Republic of Uganda
Ministry of Water and Environment（MoWE）
National Water and Sewerage Corporation（NWSC）
National Environment Management Authority（NEMA）

Republic of Uganda
Data Collection Survey for
Urban Environmental Sector
(Urban Water Supply and Air Pollution)

Final Report

November 2021

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.

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Exchange Rate

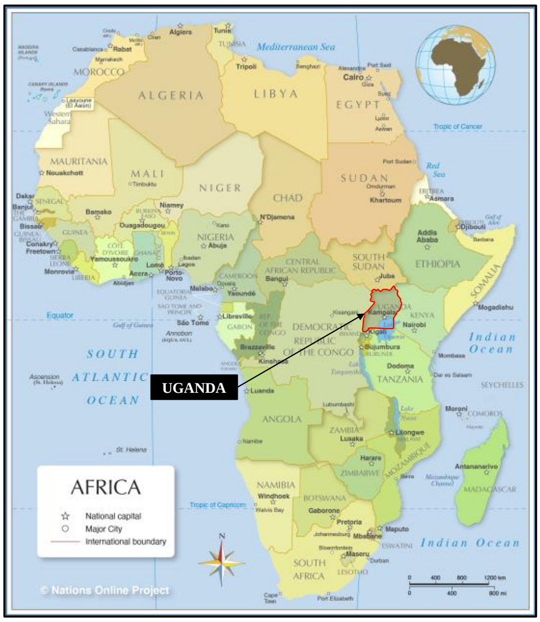
1 USD = 103.27 JPY

1 USD = 3608.53 UGX

1 UGX = 0.028 JPY

UGX: Uganda Shillings

As of December 2020



Uganda in World Map

Uganda Map in Regions

10 Target Areas

No.	Target Area	Municipalities
1	1	KAMPALA CITY
2		MUKONO
3		NANSANA
4		KIRA
5		MAKINDYESSABAGADO
6		WAKISO TC
7		KAKIRI
8	2	NJERU
9		JINJA
10		IGANGA
11	3	HOIMA
12	4	MUBENDE
13	5	LIRA
14	6	KASESE
15	7	MITYANA
16	8	TORORO
17		MALABA
18	9	SOROTI
19	10	FORT PORTAL

Target Area for Air Pollution Sector: Kampala City

Location of the Study Area

Photos (Kampala Water)

	
Raw Water Pump (Ggaba WTP)	Sedimentation Basin (Ggaba WTP)
	
Rapid Sand Filter (Ggaba WTP)	Vocational Skills Development Facility (Ggaba WTP)
	
View of Katosi WTP (Katosi WTP)	Mixing Basin, Flocculation Basin (Katosi WTP)
	
Dissolved Air Flotation Basin (Katosi WTP)	Rapid Sand Filter (Katosi WTP)

Photos (Hoima Water)

Hoima WTP

Cascade Aerator

Chlorine House

Pumping Station

Bakumira Reservoir

Kikwite Reservoir

View of Water Supply Area from Bakumira Reservoir

View of Water Supply Area from Kikwite Reservoir

Photos (Mubende Water)

	
Katoma Dam	Kachwamango Dam
	
Katoma WTP	Pumping Station
	
Sedimentation Basin	Chemical Dosing Facility
	
Kasenyi Underground Reservoir	View of Water Supply Area from Kasenyi Underground Reservoir

Photos (Mityana Water)

Intake Facility at Nakatongoli Swamp

Cascade Aerator

Missing Pond, Flocculation Basin

Sedimentation Basin

Chemical House

Water Quality Test Laboratory

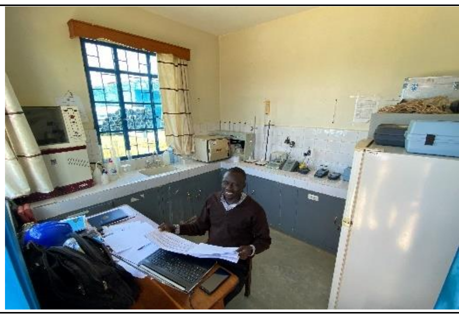
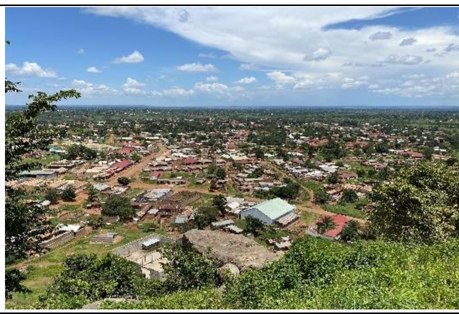
Drying Bed

Elevated Tank

Photos (Tororo Water)

	
River Malaba	Raw Water Pump
	
Sedimentation Basin	Rapid Sand Filter
	
Chlorine House	Pumping Station
	
Tororo Reservoir	Malaba Tank

Photos (Soroti Water)

	
River Awoja	Raw Water Pump
	
Sedimentation Basin	Rapid Sand Filter
	
Pumping Station	Water Quality Laboratory
	
Opiyai Rock Tank 1 (Left), 2 (Right)	View of Water Supply Area from Opiyai Rock Tank

Photos (Air Pollution Sector)

Air Quality Monitoring and Meteorological Observation Point in Makerere University

Air Quality Sensors for $PM_{2.5}$ and PM_{10}

Standard Air Quality Measuring Equipment for Calibration (BAM1020)

Traffic Congestion due to Numerous Motorcycles in Kampala

Dust Hoisting from Unpaved Road in Kampala

Open Burning in Kampala

Visit to Local Ministry (MoWE)

Visit to Local Company (Bodawerk)

Photos (Meetings with NWSC)

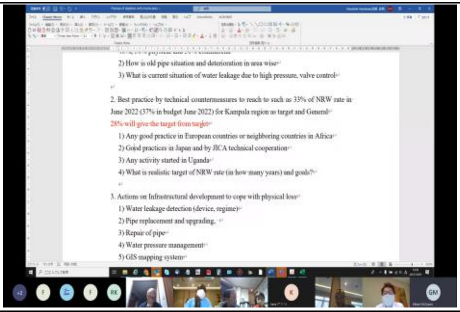
	
Meetings with Kampala Water (NWSC IREC)	Meetings with Kampala Water (NWSC HQ)
	
Meetings with Kampala Water (NWSC KW)	Meetings with Hoima Water (NWSC Hoima)
	
Meetings with Mubende Water (NWSC Mubende)	Meetings with Mityana Water (NWSC Mityana)
	
Meetings with Tororo Water (NWSC Tororo)	Meetings with Soroti Water (NWSC Soroti)

Photos (Business Matching Workshop and Public-Private Joint Ideathon)

Workshop Venue (Urban Water Supply)

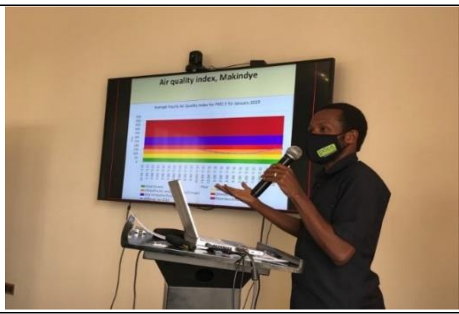
Online Streaming Status (Urban Water Supply)

Ideathon Venue (Urban Water Supply)



Online Discussion (Urban Water Supply)

Workshop Venue (Air Pollution)



Presentation by KCCA (Air Pollution)

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Republic of Uganda
Data Collection Survey for Urban Environmental Sector
(Urban Water Supply and Air Pollution)

FINAL REPORT

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List of Abbreviations

Abbreviation	Original
AC	Asbestos Cement
ACF	Activated Carbon Fiber
AI	Artificial Intelligence
AFD	Agence Frangaise de Developpement
AfDB	African Development Bank
AfWA	African Water Association
AGRG	Albertine Graben Refinery Consortium
AIA	Appropriation in Aid
AQI	Air Quality Index
AQMS	Air Quality Monitoring System
ASAP	A systems approach to Air Pollution
AU	African Union
AWASA	Africa Water and Sanitation Academy
BAM	Beta Attenuation Monitoring
BRT	Bus Rapid Transit
BSWSC	Bauchi State Urban Water and Sewerage Corporation
CAAP	Clean Air Action Plan
CEO	Chief Executive Officer
CD	Capacity Development
CI	Cast Iron
CO	Carbon Monoxide
COVID-19	Coronavirus Disease 2019
CSR	Corporate Social Responsibility
CWASA	Chittagong Water and Sewerage Authority
DANIDA	Danish International Development Agency
DB	Data Base
DEA	Directorate of Environmental Affairs
DFCD	Dutch Fund for Climate and Development
DF/R	Draft Final Report
DI	Ductile Iron
DIT	Directorate of Industrial Training (Ministry of Education and Training)
DMA	District Metered Area
DPF	Diesel Particulate Filter
DPO	Development Policy Operation
DRIVE	Development Related Infrastructure Investment Vehicle
DWD	Directorate of Water Development
DWRM	Directorate of Water Resources Management
EAWAG	Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz
ECI	Environment Compliance Institute
EIA	Environmental Impact Assessment

Abbreviation	Original
EIB	European Investment Bank
EMT	Electro-Mechanical Technicians
EOI	Expression of Interest
EPSRC	Engineering and Physical Science Research Council
ESAWAS	Eastern and Southern Africa Water Sanitation Regulators Association
EU-ITF	European Union Africa International Trust Fund
FCTWB	Federal Capital Territory Water Board
F/R	Final Report
ES	External Services
GDP	Gross Domestic Product
GI	Galvanized Iron
GIS	Geographic Information System
GIZ	Deutshe Geselleschaft fuur Internationale Zusammenarbei
GJA	Greater Johannesburg Area
GNI	Gross National Income
GSA	Geo Strategy Unit
HDPE	High-Density Polyethylene
IC/R	Inception Report
ICF	International Classification of Functioning, Disability and Health
ICT	Information and Communication Technology
IDA	International Development Association
IGIP	Ingenieur-Gesellschaft für internationale Planungsaufgaben
IMF	International Monetary Fund
IREC	International Resource Center
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
IWA	International Water Association
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
JSS	Japan Security Service
KCC	Kampala City Committee
KCCA	Kampala Capital City Authority
KCCAP	Kampala Climate Change Action Plan
KEWI	Kenya Water Institute
KfW	Kreditanstalt für Wiederaufbau
LGBC	Local Government Budget Committee
LGFC	Local Government Finance Commission
LGRECC	Local Government Revenue Enhancement Coordinating Committee
LPG	Liquefied Petroleum Gas
MM	Man-Month
MoEMD	Ministry of Energy and Mineral Development
MoES	Ministry of Education and Sport
MoFPED	Ministry of Finance, Planning and Economic Development

Abbreviation	Original
MoGLSD	Ministry of Gender, Labor and Social Development
MoH	Ministry of Health
MoWLE	Ministry of Water, Lands and Environment
MoWT	Ministry of Works and Transport
MoWE	Ministry of Water and Environment
MP	Master Plan
MTN	Mobile Telephone Network
NDP III	Third National Development Plan
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NGO	Non-Governmental Organization
NMA	National Meteorology Agency
NO_x	Nitrogen Oxides
NRW	NonRevenue Water
NWSC	National Water and Sewerage Corporation
O_3	Ozone
O&M	Operation & Management
PAC	Poly Aluminium Chloride
PC	Performance Contract
PM	Particulate Matter
PoC	Proof of Concept
PSFU	Private Sector Foundation Uganda
HDPE	High Density Polyethylene Pipe
PIP	Performance Improvement Plan
PM2.5	Particulate Matter 2.5
PPP	Public-Private Partnership
PPWM	Prepaid Water Meter
PRV	Pressure Reducing Valve
PSP	Public Stand Pipe
PSV	Pressure Sustaining Valve
PVC	Polyvinyl Chloride
R&D	Research and Development
RC	Reinforced Concrete
RfP	Request for Proposal
RO	Reverse Osmosis
ROA	Return on Asset
ROCE	Return on Capital Employed
RRACE	Customer Re-connect Program and Revenue Recovery Acceleration Program
SCADA	Supervisory Control And Data Acquisition
SCAP	Service Coverage Acceleration Project
SDGs	Sustainable Development Goals
SO_2	Sulphur Dioxide
SP	Strategic Priorities
SPA	Strategic Priority Area

Abbreviation	Original
ST	Steel
TDS	Total Dissolved Solid
TOC	Total Organic Carbon
TOT	Transfer Of Technology
TSS	Total Suspended Solid
UBOS	Uganda Bureau of Statistic
UFW	Unaccounted-For-Water
UN	United Nations
UNBS	Uganda National Bureau of Standards
UNEP	United Nations Environment Programme
UN-HABITAT	United Nations Human Settlements Programme
UNMA	Uganda National Meteorological Authority
URA	Uganda Revenue Authority
UVQF	Uganda Vocational Qualifications Framework
UWA	Umbrella Water Authorities
VAT	Value Added Tax
VEI	Vitens-Evides International
VSDF	Vocational Skills Development Facility
WATSAN	Water and Sanitation
WB	World Bank
WHO	World Health Organization
WLMS	Water Loss Management System
WOP	Water Operators Partnership
WURD	Water Utility and Regulation Department

CHAPTER 1 Outline of the Survey

1.1 Background of the Survey

The total population of Uganda is 44.27 million, of which 10.78 million are living in urban areas. In 2019, the urban population is growing at an annual rate of about 6%, which is more than the country's average of 3.6% and sub-Saharan Africa's average of 2.7%[1]. The population in urban areas has grown about 1.7 times in the last decade. Of these, Kampala Capital City has a population of 1.68 million in 2020[2]. It is the center of political, commercial, manufacturing, and transportation industries, which account for 80% of the country's commerce and industry and more than 65% of its gross domestic product (GDP)[3]. The GDP growth has been above 5% almost continuously since 2001, and the economy was growing steadily at 6% in 2019/20 (IMF Staff Country Report, May 2020) before the coronavirus disease (COVID-19) outbreak. In Uganda's urban areas, this rapid population growth and expansion of economic activities have led to the deterioration of hygienic environment and air pollution.

The Third National Development Plan 2020/21-2024/25, formulated by the Government of Uganda (GoU), has a “Human Resource Development Program”, which aims to achieve a higher quality of life through improved access to safe and clean water targeting 100% urban water supply by 2025. “The Natural Resources, Environment, Climate Change, and Water Resources Management Program” addresses the maintenance and restoration of a clean, healthy, and productive environment through improvement of air pollution and waste management in urban areas as critical issues.

As of FY 2019/20, the percentage of people with access to essential water services in urban areas remained at 70.5%[4]. Also, the rate of people with access to safely managed water services in urban areas has fallen from 26% in 2000 to 16% in 2017[5], and infrastructure development and other measures cannot catch up with urban population growth.

The National Water and Sewerage Cooperation (NWSC) is responsible for providing water supply and sanitation services in 258 cities, including Kampala City. In contrast, the remaining smaller cities are served by the Directorate of Water Development of the Ministry of Water and Environment (MoWE). NWSC is a parastatal corporation established in 1972 under MoWE. It operates in four regions across Uganda: Kampala Metropolitan Area, Central Region, Eastern and Northern Region, and Western and South West Region.

NWSC has expanded the number of cities covered from 110 to 258 between the years 2015 and 2020, increasing water supplies, water sales, and annual sales to 137%, 131%, and 219%, respectively[6]. However, water supply coverage is low in some cities, partly due to inadequate water distribution networks. Also, the non-revenue water (NRW) rate in 2020 was as high as 34%[6] in the entire NWSC. Therefore, infrastructure development, such as the construction of water treatment plants and

[1] World Bank Open Data
[2] Uganda Bureau of Statics, Population Projections 2018
[3] Strategic Plan 2014/15-2018/19, Kampala Capital City Authority
[4] Sector Performance Report 2020, https://www.mwe.go.ug/library/sector-performance-reports
[5] Progress on household drinking water, sanitation and hygiene 2000-2017, JMP
[6] NWSC Integrated Annual Report 2019/20

reconstruction of District Meter Area (DMA), is being implemented with other donors' support. Low-income residents are forced to live in unsanitary conditions in areas with inadequate water supply facilities, making it challenging to prevent infectious diseases. The importance of sanitation has increased in response to the spread of COVID-19.

In terms of air pollution, the concentration of PM2.5 in Kampala averages about 50 μg/m^3 per year, five times higher than the World Health Organization (WHO) standard of 10 μg/m^3 and is at the level of "Unhealthy" according to the Air Quality Index. The mortality rate in Uganda due to air pollution is estimated at 155.7 per 100,000 people (2016)[7], which is 2.3 times higher than the global average of 68.9 per 100,000 people (2017)[8], making it a serious situation. The current epidemic trend of COVID-19 shows that people with respiratory diseases are at high risk of becoming seriously ill[9]. Therefore, air pollution control measures are also crucial from the perspective of COVID-19 countermeasures. The air pollution measurement and monitoring regime in Kampala City remains inadequate. The total of one monitoring station installed in the United States Embassy and other stations installed as part of the AirQo Project which has been jointly implemented by the Kampala Capital City Authority (KCCA) and Makerere University is only about 80 locations. As a result, effective measures cannot be taken since the source of air pollutant emissions in Uganda is unknown. While there are concerns about worsening air pollution due to the annual increase in automobile traffic and industrial activities, there are also challenges in implementing measures to mitigate and reduce air pollution emissions. The improvement of solid waste management is also a large issue in the urban environment. However, it is excluded from the Data Collection Survey for Urban Environmental Sector (Urban Water Supply and Air Pollution) (herein referred to as the “Survey”) since it will be expected to be conducted in another JICA study.

Based on the above, the targets of the Survey are the current situation, issues, and improvement measures in the urban environmental sector focusing on urban water supply and air pollution. Furthermore, strategies and cooperation policies for future urban environmental improvement will be examined, and the needs for cooperation in the urban environmental sector under the influence of COVID-19 will be identified. The possibility of private sector cooperation in this sector will also be investigated and examined.

1.2 Objective of the Survey

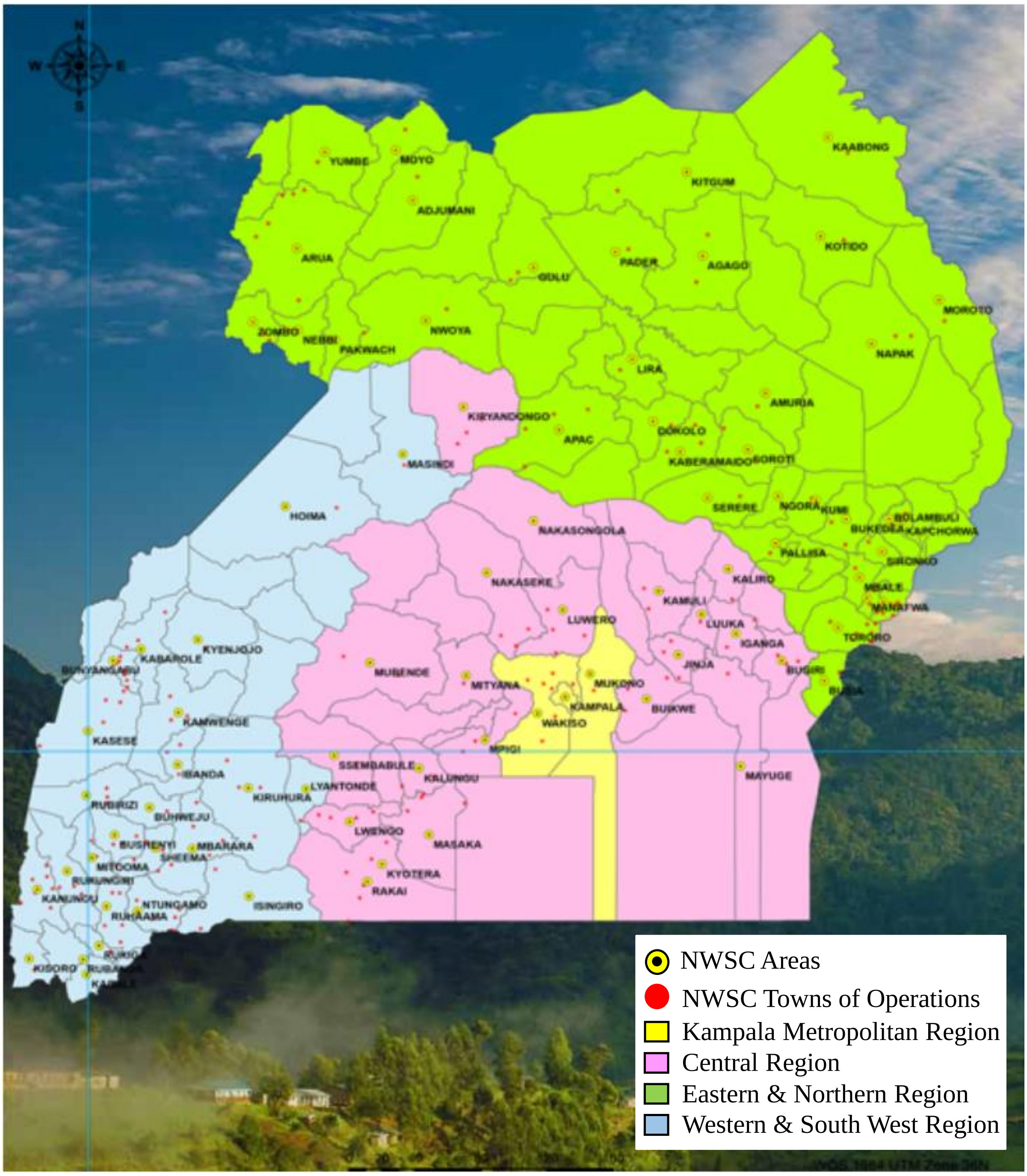
- Investigate the current state of the urban environmental sector in Uganda focusing on urban water supply and air pollution, and the impact of the novel COVID-19 on the sector.
- Identify priority issues and needs for assistance.
- Consider the cooperation policy for the urban environmental sector.

[7] World Health Statistics（2019）http://library.health.go.ug/publications/statistics/world-health-statistics-2019
[8] Our World in Data Website, https://ourworldindata.org/grapher/death-rate-by-source-from-air-pollution?country=~OWID_WRL
[9] Ministry of Health, Labour and Welfare, https://www.mhlw.go.jp/content/000650160.pdf

1.3 Subject of the Survey

1.3.1 Target Areas

The Survey consists of the urban water supply sector and air pollution sector. In the urban water supply sector, about ten cities/areas are selected from 258 cities/areas operated and maintained by NWSC based on the population and discussion with NWSC. Figure 1.3.1 shows the 258 water supply areas operated and maintained by NWSC. In the air pollution sector, Kampala City, which has severe air pollution, is selected as the target area.



Source: NWSC Integrated Annual Report 2019/20

Figure 1.3.1 Location of NWSC Water Supply Areas

1.3.2 Survey Schedule

The works in Japan have commenced since December 2020. Literature materials and academic papers that are available to the public on the web were collected through the internet and analyzed. Also, necessary information was collected by local engineers through discussions and meetings held with major related organizations. In the urban water supply sector, interviews were conducted with the Urban Water and Sewerage Department of MoWE and NWSC. In the air pollution sector, interviews were conducted with the Environment Sector Support Services Department of MoWE, NEMA, KCCA, and AirQo Project. Table 1.3.1 shows the major related organizations for the works in Japan and Uganda. The list of interviewees for the field survey is shown in Appendix-1.

Table 1.3.1 Major Related Organizations for the Works in Japan and Uganda

Target Areas	Related Organizations
Urban Water Supply Sector	
Whole Country	Ministry of Water and Environment (MoWE), National Water and Sewerage Corporation (NWSC), NWSC Headquarters (Including IREC)
Kampala City	NWSC Kampala Water
Hoima City	NWSC Hoima
Mubende City	NWSC Mubende
Mityana City	NWSC Mityana
Tororo City	NWSC Tororo
Soroti City	NWSC Soroti
Air Pollution Sector	
Kampala City	Ministry of Water and Environment (MoWE), National Environment Management Authority (NEMA), Kampala Capital City Authority (KCCA), AirQo Project

Source: JST

1.3.3 Survey Program

(1) First Field Survey

The composition of the JICA Survey Team (JST) for the first field survey is shown in Table 1.3.2.

Table 1.3.2 Composition of the JICA Survey Team (JST) for the First Field Survey

Survey Team	Name	Company	Position	Period
Consultant Survey Team	Shohei Yamamoto	Nippon Koei Co., Ltd.	Team Leader/ Urban Water Supply	10th Feb 2021 to 6th Mar 2021
	Cavan Goh Wei Yung	Nippon Koei Co., Ltd.	Coordinator/ Urban Water Supply (Company's Expense)	10th Feb 2021 to 6th Mar 2021

Source: JST

The programs for the first field survey are shown in Table 1.3.3.

Table 1.3.3 Programs for the First Field Survey

First Field Survey: 10th February 2021 – 6th March 2021		
Date	Time	Programs
10th Feb (Wed)	Evening	・Narita Airport Terminal 2 → Entebbe International Airport (Uganda)
11th Feb (Thu)	Afternoon	・Arrive at the Entebbe International Airport (Ugana) via Dubai and transfer to hotel ・Meeting with local engineers
12th Feb (Fri)	Morning	・Courtesy call and discussion with JICA Uganda Office ・Courtesy call and discussion with NWSC
	Afternoon	・Courtesy call and discussion with MoWE
13th, 14th Feb (Sat, Sun)	All Day	・Organization of collected documents
15th Feb (Mon)	Morning	・Discussion with NWSC
	Afternoon	・Courtesy call and discussion with KCCA ・Discussion with NWSC Kampala Water
16th Feb (Tue) National Holiday	All Day	・Organization of collected documents
17th Feb (Wed)	Morning	・Discussion with NWSC
	Afternoon	・Courtesy call and discussion with the Urban Water and Sewerage Department of MoWE
18th ,19th Feb (Thu, Fri)	All Day	・Organization and confirmation of collected documents on urban water supply ・Discussion with NWSC
20th, 21st Feb (Sat, Sun)	All Day	・Organization of collected documents
22nd Feb (Mon)	Morning	・Discussion with JICA Uganda Office
	Afternoon	・Discussion with NWSC
23rd Feb (Tue)	Morning	・Discussion with NWSC
	Afternoon	・Courtesy call and discussion with NEMA
24th Feb (Wed)	Morning	・Organization and confirmation of collected documents on urban water supply
	Afternoon	・Discussion with NWSC Kampala Water
25th Feb (Thu)	Morning	・Online meeting with JICA HQ, JICA Uganda Office ・Discussion with NWSC
	Afternoon	・Discussion with NWSC Kampala Water
26th Feb (Fri)	All Day	・Site visit to NWSC Kampala Water's water supply facilities, training center
27th Feb (Sat)	All Day	・Inspection of water supply situation in Lugazi
28th Feb (Sun)	All Day	・Organization of collected documents, Preparation of documents
1st Mar (Mon)	All Day	・Site visit to Hoima Water
2nd Mar (Tue)	Morning	・Site visit to Mubende Water
	Afternoon	・Site visit to Mityana Water
3rd Mar (Wed)	Morning	・Kick-off meeting for air pollution sector
	Afternoon	・Discussion with NWSC ・PCR Test
4th Mar (Thu)	Morning	・Discussion with NWSC Kampala Water ・Discussion with NWSC
	Afternoon	・Confirmation of potential venues for workshop, seminar, etc. ・Discussion with JICA Uganda Office
5th Mar (Fri)	Morning	・Discussion with NWSC
	Afternoon	・Entebbe International Airport (Uganda) → Narita Airport
6th Mar (Sat)	Evening	・Arrive at the Narita Airport Terminal 2 via Dubai

Source: JST

(2) Second Field Survey

The composition of the JICA Survey Team (JST) for the second field survey is shown in Table 1.3.4.

Table 1.3.4 Composition of the JICA Survey Team (JST) for the Second Field Survey

Survey Team	Name	Company	Position	Period
Consultant Survey Team	Shohei Yamamoto	Nippon Koei Co., Ltd.	Team Leader/ Urban Water Supply	26th May 2021 to 12th Jun 2021
	Shunichi Okahisa	Nippon Koei Co., Ltd.	Air Pollution Management	26th May 2021 to 13th Jun 2021
	Masahide Hanabusa	Nippon Koei Co., Ltd.	Private Sector Technology/ Business Matching	26th May 2021 to 12th Jun 2021
	Cavan Goh Wei Yung	Nippon Koei Co., Ltd.	Coordinator/ Urban Water Supply (Company's Expense)	26th May 2021 to 12th Jun 2021

Source: JST

The programs for the second field survey are shown in Table 1.3.5.

Table 1.3.5 Programs for the Second Field Survey

Second Field Survey: 26th May 2021 – 12th June 2021		
Date	Time	Programs
26th May (Wed)	Evening	・Narita Airport Terminal 2 → Entebbe International Airport (Uganda)
27th May (Thu)	Afternoon	・Arrive at the Entebbe International Airport (Uganda) via Dubai and transfer to hotel
28th May (Fri)	All Day	・Discussion with NWSC (HQ, Kampala Water), NEMA, KCCA
29th, 30th May (Sat, Sun)	All Day	・Organization of collected documents, Preparation of documents
31st May (Mon)	Morning	・Meeting with AfDB
	Afternoon	・Meeting with WB ・Discussion with NWSC (HQ, Kampala Water)
1st Jun (Tue)	Morning	・Discussion with JICA Uganda Office
	Afternoon	・Discussion with NWSC and MoWE ・Meeting with AFD
2nd Jun (Wed)	All Day	・Site visit to Katosi WTP
		・Discussion with AirQo Project (Makerere University)
3rd Jun (Thu) National Holiday	All Day	・Organization of collected documents, Preparation of documents
4th Jun (Fri)	Morning	・Discussion with NWSC, Contact with local companies
	Afternoon	・Discussion with NWSC Kampala Water
5th Jun (Sat)	Morning	・Inspection of venues for workshop, Quotation obtained
	Afternoon	・Organization of collected documents, Preparation of documents
6th Jun (Sun)	All Day	・Organization of collected documents, Preparation of documents
7th Jun (Mon)	Morning	・Discussion with NWSC
	Afternoon	・Discussion with NWSC Kampala Water ・Discussion with MoWT ・Meeting with KfW
8th Jun (Tue)	All Day	・Site visit to NWSC Kampala Water's water supply facilities, training center
	Evening	・Discussion with NEMA
9th Jun (Wed) National Holiday	All Day	・Organization of collected documents, Preparation of documents
	Morning	・Discussion with MoH
	Afternoon	・Meeting with UNICEF
10th Jun (Thu)	Morning	・PCR Test ・Discussion with NWSC (Kampala Water, Soroti) ・Meeting with 3WM Uganda Ltd. (Imports and sells second-hand cars), Bodawerk International Ltd. (Sells and repairs motorbikes), Yamaha Uganda Ltd. (Sells and repairs motorbikes)
	Afternoon	・Discussion NWSC (HQ, Tororo) ・Meeting with private company (Total Uganda)
11th Jun (Fri)	Morning	・Discussion with JICA Uganda Office ・Discussion with NWSC
	Afternoon	・Entebbe International Airport (Uganda) → Narita Airport
12th Jun (Sat)	Evening	・Arrive at the Narita Airport Terminal 2 via Dubai (Yamamoto, Hanabusa, Goh)
13th Jun (Sun)	Morning	・Arrive at the Narita Airport Terminal 2 via Amsterdam (Okahisa)

Source: JST

(3) Third Field Survey

The composition of the JICA Survey Team (JST) for the third field survey is shown in Table 1.3.6.

Table 1.3.6 Composition of the JICA Survey Team (JST) for the Third Field Survey

Survey Team	Name	Company	Position	Period
Consultant Survey Team	Shohei Yamamoto	Nippon Koei Co., Ltd.	Team Leader/ Urban Water Supply	18th Sep 2021 to 8th Oct 2021
	Shunichi Okahisa	Nippon Koei Co., Ltd.	Air Pollution Management	18th Sep 2021 to 8th Oct 2021
	Masahide Hanabusa	Nippon Koei Co., Ltd.	Private Sector Technology/ Business Matching	18th Sep 2021 to 9th Oct 2021
	Cavan Goh Wei Yung	Nippon Koei Co., Ltd.	Urban Water Supply 2	18th Sep 2021 to 9th Oct 2021

Source: JST

The programs for the third field survey are shown in Table 1.3.7.

Table 1.3.7 Programs for the Third Field Survey

Third Field Survey: 18th September 2021 – 9th October 2021		
Date	Date	Programs
18th Sep (Sat)	Evening	・Narita Airport Terminal 2 → Entebbe International Airport (Uganda)
19th Sep (Sun)	Afternoon	・Arrive at the Entebbe International Airport (Uganda) via Dubai and transfer to hotel.
20th Sep (Mon)	Morning	・Organization of collected documents, Preparation of documents ・Discussion with MoWE
	Afternoon	・Discussion with NWSC, MoWT
21st Sep (Tue)	Morning	・Discussion with JICA Uganda Office
	Afternoon	・Discussion with NWSC Kampala Water, Uganda Manufacturers Association
22nd Sep (Wed)	Morning	・Inspection of venues for workshop
	Afternoon	・Discussion with NWSC Kampala Water, AirQo Project, MoH ・Meeting with private company (Zembo)
23rd Sep (Thu)	Afternoon	・Meeting with private company (Bodawerk International)
	All Day	・Site visit to Katosi WTP
24th Sep (Fri)	Morning	・Discussion with NWSC HQ
	All Day	・Discussion with local private sectors, donors (UNEP/WB), NWSC HQ ・Discussion with JICA Uganda Office (Air Pollution Sector)
25th, 26th Sep (Sat, Sun)	All Day	・Organization of collected documents, Preparation of documents
27th Sep (Mon)	Morning	・Discussion with NWSC (Kampala Water, HQ)
	Afternoon	・Preparation of workshop
28th Sep (Tue)	All Day	・Preparation of workshop
	Morning	・Inspection of venues for workshop, preliminary meeting
	Afternoon	・Meeting with Altereo, Preparation of workshop
29th Sep (Wed)	All Day	・Preparation of workshop
	Afternoon	・Discussion with NWSC HQ
30th Sep (Thu)	All Day	・Business Matching Workshop
1st Oct (Fri)	All Day	・Public-Private Joint Ideathon
2nd Oct (Sat)	All Day	・Organization of collected documents, Preparation of documents
3rd Oct (Sun)	All Day	・Depart to Soroti ・Organization of collected documents, Preparation of documents
4th Oct (Mon)	All Day	・Site visit to Soroti ・Organization of collected documents from workshop
5th Oct (Tue)	All Day	・Site visit to Tororo, Return to Kampala, Organization of collected documents from site visits ・Organization of workshop materials, Additional discussion with ministries and local companies ・Observation of AirQo Project monitoring sites
6th Oct (Wed)	Morning	・PCR Test (Okahisa)
	All Day	・Organization of collected documents, Preparation of documents
7th Oct (Thu)	Morning	・PCR Test (Yamamoto, Hanabusa, Goh)
	Afternoon	・Entebbe International Airport (Uganda) → Narita Airport (Okahisa)
8th Oct (Fri)	Morning	・Discussion with NWSC ・Organization of collected documents, Preparation of documents
	Afternoon	・Discussion with JICA Uganda Office ・Entebbe International Airport (Uganda) → Narita Airport (Hanabusa, Goh)
	Evening	・Arrive at the Narita Airport Terminal 2 via Dubai (Okahisa)
9th Oct (Sat)	Evening	・Arrive at the Narita Airport Terminal 2 via Dubai (Hanabusa, Goh) ・Entebbe International Airport (Uganda) → Arrive at Jomo Kenyatta International Airport (Kenya) (Yamamoto)

Source: JST

CHAPTER 2 Outline of Urban Cities in Uganda

2.1 Current Status of Entire Uganda

2.1.1 Natural Conditions (Topography and Geography, Geology, Weather and Rainfall, Temperature, Watershed Classification and Water Usage)

(1) Topography and Geography

As shown in Figure 2.1.1, Uganda is a landlocked country located in East Africa, surrounded geopolitically by five countries: Kenya to the east, Tanzania to the south, Rwanda to the southwest, Democratic Republic of the Congo to the west, and South Sudan to the north. The major topographical feature is that the East Rift Valley and West Rift Valley of the African Great Rift Valley run north-south, intervening Uganda in between. The elevation of the intervening plains decreases from south to north, and the Nile River, whose water source is Lake Victoria (about 1,135 m above sea level), flows into South Sudan (about 600 m above sea level).

Source: Online Map from World Atlas

Figure 2.1.1 Location Map of Uganda

Uganda has an area of 241,000 km^2, which is about the same as the mainland of Japan. However, Lake Victoria in the southern part of the country, and Lake Albert, Lake Edward, and Lake Kyoga in the western part of the country occupy about 18% (about 44,000 km^2) of the country's area, which means that 82% (197,000 km^2) of Uganda's total area is land area.

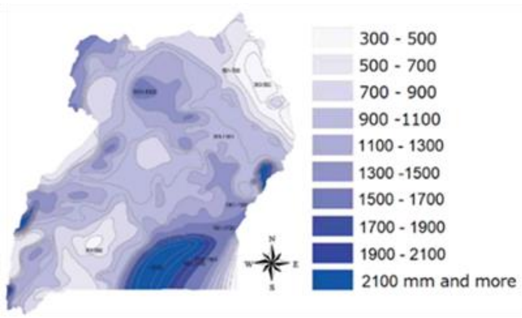
On the border with the Democratic Republic of the Congo, Lake Albert and Lake Edward are formed along the border of the Western Rift Valley, and the Rwenzori Mountains are also located along the border between the two lakes. On the Kenyan border to the east is Mount Elgon, and on the Rwandan border to the southwest are the Virunga Mountains. Lake Victoria, which is located to the southeast, is the largest lake on the African continent in terms of surface area. The majority of the plains are peneplain with gradual topographical changes at an elevation of about 1,000 to 1,200 meters. Lake Kyoga (about 1,034 m above sea level) is located in this peneplain, and water from Lake Victoria (about 1,134 m above sea level) flows in from the south through the Nile River and flows out in a northwesterly direction toward the outlet of Lake Albert (about 615 m above sea level).

(2) Geology

The geology of the bedrocks is mostly composed of the oldest Precambrian geology. The Precambrian geology consists of slightly metamorphosed and less metamorphosed rocks. The geology is classified into several categories according to the time of metamorphism, type of metamorphism, and degree of metamorphism, but mostly consists of gneiss and granite.

(3) Weather and Rainfall

Uganda has a savanna climate, with two rainy seasons, a heavy rainy season generally from March to May and a light rainy season from October to November. The severe dry season is from December to February, with rainfall of a few millimeters per month in the dry areas. In the southern part of Uganda, where Kampala is located, rainfall is observed throughout the year and there is no definite wet or dry season. Figure 2.1.2 shows the annual average rainfall in Uganda.



Source: Water Resources of Uganda – an Assessment and Review

Figure 2.1.2 Annual Average Rainfall

(4) Temperature

The average temperature in Uganda ranges from about 10 °C to 32 °C. The average annual minimum temperature is about 10 °C in Kabale in the south, about 17 °C in Kitgum in the north, and about 17 °C in Kampala Capital City. The average annual maximum temperature is about 23 °C in Kabale in the south, about 32 °C in Kitgum in the north, and about 26 °C in Kampala Capital City.

(5) Watershed Classification and Water Usage

As shown in Figure 2.1.3**,** Uganda can be divided into eight watersheds. The water consumption in Uganda was 66 km^3/year in 2018, with 51% for domestic use, 41% for agricultural use, and 8% for industrial use. Household water consumption has increased by 45% from 2002 due to population growth and per capita consumption, which increased from 12 m^3/year to 21 m^3/year. Meanwhile, the amount of water available is estimated to decrease in more than 75% of the country by 2015. There is an estimated decrease in the Eastern and Northern Regions and the Western and Southern Regions, where the average annual rainfall is lower (600 mm to 900 mm) due to climate change[1]. Therefore, there is a need for a stable supply of safe and secure water to meet regional demand in the face of population growth and climate change.

Source: Water Resource of Uganda. Assessment and Review

Figure 2.1.3 Watershed in Uganda

[1] Water Resources of Uganda: An Assessment and Review, Scientific Research

2.1.2 Socioeconomic Status

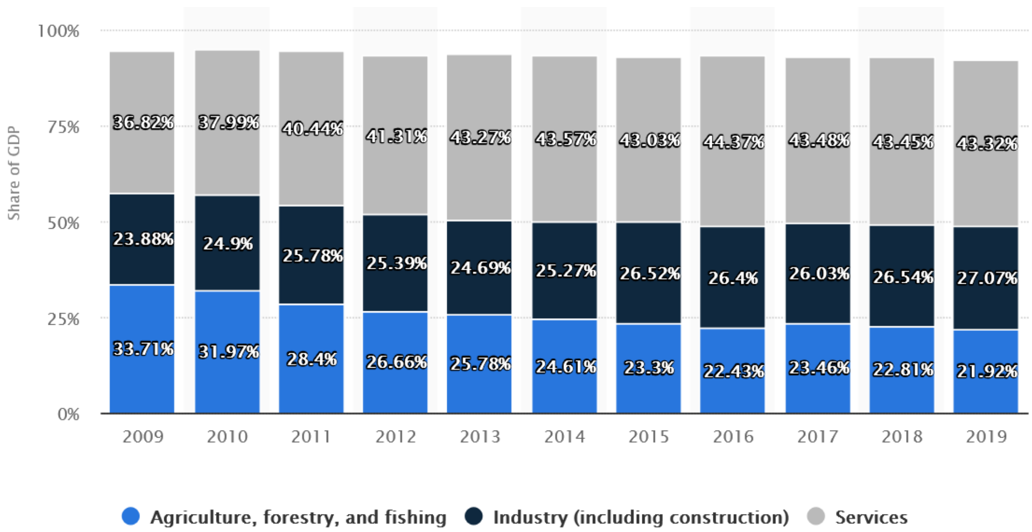
Table 2.1.1 shows the key economic indicators for Uganda. The gross national income (GNI) per capita is low at USD 780 (2019) and the country is classified as a low-income country. In recent years, Uganda's economy has experienced gross domestic product (GDP) growth rates of between 3% and 7%. In 2019, the service sector will account for 46%, industry will account for 30%, and agriculture will account for 24% of GDP and the main industries will be bananas, sugar, brewing, tobacco, textiles, cement, and steel[2]. However, Uganda's real GDP grew at 2.9% in 2020, less than half the 6.8% recorded in 2019, due to the effects of the COVID-19 pandemic. GDP is expected to grow at a similar level in 2021.

Table 2.1.1 Key Economic Indicators for Uganda

Year	2015	2016	2017	2018	2019	2020
GDP Growth Rate (%)	5.2	4.8	3.8	6.2	6.8	2.9
GNI per capita (USD)	830	790	740	750	780	800
Consumer Price Inflation Rates (%)	5.4	5.5	5.6	2.6	2.9	3.8

Source: World Bank (WB)

As shown in Figure 2.1.4, the economy of Uganda before the COVID-19 pandemic has shown that a decrease in the total population of agricultural workers has contributed to an increase in productivity per capita. This transformation was characterized by a reduction in the total workforce employed in agriculture and a take-off in services and industrial production, largely in agro-processing. Notwithstanding shifts to higher productivity jobs, per capita real GDP growth decelerated to 1.3% in the five years prior to the COVID-19 crisis, from 2.2% between 2010 and 2015. Following the shock of COVID-19, there have been widespread firm closures, permanent layoffs in industry and services, a rapid slowdown of activity particularly in the urban informal sector, and a movement of labor back to farming which is causing the falling of household income.



