855

Source: Study Team

3) Compensation for Loss of Assets

The assets which are the targets of compensation are structures such as houses and fence, trees and perennial crop.

- Structures

Dozens of structures are the target of land expropriation. The location map and list of targeted structures are shown below. The compensation rate is decided, according to the type of structure, considering full replacement cost, including the cost of materials and labors.

Referring to the project by World Bank, Development of Urban Infrastructure in six Secondary Cities of Rubavu, Rusizi, Musanze, Muhanga, Huye and Nyagatare of Rwanda, and the City of Kigali, if the area of the expropriated house or premises is more than 20% of the total area, the house is regarded as the targets of resettlement. As a result, two houses are regarded as the targets of resettlement. Resettlement price is defined by the following.

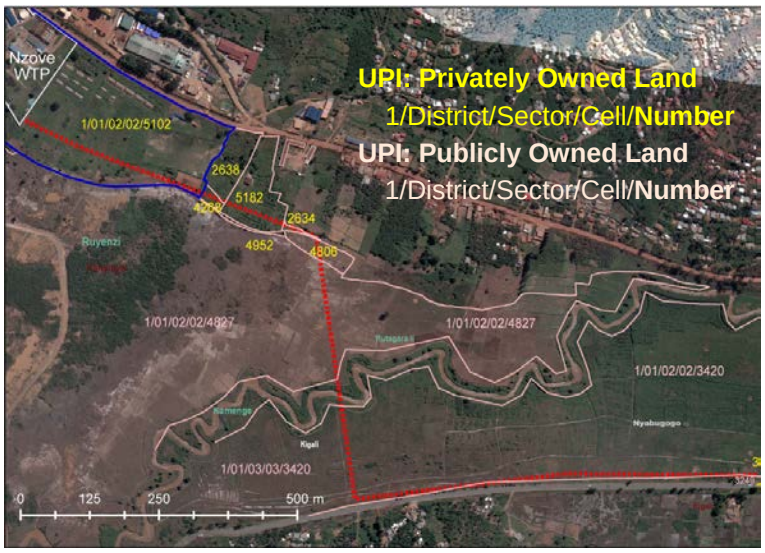
Resettle price is cost to reacquire the affected asset and the resettlement price calculated before relocation without subtracting taxes or fees for depreciation and transactions.

In Rwanda's domestic law, compensation is assessed as follows.

- Assess price for the real property owned at fair market price according to laws and regulations.
- Compensate price for the real property which added disturbance allowances as 5% in accordance with the law.

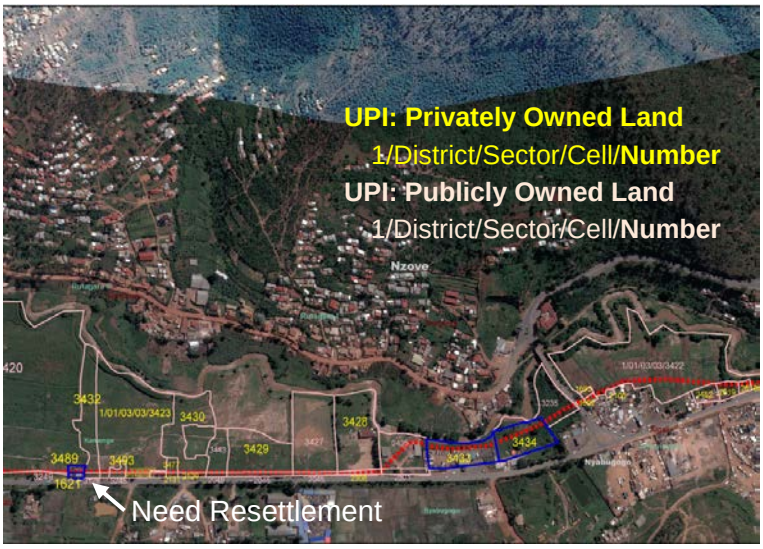
In this case, the domestic law of Rwanda is not described whether depreciation is provided or not. Therefore, even if there is an additional 5% of disturbance allowances, it can not be confirmed whether it is possible to compensate with resettlement price to reacquire the real property. In assessing the amount of compensation based on Rwanda's domestic law, compensation price is calculated without depreciation. Compensation price is calculated including taxes and fees on transactions, and added 5% of disturbance allowances. Compensation for resettlement price defined above is guaranteed.

Nzove



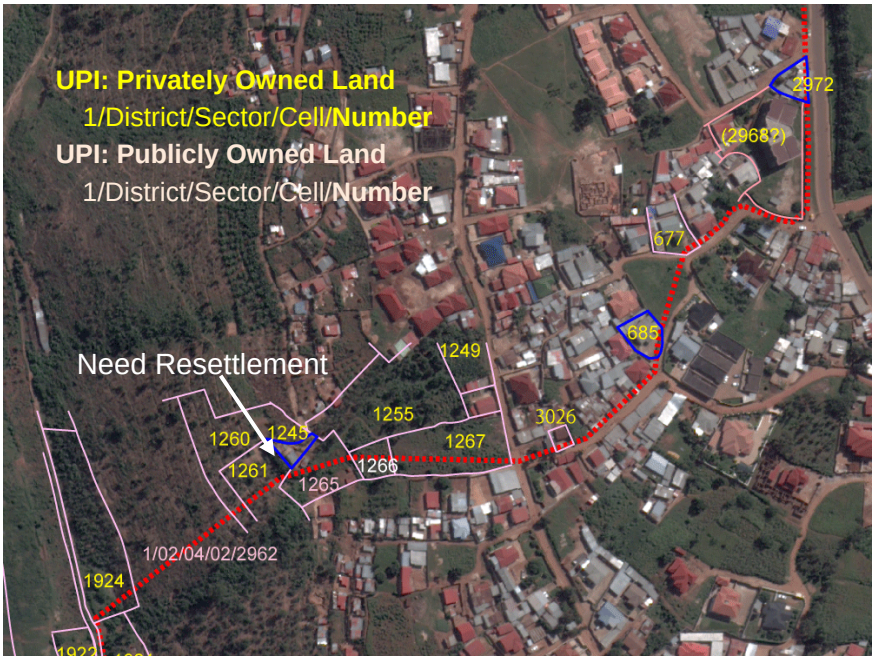
No	Name of Owner/User	UPI (Unique parcel Identifier)	Total land	Owner ship	Affected Land/Qty	Structures		Unit	Qty
						Nature	Materials		
1		1/01/02/02/5102	121886	Private	3536	Fence	Steel Frame	㎡	12.5

Nyabugogo



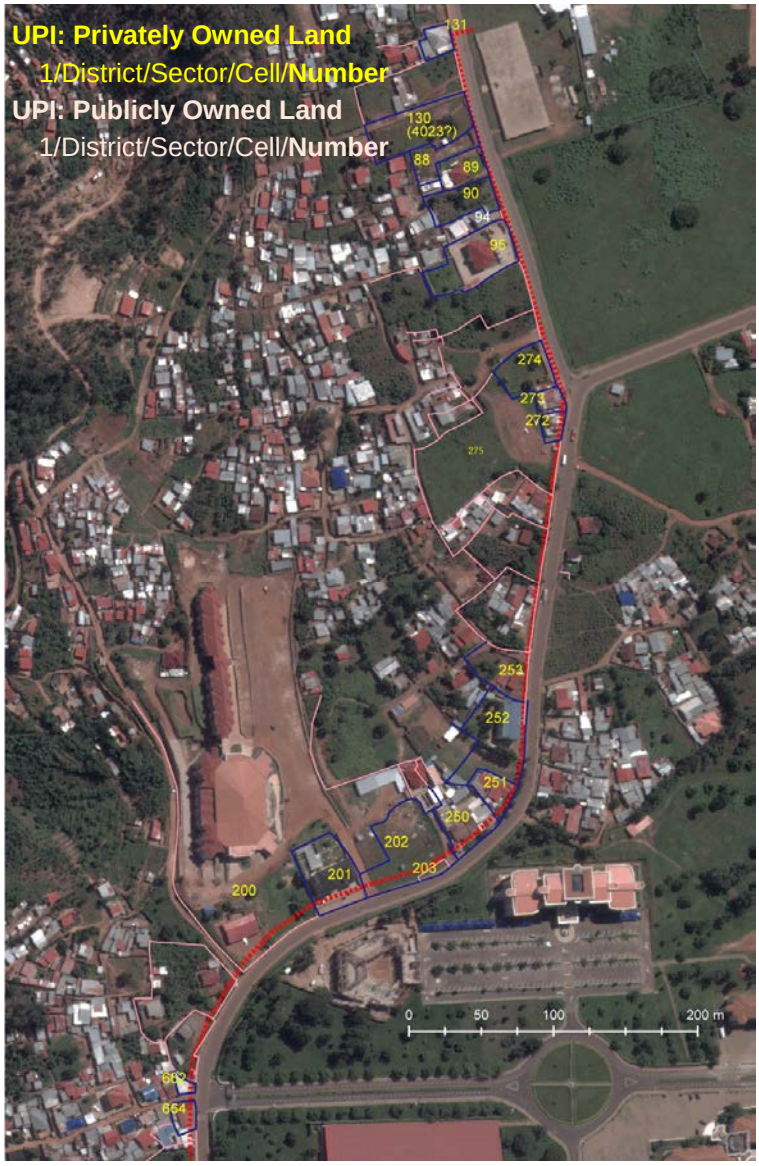
No.	Name of Owner/User	UPI (Unique parcel Identifier)	Total land	Owner ship	Affected Land/Qty	Structures		Unit	Qty
						Nature	Materials		
1		1/01/03/03/1621 1/01/03/03/3489	288 377	Private Private	116.5 370	House	Tree Trunk with mud and concrete	units	4
2		1/01/03/03/3433	5694	Private	437	Fence	Concrete Block	㎡	114
						Storage 1 behind fence	Concrete Block	㎡	7.5
						Tap Water	Steel Frame	Pies	1
						Storage 2	Cement Brick	㎡	8.5
3		1/01/03/03/3434	5507	Private	335	Fence	Steel Frame	㎡	182

Ruhango (a steep hillside)



No.	Name of Owner/User	UPI	Total land	Owner ship	Affected Land/Qty	Structures		Unit	Qty
						Nature	Materials		
1		1/02/04/02/685	571	Private	44	Fence	Steel Frame	㎡	26
2		1/02/04/02/1260 1/02/04/02/1245	2307.11	Private	80	House	Mud bricks	unit	2
3		1/02/04/02/2972	410	Private	30	Basement stairs	Cement and stones	㎥	1.5
						windows + protective screen	metallic	㎡	1.2
						Door	metallic	pces	1
						Partial House wall	mud bricks	㎡	14.3

Ruhango (along the paved road)



No.	Name of Owner/User	UPI	Total land	Owne r ship	Affected Land/Qt y	Structures		Unit	Qty
						Nature	Material s		
1		1/02/04/02/131	350	Privat e	30	Paves	Concret e	㎡	21.75
						Fence	Bricks	㎥	76.3
						Gate	Steel	Pces	1
2		1/02/04/02/4023	916	Privat e	15.46	Entrance	Cement	㎡	3.85

No.	Name of Owner/User	UPI	Total land	Ownership	Affected Land/Qty	Structures		Unit	Qty
						Nature	Materials		
3		1/02/04/02/88	761	Private	24	Paves Floor	concrete	m²	17.4
4		1/02/04/02/89	729	Private	30	Paves Floor	concrete	m²	21.75
						Fence	Bricks+ Grasses	m³	106.7
5		1/02/04/02/95	1914.7	private	60	Paves	concrete	m²	43.5
						gate house foundation	stones and cement	m³	12.6
						gate house walls	oven fired bricks	m³	12.87
						gate house Door	metal and glass	Pces	1
						gate house roof	metallic sheet	m²	24.75
						Entrance	Cement	m²	5.4
						Fence	Stones	m²	19.5
6		1/02/04/02/274	1098.0	Private	18.7	Paves Floor	Bricks	m²	18.7
7		1/02/04/02/90	1000	Private	40	Paves Floor	concrete	m²	29
		1/02/04/02/273	342.23	Private	11	concrete base	concrete and stones	m³	7.7
8		1/02/04/02/272	313.85	Private	11	concrete base	concrete and stones	m³	7.7
9		1/02/04/02/253	1192.48	Private	15.58	Fence wall	Concrete blocks	m³	8.7
10		1/02/04/02/252	2173.6	Private	30.38	Paves Floor	Concrete	m²	30.38
						Fence	Metal	m²	78
11		1/02/04/02/251	563.5	Private	30	Paves Floor	concrete	m²	30
12		1/02/04/02/250	1625.4	Private	20	Fence wall	concrete blocks	m²	103
13		1/02/04/02/201	1743.7	Private	19.904	Paves Floor	concrete	m²	19.404
14		1/02/04/02/662	162	Private	5.565	Stairs	concrete	m²	4.565
15		1/02/04/02/664	368	Private	8.5	Stairs	Concrete	m²	8.5

- Involuntary Resettlement

As mentioned above, two houses are regarded as the targets of resettlement. One is located at the permanently affected land along the RN1, and the other is located at the temporary affected area on the steep slope.

Table 1-30 Targeted Households of Involuntary Resettlement

No.	Name of Owner/User	Cell	No. of family member	Ownership		Main income sources
				Land	Structure	
1		Nyabugogo	4	registered	registered	Livestock business and farming
2		Ruhango	6	registered	registered	Employed (part time) professional

Source: Study Team


House to be resettled in Nyabugogo Cell


House to be resettled in Ruhango Cell

Houses necessary to be resettled

- Trees and Perennial Crops

Either at private and government land, loss of trees and perennial crops will be compensated by market price plus 5% of disturbance allowances.

The list of trees and crops, which were identified as the targets of compensation by the inventory survey. The total area of affected farming land and number of households who use these land is summarized in the table below.

Table 1-31 Area of farming land affected by the project

DISTRICT	SECTOR	CELL	Affected HHs	Government Land	Private land	Total
Gasabo	Gatsata	Nyamabuye	5	2,680	482	3,162
		Nyamugari	5	2,926	648	3,574
	Gisozi	Ruhango	23	969	4,919	5,888
Nyarugenge	Kanyinya	Nyamweru	5	98	1,834	1,932
		Nzove	6		5,050	5,050
	Kigali	Nyabugogo	13	10,154	1,721	11,875
	Kimisagara	Kimisagara	0*	280		280
Grand Total			**57**	17,106	14,655	31,761

*: User of the land is counted at Nyamweru Cell, because they do business there

Source: Study Team

4) Compensation for Loss of Income

- Temporary loss of income

Due to the temporary land expropriation, farmers and corporations will lose a part of income or sales for a certain period. It is necessary to consider compensation for the temporary loss.

Compensation for temporary disability

A driving school has to close its business during the construction work. As a compensation for temporary disability, revenue plus 5% of disturbance allowances along with fixed costs for 3 months will be arranged.

Compensation for loss of income from farming activities

Due to the temporary land expropriation, farmers will lose a part of income for one season. As a compensation for the temporary loss of income, compensation for annual crops will be arranged (market price + 5%).

- Compensation for the permanent loss of income

The impact of the Project on the income of farmers depends on the area of the farming land (the smaller the size of farming land, the larger the negative impact on the income) and the degree of dependence on the revenue from farming.

There are 2 households, who cultivate the government land, depend solely on revenue from farming activities, and will lose around 30 % of the farmland. In Kigali, where land is scarce resource, it is very difficult to arrange land-for-land compensation. Priority in employment as a construction worker will be considered.

According to the result of socio-economic survey, annual household income is around US$ 2,000, and due to the permanent land acquisition, they would lose about 30 % of income (US$ 600). On the other hand, daily wage for unskilled construction workers is US$5－US$8, and they will be able to earn 2 year – 3 year of the lost income for one year.

(5) Supporting Measures for Socially Vulnerable People

Seven households were identified as socially vulnerable. Supporting measures such as support of smooth payment of compensation and priority in employment will be arranged.

(6) Restoration of Livelihood

As mentioned above, two houses were judged necessary to be relocated. Both households own land plots and houses and can receive full compensation.

One household in Nyabugogo Cell makes a living from farming livestock and crops. In order to continue their livestock business, farming land is required. Their annual income is over US$ 5,000 and it is possible to continue livestock business in the suburb of Kigali City with compensation of full replacement cost. The livelihood after the resettlement will be monitored under the RAP monitoring program.

The other household in Ruhango Cell makes a living from part-time job (categorized as professional) and own business, and it can be said that the negative impact of resettlement on their livelihood is not serious.

Eligibilities to receive compensations is summarized in the entitle matrix shown below.

Table 1-32 Proposed Entitlement Matrix

Type of Loss	No HH	Quantity	Unit	Eligibility Criteria	Entitlement
1.Loss of Private Land					
1.1. Permanent loss of private Land	80	5,946	㎡	Land owners where the proposed pipeline will be installed	Compensation in cash because the land to be affected is small and no free land available. Compensation for loss of land will be arranged based on the full replacement cost
1.2. Temporary Loss of Private Land (1) in construction road	84	12,855	㎡	Land owners where the proposed pipeline and construction roads facilities will be constructed temporarily	People will be notified on time and the construction period should have shortened. Temporary loss of land results in the loss of income, and this is covered by compensation for loss of income.
2. Loss of Government Land					
2.1. Loss of government land	9 + 23	4,917	㎡	Current users of affected land	No compensation required because its government land and only small portion will be affected. Affected households should be allowed to use the land outside the pipeline area
3. Loss of assets in the private/government land					
3-1 Perennial crops and trees	57	241 4,158.7	Pies Are	Various rights and interest holders	Cash compensation and 5% disturbance allowances per as expropriation law
3-2 Loss of houses	2	2	Unit	House owners	Compensation of the house at replacement cost based on the market value such as materials and labor cost without depreciation, and disturbance allowances as 5% of market value. Transaction tax and commission fee shall be added as compensation.
3-3 Loss of other structures	22	22	Unit	Various rights and interest holders	Compensation of other structures at replacement cost based on the market value such as materials and labor cost without depreciation, and disturbance allowances as 5% of market value. Transaction tax and commission fee shall be added as compensation.
4. Loss of income					
4-1 Temporary loss of income for business	1	2	Weeks	Business owner in the projects construction area such as driving school	Disturbance allowances to be included in compensation of assets
4-2 Temporary loss of income for farmers	57			Current users of affected land	Cash compensation for one-year crop for one season and 5% disturbance allowances
4-2 Permanent loss of income (farmers)	2	2	HHs	HHs who will lose Farming income	Priority in employment during construction
5. Support for vulnerable people					
5-1 Vulnerable people	7	7	HHs	Households where the head of household is vulnerable	Priority in employment during construction

Source: Study Team

(7) Grievance Redress Mechanism

District is an acknowledged institution for which the PAPs recognized as a venues for expressing discontent and disapproval to the resettlement and compensation process. Article 26 of the expropriation law N0 18/2015 of 19/04/2015 provides complaints procedures for individuals dissatisfied with the value of their compensation. The law stipulates that dissatisfied persons have a period of 30 days after project approval decision has been taken to appeal (Article 19). Grievance procedures are required to ensure that PAPs are able to lodge

complaints or concerns, without cost, and with the assurance of a timely and satisfactory resolution of the issue. The procedures also ensure that the entitlements are effectively transferred to the intended beneficiaries. Stakeholders will be informed of the intention to implement the grievance mechanism, and the procedure will be communicated at the time that the RAPs are finalized. Grievances may arise from members of communities who are dissatisfied with eligibility criteria use, community planning and actual implementation or compensation.

(a) Process of grievance

The overall process of grievance is as follows:

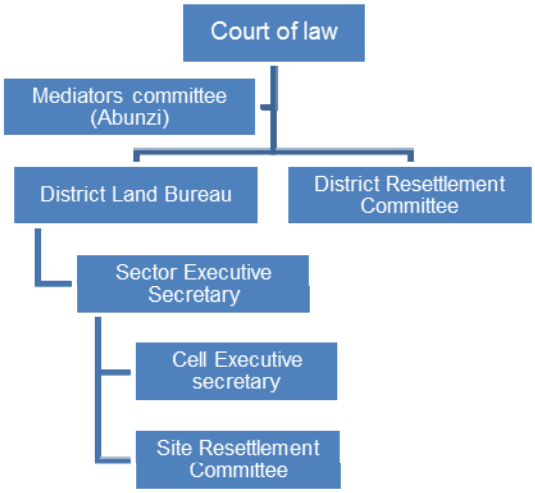
1. During the initial stages of the valuation process, the affected persons will be given copies of grievance procedures as a guide on how to handle the grievances.
2. The process of grievance will start with registration of the grievances to be addressed for reference.
3. The project will use a local mechanism, which includes resettlement committees, peers and local leaders of the affected people. These will ensure equity across cases, eliminate nuisance claims and satisfy legitimate claimants at low cost.
4. The response time will depend on the issue to be addressed but it should be addressed with efficiency.
5. Compensation will be paid to individual PAPs only after a written consent of the PAPs, including both husband and wife.

(b) Procedure of grievance

The aggrieved person should file his/her grievance, relating to any issue associated with the resettlement process or compensation, in writing to the sub-project Resettlement and Compensation Committee. The grievance note should be signed and dated by the aggrieved person. The designated WASAC officer and the Resettlement and Compensation Committee will consult to determine the validity of claims. If valid, the Committee will notify the complainant and she/he will be assisted. The Resettlement and Compensation Committee will respond within 7 days during which time any meetings and discussions to be held with the aggrieved person will be conducted. If the grievance relates to valuation of assets, a second or even a third valuation will be undertaken, until it is accepted by both parties. These should be undertaken by separate independent valuers than the person who carried out the initial valuation.

If the aggrieved person does not receive a response or is not satisfied with the outcome within the agreed time, she/he may lodge his/her grievance to the relevant local administration such as the District Land Bureau, which is mandated to help resolve such matters. If requested, or deemed necessary by the subproject Committee, the District Project Coordination officer will assist the aggrieved person in this matter. The relevant Local Administration will then attempt to resolve the problem (through dialogue and negotiation) within 30 days of the complaint being lodged. If no agreement is reached at this stage, then the complaint is dealt with through the local courts (Abunzi) where possible. Where matters cannot be resolved through local routes, the grievance will be referred to higher authorities at the national level. The Resettlement and Compensation Committee will provide assistance at all stages to the aggrieved person to facilitate resolution of their complaint and ensure that the matter is

addressed in the optimal way possible. If administrative ways of grievance redress is not enough to address the complaint, then the unsatisfied person may refer to judicial system. Based on the nature of complaints, the process will start from mediators for assets below 3 million Rwandan francs and if the value is more than three million, the process will start from intermediate courts, high court and to Supreme Court. The proposed grievance redress system is as illustrated follows:



Source: Study Team

Figure 1-17 Flow of Grievance Redress Mechanism

(8) Implementation structure (Organizations responsible for resettlement and their responsibilities)

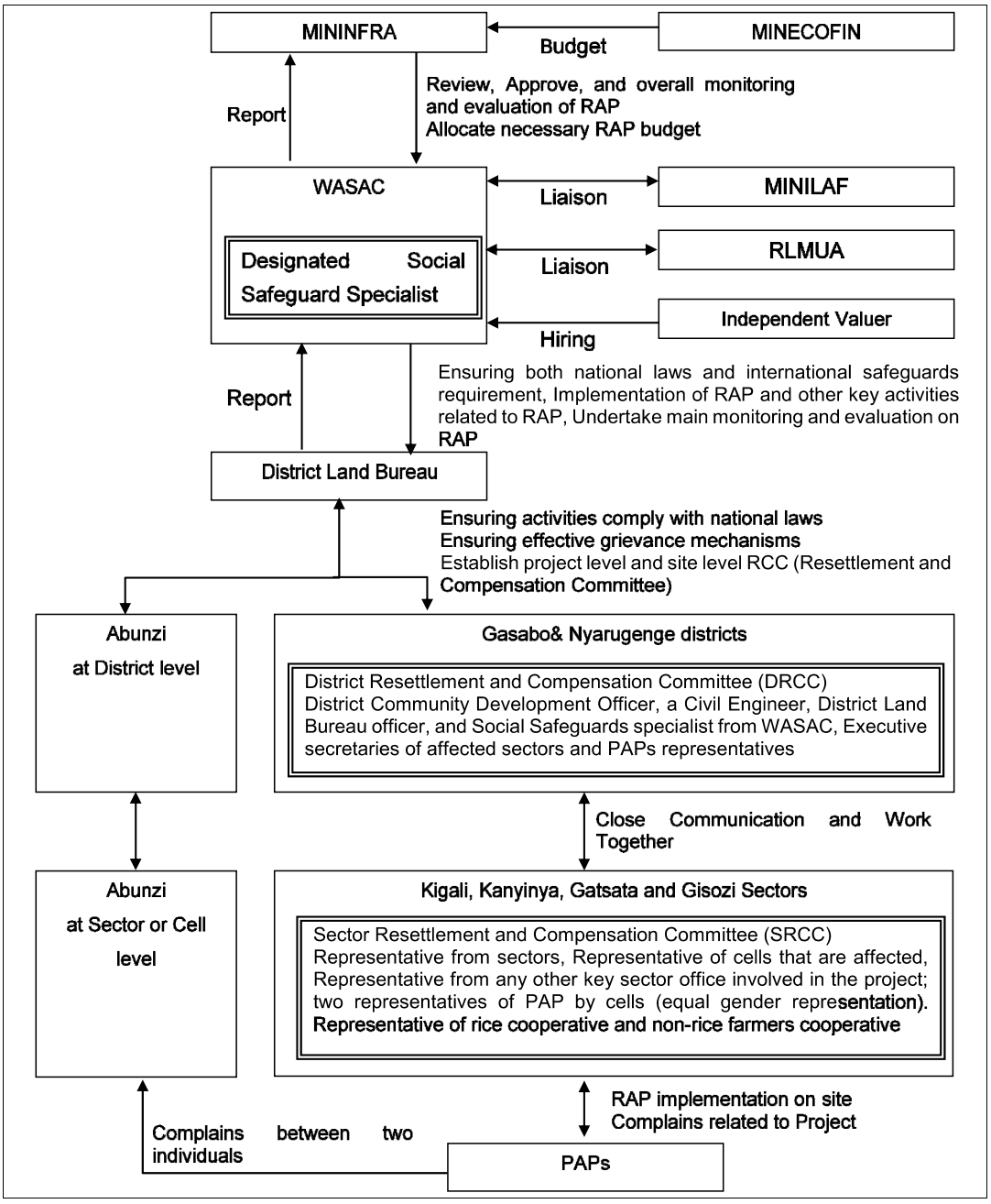
Responsibilities of organizations responsible for implementing RAP are summarized in the table below.

Table 1-33 Responsibilities of Organization in implementing RAP

Institutions	Responsibilities
WASAC Ltd	Designate a social safeguard specialist(s) who will be the focal point for RAPs implementation and will liaise with other stakeholders. Initiate the expropriation process and compensation requirements; Preparation and signature of compensation grant agreement with the district; To establish Resettlement and Compensation Committee in consultation with District Land Bureau; Have a representation in District Resettlement and Compensation Committee Provision of capacity building and technical support relating to expropriation and compensation activities; Ensure funds allocated appropriately, according to RAP; Prepare the RAP closure report and file all documentation related to RAP implementation; Hire independent assets valuar upon the completion of final detailed design study.
MINILAF	To ensure that the expropriation process is done in compliance with land policies, land law and expropriation law; Ensure the RAP is within the context of national land use plan.

Institutions	Responsibilities
RLMUA	To advise on matters related to land ownership and expropriation activities; To participate in verification of land ownership and land titles.
Districts	Verify land owners from records of land register; Monitor and approve activities pertaining to valuation of land and other immovable property; Approve land expropriated land surveys; Coordinate the establishment of Resettlement Committees; Work in collaboration with the Resettlement and Compensation Committees to ensure that the valuation and compensation is done in accordance with the law and the requirements of this RAP. To facilitate the PAPs to purchase new land; Facilitate the transfer of land titles after;
District Resettlement Committee	Verifying PAPs Validate inventories of PAPs and valuation affected assets; Allocate land, where required, to permanently affected households; Facilitate conflict resolution and addressing grievances.
Site resettlement Committee	Help in creating awareness on expropriation process; Monitor the implementation of expropriation closely with environment protection committees to monitor the use of marshlands and reserved areas; Conflicts resolution; Help in land demarcation confirm holders of land rights during land resettlement process, participate in the identification of community settlement sites, identify and list escheat land, and serve as witnesses in compensation and resettlement
Mediators/ Abunzi	Resolving disputes Provide grievances mechanism following land acquisition. Help in designing RAP at the community level to ensure community buy in.
Project Affected Persons	Be present when the land survey and inventory is being carried out Provides all required information in regards to resettlement activities Participate in expropriation activities

Source: Study Team



Source: Study Team

Figure 1-18 Implementation system of RAP

(9) Implementing Schedule (implementing resettlement after receiving compensation)

The draft of RAP implementation schedule is shown below.

Items \ Year	2018					2019											2020											2021									
Month accumulated	8	9	10	11	12	1	2	3	4	5	5	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
RAP preparation																																							
RAP Confirmation																																							
Final detailed design and bid opening																																							
Confirmation of eligibility																																							
Final cut-off date																																							
Establishment of resettlement committee																																							
Final assets valuation and compensation agreement																																							
Compensation																																							
Construction																																							
Monitoring and grievance redress																																							
RAP closure report																																							

(10) Cost and financial source

The cost necessary to implement RAP including monitoring is shown below. All the necessary cost will be borne by WASAC.

(a) RAP implementation Cost

RAP implementation cost is shown below.

Table 1-34 RAP implementation Cost

No	Item description	HHs/Corporation	Unit	Quantity	Total Cost(frw)
1	Permanent loss of land	80	SQ	15,820	62,257,509
2	Loss of trees and crops	57	Pces Sqm	569 4408	6,914,742
3	Loss of houses & structures	2	House	2	62,834,470
		22	Structure	21	
4	Final valuation	-	Ls	1	20,010,000
		95			**152,016,721**

Source: Study Team

(b) Cost of implementing RAP monitoring

Table 1-35 RAP Monitoring Cost

Activity	Indicator	Qty	Unit cost (FRW)	Total Cost (FRW)
Meeting for set up resettlement committees	Established committee	5	100,000	500,000
Follow up valuation and compensation process	Field report	7	360,000	2,520,000
Meetings for grievance redress	Meetings/grievance resolved	12	100,000	1,200,000
PAPs Livelihoods assessment	Assessment report	1	5,000,000	5,000,000
Total				9,220,000

Source: Study Team

(11) Monitoring System by Implementing Organization and Monitoring Form

The main purpose of RAP monitoring is to check if all the PAHs receive compensation before the start of the Project and if the level of livelihood of PAHs is the same or better than that before the start of the Project.

As shown in Figure 1-18 Implementation system of RAP, WASAC will prepare for the report, based on the information from Sector Resettlement and Compensation Committee (SRCC), in cooperation with District Resettlement and Compensation Committee, in which WASAC participate as a member.

Proposed monitoring forms are shown 1-3-1-3 .

(12) Public Consultation Meetings

Public Consultation meetings concerning RAP were organized together with public consultation meeting for EIA. The details of the public consultation meetings regarding RAP can be referred in 1-43(13).

1-3-1-3 Others

(1) Proposed Monitoring Form

Environmental Management Plan

Proposed monitoring forms, based on

Table 1-16 Environmental Management (EMP) are shown below.