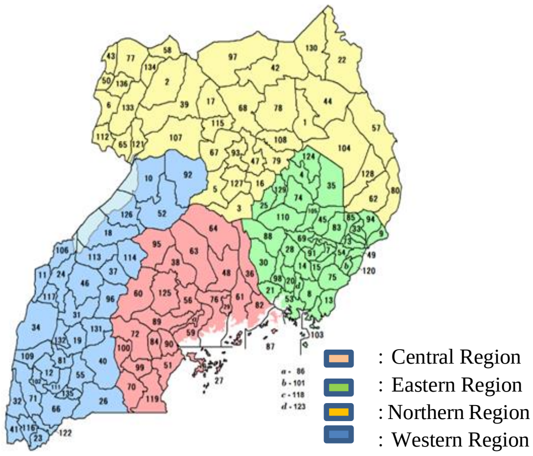
Source: https://www.statista.com/statistics/447716/uganda-gdp-distribution-across-economic-sectors/

Figure 2.1.4 Gross Domestic Product Distribution Across Economic Sectors (2009 - 2019)

[2] WB2018, CIA-The World Factbook

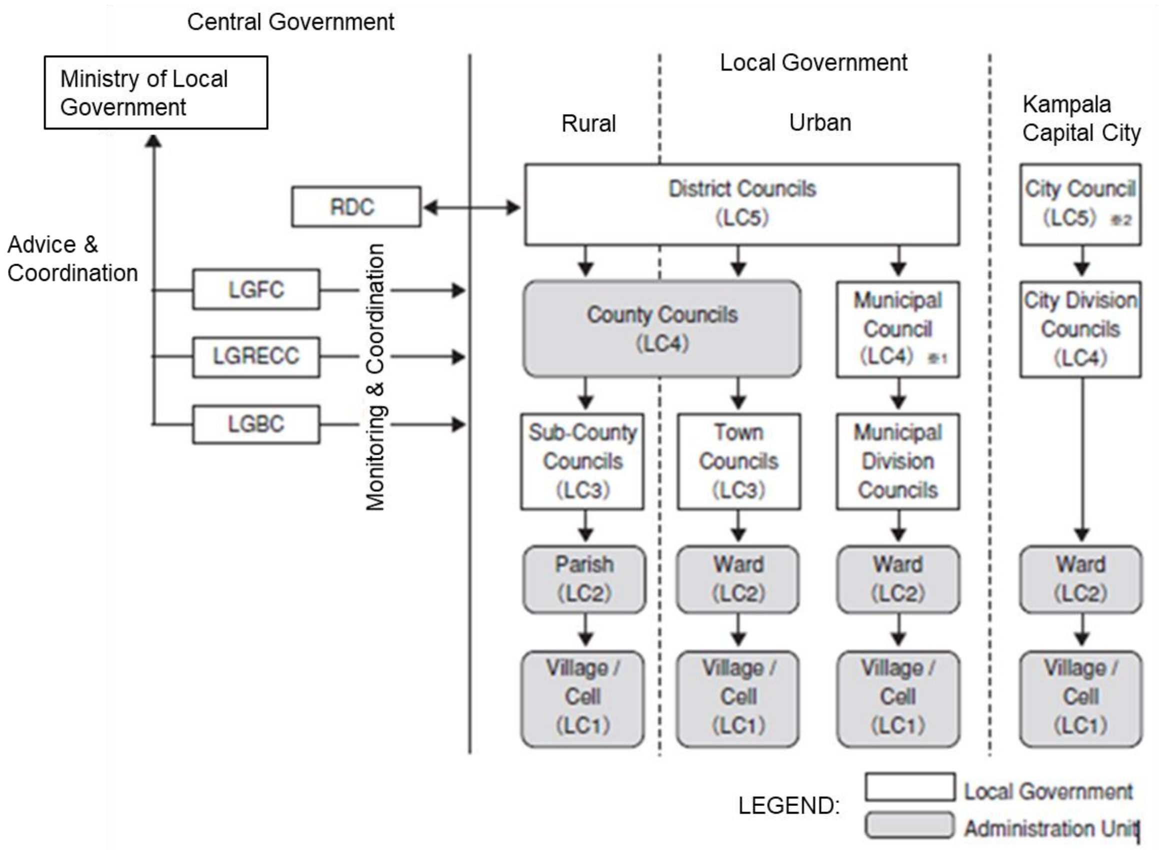
2.1.3 Administrative Divisions

As shown in Figure 2.1.5, Uganda consists of four regions: Central Region, Eastern Region, Northern Region, and Western Region. The administrative divisions are divided into five levels: LC1 (Village), LC2 (Parish and Ward), LC3 (Sub-county and Town Council), LC4 (Municipal Councils), and LC5 (District and City). As of July 2020, the upper tier of administrative division, LC5, consists of 135 districts and its equivalent, Kampala Capital City. The structure of the central and local governments is shown in Figure 2.1.6. The seven municipalities (Arua, Gulu, Jinja, Mbarara, Fort Portal, Mbale, and Masaka) were upgraded to cities on July 1, 2020.



Source: Wikipedia

Figure 2.1.5 Regional Composition of Uganda



Note:
LGFC: Local Government Finance Commission
LGRECC: Local Government Revenue Enhancement Coordinating Committee
LGBC: Local Government Budget Committee
※ 1: In the case of cities of a certain size, LC4 (Municipal Council) is the legal entity and is granted autonomy by LC5.
※ 2: In Kampala Capital City, the City Council is treated as LC5. The chairperson of the City Council is known as the Mayor.
※ 3: Currently, this structure was partially modified as integration of the County Council (LC4) and Sub County (LC3).
Source: Decentralized Service Delivery in East Africa. A Comparative Study of Uganda, Tanzania and Kenya, March 2008

Figure 2.1.6 Central and Local Government Structures

2.2 Socioeconomic Status of the Ten Target Areas

2.2.1 Region Classification of NWSC and Administrative Division of the Ten Target Areas

As shown in Figure 2.2.1, the service area of the National Water and Sewerage Corporation (NWSC) is classified into four regions: Kampala Metropolitan Area, Central Region, Eastern & Northern Region, and Western & South West Region, which is different from the administrative division of Uganda government. By the end of 2020, NWSC has provided water and sanitation services to 258 areas, including Kampala Capital City.

Source: Integrated Annual Report 2018/19

Figure 2.2.1 Region Classification of NWSC Service Area

The ten target areas of this survey consist of: one area in Kampala Metropolitan Area, three areas in Central Region, three areas in Eastern & Northern Region, and three areas in Western & South West Region. The target areas, region classification, and administrative divisions are shown in Table 2.2.1.

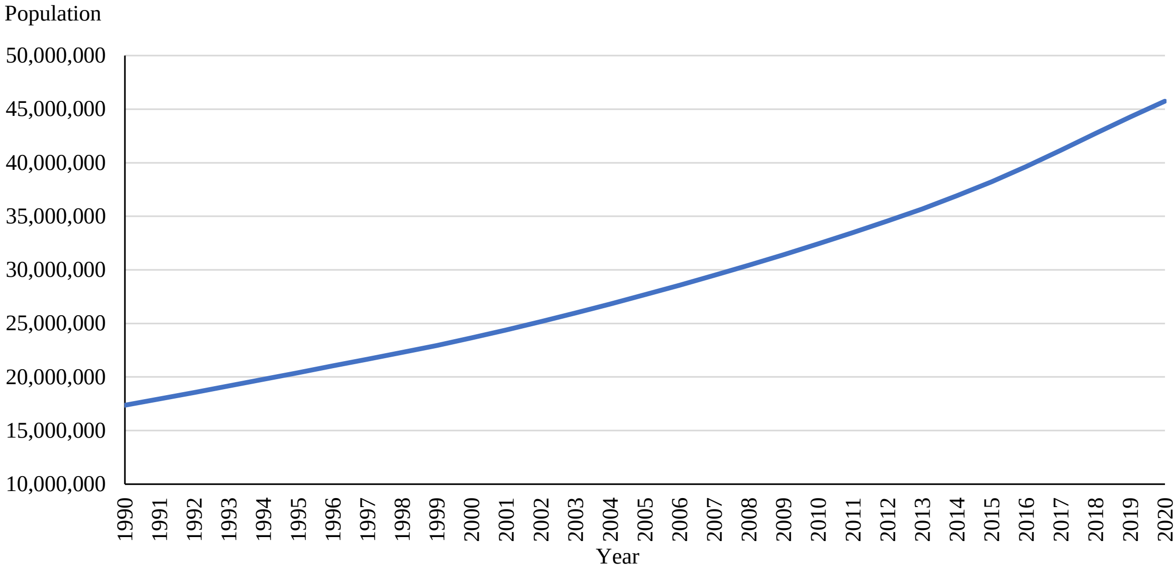
Table 2.2.1 Target Areas, Region Classification, and Administrative Division

No.	Area	Target Area	Region Classification of NWSC	Uganda's Administrative Divisions	Administrative Divisions
1	Kampala	1	Kampala Metropolitan Area	Central	LC5
2	Mukono			Central	LC4
3	Nansana			Central	LC4
4	Kira			Central	LC4
5	Makindyessabagado			Central	LC4
6	Wakiso Town Council			Central	LC3
7	Kakiri			Central	LC4
8	Njeru	2	Central Region	Central	LC4
9	Jinja			Central	LC5
10	Iganga			Central	LC4
12	Hoima	3	Western & South West Region	West	LC4
11	Mubende	4	Central Region	Central	LC4
13	Lira	5	Eastern & Northern Region	North	LC4
14	Kasese	6	Western & South West Region	West	LC4
15	Mityana	7	Central Region	Central	LC4
16	Tororo	8	Eastern & Northern Region	East	LC4
17	Malaba			East	LC4
18	Soroti	9	Eastern & Northern Region	East	LC4
19	Fort Portal	10	Western & South West Region	West	LC5

Source: JST

2.2.2 Demographic Trends

The recent census in Uganda was conducted in 2014. According to the World Bank statistics shown in Figure 2.2.2, the total population of Uganda is 45.74 million, which has increased more than 2.6 times in 30 years between 1990 and 2020. Kampala Capital City, with 1.68 million people (projected population for 2020), is home to about 4% of Uganda's total population. Also, the Greater Kampala Metropolitan Area has 3.298 million people (projected population for 2020)[3], is home to about 7.5% of Uganda's total population. The annual population growth rate (2014-2020) for each administrative division is 3.28% in Central Region, 3.06% in Eastern Region, 3.05% in Northern Region, and 2.97% in Western Region, indicating that the Central Region, where Kampala is located, has the largest population growth rate[4].



Source: World Bank (WB)

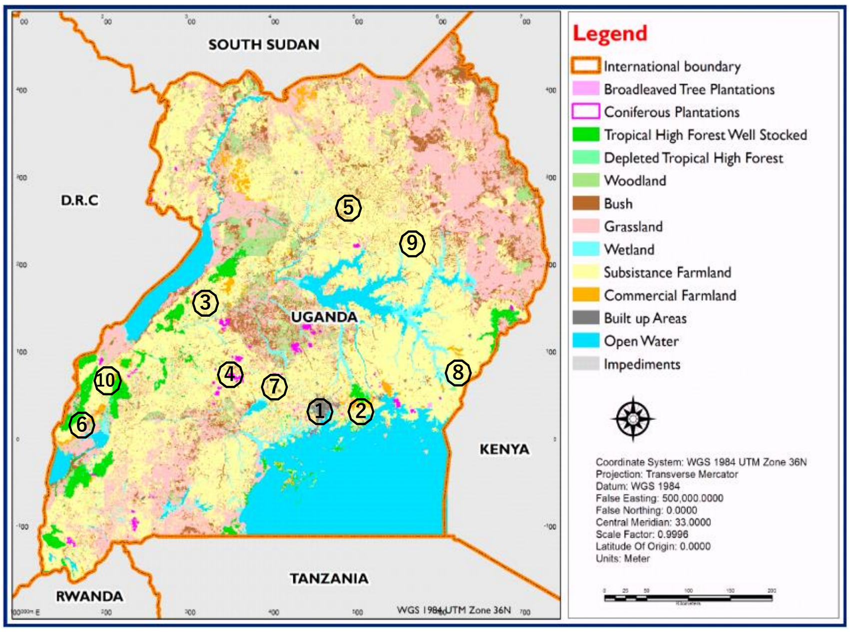
Figure 2.2.2 Total Population of Uganda (1990 – 2020)

2.2.3 Areas, Land Use Trends, and Economic Activities

Figure 2.2.3 shows the land use in Uganda and the areas for the ten target areas. The main land uses in Uganda (2015) are roughly 45% agricultural land, 21% grassland, 18% lakes and wetlands, 7% bushlands, 5% woodland / forest, and 3% tropical high forest, with a very limited urban area of 0.6%. Urban area is mostly concentrated in and around Kampala City[5]. In Uganda, Kampala City and the surrounding areas are the economic center, where 70% of the manufacturing industry is located[6]. The main economic activities in the target areas, excluding Kampala and its surroundings (including parts of Jinja), are agriculture, forestry, and fishing as primary industries, and coffee is a major export product. Also, oil reserves have been identified in Hoima, and a contract was signed in 2018 between the GoU

[3] United Nations – World Population Prospects
[4] Uganda Administrative Division, https://www.citypopulation.de/en/uganda/admin/
[5] Assessing the Extent of Historical, Current, and Future Land Use Systems in Uganda
[6] The Role of City Government in Economic Development of Greater Kampala

and Albertine Graben Refinery Consortium (AGRG) for the design, financing, construction, operation, and maintenance of a 60,000 barrel oil refinery. An airfield is also under construction in Hoima, and depending on the development, it is expected to become the second largest economic zone after the Greater Kampala Metropolitan Area.



Target Areas for Urban Water Supply		
Target Area	**Area**	**Area (km²)**
1	Kampala	180
	Mukono	1,850
	Nansana	192
	Kira	98.83
	Makindyessabagado	84
	Wakiso Town Council	-
	Kakiri	-
2	Njeru	-
	Jinja	688
	Iganga	639
3	Hoima	1,556
4	Mubende	2,711
5	Lira	1,322
6	Kasese	3,199
7	Mityana	1,583
8	Tororo	1,192
	Malaba	-
9	Soroti	1,416
10	Fort Portal	1,312

Source: Assessing the Extent of Historical, Current, and Future Land Use Systems in Uganda

Figure 2.2.3 Land Use in Uganda and Areas for the Ten Target Areas

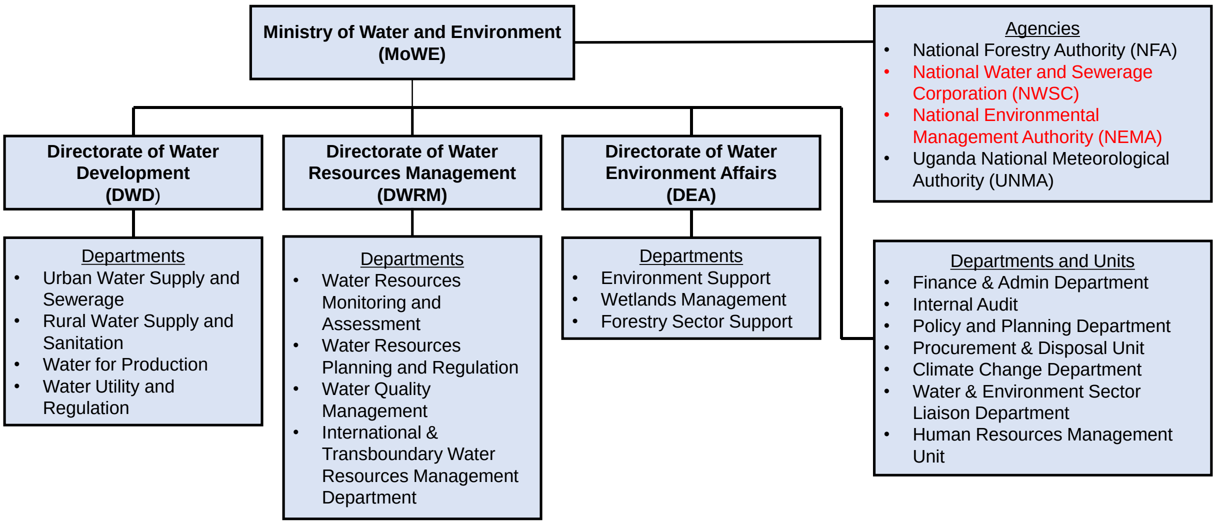
CHAPTER 3 Current Status and Issues in Urban Water Supply Sector

3.1 Outline of Urban Water Supply Sector

3.1.1 Administration and Organizations of Water Supply

(1) Administration and Organizations of Water Supply

The Ministry of Water and Environment (MoWE) has jurisdiction over the water supply and sewerage sector in Uganda. On the other hand, the National Water and Sewerage Corporation (NWSC), which was established as a public utility under the control of MoWE is responsible for water supply and sanitation services in the urban areas. As a major stakeholder in air pollution, the National Environment Management Authority (NEMA) is also under the control of MoWE. Figure 3.1.1 shows the administration and organizational structure of water supply in Uganda.



Source: Prepared by JST based on the Ministry of Water and Environment website (MoWE Structure)

Figure 3.1.1 MoWE Structure

(2) Ministry of Water and Environment (MoWE)

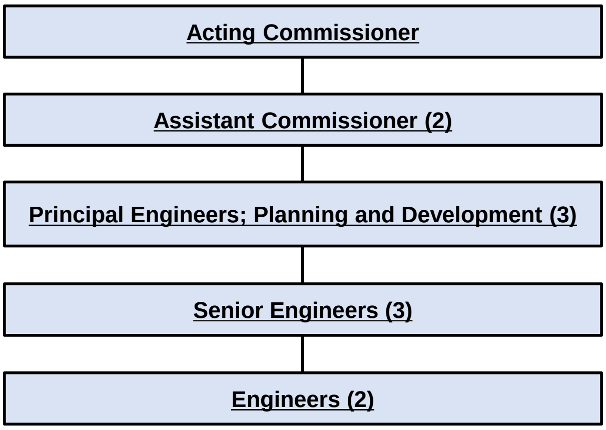
The MoWE was established from the then Ministry of Water, Lands and Environment (MoWLE), following the cabinet decision taken on 15th April 2007. MoWE has the responsibility for setting national policies and standards, managing and regulating water resources, and determining priorities for water development and management. As shown in Figure 3.1.1, MoWE comprises three directorates, namely: Directorate of Water Development (DWD), Directorate of Water Resources Management (DWRM), and the Directorate of Environmental Affairs (DEA).

1) Directorate of Water Development (DWD)

The NWSC is responsible for water supply and sanitation services in the urban areas, including Kampala City, while the other areas are managed by DWD. DWD is responsible for providing overall technical insight for planning, implementation, and supervision of the delivery of urban and rural water sanitation services across the country. Also, DWD is responsible for the provision of capacity development and other support services to local governments, private operators, and other service providers. As shown in Figure 3.1.1, DWD comprises four departments: Rural Water Supply and Sanitation, Urban Water Supply and Sewerage, Water for Production, and Water Utility and Regulations[1].

The Urban Water Supply and Sewerage Department is responsible for overall coordination, policy formulation, setting standards, inspection, monitoring, technical back-up, and initiating legislation. Also, the department directly oversees and supports water supply and sanitation service delivery in all water supply areas that are not under the management of NWSC. The organizational structure of the department is shown in Figure 3.1.2.

Since August 2017, MoWE has introduced Umbrella Water Authorities (UWA) that will provide backstopping support to all piped water schemes for six regions (Karamoja, Northern, Central, Eastern, Mid-Western, South-Western). Also, UWA provides O&M backup support services for small water supply schemes outside NWSC jurisdiction regardless of their management arrangement and size.



Note: No. of people in parentheses
Source: MoWE

Figure 3.1.2 Organizational Structure of Urban Water Supply and Sewerage Department

2) Directorate of Water Resources Management (DWRM)

The DWRM is responsible for managing and developing the water resources of Uganda in an integrated and sustainable manner to provide water of adequate quality and quantity for all social and economic needs for the present and future generation.

3) Directorate of Environmental Affairs (DEA)

The DEA is responsible for environmental policy, regulation, coordination, inspection, supervision, and monitoring of the environment and natural resources as well as the restoration of degraded ecosystems and mitigating and adapting climate change. DEA is a major stakeholder in the air pollution sector.

(3) National Water and Sewerage Corporation (NWSC)

The NWSC is a public utility company established in 1972 by Decree 34 (1972) to improve urban

[1] MoWE Website: https://www.MoWE.go.ug/MoWE/about-ministry

water supply and sanitation services in Uganda. Also, the NWSC Act 1995 (NWSC Statute 1995) was enacted to enable the corporation to operate and provide water and sewerage services in areas entrusted to it on a sound commercial and viable basis. As of FY 2019/20, NWSC is responsible for the provision of water supply and sanitation services in 258 cities, including Kampala City.

The details about NWSC organizational structure and water supply services are explained in Chapter 3.2.1.

3.1.2 Financial Mechanism and National Budgets

(1) Financial Mechanism

Taxes in Uganda are classified as either direct or indirect. Direct taxes (corporation tax, individual income tax) are imposed on income arising from business, employment, property and the burden of the tax is borne by the individual or business entity. Indirect taxes (value-added tax (VAT), excise duty, import duty) are taxes levied on consumption of goods and services collected by taxpayer[2]. The Uganda Revenue Authority (URA) which operates under the Ministry of Finance, Planning and Economic Development (MoFPED) is responsible for enforcing, assessing, collecting, and accounting for the various taxes imposed in Uganda. MoFPED represents the executive arm in the tax administration and oversees and funds the operations of URA. Also, MoFPED monitors the financial compliance of each sector and national targets.

Funding to the water and environment sector in Uganda can be classified into “On-budget funding” and “Off-budget funding”. “On-budget funding” is categorized as funds that are released from the National Treasury and MoFPED, while “Off-budget funding” is usually transferred directly to the sector and does not go through the National Treasury. These are usually transferred to the sector direct from the funders or spent by development partners themselves on behalf of the sector based on agreed workplan, activities, and outputs[3].

(2) National Budgets

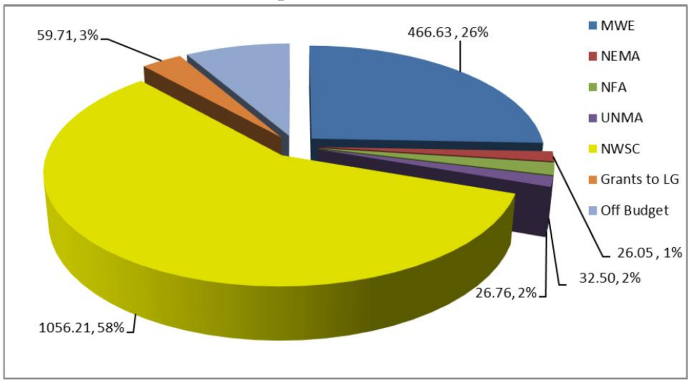
As shown in Table 3.1.1, the budget including off-budget funds for the water and environment sector in FY 2019/20 was UGX 1,820.9 billion (about JPY 55 billion[4]) which is lower than UGX 1,931.1 billion (about JPY 59 billion) in FY 2018/19. As shown in Figure 3.1.3, NWSC accounted for 58% of the total budget at UGX 1,506.2 billion (about JPY 45 billion), MoWE accounted for 25.6% at UGX 466.6 billion (about JPY 14.1 billion), NEMA accounted for 1.4% at UGX 26 billion (about JPY 780 million), NFA is at 1.8% with UGX 32.5 billion (about JPY 990 million), and UNMA is at 1.5% with UGX 26.8 billion (about JPY 810 million).

[2] Uganda Revenue Authority Taxation Handbook – A Guide to Taxation in Uganda, Second Edition
[3] Water and Environment Sector Performance Report 2020, Ministry of Water and Environment
[4] Exchange rate (April 2021): UGX 1.00 = JPY 0.030280

Table 3.1.1 Funding Sources for the Water and Environment Sector（FY 2019/20）

	Funding Source	Approved Budget (UGX Billion)	Released (UGX Billion)	Percentage of Budget Released (%)
On-budget	GoU	566.577	451.358	79.7%
	Donor	523.287	287.964	55.0%
	AIA	578.000	391.000	67.6%
Off-budget	Off-Budget	153.110	77.250	50.5%
Total		1,820.974	1,207.572	66.3%

Source: Water and Environment Sector Performance Report 2020



Source: Water and Environment Sector Performance Report 2020

Figure 3.1.3 Budget for the Water and Environment Sector (FY 2019/20)

3.1.3 Legislation, Regulations, and Compliance

(1) Legislation

1) The Water Act (The Water Statute 1995, The Water Act 1997: Uganda Decree No.152)

The Water Act was enacted in 1995 and came into effect in April 1997. The Water Act provides for hydropower, water use, expansion of water supply, and the need for sewerage system development. It also provides for equitable and sustainable water resources management and utilization in Uganda through supervision and coordination of all activities affecting water resources.

2) The National Water and Sewerage Corporation Act 1995, Uganda Decree No.317

The National Water and Sanitation Corporation Act provides for the NWSC to operate and provide water and wastewater services in areas under its jurisdiction under the Water Statute of 1995.

3) The Water Resources Regulations 1998

The Water Resources Regulations was enacted in April 1997 under Section 107 of the Water Act (The Water Statute, 1995) and has been in effect since 1998. It provides for permits for construction and excavation in water sources (surface water and groundwater).

4) The Water (General Rates) Regulations 1998

The general water rates were enacted on 28th October 2018 in accordance with the Water (General Rates) Regulations, 2018 under Section 107 (2) (q) of the Water Act, Cap. 152 and came into force on 1st November 2018. Based on the regulations, NWSC sets the water rates in the water supply area under its jurisdiction.

(2) Regulations

1) Drinking Water Quality Standards

The drinking water quality standards in Uganda follow the standards set by the Uganda National Bureau of Standards (UNBS) in 2014. Table 3.1.2 shows the drinking water quality standards of Uganda, WHO, and Japan based on the indicators of Uganda National Water Quality Standards.

Table 3.1.2 Drinking Water Quality Standards of Uganda, WHO, and Japan

Indicator	Unit	Uganda	WHO	Japan
pH	-	6.5-8.5	Not Established*1	5.8 - 8.6
Electrical Conductivity	μS/cm	1500	-	-
Colour	PtCo	15	Within user's tolerance level	5
Turbidity	NTU	5.0	5	2
Total Dissolved Solids: TDS	mg/L	700	Not Established*1	-
Total Suspended Solids: TSS	mg/L	0.0	-	-
Alkalinity	mg/L	500	-	-
Hardness	mg/L	300	-	300
Calcium: Ca^{2+}	mg/L	150	Not Established*1	300
Magnesium: Mg^{2+}	mg/L	100	Not Established*1	300
Bi-Carbonate: $CaCO_3$	mg/L	500	Not Established*1	-
Manganese: Mn^{2+}	mg/L	0.2	Not Established*1	0.05
Chloride: Cl^-	mg/L	250	250	200
Fluoride: F^-	mg/L	1.5	1.5	0.8
Iron: Fe	mg/L	0.300	0.3	0.3
Sulphate: SO_4^{2-}	mg/L	400	Not Established*1	-
Nitrate: NO_3	mg/L	45	50	10
Aluminum: Al	mg/L	<0.20	0.1-0.2	0.2
Chlorine: Free Residual	mg/L	0.20-0.50	0.2-0.5	-
Chlorine: Total Residual	mg/L	Not Specified	-	-
Ammonia: NH_3	mg/L	0.5	-	-
Orthophosphate: H_3PO_4	mg/L	2	-	-
Cadmium: Cd	mg/L	0.003	0.003	0.003
Copper: Cu	mg/L	1.000	2.0	1.0
Lead: Pb	mg/L	0.01	0.01	0.01
Zinc: Zn	mg/L	5	Not Established*1	1.0
E-Coli	CFU/100 mL	0	0	0
Total Coliforms	CFU/100 mL	0	0	0
Faecal Coliforms	CFU/100 mL	0	0	0

*1: Not of health concern at levels found in drinking water
Source: Uganda: Uganda National Bureau of Standards (UNBS) 2014, WHO: Guidelines for Drinking Water Quality Fourth Edition, Japan: Water Quality Standards (51 Items)

(3) Targets

The Water Utility and Regulation Department (WURD) under the management of DWD recommends performance contracts (PC) to be signed between the GoU and water utilities to ensure compliance with water service standards in Uganda. MoWE has signed PC contracts with water utilities (UWA and NWSC). These contracts contain detailed specifications and performance evaluation targets to be followed by the water utilities. WURD then collects and verifies the service status of water utilities and publishes information on their performance. However, if service standards and performance targets of the PC are not met, WURD will impose penalties and sanctions, or will provide advice to these water utilities on how to improve their services to meet the standards and targets.

1) Targets for Each Key Performance Indicator in PC1 Signed by MoWE and UWA

For the first time, MoWE signed a three-year (2019 - 2022) performance contract (PC1) with UWA in July 2019. The targets for non-revenue water (NRW), water supply hours, and water tariff collection rate are shown in Table 3.1.3. NRW is one of the key performance indicators for assessing UWA's performance and has been prioritized to improve services in the areas under UWA's jurisdiction. The metering ratio is defined as "total number of metered connections"/ "total number of connections" x 100, which directly affects the level of NRW in the areas. Collection efficiency was targeted at 90% for Central Region, 80% for South-Western Region, Mid-Western Region and Eastern Region, 70% for Northern and Karamoja Regions to improve financial sustainability. On the other hand, drinking water quality standards are required to be 100% complied with in all regions of the country.

Table 3.1.3 Targets in the Performance Contract (PC1) between MoWE and UWA

Key Performance Indicators	Region	Annual Target
NRW	Central	30%
	South-Western	35%
	Mid-Western	20%
	Eastern	38%
	Northern	35%
	Karamoja	30%
Water Supply Hours	Central	12 hours
	South-Western	15 hours
	Mid-Western	15 hours
	Eastern	10 hours
	Northern	12 hours
	Karamoja	9 hours
Metering Ratio	Central	90%
	South-Western	95%
	Mid-Western	85%
	Eastern	80%
	Northern	100%
	Karamoja	92%
Collection Efficiency	Central	90%
	South-Western	80%
	Mid-Western	80%
	Eastern	80%
	Northern	70%
	Karamoja	70%
Compliance to Drinking Water Standards	Central	100%
	South-Western	100%
	Mid-Western	100%
	Eastern	100%
	Northern	100%
	Karamoja	100%

Source: Compiled by JST based on Water and Environment Sector Performance Report 2020.

2) Targets in the PC Signed by MoWE and NWSC

The NWSC signed the first performance contract (PC 1) with the Ministry of Water, Land and Environment (MoWLE) (the predecessor of the MoWE in 2000, and the contract has been renewed every three years to the present PC 6 (2018 - 2021). PC 4 was originally for the period 2009-2012, but the preparation of PC 5 was delayed and therefore, PC 4 was extended until 2015. Table 3.1.4 shows the main targets for the final year of each PC. Table 3.1.5 also shows the targets for the latest contract (PC 6) for FY 2019/20.

Table 3.1.4 Main Targets in the PC between MoWE and NWSC

Performance Contract (PC)	Main Targets (Final Year)
PC 1 (2000 – 2003)	ND
PC 2 (2003 - 2006)	ND
PC 3 (2006 – 2009)	NRW: 30.6%
PC 4 (2009 – 2015)	NRW (Kampala): 36% NRW (Others): 15.7% New Water Connection: 22,780 connections
PC 5 (2015 – 2018)	NRW (Kampala): 31% NRW (Central): 32% NRW (Eastern & Northern): 21% NRW (Western & South West): 20% New Water Connection: 28,000 connections
PC 6 (2018 – 2021)	NRW (Kampala): 35% NRW (Central): 21% NRW (Eastern & Northern): 18% NRW (Western & South West): 21% New Water Connection: 50,000 connections

Note: ND (No Data)
Source: Compiled by JST based on materials from each performance contract.

Table 3.1.5 Targets in PC 6 (FY 2019/20)

Key Performance Indicator		Annual Target
NRW	Kampala	36.0%
	Central Region	22.0%
	Eastern & Northern Region	19.0%
	Western & South West Region	22.0%
Metering Coverage		76.0%
New Water Connections		47,000 connections
New Sewerage Connections		240 connections
Capex Budget Implemented		82.0%
Water Sales Volume Growth		87,000,000 m^3
Collection/Billing Ratio		95%
Return On Capital Employed (ROCE)		1.0%
Operating Cost/Revenue		80.0%
Compliance to Drinking Water Standards		98.0%
Compliance to Sewerage Standards		50.0%
Pro-Poor Connection Growth		1,200 connections
Customer Satisfaction Index		70%

Source: Water and Environment Sector Performance Report 2020

(4) Compliance

1) Compliance with PC1 Signed by MoWE and UWA

As shown in Table 3.1.6, by the end of FY 2019/20, the achievement rate of NRW in the South-Western Region and Eastern Region is 106% and 121% respectively which exceeded the annual targets of 35% and 38%. The lowest performance was registered in the Mid-Western Region and Karamoja Region which were 46% and 21% below the annual targets of 20% and 30%, respectively. It is recommended that UWA implements NRW reduction measures such as increased metering, replacement of faulty metering, leak detection measures, replacement of old networks, etc., to significantly improve the current NRW levels. The highest achievement of water supply hours was in the Northern Region with an average of 21 hours, whereas the lowest was in the Mid-Western Region and Eastern Region with an average of 8 hours. The annual target for metering ratio was achieved in all the regions under UWA's jurisdiction. The highest performance for collection efficiency was achieved in the Central, Region, Mid-Western Region, Eastern Region, and Northern Region, whereas the lowest performance was registered in the South-Western Region and Karamoja Region at 77% and 68% below the annual targets of 80% and 70%, respectively. There was a decline in water quality levels due to the high levels of rains and floods in the year 2019/2020. The low compliance of the small towns in Central Region (87%), Mid-Western Region (86%), and Karamoja Region (79%) was the result of the increasing old schemes that are being provided with some level of technical improvement to cater to water safety, the increased levels of floods in the regions and the increase of water supply and sanitation schemes that have been added on the management list.

Table 3.1.6 UWA Performance and Achievement Rate in PC1 (FY 2019/20)

Key Performance Indicator	Region	Annual Target	Actual Performance	Achievement Rate
NRW	Central	30%	32%	93%
	South-Western	35%	29%	121%
	Mid-Western	20%	38%	54%
	Eastern	38%	36%	106%
	Northern	35%	43%	82%
	Karamoja	30%	38%	79%
Water Supply Hours	Central	12 hours	11 hours	92%
	South-Western	15 hours	10 hours	67%
	Mid-Western	15 hours	8 hours	53%
	Eastern	10 hours	8 hours	80%
	Northern	12 hours	21 hours	175%
	Karamoja	9 hours	9 hours	100%
Metering Ratio	Central	90%	92%	102%
	South-Western	95%	96%	101%
	Mid-Western	85%	90%	105%
	Eastern	80%	93%	116%
	Northern	100%	100%	100%
	Karamoja	92%	99%	108%
Collection Efficiency	Central	90%	94%	104%
	South-Western	80%	77%	96%
	Mid-Western	80%	85%	106%
	Eastern	80%	82%	103%

Key Performance Indicator	Region	Annual Target	Actual Performance	Achievement Rate
	Northern	70%	81%	116%
	Karamoja	70%	68%	97%
Compliance to Drinking Water Standards	Central	100%	87%	87%
	South-Western	100%	100%	100%
	Mid-Western	100%	86%	86%
	Eastern	100%	100%	100%
	Northern	100%	98%	98%
	Karamoja	100%	79%	79%

Source: Compiled by JST based on Water and Environment Sector Performance Report 2020.

2） Compliance with PC6 Signed by MoWE and NWSC

As shown in Table 3.1.7, the Western & South West Region achieved the annual target of 22% for NRW. The actual performance of Kampala Metropolitan Area, Central Region, Eastern & Northern Region was 39.5%, 25.5%, and 23.4% with an achievement rate of 91%, 86%, and 81%, respectively. The collection/billing ratio was 92% with Kampala Metropolitan Area at 97%, Central Region at 90%, Eastern & Northern Region at 79%, and Western & South West Region at 85%. The annual target for compliance with drinking water quality standards based on the National Water Quality Standards was 98%, and NWSC has achieved the target.

Table 3.1.7 NWSC Actual Performance and Achievement Rate in PC6 (FY 2019/20)

Key Performance Indicator		Annual Target	Actual Performance	Achievement Rate
NRW	Kampala Metropolitan Area	36.0%	39.5%	91%
	Central Region	22.0%	25.5%	86%
	Eastern & Northern Region	19.0%	23.4%	81%
	Western & South West Region	22.0%	22.0%	100%
Metering Coverage		76.0%	76.0%	100%
New Water Connections		47,000 connections	61,521 connections	131%
New Sewerage Connections		240 connections	280 connections	117%
Capex Budget Implemented		82.0%	82.0%	100%
Water Sales Volume Growth		87,000,000	87,000,000	100%
Collection/Billing Ratio		95%	92	97%
Return On Capital Employed (ROCE)		1.0%	-	-
Operating Cost/Revenue		80.0%	79.1%	99%
Compliance to Drinking Water Standards		98.0%	98.0%	100%
Compliance to Sewerage Standards		50.0%	46.0%	92%
Pro-Poor Connection Growth		1,200 connections	4,429 connections	369%
Customer Satisfaction Index		70%	77	110%

Source: Compiled by JST based on Water and Environment Sector Performance Report 2020.

3.1.4 Progress and Challenges in Policy and Development Planning

(1) Policy

1) The National Water Policy 1999

The National Water Policy was enacted in 1999 by the then MoWLE to cover water resources, water supply, agricultural water, and other water uses. The policy covers water resources management and utilization strategies aimed at monitoring, evaluating, distributing, and protecting water resources, as well as water resources development and utilization practices to ensure adequate and safe drinking water supply for the entire population. It also pushes for a new, integrated way of approaching the management of water resources in a way that is sustainable and most beneficial to the Ugandan people.

(2) Progress on Development Plan

1) Third National Development Plan (2020/21–2024/25)

The Third National Development Plan 2020/21–2024/25, formulated by the GoU, has a “Human Resource Development Plan”, which aims to increase water service coverage from 74% to 100% in urban areas and from 70% to 85% in rural areas by 2025 and achieve a higher quality of life through improved access to safe and clean water.

However, only 70.5% of the population has access to basic water supply services in urban areas in FY 2019/20. Also, the percentage of population with access to safely managed drinking water services improved from 20% in FY 2017/18 to 57% in FY 2019/20[5].

The Ministerial Policy Statement 2020/21 summarized by MoWE, sets out the progress of the annual development plan and targets for the years ahead in the form of Medium Term Plans, and each target value is guided by the NDP III. The targets are 1) improve water supply facilities in urban and rural areas to reduce water collection waiting time, 2) accelerate 100% water coverage for large towns under NWSC and UWA, and 3) improve water resources management in an integrated, sustainable, and coordinated manner.

Table 3.1.8 shows the achievement of the development programs for urban water supply in FY 2019/20 and the targets for FY 2020/21of the latest Medium Term Plans. All the plans are expected to be completed in FY 2020/21.

[5] Water and Environment Sector Performance Report 2020, Ministry of Water and Environment

Table 3.1.8 Urban Water Supply Programs and the State of Progress Listed in the Ministerial Policy Statement 2020/21

No.	Output Description	State of Progress	
		FY 2019/20 (Status)	FY 2020/21 (Target)
1	Construction works for piped water systems in 29 small towns and rural growth centers. (South-Western, Eastern, Central, Northern Regions and Kampala's surroundings)	Contractor procurement stage – 85% of construction completed.	All construction complete.
2	Designs for piped water systems in 56 towns (South-Western, Eastern, Central)	Not implemented (5 projects)	All designs complete.
3	Construction and rehabilitation of Katosi WTP, Katosi – Kampala transmission and distribution mains（Kampala Water Lake Victoria Water and Sanitation Project）	・Sonde Reservoir: Under construction ・ Transmission mains works : 72% ・Overall: 40% progress	100% completion scheduled.
4	Upgrade of Kapeeka water supply (Water Services Acceleration Project (SCAP))	・Installation of 1,974 km of water mains. ・ 33,724 new customers have been connected to water supply network.	Installation of 2,493 km of water mains (100%).

Source: Compiled by JST based on the Ministerial Policy Statement Water and Environment Sector FY 2020/21.

(3) Challenges in Policy and Development Planning

The following issues need to be addressed in order to implement the policies and development plans:

1) Land Acquisition and High Costs

Land acquisition has been a major factor in project delays, and there have been cases where projects have been abandoned due to land acquisition problems. The reason is largely due to selfishness of landowners who in some cases do not accept the value provided by the Chief Government Valuer as required by law.

2) Deterioration of Water Quality

The water quality of Lake Victoria, which is the water source for Ggaba I, II, III and Katosi WTP, has deteriorated due to water level fluctuations caused by climate change and water intake by countries along the River Nile, eutrophication caused by nutrients entering the lake through rivers or atmosphere, and water pollution caused by untreated wastewater entering from coastal urban areas. In recent years, the amount of chemicals used for water treatment at Ggaba WTP has increased and the cost has tripled.

3.1.5 Details of Cooperation by the Japan International Cooperation Agency (JICA) in Urban Water Supply Sector

(1) JICA's Aid in the Water Supply Sector in Uganda

As shown in Table 3.1.9, in addition to the grant aid of JPY 1.706 billion for "The Project for Rural

Water Supply in Lake Kyoga Basin", for the construction of elevated service reservoirs and water supply facilities, technical cooperation focusing on rural water supply (The Project for Operation & Maintenance for Rural Water Supply and Improved Hygiene and Sanitation), and dispatch of experts, etc., are planned until the year 2022.