1. Response/Actions to Comments and Guidance from Government Authorities and the Public

Date:

Venue:

Organizations or Communities:

Monitoring Item	Monitoring Results during Report Period
Number and contents of formal comments made by the public	
Number and contents of responses from Government agencies	

2. Pollution

1) Surface Water Quality

Item	**Unit**	Down-stream	Main point	Up-stream	**Country Standards**	**Standards for Contract**	**Referred National Standards***	**Frequency**
pH	-				-	6.5-85	RS 109 (discharged industrial wastewater)	Quarterly
Temperature	degree				-	<3	RS546 (Drinking water	
Turbidity	NTU				-	5	RS546 (Drinking water	
TSS	mg/l				-	50	RS 109 (discharged industrial wastewater)	
Oil					-	observed		

Sampling point: WQ16: Nyabugogo at Giticyinyoni on Nemba gauging station

Result of the baseline survey and standards

	Unit	Down-stream	Main point	Up-stream	National permissible limit[2]	Reference national Standards
Temperature	ºC	20.5	20.2	20.4	<3	RS 109 (discharged industrial wastewater)
pH	-	6.63	6.86	6.84	6.5-85	RS546 (Drinking water
Turbidity	NTU	723	702	688	5	RS546 (Drinking water
TSS	(mg/l)	282	280	276	50	RS 109 (discharged industrial wastewater)

Source: UR/College of Applied Science and Technology, Feb 2018

2) Noise and Vibrations

Item	Unit	Measured Value (mean)	Measured Value (Max)	Country Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Noise LAeq	dB(A)			60 (residential area) 65 (Industrial area)	60/65	85 (Japan)	Nzove WTP, Ntora Reservoir, 4 sections at the wetland, and steep slope	Quarterly
Vibrations	dB(A)			-	-	75 (Japan)	Nzove WTP, Ntora Reservoir, 4 sections at the wetland, and steep slope	Quarterly

Result of the baseline survey

Full name of the	Noise	Vibrations

[2] Rwanda does not have specific standards for surface water or ground water. Water assessment results were compared either with drink water (RS 546) or industrial wastewater discharge (RS 109).

feature/area	Maximum dB(A)	Minimum dB(A)	Average dB(A)	Maximum (VdB)	Minimum (VdB)	Average (VdB)
Trinity Nursery school	66.4	48.6	55.4	3.5	0.4	2.3
Gatsata near Nyamabuye cell	64.7	42.5	51.6	2.3	0.2	1.8

Ambient noise standards in Rwanda

No	Area	Time During Day (hours)	Limits, dB(a)
1.	Industrial Noise	07:00-21:00 21:00-07:00	60.0 55.0
2.	Neighborhood Noise	07:00-18:00 18:00-21:00 21:00-07:00	60.0 55.0 50.0

3) Waste (Construction waste)

Frequency: weekly

Date: Item: Waste Management Mark: "✔" if management is done as required

Location	Exact location	Kind of waste	Volume of waste (m^3)	Final disposal or reuse	Stored at designated place	Waste separation	Remark
WTP site	-						
Ntora Reservoir	-						
Section 1							
Section 2							
Section 3							
Section 4							
Steep slope							
Ruhango (residential area)							

3) Mitigation measures

Frequency: weekly

Date: Mark: "✓" if mitigation measure is done

No	item	Monitoring Site **	Exact Location of pipe installation work(Cell/Village)	Mitigation measure is done or not	Remarks
1	Check the conditions of vehicles (dust control)				
2	Watering (dust control)				
3	Covering truck load with a sheet (dust control)				
4	Using oil pan (soil pollution prevention)				
5	Installing fence at steep slope (soil erosion prevention)				

** Monitoring site:

Source: Study Team

Nzove WTP, Ntora Reservoir, 4 sections at the wetland, steep slope, Ruhango, and a Storage

places

3. Natural Environment

1) Biota and ecosystems

Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Clearance activities (visual inspection)			Weekly
Management of top soil (visual inspection)			Weekly

2) Hydrological Situation

Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Impact of construction work on steep slope (visual inspection)	*Soil erosion*		Weekly

4. Social Environment

1) Resettlement

Pre-Construction phase

Resettlement, Land expropriation, and compensation for assets and crops (monthly report)

1.Preparation		Planned Total	Unit	2019.2		2019.3		2019.4		2019.5				Expected completion date	Responsible organization
				Qty	%	Qty	%	Qty	%	Qty	%				
1-1	Employment of Individual Valuer	5	Times												WASAC
1-2	Designation of Social Safeguard Staff in WASAC	1	M/M												
1-3	Establish SRCC and DRCC Committee	5	Committee												
1-4	Training of officers involved for 1-3	1													
2.Update PAPs list and Final Asset Valuation															WASAC
2-1	Identification of final PAHs	95	HH												
2-2	Announcement to Affected people	3	Time												
2-3	Cost estimation for expropriation														
2-4	Consultation meeting times	10	Time												
2-5	PAHs sign agreement	95	HH												
3. Progress of resettlement															WASAC
3-1	Kanyinya														
3-2	Kigali	1	HH												
3-3	Gatsata														
3-4	Gisozi	1	HH												
4. Progress of land acquisition															WASAC
4-1	Kanyinya	8,511	m^2												

1.Preparation		Planned Total	Unit	2019.2		2019.3		2019.4		2019.5				Expected completion date	Responsible organization
				Qty	%	Qty	%	Qty	%	Qty	%				
4-2	Kigali	14,261	㎡												
4-3	Gatsata	9,338	㎡												
4-4	Gisozi	8,102	㎡												
4-5	Kimisagara	280													
5.Progress of compensation in cash															WASAC
5-1	Kanyinya	16	HH												
5-2	Kigali	19	HH												
5-3	Gatsata	19	HH												
5-4	Gisozi	41	HH												
6. Construction work job arrangement for some PAHs															Local authorities, WASAC
6-1	Kanyinya		HH												
6-2	Kigali		HH												
6-3	Gatsata		HH												
6-4	Gisozi		HH												
7. Complain and Grievance Redress N/A Cases			Case												RCC
7-1	Solved cases		Case												
7-2	Unsolved cases		Case												

Record of Complain and Grievance Management

No	Date	Complain and Grievance from PAPs	Solution / Result / Any actions to be taken

Consultation meetings

No	Date	Sector	Nos of Participants	Key agenda and result of discussion

During Construction

Social Economic Survey for Resettled Households (once in a half year for the first yea, once in a year for the second year)

Questionnaire: a part of the questionnaire, used for the socio-economic survey, will be used.

2) Livelihood

Before Construction

Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Support for vulnerable groups			Monthly
Priority in Employment			Monthly
Other employment			Monthly

3) Safety Management (Health and Occupational Safety)

Safety and health management plan

Pre-construction phase

	Safety and health management plan is submitted	Approved by the Consultant
Date:		

Training programs

No	Date	Training	Agenda	Participant
1				
2				

During Construction

Safety management

Date:

No	item	Monitoring Site **	Exact Location of pipe installation work (Cell/Village)	Result	Remarks
1	Number of meetings organized since the previous monitoring				
2	Safety gear distribution (%)				
3	Keep records of accidents and injuries properly (Yes/No)				
4	Installation of fences, assignment of guards (Yes/No)				

** Monitoring site:

Nzove WTP, Ntora Reservoir, 4 sections at the wetland, steep slope, and Ruhango

Record of Accidents

No	Date	Details of accidents	Solution / Result / Any actions to be taken

4) Other checklist

Date: Mark: "✔" if mitigation measure is done

No	item	Monitoring Site **	Exact Location of pipe installation work (Cell/Village)	Mitigation measure is done or not	Remarks
1	Communities get the information on the construction schedule				
2	Communities know get the information of traffic management				
3	Installation of signboard				

** Monitoring site:

Nzove WTP, Ntora Reservoir, 4 sections at the wetland, steep slope, and Ruhango

5) Record of Complains

No	Date	Complains	Solution / Result / Any actions to be taken

(2) Environmental Check List

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)Yes (b)N (c)N (d)N	(a) EIA report was prepared and submitted to RDB in July (b) EIA report was approved in July (c) (d)
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) At the stakeholder meetings, the project contents and its impact were adequately explained and stakeholders basically agreed with the project. (b) Participants of consultation meetings made comments and questions; however, none of them was critical.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative routes and river crossing methods were examined with social and environmental considerations.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) N (b) -	(a) Construction/modification of water purification plant is not included in the project components. (b) ditto
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a) -	(a) Construction/modification of water purification plant is not included in the project components.
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a) -	(a) Construction/modification of water purification plant is not included in the project components.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) Y	(a) The transmission pumps, which are to be installed at Nzove WTP, will be covered with RC walls and nearest houses are far away from the pump station, so the noise will not reach the boundary of the site and neighboring houses.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) No groundwater will be used.
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) The project site is not located in protected areas and there is no expected impact of the project on the protected areas.
3 Natural Environment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?(b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?(d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) Y (d) N	(a) The result of the EIA survey shows no important habitats inside and around the project site. (b) Ditto (c) No serious impact is expected but necessary measures, such as conserving top soil and protecting animals/birds during the site-clearance, will be taken. (d) Construction of new water intake is not included in the project components.
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a) N	(a) There is no new water intake; however, there are 6 river-crossing points, which could have impact on the river bank. Pipe jacking method will be applied and this could minimize its impact. At the pipe installation work near springs, back-filling work will be done carefully.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, and people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y (b) Y (c) Y (d) Y (e) Y (f) Y (g) Y (h) Y (i) Y (j) Y	(a) Two households are needed to be resettled. 22 other households/ corporations have to demolish or move structures such as fences and paved floors. 147 plots of land with the total area of 40,665 ㎡ will be affected by the project, and among them 5,946 ㎡ of private land will be permanently expropriated. RAP is being prepared to minimize the impact of the project. (b) Community consultation meetings were organized to explain about compensation and measures of livelihood restoration before the project. (c) RAP is being developed based on socio-economic studies and inventory survey as well as a number of meetings with various stakeholders. (d) Compensation at full replacement cost will be paid prior to the resettlement according to the both Rwandan laws and JICA guidelines. (e) Compensation policies will be prepared as a part of Entitlement Matrix in RAP (f) A support will be provided for vulnerable persons and/or his/her family and priority of job opportunity during the construction period will be also given. (g) Agreements with the affected people will be obtained and compensation will be paid prior to resettlement. (h) The RAP, which is being prepared according to the Rwandan laws and JIC guideline/WB OP 4.12, specifies the resettlement schedule, proposes the resettlement implementation system and necessary budget. (i) The RAP shows the monitoring plan. (j) According to the Rwandan law, the grievance redress mechanism is proposed and will be established. Necessary cost for grievance redress mechanism will be also calculated and presented in the RAP.
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?(b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	(a) Y (b) Y	(a) Some farmers will face the reduction in their farm land, and a support (priority in employment) will be provided for farmers who depend on income from farming activities (b) The transmission pipeline installation work could have negative impact on some springs, and a countermeasure will be taken if necessary.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) No such facilities are identified in the project area.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There will be no serious problems; however, site clearance work at the marshland and cutting trees and bamboos will change the landscape locally. After the construction work, rehabilitation work will be conducted.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	(a) Ethnic minorities and indigenous people are not confirmed in the Project area. (b) ditto
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Contractors/sub-contractors are requested to take a training provided by Ministry of Public Service and Labor in order to make sure that they would abide by related Rwandan laws and international rules such as OHSAS (b) Measures are taken to oblige workers to wear safety boots and helmets and to manage waste properly, in order to prevent accidents during the construction work (c) The safety and sanitation plan will be planned and regular safety education will be implemented, in consultation with a district work safety inspector (d) Security guards, who are provided with training of health and safety, are assigned and measures are taken such as installation of fence and signboards in order to prevent accidents and troubles involving local residents near the construction site

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b) Y (c) Y (d)	(a) Based on the baseline survey, the impact of the project was evaluated and mitigation measures were planned. (b) Ditto (c) ditto (d) A part of the transmission pipe line runs along the main roads. The installation work there could cause traffic congestion and mitigations measures will be taken.
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?(b) What are the items, methods and frequencies of the monitoring program?(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) The environmental monitoring plan was prepared for target items of mitigation measures, and will be implemented.(b) The feasible monitoring methods and frequency were decided in consultation with the environmental authorities (c) The monitoring system will be established through the EIA survey (d) The reporting system will be established through the EIA survey.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.	(a) Y	(a) Since there are 6 river crossing points, river water quality is included in the check items during the construction period.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) The project does not have possibility of significant adverse impacts on environment, including global warming

Chapter 2 Content of the Project

2-1 Basic Content of the Project

2-1-1 Project Objective

The Republic of Rwanda (hereinafter referred to as "Rwanda") has set the goal of 100% access to safe drinking water throughout the country by 2020. However, with the rapid population growth in Rwanda, the current water supply capacity in Kigali City is not sufficient. Also its existing water supply facilities are deteriorating. To achieve this goal, the government of Rwanda is facing many challenges including the review of all water supply facilities and securing of necessary budget.

The existing Nzove - Ntora transmission pipeline (diameter: 600 mm, planned water supply volume: 40,000 ㎥/day) connects Nzove WTP, the largest water treatment plant in Kigali City, and Ntora Reservoir. Also its water system is called Ntora pipe-system. The existing Ntora pipe-system cannot utilize fully the water treatment capacity of Nzove WTP (62,000 ㎥/day as of July 2018) due to its poor processing capacity. In addition, the water treatment capacity of Nzove WTP is planned to be further increased (Ntora pipe-system: up to 87,000 ㎥/day). Therefore, a transmission pipeline that can fully utilize the capacity of Nzove WTP shall be installed as it will play an important role to meet the expected future water demand in Kigali City.

Under these circumstances, the Project aims to increase and stabilize the water supply volume by improving the water supply facilities including Nzove – Ntora transmission pipeline and pump facilities at Nzove WTP and Ntora Reservoir — which are the main water supply facilities in Kigali City. The Project contributes to the advancement of social services through the improvement of water supply situations.

2-2 Outline Design of the Japanese Assistance

To achieve the above goal, the facilities of Ntora pipe-system will be improved by the Project. The Project will replace the existing transmission pipeline connecting Nzove WTP and Ntora Reservoir by constructing a new pipeline; expand Nzove WTP by installing additional water supply pumps; and construct a new elevated tank in Ntora Reservoir as well as restructuring its piping arrangement. As a result, the current maximum water supply volume from Nzove WTP to Ntora Reservoir of 40,000 ㎥/day (at present) will be increased to 87,000 ㎥/day (Including installation of water supply pumps (25,000 ㎥/day) of New Nzove 1 treatment plant by Rwanda side).

2-2-1 Design Policy

2-2-1-1 Basic Policy

The target year of the Project is set as 2030; and the planned water supply volume shall be determined in consideration of Nzove WTP development plan. The optimum route of the new transmission pipeline will be decided by setting the criteria of construction and economic efficiency and revising routes that were proposed in the prior data collection survey.

As for Nzove WTP, there is no water supply pumps that can satisfy the capacity of Nzove WTP at the present; thus new water supply pumps will be installed by the Project to secure the

planned water supply volume.

As for Ntora Reservoir, the distribution of water to the surrounding areas is operated by the existing transmission pipeline and water is not distributed during the suspension period of the transmission pipeline. Therefore, the facilities will be improved installing an elevated water tank in the Ntora Reservoir by the Project to secure a continuous water supply system.

2-2-1-2 Policy on Natural Conditions

There are two rainy seasons in Rwanda that can be categorized as heavy rainy season from March to May and light rainy season from September to November. In the riverside area of the Nyabugogo River, which is part of the route for installing the transmission pipeline, the water level rises to the flood plains, particularly in the downstream during the rainy seasons. Therefore, when installing facilities such as a transmission pipeline in the flood plain, the design shall include measures including buoyancy countermeasure to avoid any risks even when the water level is high. Furthermore, there is a high possibility that the installation of transmission pipe along the flood plain would not be able to be carried out due to the rise of water level of the river during the rainy seasons. Thus, the construction plan shall be made under the condition that the construction will not be carried out in the flood plain during the rainy seasons.

Regarding the earthquakes, Kigali City has low rate of earthquake occurrence and Rwanda does not have a clear earthquake-resistant design standard; thus the design seismic intensity is determined based on Rwandan customs and similar projects in Rwanda.

2-2-1-3 Policy on Socio-Economic Conditions

Full two holiday week system, Saturday and Sunday, is established in the official agencies in Rwanda, and working hours are generally from 7 am to 5 pm in government offices. The national holidays are 11 days a year. In addition, Rwanda has a custom of leaving work early and playing sports every Friday afternoon; and the social service activity called "*Umuganda*" in the morning of the last Saturday of every month is obligated by all adults in Rwanda. Influences on construction works by these customs and systems need to be considered.

2-2-1-4 Policy on Construction Conditions, Special Conditions and Commercial Practices

There are no systems and design standards related to design of water supply facilities in Rwanda. Also the water supply facility design of projects by WASAC is not carried out using specific standards. Therefore, standards for the facility design of the Project will be decided after consultation with WASAC. Specifications of facilities and construction methods for river and road crossings for the route of the transmission pipeline will be determined after the consultation with the related organizations.

Rwanda is an inland country; there is a high possibility that the necessary equipment and materials will not be available. Thus, the procurement source of general construction equipment and materials shall not be limited to Rwanda; neighboring countries shall be also considered. For the construction equipment and materials that are difficult to be procured in Rwanda and neighboring countries, Japan and third countries shall be considered. The transmission pipeline, that will be replaced, shall be procured from Japan, considering that it can endure high water pressure and long-term use.

2-2-1-5 Policy on Utilization of Local Contractors (Construction Company and Consultant)

(1) Use of Local Contractors

In principle, the Project actively let the local contractors provide construction equipment and laborers in the construction. However, Japanese experts shall be dispatched for quality management, construction schedule control, safety management and equipment test and adjustment.

(2) Use of Local Equipment and Materials

Construction materials such as stones, aggregates for concrete cement and reinforced bars can be procured locally in Rwanda. However, the material cost is expensive in Rwanda as most of the materials are imported excluding stones and aggregates for concrete cement.

It is necessary to confirm the concrete strength that is adopted for the construction because the strength differs for each concrete manufacturer as they have different sources and methods of material management. Portland cement is the most common product and its quality is guaranteed.

Some construction materials, such as steel frames, finishing materials, equipment materials, piping materials and electric cables, are common products in Rwanda; however, they are not sufficient. Procurement from Japan shall be considered for the materials, which will be used for the construction of a pump station in the Project, in view of durability, airtightness and construction accuracy.

(3) Procurement from Third Countries

In procuring equipment and materials from third countries, careful consideration shall be given to costs, quality, and delivery time, ease of spare-parts procurement after start of operation, after-sales service, and consistency with existing facilities. All of the existing facilities and electrical equipment in Rwanda are imported, and many of these products are from Europe and Turkey. Therefore, procurement from third countries shall be considered for facilities and electrical equipment in the Project. However, it will be desirable to procure the steel pipes for the transmission pipeline from Japan, in view of its construction experiences, material ability to withstand high water pressure, quality and durability.

(4) Construction Works

There are several construction companies and electrical construction companies in Rwanda; therefore, laborers, transportation vehicles and heavy construction machinery can be locally procured. However, the construction work generally tends to concentrate in the dry season to avoid work in the rainy season; and thus the number of heavy construction machinery is limited during this season in Rwanda. Especially for the machinery, careful negotiations with Rwandan construction contractors are necessary to secure them, or it is required to procure them from third countries. In addition, the construction machinery necessary for special construction work, such as improvement of the river using pipe jacking method, temporary monorail, and hot tapping work, shall be procured from Japan.

The basic policy for the Project is the utilization of local contractors; however, the material of the new transmission pipeline is planned to be steel and requires pipe welding work. Skilled welders from Japan and third countries will be dispatched to connect the pipes by welding to

prevent accidents such as rupture or burst of the pipes after construction.

2-2-1-6 Policy on Operation and Maintenance

After starting the water supply service, the operation and maintenance of water supply facilities implemented by the Project shall be carried out by WASAC, as well as existing facilities. WASAC operates and maintains the existing water treatment plants and reservoirs, and has knowledge and technical skills of general water treatment and water transmission and distribution system. For this reason, the Project plans to only carry out an initial operation guidance of the elevated water tank and procured equipment, even though it will install additional water supply pumps in Nzove WTP, construct an elevated tank in Ntora Reservoir and procure equipment such as flow meters and water level gauges for both facilities.

However, a technical assistance (Soft Component) is prepared for WASAC by the Project. It provides a technical support regarding an increase in water supply volume due to the replacement of transmission pipeline and installation of additional water supply pumps in Nzove WTP. It also relates to the water level management of Ntora Reservoir and water distribution management after passing through Ntora Reservoir through restructure of its piping arrangement (inflow and outflow pipes).

2-2-1-7 Policy of Setting Grades for Facility and Materials

Considering the conditions outlined above, the basic policy for the installation range for facility and materials of the Project and its technical level will be as follows.

(1) Policy of Range of Facility and Materials

Each facility improved in the Project has the basic policy of maintaining the current structure of the existing water supply system. The water supply facility design shall allow an efficient and economical operation and maintenance. In particular, measures against high water pressure and water hammer pressure are necessary for the transmission pipes. Thus, it is necessary to confirm the existing system including the pipe type and measures against water hammer pressure, and determine the specifications for the transmission pipes that can bear the assumed water pressure fluctuation.

(2) Policy of Technical Level

WASAC has already operated the water treatment plants in Kigali City and expanded Nzove 2 WTP and New Nzove WTP. Thus, WASAC has already shared the technology regarding water supply facilities. Therefore, it is possible for WASAC to operate and manage the water supply facilities, mainly the water transmission facilities to be improved by the Project, through the completion of OJT and the soft component to improve their skills. The specifications of each facility and equipment shall be determined in consideration of the existing system and WASAC's skill level to operate the water supply facilities.

Water supply facilities to be improved by the Project shall be selected by reviewing if those meet the quality conditions such as long term weather resistance and durability performance. In addition, equipment and materials shall be selected adopting models or equipment types that are relatively easy to procure and to operate by WASAC and avoiding those that require special specifications. Also products that are easy to procure in Rwanda and that are prone to price competition shall be selected. Moreover, the selection of these shall be carried out by planning an acquisition system that allows the running cost to be more economical. In the selection of equipment, equipment failure shall be taken into consideration and conditions of after-sales

service after the installation shall be examined.

The Japanese Standards and International Standards such as JIS, BS, ACI and ASTM shall be applied as much as possible to provide a technical and economical appropriate design. Moreover, the Project aims to create or introduce an installation structure that will be easy to operate and maintain by minimizing the types of materials to be procured.

2-2-1-8 Policy of Construction, Procurement Measures and Time schedule

The Project is based on the scheme of Japanese Grant Aid. After concluding the Grant Agreement, the procurement and the construction shall be completed according to the required period. In order to achieve expectations and complete the Project within the timeline, cooperation for the construction work should be carried out between Japan and Rwanda. Also it is necessary to formulate a process plan that takes into account transport routes, transport methods, various procedures, etc.

In the Project, most of the areas of the transmission pipes laying route is wetland area, and thus the installation of pipes will be difficult during the rainy season. Therefore, construction works of the transmission pipes in the wetland area is planned only for the dry season. Construction works that will not be affected by rainfall, such as transmission pipe installation excluding wetland areas and pipes installation inside buildings, should be planned in the rainy season.

2-2-2 Basic Plan (Facility Design/Equipment Design)

2-2-2-1 Planned Target Year

The transmission pipeline to be replaced in the Project is a difficult task compared to other water supply facilities work as it is the core infrastructure in Rwanda and needs a large-scale expansion and various reviews. Therefore, it needs to be planned carefully with a long-term schedule. In the Japanese Design Criteria for Water Supply Facilities, the standard planed target year for facility design is set to be around 10 to 15 years from the project' planning phase. Thus, the planned target year of the Project has set as 2030, based on the Japanese Design Criteria for Water Supply Facilities.

2-2-2-2 Planed Water Supply Volume

The planned water supply volume will be set after comparing the water demand in water supply areas covered by Ntora Reservoir in 2030, which is the target year of the Project, with the water supply capacity at Nzove WTP.

The results of examination of the demand volume in 2030 and the water supply capacity of Nzove WTP is shown as below.

(1) Water Demand in Water Supply Areas Covered by Ntora Reservoir in 2030

1) Population Projection

① Population growth rate

In consultation with WASAC, the low scenario was adopted for the population growth rate taking into account to prevent the construction of an overlarge facility. The low scenario, which is the lowest population growth rate, was selected among the three population growth scenarios set in the Kigali City Master Plan (2013). Population growth rate of is set to 4.1% by 2025 and 1.8% by 2040.

Table 2-1 Population growth rate in Kigali City

	Low scenario	Medium scenario	High scenario
2012~2025 Year	4.1%	5%	5.8%
2025~2040 Year	1.8%	2.5%	2.5%

Source : Kigali City Master Plan（2013）

② Population projection (household)

The popupaltion of Kigali City is calculated based on the Fourth Population and Housing Census, Rwanda 2012 (RPHC4) issued by the National Institute of Statistics of Rwanda, a National Agency of Bureau of Statistics, on January of 2014. Population projection was created by multiplying the population of 2012, which is the base year of RPHC 4, and the population growth rate of the above-mentioned low scenario.

Table 2-2 Population projection of household

District		2012(Base year)			2018		
		Total	Urban	Rural	Total	Urban	Rural
Nyarugenge District		284,561	214,020	70,541	362,143	272,370	89,773
1	Gitega	28,728	28,728	0	36,560	36,560	0
2	Kanyinya	21,859	0	21,859	27,819	0	27,819
3	Kigali	30,023	4,748	25,275	38,208	6,042	32,166
4	Kimisagara	46,753	46,753	0	59,500	59,500	0
5	Mageragere	23,407	0	23,407	29,789	0	29,789
6	Muhima	29,768	29,768	0	37,884	37,884	0
7	Nyakabanda	25,666	25,666	0	32,663	32,663	0
8	Nyamirambo	40,292	40,292	0	51,277	51,277	0
9	Nyarugenge	21,302	21,302	0	27,110	27,110	0
10	Rwezamenyo	16,763	16,763	0	21,333	21,333	0
Gasabo District		529,561	365,371	164,190	673,939	464,984	208,954
1	Bumbogo	35,381	4,246	31,135	45,027	5,404	39,624
2	Gatsata	37,110	37,110	0	47,228	47,228	0
3	Gikomero	16,625	0	16,625	21,158	0	21,158
4	Gisozi	44,003	44,003	0	56,000	56,000	0
5	Jabana	33,577	9,271	24,306	42,731	11,799	30,933
6	Jali	25,057	3,808	21,249	31,888	4,846	27,042
7	Kacyiru	37,088	37,088	0	47,200	47,200	0
8	Kimihurura	21,672	21,672	0	27,581	27,581	0
9	Kimiromko	57,430	57,430	0	73,088	73,088	0
10	Kinyinya	57,846	53,162	4,684	73,617	67,656	5,961
11	Ndera	41,764	33,469	8,295	53,150	42,594	10,557
12	Nduba	25,370	0	25,370	32,287	0	32,287
13	Remera	43,279	43,279	0	55,078	55,078	0
14	Rusororo	35,453	20,833	14,620	45,119	26,513	18,606
15	Rutunga	17,906	0	17,906	22,788	0	22,788
Kicukiro District		318,564	279,941	38,623	405,416	356,263	49,153
1	Gahanga	27,808	11,698	16,110	35,389	14,887	20,502
2	Gatenga	48,640	46,306	2,334	61,901	58,931	2,970
3	Gikondo	17,146	17,146	0	21,821	21,821	0
4	Kagarama	14,385	14,385	0	18,307	18,307	0
5	Kanombe	44,426	44,426	0	56,538	56,538	0
6	Kicukiro	16,450	16,450	0	20,935	20,935	0
7	Kigarama	43,907	43,907	0	55,878	55,878	0
8	Masaka	39,548	19,369	20,179	50,330	24,650	25,681
9	Niboye	26,197	26,197	0	33,339	33,339	0
10	Nyarugunga	40,057	40,057	0	50,978	50,978	0
Total		**1,132,686**	**859,332**	**273,354**	**1,441,498**	**1,093,617**	**347,880**

District		2024			2030		
		Total	Urban	Rural	Total	Urban	Rural
Nyarugenge District		460,876	346,628	114,248	524,534	394,505	130,029
1	Gitega	46,528	46,528	0	52,955	52,955	0
2	Kanyinya	35,403	0	35,403	40,293	0	40,293
3	Kigali	48,625	7,690	40,935	55,342	8,752	46,590
4	Kimisagara	75,721	75,721	0	86,180	86,180	0
5	Mageragere	37,910	0	37,910	43,146	0	43,146
6	Muhima	48,212	48,212	0	54,872	54,872	0
7	Nyakabanda	41,569	41,569	0	47,310	47,310	0
8	Nyamirambo	65,257	65,257	0	74,271	74,271	0
9	Nyarugenge	34,501	34,501	0	39,266	39,266	0
10	Rwezamenyo	27,149	27,149	0	30,899	30,899	0
Gasabo District		857,679	591,756	265,923	976,145	673,492	302,653
1	Bumbogo	57,303	6,877	50,426	65,218	7,827	57,391
2	Gatsata	60,103	60,103	0	68,405	68,405	0
3	Gikomero	26,926	0	26,926	30,645	0	30,645
4	Gisozi	71,267	71,267	0	81,111	81,111	0
5	Jabana	54,381	15,015	39,366	61,893	17,089	44,803
6	Jali	40,582	6,167	34,415	46,188	7,019	39,168
7	Kacyiru	60,068	60,068	0	68,365	68,365	0
8	Kimihurura	35,100	35,100	0	39,948	39,948	0
9	Kimiromko	93,014	93,014	0	105,861	105,861	0
10	Kinyinya	93,688	86,101	7,586	106,628	97,994	8,634
11	Ndera	67,641	54,207	13,435	76,984	61,694	15,290
12	Nduba	41,089	0	41,089	46,765	0	46,765
13	Remera	70,095	70,095	0	79,777	79,777	0
14	Rusororo	57,420	33,741	23,679	65,351	38,402	26,949
15	Rutunga	29,001	0	29,001	33,006	0	33,006
Kicukiro District		515,947	453,393	62,554	587,212	516,018	71,194
1	Gahanga	45,038	18,946	26,092	51,259	21,563	29,696
2	Gatenga	78,778	74,997	3,780	89,659	85,356	4,302
3	Gikondo	27,770	27,770	0	31,605	31,605	0
4	Kagarama	23,298	23,298	0	26,516	26,516	0
5	Kanombe	71,953	71,953	0	81,891	81,891	0
6	Kicukiro	26,642	26,642	0	30,322	30,322	0
7	Kigarama	71,112	71,112	0	80,934	80,934	0
8	Masaka	64,052	31,370	32,682	72,899	35,703	37,196
9	Niboye	42,429	42,429	0	48,289	48,289	0
10	Nyarugunga	64,876	64,876	0	73,837	73,837	0
Total		**1,834,502**	**1,391,777**	**442,725**	**2,087,891**	**1,584,015**	**503,876**

Source: Study Team

③ Estimation of customers by industry

The estimation of customer growth by industry is calculated by extracting the water supply contracts of each industry from the customer database managed by WASAC (2016 performance) considering the number of contracts (actual values) of commerce, government agencies, and industries and using the growth rate described in the Kigali City Master Plan. The result of the estimation is shown as follows.

Table 2-3 Estimation of customer growth by industry

		2016（Average of Apr-Jul.2016）(Actual value)			2024			2030		
		Commercial	Government	Industry	Commercial	Government	Industry	Commercial	Government	Industry
NYARGENGE		1,237	169	15	1,706	233	21	1,942	265	24
1	Gitega	67	5	1	92	7	1	105	8	2
2	Kanyinya	2	2	0	3	3	0	3	3	0
3	Kigali	13	2	0	18	3	0	20	3	0
4	Kimisagara	117	5	2	161	7	3	184	8	3
5	Mageregere	0	0	0	0	0	0	0	0	0
6	Muhima	301	12	4	415	17	6	472	19	6
7	Nyakabanda	30	2	1	41	3	1	47	3	2
8	Nyamirambo	74	5	0	102	7	0	116	8	0
9	Nyarugenge	580	134	7	800	185	10	910	210	11
10	Rwezamenyo	53	2	0	73	3	0	83	3	0
GASABO		1,489	237	70	2,054	327	97	2,337	372	110
1	Bumbogo	22	3	4	30	4	6	35	5	6
2	Gatsata	67	3	1	92	4	1	105	5	2
3	Gikomero	0	0	0	0	0	0	0	0	0
4	Gisozi	102	11	0	141	15	0	160	17	0
5	Jabana	24	2	4	33	3	6	38	3	6
6	Jali	9	4	0	12	6	0	14	6	0
7	Kacyiru	204	48	2	281	66	3	320	75	3
8	Kimihurura	136	36	1	188	50	1	213	57	2
9	Kimironko	217	23	2	299	32	3	341	36	3
10	Kinyinya	200	59	7	276	81	10	314	93	11
11	Ndera	44	7	44	61	10	61	69	11	69
12	Nduba	0	0	0	0	0	0	0	0	0
13	Remera	415	32	3	572	44	4	651	50	5
14	Rusororo	49	9	2	68	12	3	77	14	3
15	Rutunga	0	0	0	0	0	0	0	0	0
KIKUKIRO		813	123	61	1,121	170	84	1,276	193	96
1	Gahanga	16	8	2	22	11	3	25	13	3
2	Gatenga	82	9	1	113	12	1	129	14	2
3	Gikondo	140	25	23	193	34	32	220	39	36
4	Kagarama	42	10	0	58	14	0	66	16	0
5	Kanombe	84	12	4	116	17	6	132	19	6
6	Kicukiro	110	12	24	152	17	33	173	19	38
7	Kigarama	86	10	0	119	14	0	135	16	0
8	Masaka	51	15	2	70	21	3	80	24	3
9	Niboye	105	5	3	145	7	4	165	8	5
10	Nyarugunga	97	17	2	134	23	3	152	27	3
Total		3,539	529	146	4,881	730	201	5,555	830	229

Source: Study Team

2) Calculation of Water Demand

① Water demand unit (households)

The unit of water demand for households was adopted from the unit described in the Kigali City Master Plan (2013) as shown below.

Table 2-4 Unit of water demand of households

Category	Water demand Unit
Urban	120 L/person
Rural	80 L/person

Source : Kigali City Master Plan (2013)

② Water demand unit（by industry）

The monthly average water usage of each industry (commerce, government agencies and industries) from April to July 2016 is shown in the table below.

Table 2-5 Water usage of each industry (Monthly average from April to July 2016)

Name of sector		Commerce		Government Agency		Industry	
		No. Contract	Consumption (㎥/Month)	No. Contract	Consumption (㎥/Month)	No. Contract	Consumption (㎥/Month)
Nyarugenge District		1,237	75,373	169	34,339	15	2,941
1	Gitega	67	1,394	5	587	1	1,285
2	Kanyinya	2	35	2	61	0	0
3	Kigali	13	159	2	8	0	0
4	Kimisagara	117	2,226	5	105	2	7
5	Mageregere	0	0	0	0	0	0
6	Muhima	301	12,809	12	4,750	4	525
7	Nyakabanda	30	1,763	2	55	1	49
8	Nyamirambo	74	2,390	5	418	0	0
9	Nyarugenge	580	53,279	134	28,293	7	1,075
10	Rwezamenyo	53	1,318	2	62	0	0
Gasabo District		1,489	88,737	237	45,125	70	21,813
1	Bumbogo	22	1,366	3	24	4	712
2	Gatsata	67	1,289	3	11	1	6
3	Gikomero	0	0	0	0	0	0
4	Gisozi	102	3,282	11	890	0	0
5	Jabana	24	666	2	16	4	339
6	Jali	9	378	4	333	0	0
7	Kacyiru	204	14,133	48	12,254	2	233
8	Kimihurura	136	16,986	36	17,904	1	142
9	Kimironko	217	7,970	23	1,935	2	12
10	Kinyinya	200	13,504	59	2,450	7	2,210
11	Ndera	44	1,481	7	831	44	5,819
12	Nduba	0	0	0	0	0	0
13	Remera	415	25,871	32	8,144	3	163
14	Rusororo	49	1,811	9	333	2	12,177
15	Rutunga	0	0	0	0	0	0
Kicukiro District		813	27,591	123	28,126	61	15,831
1	Gahanga	16	1,003	8	63	2	1
2	Gatenga	82	4,549	9	652	1	241
3	Gikondo	140	4,638	25	1,868	23	888
4	Kagarama	42	1,447	10	639	0	0
5	Kanombe	84	2,111	12	435	4	102
6	Kicukiro	110	4,798	12	1,731	24	14,052
7	Kigarama	86	1,451	10	307	0	0
8	Masaka	51	1,565	15	440	2	48
9	Niboye	105	2,646	5	224	3	380
10	Nyarugunga	97	3,383	17	21,767	2	119
Total		3,539	191,701	529	107,590	146	40,585

Source : WASAC water sales performance on April to June 2016 (Monthly average from April - July 2016)

Actual value of the average water consumption per one contract by industry is shown below.

Table 2-6 Monthly average of water supply (Actual value)

		Commerce	Government Agency	Industry
Average water supply (actual value)	㎥/connection/ month	54.2	203.4	278.0

Sousce : WASAC water sales performance on April to June 2016

The water demand unit by industry (planned average water supply per day/person) is calculated from the population rate of households in urban areas and rural areas in Kigali City. The calculation result is 110.3 L/person/day as shown in the tabel below.

Table 2-7 Predictive value of water demand in Kigali City（As of 2012）

		Urban	Rural	Total
Population in 2012		859,332	273,354	1,132,682
Unit of water demand	L/人/day	120	80	–
Total water demand	L	103,119,840	21,868,320	**124,988,160**

Source: Study Team

Planed average water supply per person per day

＝Total water supply（Urban supply＋Rural supply）÷ Population of Kigali City

＝124,988,160 L/day÷1,132,682 person＝110.3 L/person/day

In the Kigali City Master Plan, the current water supply volume of the whole city is 45 L/ person/day, and the water demand unit is 2.45 times more than the current unit (= 110.3 L/person/day÷45 L/person/day). This is because sufficient amount of water is not secured due to delays in strengthening the water facilities to suit Kigaki City needs as its population continues to increase. Water demand unit by industry is calculated by multiplying 2.45 to the actual value of water supply per contracts by industry.

Table 2-8 Water demand unit by industry

		Commerce	Government Agency	Industry
Average water supply (actual value)	㎥/connection/ month	54.2	203.4	278.0
Planned average water supply （predicted value of unit of water demand)	㎥/connection/ month	**132.8**	**498.7**	**681.6**

Source : Study Team

③ Planned revenue water ratio (RWR)

In WASAC 5 Year Strategic Business Plan 2015, WASAC has set a goal of reducing the non-revenue water ratio to 25% by 2020. Therefore, the planned revenue water ratio is 75%.

④ Planned load factor

There are three water treatment plants, Nzove, Karenge and Kimisagara, that distributes water in the Kigali City. The maximum daily water supply of each water treatment plant was calculated

from the operation results (from December 2015 to October 2016). The planned load factor was calculated from dividing the average water supply per day with the maximum water supply per day.

Table 2-9 Water production of each water treatment plant（actual performance）and load factor

Nzove WTP			Karenge WTP			Kimisagara WTP		
Total water supply		11,731,495 m3	Total water supply		5,035,587 m3	Total water supply		8,870,874 m3
Operation days *		336 days	Operation days *		336 days	Operation days *		336 days
Ave. water supply		34,915 m3/d	Ave. water supply		14,987 m3/d	Ave. water supply		26,401 m3/d
Max. water supply		45,553 m3/d	Max. water supply		15,930 m3/d	Max. water supply		29,692 m3/d
Max. value	Dec. 2015	23,391 m3/d	Max. value	Dec. 2015	15,028 m3/d	Max. value	Dec. 2015	26,829 m3/d
	Jan. 2016	23,982 m3/d		Jan. 2016	15,143 m3/d		Jan. 2016	26,961 m3/d
	Feb. 2016	35,980 m3/d		Feb. 2016	15,544 m3/d		Feb. 2016	27,224 m3/d
	Mar. 2016	44,786 m3/d		Mar. 2016	15,918 m3/d		Mar. 2016	28,682 m3/d
	Apr. 2016	43,497 m3/d		Apr. 2016	15,757 m3/d		Apr. 2016	28,598 m3/d
	May 2016	43,233 m3/d		May 2016	15,930 m3/d		May 2016	28,631 m3/d
	Jun. 2016	44,480 m3/d		Jun. 2016	15,778 m3/d		Jun. 2016	29,200 m3/d
	Jul. 2016	45,553 m3/d		Jul. 2016	15,858 m3/d		Jul. 2016	29,273 m3/d
	Aug. 2016	45,333 m3/d		Aug. 2016	15,811 m3/d		Aug. 2016	29,692 m3/d
	Sep. 2016	45,528 m3/d		Sep. 2016	15,686 m3/d		Sep. 2016	28,470 m3/d
	Oct. 2016	45,303 m3/d		Oct. 2016	15,590 m3/d		Oct. 2016	28,988 m3/d
Load factor rate		77%	Load factor rate		94%	Load factor rate		89%

* Calculation by WASAC Daily Report (1st December 2015 to 31st October 2016)

Source: The Study Team

⑤ Water demand volume estimation

The planned maximum water supply per day in the Kigali City in 2024 and 2030 was calculated based on the above conditions. The calculation results are shown in the table below.

Table 2-10 Planned maximum water supply per day in the Kigali City in 2024 and 2030

Sector		2024						2030					
		Domestic (m3/day)	Commercial (m3/day)	Government Institution (m3/day)	Industry (m3/day)	Design average daily supply (m3)	Design maximum daily supply (m3)	Domestic (m3/day)	Commercial (m3/day)	Government Institution (m3/day)	Industry (m3/day)	Design average daily supply (m3)	Design maximum daily supply (m3)
Nyarugenge District		50,735	7,553	3,875	470	81,423	105,036	57,743	8,597	4,410	535	92,670	119,544
1	Gitega	5,583	409	115	31	7,980	10,294	6,355	466	130	36	9,082	11,716
2	Kanyinya	2,832	12	46	0	3,757	4,847	3,223	14	52	0	4,276	5,517
3	Kigali	4,198	79	46	0	5,620	7,249	4,777	90	52	0	6,396	8,251
4	Kimisagara	9,087	714	115	63	12,972	16,734	10,342	813	130	71	14,764	19,045
5	Mageragere	3,033	0	0	0	3,943	5,086	3,452	0	0	0	4,487	5,789
6	Muhima	5,785	1,838	275	125	10,431	13,456	6,585	2,092	313	143	11,872	15,315
7	Nyakabanda	4,988	183	46	31	6,823	8,802	5,677	208	52	36	7,766	10,018
8	Nyamirambo	7,831	452	115	0	10,917	14,082	8,912	514	130	0	12,424	16,027
9	Nyarugenge	4,140	3,542	3,072	219	14,265	18,402	4,712	4,031	3,497	250	16,236	20,944
10	Rwezamenyo	3,258	324	46	0	4,716	6,083	3,708	368	52	0	5,367	6,923
Gasabo District		92,285	9,092	5,434	2,194	141,705	182,800	105,031	10,348	6,184	2,497	161,278	208,049
11	Bumbogo	4,859	134	69	125	6,744	8,700	5,531	153	78	143	7,676	9,902
12	Gatsata	7,212	409	69	31	10,038	12,949	8,209	466	78	36	11,425	14,738
13	Gikomero	2,154	0	0	0	2,800	3,612	2,452	0	0	0	3,187	4,111
14	Gisozi	8,552	623	252	0	12,255	15,809	9,733	709	287	0	13,948	17,993
15	Jabana	4,951	147	46	125	6,850	8,836	5,635	167	52	143	7,796	10,056
16	Jali	3,493	55	92	0	4,732	6,104	3,976	63	104	0	5,386	6,947
17	Kacyiru	7,208	1,246	1,101	63	12,502	16,128	8,204	1,418	1,253	71	14,229	18,355
18	Kimihurura	4,212	830	825	31	7,669	9,893	4,794	945	939	36	8,728	11,259
19	Kimiromko	11,162	1,325	527	63	17,000	21,930	12,703	1,508	600	71	19,348	24,959
20	Kinyinya	10,939	1,221	1,353	219	17,852	23,029	12,450	1,390	1,540	250	20,318	26,210
21	Ndera	7,580	269	160	1,379	12,204	15,743	8,626	306	183	1,569	13,889	17,917
22	Nduba	3,287	0	0	0	4,273	5,513	3,741	0	0	0	4,864	6,274
23	Remera	8,411	2,534	734	94	15,305	19,744	9,573	2,884	835	107	17,419	22,471
24	Rusororo	5,943	299	206	63	8,465	10,920	6,764	341	235	71	9,634	12,428
25	Rutunga	2,320	0	0	0	3,016	3,891	2,641	0	0	0	3,433	4,428
Kicukiro District		59,412	4,964	2,820	1,912	89,840	115,893	67,618	5,650	3,210	2,176	102,249	131,901
26	Gahanga	4,361	98	183	63	6,116	7,890	4,963	111	209	71	6,961	8,979
27	Gatenga	9,302	501	206	31	13,053	16,838	10,587	570	235	36	14,856	19,164
28	Gikondo	3,332	855	573	721	7,126	9,192	3,793	973	652	820	8,110	10,462
29	Kagarama	2,796	256	229	0	4,266	5,503	3,182	292	261	0	4,855	6,263
30	Kanombe	8,634	513	275	125	12,412	16,011	9,827	584	313	143	14,126	18,223
31	Kicukiro	3,197	672	275	752	6,365	8,211	3,639	764	313	856	7,244	9,345
32	Kigarama	8,533	525	229	0	12,074	15,576	9,712	598	261	0	13,742	17,727
33	Masaka	6,379	311	344	63	9,226	11,902	7,260	354	391	71	10,500	13,546
34	Niboye	5,091	641	115	94	7,724	9,963	5,795	730	130	107	8,790	11,340
35	Nyarugunga	7,785	592	390	63	11,479	14,808	8,860	674	444	71	13,064	16,853
Total		202,431	21,610	12,128	4,575	312,968	403,729	230,392	24,595	13,804	5,207	356,197	459,494

Source: Study Team

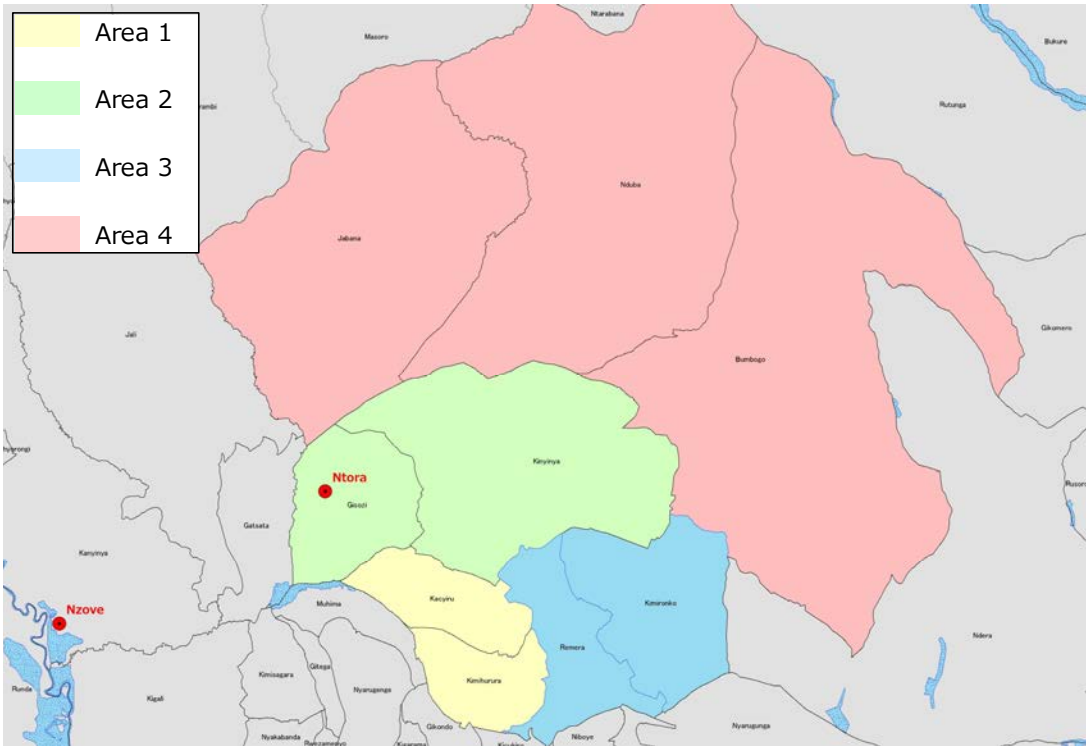
The water supply areas covered by Ntora Reservoir in the Project is the area indicated by orange highlight in the above table. These areas are categorized into four areas as shown in the table below. Area 1 is Kacyiru and Kimihurura located in the southern part of Ntora Reservoir, where water distribution is carried out by an outflow pipe connected to only one reservoir, Ntora Reservoir. Area 2 is Gisozi including Ntora Reservoir and Kinyinya located to the east of Ntora Reservoir. Area 3 is located in the southeast of the Nottra water reservoir adjacent to Kinyinya in area 2, where water distribution is carried out via Konyinya from the Nottra water reservoir. These Areas 1 to 3 are the water supply areas currently covered by Ntorra reservoir. At the present, Area 4 does not belong to the water supply area of WASAC; however WASAC is planning to develop a transmission pipeline to the northern part of the Kigali City, which is an unserved area, with the cooperation of AfDB. The transmission pipe is planned to be extended from Ntora Reservoir. Therefore, in the Project, water demand is calculated for 4 areas including Area 4.

Table 2-11 Area covered by Ntora Reservoir

No.	Area	Sector	Elevation of target supply area	Remark
1	Area 1	Kacyiru	1400m~1850m	Areas covered by Ntora Reservoir
2		Kimihurura		
3	Area 2	Gisozi	1450m~1850m	
4		Kinyinya		
5	Area 3	Kimironko		
6		Remera		

No.	Area	Sector	Elevation of target supply area	Remark
7	Area 4	Bumbogo	1400m~1800m	Water supply area which will be covered by the new water supply pipe planned by WASAC
8		Nduba		
9		Jabana		

Source: Study Team



Source: Study Team

Figure 2-1 Water supply areas covered by Ntora Reservoir

In case that the water is distributed from Ntora Reservoir to these four areas, the diference in elevation from Ntora Reservoir is set as 100 m considering the range that allows to distribute the water with an appropriate water pressure from Ntora Reservoir (GL: about 1,550 m). For the Kacyiru area, water is distributed from the Kimisagara WTP (GL: about 1430 m); however, water supply is difficult in some areas of Kacyiru where the altitude exceeds about 1,400 m. Therefore, the areas of Kacyiru which have diference in elevation from Ntora Reservoir up to 150 m will be included in the water supply area. As for the unserved area (Area 4)) in the northern part of Kigali City, where WASAC is planning to develop a transmission pipeline, water will be only distributed from Ntora Reservoir. Thus, all areas of Area 4 were calculated to be the target of water supply covered by Ntora Reservoir in the Project, regardless of its elevation. Pump pressure, depressurizing facilities, etc. will be prepared as necessary in future plans for the northern area where WASAC does not supply water yet.

Table 2-12 Water demand volume of the service area covered by Ntora Reservoir in 2024

Area	No.	SECTOR	1300-m(G.L)	1350-m(G.L)	1400-m(G.L)	1450-m(G.L)	1500-m(G.L)	1550-m(G.L)	1600-m(G.L)	1650-m(G.L)	1700-m(G.L)	1750-m(G.L)	1800-m(G.L)
			m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d
Area1	1	Kacyiru	323	4,125	10,374	10,465	409	133	70	59	20	39	5
	2	Kimihurura											
	Usage rate by elevation		1.2%	15.9%	39.9%	40.2%	1.6%	0.5%	0.3%	0.2%	0.1%	0.1%	0.0%
Area1 total		26,021	4,448		21,573								
Area2	3	Gisozi	305	3,065	15,386	16,528	2,497	634	118	106	73	56	72
	4	Kinyinya											
	Usage rate by elevation		0.8%	7.9%	39.6%	42.6%	6.4%	1.6%	0.3%	0.3%	0.2%	0.1%	0.2%
Area2 total		38,838	18,756		20,082								
Area3	5	Kimironko	162	1,468	12,878	19,669	5,924	423	137	111	42	52	807
	6	Remera											
	Usage rate by elevation		0.4%	3.5%	30.9%	47.2%	14.2%	1.0%	0.3%	0.3%	0.1%	0.1%	1.9%
Area3 total		41,673	14,508		27,165								
Area 1+2+3 TOTAL			790	8,659	28,264	57,035	8,830	1,190	325	275	134	147	883
			0.7%	8.1%	26.5%	53.5%	8.3%	1.1%	0.3%	0.3%	0.1%	0.1%	0.8%
			37,713			**68,820**							
Area4	7	Bumbogo	**23,048**										
	8	*Nduba*											
	9	Jabana											
TOTAL (Area 2,3 >1,450m+Area1>1,400m+Area4)			-			**91,868**							
TOTAL (Area 2,3<1,450m +Area1<1400m)			**37,713**			-							
Grand Total			**129,581**										

Source: Study Team

Table 2-13 Water demand volume of the service area covered by Ntora Reservoir in 2030

Area	No.	SECTOR	1300-m(G.L)	1350-m(G.L)	1400-m(G.L)	1450-m(G.L)	1500-m(G.L)	1550-m(G.L)	1600-m(G.L)	1650-m(G.L)	1700-m(G.L)	1750-m(G.L)	1800-m(G.L)
			m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d	m3/d
Area1	1	Kacyiru	367	4,695	11,806	11,910	466	151	80	67	22	44	5
	2	Kimihurura											
	Usage rate by elevation		1.2%	15.9%	39.9%	40.2%	1.6%	0.5%	0.3%	0.2%	0.1%	0.1%	0.0%
Area1 total		29,615	5,062		24,552								
Area2	3	Gisozi	347	3,489	17,511	18,810	2,842	722	134	120	83	64	82
	4	Kinyinya											
	Usage rate by elevation		0.8%	7.9%	39.6%	42.6%	6.4%	1.6%	0.3%	0.3%	0.2%	0.1%	0.2%
Area2 total		44,203	21,347		22,856								
Area3	5	Kimironko	184	1,671	14,657	22,386	6,742	482	156	126	48	60	918
	6	Remera											
	Usage rate by elevation		0.4%	3.5%	30.9%	47.2%	14.2%	1.0%	0.3%	0.3%	0.1%	0.1%	1.9%
Area3 total		47,429	16,512		30,917								
Area 1+2+3 TOTAL			899	9,855	32,168	64,913	10,049	1,355	370	313	153	168	1,005
			0.7%	8.1%	26.5%	53.5%	8.3%	1.1%	0.3%	0.3%	0.1%	0.1%	0.8%
			42,922			**78,326**							
Area4	7	Bumbogo	**26,232**										
	8	*Nduba*											
	9	Jabana											
TOTAL (Area 2,3 >1,450m+Area1>1,400m+Area4)			-			**104,557**							
TOTAL (Area 2,3<1,450m +Area1<1400m)			**42,922**			-							
Grand Total			**147,479**										

Source: Study Team

(2) Capacity of Water Distribution of Nzove WTP

There are three systems of water treatment plant (WTP), Nzove 1 WTP, Nzove 2 WTP, and New Nzove 1 WTP, in Nzove WTP. After the construction of Nzove 1 WTP, which operation started first, WTP of Nzove 2 and New Nzove 1 were added. Until 2017, Nzove 1 WTP and Nzove 2 WTP were operated. New Nzove 1 WTP was under construction but currently the construction of New Nzove 1 WTP is completed and started its operation in April 2018 on a trial basis.

Table 2-14 Water Treatment capacity of Nzove WTP

Nzove WTP (㎥/day)		Design Volume (㎥/day)	Maximum Production Ability (㎥/day)	Current Production Volume (Average) (2017: ㎥/day)	Maximum Production Volume (2018)	Maximum Production Volume (after 2024)
Ntora	Nzove1 WTP	40,000	25,000	17,000	25,000	25,000
	Nzove2-1 WTP	25,000	25,000	21,750	25,000	25,000
	Nzove2-2 WTP	15,000	15,000	Not operated	15,000	15,000
	New Nzove 1-2WTP	25,000	25,000	Under Construction (Phase I)	-	25,000 (Phase II is essential)
	Sub Total -Breakdown-	105,000	90,000	38,750	65,000	90,000
	・Ntora Reservoir	**102,000**	**87,000**	**35,750**	**62,000**	**87,000**
	・Kimisagara WTP	3,000	3,000	3,000	3,000	3,000
Mount Kigali	New Nzove 1-1WTP	40,000	40,000	Under Construction (Phase I)	40,000	40,000
Total		145,000	130,000	38,750	105,000	130,000

※The table shows the maximum water treatment capability of the Nzoze water treatment plant. The water supply amount planned in 2024 is 52,800 ㎥/day (average water supply amount) indicated in the chapter of 3-4-2 (1) Quantitative impact.

Source: Study Team

From the total amount of water treated at Nzove WTP, the maximum amount of water to supply to Ntora Reservoir is 87,000 ㎥/day in 2024. Regarding to the New Nzove 1 WTP, the construction of a facility has been completed – which satisfies the water supply of 65,000 ㎥/day, together with the water supply amount to Mount Kigali, 40,000 ㎥/day. However, only water pumps that deliver water of 40,000 ㎥/day to Mount Kigali are being equipped. On basis that Rwanda shall prepare the pressure filter and water supply pumps to deliver the planned water of 25,000 ㎥/day to Ntora Reservoir, the Project has set the water supply volume of Ntora pipe-system from Nzove WTP as 87,000 ㎥/day.

(3) Planned Water Supply Volume

Water demand in 2030 is estimated to be about 105,000 ㎥/day from the above. On the other hand, the capacity of water supply that can be delivered from Nzove WTP is estimated as 87,000 ㎥/day in 2024. The water demand volume of 105,000 ㎥/day is confirmed; however, currently the Nzove WTP development plan with more water supply capacity of 87,000 ㎥/day is not confirmed. Thus, the planned water supply volume to be set in the Project shall be 87,000 ㎥/day based on the expansion plan that can be confirmed at the present. However, the replaced transmission pipeline shall be designed to allow 105,000 ㎥/day of water supply in case of expansion plan for Nzove WTP in the future.

2-2-2-3 Construction Plan

The Project components are shown in the table below. The Project set the target year as 2030 and aims to improve the facilities between Nzove WTP and Ntora Reservoir in accordance with the planned water supply volume of 87,000 ㎥/day. Major construction works of the Project are the replacement of transmission pipeline between Nzove WTP and Ntora Reservoir, an expansion of Nzove WTP to meet the planned water supply volume, establishment of an elevated water tank at Ntora Reservoir, and restructure of outflow pipes of Ntora Reservoir.

Table 2-15 the Project Components

Items	Target		Specifications
Transmission Pipeline	Transmission Pipeline	Planned water supply volume	87,000 ㎥/day
		Diameter	900 mm
		Total length of pipe	9,400 m
		Pipe type	Steel pipe: 8,000 m (from Nzove WTP to the steep hill)
			Ductile iron pipe: 1,400 m (from the steep hill to Ntora Reservoir)
		River Crossing	6 places
			River crossing method: inverted siphon will be implemented in all six places
	Air valve		9 places
	drain valve		4 places
Nzove WTP	Installation of additional water pumps		Capacity: 22,000 ㎥/day Pump head: 240 m Pumping rate: 7.6 ㎥/min (11,000㎥/day) x 3 - 3 pumps (Two for operation and one for reserve)
	Compression tank		1 set
	Pump station		New water pump station for additional water pumps at Nzove WTP
	Meters and gauges		Two flowmeters One at conduit pipe of Nzove 1 WTP Another at inlet pipe of the new pump station
Ntora Reservoir	Ntora Reservoir		Restructure of two outflow pipes from Ntora Reservoir Installation of new ventilation holes at Ntora Reservoir
	Elevated water tank		Volume: 200 ㎥ (10m x 10m x 2.5m) Height: 10 m Material: Steel Frame: RC
	Lifting pump		Capacity:576㎥/day Pump head: 20m Pumping rate: 0.4 ㎥/min (576 ㎥/day) x 2 -Two pumps (one for operation and another for reserve)

Items	Target	Specifications
	Meters and gauges	Three flowmeters One for inlet pipe of Ntora Reservoir One for an outflow pipe to Kacyiru area One for a transmission pipeline (to Fawe Girls School Reservoir) Four water level gauges Two for each tank (double tank type) of Ntora Reservoir Two for each elevated tank (double tank type)

Source: Study Team

(1) Transmission Pipeline

1) Route of the Transmission Pipeline to be installed

Seven routes for the new transmission pipeline to be installed were examined in consultation with WASAC. The yellow line route shown below has been chosen for the Project.

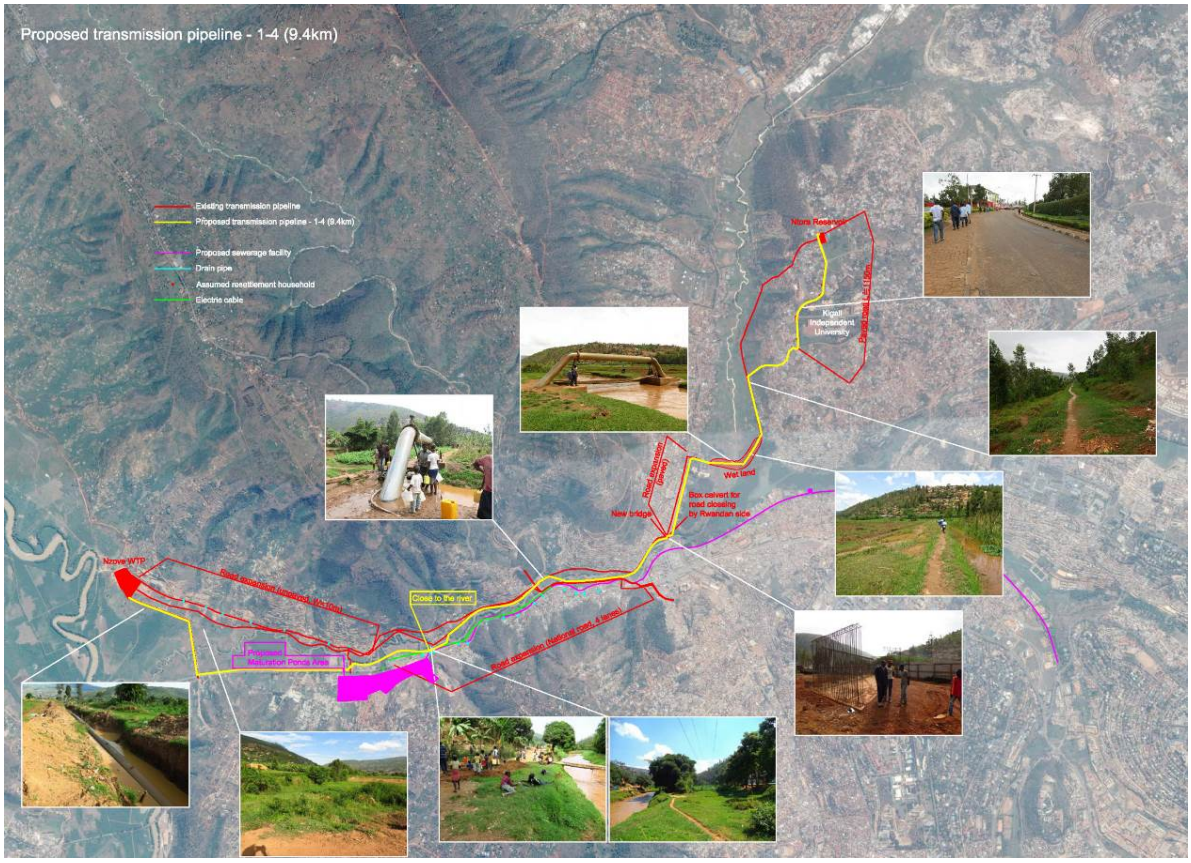


Figure 2-2 Route of transmission pipeline

In selecting the route of the transmission pipeline, the following points were carefully consulted with the Rwandan side and the final route was decided for the Project.

① Permission to install the transmission pipeline under the public road

In consultation with the Rwandan side, it has been confirmed that the installation of transmission pipeline under the paved road is difficult. Although the existing transmission pipeline is installed under an unpaved public road in the neighborhood of Nzove WTP, this unpaved road is expected to be paved in the near future. Thus, the new transmission pipeline to

be implemented will cross the Nyabugogo River from Nzove WTP and will be installed along RN1 National Road.

② Interaction with the existing transmission pipeline

In the case of avoiding the installation under the public roads, the existing and new transmission pipeline to be implemented will be laid in parallel at some sections. If this is the case, the pipes will be exposed when excavation work is carried out in the route where is close to the bent pipe sections of the existing pipeline. The earth pressure will no longer act on concrete protection against uneven force in the existing pipeline and it will move with water pressure. There is a high risk of serious leakage accident due to the uncoupling of pipes. Thus, the construction plan was made avoiding the route close to the bent pipe sections of the existing pipes in consideration of construction safety.

2) Diameter of Transmission Pipe

The Project sets the diameter of the transmission pipeline as 900 mm to distribute the planned water supply volume of 87,000 ㎥/day. The diameter setting was calculated by the Hazen Williams equation that is common in designing a water supply pipeline. The set basic value and calculation result are as follows.

$h = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$

h = Friction head loss（m）
L = Length of the pipe（m）
Q = Flow rate（㎥/s）
D = Diameter（m）
C = Velocity coefficient
V = Mean flow velocity in the pipe（m/s）
I = Hydraulic gradient (‰)

Set Basic Value

Flow rate Q＝87,000 ㎥/day（1.007 ㎥/s）
Length of the pipe L＝9,400m
Velocity coefficient C＝110
（Adopt the design value in Japanese Design Criteria for Water Supply Facilities）
Diameter D＝900mm（0.9m）
Difference in elevation＝208.5m

Result

Flow velocity V＝1.58m/s
Hydraulic gradient I＝3.02‰
Friction head loss h =around29.3m
Total head= around 237.8m

In this Project the optimum diameter is 900 mm which is calculated based on the planned water supply volume of 87,000 ㎥/day. The water demand in the target year of 2030 is 105,000 ㎥/day (1.215 ㎥/s) which is calculated by applying the water demand into the Hazen Williams equation and the results are shown below. Although the flow velocity, hydraulic gradient, and

head loss are all larger than 87,000 ㎥/day, this does not cause any issues in water supply. Thus, even if further expansion of water treatment plant is planned in the future, the water supply up to 105,000 ㎥/day is possible. If the water supply volume of the replaced transmission pipeline increases, both flow velocity and total head will increase. Thus, the water supply pump needs to be redeveloped according to an increase in flow velocity and total head.