Table 3.1.9 JICA Water Supply Projects and Aid in Uganda

Project	Period of Cooperation	Cost	Main Contents
The Project for Rural Water Supply in Lake Kyoga Basin, Eastern Uganda (Grant Aid)	May 2017-June 2020	JPY 1.706 billion	・Five districts in Lake Kyoga Basin ・Construction of nine piped water supply facilities (simple water supply facilities using communal stand pipes system by installing pipes) (water intake facilities, distribution reservoirs, distribution facilities, communal stand pipes (88 in total), water mains for public facilities, total pipeline length of about 115 km) ・Strengthen the capacity for operations and maintenance (O&M) of water supply facilities as a soft component.
JICA Knowledge Co-Creation Course O&M of Urban Water Supply System (Water Quality and Purification A)	June-August 2018	-	One trainee from Uganda (four trainees from four other countries, including Nigeria) was given a tour of the water treatment facilities, maintenance, inspection, and calibration training for continuous water quality monitoring equipment, and guidance on creating an action plan in Kyoto and Osaka cities.
JICA Knowledge Co-Creation Course African Region Urban Waterworks Engineering	November - December 2017	-	Ten trainees from eight African countries, including Uganda, are trained at the Yokohama City Waterworks Bureau on water treatment plant operation, NRW reduction, drawing management, waterworks construction, management planning, etc.
The Project for O&M for Rural Water Supply and Improved Hygiene and Sanitation (Technical Cooperation)	July 2015-October 2021	JPY 540 million	Targeted districts will be selected in areas where Japan has provided assistance in the past, and support will be provided to strengthen the O&M support system for rural water supply facilities in the public and private sectors, to strengthen the construction supervision capacity of central government and district officials for the development of rural water supply facilities, and to improve sanitation conditions in pilot villages.
The Project for Rural Water Supply (Phase 2) (Grant Aid)	December 2003–March 2006	JPY 599 million	Construction of deep-well water supply facilities with hand pumps and procurement of equipment for groundwater development research and educational activities will be carried out in Mukono, Kayunga, and Masaka districts to ensure a stable supply of safe drinking water for the residents of the targeted areas.
The Project for Rural Water Supply (Grant Aid)	1997-2001	JPY 638 million (1st term) JPY 2.659 billion (2nd term)	Four boreholes have been drilled with the support of NGOs in Mukono, and water sanitation committees have been established by NGOs and local governments in the three targeted districts.

Source: JICA Website, Ministry of Health, Labor and Welfare "Summary of International Cooperation in Water Supply Sector", IWA Japan National Committee Data

(2) JICA's Aid in Water Supply Sector in Neighboring Countries

1) NRW Related Projects in Urban Water Supply Sector

JICA is currently implementing non-revenue water projects such as "The Project for Strengthening Capacity in NRW Reduction" in Kenya, "The Project for Strengthening NRW Control in Kigali City Water Network" in Rwanda, and "The Project for Strengthening the Capacity of NRW Reduction for Lilongwe Water Board" in Malawi. Table 3.1.10 shows the NRW-related projects targeting urban areas in the African region, including grant aid projects which include the renewal of aging pipes that were installed in the past.

Table 3.1.10 List of NRW Related Projects (Africa)

No.	Country	Project	Project Scheme	Year of Implementation
1	Kenya	Greater Nakuru Water Supply Project	Loan	1987-1994
2	Kenya	The Meru Water Supply Project (1st term)	Grant	2001-2003
	Kenya	The Meru Water Supply Project (2nd term)	Grant	2003-2004
3	Kenya	The Project for Augmentation of Water Supply System in Kapsabet Town	Grant	2009-2011
4	Kenya	The Project for Improvement of the Water Supply System in Embu and the Surrounding Area	Grant	2010-2013
5	Kenya	The Project for Management of NRW in Kenya	Technical Cooperation	2010-2014
6	Kenya	The Project for Augmentation of Water Supply System in Narok	Grant	2013-2016
7	Kenya	The Project for Strengthening Capacity in NRW Reduction	Technical Cooperation	2016-2021
8	Ethiopia	The Project for Strengthening Addis Ababa Water and Sewerage Authority's Management Capacity of Non-Revenue Water Reduction	Technical Cooperation	2020-2024
9	Tanzania	Project for Enhancement of Water Supply Management of Zanzibar Water Supply Authority Phase 1, Phase 2	Technical Cooperation	2008-2015
10	Nigeria	Federal Capital Territory Reduction of NRW Project	Technical Cooperation	2014-2018
11	Rwanda	Project for Strengthening NRW Control in Kigali City Water Network	Technical Cooperation	2016-2020
12	Malawi	The Project for Strengthening the Capacity of NRW Reduction for Lilongwe Water Board	Technical Cooperation	2019-2023
13	South Africa	NRW Control Project in Ekurhuleni City	Technical Cooperation	2018-2019
14	South Africa	Project for Strengthening the Training Capacity of IBTC on NRW	Technical Cooperation	2017-2020

Source: JST

2) South-South Cooperation

JICA has implemented south-south cooperation in the water supply sector in the past (where a country with advanced development in one sector supports the development of another developing country). For example, an Intra-African Cooperation "Benchmarking Workshop on NRW Measures" (1st session: 6th November 2018) was held in Kigali, the capital of Rwanda, where water utilities in Rwanda, Malawi, and Kenya learned from each other. When the Water and Sanitation Corporation (WASAC) of Rwanda visited Kenya in May 2018 as part of the "Project for Strengthening NRW Control in Kigali City Water Network", a technical cooperation project being implemented in Rwanda, it was found that both Rwanda and Kenya have a lot to learn from each other. It was decided that Embu Water Resources Management Authority from Kenya, which has advanced knowledge on countermeasures against NRW, would also participate in the workshop.

In the project to strengthen the waterworks management capacity of the South Sudan Urban Water Corporation, the staff were dispatched to NWSC and Kenya Water Institute (KEWI) for training at a time when Japanese experts could not be dispatched due to the political civil unrest in South Sudan. In cooperation with NWSC and KEWI, the training was not only lecture-style lesson but also practical training. In particular, practical and on-site training was conducted by knowledgeable and experienced staff of NWSC on water metering, electrical and mechanical maintenance, pipeline connection, water treatment plant operation, etc., at the Vocational Skills Development Facility (VSDF) and existing facilities of NWSC

3) “First Executive Forum for Enhancing Sustainability of Urban Water Services in Sub Saharan Africa”

Overview:

For two days, on the 13th and 14th of November 2019, JICA and WASAC of Rwanda co-sponsored a forum that was held in Rwanda, the first time in Africa.

Purpose:

The purpose of this forum was to promote the networking of water utilities in African countries and to share each other's knowledge, experience, and lessons learned in the project to contribute to future water business management and service improvement.

Contents:

In addition to Rwanda, which served as the host country along with JICA, 36 participants including presidents and CEOs from 14 entities in eight countries including Sudan, Kenya, Tanzania, Malawi, Zambia, South Africa, and Nigeria, all of which are or have been implementing cooperation with JICA. In addition, a large number of local media and related companies also attended the conference and discussed water supply issues in Africa with about 100 participants.

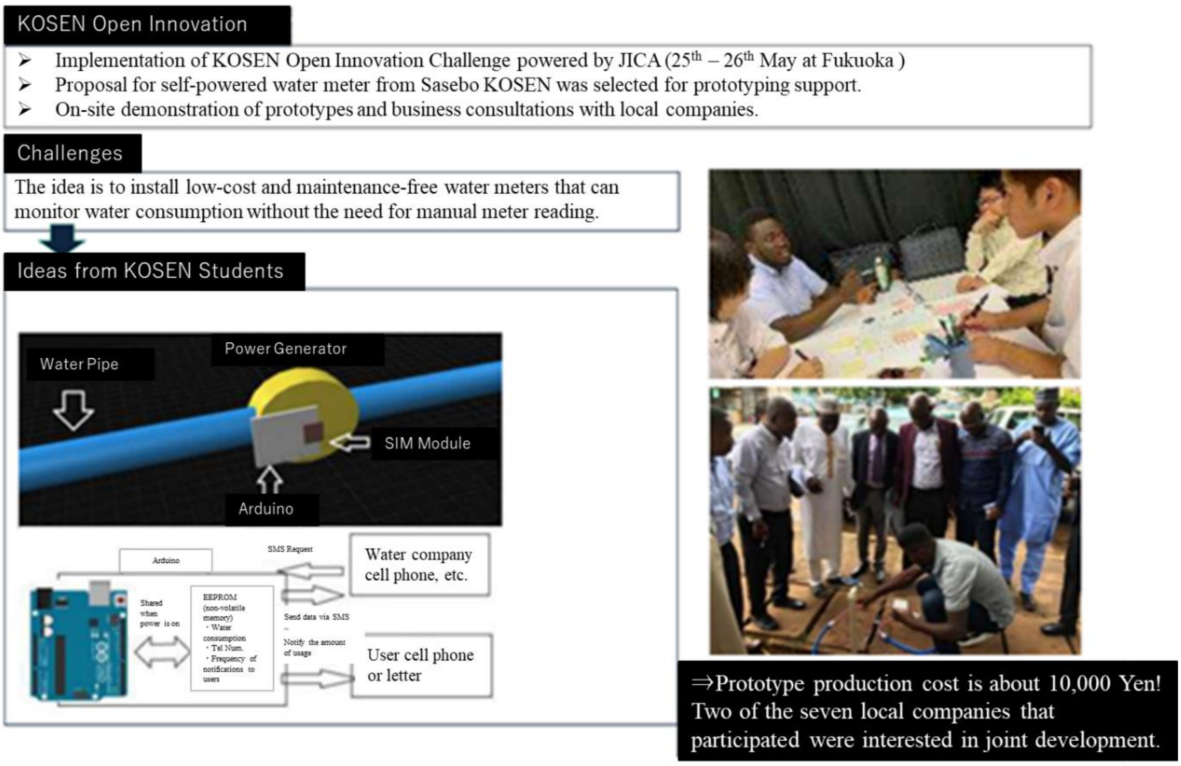
4) JICA-KOSEN Open Innovation Challenge: Solving Social Issues through Academia's Involvement

As shown in Table 3.1.11 and Figure 3.1.4, the case study of JICA's new initiative in the urban water supply sector in neighboring country was introduced. In the "JICA-KOSEN Open Innovation Challenge: Solving Social Issues through Academia's Involvement", an innovative idea to support overseas deployment of self-powered water meters was proposed by students from KOSEN. The prototype was brought to the site and a demonstration (on-site demonstration) was conducted with the local partner companies from 13 July to 1 August 2019, while meetings were held with local partner companies and businesses for about one month in 2019. In this project, local demonstrations in the agricultural sector were also conducted in Kenya and Rwanda.

Table 3.1.11 JICA-KOSEN Open Innovation Challenge (On-site Demonstration in Nigeria)

Challenge	Ideas for low-cost installation and maintenance-free operation of water meters that can track usage without manual meter reading are sought.
Local Cooperation	Local collaboration start-up JAFFA Inc.
KOSEN	Sasebo KOSEN, Kitakyushu KOSEN (One teacher and one student travelled from Sasebo KOSEN)
Prototype	Self-powered water meter (Independent power supply by hydroelectric power generation, automatic transmission of measurement data)
Demonstration Schedule	29 July (Monday) for the Federal Capital Territory Water Board (FCTWB) 30 July (Tuesday) for local companies
Attendance	FCTWB, companies that participated in the 1st Open Innovation Challenge, local water companies, etc.

Source: JICA



Source: JICA

Figure 3.1.4 Water Sector PoC Supported by JICA (Successful Case Study in Nigeria)

3.1.6 Existence and Achievement of International Commitments

(1) International Commitments

Uganda is committed to increase water service coverage for the least-served areas, operationalize non-functional water points, and establish more pro-poor facilities, where people pay less or equal to the house connection tariff in the service area to achieve the Sustainable Developments Goals (SDG) 6 listed in Table 3.1.12[6].

Table 3.1.12 Sustainable Development Goals 6（SDG 6）

SDG 6	Contents
6.1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
6.2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.
6.4	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.
6.5	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.
6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands,

[6] UN website: https://sdgs.un.org/basic-page/uganda-24784

SDG 6	Contents
	rivers, aquifers and lakes.
6.a	By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.
6.b	Support and strengthen the participation of local communities in improving water and sanitation management.

Source: Compiled by JST based on Ministry of Foreign Affairs of Japan website[7].

(2) Achievement

As shown in Table 3.1.13, the percentage of the population using improved drinking water sources increased from 71% in FY 2015/16 to 79% in FY 2018/19 in Uganda's urban areas, while in rural areas, the percentage increased from 67% to 69% over the same period. However, both urban and rural areas had a decrease in percentage in FY 2019/20, especially in urban areas which decrease to 70.5%. The main reason is due to the improved accuracy of the evidence-based database and the lack of connections in the large project target areas. The percentages of drinking water that comply with the national standards in FY 2019/20 were 59% in rural, 91.6% in small towns under the jurisdiction of UWA, and 98% in the districts under the jurisdiction of NWSC.

Table 3.1.13 Water Sector Performance Indicator

Performance Indicator	Area	2015/16	2016/17	2017/18	2018/19	2019/20
Percentage of population using an improved drinking water source	Rural	67%	70%	70%	69%	68%
	Urban	71%	71%	77%	79%	70.5%
Drinking water qualities: Percentage (%) of water samples taken that comply with national standards	Rural	41%	59%	64%	59%	59%
	Small Towns	n/a	ND	89%	93.3%	91.6%
	NWSC	99%	99.6%	99.3%	99.6%	98%
Percentage of towns with pro-poor facilities where people pay less or equal to the house connection tariff in the service area	Small Towns	n/a	ND	38%	31%	31%
	NWSC	n/a	ND	83%	ND	ND

Note: n/a (not applicable), ND (No Data)
Source: Water and Environment Sector Performance Report 2020

[7] Ministry of Foreign Affairs of Japan website: https://www.mofa.go.jp/mofaj/gaiko/oda/sdgs/statistics/goal6.html

3.1.7 Impact and Actions for COVID-19 in Urban Water Supply Sector

(1) Status of Efforts by MoWE

Hand washing with soap has been recommended as a measure to minimize chances of contracting the disease due to the global spread of COVID-19 in Uganda. For this reason, public hand washing facilities have been installed and daily hand washing is recommended to minimize the risk of infection. Around 145 hand washing facilities (Photo 3.1.1) have been installed in public places.

Source: Water and Environment Sector Performance Report 2020

Photo 3.1.1 Hand Washing Facilities

(2) Impact on NWSC

As shown in Table 3.2.19 of Section 3.2.4, the water tariff collected by NWSC decreased from UGX 437 billion in FY 2018/19 to UGX 391 billion in FY 2019/20, a decrease of about 10% and only 75% of the annual target of UGX 522 billion[8]. This was due to a decrease in water consumption caused by the closure of many institutions, schools, and commercial facilities as a result of COVID-19. Water consumption decreased to about 70% in commercial and industry and about 90% in local governments and Overseas Diplomatic Establishments as economic activities are stagnated due to the regulatory measures by GoU[9]. NWSC continues to provide water supply services to those in financial distress due to COVID-19, even though their water bills are still unpaid.

NWSC has continued to provide water supply services under the government's notification even during the COVID-19 outbreak; the decrease in income has made securing revenue a challenge for sound business operations. NWSC has partnered with Africa’s most extensive data communication company, Mobile Telephone Network (MTN)-Ug and has received the assistance of UGX 220 million (about JPY 6.5 million[4]) for a project to install 100 public stand pipes (PSP) with a capacity of 100 m^3 in Kampala City. Also, MoWE has also been facilitated by the Development Policy Operation (DPO) of the GoU to receive financial assistance from the World Bank[10].

[8] NWSC Integrated Annual Report 2019/20

[9] World Bank Blogs: https://blogs.worldbank.org/water/water-and-sanitation-uganda-two-months-when-world-changed, Water and sanitation in Uganda: Two months when the world changed

[10] NWSC website: https://www.nwsc.co.ug/notices/news/98-nwsc-and-mtn-ug-in-water-relief-partnership-amidst-covid-19-trials

3.2 Outline of the National Water and Sewerage Corporation (NWSC)

3.2.1 Organizational Structure and Staff Composition

(1) Organizational Structure

The NWSC is a public utility company established in 1972 by Decree 34 (1972) to improve urban water supply and sanitation services in Uganda. NWSC operates and maintains water and wastewater facilities, manages the planning, design and construction of these facilities (project management), training of staff and provides consultancy services both nationally and internationally through the International Resource Center (IREC). As of FY 2019/20, NWSC is responsible for the provision of water supply and sanitation services in 258 cities using the facilities that NWSC manages including dams and wells as water sources, water treatment plant, water transmission pipes, distribution reservoirs, pumping stations, distribution pipes, public stand pipes, and water meters, as well as O&M of these facilities and collection of water bills from customers. Figure 3.2.1 shows the organizational structure of NWSC.

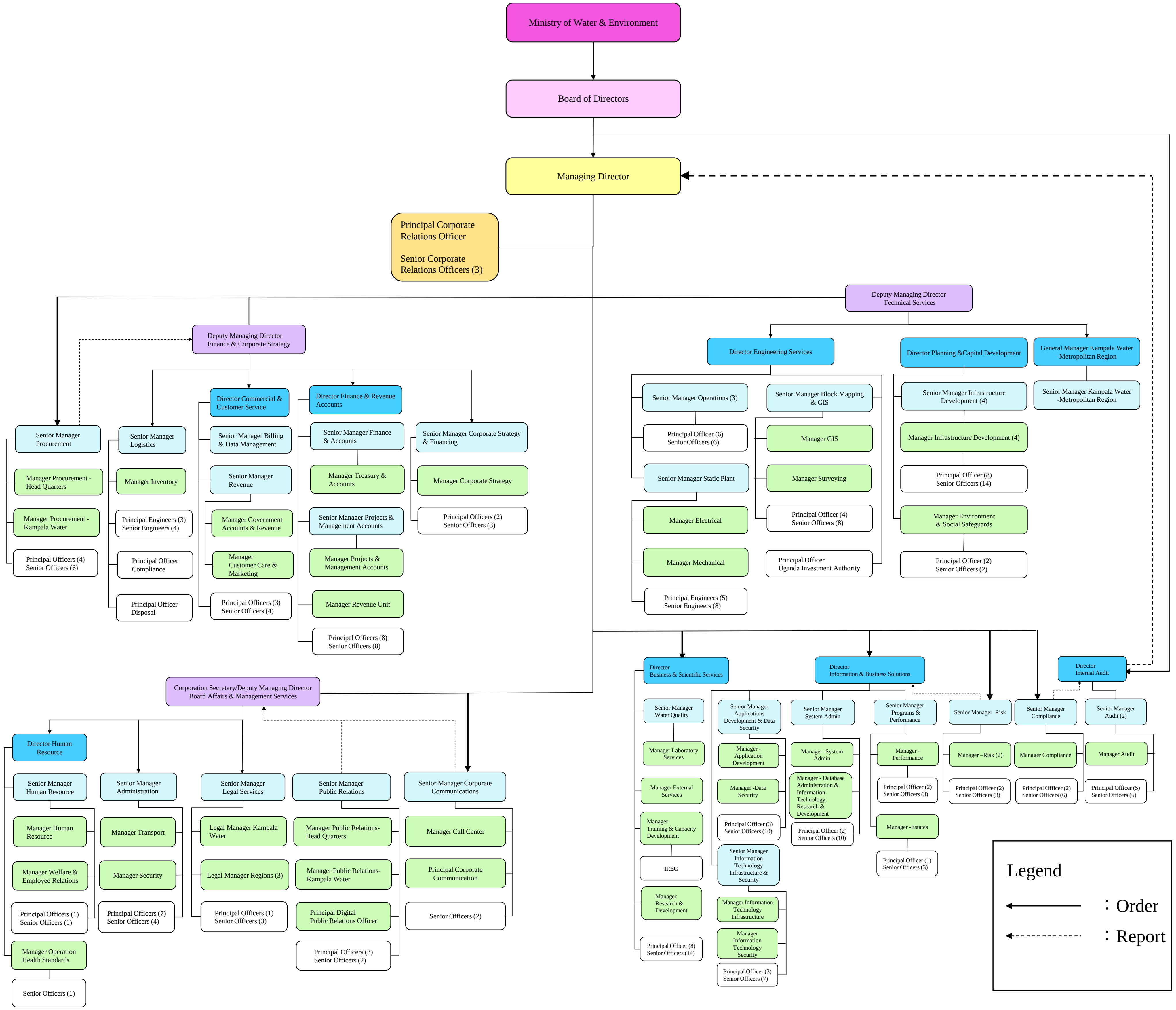
(2) Staff Composition

The staff composition of NWSC Head Office as well as other regions for FY 2018/19 and FY 2019/20 is shown in Table 3.2.1. NWSC Head Office, Central Region, Eastern & Northern Region, and Western & South West Region had an increase of about 10 to 20 staff when compared with the previous year, while Kampala Metropolitan Area had an increase of about 200 staff. The total number of staff in NWSC increased by 300.

Table 3.2.1 NWSC Staff Composition

Region	Staff Composition	
	FY 2018/19	FY 2019/20
NWSC Head Office	525	541
Kampala Metropolitan Area	1,258	1,499
Central	654	678
Eastern & Northern	661	668
Western & South West	680	696
Total	3,778	4,082

Source: NWSC Annual Integrated Report 2019/20



Source: NWSC

Figure 3.2.1 NWSC Organizational Structure

3.2.2 Management, Financial Status, and Business Plan

(1) Management

The NWSC Board comprised seven non-executive members and one executive member, the Managing Director. The appointment of the Board of Directors (except for the Managing Director who is appointed by the Board) shall be done by MoWE and this appointment will be for three years, with eligibility for reappointment for another term.

The Board plays the following key roles:

- Develop policies to guide the operations of the Corporation, taking into account the interest of the various stakeholders.
- Put in place the Corporate Plan that serves as a broad framework for guiding management in the medium term.
- Approve major capital expenditure in the Corporation.
- Risk management and monitoring of operational and financial performance.
- Review and approve accounting policies, financial statements, and annual reports.
- Review and approve the Corporation's annual budgets and forecasts.
- Authorize material borrowings and changes to the Corporation's capital structure.
- Appoint the Managing Director, Management and staff.
- Oversee and review the effectiveness of the risk management and internal control system.
- Formulate the medium and long-term plans of the Corporation, including strategy, major investments, acquisitions and disposal of major assets.

Various decisions made by the Board of Directors are deliberated and decided in seven meetings: 1) Full Board Meetings (four times a year), 2) Special Board Meetings (irregular), 3) Audit Committee Meetings (four times a year), 4) Risk Management Committee Meetings (four times a year), 5) Human Resources & Legal Administration Committee Meetings, 6) Finance & Planning Committee Meetings, and 7) Technical Services Committee Meetings.

(2) Financial Resources Over the Past Five Years (FY 2016/17-FY 2020/21)

Table 3.2.2 shows the NWSC internal and external financial resources. NWSC financial resource envelop comprises collections from the water and sewerage billings for internal resources, funding from development partners and GoU for external resources. The total amount realized during the five-year period of FY 2016/17–FY 2020/21 was UGX 3.352 trillion, of which water and sewerage billings and ES accounted for 60%. The generated resources of NWSC are mainly used to finance the operating expenditure, minor capital investments as well as meeting the co-financing obligations for major projects.

In 2018, the World Bank (WB) financed a study to investigate the borrowing capacity to finance future infrastructure projects. The report of the study concluded that NWSC has the capacity to issue bonds of up to USD 200 million, over a period of five years. At the same time, a study carried out by the Global Rating Company assigned NWSC a credit rating of AA+ with a stable outlook up to 31 October 2019.

The NWSC required UGX 50 billion in FY 2019/20 for emergency facility maintenance, but the Corporation could not raise the funds through a bond issuance as it was a single-year project. MoFPED authorized NWSC to borrow the UGX 50 billion (without Government Guarantee) from the commercial banks as a source of financing, and UGX 47.95 billion had been disbursed by 31 January 2021.

Table 3.2.2 NWSC Internal and External Financial Resources

(UGX '000)

Source	2015/16 (Baseline)	2016/17	2017/18	2018/19	2019/20	2020/21	Total
External Resources							
Donor	272,089,607	205,832,568	89,685,226	170,783,184	344,130,286	234,351,400	1,044,782,663
GoU	48,970,814	14,292,827	22,231,108	94,874,436	70,329,575	84,898,077	286,626,023
Total External Resources	321,060,421	220,125,395	111,916,334	265,657,620	414,459,861	319,249,477	1,331,408,686
Internal Resources							
Water and Sewerage	284,127,998	332,724,890	384,656,993	436,971,646	390,998,077	445,809,941	1,991,161,546
ES	2,313,083	2,078,424	7,175,292	10,463,165	7,425,708	2,500,000	29,642,588,091
Total Internal Resources	286,441,081	334,803,314	391,832,285	447,434,811	398,423,785	448,309,941	2,020,804,137
Total	607,501,502	554,928,708	503,748,618	713,092,431	812,883,645	767,559,417	3,352,212,820

ES: External Services
Source: NWSC Corporate Plan 2021-2024

(3) Operating Profit and Working Ratio

Table 3.2.3 shows the NWSC operating profit for FY 2015/16–FY 2020/21. Operating profit before depreciation increased from UGX 60.2 billion in FY 2015/16 to UGX 135 billion in FY 2020/21. Also, operating profit after depreciation increased from UGX 34.0 billion in FY 2015/16 to UGX 54 billion in FY 2020/21.

Working ratio is a measure of a company's financial sustainability and it exhibits the ability of the Corporation to cover its operating costs from annual income. Also, the lower the number of working ratio, the higher the financial sustainability. Figure 3.2.2 shows the NWSC operating cost and revenue, working ratio for FY 2015/16–FY 2020/21. The working ratio of NWSC improved from 78% in FY 2015/16 to 73% in FY 2020/21. This demonstrates the increased capacity by the Corporation to meet all the operating costs and contribute to asset replacement and expansion. The working ratio increase from 76% to 78% during FY 2018/19 was due to the massive takeover of new towns that translated into increased costs arising from the need to improve service delivery in the newly taken over towns. Whereas the dramatic improvement in FY 2020/21 is attributed to the implementation of stringent cost optimization measures to minimize the impact of COVID-19.

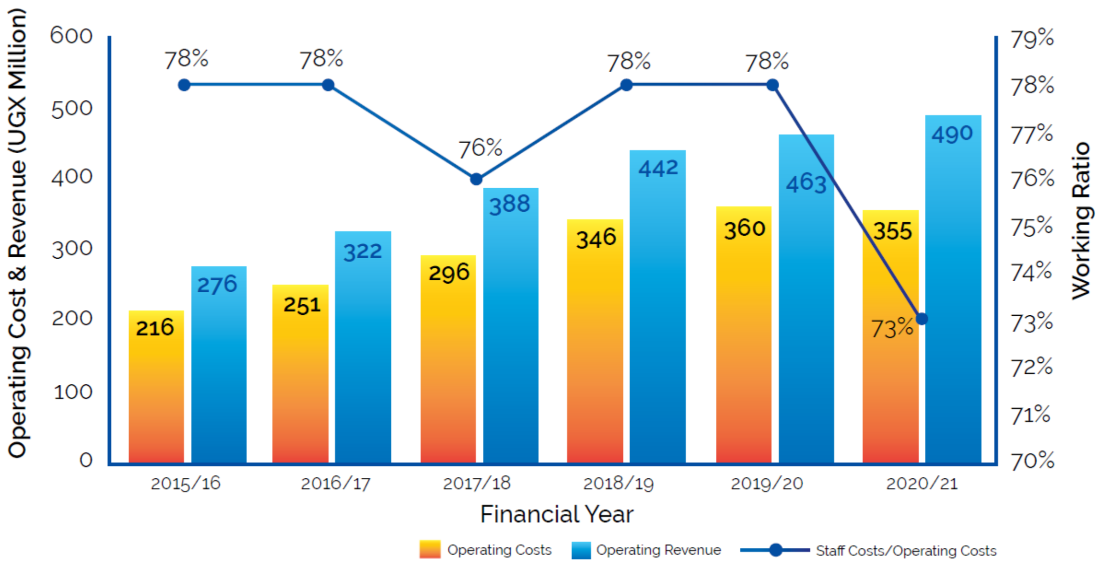
Table 3.2.4 shows the NWSC operating ratio for FY 2015/16–FY 2020/21. The operating ratio increased from 84% in FY 2015/16 to 87% in FY 2020/21. The increase is attributed to the high cost of operations especially in the new towns under the jurisdiction of NWSC and which are unable to break even. Also, COVID-19 has resulted in the lockdown measures instituted which affected business.

Table 3.2.3 NWSC Operating Profit (FY 2015/16–FY 2020/21)

(UGX '000)

Items	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21 (P*)
Operating Revenue	276,062,157	321,806,567	387,791,671	442,081,718	463,168,236	490,120,519
Operating Costs	215,889,809	250,940,410	295,524,437	345,856,705	359,844,559	355,391,320
Operating Profit Before Depreciation	60,172,350	70,866,157	92,267,234	96,225,013	103,323,677	134,729,199
Depreciation	26,160,375	31,885,358	33,377,986	40,979,001	55,656,370	80,556,492
Operating Profit After Depreciation	34,011,975	38,980,799	58,889,248	47,667,307	55,246,011	54,172,707

P*: Projected Performance
Source: NWSC Corporate Plan 2021-2024



Source: NWSC Corporate Plan 2021-2024

Figure 3.2.2 NWSC Operating Cost and Revenue, Working Ratio (FY 2015/16–FY 2020/21)

Table 3.2.4 NWSC Operating Ratio (FY 2015/16–FY 2020/21)

(UGX '000)

Items	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Operating Expenditure	215,889,809	250,940,410	295,524,437	345,856,705	359,844,559	355,391,320
Annual Revenue (Water and Sewerage Income)	258,483,328	306,434,221	340,119,685	381,895,802	370,705,256	407,775,782
Operating Ratio	84%	82%	87%	91%	97%	87%

Source: NWSC Corporate Plan 2021-2024

(4) Financial Status

The NWSC Financial Status for FY 2018/19 and FY 2019/20 are shown in Table 3.2.5 and Table 3.2.6, respectively.

Water and sewerage income is the main source of income for NWSC. The income was reduced by 3% from UGX 382 billion in FY 2018/19 to UGX 371 billion in FY 2019/20. This reduction was largely due to the impact of lockdown, which the GoU imposed to fight COVID-19. A gradual increase in water sales during FY 2020/21 is expected as business activities improve across all sectors of the economy.

For expenditure, staff expenses were increased by 10% from UGX 137 billion in FY 2018/19 to UGX 151 billion in FY 2019/20 due to increase in staff numbers from 3,778 to 4,082 arising from the expansion of water supply areas from 253 in FY 2018/19 to 258 in FY 2019/20 and the need for additional staff at newly established facilities in Gulu, Kapchorwa, Kampala, and other towns. Static plant and pipe network maintenance costs increased by 2% from UGX 98 billion to UGX 100 billion due to the need to address operational challenges in the new towns. Also, premises maintenance costs increased by 1.3% from UGX 9.6 billion to UGX 9.7 billion in FY 2019/20 as additional expenditure was incurred on rent, rates, telephone, and maintenance of the new towns.

As a result, the profit of NWSC in FY 2018/20 is UGX 27 billion, a decline of 68% compared with the previous year.

Table 3.2.5 NWSC Financial Status (Profit and Loss Statement)

(UGX '000)

Item	FY 2018/19	FY 2019/20	Percentage Change
Income			
Water and sewerage income	381,895,802	370,705,256	-3%
Other incomes	10,315,407	8,547,204	-17%
Investment income	225,437	110,493	-51%
Deferred income	49,645,072	83,805,283	69%
Total	442,081,718	463,168,236	5%
Expenditure			
Employee expenses	137,265,190	151,164,016	10%
Administrative expenses	50,367,076	51,115,559	1%
Static plant and pipe network	97,751,255	99,632,978	2%
Supplies and services	33,738,876	32,022,607	-5%
Premises maintenance	9,609,349	9,703,666	1%
Transport and mobile plant	17,124,959	16,205,734	-5%
Total	345,856,705	359,844,559	4%
Operating profit before depreciation	96,225,013	103,323,677	7%
Depreciation and amortization	40,979,001	55,656,370	36%
Operating profit before finance costs	55,246,011	47,667,307	-14%
Net financial cost	5,993,271	1,838,776	-69%
Net profit before tax	49,252,740	45,828,530	-7%
Tax (charge)/credit	36,477,535	18,385,162	-150%
Profit for the year	85,700,275	27,443,368	-68%

Source: NWSC Annual Integrated Report 2019/20

Table 3.2.6 NWSC Financial Status (Balance Sheet)

(UGX '000)

Item	2018/19	2019/20	Percentage Change
Equity			
Equity and reserves			
Government funding	317,134,727	317,204,458	-
Revaluation reserves	660,171,766	641,366,709	-3%
Retained earnings	332,099,001	332,122,207	3%
Total equity	1,299,405,494	1,290,693,374	-1%
Non-current liabilities			
Borrowings	-	36,700,000	-
Terminal benefits	5,278,115	5,129,958	-3%
Deferred tax liabilities	314,794,231	333,143,686	6%
Deferred income	1,247,943,588	1,462,813,556	17%
Total non-current liabilities	1,568,015,934	1,837,787,200	17%
Total equity	2,867,421,428	3,128,480,573	9%
Non-current assets			
Property plant and equipment	1,922,106,753	2,508,233,817	30%
Capital work-in-progress	745,102,237	554,807,537	-26%
Intangible assets	9,649	99,298	929%
Operating lease prepayments	2,354,721	4,101,177	74%
Total non-current assets	2,669,573,360	3,067,241,829	15%
Current assets			
Tax recoverable	3,506,505	3,585,302	2%
Inventories	44,548,512	37,000,742	-17%
Trade and other receivables	267,107,643	222,607,714	-17%
Short term bank deposits	1,199,855	1,544,626	29%
Cash and bank balances	129,960,005	140,533,864	8%
Total current assets	446,322,521	405,272,248	-9%
Total assets	3,115,895,881	3,472,514,077	11%
Current liabilities			
Borrowings	4,712,798	3,353,814	-29%
Annual terminal benefits	10,186,491	17,754,819	74%
Deferred income	49,645,072	83,805,283	69%
Trade and other payables	183,930,092	239,119,589	30%
Total current liabilities	248,474,453	344,033,504	38%
Net current assets	197,848,068	61,238,744	-69%
	2,867,421,428	3,128,480,573	9%

Source: NWSC Annual Integrated Report 2019/20

Table 3.2.7 shows the business indicator of NWSC for FY 2018/19 and FY 2019 /20. The Return on Assets (ROA) of NWSC was 2.8% in FY 2018/19 and decreased to 0.8% in FY 2019/20. The main reason for this was the significant decrease in annual profits due to COVID-19. ROA of at least 3% (5% for blue-chip companies) is usually considered reasonable, and the rate of return of NWSC as a water utility is low. The current ratio, which indicates the status of liquidity (cash flow), is 180% and 118% in FY 2018/19 and FY 2019/20, respectively. This means that the liquidity is not high since they are still below 200%. The capital ratio, which indicates the stability of the company's management, is below

50% and therefore cannot be regarded as stable. Operating profit before depreciation (EBITDA) was UGX 96.2 billion and UGX 103.3 in FY 2018/19 and FY 2019/20, respectively. EBITDA margin increased by 2% from FY 2018/19 to FY 2019/20. However, the capital ratio of NWSC is below 50%, so the Corporation does not have borrowing capacity. In addition, government funds amounted to UGX 317.2 billion in FY2018/19 and FY2019/20, which is about 25% of total equity. Based on an overall assessment of the business indicators of NWSC, it is considered that NWSC is able to continue to manage the O&M of its water supply and sewerage systems, but that the Corporation has insufficient borrowing capacity for the replacement of large-scale distribution pipes and construction of large-scale facilities such as new water treatment plants. The deferred income in the non-current liabilities of the balance sheet is a grant from Uganda and donors, which will be recognized as income over the expected life of the project when the project is completed.

After confirmation with NWSC, the deferred income is in the form of grant and therefore has no impact on the equity and reserves. Table 3.2.8 shows the results of calculation of NWSC business indicator excluding deferred income. The current ratio, capital ratio, and borrowing capacity have improved significantly. In particular, the borrowing capacity went from negative to positive figure.

Table 3.2.7 NWSC Business Indicator

Business Indicator	2018/19	2019/20
Return on Assets (ROA)	2.8%	0.8%
Current Ratio	180%	118%
Capital Ratio	42%	37%
EBITDA (UGX '000)	96,225,013	103,323,676
EBITDA Margin	25%	27%
Borrowing Capacity (UGX '000)	-258,542,447	-445,563,665
Percentage of Government Funding in Total Equity	24%	25%

Source: JST

Table 3.2.8 NWSC Business Indicator (Assumed Deferred Income is Excluded)

Business Indicator	2018/19	2019/20
Return on Assets (ROA)	2.8%	0.8%
Current Ratio	224%	156%
Capital Ratio	71%	67%
EBITDA (UGX '000)	96,225,013	103,323,676
EBITDA Margin	25%	27%
Borrowing Capacity (UGX '000)	390,251,884	327,745,755
Percentage of Government Funding in Total Equity	24%	25%

Source: JST

(5) Water Tariff System

1) Water Tariff

Table 3.2.9 shows the NWSC tariff set by consumer category. The water tariffs are divided into seven categories, and the tariffs vary according to consumer category and usage. However, when water vendors sell water from wells and springs, they charge as much as UGX 500-1000 per 20 liters (based on interviews in Lugazi City), and this has become a problem for the poor due to the high cost of water.

Table 3.2.9 NWSC Tariff Set by Consumer Category

Consumer Category (VAT Inclusive)	20 litres/UGX VAT Inclusive
PSP UGX 1,060/m^3	25
Domestic Customer UGX 3,516/m^3	83
Institution/Government UGX 3,558/m^3	84
Commercial <500 m^3/month UGX 4,220/m^3	99
Commercial 500-1500 m^3/month UGX 3,373/m^3	79
Industrial <1000 m^3/month UGX 4,220/m^3	99
Industrial >1000 m^3/month UGX 2,500/m^3	59

Source: Compiled by JST based on NWSC website

2) Water Tariff Collection System

After reading the customer's meter, a water bill is prepared and issued to the customer according to the amount of water usage. For customers registered with e-invoice, the bill will be sent to their registered e-mail address. Payment can be made electronically at affiliated banks, by electronic funds transfer, internet banking, mobile money, or by debiting from the bank account. If a customer does not pay the water bill even after certain procedures such as reminders have been taken, the water supply will be suspended by the water supply staff.

3) Water Tariff Settings

The NWSC regulates the water tariff for the water supply areas under its jurisdiction based on the Water (General Rates) Regulations, 2018, enacted on 28 October 2018. Indexation of rates (water tariff) has been made for the purpose of setting water tariff within the range payable by customers in the water supply areas under NWSC's jurisdiction, and those to be served in the future. The indexation of rates (water tariff) is subject to annual indexation against the domestic and foreign price index, exchange rates, and electricity tariff. However, the GoU gave directives to NWSC to maintain the water tariff of PSP at UGX 1,060/m^3 and industrial customers consuming above 1,000 cubic meters at UGX 2,500/m^3. Therefore, the water tariff for these two customer categories as shown in Table 3.2.9 remains the same when NWSC regulates the rates. If there is an increase in the rates, the water tariff for other customer categories will be adjusted. The same water tariff is applied to the water supply areas under NWSC's jurisdiction. However, there was no change in water tariff from FY 2018/19 to FY 2019/20.

(6) Business Plan

1) NWSC Five-Year Strategic Direction 2016-2021

The NWSC Five-Year Strategic Direction has identified four Strategic Priority Areas (SPA) as shown in Table 3.2.10, based on the NWSC Corporate Plan 2015-2018. The strategic focus areas consist of improving water supply reliability, expanding water supply area, comprehensive asset management, reducing NRW, environmental protection, customer satisfaction, capacity building, and research and development.

Table 3.2.10 Strategic Priorities and Business Plan Values in NWSC Five-Year Strategic Direction 2016-2021

Strategic Priorities Areas	Strategic Focus Areas	Business Plan Values for 2021
SPA 1: SMART Systems, Business Continuity and Infrastructure Growth	Asset Management, NRW, Water Service Reliability (water sources, water quality and quantity), Water Service Coverage, Timely and Efficient Delivery of Capital Investments, Risk Management, Sewerage Services Enhancement.	・Coverage Rate: 100% ・Geographical Coverage: 200 towns ・Water Production: 384 million m^3/day ・Water Sold: 102 million m^3/year ・Water Supply Hours: 24 hours ・NRW (Overall): 25% ・Customer Satisfactory: 70% ・Collection Efficiency: 101% ・Water Mains Extension: 1,000 km ・New Water Connections: 2,800 nos./year ・New PSP: 800 nos./year
SPA 2: Financial Growth and Sustainability	Enhancing Viability of New Towns (connectivity), Value for Money Investments, Investment Financing, Income Diversification, Cost Optimization and Efficiency, Revenue Growth, Compliance and Governance, Integrated ICT Solutions.	
SPA 3: Customer and Stakeholder Delight	Environment Protection, Corporate Social Responsibility, Customer Satisfaction (accountability), Stakeholder Engagement, Staff Satisfaction.	
SPA 4: Productivity and Capacity Development	Skills Development, Research and Development (R&D), Business Re-engineering, Staff Productivity.	

Source: Compiled by JST based on NWSC Five Year Strategic Direction 2016-2021

2) NWSC Corporate Plan 2018-2021

The NWSC Five-Year Strategic Direction was developed in accordance with the Strategic Priorities Areas (SPAs) set out in the NWSC Corporate Plan 2015-2018, and the NWSC Corporate Plan 2018-2021 is an update of the 2015-2018 version. As shown in Table 3.2.11, NWSC aims to further improve services through four Strategic Priorities (SPs) by achieving a 100% water service coverage rate by 2021 and reducing the overall NRW rate to less than 28%. In addition to facility development and fundraising issues, strengthening the organization and human resource development have also been identified as priorities.

Table 3.2.11 Strategic Priorities and Business Plan Values in NWSC Corporate Plan 2018-2021

Strategic Priorities	Focus Areas	Business Plan Values for 2021
SP 1: Service Reliability and Expansion	Comprehensive Asset Management System, NRW Reduction, Water Service Reliability (water sources, water quality and quantity), Water Service Coverage, Sewerage Services Enhancement, Timely and Efficient Delivery of Capital Investments, Environmental Sustainability, I.T Business Solutions (Integrated ICT Solutions).	・Coverage Rate: 100% ・Water Supplied: 145.5 million m^3 ・Water Sold: 105.5 million m^3 ・NRW (Overall): 28% ・NRW (Kampala) : 33% ・NRW (Others): 18% ・New Water Connections: 68,042 nos. (Total: 770,340 nos.) ・New PSPs: 2,043 nos. (Total: 17,597 nos.) ・New Water Mains Extensions: 1,122 km (Total: 16,233 km)
SP 2: Financial Growth and Sustainability	Revenue Growth and Management, Enhancing Viability of the Corporation, Liquidity Management, Investment Financing, Income Diversification, Governance and Transparency.	
SP 3: Customer and Stakeholder Delight	Stakeholder Engagement, Customer Delight, Corporate Citizenship, Pro-Poor Service Delivery, Staff Motivation.	
SP 4: Learning and Growth	Staff Productivity Enhancement, Enhanced Staff Welfare, and Work-Life Balance, Staff Satisfaction and Retention, Staff Capacity Development, Occupation Health and Safety, Research and Development (R&D), Organizational Capacity Development.	

Source: NWSC Corporate Plan 2018-2021

3) Business Plan (NWSC Corporate Plan 2018-2021)

The NWSC will use a mix of financing options to meet the financing requirements for the three years from FY 2018/19 to FY 2020/21. All O&M costs and minor investments of NWSC will be covered using internally generated resources through the water and sewerage income (water and sewerage income, service charges for PSP, fines for illegal connections, etc.). It is envisaged that NWSC's major capital investments will be financed by the GoU and development partners, with external funding from development partners in the form of equity, grants, and loans. NWSC will also explore new financing options, which include market finance and PPP.