Flow velocity V＝1.91m/s
Hydraulic gradient I＝4.27‰
Friction head loss h ＝about 41.5m
Total head=about 250.0m

3) Type of Pipes

The total length of the new transmission pipeline is about 9.7 km. Most of its route (about 8 km) will run in parallel to the Nyabugogo River in Nyabarongo River branch, where some parts the ground is soft, and thus part of the pipeline will be laid in flood plains despite the soft ground. Furthermore, it is important to take some measures against uneven force by high water pressure as a result of differences in elevation from Ntora Reservoir. The examination results of pipe type selection under these conditions are shown in the following table. Resin materials, such as PVC pipe, high-density PE pipe, reinforced plastic composite pipe, are not considered because those are not adequate for high water pressure.

Table 2-16 Results of examination of pipe type selection

Material	Pros	Cons
Ductile cast iron pipe	−High strength −High in toughness and strong against impact −High workability −Variety types of fittings can be selected	−The weight is relatively heavy −Pipe lying in soft ground and areas with high water pressure requires a large-scale measure against uneven force including concrete protection −It is necessary to adopt a separation-prevention coupling and the unit cost of the pipe becomes expensive
Steel pipe	−High strength（Tension / bending） −High in toughness and strong against impact −Integration of the pipe is possible with a welded joint and it is unnecessary to adopt a separation-prevention coupling	−Insertion of temperature expansion joint and flexible joint might be necessary in some cases −Consideration for electric erosion is necessary −It takes time to weld and paint fittings and it is difficult to install on spring ground.

Source: Study Team

Based on the result of the consideration, the Project selects steel pipes that is superior in dealing with uneven force in the areas with high water pressure and soft ground. In the case that ductile cast iron pipes are selected in the areas with the conditions mention above, it is necessary to use a combination of separation-prevention coupling and concrete protection. However, a large-scale concrete protection will be required increasing the weight pressure to the fragile or soft ground and in some cases it may sink. Pile foundation is also likely to be required to prevent the subsidence. Therefore, steel pipe is selected for the Project areas with high water pressure; and ductile cast iron pipe, that has high workability, is selected for the areas with low

water pressure where the standard of difference in altitude is within 100m from Ntora Reservoir.

① Steel pipe

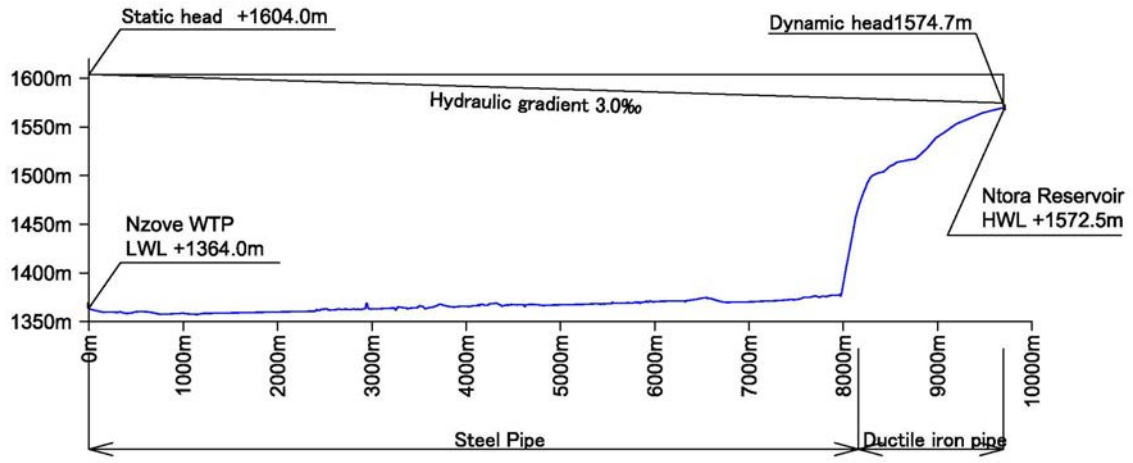
Steel pipes shall be coated steel pipes for water services stipulated in JWWA G 117 and all pipes shall be welded. The entire pipeline is integrated by welding, and the elastic force of steel pipes and the restraining force of the ground help absorb the uneven force caused by water pressure. Therefore, protecting works are not required at bent sections of the pipes. However, in case the effective length of the steel pipe against uneven force cannot be ensured at the sections of branch or installed valves, concrete protection shall be implemented.

The steel pipes plan to be laid about 8 km of the high water pressure section. The burial depth shall be 2 m for the section at the flood plain of the Nyabugogo River. Meanwhile, the burial depth of 1.5 m shall be secured for the other unpaved road sections, mainly parallel to existing transmission pipeline.

② Ductile cast iron pipe

A ductile cast iron pipe shall adopt a Tyton-type shape in a linear part, while it adopts a mechanical type in a bent pipe section where uneven force acts. A retainer gland with separation preventing function shall be used for mechanical type. Additionally, concrete protection shall be used for the section where separation preventing function cannot cope with uneven force because of the status of water pressure and pipe angles.

The burial depth of the ductile cast iron pipe shall be 1.2 m which is generally use for public roads in Japan.



Source: Study Team

Figure 2-3 Longitudinal diagram of new transmission pipeline

4) Pipe Thickness and Allowable Stress of Steel Pipe

The pipe thickness of the steel pipe was calculated based on the steel pipe for water services by the Japan Water Steel Pipe Association, and it was set to be thick enough to withstand high water pressure. The design conditions are as follows.

Table 2-17 Design for pipe Thickness Calculation

Design			
Outer diameter	914.4	mm	
Thickness	8. 0	mm	
Material	STW 400		
Elastic modulus of steel (E)	200,000	N/㎟	
Allowable deformation rate (painting) (%)	5	%	
Allowable stress degree (σa)	140 210	N/㎟ N/㎟	(Hydrostatic pressure only) (Hydrostatic pressure + water hammer pressure)
Pressure head	240 355 374	m m m	Hydrostatic pressure (internal pressure (P): 2.35 Mpa) Hydrostatic pressure + water hammer pressure (internal pressure (P): 3.48 Mpa) : 87,000㎥ Hydrostatic pressure + water hammer pressure (internal pressure (P): 3.67 Mpa) : 105,000㎥
Clay covering	2.0	M	
Base support angle (°)	90	°	
Unit volume weight of soil (Ys)	18	kN/㎥	
Reaction force coefficient of soil (E ')	1.4	N/㎟	Soil classification: Silt ML, light compaction
Wheel load	2	unit	T-25
Shape factor (f)	1.5		

Source: Study Team

① Study on internal pressure

The following calculations are carried out based on the design conditions.

In the case that the pipe thickness is 8 mm, the circumferential stress degree by the internal pressure is 132.1N/m ㎡, only for hydrostatic pressure. This is less than the allowable value of 140N/m ㎡. In the case that hydrostatic pressure and water hammer pressure are taken into consideration, the circumferential stress degree by the internal pressure with water supply amount 87,000 ㎥/day is 195.3N/m ㎡, the circumferential stress degree by the internal pressure with water supply amount 105,000 ㎥/day is 205.8 N/m ㎡ , which is less than the allowable value of 210N/m ㎡.

② Study on external pressure

- Deformation rate

The deformation rate corresponds to external pressure is 2.8% and it is less than the allowable deformation ratio of 5%. Therefore, there is no issue.

- Bending stress

The bending stress degree against external pressure is 125.6 N/m ㎡, which is less than allowable stress level of 140N/m ㎡.

5) Measures against Corrosion of Pipes

Steel pipe coating will be carried out as follows. Coating which can withstand long-term use shall be applied. Ductile cast iron pipe needs to be protected with polyethylene sleeves as a countermeasure against corrosion.

Table 2-18 Paint specifications for ductile cast iron pipes and steel pipes

	Interior	Exterior	Welding	
			Interior	Exterior
Steel pipe	JWWAK 157 Solvent-free epoxy resin coating	JWWAK 151 Polyurethane coating	JWWAK 157 Solvent-free epoxy resin coating: 0.3 mm (Including primer 0.4 mm)	JWWA K 153 Joint coat

	Interior	Exterior
Ductile cast iron pipes	Straight pipe: JWWA A 113 Mortar lining Deformed pipe: JWWA G 112 Epoxy resin powder coating 0.3mm	Straight and deformed pipe (including joint): JWWA K 139 Synthetic resin paints JWWA K 158 Polyethylene sleeve

Source: Study Team

6) Countermeasure to Water Hammer Pressure and Negative Pressure

As a countermeasure to the water hammer pressure of the new transmission pipeline to be implemented, compression tank will be installed in Nzove WTP. The installation of a flywheel in a pump in addition to a compression tank is a common measure against water hammer pressure; however, only few Japanese pump manufacturers are dealing with flywheels. If the Project adopts the installation of flywheel in this circumstances, procuring a pump corresponding to the flywheel in Rwanda at the time of renewal of the pump will be difficult. In addition, countermeasures against the water hummer pressure with a compression tank have been already carried out on existing pumps. Thus, the Project will not adopt a flywheel.

As shown in the figure below, when measures against water hammer pressure are not applied to the new transmission pipeline, a negative pressure will be generated when the pipeline passes 8 km from Nzove WTP. However, water hammer pressure will be relieved by installing a compression tank; and as result no negative pressure will not occur in the transmission pipeline.

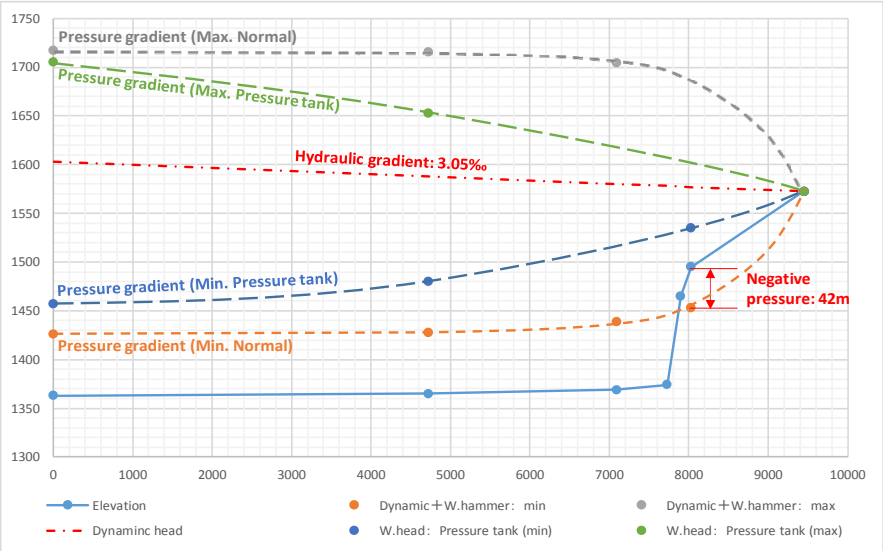


Figure 2-4 Measures against water hammer pressure

Therefore, the measure against water hammer pressure will be taken by installing a compression tank. However, the transmission pipeline shall be designed following the condition that the pipe will not be affected by water pressure, even if the compression tank cannot operate by any chance, and with the maximum water pressure in case the measure is not implemented.

7) River Crossing

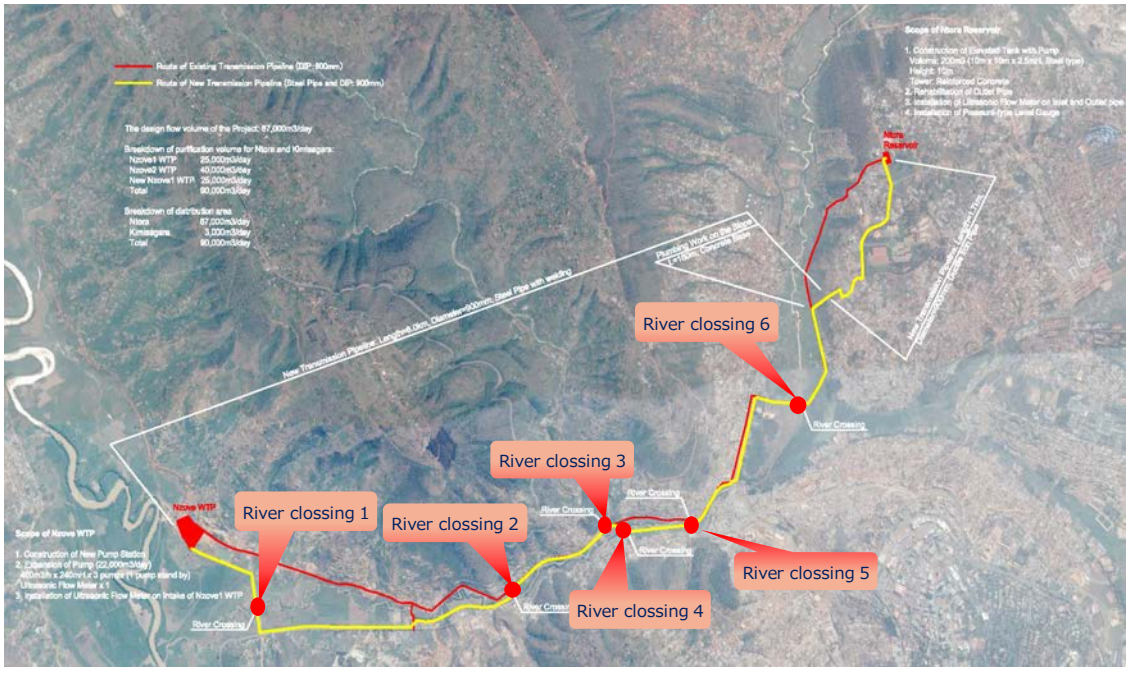
① Ground of river crossing section

The ground survey results of the route for the new transmission pipeline are shown below. The survey results of the soft ground along river, including river crossing section (earth covering 2m, excavation depth 3m), are that the N value is very small as approximately 1 to 4.

Table 2-19 Geological Survey Result (N Value)

Depth(m)	No.1	No.2	No.3	No.4	No.5	No.6
1	1	3	3	2	17	8
2	1	2	2	4	43	2
3	2	2	3	4	72	1
4	1	3	2	7	79	1
5	1	2	4	12	91	2
6	1	4	4	1	97	1
7	19	14	3	2	101	2
8	16	100	5	3	91	2
9	4	100	9	6	110	3
10	3	100	7	6	112	2
11	2	100	9		113	3
12	2	100	11		115	6
13	3	100	7		120	4
14	3		6			16
15	1		4			41
16	2		5			93
17	1		5			98
18	2		4			84
19	1		6			102
20	2		6			101

Source: Study Team



Source: Study Team

Figure 2-5 Ground survey spot at crossing river

② River crossing method

There are six rivers passing the route for new transmission pipeline to be implemented. As a method of crossing the rivers, the construction work can be carried out by either water pipe bridges or pipe jacking method underneath the river. In the case of a water pipe bridge, due to structural problems, the thickness of the pipe needs to be thicker; and as a result the water pipe bridge becomes heavier. Thus, the foundation needs to be enlarged to support the weight. However, since the transmission pipeline route of the Project is soft ground, it may not possible to secure enough ground tolerance to withstand weight, and pile construction will be necessary. The foundation of the existing pipeline is inclined despite the fact that a pile construction is applied. Judging from this situation, when planning a water pipe bridge in the Project, it seems to be difficult to maintain the function of a water pipe bridge with a pile construction. In addition, it is necessary to use other materials such as flexible pipes due to the difference in settlement characteristics in the ground of the water pipe bridge and the transmission pipeline and will increase greatly the cost of the Project cost. Therefore, the construction work will be completed with a pipe jacking method underneath the river applying it to all river crossing/passing of the transmission pipeline.

- Type of pipe jacking method

A slurry type pipe jacking method that is classified into a sealing type pipe jacking method is adopted for the Project.

- Launch and reception shafts

A steel sheet pile method will be used as a shaft method necessary for pipe jacking method. In this method, water cut-off performance on the wall is secured by inserting a joint of a sheet pile into another joint.

① Construction method

While excavating the underground with an excavator, a pipe sleeve (hume pipe: 1100 mm diameter) is inserted from a launch shaft and the excavator will drill up to the reception shaft. After an injection of the pipe sleeve, the transmission pipe will be installed inside; and mortar is filled in the gap between the pipe sleeve and the transmission pipe.

8) Temporary Bridges

For the installation of the transmission pipeline, a transportation and construction of the equipment and materials for the construction work are required across the Nyabugogo River. Therefore, the installation of temporary bridges, which are made of steels, at three places are planned. These shall be installed ensuring 50 cm of high from the water level of the river and shall be removed after completion of construction

9) Pipe on the Slope

The new transmission pipeline is planned to run through a route along the river, passing the slope facing Ntora Reservoir and reaching its final destination the Ntora Reservoir. The slope has a gradient of about 28 degrees and the ground is stable. However, the transmission pipe will be difficult to bury on the slope because of the presence of many rocks. In the case of burying the pipe on the slope, there is a possibility of occurring displacement along the slope after the construction; measures to immobilize the transmission pipeline on the slope will be necessary. Consequently, the Project plans to lay the transmission pipe, made of steel pipe, exposing the pipe on the slope. The following construction work will be planned to lay the pipe in stable condition of the slope and in consideration of safety. First, rock excavation is carried out to

make hollows at constant intervals on the slope, followed by a formation of a bottom plate of reinforced concrete. Subsequently, the transmission pipe is placed on the bottom plate and several points of the pipeline are reinforced by concrete for stabilization. In construction, transporting and discharging of excavated soil and freshly mixed concrete will be carried out by installing a monorail. An implementation of the pipes will be performed by pulling down them from the top of the slope with a wire using a winch; and welding them in order from the lower part of the slope to connect each pipe.

10)Incidental Equipment

Air valves and drainage valves are installed in the new transmission pipeline. The air valves are installed on the route of the transmission pipeline, the convex part, and the upper part of the slope. The discharge valves are installed in 4 places at the river crossing part where direct discharge to the river is possible after branching 250 mm from principal water transmission pipeline. Since the transmission pipeline is a high water pressure pipeline, the gate valve is not installed because it is highly likely to fail and cannot guarantee long-term operation.

11)Existing Transmission Pipeline

Table 2-20 Existing transmission pipeline specification

Diameter	600mm	Total extension	8,850m
Type	Ductile cast iron pipes	Water pipe bridge	2 bridges

Source: Study Team

Ductile cast iron pipes are used for the existing transmission pipeline, and they are connected by a joint structure called a Tyton type. The existing transmission pipeline is crossing the river through two water pipe bridges. The water pipe bridges are steel pipes, and both sides of the pipes are joined by flanges. Water leakage occurred from the flange part of these two pipe bridges, and one pipe bridge was repaired by welding the flange part. However, the other pipe bridge is still leaking. Since the suspension of water is required for repairing the leaking flange part, repair work is not carried out at the present. The basic structure of these water pipe bridges is a pile foundation type. Although 4 steel pipe piles of 200mm in diameter are installed and the depth of the piles foundation is around 20m, the foundation is inclined at one of the pipe bridge due to the water pressure.

Regarding the bent pipe sections of the existing transmission pipeline, the bent part exceeding 45 ° is designed to withstand the uneven force by using a concrete protection. However, in the section where the bent pipe is less than 45 ° and where the transmission pipeline is laid loosely with a bent and no concrete protection — the pipes can be gradually displaced due to water pressure over time because the ductile cast iron pipe being used is not attached with a retaining function. Thus, leakage may occur when the pipe is detached. Even in the areas that have concrete protection, there is a possibility that sufficient protection has not been carried out — judging from the occurrence of water leakages at the water pipe bridges and the current situation of inclination of foundation.

Regarding the possibility of using the existing transmission pipeline in the Project, the safety cannot be secured due to the above reason. In addition, leakage accidents occurred six times in the past even though only 10 years have passed after its installation. This is about 10 times more frequently compared with the incidence rate of Japan's transmission pipeline. Therefore, the Project plans to use a new transmission pipeline alone to cover the whole planned water supply volume — without utilizing the existing transmission pipeline.

(2) Nzove WTP

Main facilities and specifications of Nzove WTP are shown below. Nzove 1 WTP and Nzove2 WTP have been operated. New Nzove1 WTP has been newly constructed and its operation started in April 2018. The main specifications of the three WTPs are shown below.

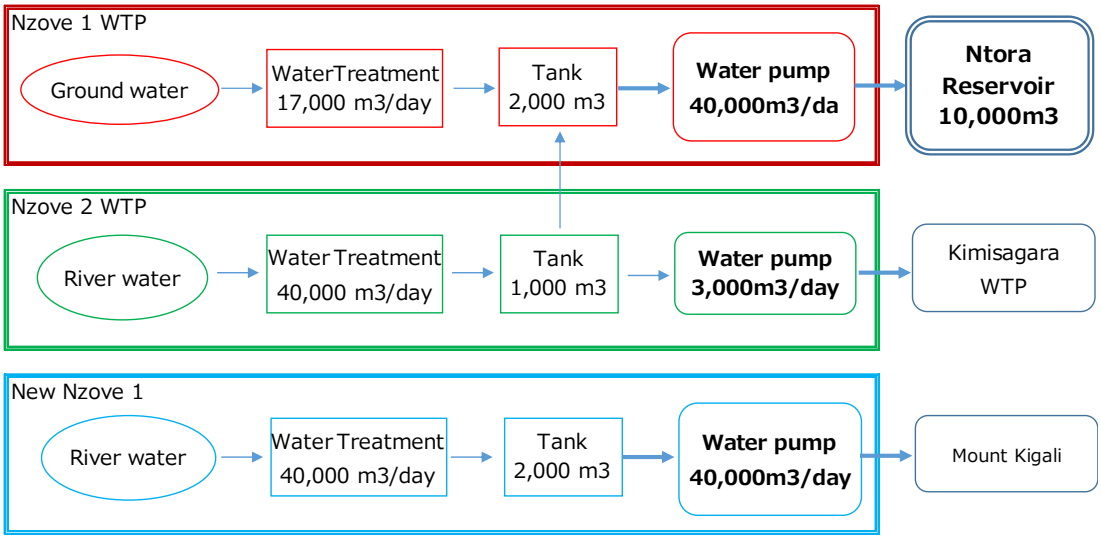
Table 2-21 Specifications of Nzove WTP

Content	Nzove-1	Nzove-2	New Nzove-1
Designed water volume (㎥/day)	40,000	40,000	65,000 (Filtration tanks and water pumps are maintained only at 40,000㎥/day)
Amount of treated water (㎥/day)	17,000 per day (Processable amount: 25,000)	40,000	40,000
System configuration	(groundwater) → Biological contact oxidation tank → Gravity type multilayer filter → Processing tank	(river) → Biological contact oxidation tank → Gravity type multilayer filter → Processing tank	(river) → Biological contact oxidation tank → Gravity type multilayer filter → Processing tank
Treated water	Raw water: <100 NTU Treated water: <5 NTU	Raw water: <10,000 NTU Treated water: <1 NTU	
Remarks	The measuring equipment is broken. The facility is operated by manual operation at the present.	Its operation started from㎥016. Automatic operation control is introduced. The central monitoring device monitors the facility operation.	Water treatment is 40,000㎥ /day from April 2018. It is facility design can be extended to 65,000 ㎥/day in the future.

※With the start of operation of the Nzove 2 WTP, the amount of treated water at the Nzove 1 WTP was decreased from 25,000 ㎥/day to 17,000 ㎥/day. This is due to the reason that the water treatment cost of the Nzove 2 WTP is more economic than the Nzove 1 WTP. However, it is necessary to confirm Water treatment capacity of Nzove 1 can predicates 25,000 ㎥/day or not during the construction work period because the time has passed since the treated water volume of Nzove 1 WTP produce 17,000 ㎥/day. If Nzove 1 cannot treat 25,000 ㎥/day, it is required to secure 25,000 ㎥/day of treated water amount of the plant by Rwanda.

Source: Study Team

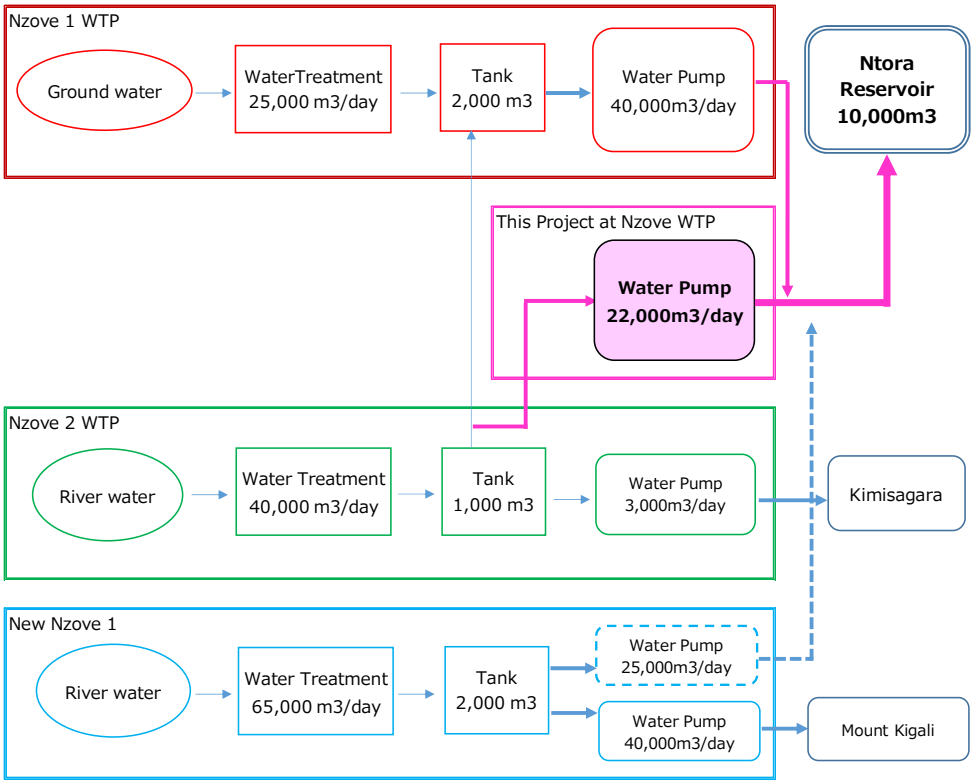
The following is the current state of Nzove WTP and the conceptual diagram of the facility after implementation of the Project. At present, Nzove1 and Nzove2 WTP can deliver 62,000 ㎥/day of treated water to Ntora water reservoir out of the maximum 65,000 ㎥/day water treatment capacity; however, existing water supply pumps and existing transmission pipelines are only 40,000 ㎥/day. Therefore, the facility capability of Nzove WTP cannot be fully performed at present.



Source: Study Team

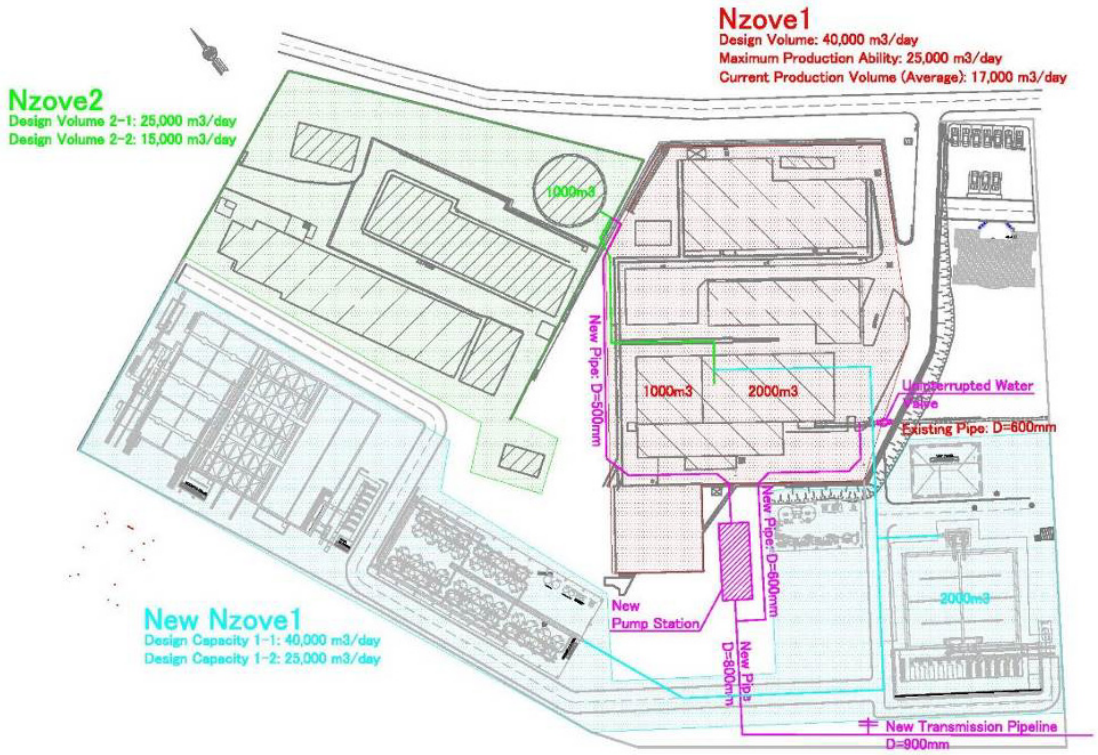
Figure 2-6 Conceptual diagram of entire facility (present condition)

In order to improve this situation, the Project is planning to install a new water supply pump with a water supply volume of 22,000 ㎥/day to secure the water supply volume of 62,000 ㎥/day. In the future, by implementing the facility improvement of New Nzove1 WTP, which produce 25,000 ㎥/day by Rwandan side, Nzove WTP will be a facility that can supply 87,000 ㎥/day of the water as follows.



Source: Study Team

Figure 2-7 Conceptual diagram of entire facility (indicated by pink is the maintenance area)



Source: Study Team

Figure 2-8 Rebuilding Plan and each treatment facility of Nzove WTP (pink)

1) Improvement of Nzove WTP

As mentioned above, the Project plans to establish new water supply facilities capable of 22,000 ㎥/day to correspond to the planned water supply volume of 87,000 ㎥/day at Nzove WTP.

Table 2-22 Design policy of Nzove WTP

Facility	Design policy
Water pump	Total water supply 22,000 ㎥/day (7.6 ㎥/min, head 240m), 3 units (2 units for operation, 1 unit for preliminary)
Pump station	Pump station that stores 3 water supply pumps
Pressure tank (Water hammer measures)	Capacity 32 ㎥, 1 unit
Flowmeter	2 flowmeters at 2 places: One flowmeter for the conduit pipe of Nzove 1 WTP One flowmeter for the inlet pipe of the new pump station
Hot tapping valve	It will use in the switching of the existing transmission pipeline
Branch	The branch pipe (including valves) will be installed to deal with the future increased water supply from the New Nzove1 WTP (25,000 ㎥/day). A connection from the branch to the New Nzove1 WTP shall be borne by the Recipient.

Source: Study Team

2) Specifications of Water Supply Pumps

Three water pumps will be installed at a pump station improved by the Project and the water supply pumps to be installed by the Project are set as the following, flow rate per unit as 11,000 ㎥/day (7.6 ㎥/min) and the head as 240 m.

3) Examination on Specifications of Compression Tank

A water hammer pressure is a shock/impact occurred due to a sudden change in pressure in the pipe. This change in pressure is caused by a sudden blockage of water flow due to a sudden stop of the pump. The Project is planning to install a compression tank to relieve the shock which is repeatedly caused by rapid rise and drop of pressure. The type of the compression tank can be either a type that has a compressor to supply air into the tank or another type that supplies the air automatically. Moreover, the compression tank, which is installed in the existing transmission pipeline, has adopted the most common type that uses the compressor system. Therefore, the Project is also planning to install the compression tank that uses a compressor, considering the experience of the executing agency and ease of operation and maintenance of the tank.

The main purpose of the compression tank is to secure the capacity of 32 ㎥ to cope with a water hummer caused by the negative pressure that generate water column separation in the pipe. In upper part of slopes negative pressure, -42 m as maximum, is generated and water column separation occurs. The capacity of the tank shall respond to the planned water supply volume of 87,000 ㎥/day — produced by the operation of water supply pumps at the three facilities, Nzove-1 WTP, Nzove-2 WTP and new Nzobe-1 WTP, when these are operated at the same time. In the case that the compression tank is not installed, the water hummer pressure (water head: 355m) shall be set as the maximum value. All equipment, such as a compression tank and pumps, to be installed in Nzove WTP shall be planned with flange standard of PN 40, and the equipment that have no issue with the maximum water hammer pressure shall be adopted. When the water supply volume increases to 105,000 ㎥/day in the future, the maximum value of the water hammer pressure will be 374 m at the water head; nevertheless, the adopted flange standard of PN40 will have no problems against the water hammer pressure.

The compression tank shall be preferably constructed near the water supply pumps, which are most affected by the water hummer pressure. Therefore, the tank shall be placed after the joint point of the transmission pipeline of the existing water pumps and the newly constructed water pumps.

4) Switching with the Existing Nzove WTP

Construction of the water supply pump facility at Nzove WTP will be carried out while operating the existing water pump and the existing transmission pipeline. Basically, construction of facilities for the Project is possible while operating the existing facilities. However, improvement of existing facilities, switching of pipes, and other work are required at each stage. The process required to work together with existing facilities at each stage are planned in the Project as follows.

1. Construction of transmission pipeline and water supply pumps

Construction of new transmission pipeline and new water pumps can be carried out without affecting existing facilities.

2. Branch from the outflow pipe connected to the regulating reservoir of Nzove 2 WTP

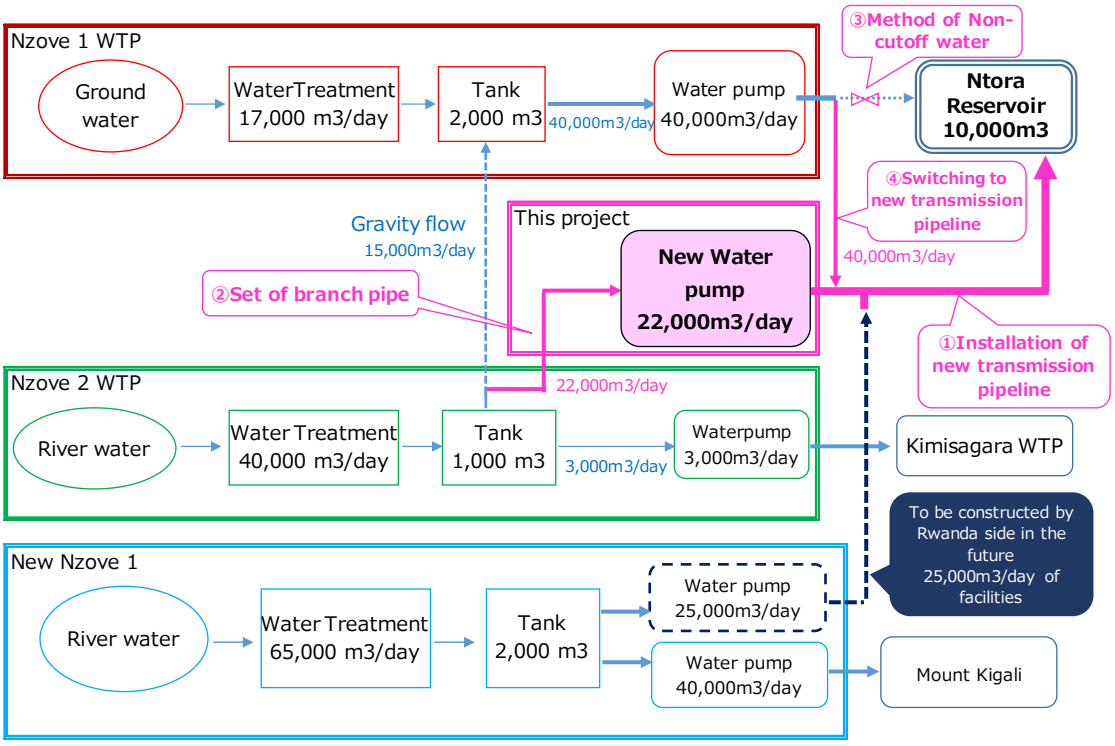
The water pump facility to be installed in the Project branches the pipe from the outflow pipe of the regulating reservoir (capacity 1,000 ㎥) of Nzove 2 WTP and connects it to the new water supply pump. Currently, its branch point is a short pipe with both flanges; and it is required to temporally remove a short pipe with both flanges and replace it to a T-shaped short pipe with flanges and a branching pipe. These works will not affect the use of the regulating reservoir, and they can be completed in several hours. The installation of this branching pipe makes it possible to operate the existing transmission pipeline as usual, until the implementation of switching the existing pipeline to the new pipeline. It is also possible to clean and fill water to the new transmission pipeline by operating the new water supply pump while operating the existing transmission pipeline.

3. Installation of hot tapping valve

Hot tapping valve is installed into the existing transmission pipeline. The hot tapping valve is not compatible with the high water pressure, and thus drainage for the section of 700 m short of Ntora Reservoir shall be conducted from the existing drain valve to reduce the water pressure of the existing transmission pipeline.

4. Switching the existing transmission pipe to new transmission pipe

It is required to close the hot tapping valve and cut the existing transmission pipeline after inserting the valve. Subsequently, it is needed to connect the existing pipeline, on the side of existing water pumps, and new transmission pipeline to finish switching of the pipes.



Source: Study Team

Figure 2-9 Switching work of existing transmission pipeline to new transmission pipeline

(3) Ntora Reservoir

① Improvement of Ntora Reservoir

Ntora Reservoir is divided into 2 tanks. The new transmission pipeline is required to branch off before entering Ntora Reservoir and dividing water to each tank. The connection point of the branch pipe shall be in diagonal line of the outflow pipe. The pipe shall connect to top end of the tank and the water will be dropped at the height of 700 mm or more in the tank to not affect the strength of the existing building of Ntora Reservoir.

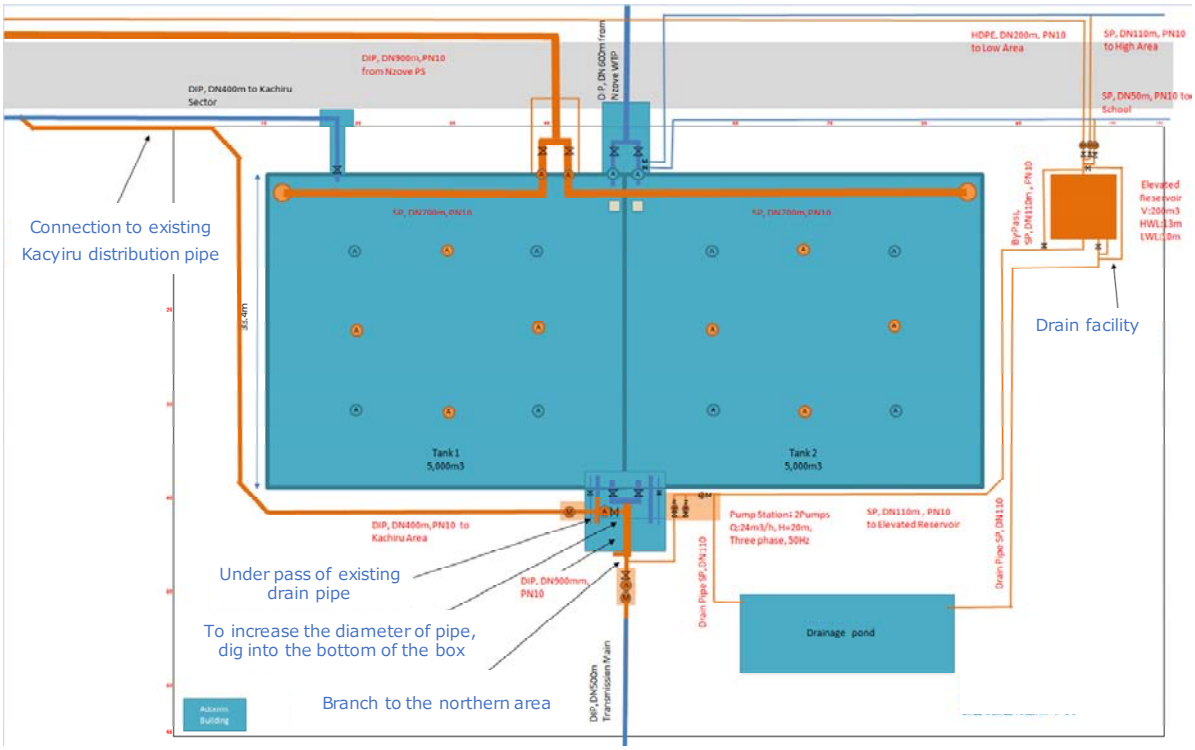
Eight 200 mm pipes are being installed at the two tanks as the existing ventilation holes. When replacing the transmission pipeline, the same area as the cross-sectional area of the outflow pipe is required to let the amount air, which is equivalent to the flow rate of the maximum daily supply water amount, freely enter and exit. Thus, eight ventilation holes (200 mm) are newly installed. A float type of water level gauge with communication function is being installed as the existing instruments; however, it is broken and difficult to repair. Therefore, in the Project a new water level gauge will be installed in consideration of easy operation and maintenance as the reservoir operator works in 24 hours basis.

1) Installation of Outflow Pipes of Ntora Reservoir

The outflow pipe will be maintained to eliminate the differences in water levels between the two tanks caused by the installation position of the pipe outflow from Ntora Reservoir, to improve the operation system of water distribution that prioritizes the water distribution to Kacyiru District, and to cope with issues of operation and maintenance such as tank cleaning.

In installing the outflow pipe, the two existing outflow pipes of Ntora Reservoir will be integrated and division pipe will be installed in consideration to the new elevated tank and the new transmission pipe for the Northern region planned by WASAC. The division pipe's diameter will be increased to 900 mm to enable the distribution in four directions, utilizing effectively the existing outflow pipe of the water supply system (DN 600 mm pipe outflow from each tank).

Flow meters will be installed in each outflow pipe in the Project to monitor the operation status of Ntora Reservoir, in addition to hydraulic isolation between fulcrums.



Source: Study Team

Figure 2-10 Outline of Renovation of Ntora Reservoir (Orange part)

2) Elevated Water Tank

To install the elevated water tank in the Project, the following components are planned.

Table 2-23 Component for the elevated water tank

Item	Outline	
Elevated water tank （two tank types）	200㎥ （two tank types made by steel panel）	Project
Stand	Reinforced concrete	Project
Lifting pump（For pumping water from Ntora Reservoir to the elevated water tank）	Water flow : 24㎥/hour（0.4㎥/min） Lifting height : 20m 2（1 for operation、1for reserve）	Project
Water level gauge	2	Project
Piping in the site	1 set	Project
Lifting rod	1 set	Project
Connection from the elevated water tank to the existing water distribution network	1 set	Rwanda side

Source: The Survey Team

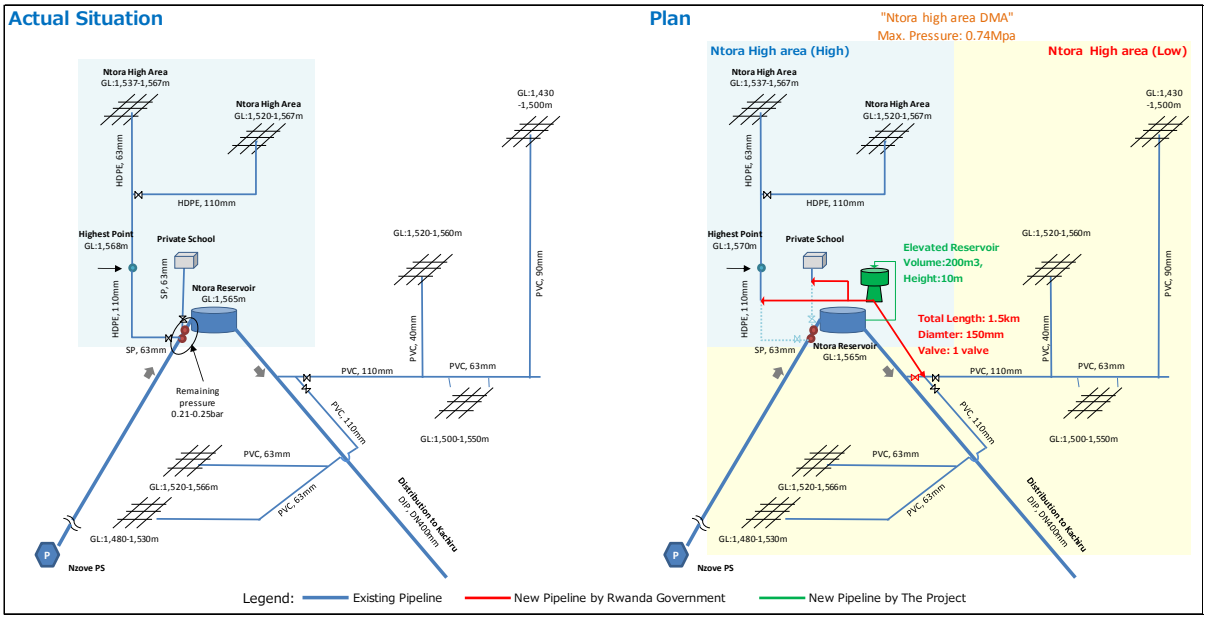
① Setting of water supply area by the elevated water tank

With the implementation of the transmission pipeline by the Project, it is necessary to manage the water supply area (water distribution area A), which is currently distributed directly from the transmission pipeline by two water distribution pipes connected to the existing transmission pipeline. Direct water distribution by the transmission pipeline needs to be switched to the

distribution from Ntora Reservoir as the water supply will be suspended for a period of time when the transmission pipeline is not in operation. However, it is not possible to distribute water directly from Ntora water reservoir to the water distribution area A because the differences in elevations with Ntora water reservoir is small and the water pressure is low.

On the other hand, water distribution facilities in Kigali City do not have a water distribution block. Therefore, it is difficult to control the water pressure of distribution pipes in Kigali City where the terrain is undulated. When a temporary suspension of the water occurs during the maintaining work of the pipeline, it will cause water outage in a wide area. Hence, it is difficult to manage water distribution by each area. A plan for water supply facilities will be prepared with an emphasis on proper water pressure management and arrangement of water distribution block for each area in a master plan of water supply to be implemented in the future.

Therefore, the Project sets the water distribution area B, where the altitude difference of about 100 m from Ntora Reservoir, in addition to the water distribution area A. Also, the elevated water tank stores the water for distribution of area A and B. This makes possible to stabilize the water pressure in the area, eliminate the risk of water suspension caused by direct water distribution from the existing transmission pipeline, and stabilize the operation of water distribution in the area.



Source: The Survey team

Figure 2-11 Outline drawing of the distribution area to be in charge by the elevated water tank

② Specification of the elevated water tank

The water demand for the area to be supplied by the elevated water tank was calculated as follows. The conditions for calculating water demand is the same as the conditions for calculating the water demand for Kigali City as a whole.

Table 2-24 Amount of the water demand

Village	2012			2016	2017					
	Population at Village	DMA Area coverage on Village	Population on DMA Area	Customer	Population on DMA Area	Demand on houshold	Demand on big customer	Total Demand	Daily Average Water demand	Daily Maximum Water demand
	persons	%	persons	user	persons	m3/day	m3/day	m3/day	m3/day	m3/day
Ntora	610	100	610	340	750	90	41	131	170	220
Nyakariba	623	50	312	240	380	46	0	46	59	76
Rukeri	617	2	13	11	20	2	0	2	3	4
Umurava	530	5	27	15	30	4	38	42	54	70
Gasharu	692	10	70	85	90	11	0	11	14	18
Amajyambere	742	5	38	23	50	6	0	6	8	10
	3,814		1,070	714	1,320	158		237	309	398

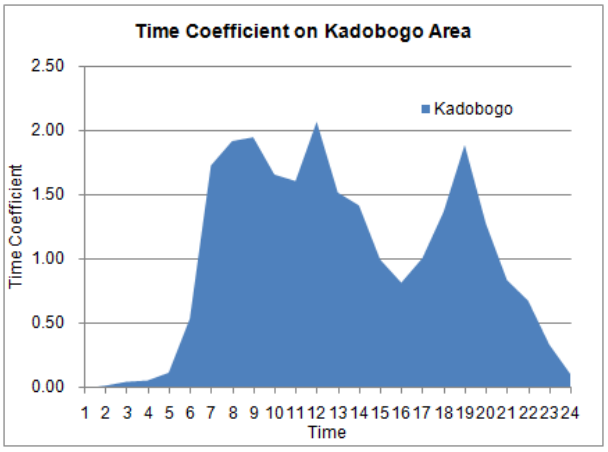
Village	2030					
	Population on DMA Area	Demand on houshold	Demand on big customer	Total Demand	Daily Average Water demand	Daily Maximum Water demand
	persons	m3/day	m3/day	m3/day	m3/day	m3/day
Ntora	1,260	151	41	192	250	322
Nyakariba	640	77	0	77	100	129
Rukeri	30	4	0	4	5	6
Umurava	60	7	38	45	59	76
Gasharu	140	17	0	17	22	28
Amajyambere	80	10	0	10	12	16
TOAL	2,210	265		344	447	577

Source: Study Team

As a result of the calculation, the population of the water distribution area covered by the elevated water tank is 2,210 people and the maximum daily water supply is estimated as 577 ㎥ /day. The data of the Kadobogo District in Kigali, where the distribution data of each hour is confirmed, is used and the time coefficient is set as follows.

Table 2-25 Time factor

Time	Time coefficient	Time	Time coefficient
0:00	0.00	12:00	1.52
1:00	0.02	13:00	1.42
2:00	0.05	14:00	1.00
3:00	0.06	15:00	0.82
4:00	0.12	16:00	1.01
5:00	0.54	17:00	1.37
6:00	1.73	18:00	1.89
7:00	1.92	19:00	1.28
8:00	1.95	20:00	0.84
9:00	1.66	21:00	0.68
10:00	1.61	22:00	0.34
11:00	2.07	23:00	0.11



Source: Study Team

In addition, the amount of water distributed per hour corresponding to 577 ㎥/day of the maximum daily water supply from the elevated tank was calculated using the set time coefficient; and the amount of water in the elevated tank at each time was calculated. The calculation result is as follows.

Table 2-26 Reservoir capacity (as of 2030)

	Flow[m3/h]	time coefficient
11:00	21.8	2.07
12:00	17.2	1.52
13:00	12.6	1.42
14:00	11.8	1.00
15:00	8.3	0.82
16:00	6.8	1.01
17:00	8.4	1.37
18:00	11.4	1.89
19:00	15.7	1.28
20:00	10.6	0.84
21:00	7.0	0.68
22:00	5.6	0.34
23:00	2.9	0.11
0:00	0.9	0.00
1:00	0.0	0.02
2:00	0.2	0.05
3:00	0.4	0.06
4:00	0.5	0.12
5:00	1.0	0.54
6:00	4.5	1.73
7:00	14.4	1.92
8:00	16.0	1.95
9:00	16.2	1.66
10:00	13.8	1.61
Average	8.7	

Time	time coefficient	Distribution volume (②)	Accumulation	②-①	Volume in reservoir
0	0.00	0.0	0.0	24.0	99
1	0.02	0.5	0.5	23.5	122
2	0.05	1.2	1.7	22.8	145
3	0.06	1.4	3.1	22.6	168
4	0.12	2.9	6.0	21.1	189
5	0.54	13.0	19.0	11.0	200
6	1.73	41.5	60.5	-17.5	182
7	1.92	46.1	106.6	-22.1	160
8	1.95	46.8	153.4	-22.8	138
9	1.66	39.8	193.2	-15.8	122
10	1.61	38.6	231.8	-14.6	107
11	2.07	49.7	281.5	-25.7	81
12	1.52	36.5	318.0	-12.5	69
13	1.42	34.1	352.1	-10.1	59
14	1.00	24.0	376.1	0.0	59
15	0.82	19.7	395.8	4.3	63
16	1.01	24.2	420.0	-0.2	63
17	1.37	32.9	452.9	-8.9	54
18	1.89	45.4	498.2	-21.4	33
19	1.28	30.7	529.0	-6.7	26
20	0.84	20.2	549.1	3.8	30
21	0.68	16.3	565.4	7.7	38
22	0.34	8.2	573.6	15.8	53
23	0.11	2.6	576.2	21.4	75

Design maximum daily supply 577 m3
Hourly average of water supply (①) 24 m3/h 0.40 m3/min

Source: Study Team

As a result of the calculation, the necessary capacity of the elevated tank is 200 ㎥. Therefore, the Project has set the effective capacity of the elevated water tank as 200 ㎥.
The elevated tank shall be a panel type made of steel with two tanks, considering ease of cleaning tanks. In addition, the lowest water level of the elevated tank has set as 10 meters above the ground.

The stand of the elevated tank is made of reinforced concrete and supposed to be injected into the elevated water tank from Ntora Reservoir with a lifting pump (flow rate: 0.4 ㎥/min, pump head 20m).

3) Meters and Gauges

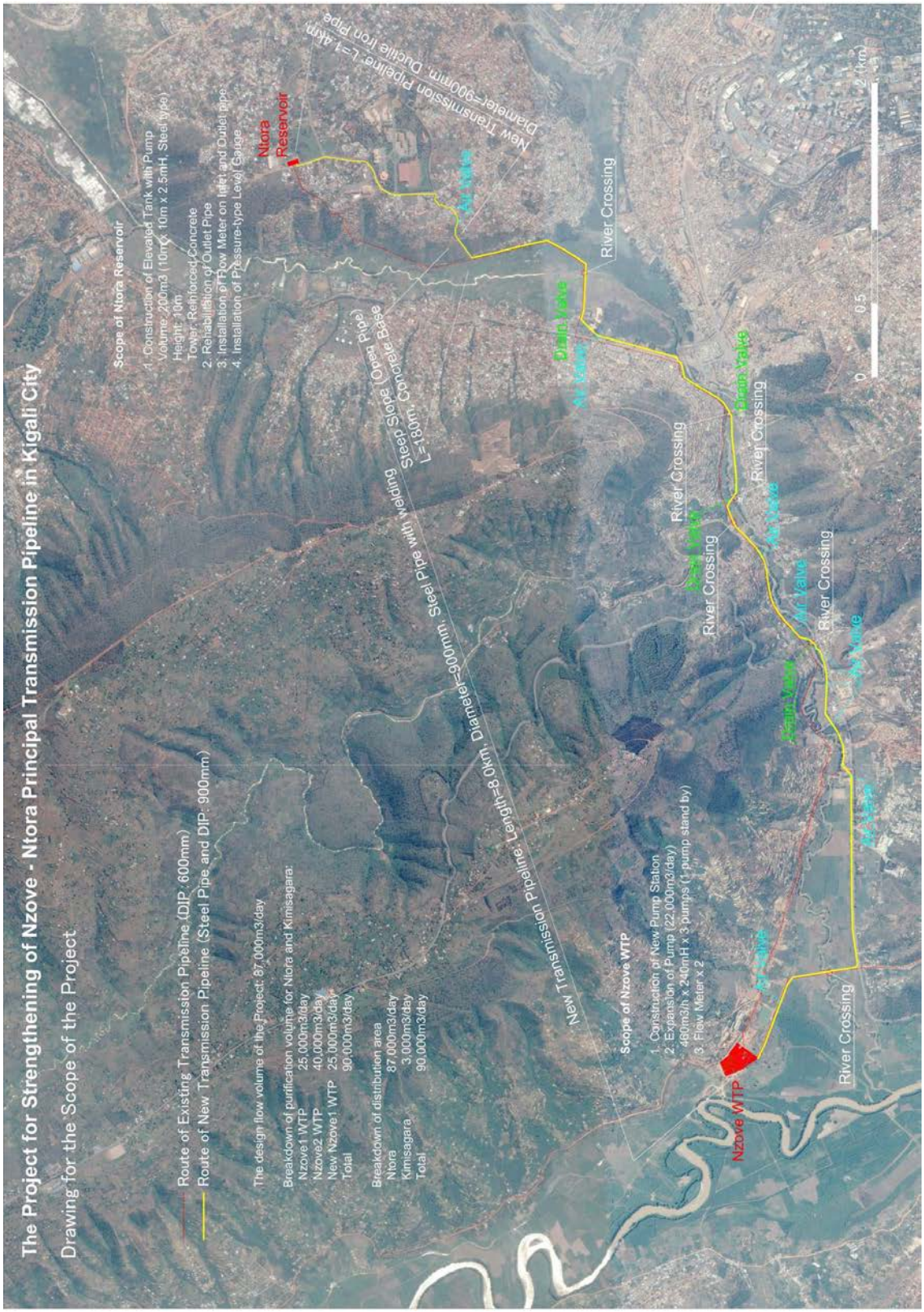
Accumulation of data pertaining to water distribution management and operation of an appropriate water supply reservoir shall be operated by installing the following instruments at Ntora Reservoir.

Flowmeter (1 unit for the inflow pipe at Ntora Reservoir, 1 unit for the outflow pipe to the Kacyiru, 1 unit for the outflow pipe to the transmission pipeline: 3 units in total)

Two water level gauges (2 units for Ntora Reservoir (2 tanks), 2 units for elevated water tanks (2 tanks): 4 units in total)

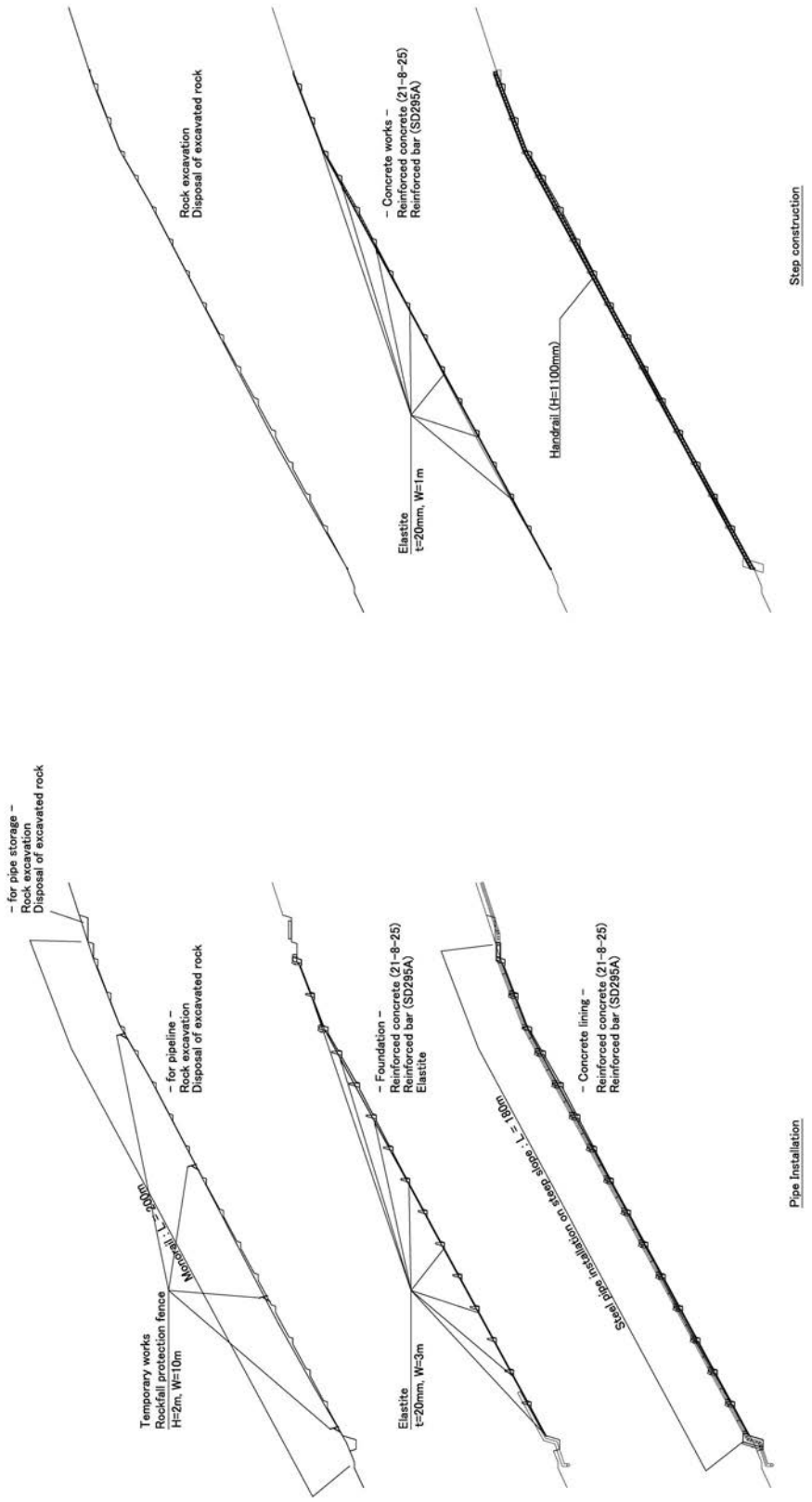
2-2-3 Outline Design Drawing

The schematic design drawing in the Project is as follows.