As shown in Table 3.2.12, the NWSC Corporate Plan has developed a business plan to generate UGX 3.4 trillion in cash revenue over three years starting from FY 2018/19. This has been determined based on the assumption that water billings will increase at an annual rate of 8% from UGX 385 billion in FY 2018/19 to UGX 479 billion (VAT inclusive) in FY 2020/21. Over the next three years, cash inflow is expected to exceed UGX 1.4 trillion with donor funding.

On the other hand, investment in major projects over the next three years starting from FY 2018/19 will amount to UGX 186 billion, averaging UGX 62 billion per year, with major investments covering 21 towns (Arua, Gulu, Bale, Kapchorwa, Kitgum, Moyo, Kotido, Kabong, Masindi Masindi, Hoima, Fort Portal, Kasese, Kisoro, Bushenyi, Mbarara, Isingiro, Kyotera, Kapeeka, Masaka, Sembabule, and Kampala Metropolitan Area). Additional capital investments will be undertaken in other towns in the form of water supply stabilization and intensification through infrastructure upgrade and expansion under the Service Coverage Acceleration Project (SCAP100).

Out of the total investments needs, NWSC will contribute about UGX 1.73 trillion from internal sources, an average of UGX 580 billion per year, with the rest coming from other sources such as funds from GoU and other development partners.

Table 3.2.13 provides a summary of the project investment plans for FY 2018/19 to FY 2020/21. Around USD 447 million has been invested in the Kampala Water Lake Victoria WATSAN Project, followed by USD 179 million for sewerage development in Kampala.

Table 3.2.12 NWSC Cash Flow Requirements (FY 2018/19–FY 2020/21)

(UGX '000)

Expenses	2017/18 (Baseline)	2018/19	2019/20	2020/21	Total (3 Years)
Financing Requirements					
Operational Expenses	369,875,910	399,035,680	422,977,821	448,356,490	1,270,369,991
Capital Expenditure Fully Financed by NWSC	80,739,822	82,629,485	86,760,959	91,099,007	260,489,451
NWSC Contribution to Major Projects	26,160,000	63,200,000	82,825,000	40,300,000	186,325,000
GoU Funding	45,436,477	45,436,477	130,781,400	48,049,723	224,267,600
Contribution from Development Partners	396,458,000	570,597,106	585,234,100	295,953,752	1,451,784,958
Total Financing Requirements	918,670,210	1,160,898,748	1,308,579,280	923,758,971	3,393,236,999
Source of Financing					
Total Receipts from NWSC/Internal Resources	475,909,948	523,500,943	575,851,037	633,436,141	1,732,788,121
GoU Funding	95,436,477	60,774,000	130,781,400	48,049,723	239,605,123
Other Donor Contributions	396,458,000	570,597,106	585,234,100	295,953,752	1,451,784,958
Total Financing	967,804,425	1,154,872,049	1,291,866,537	977,439,615	3,424,178,201

Note: Fiscal Year of NWSC runs from 1 July to 30 June.
Source: NWSC Corporate Plan 2018-2021

Table 3.2.13 Project Investment Plan of NWSC (FY 2018/19-FY 2020/21)

No.	Key Capital Development Projects and Deliverables	Investment Scale	Schedule for Completion
1	Substantial Completion of Kampala Water – Lake Victoria WATSAN Project Water Network Modelling, Master Planning and Re–zoning (Package 2) Katosi–Kampala Transmission Mains (Package 4 – TL) Katosi Water Treatment Plant (Package 4 – DWTP) WATSAN Improvement in Urban Poor Settlements (Package 5) Accompanying Measures (Package 6)	USD 447 million	June 2021 June 2020 Dec 2020 June 2021 June 2021
2	Completion of Kampala Sanitation Programme Bugolobi Wastewater Treatment Plant Kampala Sewer Network Kinawataka Pre–treatment Plant	USD 179 million	Dec 2019 Dec 2019 June 2020
3	Implementation of Uganda Water Management and Development Project Gulu Water and Sanitation Project Bushenyi Water Supply Project Arua Water and Sanitation Project Gulu (Nile Option) – Construction works ongoing Mbale – Construction works ongoing Adjumani – Construction works ongoing	USD 135 million	June 2020 Dec 2019 Dec 2019 June 2021 June 2021 June 2021
4	Implementation of Integrated Project to Improve Living Conditions in Gulu (IPILC) Phase 1 – Substantial Completion Phase 2 (Nile Option) – Construction works ongoing	USD 53 million	June 2019 June 2021
5	Substantial Completion of South West Water and Sanitation Project Kagera Water Treatment Plant and Transmission Mbarara Water and Sanitation Improvement Masaka Water and Sanitation Improvement	USD 152 million	June 2021 June 2021 June 2021
6	Substantial Completion of Kampala South Water and Sanitation Project	USD 178 million	June 2021
7	Preparation of Bankable Project Proposals for Water and Sewerage Infrastructure in priority Towns: Fort Portal, Kasese, Lira, Kitgum, Bugiri, Moroto and Soroti	ND	Dec 2019
8	Secure Financing and Commencement of Albertine Graben North (Hoima and Masindi) WATSAN Projects	USD 42 million	June 2021
9	Substantial Completion of Other Ongoing Infrastructure Development Programmes Kapchorwa Water Supply Project Fort Portal Water Production Improvement Sembabule Water Supply Project Kyotera–Lyantonde Bulk Water Production and Transfer Project	USD 2 million USD 690,000 USD 2.5 million ND	Dec 2019 Dec 2019 June 2020 June 2021
10	Implementation of Compact Wastewater Treatment Plants for Kasese Town and Kitgum Town	USD 4.3 million	ND
11	Water and Sanitation Improvement in Namanve Industrial Park	ND	June 2021
12	Kapeeka Water Supply Expansion and Sewerage Project	USD 15.6 million	June 2021

Note: ND (No Data)
Source: NWSC Corporate Plan 2018-2021

4) NWSC Corporate Plan 2021-2024

Table 3.2.14 shows the Strategic Priority Areas (SPAs), strategic goals, and objectives for NWSC Corporate Plan 2021-2024. The Corporate Plan comprises five SPAs with the aim of further improving NWSC services.

Table 3.2.14 Strategic Priority Areas (SPAs), Strategic Goals and Objectives for NWSC Corporate Plan 2021-2024

Strategic Priority Area	Strategic Objectives and Goals
SPA 1: Industrialization	・Increase water and sewerage service coverage for industrial development and growth
SPA 2: Infrastructure Development	・Increase service coverage ・Ensure compliance with water and wastewater quality standards
SPA 3: Skilling and Workforce Development	・Have a highly competent, skilled, ethical and productive workforce ・Contribute to the capacity development of the water sector
SPA 4: Private Sector Involvement	・Strengthen private sector involvement
SPA 5: Organizational Health & Sustainability	・Increase revenue, operating surplus ・Improve liquidity, operational efficiency, water supply reliability, customer services, employee motivation and commitment ・Environmental and ecological sustainability ・Enhance corporate citizenship

Source: NWSC Corporate Plan 2021-2024

5) Business Plan (NWSC Corporate Plan 2021-2024)

The NWSC will use a mix of financing options to meet the financing requirements over the next five years from FY 2021/22 – FY 2025/26. All operational and maintenance costs, plus minor investments will be financed using internally generated funds, whereas the major capital investment will be financed using funds mobilized from the external sources. The external financing will be in the form of: a) concessionary loan financing, b) grants from development partners and government, and c) market finance, among others. Where it is financially viable, NWSC will opt for market finance and explore public private partnership (PPP).

Table 3.2.15 shows the NWSC cash flow requirements from FY 2021/22–FY 2025/26. The total financing requirements over the five-year period from FY 2021/22 is UGX 5.13 trillion, of which 54% (UGX 2.77 trillion) will be committed to capital investments and 46% (UGX 2.36 trillion) will go towards meeting the operational expenditure. The total budget of UGX 5.13 trillion is expected to be financed using internally generated resources projected at UGX 3.04 trillion (59%), donor finance amounting to UGX 1.9 trillion (35%) and UGX 0.45 trillion (8%) will be co-financing by GoU. The total net cash flow over the period amounts to UGX 248.8 billion and this will be committed towards implementing the additional capital budget arising from the Corporate Plan (2021-2024) implementation strategies and key deliverables.

Table 3.2.16 shows the financing plan by NWSC, Uganda, and donors from FY 2021/22-FY 2025/26. As mentioned earlier, project funding in NWSC is mainly internally generated funds, GoU, and donors

(WB, AfDB, AFD, KfW, etc.). 1) Capital projects (upgrading of water supply systems in rural areas) from FY 2021/22-FY 2025/26 will be financed from NWSC internally generated funds, 2) NWSC contribution to projects financed by GoU and donors (including 52% of Service Coverage Acceleration Project (SCAP 100)) will be financed from NWSC internally generated funds and the remaining 48% will be financed from GoU grants, 3) Major projects (e.g., WATSAN project) will be financed from donor grants, and 4) Minor capital expenditure (repair of burst pipe networks over a short distance and reservoirs) will be financed from NWSC internally generated funds.

Table 3.2.17 provides a summary of the project-based project investment plan. The total project expenditure is about UGX 3 trillion.

Table 3.2.15 NWSC Cash Flow Requirements (FY 2021/22–FY 2025/26)

(UGX '000,000)

Cash Flow Item	2020/21 (Baseline)	2021/22	2022/23	2023/24	2024/25	2025/26	Total (5 Years)
Sources of Financing (Inflows)							
Collections (Water and Sewerage)	445,810	523,439	564,591	602,494	642,486	684,674	3,017,684
Collections from Other Income	4,915	4,915	5,137	5,369	5,632	5,907	26,960
Sub-total (Internal Sources)	450,725	528,354	569,728	607,863	648,118	690,582	3,044,644
External Sources							
GoU Releases	85,949	89,213	89,213	89,213	89,213	89,213	446,064
Donor Releases	436,782	322,822	582,066	450,279	346,568	187,500	1,889,235
Sub-total (External Sources)	522,731	412,035	671,279	539,492	435,781	276,713	2,335,299
Total Inflows	973,455	940,389	1,241,006	1,147,355	1,083,898	967,295	5,379,943
Total Financing Requirements (Outflows)							
Operating Expenditure	353,889	416,448	444,741	471,556	499,612	532,419	2,364,777
Capital Expenditure							
Capital Projects Fully Financed by the NWSC	4,163	20,320	19,100	17,580	18,000	8,250	83,250
NWSC Contribution to Projects Financed by GoU and Donor	58,094	63,100	62,948	56,000	58,672	55,000	295,720
Government of Uganda Funding to Major Projects	85,949	89,213	89,213	89,213	89,213	89,213	446,064
Donor Contribution to Major Projects	436,782	322,822	582,066	450,279	346,568	187,500	1,889,235
Minor Capital Expenditure Implemented by NWSC	32,957	30,000	40,000	60,000	70,000	90,000	290,000
Total Capital Expenditure	617,944	525,455	793,327	673,072	582,453	429,963	3,004,269
Total Outflows	971,833	941,903	1,238,068	1,144,628	1,082,065	962,382	5,369,046
Net Cash Flows	1,622	-1,514	2,938	2,727	1,833	4,913	10,899
Brought Forward (B/F)	507	2,129	615	3,554	6,281	8,114	13,027
Carry Froward (C/F)	2,129	615	3,554	6,281	8,114	13,027	23,926

Source: NWSC Corporate Plan 2021-2024

Table 3.2.16 Financing Plan by NWSC, Uganda, and Donors (FY 2021/22-FY 2025/26)

Source of Funds	Projects	Total Amount (FY 2021/22-FY2025/26)	Financing Form	Remarks
NWSC	Capital Projects	UGX 8.33 billion	Internally Generated Fund	
NWSC	NWSC Contribution to Projects Financed by GoU and Donor (Including 52% of SCAP100)	UGX 295.7 billion	Internally Generated Fund	Projects under implementation
GoU	Major Projects (Including 48% of SCAP 100)	UGX 446.1 billion	Grant	Projects under implementation
WB, AfDB, AFD, KfW	Major Projects	UGX 1,889.2 billion	Loan Grant	The WB, AFD, and AfDB funds are repaid by the central government for projects under implementation. Funds from KfW are grant.
NWSC	Minor Capital Expenditure	UGX 290 billion	Internally Generated Fund	

Source: Compiled by JST based on NWSC Corporate Plan 2021-2024

Table 3.2.17 Project Investment Plan of NWSC (FY 2021/22-FY 2025/26)

(UGX '000,000)

No.	Project	2021/22	2022/23	2023/24	2024/25	2025/26	Total (FY 2021/22– FY 2025/26)
1	Kampala Sanitation Project	51,800	-	-	-	-	51,800
2	Kampala Water Lake Victoria WATSAN Project:						
2.1	Package 2B: Network Restructuring & Rehabilitation	6,202	146,206	103,196	31,013	57,041	343,658
2.2	Package 5B: Improvement of Water Supply and Sanitation Services in Informal Settlements:	41,932	86,242	22,135	-	-	150,309
2.3	Accompanying Measures (Capacity Building)	11,211	11,211	4,484	1,793	1,345	30,044
2.4	Package 4B TM	29,085	-	-	-	-	29,085
2.5	Package 4B DWTP	39,337	-	-	-	-	39,337
3	Integrated Water Management and Development Project & Improved Project for Improved Living Conditions:						
3.1	IWMSDP- Mbale	31,240	53,351	53,351	11,855	-	149,797
3.2	IWMDP- Gulu	78,365	100,755	44,780	-	-	223,900
3.3	IWMDP-Adjumani	3,010	18,310	37,256	6,174	-	64,750
3.4	Source Protection Measures for Mbale, Gulu Adjumani and Arua	2,169	9,764	8,679	1,084	-	21,696
4	South Western Cluster - Development of Water and Sanitation Infrastructure for the Mbarara – Masaka Areas						

No.	Project	2021/22	2022/23	2023/24	2024/25	2025/26	Total (FY 2021/22– FY 2025/26)
4.1	Package 1: Kagera Water Treatment Plant	59,702	75,110	82,771	4,697	-	222,280
4.2	Package 2: Mbarara	25,615	41,737	47,344	6,060	-	120,756
4.3	Package 3: Masaka	5,505	43,671	59,926	50,675	3,900	163,677
5	Wakiso West WATSAN Project	-	30,350	151,750	242,800	121,100	546,000
6	Expansion and Development of Sewage Treatment System in Ggaba and Mukono Sub-catchments in the Kampala Metropolitan Area (LVPIII)	880	-	-	-	-	880
7	Sembabule Water Supply Project	6,000	8,100	-	-	-	14,100
8	Bushenyi Water Supply Augmentation Project	9,600	2,400	-	-	-	12,000
9	Hoima Water Production Improvement Project	4,720	300	880	-	-	5,900
10	Compact Wastewater Treatment Plants (Kitgum, Kasese and Masaka)	-	1,300	4,700	7,000	2,050	15,050
11	Water Supply Stabilization Projects for Moyo, Kotido and Kabong, Parombo and Lira	-	3,400	6,600	10,000	5,200	25,200
12	Kisoro Nkanka Water Supply Project	-	3,600	5,400	1,000	1,000	11,000
13	Kasese Water Supply Improvement Project	-	7,110	23,586	3,410	-	34,106
14	Albertine Graben Area (Hoima, Masindi, Fort Portal)	-	2,600	59,000	50,400	36,000	148,000
15	Construction of Vocational Skills Development Facility in Lira Kachungu and Mbarara –Bushenyi	3,000	4,000	3,000	2,000	2,000	14,000
16	100% Service Coverage Acceleration Project (SCAP 100)	102,000	102,000	102,000	102,000	102,000	510,000
17	Jinja/Njeru Water Supply and Sanitation Project (EUR 35 Million)	-	1,056	4,224	2,640	26,400	34,320
18	Sanitation Investment Plan	5,000	5,000	5,000	5,000	5,000	25,000
19	Other Capital Expenditure	-	-	-	-	-	0
	Total (Project Expenditure)	516,373	757,573	830,062	539,601	363,036	3,006,645

Source: NWSC Corporate Plan 2021-2024

3.2.3 Capabilities of Operation and Maintenance (O&M)

(1) Capacity Development Plan and Implementation Status of NWSC

The NWSC is working to improve its own O&M capacity under the Five-Year Capacity Development Plan (2016-2021) (CD Plan), of which 2021 is the final year. The German International Cooperation

(GIZ) and Danish International Development Agency (DANIDA) have prepared the guidelines for the CD Plan and funded MoWE. The Strategic Priority Plan of the CD Plan consists of the following four items:

SPA1: Smart System, Business Continuity, and Infrastructure Growth

(Asset management system, NRW reduction, increase production of water treatment plant, increase water service coverage, risk management, and sewerage services enhancement.)

SPA2: Financial Growth and Sustainability

(Improving the competitiveness of bidding, etc., improving the ability to raise funds including PPP for major projects, streamlining expenditures, etc.)

SPA3: Customer and Stakeholder Delight

(Environment protection, corporate social responsibility (CSR), customer satisfaction (accountability), staff satisfaction, etc.)

SPA4: Productivity and Capacity Development

(Skills development, research and development (R&D), business re-engineering, staff productivity.)

As far as the maintenance status of the facilities is concerned, the CD Plan, especially the technical plans such as SPA4, has contributed to a certain extent to improve the maintenance capacity of the technical staff.

(2) Training Status in Uganda

Initially, NWSC trained its staff in existing vocational training schools in Uganda, but the existing training schools could not duly address the technical training needs of NWSC. As a result, a fully pledged Vocational Skills Development Facility (VSDF) was constructed at the Ggaba WTP with the support of GIZ and in collaboration with the Directorate of Industrial Training - Ministry of Education and Sport (DIT - MoES).

The NWSC provides training for technicians and technician staff in ‘Vocational Skills and Development” to ensure that value-added trainings are conducted with the view of imparting relevant knowledge and skills aimed at enhancing staff productivity. Since the beginning of FY 2019/20, NWSC conducted 45 refresher courses in management related topics, while six vocational practical courses were done to equip the technicians and artisans with technical skills to perform their jobs in the field.

Ggaba VSDF school has the following nine training courses:

(i) Industrial Plumber

(ii) Electro-Mechanical Technicians (EMT)

(iii) Industrial Welders

(iv) Water Quality Technicians

(iv) Sewerage Services Technicians, Photo Voltaic and Solar Energy Technicians

(vi) Customer Service Advisors

(vii) Vocational Training Instructors

(viii) Heavy Equipment Operators

(ix) Workers' PAS (Practically Acquired Skills) certification for informally skilled technicians (※PAS certification is a certificate that certifies an individual's skills and abilities for a specific occupation.)

During FY 2019/20, NWSC carried out successful graduation and accreditation of 203 Technicians under the Workers PAS Qualification Framework, 18 Industrial Plumbers, and 102 Customer Care Advisors, who were awarded certificates of merit by the DIT-MoES. Also, 38 Electro-Mechanical Technicians (EMTs) are being prepared for DIT assessment under Level IV Uganda Vocational Qualifications Framework (UVQF).

Source: NWSC Integrated Annual Report 2018/19

Photo 3.2.1 NWSC Staff Receiving Practical Engineering Technology Training (Ggaba VSDF)

The NWSC also supports staff to complete master's degrees. Six staff completed their master's degrees at Loughborough University during FY 2019/20 and eight other staff are still pursuing the same course.

The NWSC signed a partnership agreement with IHE (Delft Institute for Water Education) Netherlands, where up to ten staff will be supported to acquire master's degree in sanitation through co-funding by NWSC and the Bill & Melinda Gates Foundation. The course will commence in October 2020. NWSC also signed another agreement with EAWAG (Swiss Federal Institute of Aquatic Science and Technology), with funding from the United States Agency for International Development (USAID) and Bill & Melinda Gates Foundation to run joint courses at the NWSC International Training Center (IREC). Under the annual training plans, NWSC Area Managers, Branch Managers, and General Managers were successfully trained in people management, as a way of improving staff productivity. A total of 180 new staff who joined NWSC during FY 2019 – 2020 were duly inducted before commencing work. All staff continue to be sensitized on customer handling practices through customer care trainings to improve the way they handle customers. Photo 3.2.1 shows practical engineering technology training undergone by NWSC staff at Ggaba VSDF.

However, the onset of COVID-19 greatly affected the implementation of the NWSC training plans. NWSC used Zoom and a total of five online trainings were conducted with 87 staff participating.

Also, the number of cities where NWSC maintained the water supply facilities was only 27 in 2013 but has increased to 258 in 2020. Therefore, efficient training of technicians has become a challenge, and NWSC is planning to build regional training centers in the Western Region and Northern Region with its own funds. NWSC has already purchased a training center (including vocational training) facility in Bushenyi City, Western Region. The training center for the Northern Region will be located in Lira, where a vocational training center with a capacity of 50 people will be established especially for training of refugees and South Sudanese. The Ggaba Vocational Training Center will cover the Central Region and Kampala Metropolitan Areas. Thus, NWSC will continue to make necessary investments to maintain and improve the level of water services in Kampala and rural areas.

According to the interviews with NWSC staff, future challenges for improving staff technical capacity include repetitive education to increase staff production capacity, prototyping of training, expansion of training courses, expansion of educational materials and equipment, and training of teachers through Transfer of Technology (TOT).

(3) Overseas Activities

The NWSC established the External Services (ES) Unit in January 2005 with the aim of providing solutions in professional and innovative manner. ES provides consultancy services to overseas clients. The partners include the World Bank (WB), African Development Bank (AfDB), GIZ, USAID, United Kingdom (UK), and the Tanzanian government, and the clients include water utilities/companies in African countries such as Kenya, Zimbabwe, Nigeria, and Tanzania, as well as the Chittagong Water Supply and Sewerage Authority (CWASA) in Bangladesh.

Source: NWSC, Vocational Skills Development Facility

Photo 3.2.2 Practical Engineering Technology Training (Chittagong, Bangladesh)

The ES Unit has implemented 79 projects from 2005 to date and the projects currently under implementation are listed in Table 3.2.18 (See Appendix-2 for all ES Unit projects). For example, as shown in Photo 3.2.2, the ES Unit is the leading partner for the Chittagong Water Supply Improvement Project in association with Dev Consultants Limited (DevCON) Bangladesh and United Nations Educational, Scientific and Cultural Organization (UNESCO)-IHE Netherlands. The project aims at assisting in developing the capacity of CWASA in the O&M of water utility services, providing support in modernization of its operating structure, system, and processes. In Nigeria, the Bauchi State Water and Sewerage Corporation (BSWSC), through the Water Operators Partnership (WOP), has commissioned the ES Unit to provide technical guidance and implement a Performance Improvement Plan (PIP) to improve its operational capacity.

Based on the track record of ES, the expertise and technical capacity of NWSC seem to have reached a level where it can be responsible for basic training for water service providers in other developing countries.

Table 3.2.18 Projects Currently Implemented by External Services (As of February 2021)

	Period	Project	Client	Country	Financier	Partners	Consulting Values	MM
1	Dec 2019 – Mar 2021	Services for the Development of Customer Relations, Management Software and its Integration to GIS and BIQ Systems for the City of Bulawayo	Bulawayo	Zimbabwe	City of Bulawayo	N/A	USD 156,460	8
2	Oct 2019 - Jun 2021	Implementation of WOP for BSWSC	BSWSC	Nigeria	WB	N/A	USD 324,700	33.5
3	Jan 2018 - Dec 2021	Utility Support to Capacity Development for Sustainable Water Services within Uganda (CaDeSWaS) - Value Addition Project	VEI	Uganda	Royal Netherlands	VEI	EUR 3.9 million	>100
4	Jan 2015 - Jun 2021	Alternative Approaches and Tools for Improved Water Supply and Sanitation for Towns in Northern Uganda (ATWATSAN) - Value Addition Project	NWSC	Uganda	FDW, The Netherlands	IHE, VEI, Kagga & Partners, D&S, Plan international, MoWE	EUR 4.5million	>100

Source: NWSC

(4) Capacity for Countermeasures Against NRW

As mentioned above, NWSC has expertise in implementing daily water supply services such as operation of water treatment plant and pipe works, etc., but the technical level of leakage control is still not sufficient, as shown by the high NRW rate (mainly leakage rate) in Kampala City. Leaks are mostly detected by visual confirmation of surface leaks, and although NWSC has equipment to detect underground leaks (such as listening sticks and leak detectors) and technical skills to detect underground leaks, the number of staff who can utilize the equipment is limited. Meanwhile, almost 100% installation rate of water meters shows that the awareness of apparent loss prevention is at a high level, and it can be said that the business operation capacity is high compared with other water utilities in Africa.

Also, maintenance and testing of household water meters are being carried out as a measure against apparent loss in Kampala. However, according to NWSC, there is no department dedicated to NRW reduction, and staff members work concurrently with other duties, with full-time staff limited to only three plumbers.

The GIS unit is divided into a unit that specializes in Kampala water supply and another unit that is in charge of other water supply branches. The unit in charge of Kampala has a block map of the water supply ledger system, which is the basis for leakage management and construction management, from water transmission and distribution to the level of individual households pipes, but does not have sufficient information on aging pipes (diameter, material, etc.). In other water supply branches, for example, in Hoima, Mubende, Mityana, Tororo, and Soroti where field surveys were conducted, updated information on transmission and distribution pipes could not be obtained from the GIS unit. Since asset management is essential for managing NRW, these systems also need to be improved.

3.2.4 Outline of Water Supply Services in NWSC Service Area

The NWSC is responsible for providing water supply and sanitation services in 258 cities (FY 2019/20), including Kampala City. The Corporation operates in four regions across Uganda: Kampala Metropolitan Area, Central Region, Eastern & Northern Region, and Western & South West Region.

Table 3.2.19 shows the key performance indicators for water supply services in NWSC service areas for the past five years from FY 2015/26-FY 2019/20. NWSC has expanded the number of water supply areas covered from 170 in FY 2015/16 to 258 in FY 2019/20, increasing water production from 106 million m^3 to 140 million m^3, water supplied from 102.7 million m^3 to 132 million m^3, and water sales from 73.9 million m^3 to 87 million m^3, an increase of 132%, 129%, and 118%, respectively. However, water service coverage is low in some cities, partly due to inadequate water distribution networks. Also, the NRW rate of the entire NWSC is as high as 34% (39.5% in Kampala Metropolitan Area) in FY 2019/20. Therefore, infrastructure development, such as the construction of water treatment plant and reconstruction of water distribution block systems, is being implemented with donors' support. Low-income residents are forced to live in unsanitary conditions in areas with inadequate water supply facilities, making it challenging to prevent infectious diseases.

Table 3.2.20 shows the key performance indicators for water supply services in NWSC service areas for the next five years from FY 2021/22-FY 2025/26. Using FY2020/21 as the baseline, NWSC is planning to expand the number of water supply areas to 283 by FY 2025/26, with water production of 213.7 million m^3, water supplied of 202.7 million m^3, and water sales of 135.7 million m^3.

Water and sewerage collection efficiency was very good at 100% in FY 2018/19. In FY 2019/20, the collection efficiency dropped to 92%, largely due to COVID-19. The arrears for FY 2020/21 are UGX 99.3 billion, mostly from ministries and government agencies. Therefore, smart meters are being introduced as a countermeasure against arrears for the ministries and government agencies, and as for the private sector, a Customer Re-connect Program and Revenue Recovery Acceleration Program (RRACE) is being proposed and implemented to reduce arrears based on each sector's circumstances. The collections include the collection of arrears.

Water quality control at NWSC is currently carried out in 70 water quality laboratories. Water quality test laboratories are classified into four classes according to the parameters to be tested. The details of the water quality tests at each class are shown below. However, many laboratories have reported that the measuring instruments are aging, and calibration of measuring instruments is also an issue.

· Class A Lab: Analyzation of drinking water/wastewater and more advanced tests like heavy metals, pesticides, total organic carbon (TOC) etc.

· Class B Lab: Analyzation of full parameters of drinking water/wastewater (Ggaba, Katosi, Lubigi, and all the regional labs (Gulu, Mbale, Mbarara)

· Class C Lab: Analyzation of full parameters of drinking water and some parameters of wastewater (Areas with wastewater treatment plants)

· Class D Lab: Areas with ground water sources and only do basic tests like turbidity, residual chorine and pH). Test kits are mainly used.

Table 3.2.19 Key Performance Indicators for Water Supply Services in NWSC Service Areas (Past Five Years)

Key Performance Indicator	2015/16	2016/17	2017/18	2018/19	2019/20
Water Services					
Number of Towns (Nos.)	170	218	236	253	258
Water Service Coverage (%)	78	78.2	83.7	83.7	84
Water Production (Million m^3)	106	120.7	126.2	134.9	140
Water Supply (Million m^3)	102.7	116.2	120.1	127.8	132
Water Sales (Million m^3)	73.9	80.2	82.9	90.5	87
Non-revenue Water (NRW, %)	28	30.9	31	29	34
New Water Connections (Nos.)	38,836	40,712	50,341	69,215	61,521
Connections Taken Over in New Towns	15,419	11,752	12,865	2,079	3,328
Total Water Connections (Nos.)	472,193	529,709	582,863	659,157	724,006
New Public Stand Pipes (Nos.)	1,129	1,164	3,342	3,550	4,429
Total Public Stand Pipes (Nos.)	10,841	10,424	12,305	17,186	21,600
New Water Mains Extensions (km)	888	911	2,021	2,727	2,135
Extensions Taken Over in New Towns (km)	547	1,221	700	430	216
Total Water Pipe Network (km)	9,960	12,113	14,466	17,556	19,974
Financial Performance					
Turnover (Billion) - (UGX) (Net VAT)	276.06	320.96	388	442	463
Billing (Billion) – (UGX) -VAT Inc.	292.3	346.81	390.2	437.4	424
Collections (Billion) - (UGX) – VAT Inc.	284.1	322.72	384.7	437	391
Collection Efficiency (%)	97	93	99	100%	92
Debt Age (Months)	2.6	3	2.9	2.3	3.6
EBITDA (Billion) - (UGX)	34	38	92	96	103
Staff Number (Nos.)	2,860	3,131	3,443	3,778	4,082
Staff Productivity (Nos.)	6	6	6	6	6

Source: NWSC Integrated Annual Report 2019/20

Table 3.2.20 Key Performance Indicators for Water Supply Services in NWSC Service Areas (Next Five Years)

Key Performance Indicator	Baseline (*P) 2020/2021	2021/22	2022/23	2023/24	2024/25	2025/26
Water Services						
Water Production (Million m^3)	141.6	181.5	186.1	190.8	210.3	213.7
Practical Capacity (Million m^3)	169.8	299.9	302.9	319.2	348.9	394.4
Water Supplied (Million m^3)	136.7	172.3	176.6	181.1	199.6	202.7
Water Sales (Million m^3)	87.4	108.9	113	117.1	131.4	135.7
NRW (%)	36	36.8	36.1	35.3	34.1	33
NRW per km of Pipe Network Length (m^3/km)	1,321	1,621	1,543	1,460	1,457	1,339
NRW per Connection (m^3/No.)	28	34	31	29	29	27
Number of Towns (Nos.)	258	263	268	273	278	283
Water Service Coverage (%)	75	78	81	84	84	86
New Water Connections (No.)	61,372	62,599	63,851	65,128	66,431	67,760
Total Connections (No.)	785,378	848,477	912,829	978,457	1,045,388	1,113,648
Active Accounts (No.)	688,328	752,819	819,110	886,726	955,695	1,026,043
New PSPs/Kiosks (No.)	3,998	3,600	3,600	4,000	4,400	3,500
Total PSPs/Kiosks (No.)	25,598	29,198	32,798	36,798	41,198	44,698
New Water Mains Extensions (Km)	539	1,000	1,200	1,400	1,600	1,800
Total Water Mains Length (km)	20,513	21,513	22,713	24,113	25,713	27,513
Customer Satisfaction Index (%)	70	70	70	70	70	70
Water Quality	98	98	98	98	98	98
FINANCIAL						
Annual Turnover. UGX Billion	456.6	533.9	570.2	608.5	648.8	691.5
Expenditure	353	411.1	437.3	464.9	493.8	524.1
Net Profit After Depr. UGX Billion (Before interest)	23.1	38.2	44.1	54.8	61.8	74.1
Billings (UGX Billion) (VAT Incl.)	418.9	523.4	559	596.5	636.1	677.9
Collections (UGX Billion)	445.8	523.4	564.6	602.5	642.5	684.7
Arrears. UGX Billion	99.3	99.3	93.7	87.7	81.4	74.6

P*: Projected Performance
Implementation of NWSC Corporate Plan (2021-2024) is based on assumptions such as 1) Funding from government and development partners is secured in time to finance the planned capital projects, 2) Procurement of capital projects will proceed uninterrupted, 3) Stable macro–economic environment, and 4) No major changes in the institutional arrangement and governance
Source: NWSC Corporate Plan 2021-2024

【Reference】Status of Prepaid Water Meter (PPWM) Usage

The NWSC has been implementing tariff collection through PPWM in Kampala, urban, and rural areas.

In the "Feasibility Study on the Limits and Possibilities of PPWM in Urban Africa (World Bank, 2014)", the WB conducted a field survey from July 2013 to April 2014 by interviewing service providers, governments, and NGOs to determine the effectiveness of PPWM in providing water supply to the urban pro-poor communities in eight cities in Sub-Saharan Africa, including Kampala City.

According to the survey report, PPWM of PSP was first introduced in Kampala in 2006 to improve the water tariff collection in the pro-poor communities. In 2014, 1,600 PPWMs of PSP were providing water to 200,000 residents, with plans to add another 3,000 by 2017.

As for the PPWM, the consultant of "The Project for Strengthening the Capacity of Water Service Management in Jenin Municipality, Palestine" (JICA GIPRO, 2017.9-2021.9) sent questionnaires to the cities and water entities mentioned in the above WB survey report, and were used as reference for the introduction of PPWM in the JICA project in Jenin City. The main points of NWSC's response to the questionnaire are as follows:

- The purpose of installing PPWM of PSP is not only to supply water to the pro-poor communities as mentioned above, but also to prevent excessive water tariff collection by the tariff collectors in each district and to reduce the need for meter reading by NWSC staff.
- The number of PPWM of PSP in Kampala has not increased much since 2014, contrary to the plan, and currently stands at about 1,500 (6,000 PSPs in total). The number of target residents is about 150,000 compared with 300,000 for all PSP users.
- The installation of PPWM of PSP is financed by NWSC, donors, government grants, and partners.
- The cost per unit of the PPWM of PSP is approximately USD 1,000 for the unit and USD 100 for installation. Each unit is expected to be replaced after ten years of use. (The units installed in 2006 are generally still in use.)
- The battery life is generally two years, and in some recent cases, solar panels have been added to replace the batteries.
- There are 15-20 places in Kampala where you can charge your prepaid card.
- Average water consumption at each PPWM of PSP is 40 m^3/month.
- The introduction of PPWM of PSP has clearly increased NWSC's revenue. On the other hand, cost for meter reading and customer service, etc., has decreased.
- The equipment is imported and not yet produced domestically. The problem is that the price is not stable depending on the exchange rate and it takes a long time to update the software.
- Both customer satisfaction and NWSC satisfaction are high and would like to continue to promote this program. Also, NWSC would like to recommend it to other organizations.

3.2.5 NWSC SCOR Analysis

Table 3.2.21 shows the NWSC Strengths, Challenges, Opportunities and Risks (SCOR) analysis. The SCOR analysis consists of an evaluation of the NWSC's strengths, challenges, opportunities and risks and incorporates political, economic, social, technological, environmental, and legal factors as an integral part of the analysis.

Table 3.2.21 NWSC SCOR Analysis

Strengths	Challenges	Opportunities	Risks
・Competent and committed workforce ・Good industrial relations ・Existence of a customer-oriented culture ・Adaptive and supportive leadership ・Existence of well-documented policies and procedures manuals ・Cross subsidy tariff mechanisms in place ・Strong Corporate brand and visibility ・Existence of operational and financial data spanning many years ・Dedicated Programs for NRW reduction ・Existence of ICT infrastructure and systems ・NWSC budget commitment to finance and implement some capital projects using internal resources ・Ability to develop in house IT systems and applications ・Capacity to finance Operation, Maintenance, and Depreciation Costs ・Resilience in operations and service delivery ・Wide geographical presence ・Existing Vocational Skills Facilities and other capacity building programs	・Inadequate water and sanitation coverage in some areas ・Inadequate infrastructure resulting in limited supply reliability in some Areas ・Inadequate financing for infrastructure upgrade and expansion ・Delay in delivery of materials which affects service delivery and performance especially in responding to queries ・Poor quality meters and frequent stock-outs ・Inadequate awareness and (or) marketing of sewerage services to customers ・Implementation of a tariff that is not full–cost recovery ・Non-break-even of most of the areas/towns ・Increasing Arrears ・Inadequate stakeholder mapping and engagement ・Limited outreach and impact of Corporate Citizenship initiatives ・Inadequate Asset Management practices ・Inadequate integration of the management information system ・Inadequate Capacity to test (equipment / facility) and inspect the water meters ・Inadequate HR system for deployment and supervision of staff ・Inadequate coverage of GIS and mapping ・Inadequate metering for consumers and system input ・Slow response to leakages and bursts ・Inadequate optimization of water treatment chemicals ・Inadequate facilities for water quality monitoring ・Inadequate succession planning and career development ・Inadequate alignment of the organization structure to business trends	・GoU support to NWSC ・Support from the Development Partners ・Enabling legislation and policy framework ・Public and customer good will ・Utility Court to address water concerns ・Availability of advanced/superior technology options in the market ・Availability of raw water sources ・Potential for partnerships and collaborations ・Unmet demand for water and sewerage services ・Business potential for income diversification (ES expansion) ・Availability of various investment financing options e.g. capital markets ・Availability of various stakeholder and customer engagement platforms ・Political stability ・Availability of potential providers for key service delivery inputs ・Monopoly service delivery in ours areas of operation	・Deteriorating raw water sources due to environmental degradation ・Power outages in some major water production plants ・Pollution and contamination in the distribution networks ・Inadequate and delayed GoU bills payments and counterpart projects funding ・Time and cost overruns of capital projects ・Delays and failures in land and wayleaves acquisition for projects ・Connectivity downtimes and failure of key IT servers ・Data / database insecurity ・Illegal water use and network vandalism ・Increasing stakeholder expectations and demands e.g. coverage, Corporate Citizenship, etc. ・Negative impact of COVID19 on NWSC business ・Negative and false information, publicity and propaganda ・High cost, poor quality and unreliable supply of key operational inputs e.g. water meters, bulk chemicals, fittings etc. ・Uncoordinated infrastructure development across different sectors ・Inadequate physical planning ・Unstable macro–economic environment ・Limited capacity of contractors to do quality work ・Continuous technological advancements can render our technologies in use obsolete ・Flooding at some of the Water Intake Plants ・Inflated cost of land for the projects

Source: NWSC Corporate Plan 2021-2024

3.3 Selection of Ten Target Areas and Water Supply Service in Target Area

(1) Selection of Ten Target Areas

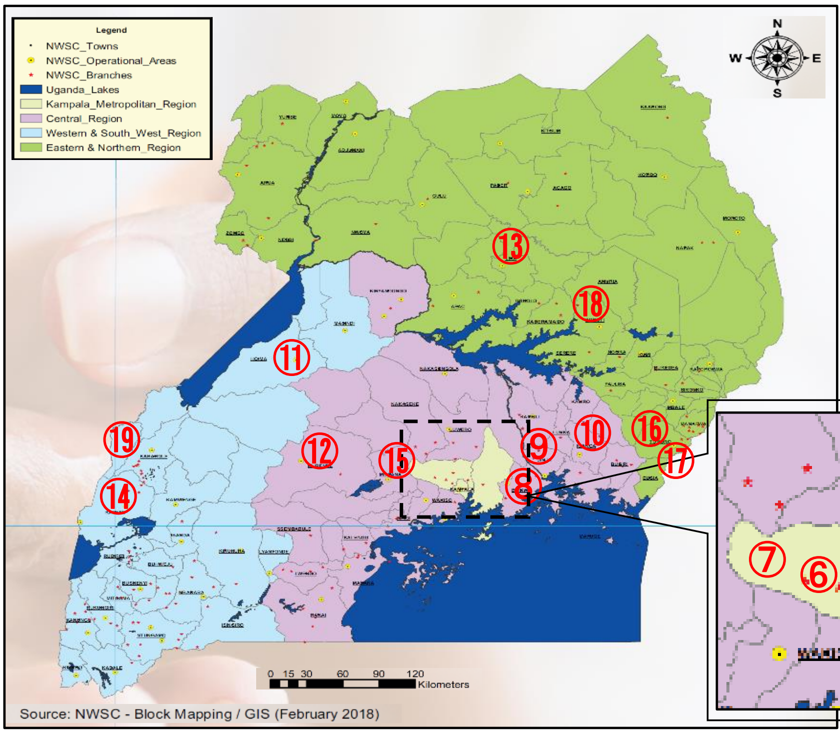
The selection of ten target areas was initially based on the population of Kampala City and municipalities. However, cities with large populations but low priority for NWSC, especially: 1) undergoing projects or projects completed in recent years, 2) municipality but a small town in reality, 3) good condition of current water supply facilities, and 4) low water demand, etc. are excluded at the request of NWSC. Kampala City is included in the target areas even though expansion project is ongoing because it is the most important city for NWSC. Target area is selected from city or municipality which is administratively categorized in Uganda. However, if two or more cities are supplied by the same water supply system, they are considered as one target area. After discussion with NWSC, ten target areas were selected out of the 45 cities as shown in Table 3.3.1.

Table 3.3.1 Selection of Ten Target Areas

No.	Target Area	Municipalities	Region	Population Year 2020	Reason for Excluding/Remarks
1	1	KAMPALA CITY	Central	1,680,600	Total Population: 3,426,000 Supplied by same water supply system.
2		MUKONO	Central	191,300	
3		NANSANA	Central	532,800	
4		KIRA	Central	462,900	
5		MAKINDYESSABAGADO	Central	413,400	
6		Wakiso TC	Central	87,900	
7		Kakiri	Central	57,100	
8	2	NJERU	Central	178,800	Total Population: 327,700 Supplied by same water supply system.
9		JINJA	Central	83,400	
10		IGANGA	Central	65,500	
11		MBARARA	Western	221,300	Ongoing AFD project.
12		GULU	Northern	177,400	Ongoing WB project.
13		LUGAZI	Central	128,400	Water distribution from new Katosi WTP is currently in plan.
14	3	HOIMA	Western	122,700	
15	4	MUBENDE	Central	121,600	
16		MASAKA	Central	116,600	Ongoing AFD project.
17	5	LIRA	Northern	116,500	Requires a 5 hours journey from Kampala.
18		IBANDA	Western	116,300	Rural area. Excluded by NWSC
19	6	KASESE	Western	115,400	Requires a 5 hours journey from Kampala.
20		MBALE	Eastern	111,300	Ongoing WB project.
21		MASINDI	Western	110,500	Good water supply system.
22	7	MITYANA	Central	105,200	
23		ENTEBBE	Central	102,600	Ongoing DANIDA project is ongoing.
24		SHEEMA	Western	86,100	Water is supplied from Busia water supply system.
25		KOTIDO	Northern	75,700	Rural area. Small town.
26		ARUA	Northern	72,400	WB project is completed.
27	8	TORORO	Eastern	48,500	Total Population: 69,300. Supplied by same water supply system. Requires a 5 hours journey from Kampala.
28		MALABA	Eastern	20,800	
29		KAMULI	Eastern	67,800	Rural area. Small town.
30		APAC	Northern	67,700	Rural area. Small town.
31		BUSIA	Eastern	64,900	Ongoing WB project.
32		KOBOKO	Northern	64,500	WB new project is expected. Requires a 5 hours journey from Kampala.
33	9	SOROTI	Eastern	60,900	Requires a 5 hours journey from Kampala.
34	10	FORT PORTAL	Western	60,800	Rehabilitation of WTP through NWSC fund. Distribution mains need to be extended. Requires a 5 hours journey from Kampala.
35		KABALE	Western	53,200	Excluded due to small population. Low watar demand. Requires a 5 hours journey from Kampala.
36		KAPCHORWA	Eastern	51,200	Excluded due to small population. Requires a 5 hours journey from Kampala.
37		KITGUM	Northern	49,000	Excluded due to small population. Requires a 5 hours journey from Kampala.
38		BUSHENYI	Western	43,700	Excluded due to small population. Requires a 5 hours journey from Kampala.
39		KUMI	Eastern	43,500	Excluded due to small population.
40		NEBBI	Northern	41,400	Excluded due to small population. Requires a 5 hours journey from Kampala.
41		RUKUNGIRI	Western	37,200	Excluded due to small population. Requires a 5 hours journey from Kampala.
42		BUGIRI	Eastern	36,000	Excluded due to small population.
43		NTUNGAMO	Western	20,900	Excluded due to small population. Requires a 5 hours journey from Kampala.
44		KISORO	Western	17,700	Excluded due to small population. Requires a 5 hours journey from Kampala.
45		MOROTO	Northern	16,300	Excluded due to small population. Requires a 5 hours journey from Kampala.

Note: Three sub-counties (Wakiso TC, Kakiri, and Malaba) are added into the 45 target cities because they are served by the same water supply system. The municipalities are based on UBOS 2018. The population for the areas served by NWSC for year 2020 is based on Uganda Bureau of Statistic (UBOS) projections.
Source: Compiled by JST based on the results of discussion with NWSC.

The names and locations of the ten target areas are shown in Figure 3.1.1.



No.	Target Area	Municipalities
1	1	KAMPALA CITY
2		MUKONO
3		NANSANA
4		KIRA
5		MAKINDYESSABAGADO
6		WAKISO TC
7		KAKIRI
8	2	NJERU
9		JINJA
10		IGANGA
11	3	HOIMA
12	4	MUBENDE
13	5	LIRA
14	6	KASESE
15	7	MITYANA
16	8	TORORO
17		MALABA
18	9	SOROTI
19	10	FORT PORTAL

Source: Compiled by JST based on the results of discussion with NWSC.

Figure 3.3.1 Names and Location of the Ten Target Areas

(2) Current Status of Water Supply Services in the Ten Target Areas

Table 3.3.2 shows the current status of water supply services in the ten target areas (Kampala Water and Branch Offices). The current status of water supply service is the overall figure for the branch offices in each of the ten target areas. However, the targeted population to be served and water supply population, which are the basis for the calculation of water service coverage, are figures calculated independently by NWSC. Of the ten target areas, Hoima, Mubende, Mityana, and Soroti were transferred from MoWE or local governments to NWSC at a relatively recent date, and parts of the distribution mains and other water supply facilities were rehabilitated before the transfer.

1) Capacity Utilization

The capacity utilization varies from 35% to 97% in the ten target areas. The current status of water supply service is the overall figure for the branch in each of the ten target areas. Although Kampala Water has increased its capacity following the rehabilitations of its facilities, the capacity utilization has always been at the upper end of the range, indicating that water demand has far exceeded water production. On the other hand, areas with low utilization rates do not necessarily have a surplus of water production, and some facilities are unable to reach their full capacity due to depletion of water sources, aging or breakdown of facilities, etc. As far as the state of O&M of facilities is concerned, it seems to be due to the inability to make necessary investments in facilities due to lack of sufficient budget rather than problems with O&M capacity.

2) Water Supply Hours

Most NWSC areas experience intermittent water supply with supply hours ranging from 8 to 24 hours. Kampala Water also supplies water based on planned water rationing schedule throughout its water supply network distribution; however, rationing of Kampala Water scheme was reduced in some part of Kampala Water networks due to newly commissioned Katosi WTP. For other water supply area, rationing may occur during peak demand periods due to low water pressure. Also, planned water shutoffs may also occur during repair of pipes.

3) Non-Revenue Water (NRW)

The NRW rate varies from 11% to 40% in each region. The main causes are water theft, defective meters, meter insensitivity, high pressure in pipes, aging pipes, and inappropriate plumbing work, etc. However, there are no active NRW countermeasures, such as night-time minimum flow surveys and leak detection, are being implemented in any of the regions. In Kampala, there are many aging pipes, leaks due to high pressure in the pipes, and meter insensitivity in areas where water is cut off, compared with other areas. The NRW rate in Kampala Water, which accounts for about 60% of NWSC's water bill collection, is extremely high at 40%. It will be the cause of many problems such as pressure on the water business management and deterioration of water supply quality if it is not improved in the future.

4) Collection Efficiency

The collection efficiency for FY 2019/20 varies from 77% to 97%, whereas the figure varies from 91% to 103% in FY 2018/19, suggesting that COVID-19 has had an impact on it[11]. The cost of water production per m^3 varies from UGX 1,717 (JPY 53) to UGX 6,746 (JPY 209), a four-fold difference. This is largely due to the raw water quality and the cost of electricity. The collection efficiency can be more than 100% as it includes collection of arrears.

5) Staff Productivity per 1,000 Connections

The number of staff per 1,000 connections is 4 to 5. The Eastern and Southern Africa Water Sanitation Regulators Association (ESAWAS) targets 5 to 8 staff per 1,000 connections, which indicates good staff productivity in the ten target areas. However, as mentioned in Section 3.2.3 (4), there is a situation where a specialized NRW department has not been established, so it is essential to verify whether NWSC is able to secure the necessary human resources.

6) Water Quality

As mentioned in Section 3.2.4, NWSC has 70 water quality laboratories. It was confirmed during the field survey that the water quality tests carried out on the water treatment plants are conducted periodically on raw water, treated water, and customer taps. Test items such as pH, electric conductivity, turbidity, TSS, color, alkalinity, hardness, iron, coliforms, and residual chlorine are conducted. The average monthly performance of Kampala Water from October to December 2020 is 185 sampling of

[11] NWSC Annual Report 2018/19

raw water and 2,421 sampling of treated water from water treatment plant, reservoirs, distribution pipes, and customer taps. The target and actual values for the achievement rate of each water quality indicator in Kampala Water were 100% against 100% for coliform, 81.2% against 95% for color, and 86.9% against 98% for residual chlorine. 98% of the water quality standards were achieved over the course of the year.

Table 3.3.2 Current Status of Water Supply Services in the Ten Target Areas (Kampala Water and Branch Offices)

Target Area	Kampala	Jinja	Hoima	Mubende	Lira	Kasese	Mityana	Tororo	Soroti	Fort Portal
Region	Kampala	Central	Western & South West	Central	Eastern & Northern	Western & South West	Central	Eastern & Northern	Eastern & Northern	Western & South West
Year of Transfer to NWSC	1972	1972	2006	2006	1990	1990	2013	1980	2002	1990
Target Population to be Served (2020)	6,761,636	929,697	253,978	288,146	440,882	366,317	241,174	760,712	383,644	484,378
Supply Population (2020)	6,354,322	724,613	107,790	122,236	427,755	204,758	124,110	521,523	244,581	267,475
Water Service Coverage (%)	94	78	42	42	97	56	51	69	64	55
Capacity Utilization (%)	97	67	64	72	71	96	40	35	103	67
Average Water Supply (hours)	15～20	15～20	8～12	18	15～20	24	20～24	15～20	20～24	20～24
Water Production (m^3/year)	85,134,735	7,483,183	770,395	598,116	2,300,565	1,303,030	708,741	1,682,653	1,787,353	1,335,755
Water Sold (m^3/year)	49,160,464	4,831,230	420,169	511,063	1,495,996	1,004,773	413,618	1,388,270	1,162,969	1,057,633
Billing Efficiency (%)	60	79	71	89	72	81	61	83	72	85
NRW (%)	40	21	29	11	28	19	39	17	28	15
Billing (UGX '000)	245,247,870	25,552,587	1,967,866	2,170,620	6,361,796	3,980,479	1,562,179	6,242,257	5,144,790	4,981,130
Collection (UGX '000)	238,705,506	24,089,215	1,849,006	1,941,737	5,668,522	3,502,556	1,455,839	4,813,520	4,482,647	4,320,708
Collection Efficiency (%)	97	94	94	89	89	88	93	77	87	87
Unit Cost of Water Production (UGX/m^3)	2,132	6,746	3,589	8,386	3,205	1,717	5,078	4,052	4,720	3,668
Staff Productivity (nos.)	4	4	4	5	5	5	5	5	5	4
Total Connection (nos.)	356,272	32,158	6,212	5,923	14,768	10,501	6,241	17,516	10,059	14,138
Total Length of Water Distribution Network (km)	3,186 (2020)	488 (2019)	261 (2021)	117 (2019)	134 (2016)	91 (2017)	231 (2021)	449 (2021)	416 (2021)	258 (2017)

Note: The target population to be served and supply population are calculated independently by NWSC.
Note: Capacity Utilization: Practical Capacity (m^3/day)/Production Capacity (m^3/day)
Source: Compiled by JST based on interviews with NWSC and collected data

3.4 Selection of Six Target Areas and Current Status and Issues of Water Supply Services

From the ten target areas, six areas will be narrowed down for the in-depth survey on the current status and issues of water supply services. For the selection, regional cities and NWSC priority areas where water supply services are expected to continue to expand are identified. According to the Director of NWSC, the priority areas are Lira, Hoima, Tororo, Kasese, Soroti, and Fort Portal. However, at the time of the first field survey (February 2021), Lira, Kasese, Tororo, Soroti, and Fort Portal, were excluded as they were within JICA's travel restrictions (more than 5 hours journey one way). In the end, the in-depth survey on water supply services was conducted in Kampala, which is a large-scale city that needs further development; Hoima, which is the core city of the region; and Mubende and Mityana, which are regional cities after discussion with NWSC and JICA. In addition, travel restrictions of JICA were changed in late March (more than 8 hours journey one way), and at the request of NWSC and discussion with JICA, additional studies were conducted in Tororo and Soroti. In the end, six areas were selected as the target area.

3.4.1 Kampala Water

(1) Organizational Structure of Kampala Water

Kampala Water was the first water supply utility transferred to NWSC in 1972, and is currently operated and maintained by one of the organizations in the Technical Services Division of NWSC. Also, it is responsible for water quality test, rehabilitation and expansion of the distribution network, installation of transmission network with water meter, construction of PSP, meter reading, preparing and receiving of the water bill, dealing with water bills arrears, finding illegal connection, repair of leakage and burst, and managing pipe pressure. Kampala Water has ten departments: 1) Finance, 2) Commercial/Marketing/Customer Service, 3) Billing/IT, 4) Human Resources, 5) Legal Service, 6) Water Production, 7) Water Supply, 8) Asset Management, 9) Project Implementation, and 10) Performance Management. The total number of employees was 1,499 in 2020. Figure 3.4.1 shows the organizational structure of Kampala Water.

(2) Management, Financial Status

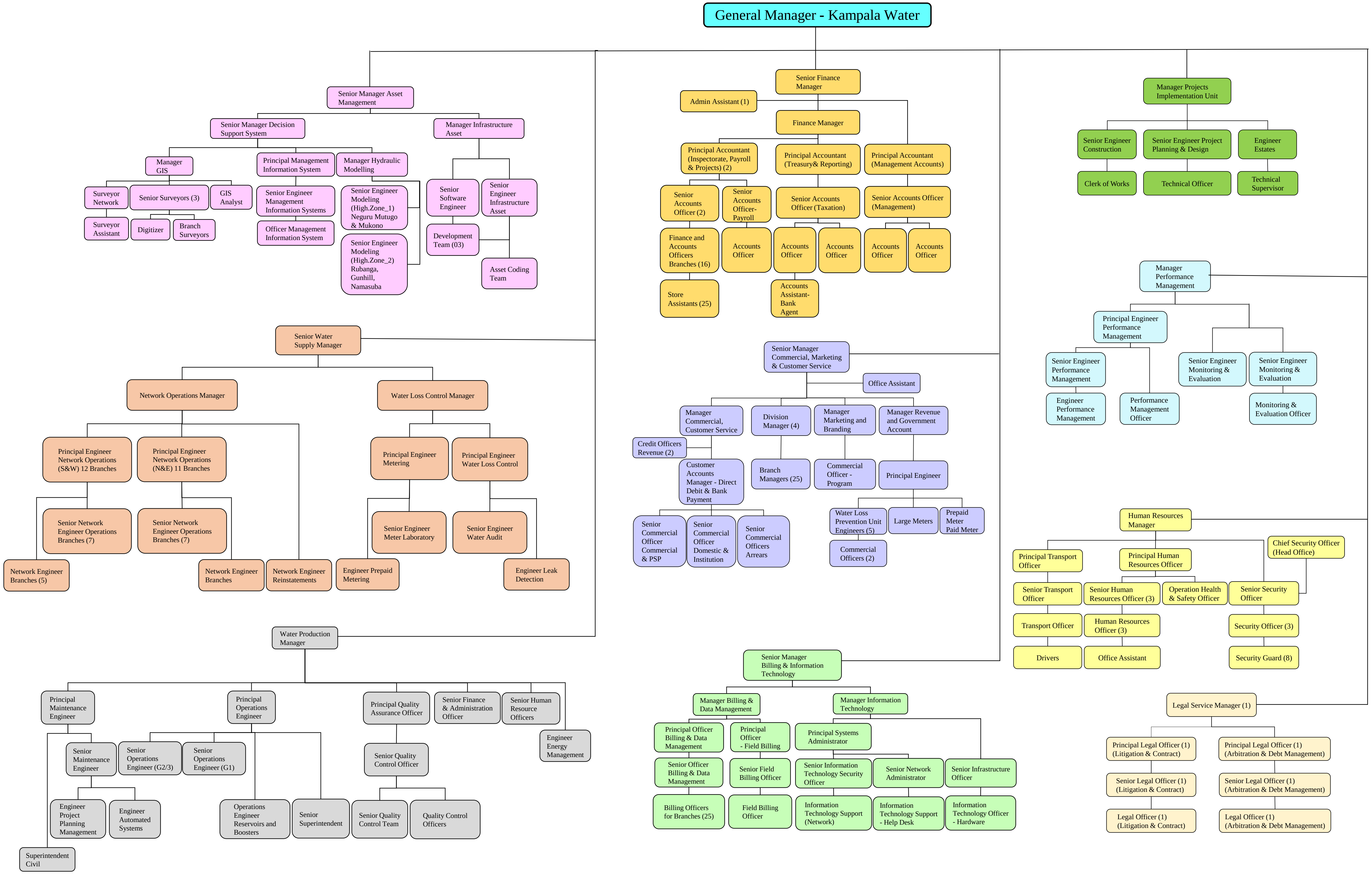
1) Number of Connections, Water Billing and Collection

Table 3.4.1 shows the number of connections in Kampala Water. As of November 2020, Kampala Water had total connections of 354,334 including PSP. Of these, 89% are active connections and 11% are inactive connections. Based on the number of NWSC staff (1,499) and the number of connections, it is estimated that the number of staff per 1,000 connections is 4.2, which indicates that Kampala Water has high productivity of staff.

Table 3.4.1 Number of Connections in Kampala Water (As of November 2020)

Type of Connections	Active	Inactive	Total
Domestic (nos.)	263,184	29,016	292,200
PSP (nos.)	4,317	1,061	5,378
PPWM (nos.)	1,500	0	1,500
Commercial & Industrial (nos.)	40,809	8,466	49,275
Institutional & Government (nos.)	5037	944	5,981
Total	314,847	39,487	354,334
Ratio	89%	11%	100%

Note: PSP (Public Stand Pipe), PPWM (Prepaid Water Meter)
Source: Compiled by JST based on interviews with NWSC and collected data



Source: NWSC Kampala Water

Figure 3.4.1 Organizational Structure of Kampala Water

Table 3.4.2 shows the water billing and collection for FY2018/19 and FY2019/20. The collection efficiency for FY 2018/19 was 100% but has decreased to 97% in FY 2019/20. According to NWSC, this was because COVID-19 had led to a reduction in use by schools and government offices, as well as an increase in the number of customers who were unable to pay their water bills due to financial difficulties.

Table 3.4.2 Water Billing and Collection in Kampala Water

Item	FY 2018/19	FY 2019/20
Billing (UGX '000)	259,159,652	245,247,870
Collection (UGX '000)	258,702,154	238,705,506
Collection Efficiency	100 %	97 %

Source: NWSC Integrated Annual Report, 2019/20

2) Income and Expenditure

Table 3.4.3 shows the income and expenditure of Kampala Water for FY 2017/18, FY 2018/19, and FY 2019/20. The expenditure of Kampala Water is covered by water tariff income. However, although the expenditure/income ratio improved to 0.45 from FY 2017/18 to FY 2018/19, the expenditure/income ratio decreased to 0.73 in FY 2019/20. This is likely due to the impact of COVID-19 and the increase in NRW, expenditure including employee and administrative expenses, costs of O&M, depreciation, etc. The profit generated from the income is also passed on to the NWSC headquarters, small project expenses, etc. The costs of new projects are covered by donor support for larger projects, while NWSC's own funds are used for smaller projects.

Table 3.4.3 Income and Expenditure of Kampala Water

Item	FY 2017/18	FY 2018/19	FY 2019/20
Income (UGX '000)	204,543,158	225,985,737	214,604,059
Expenditure (UGX '000)	130,947,553	101,531,369	156,697,643
Expenditure/Income Ratio	0.64	0.45	0.73

Source: NWSC Integrated Annual Report, 2018/19, 2019/20

(3) Non-Revenue Water (NRW)

1) Current Situation and Countermeasures for NRW

The NRW rate for Kampala Water is shown in Table 3.4.4. The NRW rate for FY 2016/17 was 37.1%, an increase of 5.3% from the previous year. This is mainly due to the completion of the rehabilitation of the Ggaba WTP and increase in water supply. The NRW rate has increased to 39.5% in FY 2019/20 and if the new Katosi WTP is operational, the NRW rate could increase rapidly as in FY 2016/17. According to NWSC, the commercial losses in Kampala Water include faulty meters, poor pipe installation, poor

Source: JST

Photo 3.4.1 Data Logger for Pressure Management

meter accuracy due to low water pressure, water theft, and delays in updating billing information. The meter installation rate is 100%. Physical losses include leaks and bursts due to pressure differences in pipes and faulty meter connections, and delays in repairs due to delays in leaks and ruptures detections caused by planned water shutoffs. In FY 2019/20, an average of 6,268 leaks from household water supplies were reported per month, while pipe bursts occurred mainly in transmission and distribution mains, with an average of 121 per month. As for commercial losses, checking and replacing faulty meters and dealing with water theft are being carried out, but as for physical losses, surface leakage countermeasures and pressure management using data loggers are the main measures, while other measures such as underground leakage detection have not been actively carried out. Photo 3.4.1 shows the data logger for pressure management.

Table 3.4.5 shows each indicator related to revenue and NRW for May 2021 prepared by NWSC and then applied and inputted to the water balance sheet based on the definition of the International Water Association (IWA). The NRW rate is 40.4%, a further increase from 39.5% in FY 2019/20.

Since District Metered Area (DMA) has not been established in the Kampala Metropolitan Area, and the installation of flow meters in each distribution area and the detailed analysis of NRW factors based on these meters have not yet been completed, the NRW rate is calculated monthly by the Principal Engineer - Physical Loss Control & Instrumentation of the NRW Department (all of whom work concurrently with other departments) based on the water production for the entire Kampala Metropolitan Area from the Water Production Department at the Ggaba WTP, the revenue water from Commercial Department and water supplied certified for billing. Commercial losses and physical losses are estimated and calculated based on the number of repaired or replaced water meters, the number of water thefts detected, and the number of repaired leaks and bursts.

Since pressure management is important in Kampala Metropolitan Area due to the significant differences in elevation, a proposal for the establishment of DMA was made in the 2014 Master Plan. Subsequently, a Hydraulic Analysis Model Group has been established within the Asset Management Section to prepare for the future construction of DMA and to progressively develop hydraulic calculation models to be applied in other DMA in addition to those planned in the Master Plan. The Hydraulic Analysis Modelling Group has purchased two licenses of Bentley's Water GEMS hydraulic analysis software on the advice of VEI (Vitens-Evides International). However, not a single DMA has yet been built in the region.

Figure 3.4.2 shows the current organization structure of the NRW-related departments in Kampala Water. However, apart from three plumbers, there is no dedicated department and staff, as they are concurrently working in other departments. It is essential to establish a specialized department, assign full-time staff, and have the department take the lead in NRW reduction activities that are linked across the board with the construction department, GIS unit, and tariff collection department in order to reduce the NRW.

Table 3.4.4 NRW Rate of Kampala Water

FY	2015/16	2016/17	2017/18	2018/19	2019/20
NRW	31.8%	37.1%	36.2%	34.6%	39.5%

Source: NWSC

Table 3.4.5 Water Balance Sheet as Defined by the IWA and Applied to NWSC

<table>
<tr><td rowspan="9">System Input Volume

7,204,513
(m^3/month)</td><td rowspan="4">Authorized Consumption

4,515,323</td><td rowspan="2">Billed Authorized Consumption
4,295,088</td><td>Billing System (Including prepaid water sales)
4,294,534</td><td rowspan="2">Revenue Water
4,295,088

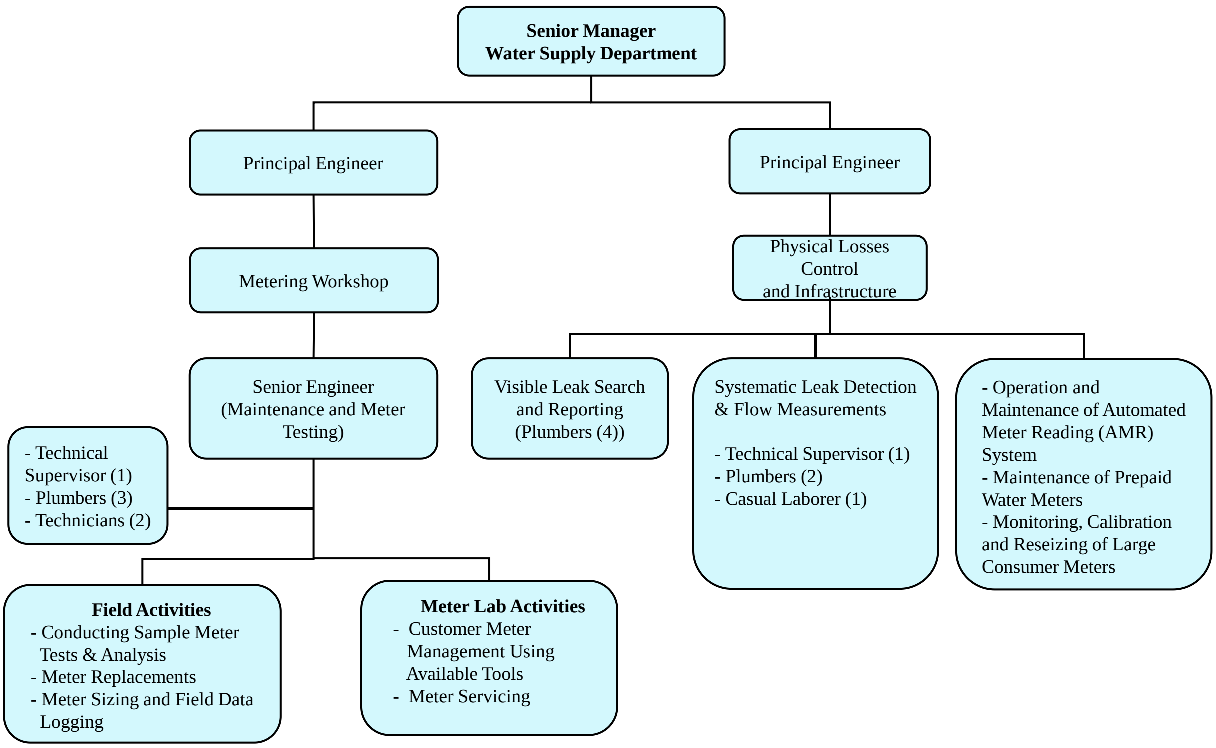
59.6%</td></tr>
<tr><td>Water Theft (Culprits charged)
554</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
220,235
3.1%</td><td>Unbilled Metered Consumption
4,100</td><td rowspan="7">NRW
2,909,425

40.4%</td></tr>
<tr><td>Unbilled Unmetered Consumption
216,135</td></tr>
<tr><td rowspan="5">Water Losses

Unaccounted-For-Water (UFW)

2,689,198</td><td rowspan="2">Commercial Loss
1,365,355
19.0%</td><td>Unauthorized Use
607,496</td></tr>
<tr><td>Metering Inaccuracies
757,859</td></tr>
<tr><td rowspan="3">Physical Loss
1,323,835
18.4%</td><td>Leaks
397,873</td></tr>
<tr><td>Reservoir Leaks and Overflows
0</td></tr>
<tr><td>Bursts
925,962</td></tr>
</table>

Source: Compiled by JST based on Non-Revenue Water Management (2011), NWSC NRW Water Balance (May 2021)



Source: NWSC

Figure 3.4.2 NRW Related Departments

2) NRW Related Equipment Possessed by NWSC and Operable Personnel

Table 3.4.6 shows the list of equipment related to NRW control owned by NWSC. This equipment can be operated by three plumbers from the NRW section. Leak detections are carried out in water service pipes based on reports from customer (approximately 20 underground leakages per month). There is no training facility for the training of leak detection, as it is only acquired through on-the-job training. On days when there are no calls or consultations from customers regarding leaks, the leak detection team (plumbers) conducts regular patrols for surface leaks.

Proactive NRW reduction control will be essential to reduce the NRW rate, and organized control of underground leakage will also be important in the future.

Table 3.4.6 List of Equipment Related to NRW Control Owned by NWSC

SI No.	Equipment	Supplier/Country	Product Name	Year	Fund	Nos.	Condition
Existing							
1	Ground Microphones/Acoustic Leak Detector	HWM-Water Ltd. (UK)	DXPRO/BT (DXmic)	2020	NWSC	2	Working
2	Leak Noise Correlators	sebakmt (Germany)	CORRELUX P-1	2012/13	NWSC	2	Not working
3	Plastic Pipe Detectors	sebakmt (Germany)	RSP 3	2012/13	NWSC	2	Working
4	Metallic Pipe Detectors	sebakmt (Germany)	VX204-1	2012/13	NWSC	2	Working
5	Valve Locator	sebakmt (Germany)	VM-880 (Made in China)	2012/13	NWSC	1	Working
6	Portable Ultrasonic Flow Meter	FLEXIM (Germany)	FLUXUS F601 Standard	2018/19	Netherlands	2	Working but limited applicable pipe size (up to D300)
7	Portable Pressure Data Logger	HWM-Water Ltd. (UK)	N/A	2012/13	NWSC	20	5 nos. working 15 nos. not working due to battery problem
8	Meter Test Bench	SOCAM (France)	N/A	1998	NWSC	1	Working but accuracy is a problem

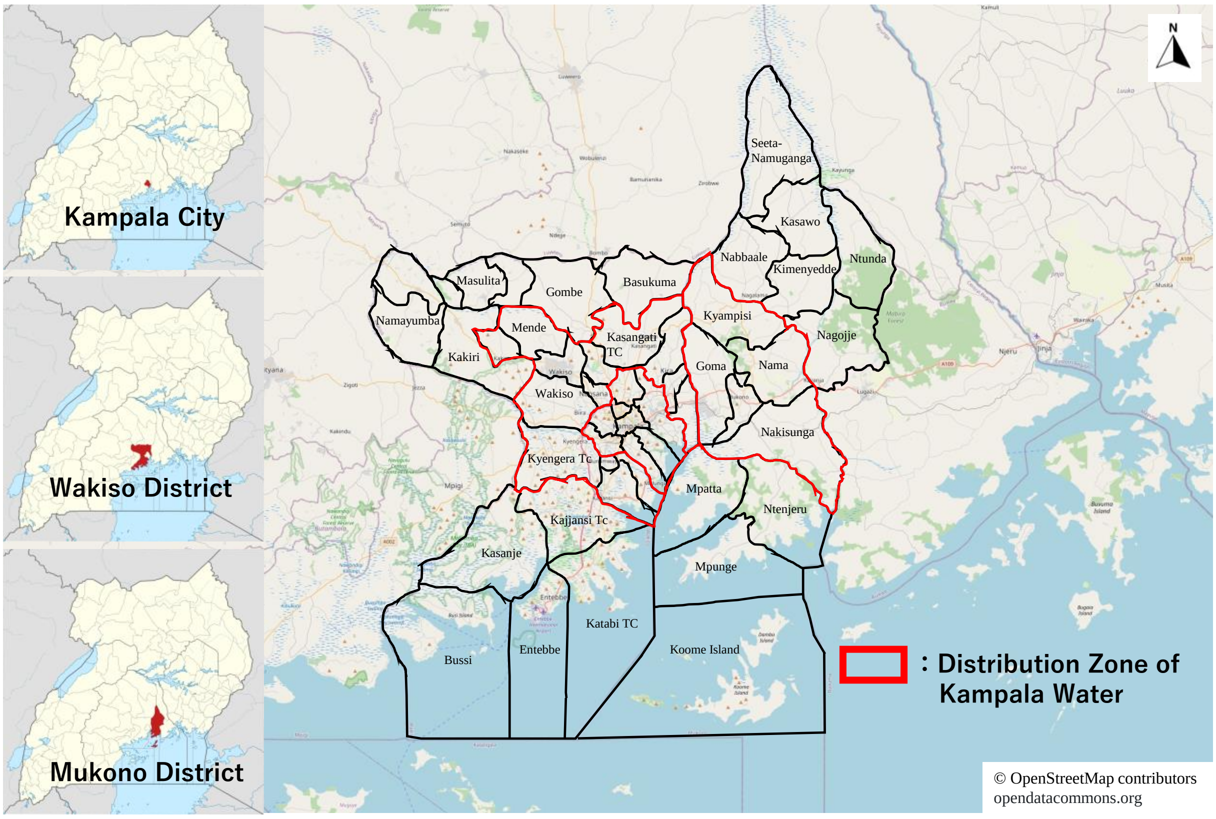
Note:
N/A: Not Available
Source: Compiled by JST based on interview with NWSC

3) Budget and Funding for NRW Control

The budget for FY 2019/20 related to NWSC is UGX 770,000,000 and more than 70% of the budget is for the replacement of water meters and connection fittings for meters, leaving little budget available for leak detection equipment, etc.

(4) Distribution Zone of Kampala Water

As of 2021, the distribution zone of Kampala Water is located on the northern shore of Lake Victoria, with Kampala Capital City at its center, and it provides water supply services to the surrounding areas of Makindyessabagado, Mukono, Nansana, Kakiri, Kira sub counties and Wakiso Town Council. Figure 3.4.3 shows the distribution zone of Kampala Water.



Source: JST

Figure 3.4.3 Distribution Zone of Kampala Water

(5) Outline of Water Supply Facilities in Kampala Water

1) Water Source and Water Treatment System

Table 3.4.7 shows the outline of water treatment system. The water treatment system of Kampala Water consists of three water treatment plants (Ggaba I, II, and III) which are constructed on the same site using Lake Victoria as the water source. The Ggaba I and II WTP were rehabilitated under the Kampala Water Lake Victoria WATSAN Project Phase 1, and Ggaba III was constructed in 2007 with support from Germany. Water is distributed from wells (11 areas), but to a limited extent in some rural areas of Kampala Water. In addition, a new 160,000 m^3/day (expandable to 240,000 m^3/day) water treatment plant using Lake Victoria as water source is being constructed in the Katosi area under the Kampala Water Lake Victoria WATSAN Project Phase 2 (WATSAN Project Phase 2), which will be operational from July 2021. As of August 2021, 60,000 m^3/day of water is being produced. Also, there is plan to gradually increase the water production capacity to 80,000 m^3/day by December 2021 and 120,000 m^3/day by December 2022. The locations of each facility for Ggaba WTP are shown in Figure 3.4.4 and the locations of each facility for Katosi WTP are shown in Figure 3.4.5 and Figure 3.4.6. Photo 3.4.2 shows the view of Ggaba WTP, mixing pond/ drying beds, and rapid sand filter. Photo 3.4.3 shows the view of Katosi WTP, dissolved air flotation basin, and rapid sand filter.

Table 3.4.7 Outline of Water Treatment System in Kampala Water

Item	Specifications
Water Source	Lake Victoria Water intake method (Ggaba): Intake basin (old intake facility (1929), new intake facility (2010)) Water intake method (Katosi): Intake basin (2021)
Water Production Capacity	Design water production capacity of Ggaba: 230,000 m^3/day Ggaba I: 70,000 m^3/day (Constructed in 1929 with support from United Kingdom and was rehabilitated later) Ggaba II: 80,000 m^3/day (Constructed in 1993 with support from Germany and was rehabilitated later) Ggaba III: 80,000 m^3/day (Constructed in 2007 with support from Germany) Katosi WTP: 160,000 m^3/day (expandable to 240,000 m^3/day) (Constructed in 2021 with support from France)) Total water production capacity: 390,000 m^3/day (expandable to 470,000 m^3/day)
Treatment Method and Main Facilities	The water treatment system is the same for Ggaba I, II, and III. 1) Water well, 2) Mixing basin, flocculation basin, 3) Sedimentation basin, 4) Rapid sand filter, 5) Backwash facility, 6) Chemical house, 7) Water reservoir, 8) Pumping station, 9) Drying bed etc. Katosi WTP 1) Raw water pumping station, 2) Mixing basin, flocculation basin,3) Dissolved air flotation basin, 4) Rapid sand filter, 5) Backwash water and sedimentation tank, 6) Chemical building, 7) Water reservoir, 8) Pumping station, 9) Drying bed and lagoon, 10) Thickeners etc.
Water Quality Test	Water quality laboratories are classified into four classes based on the parameters tested: A, B, C, and D. Class B is applied to Katosi WTP and Ggaba WTP, which can test all drinking water quality standards. Water quality test has been conducted based on the water quality testing schedule and test items. Also, jar tests are conducted once per week, and the concentration of flocculant used is measured. The treated water meets the water quality standards.
Treatment Conditions	• The efficiency of water treatment is decreasing throughout all the water treatment facilities, due to deterioration of water quality in Lake Victoria (especially algae blooms). • The Ggaba III WTP has a capacity of 80,000 m^3/day but currently operating at 110,000 m^3/day and continues to be overloaded by 30,000 m^3/day due to insufficient water supply. Improvement can be expected through the operation of Katosi WTP. • Backwashing is carried out at short intervals (every 18 hours) due to the reduction in water treatment capacity caused by deteriorating water quality and overloaded operations, resulting in continued inefficient operation. • It is not possible to measure the exact amount of water intake because there is no raw water flow meter; thus, chemicals are sometimes injected more than is required.
Wastewater Treatment	Treated by drying beds.
O&M and others	• Chemical dosing is done manually. • Polymers have been added in addition to Aluminum Sulphate due to the deterioration of raw water quality, which has tripled the cost of chemicals. • The Ggaba I WTP is operated manually, but as far as the backwashing and other operations are checked, the plant is operating according to schedule. • Katosi WTP has implemented SCADA system, but there is a skills gap in O&M due to insufficient training.

Source: Compiled by JST based on interviews with NWSC and collected data

Source: JST

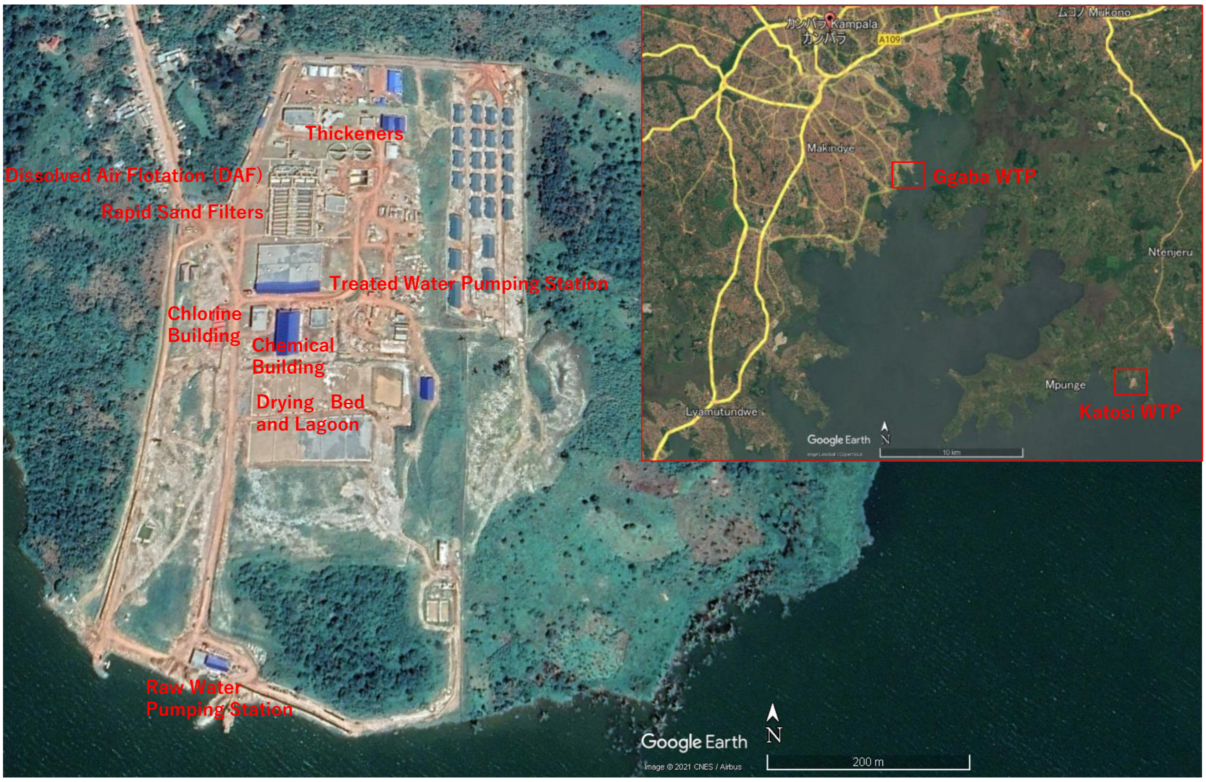
Photo 3.4.2 Ggaba WTP：View of Water Treatment Plant (Left), Mixing Pond/ Drying Beds (Center), Rapid Sand Filter (Right)

Source: Compiled by JST based on field survey, Google Earth

Figure 3.4.4 Location of Each Facility for Ggaba Water Treatment Plant

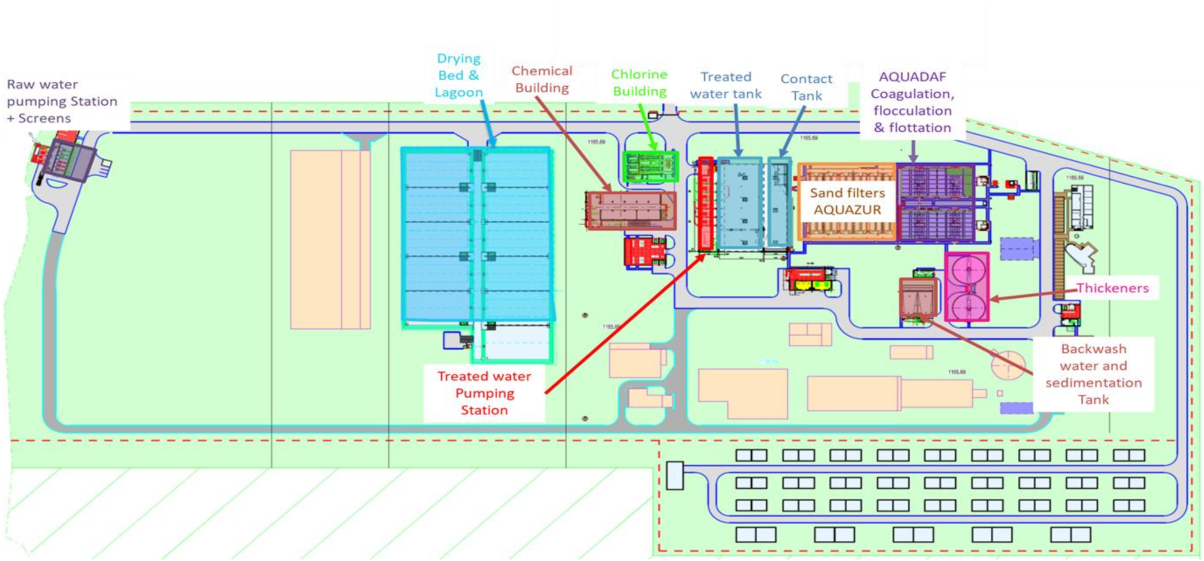
Source: JST

Photo 3.4.3 Katosi WTP: View of Water Treatment Plant (Left), Dissolved Air Flotation Basin (Center), Rapid Sand Filter (Right)



Source: Compiled by JST based on field survey, Google Earth

Figure 3.4.5 Location of Each Facility for Katosi Water Treatment Plant



Source: NWSC

Figure 3.4.6 Location of Each Facility for Katosi Water Treatment Plant

2) Water Transmission System

Table 3.4.8 shows the specifications of water pumps in Kampala Water. Ggaba WTP has three pumping stations (Ggaba I Pumping Station, Ggaba II Pumping Station, and Ggaba III Water Transmission Pumping Station), and the treated water (purified water) is delivered from these pumping stations to the main reservoirs of Muyenga, Naguru, and Gunhill. Also, some of the treated water is distributed directly to Buziga. Ggaba I Pumping Station consists of five low level and five high level pumps, and four new pumps, respectively. The high level pumps deliver water to Naguru Reservoir, the low level pumps deliver water to Buziga and the clear water tank of Ggaba II, while the new pumps deliver water to the Namasuba Reservoir. The Ggaba II Pumping Station (Photo 3.4.4) consists of six high level pumps, which deliver water to the Muyenga Reservoir. Ggaba III Pumping Station consists of three low level and three high level pumps. The high level pumps are used to deliver water to Muyenga Reservoir, the low level pumps are used to deliver water to Gunhill Reservoir and to distribute water to Buziga District.