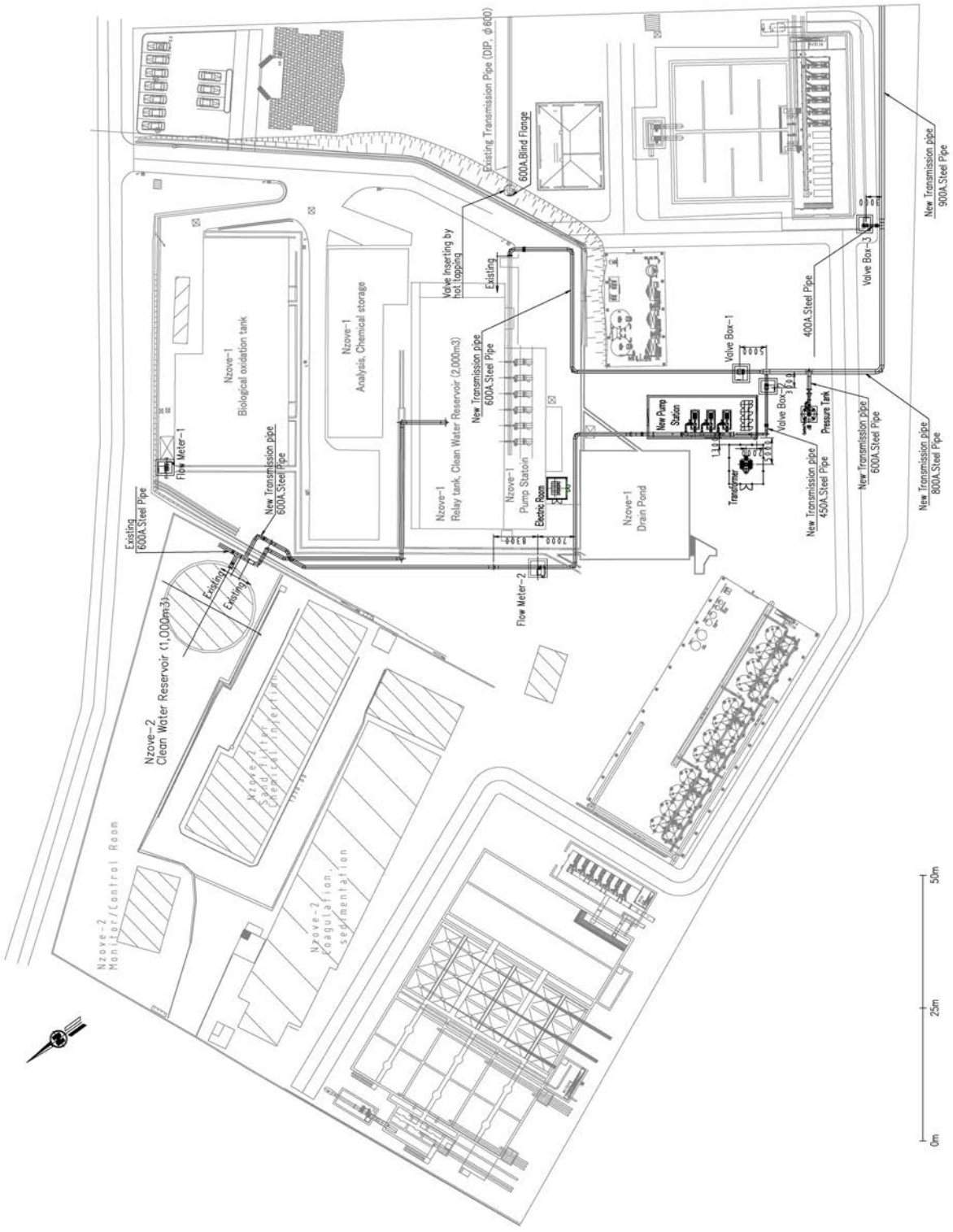
Source: Study Team

Figure 2-12 New transmission pipeline installation



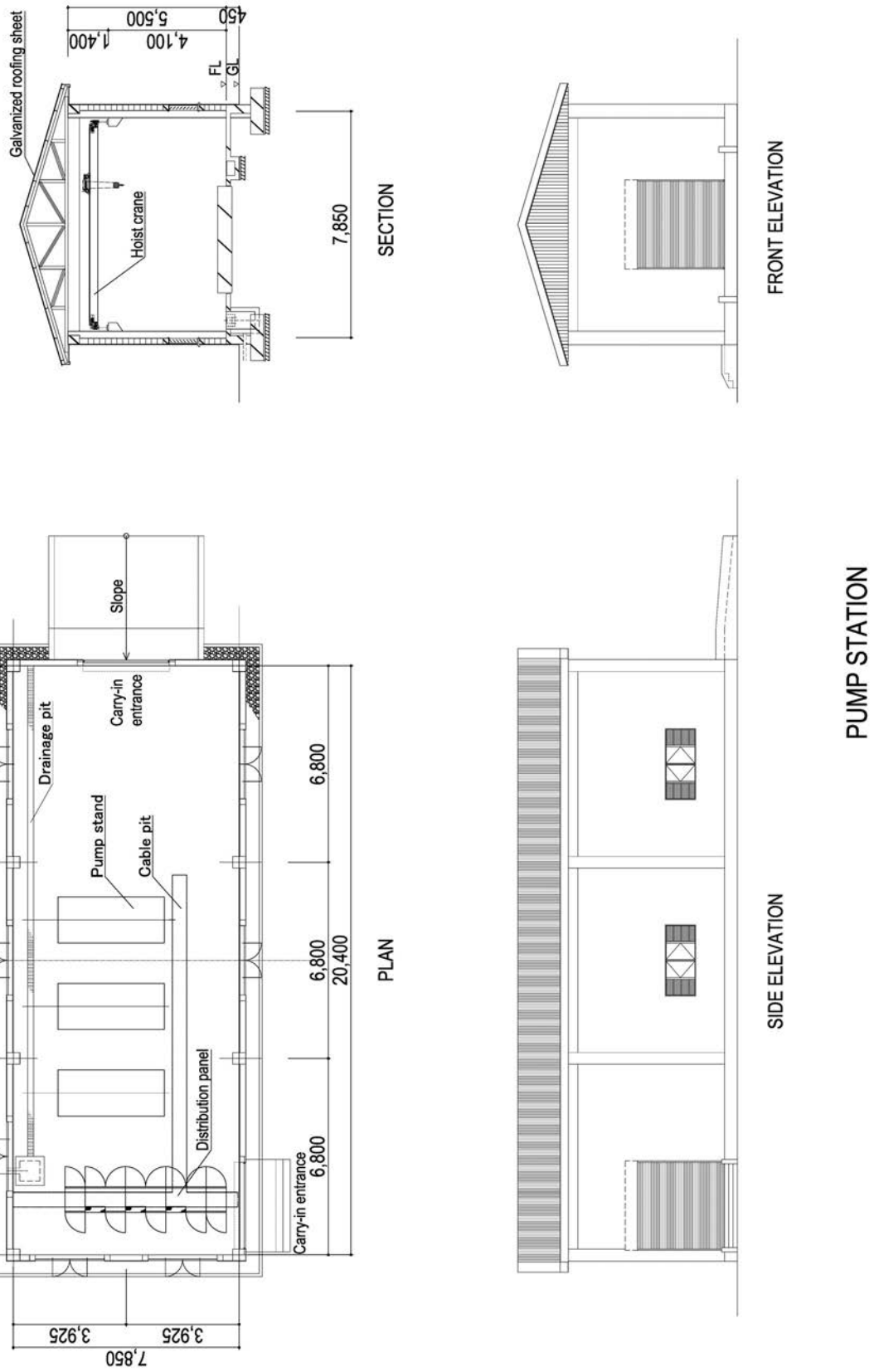
Source: Study Team

Figure 2-13 Steep slope pipe installation



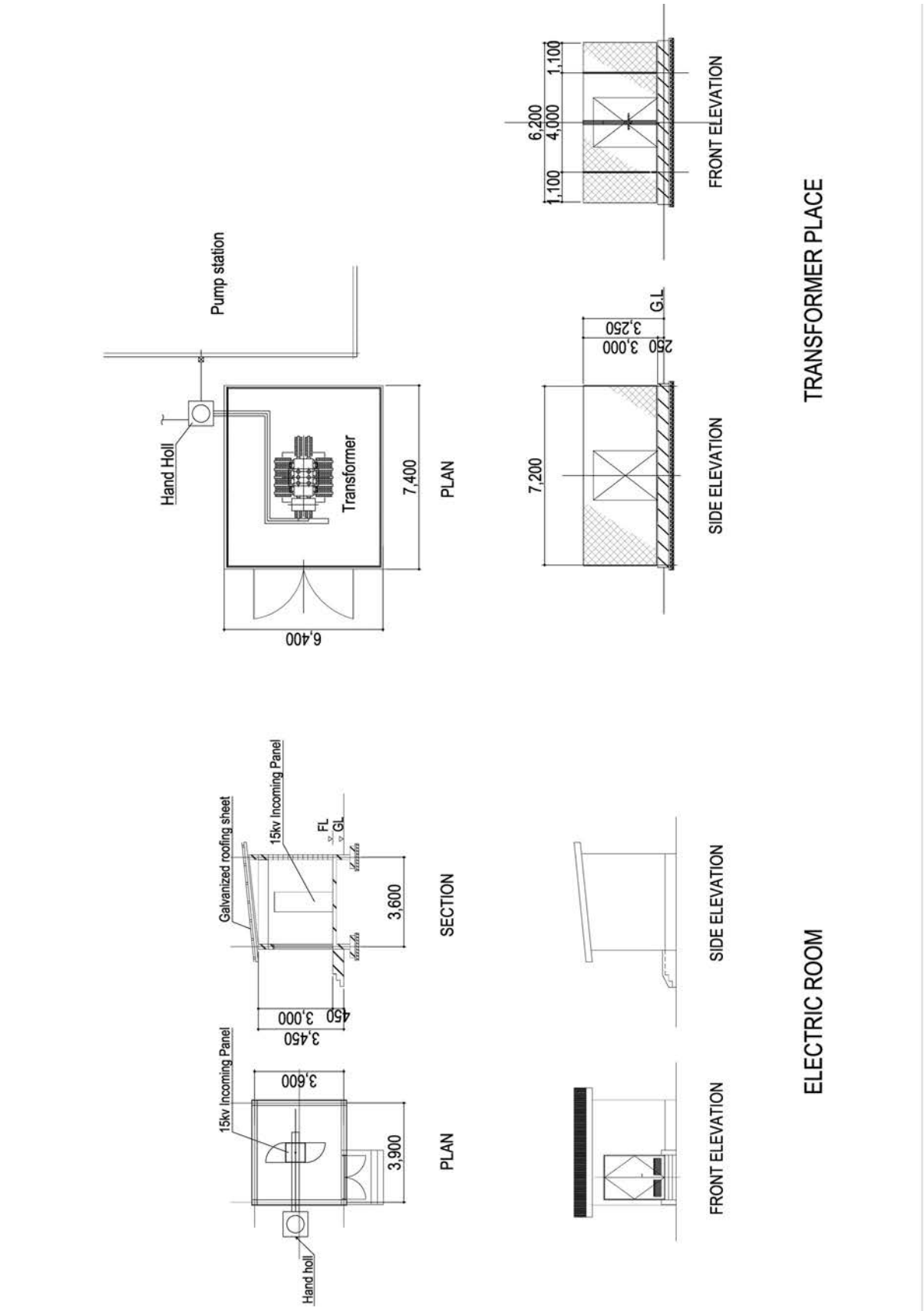
Source: Study Team

Figure 2-14 Nzove WTP expansion plan



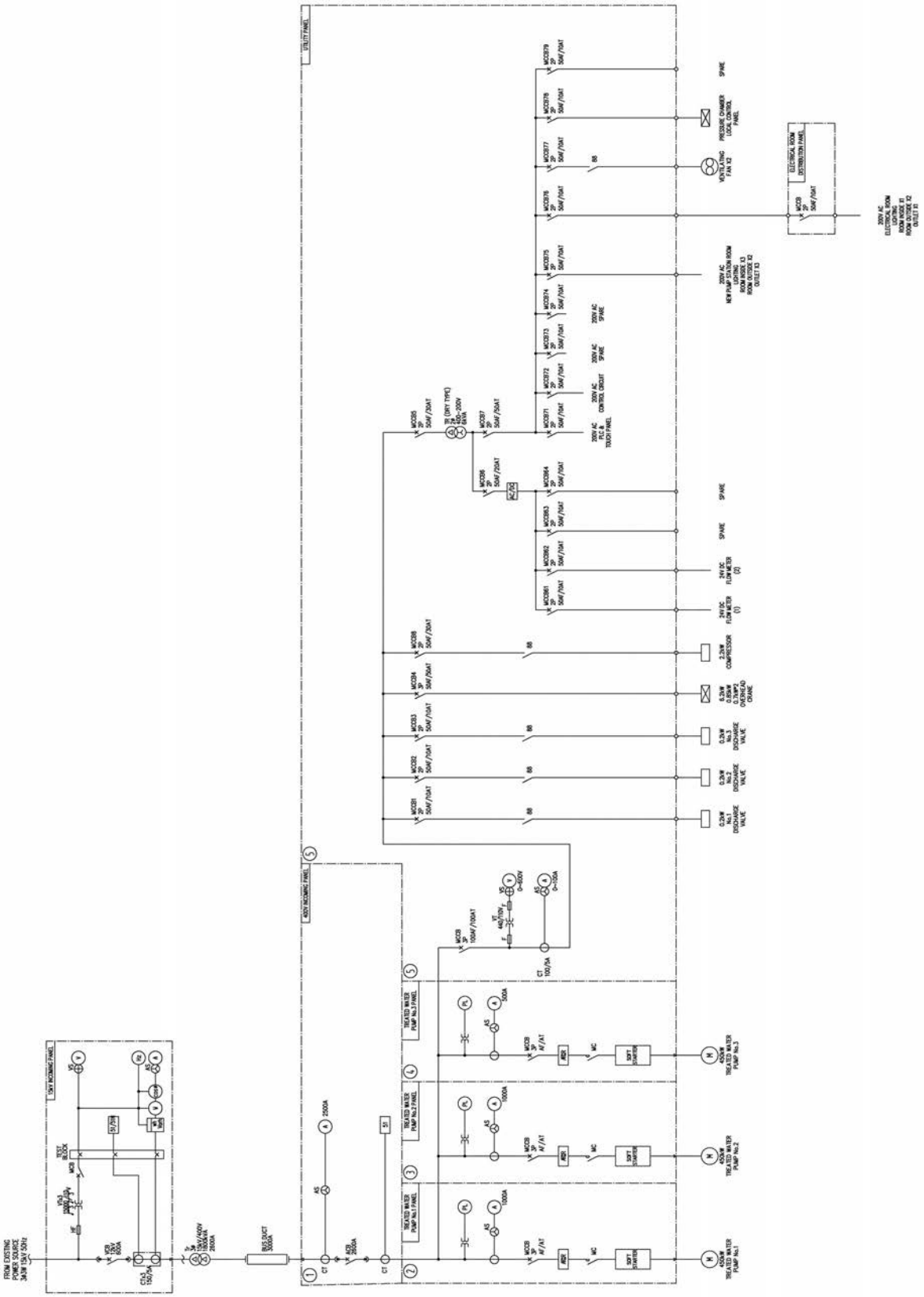
Source: Study Team

Figure 2-15 Nzove WTP new pump station



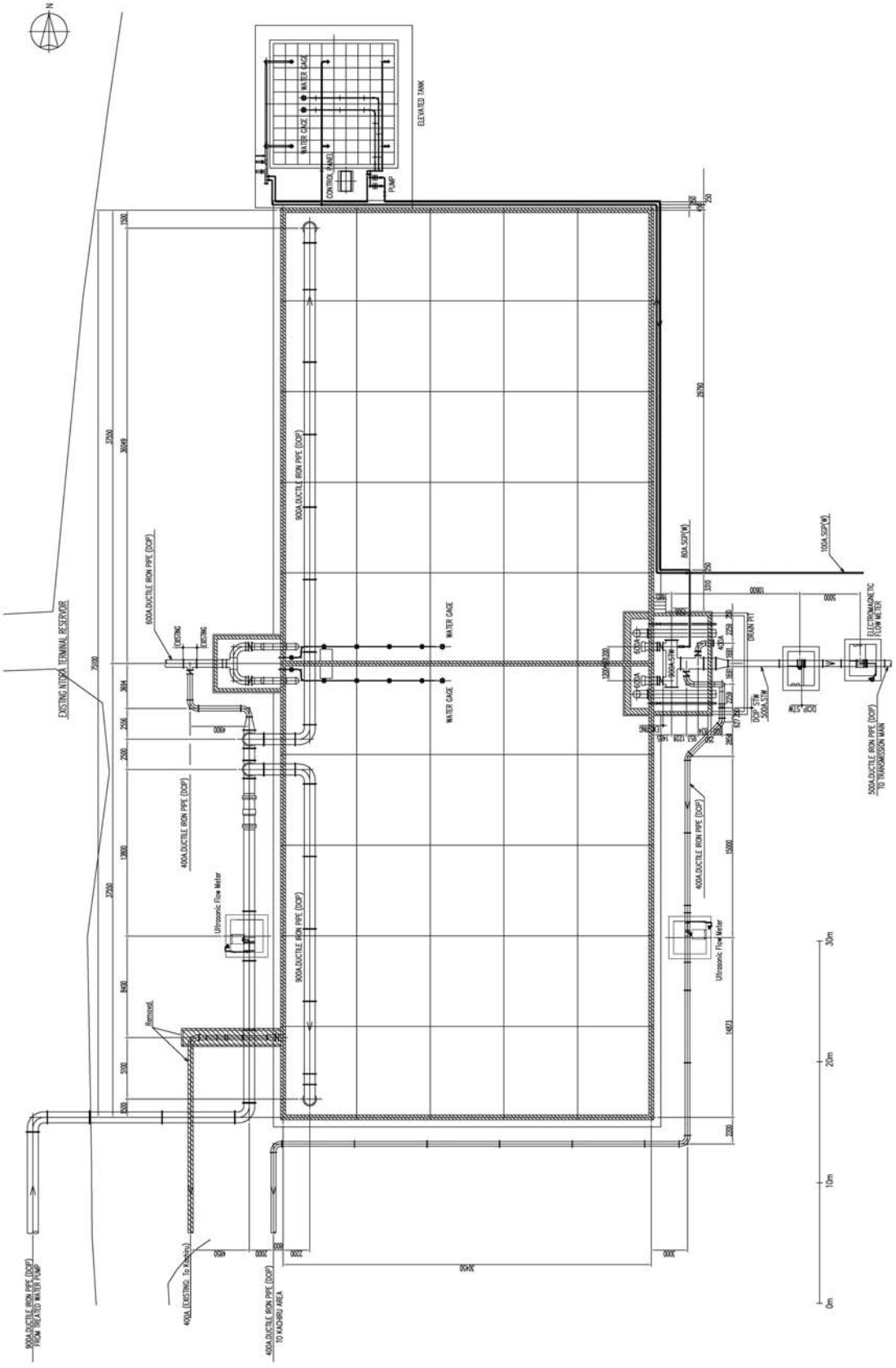
Source: Study Team

Figure 2-16 Nzove WTP electric room



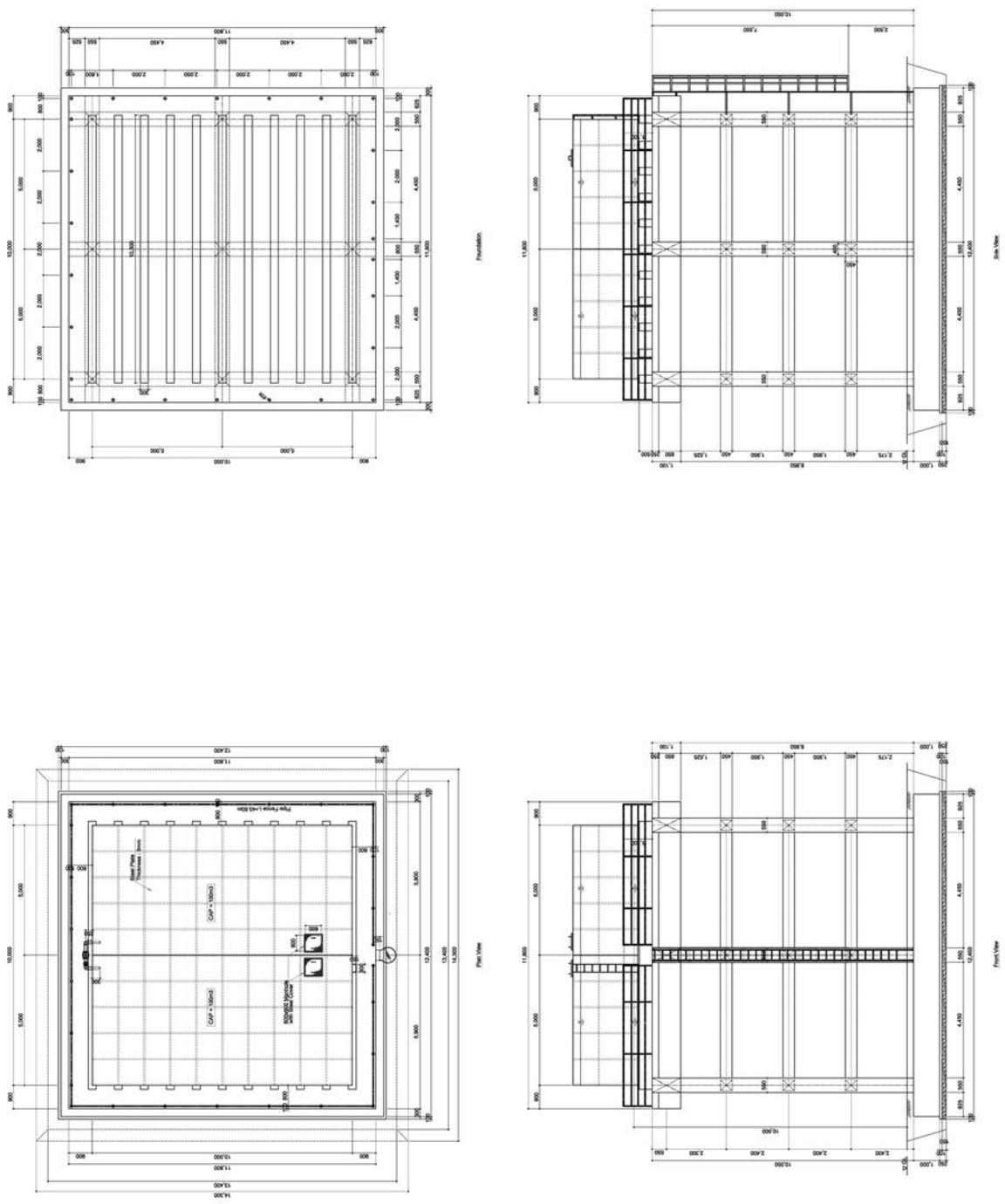
Source: Study Team

Figure 2-17 Nzove WTP single line diagram



Source: Study Team

Figure 2-18 Ntora Reservoir improvement plan



Source: Study Team

Figure 2-19 Elevated tank construction plan

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project is implemented based on the exchange of notes (E/N) concluded between the Government of Rwanda ("GoR") and the Government of Japan ("GoJ") and the subsequent grant agreement (G/A) concluded between GoR and JICA. The basic items and special considerations for implementing the Project are shown below.

(1) Project Implementation Agency of Rwandan Side

WASAC, the implementation agency of the Project, shall be in charge of maintaining the facilities after the achievement of the Project. Moreover, WASAC should be in close contact with the Japanese Consultant and the Contractor to proceed smoothly with the business, and needs to select counterparts who will be in charge of the abovementioned and Project related work. The selected counterparts of WASAC shall explain the Project concept to the relevant staff of WASAC, relevant organizations and residents, and raise their understanding to promote cooperation with the Project.

(2) Consultant

Japanese consultants which are recommended by JICA for procurement and construction of the Project will conclude a contract about design and supervision with WASAC and will design, procure and supervise the Project. Moreover, Japanese consultants will also make a bid documents and carry out the bid opening on behalf of WASAC.

(3) Contractors

In accordance with a framework of Japanese Grant Aid, Japanese contractors chosen by Rwandan side through the bid opening will carry out procurement of materials and the construction of the facilities required under the Project. Moreover, after the completion of the Project, it will be necessary to have after-sales service that includes dealing with breakdowns and a supply of spare parts on a continuing basis. Such matters should be fully taken into consideration when stipulating the requirements (in the bid contract).

(4) Necessity of Dispatching Japanese Engineers

The Project includes the implementation of the transmission pipeline with high water pressure; the expansion work while operating an existing facilities in Nzove WTP, and the construction of facility relating to redevelopment of Ntora Reservoir. These will be constructed by different work groups, and they have to carry out construction cooperatively. Moreover, these works are carried out at the same time, and the site supervisor should be dispatched from Japan in order to manage the whole construction consistently.

2-2-4-2 Implementation Conditions

(1) Access Conditions

The road from Mombasa Port in Kenya to Kigali is covered by asphalt. The land transportation shall use the open-top container because the steel pipes for the transmission pipeline are 9 m long. There are few open-top containers and the loading number of shipping is about 15 to 20 pipes; therefore, those need to be transported separated by 6 to 7 times by maritime shipping. Considering other materials, sea shipping will carry out 9 to 10 times. Careful consideration on

the transportation plan of equipment and materials is required to avoid delays in construction.

(2) Points of Attention in Construction

A part of the route for the transmission pipeline is the flood plain and the tolerance of soil is confirmed to be very frail (N value is 1~2).

Earth covering of the transmission pipeline is also 2 m in the flood plain and the excavation depth is about 3 m. Hence, an appropriate gradient to prevent the collapse by excavation should be installed. Also, the entire circumference of the pipe will be welded for steel pipes, and thus implementing earth retaining works is required to prevent collapse of the excavated cross sections. In filling back of the transmission pipeline, high-quality soil shall be used to fix the pipes performing sufficient compaction every 30 cm of the backfilling thickness so that displacement of the transmission pipeline will not occur.

Moreover, it takes time to weld the transmission pipeline. Especially it is not possible to install the pipes in the flood plain during the rainy season. Therefore, the implementation of the transmission pipeline shall be conducted in the dry season. The constructions shall be organized to prevent the construction delays from the process planning stage considering thoroughly creation of appropriate work groups and setting of the construction sections for each group.

Welding of steel pipes requires high construction quality to cope with the high water pressure. Therefore, welding work is performed by skilled welders, such as Japanese engineers, who have experience in welding steel pipes in the Project. The groove shape used for the butt joint of welding is X type and the inner and outer surfaces of the transmission pipe is welded. Furthermore, an X-ray inspection is carried out at a necessary part of welding.

In the section where the steel pipe is laid in the flood plain, work will be implemented while draining using a drainage pump during construction because the groundwater level is 0.6 m - 1.0 m. There is a risk of groundwater flowing into the implemented steel pipes as the groundwater level rises during the night, when work is suspended. Therefore at the end each day of work, the end of pipes shall be connected to a stopper to prevent the flow of groundwater into the pipes

(3) Country of Procurement for Equipment and Materials

The materials to be procured in the Project, including pipes (steel pipes, ductile cast iron pipes) and lifting pump, cannot be produced in Rwanda; and thus they must be imported. As a principle, all of the materials for the Project other than crushed stones, cement, sand and aggregates for concrete shall be procured from Japan and/or third countries

(4) Safety Measures

The Project site is an area with fewer security problems; however, theft prevention for the equipment and materials and the worker’s safety during construction shall be taken into consideration. For this reason, Rwanda side shall take necessary safety measures to implement the Project. Also Japanese Contractors shall consider the safety measures such as setting a fence around material yard and placing a guard in the equipment and materials store.

The pipe material to be used for the transmission pipeline is heavy and large in diameter; hence special attention shall be paid during the transportation and lifting work to prevent dangerous work. In addition, an appropriate excavation gradient and earth retaining work shall be applied to prevent collapse of the excavated cross section. The new transmission pipeline will be laid on a slope with a gradient of about 28 degrees at a point about 8 km from Nzove WTP. In the

installation of the transmission pipeline on the slope is planning to lay a bottom plate of reinforced concrete on the entire slope, and lift down the steel pipes from the upper part of the slope by winch. At the time of construction of the bottom plate, safety protective measures against falling rocks and materials will be introduced. For the lift down steel pipes, measures shall be implemented to avoid predictable accidents, such as attaching a safety wire on pipes preventing their fall due to rupture of the main wire.

(5) Tax Exemption

Tax exemption is applied for the Project in accordance with E/N concluded between Rwanda and Japan. Post-exemption is applicable for Value Added Tax ("VAT") and Withholding Tax by the Project executing agency of Rwanda; and an exemption of these taxes requires a submission of the items list to the executing agency. The items list shall be prepared by the contractors every month. If the purchase is determined to be necessary in the Project after verifying the actual purchase with the list, the Project implementation agency will submit an application for tax exemption (post-refund system) to Rwanda Revenue Authority (RRA). Necessary documents for tax exemption procedures are the items list purchased at the application month, the original invoice, and the receipt that is issued at Electric Billing Machine (EBM). The executing agency will be checked whether proper tax exemption is conducted since the period until the return of VAT or Withholding Tax may take longer than six months after the application for post-refund. In addition, the following documents are required at the import duties for the materials from Japan.

- ✓ Master List
- ✓ Air waybill (bill of lading)
- ✓ Original Invoice
- ✓ Packing List
- ✓ Letters from the relevant ministries and the executing agencies
- ✓ Instruments of ratification of the government of Rwanda
- ✓ Arrival notice (If necessary)

The above-mentioned documents will be carefully examined by the executing agency of the Project. If the contents of these documents are correct, the executing agency shall pay the customs. At the time of customs clearance, staff of the executing agency must be present and sign the documents; therefore, they shall be informed in advance. Furthermore, when importing equipment and materials the following shall be noted: imports shall be carried out by using the name of the Project executing agency avoiding the use of the name of the Contractor. This is because the payment of customs clearance tax will be carried out by the Project executing agency, and thus the equipment shall be imported under the name of the payer.
When importing the necessary equipment temporarily for construction in Rwanda, and exporting the equipment again after the completion of construction, tax exemption is effected by getting approval of Temporary Importation. For approval of temporary imports, it is necessary for the implementing agency to apply to Rwanda Development Board (RDB), also the approval takes about 1 to 2 weeks.

Therefore, when temporary imports will be held, the executing agency shall obtain the Temporary Import approval from RDB in advance.

(6) Precautions for Procurement of Equipment and Materials

Excluding the welding work, local contractors are deemed to have the necessary capacity to

implement the Project according to the specifications and scale of the Project. In this Project, they shall be actively employed under the supervision of Japanese engineers.

In principle, the necessary equipment and materials for the Project shall be procured locally as it is low cost confirmed by the cost comparison with other countries. However, the materials that cannot be purchased locally and/or have some distribution issues that cannot meet the determined schedule shall be procured from Japan.

2-2-4-3 Scope of Works

The following table shows the scope of work to be borne by Japan and Rwanda.

Table 2-27 The scope of work to be borne by the Japanese side and Rwandan side

Work contents	Japanese side	Rwandan side
1. Issue of Banking Arrangement and Authorized to Pay		
■Signing of Banking Arrangement (B/A)		○
■Issue of Authorization to Pay (A/P)		○
■Various expenses burden for items listed above		○
2. Necesarry procedures for Environmental and Social Considerations (Resettlement, Land Acquisition, Monitoring)		○
3. Tree removal, Ground leveling, Obstacle removal		○
4. Obtain of building permit		
■Notice and request of an approval of installing the transmission pipeline to administrator of road and river		○
5. Securing storages for equipment and materials		○
6. Transportation and customs clearing of materials		
■Transportation of materials to Mombasa port	○	
■Transportation of materials to the construction sites	○	
■Customs clearance		○
■Tax exemption (Customs, VAT)		○
■Obtaining a permission to import materials		○
7. Construction of facilities		
■Maintenance of construction roads	○	
■Implementation of new transmission pipeline between Nzove and Ntora	○	
■Replacement from the existing transmission pipeline	○	
■Construction of pump station at Nzove reservoir	○	
■Installing water supply pump at Nzove reservoir	○	
■Construction of the elevated water tank at Ntora reservoir	○	
■Re-arrangement of outflow pipes at Ntora reservoir	○	
■Installation of flowmeter and water level guage	○	
■Recovery of production volume at Nzove 1 WTP		○
■Increase of production volume at New Nzove 1 WTP (40,000㎥→65,000㎥)		○
■Installation of box culvert at the bridge being constructed		○
■Re-arrangement of distribution pipes and equipped facilities at Ntora reservoir		○
■Provision of a disposal site for surplus soil and waste water		○
■Provision of test water and chlorine agent		○
■Advance notice of possible water suspension while switching the transmission pipelines		○
8. Cost required for approval and procedure for immigration and stay in Rwanda		○
9. Procedure necessary for an approval relating to implementation of the Project		○
10. Burden of costs on related work not included in the scope of Grant Aid		○
11. Support for bidding process		
■Support for preparation of bidding documents	○	
■Consulting work for bid opening and supervision of procurement	○	
12. Inspection of procured equipment		
■Observation for inspection of procured equipment	○	○
■Approval procedure of procured equipment	○	○
13. Other		
Continuous collection and management of indicators relating project monitoring		○
Acquisition of cooperation from surrounding residents and necessary measurements for traffic regulation		○

Source: Study Team

2-2-4-4 Consultant Supervision

In compliance with Japanese Grant Aid Policy, the Consultant shall organize a consistent project team for the Detailed Design (D/D), management of construction and procurement of equipment and materials of the Project based on the Outline Design (O/D) in the previous survey, and ensure the efficient implementation of the Project.

The Consultant will dispatch at least one engineer to be on site for procurement and construction supervision of the Project to carry out the process, quality and safety management. Moreover, Japanese experts will supervise factory inspections and pre-shipmen inspections to prevent the issues after the arrival of the equipment and materials.

(1) Basic Policy of Management of Construction and Procurement

The consultant shall supervise the progress of procurement and construction work to be completed within a predetermined period. In addition, they shall manage and instruct the contractors on site to carry out the construction safely, confirm the quality described in the Contract, and secure the due date of procurement. To complete the entire Project within the determined schedule, it is important to complete the procurement and construction work within each respective schedule.

Moreover, it is important to confirm the progress of each items of work to be borne by Rwandan side. The supervision contents are procurement of equipment and materials, temporary constructions, foundation work, framework construction, equipment installation, plumbing work and more. Therefore, the consultant shall communicate and cooperate with the residents and contractors, and related Ministries of Infrastructure to manage the procurement and construction work properly. The main points of construction management are shown below.

1) Schedule Management

The contractor has to check the actual progress of work, either weekly or monthly, in comparison with the schedule indicated in the Contract. If delays in the schedule are predicted, the Consultant should warn and demand the contractor to submit a measure plan against the issue and implement the plan to complete the procurement and construction work according to the deadline. The main items for checking the work progress are shown below:

- Check the completion and interim inspection including factories inspections
- Check materials delivered to the site such as pipes and pump facilities
- Check the temporary work and preparation of heavy equipment
- Check the actual working days of engineers, technicians and workers in comparison with the planned working days

2) Safety Management

The contractor will conduct the safety management ensuring the safety at the work site, preventing work-related injuries or/and accidents, and preventing accidents of third parties during the construction through discussions and cooperation with the Consultant. The points for safety management at the site are shown below:

- Establish safety regulations and select the person(s) to be in charge of safety management
- Hold regular safety management meetings
- Prevent accidents by implementing regular checks of heavy equipment

- Select a proper route for the construction vehicles and heavy equipment, and make sure workers drive with slow speed the roads
- Take necessary measures to ensure welfare benefits for workers and encourage them to take days off

(2) Supervisors

The Contractor shall implement the facility construction work under the construction contract by subcontracting local contractors in Rwanda. Therefore, the Contractor will dispatch to the work site engineers/technicians with similar work experience in overseas to manage the subcontractors in order to thoroughly enforce the management of construction process, quality and safety during the construction period. The Consultant will dispatch a resident supervisor to supervise and thoroughly enforce these management by Contractor.

2-2-4-5 Quality Control Plan

The Consultant as the construction supervisor of the Project shall confirm whether the condition and quality of procured equipment and materials match the specifications and the design described in the Contract, in accordance with the items listed below. If the quality and condition does not meet the required level, the Consultant should request the materials to be modified, changed, or repaired.

- Verify the specification and the design of the equipment and materials
- Verify the results of the factory/stores inspections
- Inspect the measurement used for packing, transporting and storing
- Inspect the working drawing for heavy equipment and the installation manual
- Check the inspection manual, measures of trial operations and arrangement of equipment
- Attend and observe installation of facilities and auditing trial operations, arrangements and inspections
- Inspect the equipment and construction drawing compared with the completed construction
- Inspect completion drawings

(1) Concrete

1) Concrete mix design

It is necessary to determine the concrete mix design for each nominal strength through kneading tests. As for concrete mix design, the average compression strength of test pieces must surpass a target strength which is set by each nominal strength, and the slump should be within a permissible range. The target strength is to be the nominal strength plus the standard deviation.

Concrete compression test is supposed to be carried out in a laboratory of the concrete manufacturer or on site. Test pieces are picked up on site every pour of 100 m^3 or less. Six test pieces are collected at once, and three of them are to be compressed seven days after pouring (of the concrete) and the others are to be compressed 28 days after pouring.

2) Concrete manufacture

There are some ready-mixed-concrete manufacturers in Kigali; and thus it is possible to purchase ready-mixed-concrete locally. The ready-mixed-concrete will be basically procured

from manufacturers and transported to the site. However, the ready-mixed concrete will be transported by transshipment for the place where manufacturers cannot carry the materials, such as narrow parts and slopes.

3) Slump test

Slump test shall be carried out for every concrete pour. The permissible range shall be within ±2.5cm.

4) Concrete compression test

The concrete compression test shall be carried out in a laboratory of a concrete plant company. Test pieces are collected every pour of 100 ㎥ or less; and there are three pieces for every batch.