Source: JST

Photo 3.4.4 Ggaba II Pumping Station

Source: JST

Photo 3.4.5 Katosi Pumping Station

The pumping station at Katosi WTP (Photo 3.4.5) consists of six pumps, including two on stand-by. Water treated at Katosi WTP is distributed to Nsumba Reservoir by transmission pumps, which is then distributed to Sonde Reservoir by gravitational flow. Also, water is distributed by gravitational flow from Sonde Reservoir to Namugongo Pumping Station, where the water is boosted by three booster pumps to Naguru Main Reservoir.

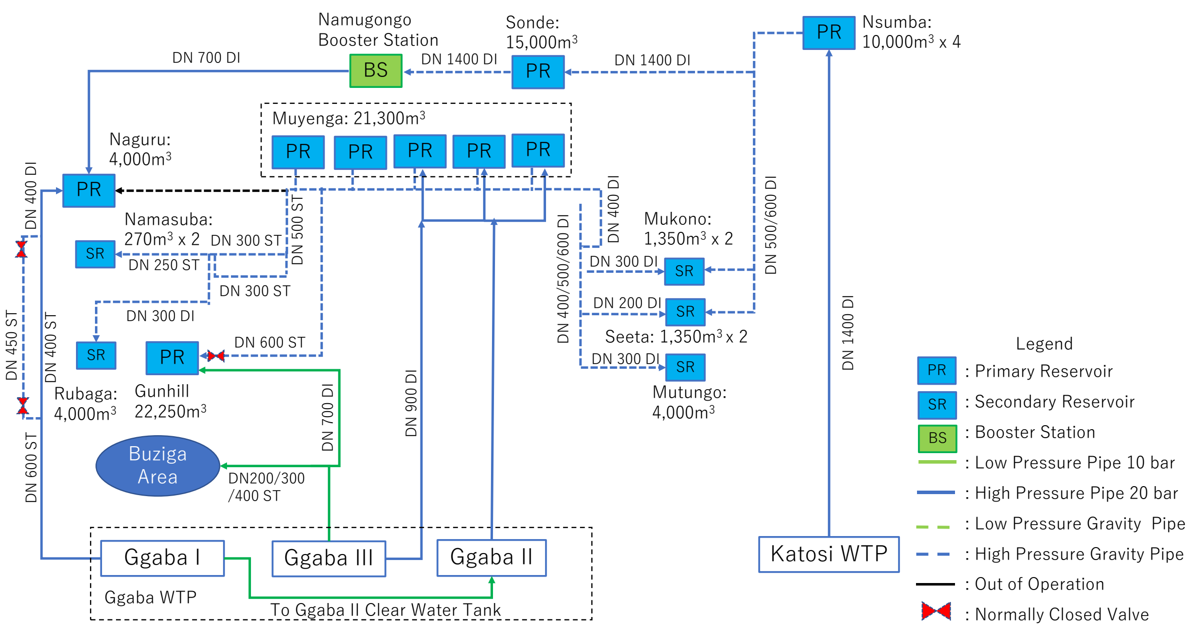
The O&M works of the pumping stations are relatively good. However, stand-by units are also in operation due to the high water demand which makes it difficult to respond to breakdowns.

Figure 3.4.7 shows the transmission main system diagram of Kampala Water.

Table 3.4.8 Specifications of Water Pumps in Kampala Water

Pumping Stations	Type of Pumps	No. of Pumps	Specifications	Year of Construction
Ggaba I Pumping Station	Ggaba I high level pumps	5 units	Delivery head: 19.25 bar, Flow: 325 m^3/h	2005/2010
	Ggaba I low level pumps	5 units	Delivery head: 17.6 bar, Flow: 468 m^3/h	2002/2010
	Ggaba I new pumps	4 units	Delivery head: 15 bar, Flow: 720 m^3/h	2017
Ggaba II Pumping Station	Ggaba II high level pumps	6 units	Delivery head: 19.3 bar, Flow: 833 m^3/h	2010
Ggaba III Pumping Station	Ggaba III high level pumps	3 units	Delivery head: 18.4 bar, Flow: 1152 m^3/h	2006
	Ggaba III low level pumps	3 units	Delivery head: 11.5 bar, Flow: 756 m^3/h	2006
Katosi Pumping Station	Katosi treated water pumping station	6 units	Delivery head: 138.3 m, Flow: 1,820 m^3/h	2021
Namugongo Pumping Station	Namugongo booster pumping station	3 units	Delivery head: 62 m, Flow: 416 m^3/h	2021

Source: Compiled by JST based on Kampala Water Supply Master Plan and interviews



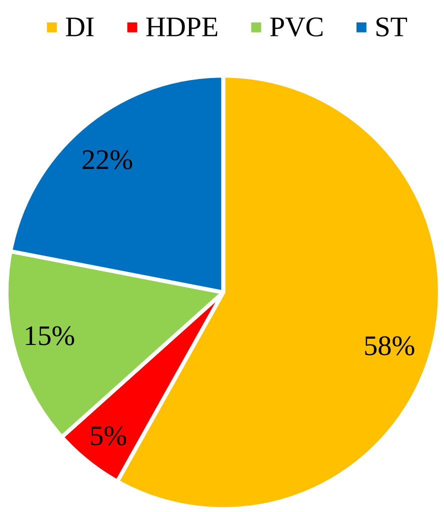
Source: Compiled by JST based on interviews with NWSC

Figure 3.4.7 Transmission Main System Diagram

Table 3.4.9 shows the length of the transmission mains by diameter and material of Kampala Water. The total length of the transmission mains, including from Katosi WTP is 235.3 km. The main transmission mains from Ggaba I, II, and III pumping stations are for pumping water to the main reservoir and are made of ductile iron (DI) and steel (ST) with diameters ranging from 400 mm to 900 mm. Also, the transmission mains from Katosi water pumping station are for pumping water to Nsumba Reservoir, Sonde Reservoir, Namugongo Booster Pumping Station and the existing Naguru Main Reservoir and are made of ductile iron with diameters ranging from 700 mm and 1,400 mm and total length of 59.3 km. Information on pipes, materials, number of water taps, etc. are updated by the GIS unit specializing in water supply in Kampala.

Table 3.4.9 Transmission Mains of Kampala Water

Diameter	Transmission Pipe Diameters and Material Water Network					
	DI (km)	HDPE (km)	PVC (km)	ST (km)	Total (km)	Share (%)
1400	49.1	-	-	-	49.1	20.9%
900	6.1	-	-	-	6.1	2.6%
800	5.7	-	-	-	5.7	2.4%
700	29.9	-	-	-	29.9	12.7%
600	6.0	-	-	1.8	7.8	3.3%
550	-	-	-	-	-	-
525	-	-	-	0.4	0.4	0.2%
500	20.4	-	-	7.2	27.6	11.7%
450	-	-	-	7.6	7.6	3.2%
400	13.6	-	-	15.2	28.7	12.2%
350	-	-	6.7	4.4	11.1	4.7%
300	4.2	-	0.1	1.9	6.3	2.7%
250	-	-	17.2	9.6	26.8	11.4%
200	1.6	-	1.5	3.5	6.6	2.8%
150	0.1	-	3.5	-	3.6	1.5%
125	-	-	-	-	-	-
100	0.1	0.8	3.5	-	4.4	1.9%
<100	-	11.5	2.1	-	13.6	5.8%
Total	136.8	12.3	34.5	51.7	235.3	100%

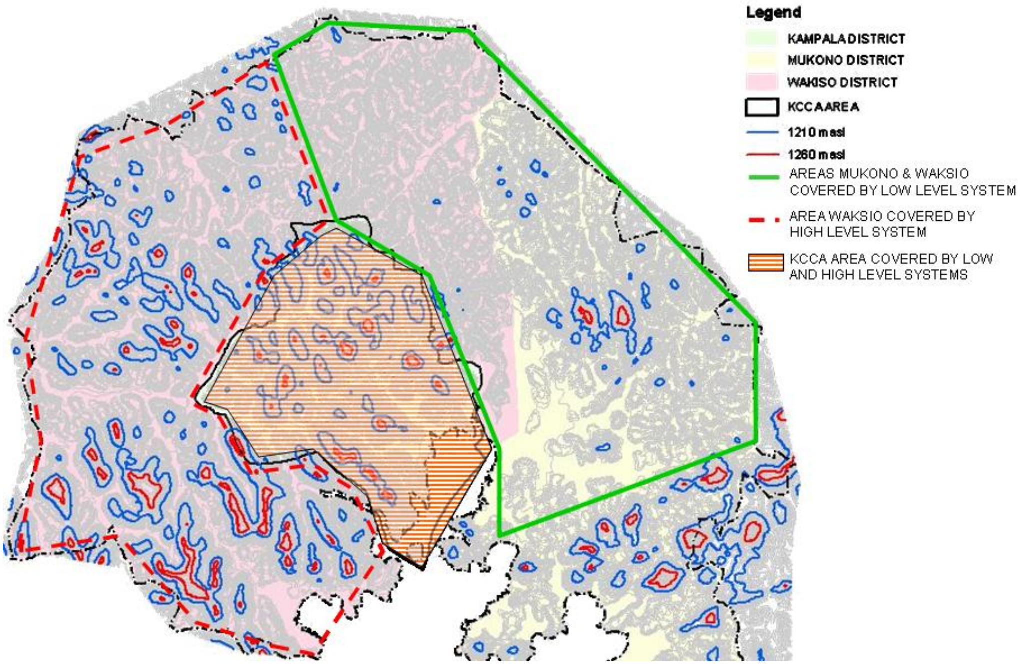


Source: Compiled by JST based on information collected from NWSC.

3) Water Distribution System

a) Water Distribution Status

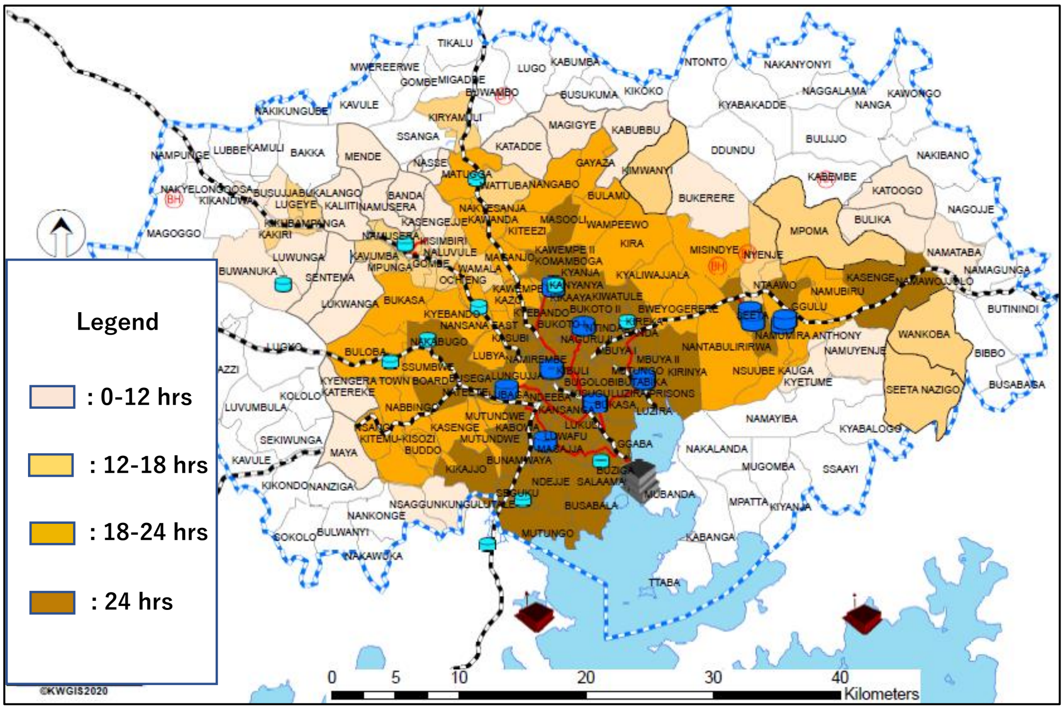
The pressure zone of Kampala Water is divided into low level pressure zone and high level pressure zone, due to the terrain of Kampala which has a large difference in elevation as it has seven hills. However, many interconnections were installed in the transmission and distribution mains between the zones to reduce the water pressure in the low level pressure zone and to distribute water to the new distribution area. The integration of the low and high level pressure zones has further increased the water pressure in the pipes, which is one of the causes of leakage. In addition, the location of the interconnections is unknown in some areas, which makes O&M more complicated. The Kampala Water Supply Master Plan (Kampala MP Report) calls for the division of water distribution zones into low level zone (KCCA area < 1,200 m above sea level, Wakiso North-East and Mukono District) and high level zone (KCCA area > 1,200 m above sea level, North, West and South Wakiso). Figure 3.4.8 shows the proposed distribution zones of Kampala Water.



Source: Kampala MP Report

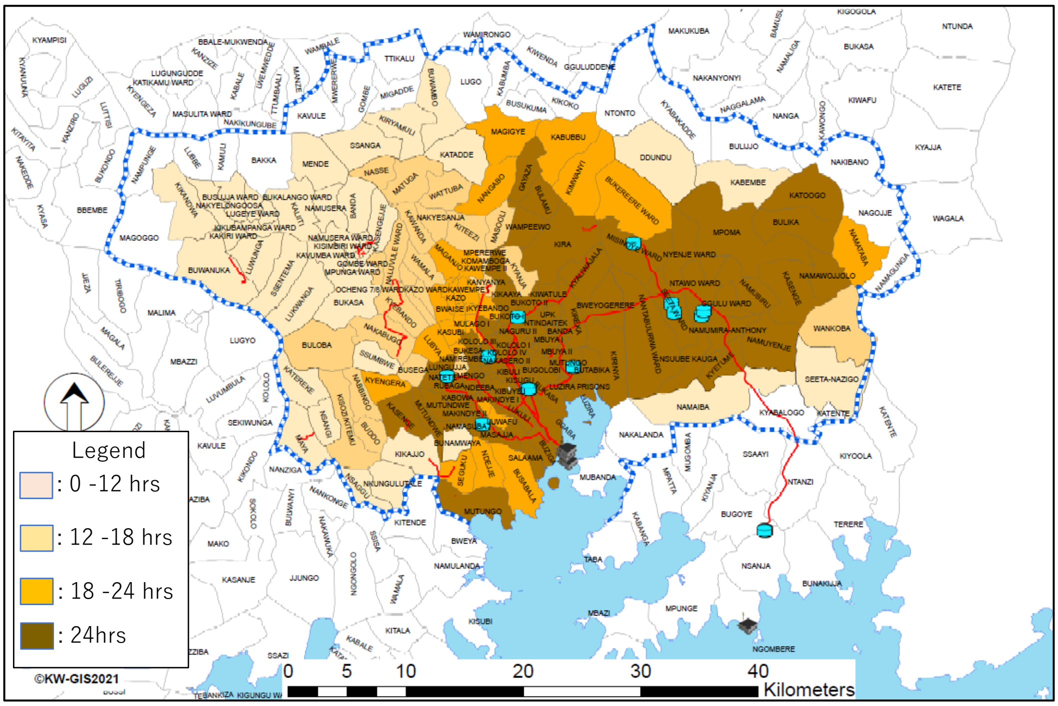
Figure 3.4.8 Distribution Zone of Kampala Water

Figure 3.4.9 shows the water supply hours of Kampala Water before the newly commissioned Katosi WTP. The water distribution network is being expanded due to the increase in water demand around Kampala City. However, the water supply pressure decreases the farther away from Kampala City. Under these circumstances, NWSC is conducting water rationing in some distribution areas. The daily water supply hours in Kampala City and the southern part of the city are 24 hours/day, while in the surrounding areas of Kampala City, it varies from 0 to 24 hours/day, and the water supply hours tend to be shorter in areas far from the center of Kampala due to low water pressure. Figure 3.4.10 shows the water supply hours of Kampala Water after the newly commissioned Katosi WTP. Katosi WTP has been in operation since July 2021 with an additional production capacity of 60,000 m^3/day. This has improved water supply hours in the eastern part of Kampala and increased the number of areas with 24-hour water supply, but at the moment, this has only improved water supply hours in some areas and has not led to any major improvement in the rationing schedule. However, the non-revenue water (NRW) rate has been on the rise, and the increase in pipe pressure in the 24-hour water supply area is thought to increase the NRW. Based on the NWSC NRW water balance for July and August 2021, the NRW rate of Kampala Water had worsened to 44.2% and 43.1%, respectively. Figure 3.4.11 shows the existing distribution system of Kampala Water (excluding the new Katosi water distribution system).



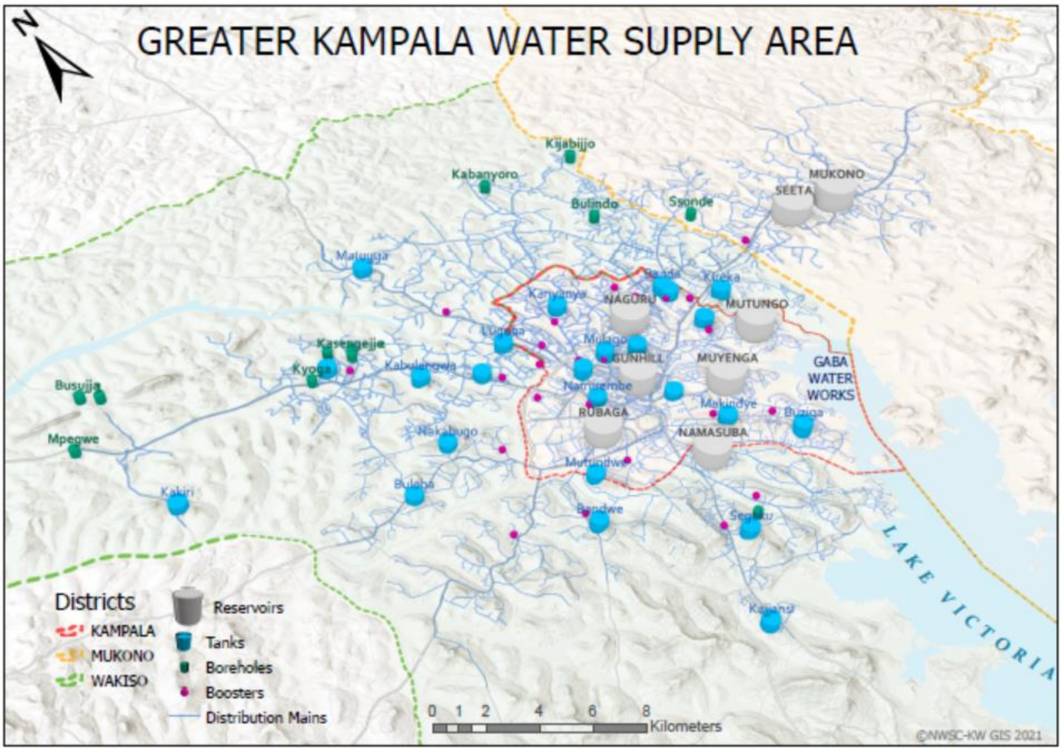
Source: NWSC

Figure 3.4.9 Water Supply Hours of Kampala Water (Before Newly Commissioned Katosi WTP)



Source: NWSC

Figure 3.4.10 Water Supply Hours of Kampala Water (After Newly Commissioned Katosi WTP)



Source: NWSC

Figure 3.4.11 Distribution System of Kampala Water

b) Water Distribution Status

The existing distribution zone of Kampala Water comprises: 1) 3 primary reservoirs, 2) 5 secondary reservoirs, and 3) 23 balancing tanks and reservoirs for water distribution. In addition, there are three privately owned reservoirs. Photo 3.4.6 shows the Muyenga Main Reservoir. In addition to these existing reservoirs, Nsumba Reservoir (Photo 3.4.7) and Sonde Reservoir are being constructed in 2021 under the Kampala Water Lake Victoria WATSAN Project Phase 2. The water treated at Katosi WTP is distributed to Nsumba Reservoir, Sonde Reservoir, the existing Naguru Main Reservoir, Seeta Secondary Reservoir, and Mukono Secondary Reservoir. The water level in these reservoirs is expected to be stabilized and the water supply hours are to be extended with the increase in water production in the future in view of the newly commissioned Katosi WTP. The maintenance of the existing reservoirs is relatively good, and there is evidence that leaks have been properly repaired. Table 3.4.10 shows the specifications of the primary and secondary reservoirs.

Source: JST

Photo 3.4.6 Muyenga Main Reservoir

Source: JST

Photo 3.4.7 Nsumba Reservoir

Table 3.4.10 Specifications of Primary and Secondary Reservoirs in Kampala Water

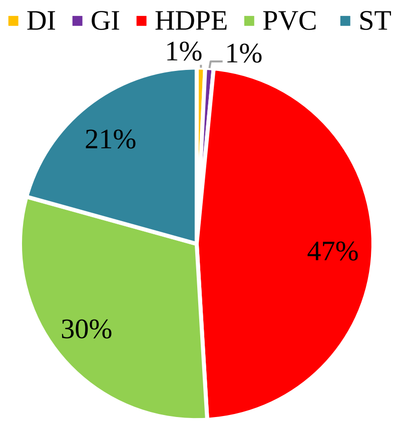
Reservoirs	Specifications	Capacity (m^3)	Year of Construction
Muyenga Main Reservoir	Diameter: 28 m, Height of maximum water level: 6.5 m, 4,000 m^3 x 2 (from Ggaba)	8,000	1969
	Diameter: 28.7 m, Height of maximum water level: 7.0m, 4,500 m^3 x 3 (from Ggaba)	13,500	1987
Gunhill Main Reservoir	Rectangular-shaped: 27 m x 48 m, Height of maximum water level: 4.9 m (from Ggaba)	6,350	1931
	Rectangular-shaped: 47.5 m x 75 m, Height of maximum water level: 5.3m (from Ggaba)	18,900	1959
Naguru Main Reservoir	Circle-shaped tank, Diameter: 28 m, Height of maximum water level: 6.5 m (from Ggaba and Katosi)	4,000	1969
Rubaga Secondary Reservoir	Rectangular-shaped: 33.3 m x 24 m, Height of maximum water level: 5 m (from Ggaba)	4,000	1993
Mutungo Secondary Reservoir	Rectangular-shaped: 33.3 m x 24 m, Height of maximum water level: 5 m (from Ggaba)	4,000	1993
Mukono Secondary Reservoir	Diameter: 20.7 m, Height of maximum water level: 4 m, 2 reservoirs (from Ggaba and Katosi)	2,700	2009
Seeta Secondary Reservoir	Diameter: 24 m, Height of maximum water level: 3.3 m (from Ggaba and Katosi)	1,500	2009
Namasuba Secondary Reservoir	Rectangular-shaped: 12.2 m x 6 m, Height of maximum water level: 3.6 m (from Ggaba)	270	2017
	Diameter: 9 m, Height of maximum water level: 4.5 m (from Ggaba)	270	2017
Nsumba Reservoir	Diameter: 43 m, Height of maximum water level: 7 m, 4 reservoirs (from Katosi)	40,000	2021
Sonde Reservoir	Rectangular-shaped: 50 m x 6 m Height of maximum water level: 5.7 m (from Katosi)	15,000	2021

Source: Compiled by JST based on Kampala Water Supply Master Report and interviews.

Table 3.4.11 shows the diameter and length by material type of the existing distribution mains. According to the interview with NWSC, the total length of distribution mains is about 4,000 km at present. The total length of the existing distribution mains is registered as 3,185.6 km as the information in the GIS system does not register old pipes, etc. High-density polyethylene (HDPE) pipes with diameter of 100 mm or less account for about 50% of the total length. The average age of pipe network is about 40 years according to the Kampala Water Supply Master Plan Report. The network in the central part of Kampala is said to be more than 50 years and is prone to leaks and bursts. HDPE pipes, which account for 50% of the total length, were laid in relatively recent date.

Table 3.4.11 Distribution Mains in Kampala Water

Diameter	Distribution Pipe Diameters and Material Water Network						
	DI (km)	GI (km)	HDPE (km)	PVC (km)	ST (km)	Total (km)	Share (%)
700	2.6	-	-	-	-	2.6	0.1%
600	0.9	-	-	-	3.8	4.7	0.1%
550	-	-	-	-	0.3	0.3	0.0%
525	-	-	-	-	-	-	-
500	1.4	-	-	-	0.8	2.2	0.1%
450	0.4	-	-	-	2.0	2.4	0.1%
400	5.1	-	-	2.2	6.5	13.7	0.4%
350	-	-	-	6.7	10.3	17.1	0.5%
300	8.2	-	-	66.4	19.5	94.1	3.0%
250	2.6	-	-	81.5	42.0	126.2	4.0%
200	3.0	-	-	115.3	15.6	133.9	4.2%
150	0.2	0.6	-	286.5	59.2	346.5	10.9%
125	-	-	-	-	4.1	4.1	0.1%
100	-	5.6	60.3	302.6	99.3	467.8	14.7%
<100	-	18.2	1453.3	102.9	395.6	1970.0	61.8%
Sum	24.4	24.4	1513.6	964.1	659.0	3185.6	100%



Source: Compiled by JST based on information collected from NWSC.

Each household in Kampala Water is connected with HDPE pipes up to 80 mm and PVC pipes above 100 mm. Gate valves and water meters are installed for each household water supply. According to NWSC data, the percentage of each connection type in 2020 is 82.4% for domestic water supply, 1.9% for public water taps (PSP 1.5%, PPWM 0.4%), 14.0% for industrial and commercial, and 1.7% for institutional and government offices. Also, the installation of tanks on the premises is widely practiced in situation where stable water supply cannot be expected due to water supply restrictions and burst pipes.

c) Water Meters

The water meters installed by NWSC (for general water supply) are mostly of the flow velocity type, i.e., Tangent Flow Impeller Type (bore size DN15-40), as the Vertical Axial Flow Impeller Type and Turbine Type are rarely used. The manufacturers are mainly BAYLAN (Turkey) and Itron (USA, but made in Indonesia). Also, some meters that are made in China have been installed. BAYLAN is the most widely installed, but many of the older meters are Class-B (ISO standard) in accuracy. Newly procured water meters, regardless of manufacturer, are Class-C with high accuracy. The meter is usually used for seven to ten years. There have been cases where some meters are continuing to be used for more than ten years if determined that there are no issues.

d) Prepaid PSP

The PSP, which include prepaid system, were installed in 1,600 areas in Kampala Water and will be installed in the future. In the past, the existence of water vendors in each district resulted in excessive collection and meter reading which are time consuming works, and the widespread use of prepaid PSP is an effective countermeasure against these issues. Photo 3.4.8 shows the prepaid PSP, charging device, and general PSP.

A token (key for water supply) form NSWC is needed in order to use the prepaid PSP. The token can be charged at any store that has a contract with NWSC. Insert the token into a prepaid PSP, and water will be supplied automatically. Pull out the token to stop the water supply. The prepaid PSP that the JICA Survey Team (JST) visited during the first field survey are powered by a solar system. The water tariff is UGX 25 per 20 liters, which is cheaper than the general PSP. More of these prepaid PSP are planned to be installed in the future, mainly in poor areas.

Source: JST

Photo 3.4.8 Prepaid PSP (Left), Charging Device (Center), General PSP (Right)

For three years from FY 2012/13, a pilot project including the installation of smart meters capable of automatically measuring and recording water volume was implemented at the manufacturer's expense (partially paid by NWSC). Pressure management and smart meters (automatic meter reading for large-scale customers: 200 units) were installed and the operation and handling were verified. Manufacturers such as Huawei (China), Automatic Meter Reading (AMR), AMI (Advanced Metering Infrastructure), and MANAS (Turkey) have implemented the project. In addition, a smart meter demonstration was recently conducted by Itron. The data from the smart meters are transferred to the Kampala Water Office, where water usage fees can be managed. NWSC would like to introduce this system in the future, but the high cost of communication (USD 5/month per connection) is an issue.

e) Introduction of Prepaid Systems in Government Agencies

Since 2018, NWSC has introduced a total of 245 prepaid meters in Kampala, Jinja, and Entebbe for government agencies that previously had many arrears. NWSC has a plan to increase the number of prepaid meter by 500 in FY 2021/2022. According to the interview with NWSC, the advantages of introducing the prepaid meters are reduction of water charge arrears for NWSC and the application of discounted rates of 10% to 20% for customers.

4) GIS Mapping System

a) GIS Implementation Department

GIS is part of asset management, and the Asset Management Section of NWSC Kampala Water consists of three groups: (1) GIS, (2) Hydraulic (mentioned in the DMA above), and (3) Asset

Management (records and replacement plans for pipe repairs, etc.). The GIS group is in charge of the mapping system program.

b) Applied Program

Based on the partnership agreement between NWSC and VEI, VEI introduced "Map Kit", a software sold by a Dutch supplier that can be linked to Google Maps, Google Earth, and ArcGIS. NWSC purchased the software with an unlimited license, using internally generated funds rather than grant aid. Kampala Water has been the first pilot to be introduced, and the project will be expanded to rural areas.

c) Acquired Information

For water supply, information such as the starting point of the water treatment plant (but only the point and not the coverage), pumping stations, distribution reservoirs, pipeline routes, valves, air valves, water taps (hydrants), customer connections, and photos of construction of the facilities are being worked on. The input of location information for old and small diameter pipes without contour lines or digital data is omitted. For transmission and distribution mains, the year of construction, material, diameter, and length of the pipe are required. However, there are many aging pipes for which the location is known, but the year of construction is unknown and has not been registered. The PSP can also be registered, but many are missing due to lack of location information.

Information on pipe routes and manhole locations is mainly registered for sewage, but priority is given to water supply at this stage.

d) Method and Duration Required to Update Service Pipes, Pipelines, Valves, etc.

In addition to the GIS group, the Water Supply Department of Kampala Water is also using Map Kit to register large-scale information for the as-built drawings. In the case of household connections in Kampala, this is generally carried out within a week. Since the details of customer information are separated from the GIS and handled by the Commercial Section (mainly Branch Office), only the number of customers is registered in the GIS. Pipelines and valves shall be reflected in the as-built drawings with location information prepared by the contractor.

(6) Population and Water Demand Projection

NWSC divides the population projections for each water supply area into urban and rural areas, and the projection method takes into account the population growth rate as well as residents who do not have resident card in Kampala, business travelers, and tourists. For rural areas, the population projections of the Uganda Bureau of Statistics (UBOS) are adopted, and for urban areas, the population projections of the UBOS are multiplied by a factor of about two. As a result, the population projection of NWSC is 6,761,636, about twice the population projection of UBOS which is 3,426,000 (2020). Meanwhile, the

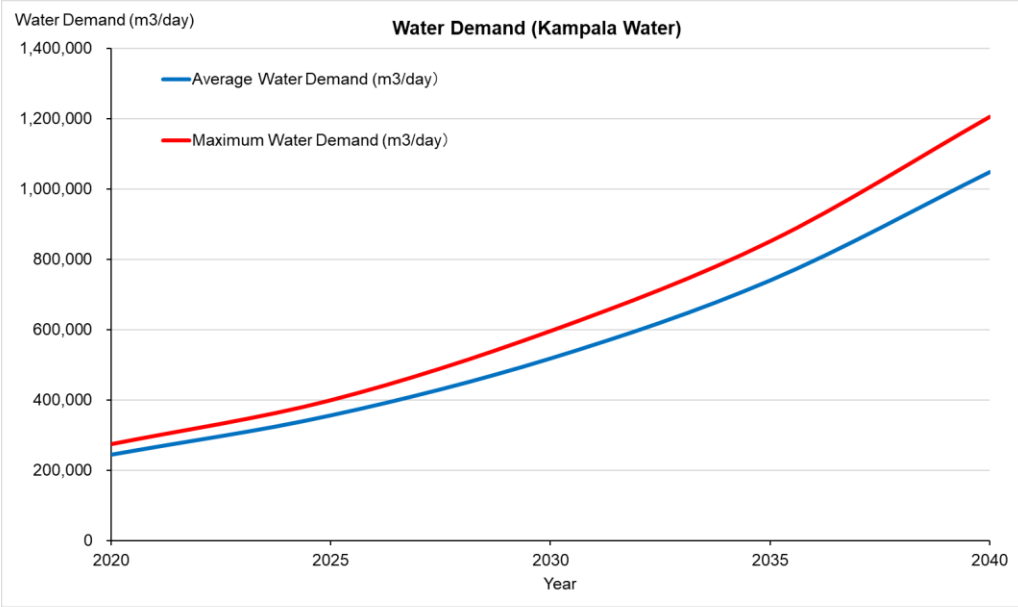
Kampala Water Supply Master Plan Report (MP) projects the average and maximum water demand, with the maximum water demand being 15% of the average water demand. The NWSC population projections were adopted for this survey and projected to 2040 based on the estimated population growth rate (4.4%) of UBOS. The water demand in 2040 is estimated to be 1,047,845 m^3/day for average water demand and 1,205,000 m^3/day for maximum water demand. However, the water demand in MP is estimated to be 525,000 m^3/day for average water demand and 596,600 m^3/day for maximum water demand.

The water demand projection for Kampala Water is shown in Table 3.4.12 and Figure 3.4.12. There are many assumptions in this water demand projection; therefore, it is essential to collect, organize, as well as to consult with related organizations on the population served, expansion of water supply areas in the future, unit consumption, connection rate of each household and PSP, NRW rate, etc., to study the future demand projection in detail.

Table 3.4.12 Water Demand Projection of Kampala Water

Indicator	2020	2025	2030	2035	2040
Target Population (People)	6,761,636	8,366,571	10,352,451	12,809,698	15,850,195
Service Population *1 (People)	2,219,172	4,151,077	6,875,065	10,658,331	15,850,195
Domestic (m^3/ d)	84,616	156,602	271,598	440,904	686,579
PSP (m^3/ d)	7,903	18,462	32,436	53,338	84,130
Commercial & Industrial (m^3/d)	38,824	40,804	42,886	45,073	47,373
Institutional & Government (m^3/d)	16,550	17,394	18,281	19,214	20,194
NRW (%)	39.5	34.5	29.5	26.5	20
Average Water Demand (m^3/d)	244,451	356,126	518,016	739,774	1,047,845
Maximum Water Demand (m^3/d)	273,790	398,860	595,720	850,740	1,205,000

*1: The Service Population is calculated by the population of domestic and PSP. The Service Population in Table 3.3.2 is calculated by the population of domestic, PSP, commercial & industrial, institutional & government.
1. Service Population: 32.8% in 2020, assumed to be 100% by 2040 (3.4% annual growth)。
2. Connection rates for domestic and PSP: Calculated using trends from 2015 to 2020.
3. Unit water consumption per capita for domestic and PSP: 50 liters and 15 liters in 2020, with an annual growth of 1%.
4. Commercial & industrial water consumption: Assumed to increase by 1.0% per year based on actual results from 2015 to 2020.
5. Institutional & government water consumption: Assumed to increase by 1.0% per year based on actual results from 2015 to 2020.
6. NRW: Assumed to decrease by 1% per year based on the actual results of 39.5% in 2020.
Source: JST



Source: JST

Figure 3.4.12 Water Demand Projection of Kampala Water

(7) Kampala Water Lake Victoria WATSAN Project Phase 2

Kampala City and the surrounding areas are facing an urgent need to further expand the water supply capacity to address the current water supply gap and the rapidly growing population. Thus, AFD, EIB, EU-ITF, KfW, and WB are implementing projects highlighted in Table 3.4.13 for Kampala Water to address these issues. This project will increase the water production capacity from the current 230,000 m^3/day to 390,000 m^3/day (expandable to 470,000 m^3/day). In addition, the Katosi-Kampala transmission mains, distribution reservoirs, and SCADA system are also being constructed. The rehabilitation of the Ggaba WTP was completed in December 2019 and is currently operational. The construction of the Katosi WTP and the Katosi-Kampala transmissions mains and pumping station have also been completed, and as of August 2021, 60,000 m^3/day of water is being distributed.

Table 3.4.13 Construction Details and Progress of Kampala Water Lake Victoria WATSAN Project Phase 2

Item	Construction Details	Progress (June 2019)	Scheduled Completion
Ggaba WTP	Rehabilitation of Ggaba WTP.	Completed.	Dec 2019
Construction of the new Katosi WTP	160,000 m^3 (possibility of increase to 240,000 m^3/day)	Completed	Jul 2021
Installation of Katosi-Kampala transmission mains	Construction of transmission mains (1,400 mm, 45 km, 700 mm, 15 km), reservoir, pumping stations.	Transmission mains: 88% Reservoir, pumping stations, distribution: Under construction	Jul 2021
Installation of transmission mains	Reconstruction and rehabilitation of the water distribution network	Detailed design stage.	2024
Rehabilitation of water supply facilities in informal settlements	Construction of faecal sludge treatment plant. Other construction works.	Faecal sludge treatment plant: Under construction. Selection of contractors for other construction works has been delayed due to COVID-19.	Dec 2023

Source: NWSC Annual Report 2019/2020 and interview with NWSC

(8) Issues on the Development of Water Supply Facilities

1) Dedicated NRW Department

The new Katosi WTP (160,000 m^3/day) is scheduled to start operation in July 2021, and together with the existing Ggaba WTP, the total water production volume will increase to 390,000 m^3/day. If 390,000 m^3/day is distributed to the existing distribution network, the NRW rate of 40% (at the end of 2020) is expected to be even higher due to the increased pressure in the pipes. NWSC is currently developing a plan to rehabilitate the Kampala distribution network; however, no specific plan for NRW reduction has been taken at this time. NRW reduction is considered to be the top priority since the only technical NRW measures implemented by Kampala Water are mainly leakage control of surface water and regular monitoring of pipe pressure, and as mentioned in 3.4.1 (3) Non-Revenue Water, a specialized department for NRW reduction activities including human resource development needs to be established as soon as possible.

2) Construction of DMA

The low and high level distribution zones that were originally constructed have been integrated with a number of connecting pipes and are now no longer distinguishable. Also, no DMA has been constructed. This causes the pressure in the pipe (especially in the low level distribution zone) to increase, which is one of the causes of pipe leakage and rupture. It is recommended to establish a water distribution system that separates the low level distribution zone from the high level distribution zone, and construct DMAs in each distribution zone for systematic leakage management. Detailed design for the reconstruction and rehabilitation of water distribution network is being carried out under Kampala Lake Victoria WATSAN Project; however, the project only covers part of the network due to budget shortage. Further funding is needed for the rehabilitation of the water distribution network.

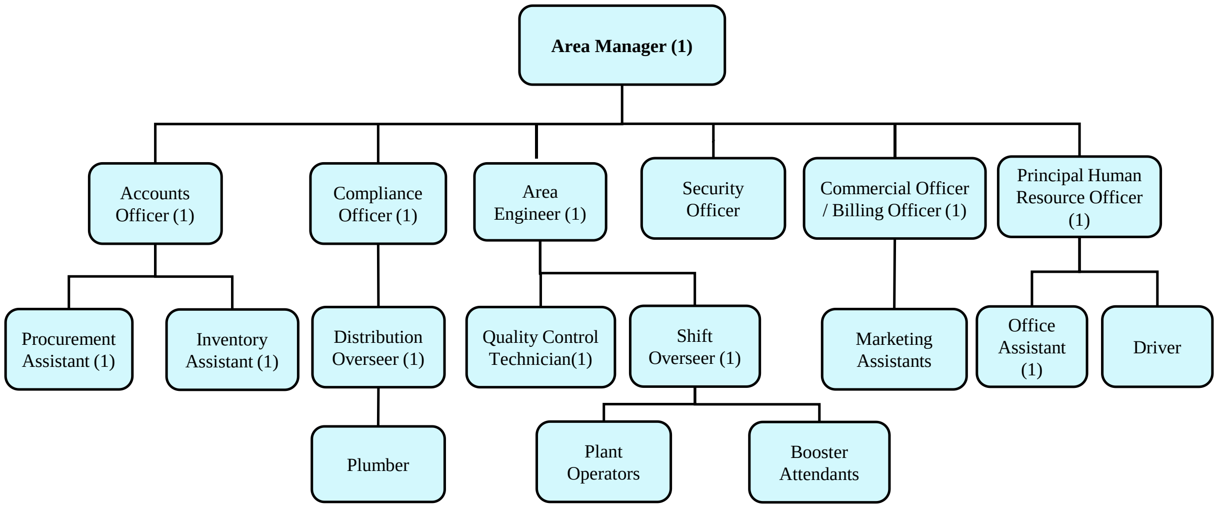
3) Systematic Development Planning to Meet Water Demand

Water supply restrictions are occurring in and around Kampala due to the extension of pipes around Kampala, even though water demand is exceeding the water production volume due to rapid population growth. Therefore, although the population served is increasing, the water usage per capita is decreasing. After discussion and consultation of the planning year and the distribution zone with relevant organizations, it is recommended to formulate a development plan that is well planned to meet the future water demand, including the transmission and distribution network.

3.4.2 Hoima Water

(1) Organizational Structure of Hoima Branch

Hoima Water was transferred to NWSC in 2006 and is currently operated and maintained by Hoima Waterworks as one of the organizations in the Technical Services Division of NWSC. Also, Hoima Waterworks is responsible for water quality test, rehabilitation and expansion of the distribution network, installation of transmission network with water meter, construction of PSP, meter reading, preparation and sending of water bills, collection of water bills, dealing with water bills arrears, finding illegal connection, repair of leakage, etc. Under the supervision of the Area Manager, Hoima Branch consists of an Accountant Officer, Compliance Officer, Area Engineer, Security Officer, Commercial Officer / Billing Officer, and Principal Human Resource Department, and has 24 employees as of FY 2019/20. Figure 3.4.13 shows the organizational structure of Hoima Branch.



Source: NWSC Hoima

Figure 3.4.13 Organizational Structure of Hoima Branch

(2) Management, Financial Status

1) Number of Connections, Water Billing and Collection

Table 3.4.14 shows the number of connections of Hoima Branch. As of November 2020, Hoima Branch had total connections of 4,931. Of these, 80% are active connections and 20% are inactive connections. The main reasons for the inactive connections are alternative water sources (boreholes) in place of the water supply from NWSC, delayed payment, shut off of water supply due to highly elevated area, and in some cases, connections that have been shut down for a long time. Based on the number of NWSC staff (24) and the number of connections, it is estimated that the number of staff per 1,000 connections is 3.9, which indicates that Hoima Branch has good staff productivity.

Table 3.4.14 Number of Connections of Hoima Branch (As of November 2020)

Type of Connections	Active	Inactive	Total
Domestic (nos.)	3,693	862	4,555
PSP (nos.)	133	12	145
Commercial & Industrial (nos.)	955	344	1,299
Institutional & Government (nos.)	150	33	183
Total	4,931	1,251	6,182
Ratio	80%	20%	100%

Source: Compiled by JST based on interviews with NWSC and collected data

Table 3.4.15 shows the water billing and collection for FY 2018/19 and FY 2019/20. Although the collection efficiency was almost the same, the water billing has decreased significantly. The reasons include increase of NRW, but mainly due to lockdown of accommodation and commercial business premises in Hoima, which is also a tourist area, as a result of COVID-19.

Table 3.4.15 Water Billing and Collection of Hoima Branch

Item	2018/19	2019/20
Billing (UGX '000)	2,975,637	1,967,866
Collection (UGX '000)	2,736,477	1,894,006
Collection Efficiency	92%	94%

Source: NWSC Integrated Annual Report 2019/20

2) Income and Expenditure

Table 3.4.16 shows the income and expenditure of Hoima Branch for FY 2017/18, FY 2018/19, and FY 2019/20. The expenditure/income ratio of Hoima Branch improved in FY 2018/19 but worsened to 1.4 in FY 2019/20. The reasons for this are that the income was affected by the low water consumption due to COVID-19, leaks due to burst pipes, unstable power supply that affects water production, and water theft. The expenditure was affected by breakdowns and maintenance at water intake points, and the 1.5 times increase in water production costs.

Table 3.4.16 Income and Expenditure of Hoima Branch

Item	2017/18	2018/19	2019/20
Income (UGX '000)	1,612,790	2,098,612	1,730,315
Expenditure (UGX '000)	1,819,040	2,109,606	2,388,113
Expenditure/Income Ratio	1.1	1.0	1.4

Source: NWSC Integrated Annual Report 2018/19, 2019/20

(3) Countermeasures for Non-Revenue Water (NRW)

The NRW rate of Hoima Branch is shown in Table 3.4.17. The NRW rate for FY 2019/20 was 29%. Commercial losses include faulty meters and inaccurate water metering due to intermittent operation (insufficient water pressure in distribution network). However, the meter installation rate is 100%. Meanwhile, physical losses include burst on the pump water pipes, leakage due to poorly constructed distribution and transmission mains, and leakage from aging valves. Since the water supply hours is 8 to 12 hours, which is short (the pressure inside the pipes becomes low and therefore lesser time for leakage), and most of the pipes are relatively new, leakage from the distribution mains is low. The main losses are due to damage on water pipe caused by road construction, etc., but losses also occur during maintenance, and as shown in Photo 3.4.9 taken during site visit, overflow from the reservoir occurred because the pumps at the water treatment plant were still operating even when the reservoir has reached a high-water level. According to Hoima Branch, the yearly fluctuation in the NRW rate was due to burst on the pumping water pipes at irregular intervals and overflows.

Source: JST

Photo 3.4.9 Overflow from Kikwite Reservoir

Current countermeasures for NRW include replacing faulty meters, educating customers about water theft, ensuring that dormant accounts are properly managed, and keeping inactive water meters sealed to deal with commercial losses. Also, inspections of fire hydrants and valves, prompt repair of leakage and burst pipes, installation of water level gauges in reservoir, leakage management by exposing distribution mains installed in wetlands to deal with physical losses. However, detection of underground leaks, etc., is not being carried out at present.

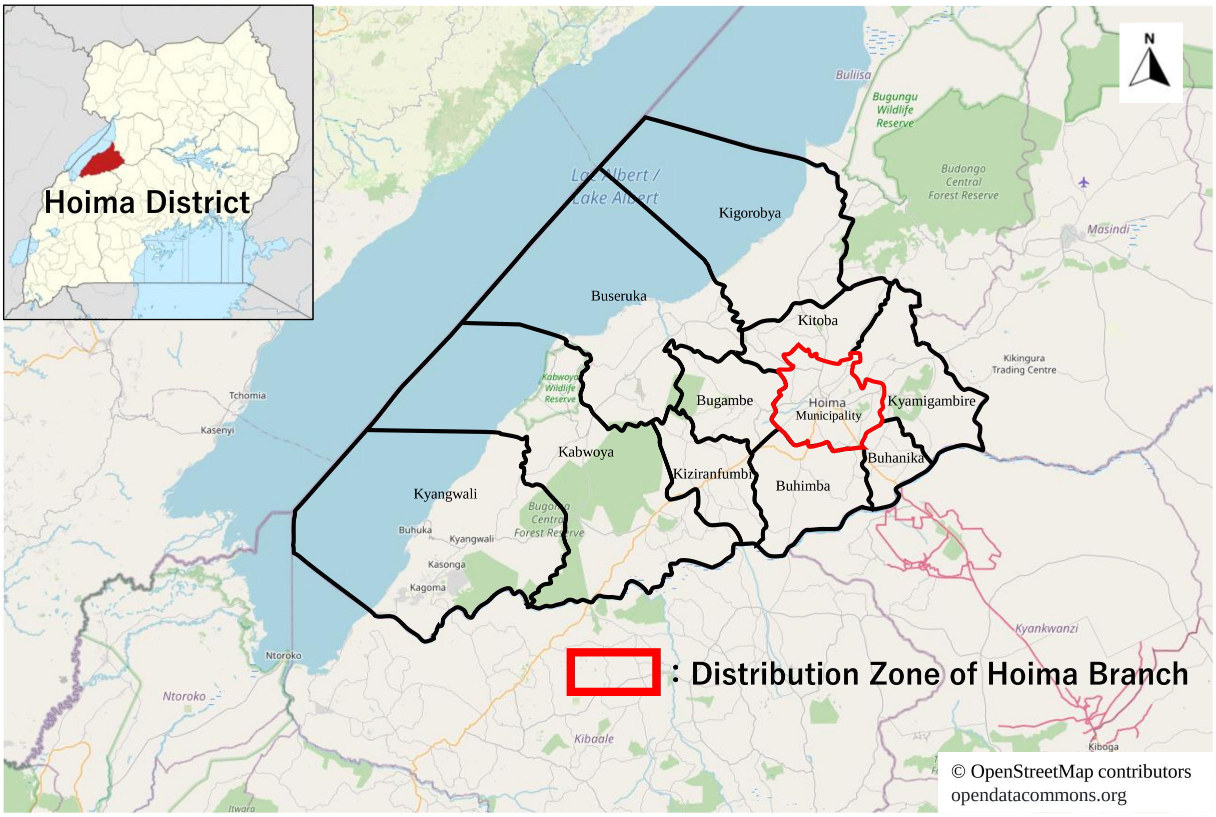
Table 3.4.17 NRW Rate of Hoima Branch

FY	2015/16	2016/17	2017/18	2018/19	2019/20
NRW	31.6%	19.9%	31.3%	19.0%	29.0%

Source: NWSC

(4) Distribution Zone of Hoima Branch

The distribution zone of Hoima Branch is located 30 km east of Lake Albert and serves Hoima Municipality (Bujumbura Division, Busiisi Division, Kahoora Division, and Mparo Division). Figure 3.4.14 shows the distribution zone of Hoima Branch.



Source: Compiled by JST based on data collected from NWSC

Figure 3.4.14 Distribution Zone of Hoima Branch

(5) Outline of Water Supply Facilities of Hoima Water

1) Water Source and Water Treatment System

Hoima Water uses boreholes as its water source, which is then treated at a water treatment plant. The water quality from the boreholes is too high in iron concentration and color to be distributed directly; therefore, the water is treated at the water treatment plant before being distributed. As of March 2021, two of the eight boreholes had breakdowns, reducing the water production capacity to 2,105 m^3/day compared with the current capacity of 3,000 m^3/day (design capacity: 8,560 m^3/day). The breakdowns were caused by the collapse of the well casing and the deterioration of groundwater quality. Table 3.4.18 provides an outline of the water treatment system. Photo 3.4.10 shows the rapid sand filtration, chlorine house, and water quality test laboratory of Hoima WTP.

Table 3.4.18 Outline of Water Treatment System of Hoima Water

Item	Specifications
Water Source	Kiribanywa–Bigajuka Groundwater Boreholes: 8 (pumping capacity: 20 – 80 m^3/hour) constructed in 2006
Water Production Capacity	Hoima WTP: 3,000 m^3/day (design water production capacity: 8,560 m^3/day)
Treatment Method and Main Facilities	1) Cascade aerator, 2) Rapid sand filter, 3) Backwash facility, 4) Water reservoir, 5) Chemical house, 6) Pumping station, 7) Emergency generator station, 8) Water quality test laboratory, etc.
Water Quality Test	Water quality test has been conducted based on the water quality testing schedule and test items. According to the water quality test results, the water quality at the water treatment plant is within the standard values.
Treatment Conditions	The design water production capacity was 8,560 m^3/day, but the production capacity has been reduced to 3,000 m^3/day due to deterioration of the raw water quality (iron, algae, etc.) and the use of inappropriate filter media. Water supply from the boreholes is 2,015 m^3/day, and the actual water production capacity varies depending on the raw water supply from the boreholes. Also, unstable power supply is also affecting the raw water supply volume. The chlorine dosing system has no dosing pump or mixer; therefore, it is difficult to determine whether the dosed volume can be properly controlled.
Wastewater Treatment	There is no wastewater treatment facility, and the wastewater is directly discharged.
O&M and Others	• Overflow from the reservoir was confirmed due to inadequate O&M of the water transmission pump installed in the water treatment plant. However, implementation is being carried out where possible in view of the current status of the facilities, including cleaning of the facilities. • Installation of mixing basin, sedimentation basin, and treatment of water with chemicals before entering the filtration ponds are needed if the water quality in the boreholes does not improve in the future. • Replacement of aging pipes, valves, etc. • Rehabilitation of chlorine dosing system is required.

Source: Compiled by JST based on interviews with NWSC and collected data


Source: JST

Photo 3.4.10 Hoima WTP (Rapid Sand Filtration (Left), Chlorine House (Center), Water Quality Test Laboratory (Right))

2) Water Transmission System

Source: JST

Photo 3.4.11 Hoima Pumping Station

The water treated at Hoima WTP is pumped to Bakumira Reservoir and Kikwite Reservoir from a pumping station (Photo 3.4.11) located within the water treatment plant. The transmission system consists of two systems: PVC pipe with diameter of 100 mm and total length of 3.1 km to Bakumira Reservoir, and PVC pipe with diameter of 250 mm and total length of 3.1 km to Kikwite Reservoir. The transmission system consists of three pumps that deliver water to the two reservoirs. Two of the three pumps are aging rapidly. Also, there is no spare equipment, making it difficult to respond to a pump failure. As the pumping stations are operated manually, overflows occur when Bakumira Reservoir, which has a small storage capacity, is filled with water. Table 3.4.19 shows the total length and materials of the transmission mains as of 2016. The information on the transmission and distribution mains is managed by the GIS unit of Kampala Water (other than Kampala Water Supply), but other than the number of connections, the information has not been updated since 2016.

Table 3.4.19 Transmission Mains of Hoima Water (As of 2016)

Diameter	Transmission Pipe Diameters and Material Water Network		
	PVC (km)	Total (km)	Share (%)
200	5.6	5.6	52.9%
150	1.6	1.6	15.5%
125	-	-	-
100	3.3	3.3	31.7%
<100	-	-	-
Total	10.6	10.6	100%

Source: Compiled by JST based on information collected from NWSC

3) Water Distribution System

Figure 3.4.15 shows the Hoima water distribution network. Table 3.4.20 shows the reservoir at Hoima Water. Hoima Water distribution network is divided into two major regions, and water is distributed from Bakumira Reservoir and Kikwite Reservoir (Photo 3.4.12). Bakumira Reservoir serves the eastern part of Hoima and areas that cannot be served by the Kikwite Reservoir due to low water pressure, while Kikwite Reservoir serves the central and southern, northern and western part of Hoima. Both reservoirs are built on top of a hill, and water is distributed by gravity flow. The Kikwite Reservoir is not filled with water as the water production capacity of Hoima WTP is only about 2,000 m^3/day.

Source: JST

Photo 3.4.12 Kikwite Reservoir

Table 3.4.20 Reservoirs of Hoima Water

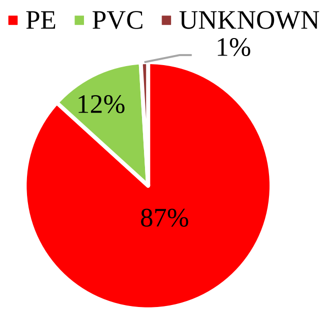
Reservoir	Size	Year of Construction
Bakumira Reservoir	Steel circular tanks, above ground, 162 m^3 x 2	2017
Kikwite Reservoir	RC circular tanks, semi-underground, 1,500 m^3 x 2	2005

Source: Compiled by JST based on information collected from NWSC

The total length of the existing distribution mains is 261 km (2021), with diameters ranging from 25 mm to 300 mm, mainly PVC and HDPE pipes. Hoima Water was transferred to NWSC in 2006, and most of the pipes were installed during the transfer period. Table 3.4.21 shows the diameter and length by material type of the water distribution mains (as of 2016).

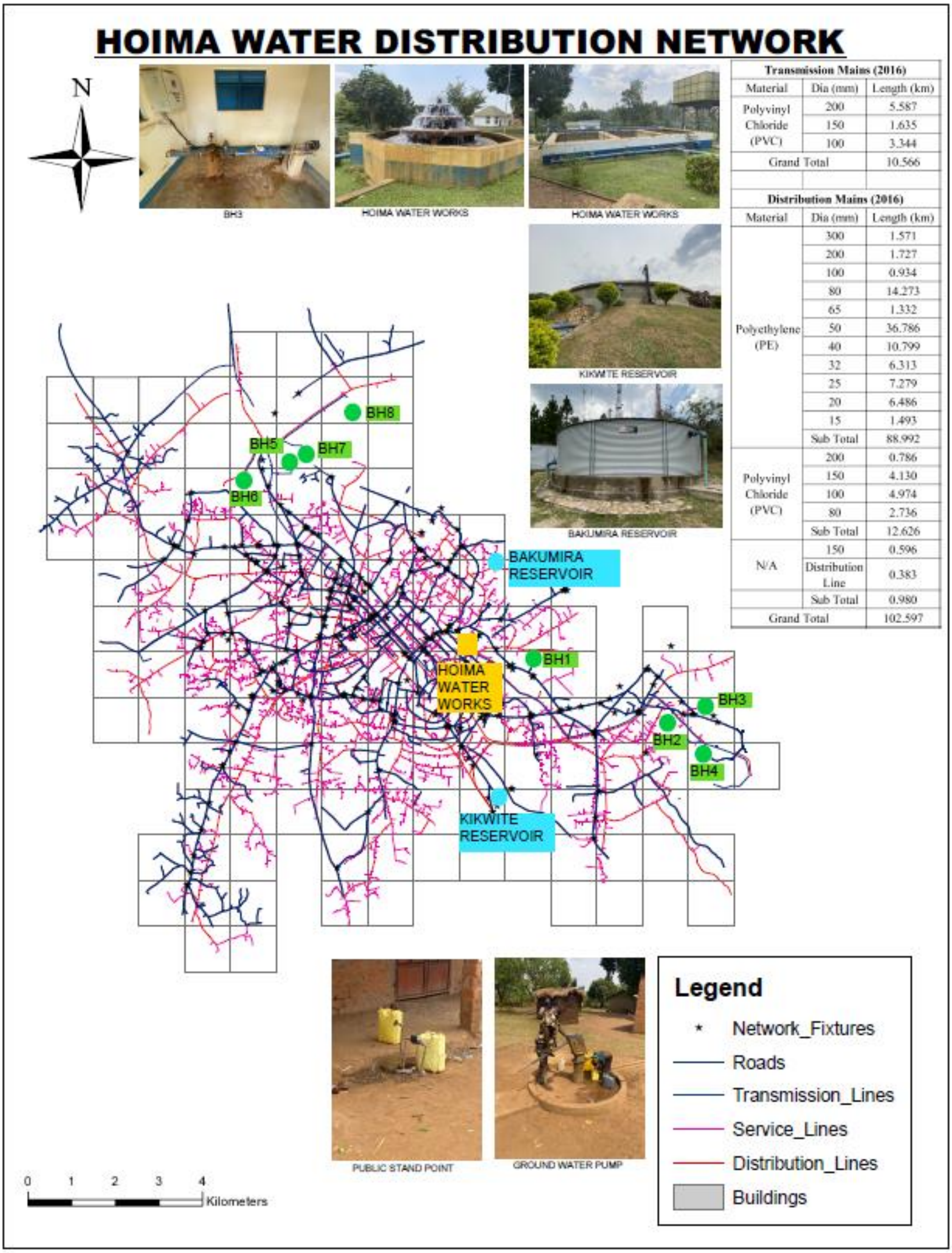
Table 3.4.21 Distribution Mains of Hoima Water (As of 2016)

Diameter	Distribution Pipe Diameters and Material Water Network				
	PE (km)	PVC (km)	UNKNOWN (km)	Total (km)	Share (%)
300	1.6	-	-	1.6	1.5%
250	-	-	-	-	-
200	1.7	0.8	-	2.5	2.4%
150	-	4.1	0.6	4.7	4.6%
125	-	-	-	-	-
100	0.9	5.0	-	5.9	5.8%
<100	84.8	2.7	-	87.5	85.3%
UNKNOWN	-	-	0.4	0.4	0.4%
Total	89.0	12.6	1.0	102.6	100%



Source: Compiled by JST based on information collected from NWSC

PVC and HDPE pipes are used for household connections, and gate valves and water meters are installed. The ratio of each connection type in Hoima Branch as of November 2020 was 74% for domestic, 2.3% for PSP, 21% for commercial and industrial, and 2.7% for institutional and government. Prepaid PSP and smart meters are not installed in Hoima Branch. Also, the installation of tanks on the premises is widely practiced in situation where stable water supply cannot be expected due to water supply restrictions and burst pipes.



Transmission Mains (2016)		
Material	Dia (mm)	Length (km)
Polyvinyl Chloride (PVC)	200	5.587
	150	1.635
	100	3.344
Grand Total		10.566

Distribution Mains (2016)		
Material	Dia (mm)	Length (km)
Polyethylene (PE)	300	1.571
	200	1.727
	100	0.934
	80	14.273
	65	1.332
	50	36.786
	40	10.799
	32	6.313
	25	7.279
	20	6.486
	15	1.493
	Sub Total	88.992
Polyvinyl Chloride (PVC)	200	0.786
	150	4.130
	100	4.974
	80	2.736
	Sub Total	12.626
N/A	150	0.596
	Distribution Line	0.383
	Sub Total	0.980
Grand Total		102.597

Source: NWSC GIS Unit

Figure 3.4.15 Hoima Water Distribution Network

4) Population and Water Demand Projection

As described in the Population and Water Demand Projections of Kampala Water, NWSC divides the population projections for each water supply area into urban and rural areas for the calculation of the population served, and Hoima Branch is classified as urban area. In 2020, the population projection of NWSC is 253,978 compared with the population projection of UBOS which is 122,700. The water demand in 2040 is estimated to be 22,577 m^3/day for average water demand and 25,960 m^3/day for maximum water demand. However, according to the Hoima FS Report[12], the average water demand in 2043 is estimated to be 31,575 m^3/day and the maximum water demand is estimated to be 49,257 m^3/day, a difference of more than 1.4 times in average water demand. The difference is mainly due to differences in unit water consumption in the target areas and in each category.

The water demand projection for Hoima Branch is shown in Table 3.4.22 and Figure 3.4.16. There are many assumptions in this water demand projection; therefore, it is essential to collect, organize, as well as to consult with related organizations on the population served, expansion of water supply areas in the future, unit consumption, connection rate of each household and PSP, NRW rate, etc., to study the future demand projection in detail.

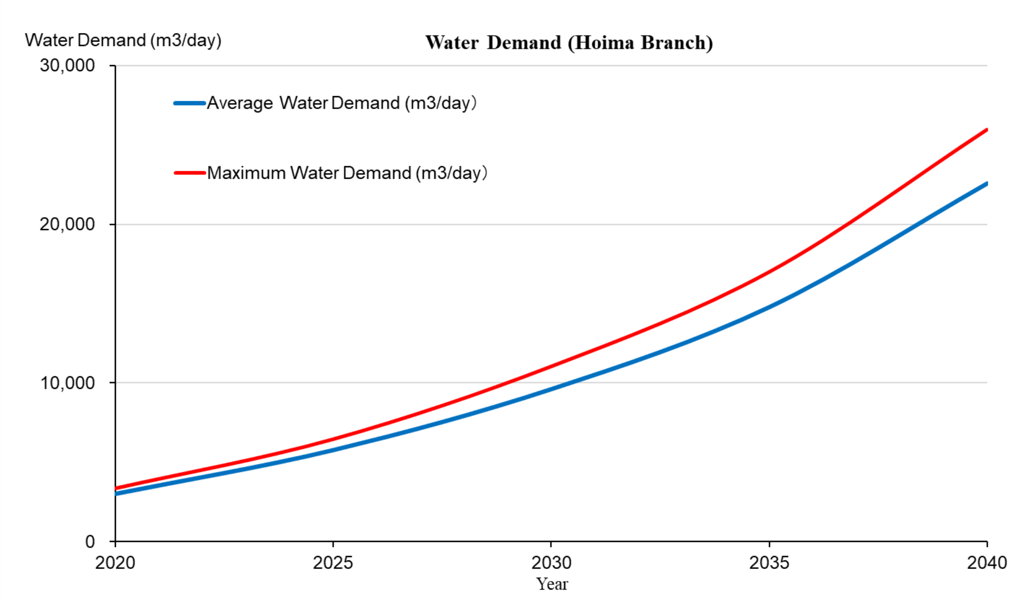
Table 3.4.22 Water Demand Projection of Hoima Branch

Indicator	2020	2025	2030	2035	2040
Target Population (People)	253,978	302,265	360,589	429,655	511,950
Service Population*1 (People)	47,844	118,412	214,258	342,476	511,950
Domestic (m^3/day)	1,278	2,810	5,219	8,559	13,118
PSP (m^3/day)	334	1,024	1,984	3,396	5,435
Commercial & Industrial (m^3/day)	296	311	327	344	361
Institutional & Government (m^3/day)	225	236	249	262	276
NRW (%)	29	24	19	15	15
Average Water Demand (m^3/day)	3,003	5,765	9,604	14,778	22,577
Maximum Water Demand (m^3/day)	3,360	6,460	11,040	16,990	25,960

*1: The Service Population is calculated by the population of domestic and PSP. The Service Population in Table 3.3.2 is calculated by the population of domestic, PSP, commercial & industrial, institutional & government.
1. Service Population: 18.8% in 2020, assumed to be 100% in 2040 (4.1% annual growth）。
2. Connections rates for domestic and PSP: Calculated using trends from 2015 to 2020.
3. Unit water consumption per capita for domestic and PSP: 50 liters and 15 liters in 2020, with an annual growth of 1%.
4. Commercial & industrial, institutional & government water consumption: Assumed to increase by 1.0% based on Hoima FS Report.
5. NRW: Assumed to decrease by 1% per year to 15% based on the actual results of 29% in 2020.

Source: JST

[12] Feasibility Study and Pre-Design for the Development of Water and Sanitation Infrastructure for the Hoima-Masindi Areas



Source: JST

Figure 3.4.16 Water Demand Projection of Hoima Branch

(6) Issues on the Development of Water Supply Facilities

1) Development of Water Source

The current water source in Hoima Water is limited to groundwater. NWSC has carried out a Feasibility Study on Water Supply Development in Hoima-Masindi Area, with proposed water sources being groundwater and the River Kafu (40,000 m^3/day, approximately 18 km south of the center of Hoima). At the time the JST visited the site, it was unclear whether 40,000 m^3/day could be abstracted as the flow rate was limited at the end of the dry season. If River Kafu (Photo 3.4.13) was to be used as water source, a long-term flow survey is essential to be carried out to ensure that the flow rate is sufficient to ensure abstraction. It is also suggested that a comprehensive water source development plan be formulated by investigating the amount of groundwater available in a wide area.

Source: JST

Photo 3.4.13 River Kafu during the Dry Season

2) Water Treatment System

As mentioned earlier, the design water production capacity of Hoima WTP is 8,560 m^3/day, but the current production capacity has decreased to 3,000 m^3/day. Although the water treatment plant could be rehabilitated to restore its capacity, it is desirable to construct a new water treatment plant from the viewpoint of ease of operation and maintenance.

3) Water Distribution System

Unlike Mubende Water and Mityana Water, etc., Hoima Water mainly supplies water to the city through a network of distribution pipes. Recently, the water distribution area has been expanded to the outskirts of the city, but it is important to plan the water distribution system after clarifying the policy of NWSC and discussing with relevant organizations on how far to expand the water distribution area by setting a planning year.

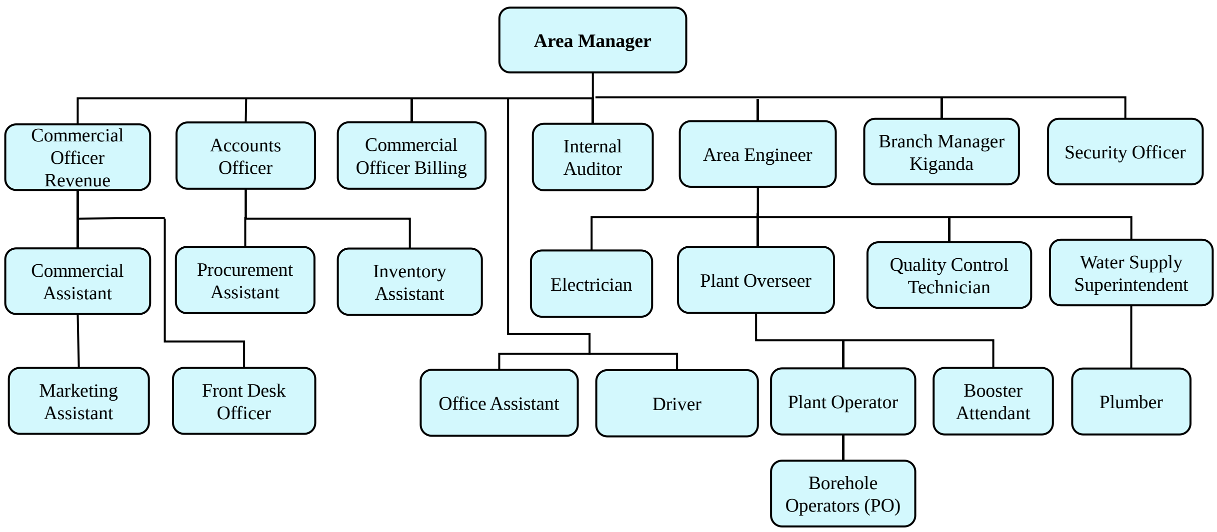
4) Countermeasures for Non-Revenue Water (NRW)

The NRW rate in Hoima Branch is about 20% to 30% and fluctuates by about 10% from year to year. The reason is mainly due to burst and overflow of pump water pipes with high internal pressure. In addition to the ground leakage management that is currently being implemented, pressure management and asset management of aging pipes and water meters, etc., are important for NRW countermeasures, but no proactive measures have been taken. It is presumed that the training of NWSC has, to some extent, laid the groundwork for knowledge on NRW reduction. However, with the current composition of technical staff, it is difficult to set up a department dedicated to NRW reduction, and it would be desirable for NWSC HQ to actively participate in the NRW programmes. For example, several branch offices should be organized as one group, and a corresponding NRW reduction team should be organized and trained to carry out efficient operations such as pipe renewal in sections with frequent leakage from aging pipes, pressure management, leakage detection, and coordination with GIS units. This will also enable the efficient use of materials and equipment for leakage control.

3.4.3 Mubende Water

(1) Organizational Structure of Mubende Branch

Mubende Water was transferred to NWSC in 2006 and is responsible for the operation and maintenance of two water distribution systems in Mubende Municipality and its surrounding areas, as well as in Kiganda Sub-county, 36 km to the east. Mubende Branch is responsible for water quality test, rehabilitation and expansion of the distribution network, installation of transmission network with water meter, construction of PSP, meter reading, preparation and sending of water bills, collection of water bills, dealing with water bills arrears, finding illegal connection, repair of leakage, etc. Under the supervision of the Area Manager, Mubende Branch consists of a Commercial Officer Revenue, Account Officer, Commercial Officer Billing, Internal Auditor, Area Engineer, Branch Manager Kiganda, and Security Officer, and has 29 employees as of FY 2019/20. Figure 3.4.17 shows the organizational structure of Mubende Branch.



Source: NWSC Mubende

Figure 3.4.17 Organizational Structure of Mubende Branch

(2) Management, Financial Status

1) Number of Connections, Water Billing and Collection

Table 3.4.23 shows the number of connections in Mubende Branch. As of November 2020, Mubende Branch had total connections of 5,878. Of these, 86% are active connections and 14% are inactive connections. The main reasons for the inactive connection are delayed payment, and in some cases, connections that have been shut down for a long time. Based on the number of NWSC staff (29) and the number of connections, it is estimated that the number of staff per 1,000 connections is 4.9, which indicates that Mubende Branch has good staff productivity.

Table 3.4.23 Number of Connections of Mubende Branch

Type of Connections	Active	Inactive	Total
Domestic (nos.)	3,809	585	4,394
PSP (nos.)	208	10	218
Commercial & Industrial (nos.)	886	207	1,093
Institutional & Government (nos.)	146	27	173
Total	5,049	829	5,878
Ratio	87%	13%	100%

Source: Compiled by JST based on interviews with NWSC and collected data

Table 3.4.24 shows the water billing and collection for FY 2018/19 and FY 2019/20. Although the collection efficiency was almost the same, the water billing has decreased. This is largely due to pump breakdown, which causes the shut off of water supply, and lockdown of accommodation and commercial business premises as a result of COVID-19.

Table 3.4.24 Water Billing and Collection of Mubende Branch

Item	2018/19	2019/20
Billing (UGX '000)	2,416,850	2,170,620
Collection (UGX '000)	2,201,581	1,941,737
Collection Efficiency	91%	89%

Source: NWSC Integrated Annual Report 2019/20

2) Income and Expenditure

Table 3.4.25 shows the income and expenditure of Mubende Branch for FY 2017/18, FY 2018/19, and FY 2019/20. When compared with the previous years, the expenditure/income ratio has worsened to 1.8 in FY 2019/20. The reason for this is that the income was affected by the decrease in water production due to pump breakdown and lower water consumption due to COVID-19. The expenditure was affected by the increase in repair costs for the pump and increase in cost of water treatment.

Table 3.4.25 Income and Expenditure of Mubende Branch

Item	2017/18	2018/19	2019/20
Income (UGX '000)	1,836,982	2,113,517	1,942,984
Expenditure (UGX '000)	1,727,998	2,070,677	3,558,758
Expenditure/Income Ratio	0.9	1.0	1.8

Source: NWSC Integrated Annual Report 2018/19, 2019/20

(3) Countermeasures for Non-Revenue Water (NRW)

The NRW rate of Mubende Branch is shown in Table 3.4.26. The NRW rate in Mubende Branch was 11% as of 2020, which is the lowest among the ten target areas. Commercial losses include the use of inaccurate meters, poorly installed pipes, inaccurate water supply due to low water pressure, and water theft. The meter installation rate is 100%. Meanwhile, as for physical losses, the occurrence of above-ground leaks from the distribution mains is low due to the low water supply hours of 18 hours and the relatively new pipes, and leakages are reported to be mainly from the water supply to each household and from valves. Also, there are reports of damaged pipes caused by road construction. However, the length of distribution mains in Mubende Water is shorter than those in Hoima Water (261 km, 2021) and Mityana Water (231 km, 2021). This may be the reason for the low NRW rate. Similar to Hoima, active measures such as detection of underground leaks are currently not being carried out.

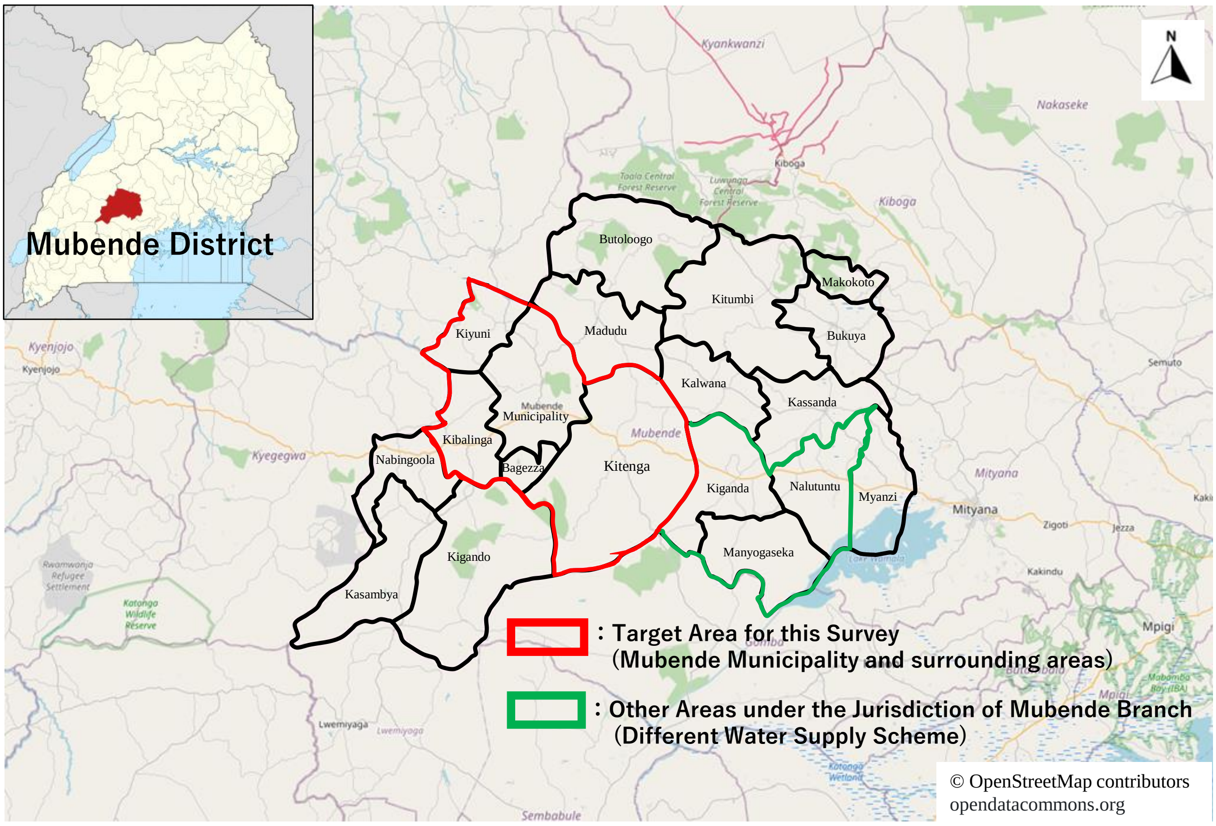
Table 3.4.26 NRW Rate of Mubende Branch

FY	2015/16	2016/17	2017/18	2018/19	2019/20
NRW	9.6%	6.5%	8.1%	7.0%	11.0%

Source: NWSC

(4) Distribution Zone of Mubende Branch

The distribution zone of Mubende Branch is located in the South East part of Lake Albert and consists of two water distribution systems. As of 2021, one system is responsible for water supply to Mubende Municipality and its surroundings areas (Kitenga Sub-county, Kiyuni Sub-county, Bagezza Sub-county, Kibalinga Sub-county), and the other system is responsible for Kiganda Sub-county, Manyogaseka Sub-county and Nalutuntu Sub-county. Figure 3.4.18 shows the distribution zone of Mubende Branch.



Source: Compiled by JST based on data collected from NWSC

Figure 3.4.18 Distribution Zone of Mubende Branch

(5) Outline of Water Supply Facilities of Mubende Water

1) Water Source and Water Treatment System

Although Mubende Branch has jurisdiction over two water distribution systems, the outline of the water treatment system in this section will focus on one system that supplies the Mubende Municipality and its surrounding areas. Mubende Water has two dams and five boreholes as its water sources. Water from the dams is treated and distributed at Katoma WTP. Water from the boreholes is treated with chlorine and pumped directly to the reservoir. Meanwhile, Kiganda Sub-county has two boreholes with pumping capacity of 480 m^3/hour.

Table 3.4.27 provides the outline of the water treatment system. Photo 3.4.14 shows the aerator at Katoma WTP and the view of Katoma Dam.

Table 3.4.27 Outline of Water Treatment System of Mubende Water

Item	Specifications
Water Source	• Area of Katoma Dam: 67,000 m^2 (measured by Google Earth, depth: about 4 m) • Kachwamango Dam • Katabalanga boreholes: 5 (pumping capacity: 6-31 m^3/hour) constructed in 2006
Water Production Capacity	Katoma WTP: 1,920 m^3/day
Treatment Method and Main Facilities	1) Cascade aerator, 2) Mixing basin, flocculation basin, 3) Sedimentation basin,4) Rapid sand filter, 5) Backwash facility, 6) Water reservoir, 7) Chemical house, 8) Pumping station, 9) Emergency generator station, 10) Water quality test laboratory, etc.
Water Quality Test	Water quality test has been conducted based on the water quality testing schedule and test items. Based on the water quality test results, the water quality at the water treatment plant is within the standard values. Although residual chlorine remains at the tap, some tested items have been found to be slightly higher than the Uganda Water Quality Standard.
Treatment Conditions	• The average water production capacity is about 1,560 m^3/day against the design production capacity of 1,920 m^3/day, an 81% capacity utilization (Two boreholes in Kiganda Sub-county are excluded). • The color of the raw water is about 4 times higher, and the iron concentration is about 3-6 times higher than the Uganda Water Quality Standard. However, the treated water meets the Uganda Water Quality Standard. • There are no dosing pump or mixer installed in the chlorine dosing system. Thus, the dosing volume is difficult to be controlled.
Wastewater Treatment	There is no wastewater treatment facility, and the wastewater is directly discharged.
O&M and Others	• The facilities are relatively well managed, but some inappropriate connections are observed in the in-place piping. • Kachwamango Dam needs to be cleaned on a regular basis. • Replacement of aging pipes, valves, etc. • Rehabilitation of chlorine dosing system is required.

Source: Compiled by JST based on interviews with NWSC and collected data


Source: JST

Photo 3.4.14 Katoma WTP (Aerator (Left), View of Katoma Dam from Katoma WTP (Right))

2) Water Transmission System

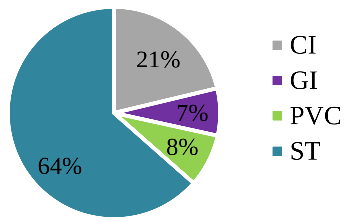
Source: JST

Photo 3.4.15 Katoma Pumping Station

Water treated at Katoma WTP is pumped from the pumping station (Photo 3.4.15) within the plant to Kasenyi Reservoir (1,700 m^3) and Booma Tank (50 m^3, water supply for the army barracks). The transmission system consists of two systems: cast iron pipe with diameter of 150 mm and total length of 9 km to Kasenyi Reservoir, and PVC pipe with diameter of 150 mm and total length of 3 km to Booma Tank. Table 3.4.28 shows the total length and materials of the transmission mains as of 2017. The pipe materials are cast iron (CI), galvanized iron (GI), PVC, and steel (ST). The information on the transmission and distribution mains is managed by the GIS unit of Kampala Water (other than Kampala Water Supply), but other than the number of connections, the information has not been updated since 2017.

Table 3.4.28 Transmission Mains of Mubende Water (As of 2017)

Diameter	Transmission Pipe Diameters and Material Water Network					
	CI (km)	GI (km)	PVC (km)	ST (km)	Total (km)	Share (%)
150	-	-	-	14.5	14.5	62.6%
125	-	-	-	-	-	-
100	-	-	-	-	-	-
<100	4.9	1.7	1.9	0.2	8.7	37.4%
Total	4.9	1.7	1.9	14.7	23.2	100%



Source: Compiled by JST based on information collected from NWSC

3) Water Distribution System

Figure 3.4.19 shows the Mubende water distribution network. One of the characteristics of the distribution network of Mubende Water is that, except for a part of the Mubende City center where the distribution network has been developed, the distribution mains are extended in a radial pattern along the roads for more than 10 km and do not spread over an area. Water is distributed mainly from Kasenyi Reservoir (underground, capacity of 1,700 m^3) as shown in Photo 3.4.16 to the center of Mubende and surrounding areas. Booma Tank (above ground, capacity of 50 m^3) is used to supply water to the army quarters. The total length of the existing distribution main is 117 km (as of 2019), with diameters ranging from 25 mm to 200 mm, mainly PVC and HDPE pipes. Mubende Water was transferred to NWSC in 2006 and most of the pipes were installed during the transfer period. Table 3.4.29 shows the diameter and length by material of the water distribution mains (as of 2017).

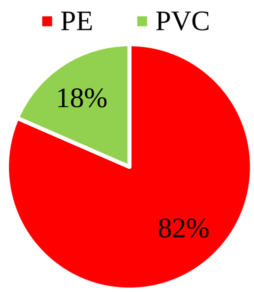
Source: JST

Photo 3.4.16 View of Water Supply Area from Kasenyi Reservoir

Table 3.4.29 Distribution Mains of Mubende Water (as of 2017)

Diameter	Distribution Pipe Diameters and Material Water Network				
	PE (km)	GI (km)	PVC (km)	Total (km)	Share (%)
200	-	-	0.5	0.5	0.4%
150	-	-	1.7	1.7	1.5%
125	-	-	-	-	-
100	0.8	-	18.5	19.2	17.2%
<100	90.0	0.0	-	90.1	80.9%
Total	90.8	0.0	20.6	111.4	100%

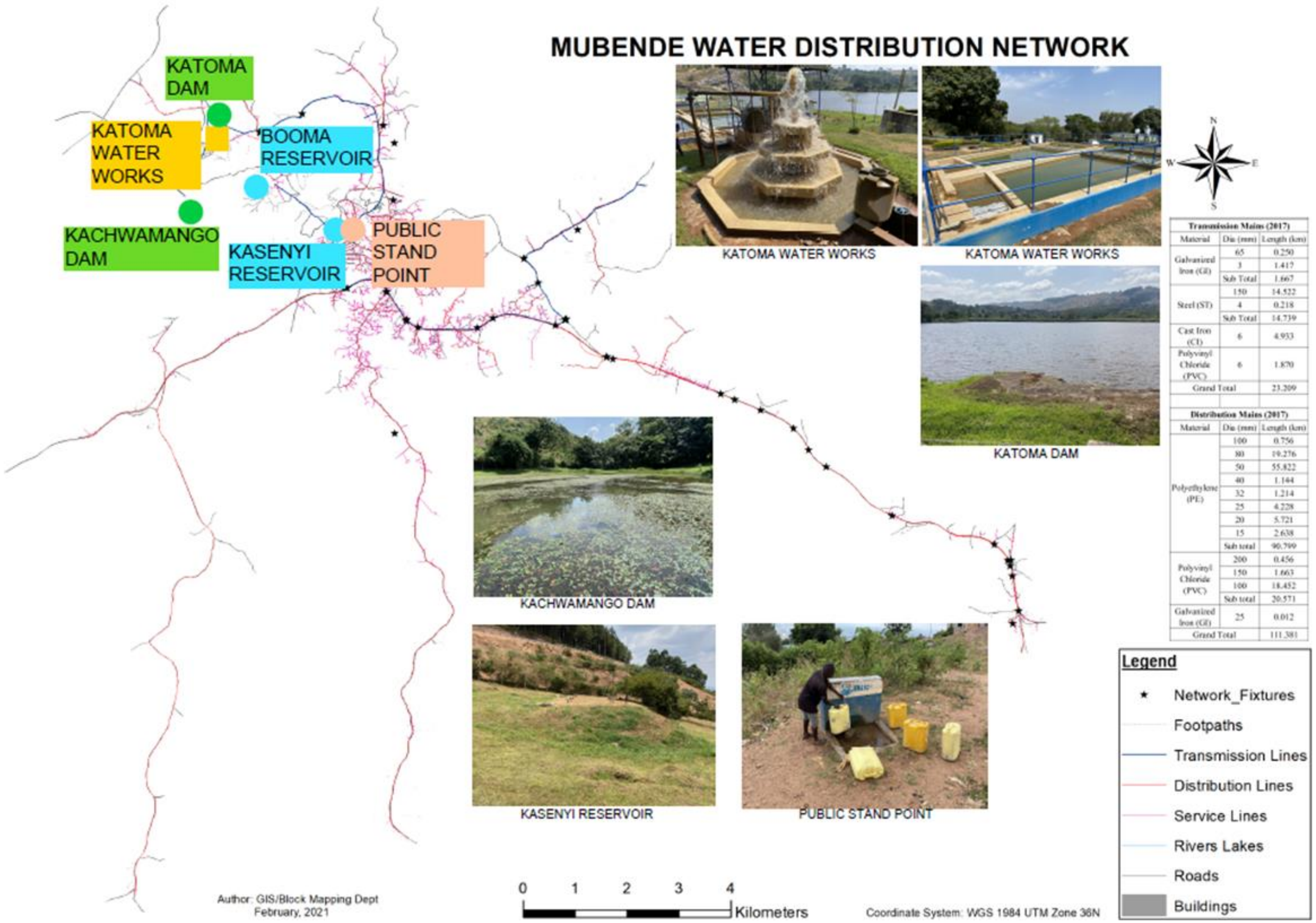
Source: Compiled by JST based on information collected from NWSC



PVC and HDPE pipes are used in the household connections, and gate valves and water meters are installed. The ratio of each connection in Mubende Branch as of November 2020 was 74% for domestic, 4% for PSP, 19% for commercial and industrial, and 3% for institutional and government. Prepaid PSP and smart meters are not installed in Mubende Branch. Also, the installation of tanks on the premises is widely practiced in situation where stable water supply cannot be expected due to water supply restrictions and burst pipes. Photo 3.4.17 shows the usage of PSP.