(2) Reinforced steel bars

A tensile test must be carried out for every diameter used to verify the strength of reinforced steel bars.

(3) Aggregates for concrete

Aggregate test for fine and coarse aggregates should be carried out to confirm the quality.

(4) Bearing Capacity of Soil

The standard penetration tests should be carried out at the pump station of Nzove WTP, the planned construction site of elevated tank in Ntora Reservoir and the planned implementation route for the transmission pipeline.

2-2-4-6 Procurement Plan

(1) Construction Materials

The procurement countries of the Project are shown in table below. The steel pipe shall be procured from Japan to ensure the withstanding high water pressure and the quality for long-term use. Moreover, in the case that the steel pipes are to be imported from Japan, competitiveness can be guaranteed since there are multiple makers and specifications are standardized. Also most construction materials are not manufactured in Rwanda; and thus these will be procured from Japan or third countries. However, some construction materials like crushed stone or sand, which can be purchased in Rwanda, are to be procured locally.

Table 2-28 Procurement of construction materials

Procurement of Equipment		Procurement Country		
		Japanese side	Rwandan side	Third countries
(Main Equipment)				
1	Coated steel pipes for water service	○		
2	Ductile cast iron pipes	○		○
3	Water supply pump facilities	○		○
4	Machine and electrical facility	○		○
5	Valves, Air valves	○		○
6	Hot tapping valves	○		
7	Iron elevated water tank	○		○
(Construction Equipment)				
1	Ready-mixed concrete		○	
2	Cement		○	
3	Aggregate（sand、gravel）		○	
4	Reinforced bars		○	
5	Steel frames		○	
6	Interior/exterior materials and fixtures	○	○	
7	Air conditioner		○	
8	Lighting facilities		○	
9	Cables for general electrical work	○	○	

Source: Study Team

(2) Construction Machinery

General construction equipment such as backhoe, dump truck, tamper, and concrete mixer shall be leased locally because the cost and transportation period are much reasonable than those when procured from Japan. The temporary monorail used for implementing the transmission pipeline on the slope; and the machines for pipe jacking method cannot be procured locally. Therefore, they shall be procured either from Japan or third countries.

(3) Transporting and Packing Plan

It will take about 35 days to transport materials from Japan to the port of Mombasa and it takes at least another 5 days for miscellaneous procedures in the Port. Also it will required another 5 days to transport those from the Port to the Project site. These required days shall be included in the transporting and packing plan.

2-2-4-7 Operation Guidance Plan

After the trial operation of the facilities implemented by the Project, operation and maintenance skills training shall be provided as an initial operation guidance to WASAC staff. WASAC has been operating and maintaining the water treatment plant in Kigali City including Nzove WTP so far; and has techniques of the operation and maintenance of pump facilities. However, it is necessary to carry out the initial operation guidance including adjustment of the water supply volume and the pump head to operate the new water pumps together with the existing water pumps.

Therefore, engineers dispatched by the contractor during the construction work shall continue to

provide practical training for general operation and maintenance of the water pump facilities to the Rwandan engineers.

Trainings for operation methods of various instruments, which are indispensable for maintenance work, shall be conducted. The contents of the trainings shall be planned to secure effective operation of the equipment.

(1) Place and implementation period of the Practical training

On-site training, for about one week, shall be conducted in Rwanda after the trial operation of the facilities.

(2) Instructors

The instructors shall be the engineers who are assigned for the equipment installation and trial operation/adjustment. They will be dispatched by the manufacturing companies of the facilities, which are maintained by the selected Contractor in Japan.

(3) Trainees

Participants from Rwandan side for the practical trainings shall be the staff of WASAC those who will be directly engaged in the operation and maintenance of the facilities, after starting operation of Nzove WTP and Ntora Reservoir. Moreover, the personnel listed below shall be required to participate in the trainings. Thus, WASAC, the Project executing agency of the Rwanda, shall appoint the trainees before the trial operation of Nzove WTP and Ntora Reservoir is completed.

- Overall technical personnel: 1 person (Nzove WTP)
- Operation and Maintenance Personnel: 6 people (Nzove WTP: 3 people, Ntora Reservoir: 3 people)

Total: 7 people

(4) Training contents

In principle, initial operation guidance shall be implemented through the on-site practical training, including the pump operation management accompanying simultaneous operation of multiple pump stations, and the maintenance of each equipment such as flow meter and water level gauge. The technical personnel at the site and the operation and maintenance personnel must have sufficient knowledge about these facilities to operate and maintain them.

2-2-4-8 Soft Component (Technical Assistance) Plan

(1) Background of Soft Component Plan

The Project for Strengthening of Nzove - Ntora Principal Transmission Pipeline in Kigali City in Rwanda aims to improve the fundamental facilities for water supply service and to achieve an efficient and stable distribution of water by strengthening the principle transmission pipeline from Nzove WTP to Ntora Reservoir in Kigali City. The Project includes improvement of water supply pump facilities at Nzove WTP, implementation of Nzove-Ntora transmission pipeline, replacement of distribution pipes diverging from the transmission pipeline, and improvement and rehabilitation of Ntora Reservoir.

The water volume will increase by the implementation of the transmission pipeline and Ntora

Reservoir, which consists of two tanks, will operate flexibly by the restructure of outflow pipes in Ntora Reservoir. The Project will allow the distribution of water from both tanks in Ntora Reservoir to the Kacyiru area, to the main transmission pipeline in direction to Fawe Girls School Reservoir, and to the neighborhood area of Ntora Reservoir. This will maximize the capacity of Ntora Reservoir to respond to the increased water supply volume from Nzove WTP. In addition, the restructure of outflow pipes in Ntora Reservoir will allow water supply to the targeted water distribution area even by utilizing one tank in the reservoir enabling periodic cleaning of the reservoir (which is expected to be cleaned at least once a year). Regarding the existing facilities, water distribution to the Kacyiru area is operated by using only one tank out of two in Ntora Reservoir; and thus, Ntora Reservoir cannot suspend water pouring in the tank and it has not been cleaned up. In addition, WASAC does not have knowledge and experiences in cleaning the reservoir. At the present, the flowmeters and the water level gauges are not utilized and Ntora Reservoir is not operated utilizing the respective data such as flow rate and water level. Therefore, a guidance for operation and maintenance of the reservoir including its cleaning and use of flowmeters and water level gauges, will be provided as a training through the implementation of technical assistance (Soft Component).

(2) Current status of the operation and maintenance of water supply facilities

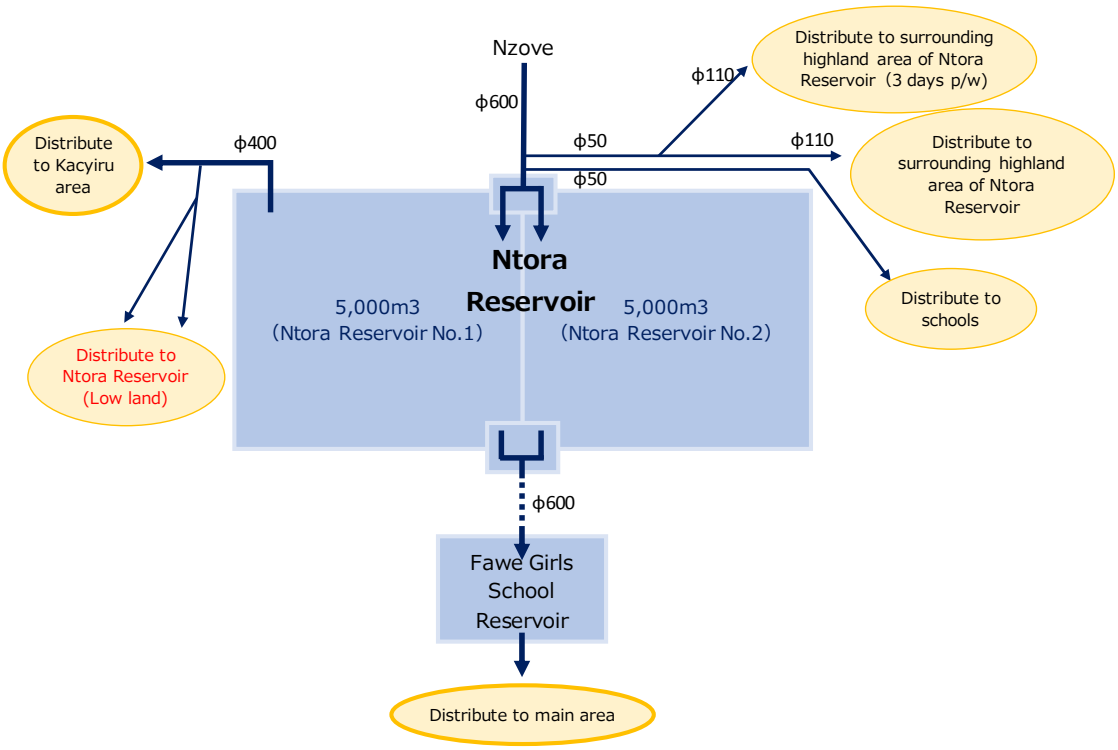
1) System of Operation and Maintenance of Nzove WTP

Currently, the water supply to Ntora Reservoir from Nzove WTP is about 40,000 ㎥/day with 5 existing pumps (there are 6 pumps in total; 5 operation pumps and 1 reserve pump). The amount of water supply from Nzove WTP to Ntora Reservoir is being adjusted by the number of operated water supply pumps — as the operation of all tanks has to be suspended when the water level of tanks reaches the maximum level. In this Project, 3 new water supply pumps in Nzove WTP will be installed in this Project (2 operation pumps and 1 reserve pumps). The main two water pumps will allow a water supply of 22,000 ㎥/day (11,000 ㎥/day/pump) additionally.

2) System of Operation and Maintenance of Ntora Reservoir

(1) Current situation of Ntora Reservoir

The existing Ntora Reservoir consists of two tanks (10,000 ㎥ [5,000 ㎥ × 2 tanks]) without a transition pipe between them. In addition, water level gauges are out of order and flow meters are not installed. An outflow pipe to Kacyiru area is only connected to one of these tanks; and two tanks are separately operated through visual inspection at present. Therefore, the capacity of reservoir is not being fully utilized due to this complicated operation and maintenance.



Source: Study Team

Figure 2-20 Current status of Ntora Reservoir

An inflow pipe (φ600 mm) from Nzove WTP has branched distribution pipes (φ50 mm) to supply water to the surrounding area of Ntora Reservoir and mechanical meters are installed on the branched part of the pipes. The branched distribution pipes (φ 50 mm) supply the water to a part of highland areas by utilizing the residual water pressure from Nzove WTP; however, it is difficult to supply water due to insufficient water pressure. Two distribution pipes (φ110 mm), which is diverged from the distribution pipe (φ 50 mm), are installed to supply water to two highland areas; and each pipe supplies water for 4 days (Sun-Wed) and 3 days (Thur-Sat) respectively.

The water level of the tank to Kacyiru area (Ntora Reservoir No. 1) hardly reach the minimum; yet, the water level of the tank at Ntora Reservoir No. 2 reaches the minimum when the water demand is high.

(3) Technical ability of operators of Ntora Reservoir

Three operators work at Ntora Reservoir (one works day shifts, the other work night shifts). Monitoring of water level, recording, and operation of inflow/outflow valves have been carried out every hour as necessary. Since water level gauges are out of order, the water level is visually monitored.

(4) Challenges of O&M of Nzove WTP and Ntora Reservoir

The challenges of O&M of Nzove WTP and Ntora Reservoir are as follows.

Challenge 1 : It is difficult to adjust an appropriate water supply amount using existing and newly installed water supply pumps because of differences in their water supply capabilities.
Challenge 2 : The water level and flow rate are not appropriately recorded because Ntora Reservoir does not equip water level gauges and flowmeters.
Challenge 3 : Facility capability of Ntora Reservoir is not optimized as two tanks in Ntora Reservoir are not equipped with a transition pipe and they are separately operated.

Challenge 1 : It is difficult to adjust an appropriate water supply amount using existing and newly installed water supply pumps because of differences in their water supply capabilities.

Water supply amount from Nzove WTP to Ntora Reservoir is adjusted by controlling the number of operated water supply pumps. In general, the amount of water supply is not frequently adjusted because the most effective water supply volume is fixed according to the water demand and capacity of the reservoir.

After the completion of the Project, adjustment of water supply amount using existing and new water supply pumps to be installed is required. These water supply pumps have different capacities to supply water and thus the amount of water differs. It is important to adjust the water amount by controlling the number of operated water supply pumps.

Challenge 2 : The water level and flow rate are not appropriately recorded because Ntora Reservoir does not equip water level gauges and flowmeters.

A water level gauge is equipped at Ntora Reservoir and currently it is out of order. In addition, a flowmeter is not installed; and thus the WASAC staff who are stationed at Ntora Reservoir monitor visually and record the water level every hour. Ntora Reservoir mainly distributes water to transmission pipeline leading to Fawe Girls School Reservoir and to Kacyiru area. However, it is difficult to grasp the amount of distributed water to each distribution area as a flowmeter is not equipped. Under the situation where the water demand in Kigali City is increasing, the need for efficient water distribution and delivery, based on a water supply plan, is increasing. It is important to record the water level and flow rate of Ntora Reservoir by utilizing water level gauges and flowmeters to be installed in the Project in order to appropriately operate the reservoir.

Challenge 3 : Facility capability of Ntora Reservoir is not optimized as two tanks in Ntora Reservoir are not equipped with a transition pipe and they are separately operated.

Ntora Reservoir consists of two tanks (capacity: 5,000 ㎥×2=10,000 ㎥) and these are not connected by a transition pipe. One of the outflow pipe in Ntora Reservoir is connected with the transmission pipeline, which distributes water after passing through Ntora Reservoir to the direction of Fawe Girls School Reservoir; and it is connected with both tanks. However, the other outflow pipe, which distributes water to the Kacyiru area, is only connected to one tank (out of two tanks). The mounting position of the outflow pipe for Kacyiru area is higher than that for the transmission pipeline in direction to the Fawe Girls School Reservoir. Accordingly, an operation of two tanks is complicated because it is necessary to keep the water level of the tank for Kacyiru area higher to distribute water to Kacyiru area. The tank used only for distributing water to the transmission pipeline in direction to Fawe Girls School Reservoir and it is often filled with water. Moreover, when water reaches the maximum level of the tank, the operation of some water supply pumps in Nzove WTP will be suspended. All of the treated water in Nzove WTP cannot be sent to Ntora Reservoir; and its capacity has not been effectively

utilized. Additionally, the operation of each tank cannot be suspended because each tank has the responsibility of supplying water to different areas. Also, Ntora Reservoir has not been cleaned before.

An outflow pipe to be installed in the Project will distribute water to the transmission pipeline and Kacyiru area from both tanks; and the facilities will be improved including the restructure of pipes so that the distribution of water to both areas can be carried out even with one tank. This restructure of pipes will make possible to cleaning of Ntora Reservoir without suspending water during the cleaning work.

(5) Objective of Soft Component

The objective of the Soft Component of this Project is defined as “Strengthening the operation capacity of Nzove WTP and Ntora Reservoir” based on the issues mentioned in the previous section.

(6) Outputs of Soft Component

Expected outputs of the Soft Component are as follows.

Table 2-29 Outputs for issues

Issues in the operation of Nzove WTP and Ntora Reservoir		Outputs
1	It is difficult to adjust an appropriate water supply amount using existing and newly installed water supply pumps because of differences in their water supply capabilities.	Planned water supply amount is secured by the number of operated water supply pumps and the adjustment of valves.
2	The water level and flow rate are not appropriately recorded because Ntora Reservoir does not equip water level gauges and flowmeters.	The status of Ntora Reservoir (water level/ flow rate) is recorded.
3	Facility capability of Ntora Reservoir is not optimized because two tanks at Ntora Reservoir are not equipped with a transition pipe and they are separately operated.	Two tanks at Ntora Reservoir are properly operated.

Source: Study Team

(7) Procedure of Confirming the Achievement of Outputs

Indicators to evaluate the level of achievements of the Soft Component of the Project are defined as follows;

Table 2-30 Indicators of each output in the Soft Component（Draft)

Outputs		Activities	Items to confirm the achievement	Indicators	Confirmation method
1	Planned water supply amount is secured by the number of operated water supply pumps and the adjustment of valves	Explain the relationship between water supply amount from Nzove WTP to Ntora Reservoir and the number of operated water pumps	The relationship between performance of pump curve and water supply amount is understood	The number of water pumps required for planned water supply amount is determined	Manual for operation of water supply
		Determine and operate the number of	The number of operational	Planned water supply amount	Record book for water level

Outputs		Activities	Items to confirm the achievement	Indicators	Confirmation method
		operated water supply pumps based on the divergence between the actual water supply amount and water supply amount calculated by pump performance curve	pump is adjusted according to planned water supply amount	is supplied	and flow rate at Ntora Reservoir
2	The status of Ntora Reservoir (water level/ flow rate) is recorded	Instruct how to record and organize the water level and flow rate data at Ntora Reservoir	The water level and flow rate are properly recorded and data is organized	The water level and flow rate per hour is recorded at Ntora Reservoir	Record book for water level and flow rate at Ntora Reservoir
3	Two tanks of Ntora Reservoir are properly operated	Consider an appropriate water supply amount from Nzove WTP, based on water level and flow rate data and provide an instruction to WASAC staff	The water level of the Ntora Reservoir is properly managed	The number of times the water level of Ntora Reservoir reaches the maximum is decreased	Record book for water level and flow rate at Ntora Reservoir
		Clean Ntora Reservoir with WASAC staff	cleaning method of Ntora Reservoir is learned	Ntora Reservoir is cleaned by an appropriate cleaning method	Field test
		Instruct adequate management of inflow and outflow amount of Ntora Reservoir during cleaning of one tank	Water level of Ntora Reservoir is appropriately maintained through the understanding of adequate amount of inflow and outflow	The tank is operated within the effective water depth with the operation of one tank only	Record book for water level and flow rate at Ntora Reservoir

Source: Study Team

(8) Plan of Soft Component Activities (Input Plan)

1) Basic policy

Basic policy of the Soft Component is as follows;

Table 2-31 Basic policy of the Soft Component

Executor of the Soft Component	Japanese Consultant (1 person) (Experience in water demand forecast and operation of reservoirs in Japan)
Target persons for the Soft Component	Nzove WTP maintenance officer from WASAC (1 person) / operators (8 people), resident staffs at Ntora Reservoir (3 people)
Implementation method of the Soft Component	Lecture, On the job training (OJT) in Rwanda
Implementation period of the Soft Component	After the construction work of the Project

Source: Study Team

2) Activities

The input plan and contents of the activities of Soft Component are defined as follows;

Output 1 : Planned water supply amount is secured by the number of operated water supply and the adjustment of valves.

Activity 1-1 : Explain the relationship between water supply amount from Nzove WTP to Ntora Reservoir and the number of operated water supply pumps

- Instruction of the relationship between the number of operated water supply pumps and water supply amount (lecture)

This activity provides a lecture regarding the relationship between the performance of pump curve and water supply volume of each of the existing and newly constructed water supply pumps. Understanding the relationship between the number of operated water pumps and water supply volume allows to conduct a water supply according to the water demand.

Activity 1-2 : Determine and operate the number of operated water supply pumps based on the divergence between the actual water supply amount and water supply amount calculated by pump performance curve

- Trial operation using the optimum combination of water supply pumps calculated by the pump performance curve (OJT at work site)
- Determination of the optimum combination of water supply pumps according to water supply amount, based on the results of trial operation
- Operation of pumps based on the determined water supply amount and the combination of water supply pumps

This activity confirms the difference between the actual water supply amount and water supply volume calculated in the activity 1-1 after trial operation. The number of operated water supply pumps and a combination of existing and new water pumps will be summarized into a reference chart, according to the actual and calculated water supply amount. Adjustment of water supply volume by the number of operated water pumps can only control the volume by one pump. Thus, a small adjustment of water supply volume will be conducted by controlling valves. Water supply pumps will be operated responding to the actual water supply volume after confirming the number and combination of operated water supply pumps.

Output 2 : The status of Ntora Reservoir (water level/ flow rate) is recorded

Activities 2-1 : Instruct how to record and organize the water level and flow rate data at Ntora Reservoir

- Explanation about operating reservoirs (lecture)

  【Theme】・Explanation of facility outline and capacity of the Project

  ・Explanation of relationship between water level of reservoirs and outflow quantity
- Monitoring and recording of reservoirs (OJT at work site)

This activity 2-1 as a lecture provides basic knowledge of the correct operation of reservoirs. This lecture will not only provide the basic knowledge required to operate the Ntora Reservoir but also other reservoirs. WASAC has not established and operated a water supply plan based on water demand forecast at present; and thus, the Soft Component will help improve the operating capacity of all water supply facilities managed by WASAC.

Moreover, instructions/guidance of monitoring and recording water level of Ntora Reservoir will be provided to WASAC staff through OJT at the work site after acquiring basic knowledge through the lectures. Instructions are carried out during the trial operation of water supply pumps conducted in Activity 1-2.

Output 3 : Two tanks at Ntora Reservoir are properly operated

Activities 3-1 : Consider an appropriate water supply amount from Nzove WTP, based on water level and flow rate data and provide an instruction to WASAC staff

- Explanation about an appropriate reservoir inflow (lecture)
- Preparation of the manual for operation of water supply

Calculations of water supply amount from Nzove WTP and water demand of the water supply area covered by Ntora Reservoir based on the flow rate and water level data obtained in Activity 2-1 — to utilize effectively the Ntora Reservoir.

In addition, operation planning is established to operate Ntora Reservoir without filling up or emptying it, while keeping the constant water supply amount from the Nzove WTP. However, it is necessary to adjust the number of operated water supply pumps responding to changes of the seasonal water demand. The operation plan of Ntora Reservoir shall be summarized into a manual as an output of the Soft Component. The contents of the manual shall include the following;

- Reference chart about the number and combination of operated water supply pumps in accordance with water supply amount
- Relationship between reservoir inflow and water level
- Operation method responding to inflow and outflow (water demand) to Ntora Reservoir
- Adjustment method of outflow quantity by valves installed at the outflow pipe at Ntora Reservoir

Activities 3-2 : Clean Ntora Reservoir with WASAC staff

- Confirmation for the method and checkpoints of cleaning (lecture)
- Cleaning one reservoir tank x 2 times (OJT at site)

- Evaluation of conditions for inside of the reservoir tank (OJT at site)

There are no records of cleaning Ntora Reservoir for about 10 years since it was constructed; and WASAC staff do not have enough experiences in cleaning the reservoir. Therefore, cleaning as well as understanding and evaluating the status of the reservoir is conducted in this activity. Cleaning will be carried out twice in total; the first cleaning will be carried out in Japan under the guidance of the experienced staff of reservoir cleaning to transfer the technical skills. The second cleaning will be carried out in the work site in Rwanda. Assuming that repair would be required depending on the condition of the reservoir, water supply is carried out using only one tank of Ntora Reservoir for a few days after cleaning. In addition, an operation method during cleaning is instructed, cooperated with staff of Nzove WTP. Water supply amount will be temporarily decreased in water supply areas covered by Ntora Reservoir while the cleaning is carried out. Therefore, the restricted water supply is required to be announced to the residents (water users).

Activities 3-3 : Instruct an adequate management of inflow and outflow amount at Ntora Reservoir during cleaning one of the two tanks

- Monitoring and recording the water level during cleaning of one tank (OJT on site)
- Operation of water supply with only one tank, assuming a repair of the tank is required for a few days (OJT on site)
- Appropriate adjustment of valves and water supply volume from Nzove WTP (OJT on site)

Water supply volume is appropriately adjusted by recording data of water level and flow rate at the time of cleaning in activity 3-2. Water supply capacity of one tank is 5,000 ㎥, which is the half of total capacity (10,000 ㎥) of two tanks. Therefore, considerable knowledge and technical skills are required to operate the reservoir in the case of supplying water to Kacyiru area and transmission pipeline leading to Fawe Girls School Reservoir with only one tank (out of two tanks). The water level at Ntora Reservoir is more likely to reach the maximum level during the cleaning as the reservoir capacity is halved than usual. Therefore, there may be a possibility to limit the water supply volume from Nzove WTP at night when the water demand is lower.

In the case where water supply is prioritized to either the transmission pipeline leading to Fawe Girls School Reservoir or Kacyiru area, the valve at the outflow pipe of Ntora Reservoir shall be adjusted. Above mentioned operation system will be guided to WASAC staff by OJT.

(9) Procurement Methods of Implementation Resources

The resources required for activities in the Software Component are as follows;

1) Japanese consultant

It is necessary to properly operate the Ntora Reservoir based on the water demand forecast in order to respond to the future reservoir operation plan. Appropriate operation of the reservoir leads to an appropriate operation of the water treatment plant; and extensive experience and knowledge is required. Therefore, the technical assistance (Soft Component) will be implemented by Japanese consultants.

2) WASAC

Cooperation of WASAC who manages water supply facilities is essential for implementation of the Software Component. Since WASAC's management system clearly defines assigned areas,

it is necessary to implement activities towards properly designated officers at WASAC. The Project requests WASAC to dispatch especially officers concerning the O&M of Nzove WTP and Ntora Reservoir to all activities of the Soft Component.

3) Other sources

Other sources required for implementation of the Soft Component are as follows;

Table 2-32 Other necessary resources

Item	Purpose
Vehicles	Transportation to the sites for Japanese consultants

Source: Study Team

(10) Implementation Schedule of Soft Component

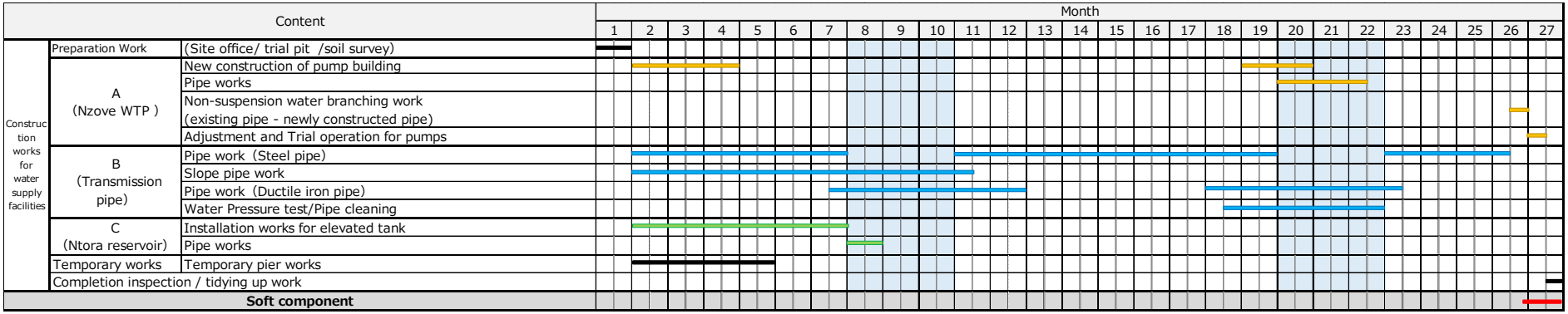
The Soft Component will be implemented after installation of water level gauges and flowmeters to the elevated water tank and Ntora Reservoir, and restructure of outflow pipes at Ntora Reservoir. The outline of the implementation process is as follows.

Table 2-33 Required Time for Implementation of the Soft Component

Output	Activities		date
Output 1 The water supply amount to be set is adjusted by number of operational pump and valve.	Activity 1-1 Instruct correlation between water supply amount from Nzove WTP to Ntora Reservoir by number of operational pump and valve	Preparation of explanation documents	1 day
		Instruction of relationship between number of operational pumps and water supply amount (lecture)	2 day
	Activity 1-2 Determine and operate number of operational pumps considering divergence of water supply amount calculated by performance of pump curve and actual water supply amount.	Trial operation by combining optimum pumps calculated from the performance of pump curve (OJT at work site)	6 day
		Determination of the optimum combination of pumps to operate according to water supply amount based on test run	1 day
		Operation of pumps based on the combination of the determined water supply amount and the pumps	(5 day) Together with other Activity
Output 2 The state (water level / flow) of Ntora Reservoir is recorded.	Activities 2-1 Instructions on how to record and organize the water level and flow data of Ntora Reservoir.	Explanation of reservoir operation (lecture)	Together with Activity 1-1
		Monitoring and recording of reservoirs (OJT at work site)	Together with Activity 1-2
Output 3 2 tanks of Ntora	Activities 3-1 Consider the appropriate water	Guidance concerning appropriate inflow of the reservoir (lecture)	Together with Activity

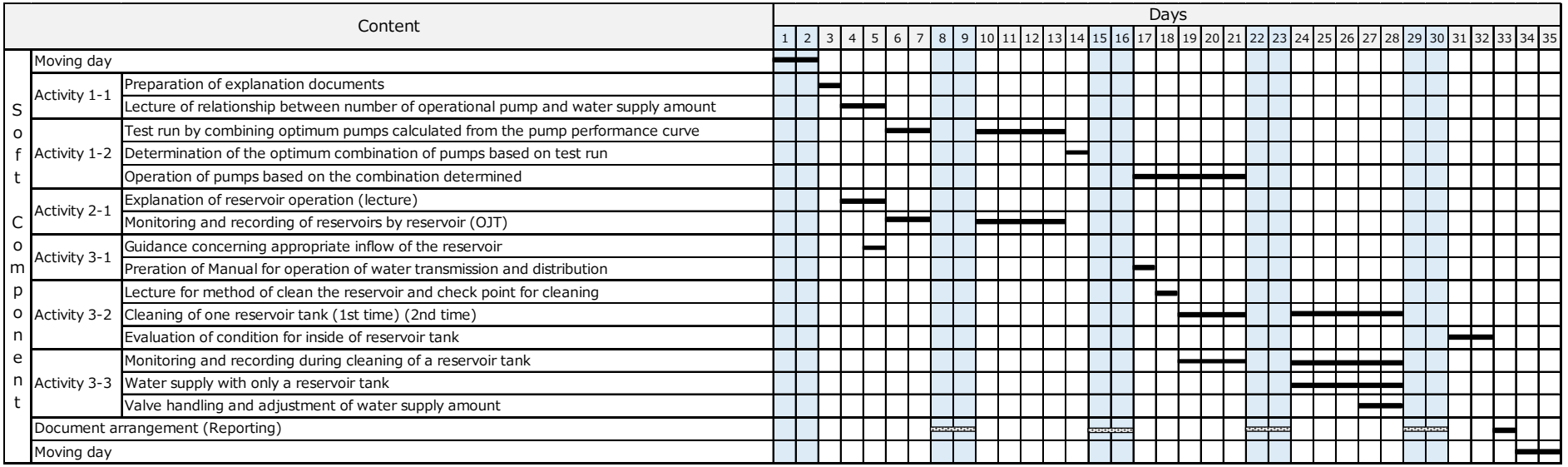
Output	Activities		date
Reservoir are properly operated.	transmission from Nzove WTP and instruct WASAC based on the water level and the flow data.		1-1
		Preparation of Manual for operation of water transmission and distribution	1 day
	Activities 3-2 To clean Ntora Reservoir with WASAC.	Confirmation of method for cleaning the reservoir and check point for cleaning (lecture)	1 day
		Cleaning of one reservoir tank (1st time)	3 days
		Cleaning of one reservoir tank (2nd time)	5 days
		Evaluation of status inside of the reservoir tank (OJT at site)	2 days
	Activities 3-3 Instruct adequate management method of inflow amount and outflow amount of the reservoir during cleaning of one tank.	Monitoring and recording during the cleaning of reservoir tank (OJT in site)	Together with Activity 3-2
		Water supply with only one reservoir tank (assuming repair of inside of the reservoir （OJT in site)	Together with Activity 3-2
		Proper valve handling and adjustment of water supply to Nzove WTP (OJT in site)	Together with Activity 3-2
Document arrangement (report preparation)			1 day
Total (weekday only)			**23 days**
Total (round trip day + Saturday and Sunday = 12 days added)			**35 days**

Source: Study Team



Source: Study Team

Figure 2-21 Implementation plan of Soft Component (Outline)



Source: Study Team

Figure 2-22 Implementation plan of Soft Component (Detail)

(11) Deliverables of the Soft Component

Deliverables of the Soft Component are as follow;

- Manual for operation of water transmission and distribution
- Soft Component completion report (English and Japanese versions)
- Soft Component Completion Report Appendix (Activity Photograph, Water Level and Flow Record Book of Ntora Reservoir, Cleaning Check List of Reservoir Tank, Explanatory documents to WASAC Staff, documents for Other Activities)

(12) Cost Estimation for Soft Component

Cost Estimation for Soft Component of this Soft Component are as follow.

Table 2-34 Cost Estimation for Soft Component

Content		Quantity	Unit Price (Yen)	Total Price (Yen)
Direct labor cost	Personnel for Planning Reservoir operation (Grade 3)	1.16MM	926,000	1,074,160
Direct cost	Travel expenses, daily allowance / accommodation expenses, vehicle rent cost	1 set	1,111,881	1,111,881
Indirect cost	Miscellaneous expenses, technical expenses	1 set	2,234,253	2,234,253
			Grand total	4,420,294

Source: Study Team

(13) Obligation of the Recipient Country

WASAC, the executing agency, needs to decide the target of the Soft Component, such as maintenance officers for Nzove WTP, operators and resident staff of Ntora Reservoir, and arrange the persons to be able to participate in all Soft Component activities. In addition, when cleaning the reservoir, WASAC notifies the local residents of the information as necessary.

2-2-4-9 Implementation Schedule

E/N will be concluded after the approval of the Project by Japanese Government, and the Project will commence based on the Japanese Grant Aid Policy. The Project includes three stages: actual design; selection of contractor (preparation of bid documents, announcement of the bid, evaluation of the bid); and construction of facilities. The following table shows the Project schedule. In the Project, implementation of the transmission pipeline is the main construction work. Some steel pipes shall be implemented in flood plains with soft ground; however, it is difficult to carry on the construction work during the rainy season. Thus, construction work for these steel pipes should be conducted during the dry season.

Table 2-35 Implementation Schedule

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Detailed Design Survey	Field survey	■															
	Detail design	□	□	□													
	Preparation for bid documents				□	□											
	Approval of bid documents					■											
	Notice of bid opening					▲											
	Distribution of bid documents					□											
	Bid opening							▲									
	Evaluation of bid							□									
	Contract							▲					(Seven months)				

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Construction	Preparation	■															
	Nzove WTP: Construction of pump station		■	■	■												
	Nzove WTP: Installation of pump facilities																
	Nzove WTP: Restructure of piping arrangement																
	Nzove WTP: Hot tapping work																
	Nzove WTP: Trial operation																
	Nzove WTP: Initial operation guidance																
	Ntora Reservoir: Construction of elevated water tank		■	■	■	■	■	■									
	Ntora Reservoir: Construction of pump facilites								■								
	Ntora Reservoir: Plumbing work on site									■							
	Ntora Reservoir: Trial operation																
	Transmmsion pipeline: Temporary work		■	■	■	■	■										
	Transmmsion pipeline: Pipe jacking method			■	■	■	■	■				■	■	■	■	■	
	Transmmsion pipeline: Installation of steel pipes					■	■	■				■	■	■	■	■	■
	Transmmsion pipeline: Installation of pipes on slope		■	■	■	■	■	■	■	■	■	■					
	Transmmsion pipeline: Installation of ductile cast iron pipes							■	■	■	■	■	■				
	Transmmsion pipeline: Pipe cleaning / hydrostatic test																
	Completion inspection / cleanup																

	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Construction	Preparation																
	Nzove WTP: Construction of pump station																
	Nzove WTP: Installation of pump facilities			■	■												
	Nzove WTP: Restructure of piping arrangement				■	■	■										
	Nzove WTP: Hot tapping work										■						
	Nzove WTP: Trial operation											■					
	Nzove WTP: Initial operation guidance											■					
	Ntora Reservoir: Construction of elevated water tank																
	Ntora Reservoir: Construction of pump facilites																
	Ntora Reservoir: Plumbing work on site																
	Ntora Reservoir: Trial operation											■					
	Transmmsion pipeline: Temporary work																
	Transmmsion pipeline: Pipe jacking method																
	Transmmsion pipeline: Installation of steel pipes	■	■	■				■	■	■	■						
	Transmmsion pipeline: Installation of pipes on slope																
	Transmmsion pipeline: Installation of ductile cast iron pipes		■	■	■	■	■	■									
	Transmmsion pipeline: Pipe cleaning / hydrostatic test											■					
	Completion inspection / cleanup											■			(27.0months)		

□ : Work in Japan ■ : Work in Rwanda

Source: Study Team

2-3 Obligations of the Recipient Country

(1) Securement of Budget for Bank Commission Fees

WASAC as the executing agency shall open an account under the name of the Government of Rwanda to the bank in Japan, based on banking arrangements. WASAC has to cover the cost of various banking fees/commissions related with banking arrangements. Therefore, WASAC has to secure the commission fees for banking arrangements immediately; and must not delay its payments.

(2) Tax Exemption

The Project is conducted within the Grant Aid framework of the Government of Japan; therefore, custom duties for Japanese and the persons from third countries involved in the Project, VAT and other financial duties are exempted. The Project executing agency has a sufficient capacity to arrange the tax exemptions, judging from the track record of other Grant Aid Projects in Rwanda. However, there could be some delays in processing tax exemptions because of insufficient preparation; thus, it is important to share information including with relevant government agencies to ensure tax exemption work is done in a timely manner. MINECOFIN is the contact point for tax exemption procedures and together with WASAC will conduct such work.

(3) Land Acquisition and Environmental and Social Considerations

In accordance with the Resettlement Action Plan (RAP) approved by WASAC, necessary compensation or support for the affected people involved in the Project shall be implemented at an appropriate time; and users and possessors of business land will be resettled. In the Project, land acquisition of 0.6 ha and the involuntary resettlement of 2 households are required.

(4) Installation of box culvert

In order to install the transmission pipeline at the bridge section (Nyabugogo area along RN3 National Road), which is constructed within the route of the transmission pipeline, Rwandan side shall install a box culvert until May 2019 before the announcement of the bid.

(5) Installation of pipe arrangements from the elevated water tank to the water distribution area in Ntora Reservoir

Construction work for pipe arrangements, connected from the new elevated water tank to the water distribution area, and its associated facilities (valves, instrumentation equipment etc.) shall be accomplished until the completion of the Project (October 2021).

(6) Ensuring additional electric power for newly installed pumps

The Project installs new pumps at Nzove WTP and Ntora Reservoir. WASAC shall secure necessary electric power by May 2019 before the announcement of bid. The requied capacity of electric power for Nzove WTP is 10.05MVA (Nzove1: 3.2MVA, Nzove2: 3.6MVA, New Nzove1: 3.25MVA) and additionally 1.8MVA is necessary for the Project. In this situation, current power supply is 5MVA, all the existing facilities can not be operated at once. In response to this, Rwandan side is constructing a substation (total capacity is 20MVA, 15MVA is for Nzove WTP) to be completed in December 2018.

(7) Implementation of capacity recovery work at Nzove 1 WTP

WASAC shall complete the project to expand production capacity of Nzove WTP by 2023 in order to achieve the maintenance effect of the Project certainly.

Nzove 1 WTP processed 25,000 ㎥/day. However, amount of treatment water was reduced to 17,000 ㎥/day when the operation of Nzove 2 WTP started. According to WASAC, this is because the water treatment cost of Nzove 2 WTP is more economic than Nzove 1 WTP. Therefore, as WASAC, it is possible to process 25,000 ㎥/day at the present situation. The time has passed since Nzove 1 WTP started operate with 17,000 ㎥/day, and the filter material of the water treatment plant leaked out. It is necessary to confirm by trial operation that whether

Nzove 1 can process 25,000 ㎥/day is possible. As a result of trail operation, if Nzove 1 WTP cannot process 25,000 ㎥/day, it is required to recover water treatment capacity by Rwanda.

(8) Support for construction permit (commencement of work) procedure

Upon the construction of the transmission pipeline of the Project, necessary licenses and approvals in Rwanda shall be obtained appropriately (especially permissions from road and river administrators). Advanced preparation is required in order not to affect the Project implementation

1. Road related: Road administrator from Rwanda Transport Development Agency (RTDA), City of Kigali
2. Crossing of river: River administrator from Rwanda Water and Forestry Authority (Water Resources Department)

(9) Operation and maintenance system and securement of operation and maintenance expenses

The transmission pipeline to be installed in the Project is an important lifeline, supporting the civil life and urban activities of the capital city of Kigali City; and the function of the water supply system must be maintained over a long period of time. Thus, WASAC shall secure the personnel structure in accordance with the increased production volume in the future; and necessary maintenance and management costs.

(10) Securement of personnel for participating in Soft Components

The target of Soft Components, which improve the operation of Ntora Reservoir, are staff at WASAC. Therefore, WASAC needs to secure the necessary expenses for staff and those who take top priority on participating in the Project.

(11) An announcement to customers at the time of replacing the transmission pipeline

Switching from the existing transmission pipeline to the new pipeline is planned to be conducted by the method of hot tapping work so as not to suspend the water supply. However, if the water level in the tank reaches the minimum at Ntora Reservoir when the construction work takes much time, water suspension may occur. Hence, WASAC needs to notify customers in advance that water supply can be affected before and during the replacement work.

(12) Others

Overview of the other undertakingsof Rwanda is shown below.

1. Provide necessary information and data of the Project
2. Implementation of the prompt unloading of materials at the port and proceeding customs clearance
3. Logistical assistance of dispatched Japanese; and equipment and materials
4. Bearing all of the necessary expenses of the Project other than Japanese Grant Aid
5. Verify the construction and observing the quality inspection of equipment and materials
6. Proper maintenance and operation of facilities and equipment provided by Japanese Grant Aid
7. Implementation of the environmental and social monitoring

8. Provide an office for construction and temporal land
9. Conclude maintenance contract with a company which procure the equipment and material; and purchase spare parts after one year of completion

2-4 Project Operation and Maintenance Plan

2-4-1 Basic Policy

The most important water supply facilities to be improved in the Project is the water supply pumps in Nzove WTP and the new transmission pipeline. In order to operate and maintain properly the facilities, it is essential the environmental conservation of the facilities as well as its operation and maintenance (O&M) to stabilize the water supply in response to the immediate variation of daily water demand.

To maintain the performance and functions of water pumps and the transmission pipeline and to supply continuous water; it is necessary to carry out appropriate preventive maintenance and maintenance and management of the facilities based on the reliability, safety and efficiency of each facility to be improved in the Project and the existing Nzove WTP facilities (Nzove I, Nzove II, New Nzove I WTP).

In this Project, Rwanda shall constantly bear in mind that basic policy mentioned above, and conduct O&M of the facilities based on the manuals and O&M techniques transferred trough the Soft Component by Consultant and the initial operation guidance by contractor during the construction period.

2-4-2 System of Operation and Maintenance

WASAC is responsible for O&M of equipment and facilities in the Project. Staffs at Nzove WTP, who belong to WASAC, are in charge of these operation and management. The department retains good engineers who had studied in universities in Japan and Europe, and their knowledge and skill levels on water supply is comparatively high. In addition, the minimum necessary maintenance, such as checking pumps on a regular basis, is being carried out.

As mentioned above, the skill level of WASAC's staff is relatively high, and if the initial operation guidance, and transferring the operation and maintenance skill by Soft Component are carried out, facilities of the Project can be operated and maintained without any issues.

2-4-2-1 Operation of water supply pumps in Nzove WTP

There are six pumps at Ntora pipe-system in Nzove WTP — five regular operation pumps and one reserve pump. Although it is 24 hours' operation, staffs at Nzove WTP and Ntora Reservoir are contacting each other to switch on and off the pumps according to the water treatment capacity of Nzove WTP, the water level of Ntora Reservoir, and the seasonal demand.

2-4-2-2 Water Treatment and inspection of Water Quality in Nzove WTP

(1) Maintenance and management in Nzove WTP

There are two technical staffs for the management of Nzove WTP. One is a person in charge of filter operation and water quality test, and the other is a person in charge of maintenance of the facilities. At Nzove II WTP, where the intake water turbidity is high, drainage and

transportation of sludge and cleaning work is carried out at the catchment area and sedimentation basin. In addition, the operation of the filtration reservoir is carried out according to the status of water treatment with visual confirmation by a staff. Water quality inspection is carried out with 20 items for both raw water and treated water. Instruments for water quality inspection are not installed in Nzove I WTP; and thus a staff collects the samples and conducts manually water quality inspection. However, continuous measurements are carried out, using turbid meter and residual chlorine meter, for raw water and treated water at Nzove II WTP.

Main maintenance of the facility is equipment failures response and leaks reparations. Regular maintenance of facilities of Nzove WTP is conducted; however, inspection of air valves, and drainage valves, including the existing transmission pipeline, is not conducted.

(2) Implementation status of maintenance

The staff of Nzove WTP also maintains and manages four pump stations besides Nzove WTP, and the periodic management items and frequency are as shown in the table below. Regular inspection and maintenance covers the inspection of pumps, replenishment of grease and accumulator of pumps. However, most of the time equipment failures response is carried out after the occurrence of leakage or machine breakdown. A pump manufacturer confirms the state of pumps and advises WASAC regarding the replacement of necessary parts on an irregular base. WASAC orders necessary parts and carries out the repairing directly.

Table 2-36 Content of maintenance

Regular inspection		
Place	Content	Number of times・shecule (month)
Espina pump station	Pump maintenance replenishment grease	9 times (Jun,Feb,Mar,May,Sep,Oct,Nov, Dec,Dec)
Nzove WTP	Pump maintenance replenishment grease	1 time (April)
Kayenzi/Runda/Birembo pump station	Pump maintenance replenishment grease	4 times（Mar,Mar,Nov,Dec)
Pileto pump station	Pump maintenance replenishment grease	3 times（Mar,Dec,Dec)
Karma pump station	Pump maintenance replenishment grease	1 time（Dec)
Flowmeter maintenance		
Nzove WTP	Accumulator maintenance	1 time（Dec)
Post correspondence		
Content		Number of times
Repair leakage(Water transmission pipe in WTP)		14 times
Repair Chlorine equipment （chlorine pump, electrolytic cell)		9 times
Pump failure		9 times
Cleaning(sedimentation pond, catchment area, etc.)		12 times
Repair valve		4 times
Cable failure		4 times

Resource : 2016 ANNUAL REPORT NZOVE WTP

2-4-3 Operation of Ntora Reservoir

Three staff members are located in Ntora Reservoir; one staff member works in the daytime and two staff members work at night in shifts. They monitor and record the water level every hour and operate the inflow and outflow valves as necessary, while watching the water level of the two reservoirs of Ntora Reservoir and the distribution volume after passing the reservoir. Water level gauge is not installed at Ntora Reservoir; the water level is confirmed by visual inspection using a ladder installed in the reservoir. Among the outflow pipes from Ntora Reservoir, the outflow pipe leading to the Kacyiru area and the water distribution pipe from the existing transmission pipeline to the surrounding area of Ntora Reservoir have flowmeters. Flow rates are recorded with the water level of Ntora Reservoir every hour.

The distribution pipe to the eastern region and the outflow pipe to Kacyiru area in the south region are connected to the two reservoirs at Ntora Reservoir respectively. The distribution pipe to Kacyiru area is located about 1.2 m higher than the distribution pipe to the eastern region; and water supply to Kacyiru area is given priority. Thus, the water level of two reservoirs is not always fixed, and this makes water distribution management of Ntora Reservoir difficult. Several reservoirs connected to the eastern distribution pipe is managed either by manned or unmanned. Monitoring of the water level is carried out three times a day at the reservoir where employees are located; however, it is not recorded.

2-4-4 Operation expenses in WTP

The table below is the operating expenses of Nzove WTP in 2015 and 2016. The water supply from Nzove WTP to Ntora Reservoir is using a water supply pump, and the power cost is prominent that is accounting for about 85% of the operation cost, due to the high pump head. Nzove II WTP has been in operation since March 2016 and WASAC considered that the operating cost of Nzove II WTP is lower than that of Nzove I WTP, which has groundwater as the source. Thus, Nzove II WTP has been operated preferentially. Therefore, the chemical costs (2015: 6.15%, 2016: 10.25%) are significantly changed because of the operation of Nzove II, which directly takes raw water with high turbidity from the river.

Table 2-37 Operation expenses in Nzove WTP

	2015		2016	
	RWF	%	RWF	%
Energy	1,550,138,009	85.99%	2,271,581,602	84.35%
Water consumed at plant	1,297,406	0.07%	11,264,185	0.42%
supply offices	745,695	0.04%	948,300	0.04%
Supply others	212,000	0.01%	-	-
Supply maintenance	17,141,285	0.95%	3,240,000	0.12%
Communication	410,000	0.02%	990,000	0.04%
Fuel	2,333,979	0.13%	4,096,300	0.15%
Salary	119,521,743	6.63%	124,848,988	4.64%
Reagents	110,841,262	6.15%	276,180,598	10.25%
total	1,802,641,379	100.0%	2,693,155,973	100.00%

Source : 2015/2016 ANNUAL REPORT NZOVE WTP

2-4-5 Regular Inspection Items

2-4-5-1 Inspection Items

(1) Standard Inspection Items of Water Supply Pumps

Daily check and maintenance are essential for using water supply pumps continuously. It is necessary to check water pumps, rotating parts of the motor, receiver of vibration and electrical parts regularly. Daily checks are undertaken indirectly by visual observation; however, regular inspections shall include retightening of each parts, applying lubricants and confirming the status of parts using tools directly.

The standard daily check items are shown below;

1. There are no damages of pumps and motors
2. There are no shaft misalignment of pumps and motors and abnormal vibration
3. There are no abnormal appearances
4. There are no damage of plugs and distribution lines; and no smoke and odor
5. Screws and nuts are strongly tightened
6. Control panel demonstrates normally

The standard regular inspection items are shown below.

1. Check appearance by visual observation
2. Check distribution lines and electrical parts
3. Retighten each parts
4. Apply or pour lubricants
5. Measure insulation resistance electric motor
6. Check device control and operation
7. Check abnormal noise
8. Check monitors
9. Check individual data

The regular inspections and daily checks are to be performed within designated period in accordance with the items in an operation manual which designed by the pump manufacturer. Any issues need to be dealt with in accordance with the operation manual.

(2) Transmission pipeline

Inspection of transmission pipeline is not implemented at present. However, it is necessary to regularly visit all the routes and check whether the transmission pipeline has any issues.

The standard daily check items are shown below;

1. Damage of transmission pipes, leakage or abnormal of the surface ground
2. Peeling of coating or rust in the exposed pipes
3. Information on abnormality by residents in the surrounding areas
4. Any loss of manhole cover

The standard regular inspection items are shown below;

1. Water leakage investigation by the leak detector
2. Functional checks of air valves, drainage valves ad compression tanks

2-4-6 Record and Store the Daily Check

Operating manager records the results of the checks and stores them after inspecting the items above. Keeping records enables to grasp the trouble of each device earlier.

2-4-7 Procurement Plan of Purchasing Spare Parts

Especially the pumps and motors provided by the Project will deteriorate as time goes by and will lose their function. It is possible to grasp such conditions of pumps and motors by checking wear members and cracks as well as measuring the water volume and electric energy. However, it is difficult to judge the deterioration condition of other electric facilities. Therefore, fuses and wiring cables should be prepared in advance as spare parts to respond immediately when signs of troubles can be confirmed by regular inspections and daily checks. The parts need to be replaced before breakdowns to maintain the reliability of the system, and preventive maintenance.

2-4-8 Plan of securing human resources and training

There is no particular need to increase the current number of personnel of Nzove WTP for operation and maintenance of the facility as the major rehabilitation is to install additional water pumps. It will be operated and maintained with the current system. Also, regular patrols of newly constructed transmission pipeline will be conducted under the current system. Operation of Ntora Reservoir will be conducted along with the Soft Component and a management system will be established to operate the reservoir properly in cooperation with Nzove WTP.

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Obligation of Rwandan Side

The cost borne by the Rwanda side is as follows.

Table 2-38 Cost borne by the Rwanda side

The cost born by the Rwanda side : 291.98 million Japanese Yen

Item	Estimated cost (million RWF)	Estimated cost (million yen)
Land acquisition	165.50	21.52
Construction of box culvert	55.00	7.15
Construction of distribution pipe around Ntora reservoir	39.00	5.07
Implementation of environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP)	4.20	0.55
Cost for tax exemption	1,958.00	254.54
Charge for banking agreement (estimation)	24.26	3.15
Total	2,245.96	291.98

Source: Study Team

(2) Condition of Quotation

1) Time of Estimation

The Project cost was estimated in April, 2018.

2) Exchange Rate

The Project cost was estimated using the following exchange rate

1 USD＝JPY 109.22
1 EUR＝JPY 134.64
1 RWF＝JPY 0.129

3) Construction Schedule

Construction period is 27.0 months shown in the implementation schedule.

4) Others

The Project cost was estimated according to the Guideline of Japanese Grant Aid.

2-5-2 Operation and Maintenance Cost

A cost of operation and maintenance cost is estimated based on water treatment cost and electricity cost accompanying an increase in water quantity.

(1) Cost of water treatment and electricity in Nzove WTP

According to the record from July 2017 to March 2018, production volume at Nzove WTP is 1,185,038 ㎥/month (39,500 ㎥/day). Total water supply volume from Nzove WTP is 1,151,389 ㎥/month (38,380 ㎥/day), of which the water supply volume of Ntora pipe-system is 1,073,907 ㎥/month (35,797 ㎥/day).
A cost of water treatment according to the volume of purified water and a cost of electricity for water supply to Ntora pipe-system are 13,248,000 JPY/month and 17,484,000 JPY/month, respectively. The cost of water purification per unit of water purification is 11.51 Japanese yen/㎥, and the cost of electricity related to water supply to Ntora pipe-system is 14.75 Japanese yen/㎥

(2) Estimation of maintenance expenses generated by the Project

The project shall make the average daily supply volume to Ntora pipe-system 52,800 ㎥/day; and the Project increases the maintenance cost as follows.

Table 2-39 Estimated cost for maintenance（Increased amount）

	2017.7～2018.3 Actual value	2021	2024
Daily average of water supply volume (Ntora pipe-system)（㎥/day）	35,797	52,800	74,000
Unit cost of water treatment（JPY/ ㎥）	11.51		
Unit cost of electricity (Ntora pipe-system)（JPY/㎥）	14.75		
Cost of water treatment（JPY/day）	412,023	607,728	851,740
Cost of electricity（JPY/day）	528,006	778,800	1,091,500
Total cost of maintenance （JPY/day）	940,029	1,386,528	1,943,240
Increase from performance year	–	446,499	1,003,211

Source: Study Team

(3) Estimated revenue of water bill

Revenue of water bill is estimated based on WASAC's water rate (323 RFW/㎥, 1 RFW = 0.129 JPY). The results are as follows.

Table 2-40 Estimated revenue of water bill（Increased amount）

	2017.7～2018.3 Actual value	2021	2024
Daily average of water supply volume (Ntora pipe-system)（㎥/day）	35,797	52,800	74,000
Unit cost water supply（JPY/ ㎥）	41.67		
Revenue of water bill (Ntora pipe-system) (JPY/ day)	1,491,660	2,200,176	3,083,580
Increase from performance year	–	708,516	1,591,920

Source: Study Team

When comparing the maintenance cost and the increase in a revenue of water bill from the performance year, the increase in a revenue of the water bill is about 1.6 times as much as the maintenance cost; and it exceeds the increased amount of maintenance cost. An increase in staff at Nzove WTP is not considered along with the expansion of facilities by the Project; and any increases in cost may not be found except the maintenance cost. Therefore, as the volume of water supply increases and a revenue of water bill can be appropriately secured, the increase in maintenance cost by the Project can be covered.

(4) Period of re-maintenance of facilities

The legal durable period is 40 years for steel pipes and ductile cast iron pipes for the transmission pipeline; and 15 years for machinery and electric equipment. However, it is possible to extend the re-maintenance period to about the following years of practical use by implementing appropriate maintenance of each facility and periodic inspection of equipment,

1) Transmission pipeline

A types of pipes for the transmission pipeline is steel pipes and ductile cast iron pipes. Both steel pipes and ductile cast iron pipes can be used up to about 70 years of practical use.

Table 2-41 Example of standard year for re-maintenance of pipes

Ductile cast iron pipe　K shape　good ground	70
Ductile cast iron pipe　except for above	60
Steel pipe　Weld joint	70
Steel pipe　except for above	40
Asbestos cement pipe	40
Hard polyvinyl-chloride pipe　RR long joint	60
Hard polyvinyl-chloride pipe　RR joint	50
Hard polyvinyl-chloride pipe　except for above	40
Polyethylene pipe　high density Thermal fusion	60
Polyethylene pipe　except for above	40

Resource : Ministory of Health, Labour and Welfare, Health Service Bureau「Manual for asset management using simple support tool ver.2.0」（April 2014）

2) Electric motors/Pumps, Flowmeters and water level gauges

Electric motors/Pumps

Examples of setting the renewal standard years of machinery and electrical equipment in Japan are as follows.

For pumps, it is 20 to 30 years according to the past cases. Meanwhile, Yokohama Water Works Bureau has own standard, which is 30 years for the electric motors and 30 years for pumps. The facility diagnosis is carried out before the service life and it is decided whether the facility to be updated or not.

Flowmeters (Electromagnetic flowmeters) and Water level gauges

The renewal standard year is 10 years to 25 years for flowmeters, water level gauges and water quality equipment in Japan. Yokohama Water Works Bureau sets 18 years for flowmeters and water level gauges.

Table 2-42 Examples of setting the renewal standard years of machinery and electricity equipment

Facility category		Year
Machine	Pump	20～30
	Sterilisation facility	15～25
	Chemical injection facility	15～30
	Sedimentation/ filter basin machinery	20～30
	Wastewater treatment	20～40
Electricity/ Instrument	Power receiving and transforming/distribution facility	20～40
	Direct current power source facility	6～20
	Back up power source facility	15～40
	Flowmeter/water level gauge/water quality meter	10～25
	Supervisor control system/ Transmission system	15～23

Resource : Ministory of Health, Labour and Welfare, Health Service Bureau「Manual for asset management using simple support tool ver.2.0」（April 2014）

It is necessary to make sure that it is used up to the legal durable period and attempt to use the facilities and equipment beyond the legal durable period by maintaining facilities properly.

Chapter 3 Project Evaluation

3-1 Preconditions

For the smooth implementation of the Project, the preconditions to be taken by Rwandan side are arranged as shown below. These preconditions need to be surely implemented at the appropriate time by Rwandan side.

(1) Preconditions for implementation of the Project

Place	Precondition	Implementation deadline
Route for new transmission pipeline	Installation work of box culvert : The bridge replacement work along with the expansion of road is in progress near the Nyabugogo along RN3 National Road. Installation of box culvert at the part of bridge is planned for the new transmission pipeline to cross. Rwanda shall complete the installation of the box culvert before the bidding (May 2019).	May, 2019
Route for existing water distribution from Ntora Reservoir	Arrangement of water distribution area by the new elevated tank : Pipe arrangement works from the new elevated tank to the water distribution area (water distribution area A, water distribution area B) and its incidental facilities (valves and instrumentation equipment) will be completed before the completion of the Project.	Completion of the Project Oct, 2021

Source: Study Team

(2) Land Acquisition and Environmental and Social Considerations

Compensation or support for the affected persons involved in the Project will be conducted at an appropriate time in accordance with the Resettlement Action Plan ("RAP") approved by WASAC.

Also, in accordance with the RAP, necessary compensation or support for the affected persons involved in the Project will be conducted at an appropriate time, and owners/possessors and users of business land will be transferred.

(3) Tax Exemption

WASAC works closely with relevant government agencies to promptly implement tax exemption such as VAT refund and exemption of customs duty.

(4) Ensuring power for the installed pump

The pumps will be installed at Nzove WTP and Ntora Reservoir in the Project. WASAC shall secure the necessary electric power by May 2019 before the announcement of the bid.

(5) Secure the budget of the construction borne by the recipient country

Ensure the required budgetary measures to secure the construction budget to be borne by Rwanda (described in the above table).

(6) Procedure of construction permissions

Upon the construction of the transmission pipeline in the Project, necessary licenses and approvals (especially permissions from roads and river administrators) in Rwanda are obtained appropriately and prepared in advance so as not to affect the Project implementation.

1. Road related: Road administrator from Rwanda Transport Development Agency (RTDA), City of Kigali
2. Crossing of river: River administrator from Rwanda Water and Forestry Authority (Water Resources Department)

(7) Securing personnel and cost for operation and maintenance

The transmission pipeline implemented by the Project is an important lifeline supporting the civic life and urban activities of the capital city of Kigali; and thus, the function of the water supply system needs to be maintained for a long time. WASAC needs to secure the personnel and necessary maintenance and management costs according to the amount of water supply to be increased in the future.

(8) Announcement to customers

The construction work to switch from the existing transmission pipeline to the new transmission pipeline will be conducted by using hot tapping work so as not to suspend the water supply. However, if the water level in the tank reaches the minimum level at Ntora Reservoir due to some troublesome work, WASAC needs to announce beforehand to the customers that the water supply can be affected before and during the construction work.

3-2 Necessary inputs by Recipient Country

(1) Maintenance items of the Recipient Country

It is necessary for the Rwandan side to securely implement the maintenance that is shown in the table below to attain the goal of the Project.

Site	Contents	Period
Nzove WTP	Recovery work on production volume of Nzove WTP I: Implementation of recovery work from current 17,000㎥/day to 25,000 ㎥/day	FY 2023

Source: Study Team

Although it is outside of the project scope, the necessary construction work (pressure type filtration, piping, water supply pump, power connection,etc) to increase the amount of treated water at New Nzove 1 WTP from the current capacity of 40,000 ㎥/day to 65,000 ㎥/day is required to be done by Rwanda side in the future.

(2) Maintenance and monitoring of operation and maintenance system after the Project implementation

The transmission pipeline implemented by the Project is an important lifeline supporting the civic life and urban activities of the capital city of Kigali; thus, the function of the water supply system needs to be maintained for a long time. Therefore, WASAC needs to inspect facilities and record these result regularly for maintenance and update of the water supply functions. Implementation of planned maintenance and update is important because an appropriate

operation and maintenance of facilities greatly affects water supply business management and water supply service.

3-3 Important Assumptions

The external conditions for achieving and sustaining the effect of the Project are as follows.

- Security and political situation of Rwanda shall not rapidly deteriorate
- Significant changes concerning water policies in Rwanda shall not occur
- Budget and personnel of WASAC for facility management and operation shall be secured and WASAC shall maintain and operate the facilities continuously.

3-4 Project Evaluation

3-4-1 Relevance

The Project is evaluated to be relevant to be implemented under the Grant Aid Scheme, based on the following reasons.

(1) Relevance in terms of the scale of recipients

The Ntora pipe-system in the Project is an important principal transmission pipeline which supports the water supply of about 550,000 citizens of 1,130,000 citizens of Kigali (as of 2012). With the implementation of the Project, it is possible to safely and steadily supply water of 87,000 ㎥/day, which is scheduled to be increased in Nzove WTP by 2024.

(2) Consistency with Policies in Rwanda

In the National Water Policy of Rwanda, one of the policy objectives is that citizens of all urban areas are given safe, reliable and economical water supply service by 2018.

Furthermore, “Vision 2020”, a long-term national development plan aims to achieve a safe water with 100% access rate by 2020; and building infrastructures including water supply facilities as one of the top priorities. Main purpose of the Project is the improvement of the necessary principal transmission pipeline for safe water supply to the citizens in the capital city of Kigali, which is consistent with the development plan in Rwanda.

(3) Consistency with Japan's Grant Aid Policy

In the Japanese Government’s Assistance Policy for Rwanda Country (April 2012), safe water supply is set as a principal development subject in the priority area of improvement of social services. The Project is consistent with Japan’s ODA policy for Rwanda.

(4) Consistency with global development goals

The Project contributes to the improvement of the living conditions of the residents by increasing the access rate to safe water and the provision of stable water supply service through the implementation of transmission pipeline as the key facility of Kigali City. The Project is consistent with SDGs’ Goal 3 of "Ensure healthy lives and promote well-being for all at all ages" and Goal 6 of “Ensure access to water and sanitation for all".

3-4-2 Effectiveness

The quantitative and qualitative impacts to be expected by the Project is shown as follows. This Project is evaluated to be effective.

(1) Quantitative Impact

The quantitative impact to be expected by the Project is shown in the following table.

Table 3-1 Quantitative impact after the implementation of the Project

Output indicator		Reference value (Actual values in 2017)	Target value (2024) (After three years of the Project completion)
Average amount of water supply in Ntora pipe-system（m³/day）	㎥/day	35,750	52,800[1)]
Number of accidents in the transmission pipeline of Ntora pipe-system)[2]	Number of accidents /100km/year	6.8	0.7
Number of days of water supply restrictions in the area surrounding the Ntora Reservoir	day/week	3～4	0
(Reference value) Number of recipients for the average water supply volume of the Ntora pipe- system[3)]	Number of person	298,000	440,000

Source: Study Team

1) 62,000×（35,750/42,000）≒52,800

2) Reference value: The accident records of the existing transmission pipeline were converted according to the calculation method of average accidents number of ductile iron pipes in Japan. The length of the existing transmission pipeline is 8.85 km and 6 accidents occurred in the past 10 years.

6/ (8.85/100)/10≒6.8

Target value: The average number of accidents on ductile iron pipes in Japan was adopted (Source: Ministry of Health, Labor and Welfare: 2012)

3) The value obtained by dividing the average water supply amount by the unit water supply rate (120 ℓ/person/day, from Kigali City Master Plan 2013)

(2) Qualitative Impact

Qualitative Impact to be expected by the Project is described below.

- The water levels of the two reservoirs in Ntora Reservoir are of an equal level; and the suspension period of water supply from the reservoir No.1 decreases.
- Water distribution status after passing through Ntora Reservoir improves.