Source: JST

Photo 3.4.17 Usage of PSP



Transmission Mains (2017)		
Material	Dia (mm)	Length (km)
Galvanized Iron (GI)	65	0.250
	3	1.417
	Sub Total	1.667
Steel (ST)	150	14.522
	4	0.218
	Sub Total	14.739
Cast Iron (CI)	6	4.933
Polyvinyl Chloride (PVC)	6	1.870
Grand Total		23.209

Distribution Mains (2017)		
Material	Dia (mm)	Length (km)
Polyethylene (PE)	100	0.756
	80	19.276
	50	55.822
	40	1.144
	32	1.214
	25	4.228
	20	5.721
	15	2.638
	Sub total	90.799
Polyvinyl Chloride (PVC)	200	0.456
	150	1.663
	100	18.452
	Sub total	20.571
Galvanized Iron (GI)	25	0.012
Grand Total		111.381

Source: NWSC GIS Unit

Figure 3.4.19 Mubende Water Distribution Network

4) Population and Water Demand Projection

As described in the Population and Water Demand Projections of Kampala Water, NWSC divides the population projections for each water supply area into urban and rural areas for the calculation of the population served, and Mubende Water is classified as rural area. Based on the population projections by UBOS, NWSC has projected the target population of 210,787 for Mubende Municipality and its surrounding areas as of 2020. The water demand in 2040 is estimated to be 29,418 m^3/day for average water demand and 33,830 m^3/day for maximum water demand.

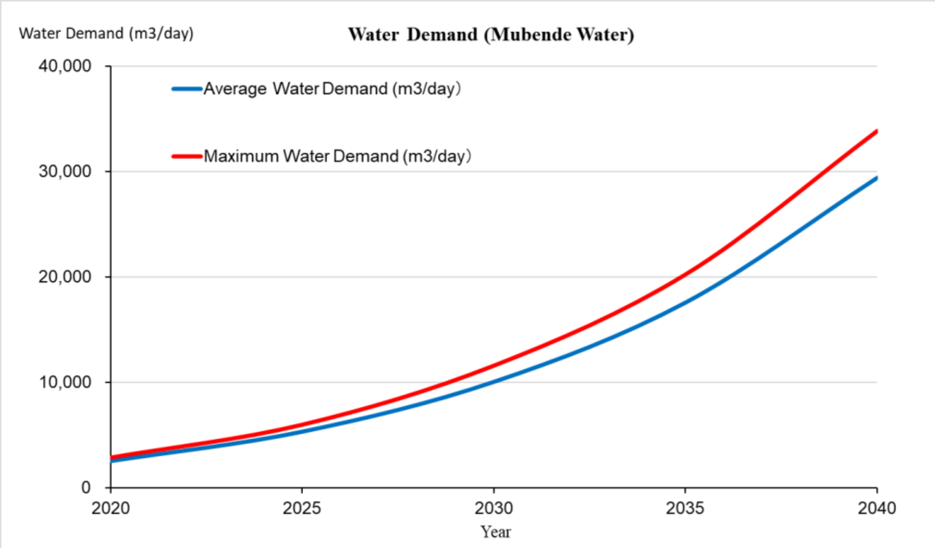
The water demand projection for Mubende Water is shown in Table 3.4.30 and Figure 3.4.20. There are many assumptions in this water demand projection; therefore, it is essential to collect, organize, as well as to consult with related organizations on the population served, expansion of water supply areas in the future, unit consumption, connection rate of each household and PSP, NRW rate, etc., to study the future demand projection in detail.

Table 3.4.30 Water Demand Projection of Mubende Water

Indicator	2020	2025	2030	2035	2040
Target Population (People)	210,787	271,838	350,572	452,110	583,056
Service Population*1 (People)	48,219	114,599	215,384	364,938	583,056
Domestic (m^3/day)	1,294	2,792	5,422	9,488	15,652
PSP (m^3/day)	335	969	1,942	3,509	5,976
Commercial & Industrial (m^3/day)	337	622	1,145	2,110	3,887
Institutional & Government (m^3/day)	304	370	451	548	667
NRW (%)	11	11	11	11	11
Average Water Demand (m^3/day)	2,551	5,341	10,067	17,590	29,418
Maximum Water Demand (m^3/day)	2,860	5,980	11,580	20,230	33,830

*1: The Service Population is calculated by the population of domestic and PSP. The Service Population in Table 3.3.2 is calculated by the population of domestic, PSP, commercial & industrial, institutional & government.
1. Service Population: 23% in 2020, assumed to be 100% by 2040 (3.9% annual growth).
2. Connection rate for domestic and PSP: Calculated using trends from 2015 to 2020
3. Unit consumption per capita for domestic and PSP: 50 liters and 15 liters in 2020, with an annual growth of 1%.
4. Commercial & industrial water consumption: Assumed to increase by 13.0% per year based on actual results from 2015 to 2020.
5. Institutional & government water consumption: Assumed to increase by 4.0% per year based on actual results from 2015 to 2020.
6. NRW: Based on actual results of 11% in 2020, NRW is assumed to remain the same until 2040

Source: JST



Source: JST

Figure 3.4.20 Water Demand Projection of Mubende Water

(6) Issues on the Development of Water Supply Facilities

1) Development of Water Source

As for the development of water sources in Mubende Water, there is a plan to build boreholes in Kibalinga area, but there no other concrete plans to develop water sources. The demand for water is expected to increase as the population grows, and the development of water sources is a challenge in the near future. Boreholes are the most effective way to develop water sources since there is no surface water in the vicinity, but efficient use of the existing Katoma Dam and Kachwamango Dam is also considered. Therefore, a comprehensive water source development and water use plan should be formulated by conducting a groundwater potential survey, as well as a survey about the amount of water available at the dam. Expansion of the existing water treatment plant will be proposed if it is possible to develop water sources beyond the capacity of the existing water treatment plants.

2) Water Distribution System

Mubende Water has been expanding its water distribution area in accordance with the requests of the city and residents. The expansion of the water distribution area is mainly done by extending the pipes in a radial pattern along the roads. This situation is expected to continue in the future, but with the increase in water demand, water distribution will not be possible at areas where water pressure is insufficient, especially at the end of the distribution mains. It is important to plan the water distribution system after clarifying the policy of NWSC and discussing with relevant organizations on how far to expand the water distribution by setting a planning year.

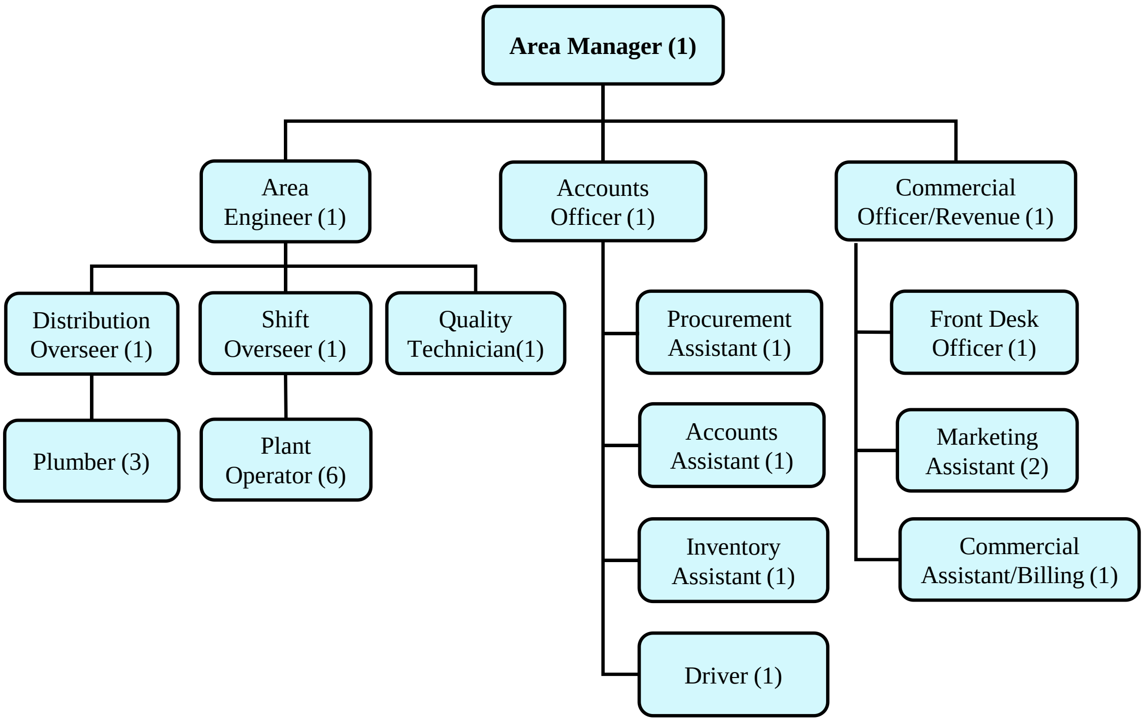
3) Countermeasures for Non-Revenue Water (NRW)

The NRW rate in Mubende Branch is relatively excellent at about 10%, but as mentioned earlier, the NRW rate may be low because the total length of pipes is short. Leakage management is essential to maintain this situation, and the countermeasures described in Hoima Water are desirable.

3.4.4 Mityana Water

(1) Organizational Structure of Mityana Branch

Mityana Water was transferred to NWSC in 2013 and is responsible for the operation and maintenance of the water distribution system of Mityana Municipality and its surrounding areas. Also, Mityana Branch is responsible for water quality test, rehabilitation and expansion of the distribution network, installation of transmission network with water meter, construction of PSP, meter reading, preparation and sending of water bills, collection of water bills, dealing with water bills arrears, finding illegal connection, repair of leakage, etc. Under the supervision of the Area Manager, Mityana Branch consists of an Area Engineer, Account Officer, Commercial Officer/Revenue, and has 28 employees as of FY 2019/20. Figure 3.4.21 shows the organizational structure of Mityana Branch.



Source: NWSC

Figure 3.4.21 Organizational Structure of Mityana Branch

(2) Management, Financial Status

1) Number of Connections, Water Billing and Collection

Table 3.4.31 shows the number of connections in Mityana Branch. As of November 2020, Mityana Branch had total connections of 6,182. Of these, 90% are active connections and 10% are inactive connections. The main reasons for the inactive connections are the alternative water sources in place of the water supply from NWSC, delayed payment, and in some cases, connections that have been shut down for a long time. Based on the number of NWSC staff (28) and the number of connections, it is estimated that the number of staff per 1,000 connections is 4.5, which indicates that Mityana Branch has good staff productivity.

Table 3.4.31 Number of Connections of Mityana Branch (As of November 2020)

Type of Connections	Active	Inactive	Total
Domestic (nos.)	4,305	490	4,795
PSP (nos.)	302	0	302
Commercial & Industrial (nos.)	712	97	809
Institutional & Government (nos.)	247	29	276
Total	5,566	616	6,182
Ratio	90%	10%	100%

Source: Compiled by JST based on interviews with NWSC and collected data

Table 3.4.2 shows the water billing and collection for FY 2018/19 and FY 2019/20. The decrease of about 3% in the collection efficiency could be due to the impact of COVID-19. Meanwhile, water billing remained almost the same despite an 8% deterioration in NRW rate. This may be due to the 12% increase in water production.

Table 3.4.32 Water Billing and Collection of Mityana Branch

Item	2018/19	2019/20
Billing (UGX '000)	1,584,138	1,562,179
Collection (UGX '000)	1,527,121	1,455,839
Collection Efficiency	96%	93%

Source: NWSC Integrated Annual Report 2019/20

2) Income and Expenditure

Table 3.4.33 shows the income and expenditure of Mityana Branch for FY 2017/18, FY 2018/19, and FY 2019/20. When compared with the previous year, the expenditure/income ratio has worsened to 2.0 in FY 2019/20. The reason for this may be that while income was almost the same, expenditure was affected by the increase in operational and maintenance cost of the water treatment plant and more than 1.3 times increase in water production costs due to increased use of chemicals.

Table 3.4.33 Income and Expenditure of Mityana Branch

Item	2017/18	2018/19	2019/20
Income (UGX '000)	1,204,111	1,421,395	1,432,947
Expenditure (UGX '000)	1,781,394	2,230,558	2,897,760
Expenditure/Income Ratio	1.5	1.6	2.0

Source: NWSC Integrated Annual Report 2018/19, 2019/20

(3) Countermeasures for Non-Revenue Water (NRW)

The NRW rate of Mityana Water is shown in Table 3.4.34. The NRW in Mityana Branch is gradually worsening. Commercial losses include faulty meters, poorly installed pipes, meter insensitivity due to low water pressure, and water theft. However, the meter installation rate is 100%. Meanwhile, physical losses may be due to the fact that the water supply hours are longer than in other water supply areas, ranging from 20 to 24 hours, which may lead to more leakages and bursts. The current countermeasures for NRW include replacement of aging pipes and replacement of faulty water meters. However, active measures such as detection of underground leaks are currently not being carried out.

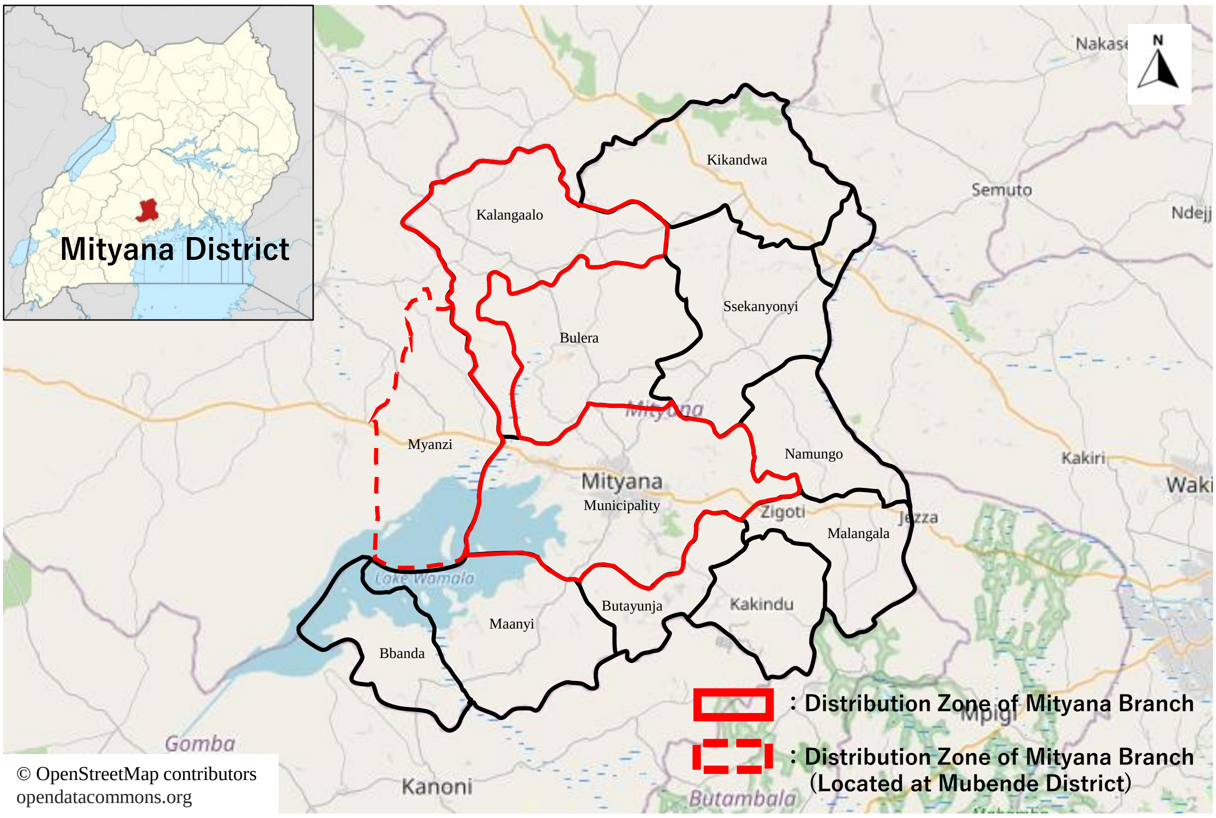
Table 3.4.34 NRW Rate of Mityana Branch

FY	2015/16	2016/17	2017/18	2018/19	2019/20
NRW	22.0%	16.9%	29.9%	31.0%	39.0%

Source: NWSC

(4) Distribution Zone of Mityana Branch

The distribution zone of Mityana Branch is located 30 km east of Lake Albert and serves the city of Mityana Municipality and its surrounding areas (Myanzi Sub-county and Kalangaalo Sub-county) as of 2021. Figure 3.4.22 shows the distribution zone of Mityana Branch.



Source: Compiled by JST based on data collected from NWSC

Figure 3.4.22 Distribution Zone of Mityana Branch

(5) Outline of Water Supply Facilities of Mityana Water

1) Water Source and Water Treatment System

Mityana Water uses Nakatongoli Swamp (Photo 3.4.18) and two boreholes as its water source. Nakatongoli Swamp is located about 8 km northwest of the town center, and water is supplied to Nakatongoli WTP by three raw water pumps. The water quality from the boreholes is too high in iron concentration to be distributed directly; therefore, the water is treated at Nakatongoli WTP before being distributed. Table 3.4.35 provides a summary of the water treatment system. Photo 3.4.19 shows the filtration basins, chemical dosing appliance, and drying beds at Nakatongoli WTP.

Source: JST

Photo 3.4.18 Nakatongoli Swamp

Table 3.4.35 Outline of Water Treatment System of Mityana Water

Item	Specifications
Water Source	Nakatongoli Swamp (estimated water storage capacity: 15,000 m^3) Boreholes: 2 (capacity: 40 – 60 m^3/hour) constructed in 2017/2018 Two new boreholes are currently under construction.
Water Production Capacity	Nakatongoli WTP: 4,800 m^3/day (constructed in 2008 with support from MoWE)
Treatment Method and Main Facilities	1) Cascade aerator, 2) Mixing basin, flocculation basin, 3) Sedimentation basin,4) Rapid sand filter, 5) Backwash facility, 6) Water reservoir, 7) Chemical house, 8) Pumping station, 9) Emergency generator station, 10) Water quality test laboratory, etc.
Water Quality Test	Water quality test has been conducted based on the water quality testing schedule and test items. Based on the water quality test results, the water quality at the water treatment plant is within the standard values. Although residual chlorine remains at the tap, some tested items have been found to be slightly higher than the Uganda Water Quality Standard.
Treatment Conditions	The average water production capacity is about 1,936 m^3/day against the design capacity of 4,800 m^3/day, and 40% capacity utilization. The raw water quality of the swamp contains a high concentration of humic substances. Based on the raw water quality data from the mixture of swamp and boreholes, the color is about 8 to 14 times higher than the Ugandan Water Quality Standard, and the iron concentration is 12 to 20 times higher, which is very high. According to the interview with NWSC, the boreholes alone has a high iron concentration. However, the treated water meets the Uganda Water Quality Standard.
Wastewater Treatment	Treated by drying beds.
O&M and Others	• The facilities are relatively well managed. • One of the two chemical dosing appliances was removed due to breakdown, and there is no spare unit. Addition of chlorine dosing is required.

Source: Compiled by JST based on interviews with NWSC and collected data

Source: JST

Photo 3.4.19 Nakatongoli WTP (Filtration Basins (Left), Chemical Dosing Appliance (Center), Drying Beds (Right))

2) Water Transmission System

Source: JST

Photo 3.4.20 Pumping Station

Water treated at Nakatongoli WTP is pumped to each distribution tank from the pumping station (water pump discharge rate of 100 m^3/hour x pump head of 146 m) as shown in Photo 3.4.20. The pipes are made of PVC, with diameters ranging from 80 mm to 250 mm and a total length of 21 km. The transmission mains have been installed since 2008. Table 3.4.36 shows the total length and materials of the transmission mains, as of 2017. The information on the transmission and distribution mains is managed by the GIS unit of Kampala Water (other than Kampala Water Supply), but other than the number of connections, the information has not been updated since 2017.

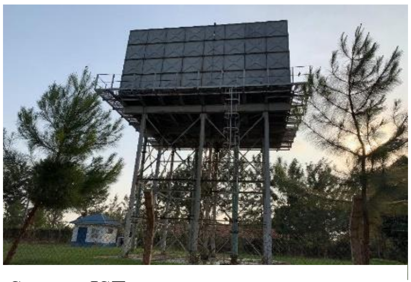
Table 3.4.36 Transmission Mains of Mityana Water (As of 2017)

Diameter	**Transmission Pipe Diameters and Material Water Network**		
	PVC (km)	**Total (km)**	**Share (%)**
200	9.0	9.0	42.6%
150	0.1	0.1	0.7%
125	-	-	-
100	-	-	-
<100	11.9	11.9	56.7%
Total	21.0	21.0	100%

Source: Compiled by JST based on information collected from NWSC

3) Water Distribution System

Figure 3.4.23 shows the Mityana water distribution network. One of the characteristics of the distribution network of Mityana Water is that although the distribution network is constructed at the center of Mityana Municipality, the distribution mains are extended along the roads in a radial pattern and do not spread over an area, which is similar to Mubende Water. Water is mainly distributed from four distribution tanks (Tank A: 100 m^3, Tank B: 350 m^3, Tank C: 450 m^3 (Photo 3.4.21), Tank D: 162 m^3) to the center of Mityana City and its surrounding areas.



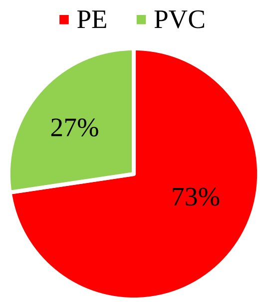
Source: JST

Photo 3.4.21 Elevated Tank

The total length of the existing distribution mains is 231 km (2021), with diameters ranging from 25 mm to 200 mm, mainly PVC and HDPE pipes. Mityana Water was transferred to NWSC in 2008, and most of the pipes were installed during the transfer period. Table 3.4.37 shows the diameter and length by material type of the water distribution mains (as of 2017).

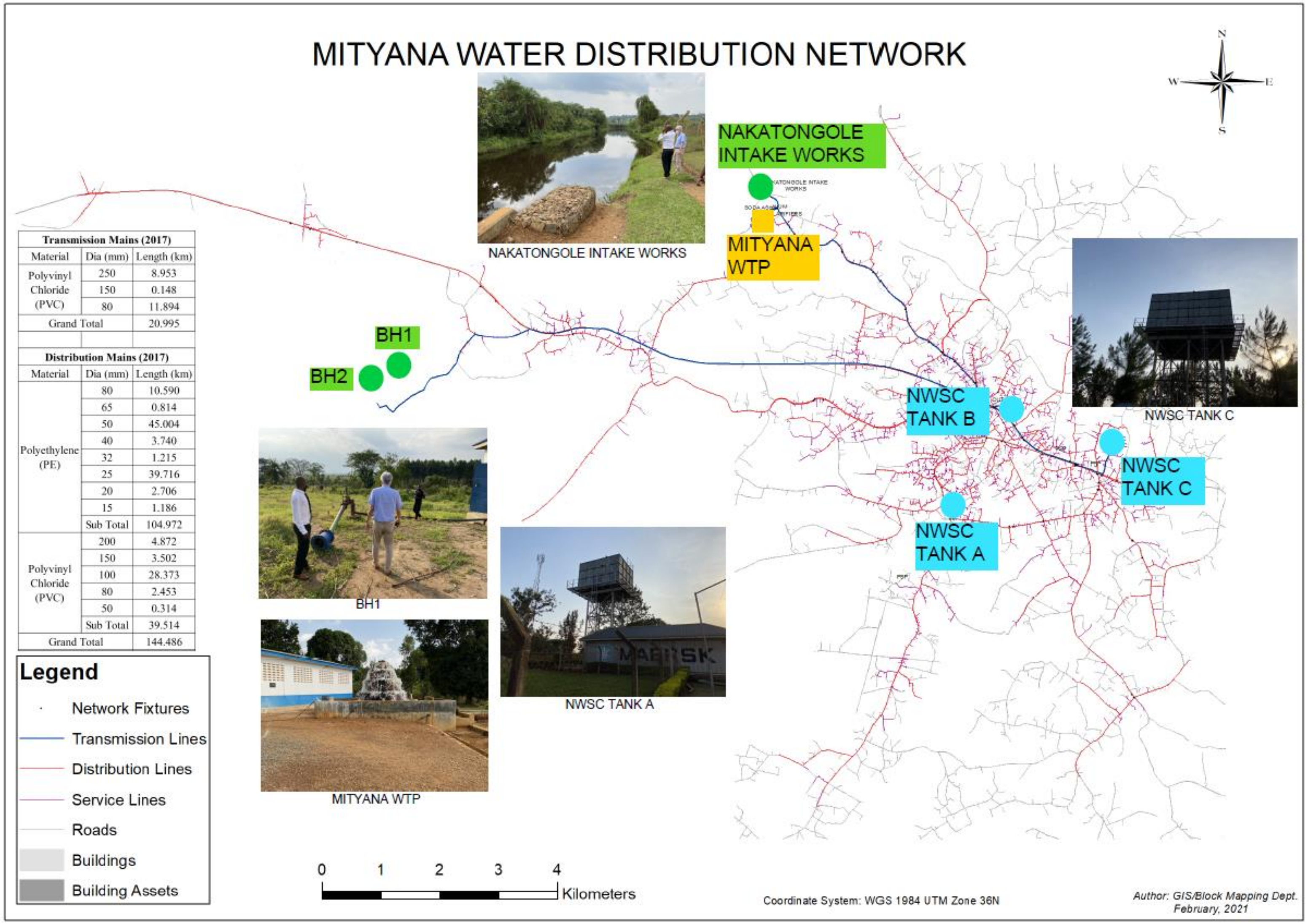
Table 3.4.37 Distribution Mains of Mityana Water (As of 2017)

Diameter	Distribution Pipe Diameters and Material Water Network			
	PE (km)	PVC (km)	Total (km)	Share (%)
200	-	4.9	4.9	3.4%
150	-	3.5	3.5	2.4%
125	-	-	-	-
100	-	28.4	28.4	19.6%
<100	105.0	2.8	107.7	74.6%
Total	105.0	39.5	144.5	100%



Source: Compiled by JST based on information collected from NWSC

HDPE pipes are mainly used for household connections, and gate valves and water meters are installed. The ratio of each connection in Mityana Branch as of November 2020 was 78% for domestic, 5% for PSP, 13% for commercial and industrial, and 4% for institutional and government. Prepaid PSP and smart meters are not installed in Mityana Branch. Also, the installation of tanks on the premises is widely practiced in situation where stable water supply cannot be expected due to water supply restrictions and burst pipes.



Transmission Mains (2017)		
Material	Dia (mm)	Length (km)
Polyvinyl Chloride (PVC)	250	8.953
	150	0.148
	80	11.894
Grand Total		20.995

Distribution Mains (2017)		
Material	Dia (mm)	Length (km)
Polyethylene (PE)	80	10.590
	65	0.814
	50	45.004
	40	3.740
	32	1.215
	25	39.716
	20	2.706
	15	1.186
	Sub Total	104.972
Polyvinyl Chloride (PVC)	200	4.872
	150	3.502
	100	28.373
	80	2.453
	50	0.314
	Sub Total	39.514
Grand Total		144.486

Source: NWSC GIS Unit

Figure 3.4.23 Mityana Water Distribution Network

4) Population and Water Demand Projection

As described in the Population and Water Demand Projections of Kampala Water, NWSC divides the population projections for each water supply area into urban and rural areas for the calculation of the population served, and within Mityana Branch, Mityana Municipality is classified as urban area and the other sub-counties are classified as rural areas. Based on the population projections by UBOS, NWSC has projected the target population of 217,674 for Mityana Municipality and 23,500 for other sub-counties, a total of 241,174 as of 2020. The water demand in 2040 is estimated to be 16,503 m^3/day for average water demand and 18,980 m^3/day for maximum water demand.

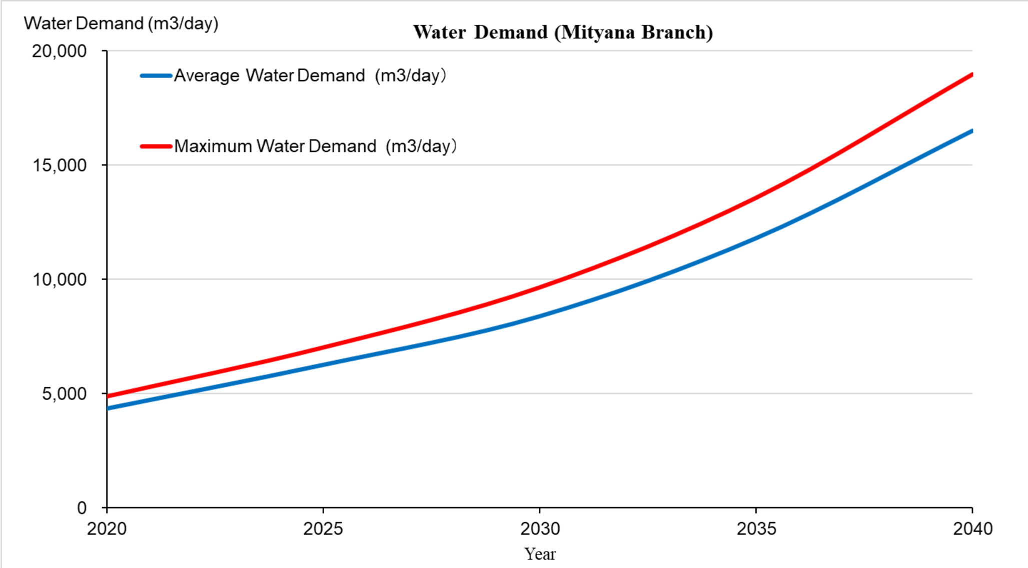
The water demand projection for Mityana Branch is shown in Table 3.4.38 and Figure 3.4.24. There are many assumptions in this water demand projection; therefore, it is essential to collect, organize, as well as to consult with related organizations on the population served, expansion of water supply areas in the future, unit consumption, connection rate of each household and PSP, NRW rate, etc., to study the future demand projection in detail.

Table 3.4.38 Water Demand Projection of Mityana Branch

Indicator	2020	2025	2030	2035	2040
Target Population (People)	241,174	265,303	291,845	321,044	353,163
Service Population*1 (People)	79,326	131,773	193,919	267,182	353,163
Domestic (m^3/day)	1,734	2,806	4,143	5,714	7,541
PSP (m^3/day)	670	1,236	1,970	2,939	4,202
Commercial & Industrial (m^3/day)	190	336	592	1,042	1,837
Institutional & Government (m^3/day)	156	203	265	344	448
NRW (%)	37	27	17	15	15
Average Water Demand (m^3/day)	4,366	6,275	8,397	11,811	16,503
Maximum Water Demand (m^3/day)	4,890	7,030	9,660	13,580	18,980

*1: The Service Population is calculated by the population of domestic and PSP. The Service Population in Table 3.3.2 is calculated by the population of domestic, PSP, commercial & industrial, institutional & government.
1. Service Population: 32.9% in 2020, assumed to be 100% by 2040 (3.4% annual growth).
2. Connection rate for domestic and PSP: Calculated using trends from 2015 to 2020
3. Unit consumption per capita for domestic and PSP: 50 liters and 15 liters in 2020, with an annual growth of 1%.
4. Commercial & industrial water consumption: Assumed to increase by 12.0% per year based on actual results from 2015 to 2020.
5. Institutional & government water consumption: Assumed to increase by 5.4% per year based on actual results from 2015 to 2020.
6. NRW: Assumed to decrease by 2% per year to 15% based on the actual results of 37% in 2020.

Source: JST



Source: JST

Figure 3.4.24 Water Projection Demand of Mityana Branch

(6) Issues in the Development of Water Supply Facilities

1) Development of Water Source

Mityana Water extracts water from two boreholes and Nakatongoli Swamp. Two new boreholes with a total capacity of 2,880 m^3/day are currently being constructed near the existing boreholes. Four of the boreholes are constructed in close proximity and may interfere with each other. The capacity of the pumps and water level of the boreholes should be measured continuously to determine the amount of yield that can be stably used. Meanwhile, Nakatongoli Swamp has dried up in the past; therefore, it is desirable to develop water sources in preparation for droughts. The current water production capacity on average is 1,936 m^3/day, with a utilization rate of 40%, so there is plenty of room for improvement.

2) Water Distribution System

Similar to Mubende Water, Mityana Water has an expanded water distribution area with branch pipes extending mainly along roads in a radial pattern. Therefore, similar measures to those taken in Mubende Water are required.

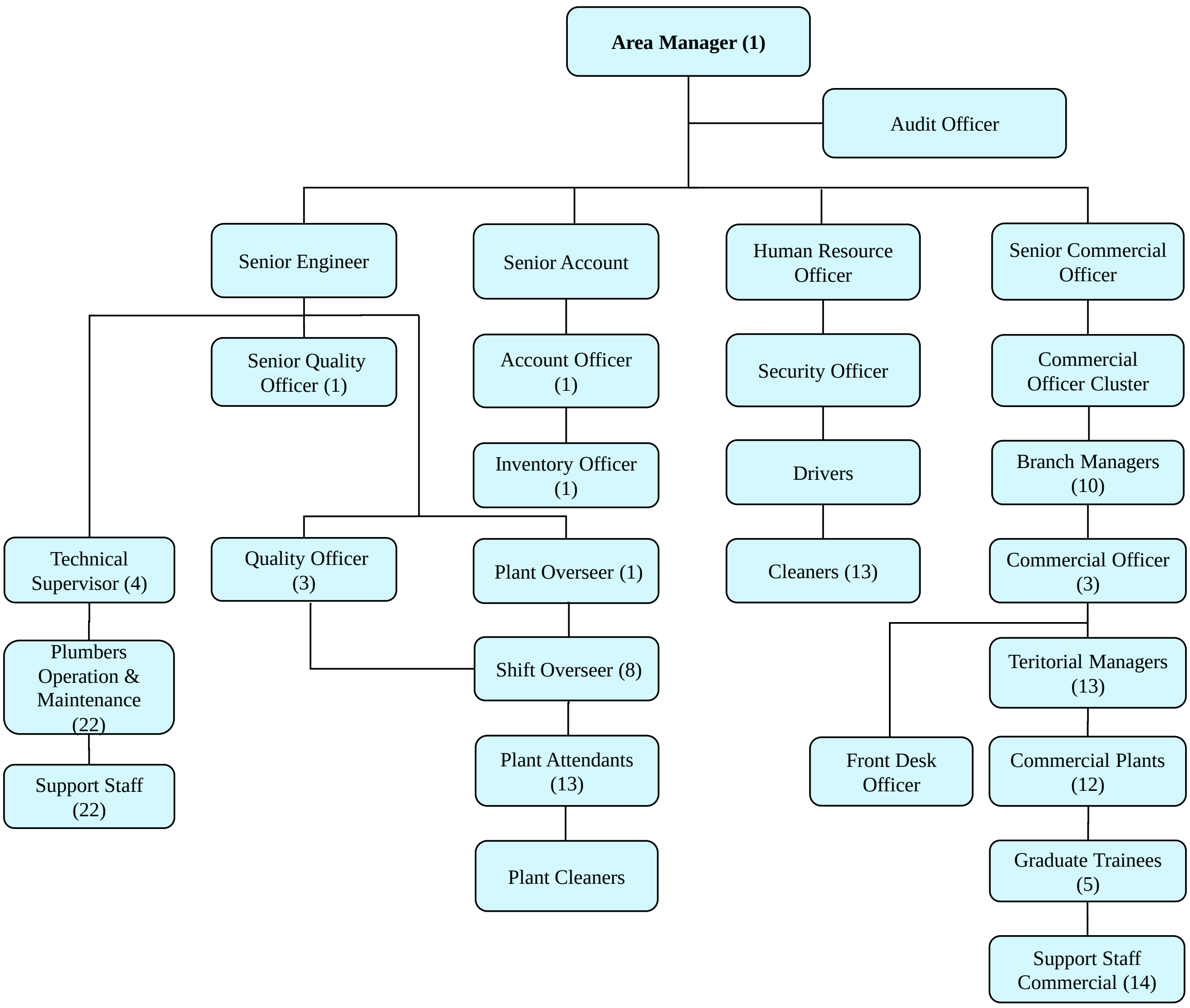
3) Countermeasures for Non-Revenue Water (NRW)

The NRW rate in the Mityana Water is very high at 39%; therefore, immediate countermeasures are desired. First of all, it is desirable to identify the specific factors for NRW and to reduce NRW systematically. Also, leakage management is essential in this situation and countermeasures such as those proposed in Section 3.4.2 Hoima Water, are to be expected.

3.4.5 Tororo Water

(1) Organizational Structure of Tororo Branch

Tororo Water was transferred to NWSC in 1980. Tororo Branch is responsible for the operation and maintenance of two water supply systems in Tororo Municipality and its surrounding areas, as well as in Busia District. As of June 2021, Tororo Branch had jurisdiction over two other water supply systems in Manafwa District and Namisindwa District. Therefore, Tororo Branch mentioned here is referring to the four water supply systems. Tororo Branch is responsible for water quality test, rehabilitation and expansion of the distribution network, installation of transmission network with water meter, construction of PSP, meter reading, preparation and sending of water bills, collection of water bills, dealing with water bills arrears, finding illegal connection, repair of leakage, etc. Under the supervision of the Area Manager, Tororo Branch consists of Senior Engineer, Senior Account, Human Resource Officer, and Senior Commercial Officer, and has 83 employees as of FY 2019/20. Figure 3.4.25 shows the organizational structure of Tororo Branch.



Source: NWSC Tororo

Figure 3.4.25 Organizational Structure of Tororo Branch

(2) Management, Financial Status

1) Number of Connections, Water Billing and Collection

Table 3.4.39 shows the number of connections in Tororo Branch. As of November 2020, Tororo Branch had total connections of 17,455. Of these, 71% are active connections and 29% are inactive connections. The main reasons for the inactive connection are delayed payment, and in some cases, connections that have been shut down for a long time. Based on the number of NWSC staff (83) and the number of connections, it is estimated that the number of staff per 1,000 connections is 5, which indicates that Tororo Branch has good staff productivity.

Table 3.4.39 Number of Connections of Tororo Branch (As of November 2020)

Type of Connections	Active	Inactive	Total
Domestic (nos.)	10,074	4,052	14,126
PSP (nos.)	1083	248	1,331
Commercial & Industrial (nos.)	872	531	1,403
Institutional & Government (nos.)	395	200	595
Total	12,424	5,031	17,455
Ratio	71%	29%	100%

Source: Compiled by JST based on interviews with NWSC and collected data

Table 3.4.40 shows the water billing and collection for FY 2017/18, FY 2018/19, and FY 2019/20. The decrease in billing for FY 2019/2020 is largely due to the failure of aging pumps, deterioration of raw water quality, frequent power outages due to the renovation of power facilities by the power supplier, and also due to the reduction in the number of travelers from the Kenyan side due to COVID-19. The decrease of about 18% in collection efficiency is largely due to the lockdown of accommodation and commercial business premises, as a result of COVID-19.

Table 3.4.40 Water Billing and Collection of Tororo Branch

Item	2017/18	2018/19	2019/20
Billing (UGX '000)	4,634,273	6,514,450	6,242,257
Collection (UGX '000)	4,146,468	6,211,260	4,813,520
Collection Efficiency	89%	95%	77%

Source: NWSC Integrated Annual Report 2019/20

2) Income and Expenditure

Table 3.4.41 shows the income and expenditure of Tororo Branch for FY 2017/18, FY 2018/19, and FY 2019/20. When compared with the previous year, the expenditure/income ratio has worsened to 1.3 in FY 2019/20. The reason for this is that income was affected by the lockdown of accommodation and commercial business premises due to COVID-19, increase in non-revenue water (NRW), customers' inability to pay the water tariff, and delayed payments. Expenditure was affected by the transfer of small-scale water supply systems in three neighboring districts to Tororo Water, increase in repair costs for aging water treatment plants and pipelines, and increase in chemical usage expenses due to deterioration of raw water.

Table 3.4.41 Income and Expenditure of Tororo Branch

Item	2017/18	2018/19	2019/20
Income (UGX '000)	4,082,051	5,712,990	4,528,224
Expenditure (UGX '000)	3,478,779	5,806,253	6,075,041
Expenditure/Income Ratio	0.9	1.0	1.3

Source: NWSC Integrated Annual Report 2018/19, 2019/20

(3) Countermeasures for Non-Revenue Water (NRW)

The NRW rate of Tororo Branch is shown in Table 3.4.42. The NRW in Tororo Branch has increased each year from 8.6% in FY 2016/17 to 17% in FY 2019/20. Commercial losses include faulty meters, poorly installed pipes, water theft. However, the meter installation rate is 100%. Meanwhile, physical losses include leakage and burst of aging pipes, damage of water pipes caused by road construction, and loss of pipe network due to frequent floods. The current countermeasures for NRW include collaborating with related organizations to educate residents about water theft, replacement of aging pipes (asbestos pipes and steel pipes), burial of exposed pipes, and replacement and confirmation of the accuracy of water meters. However, detection of underground leaks is not being carried out at present.

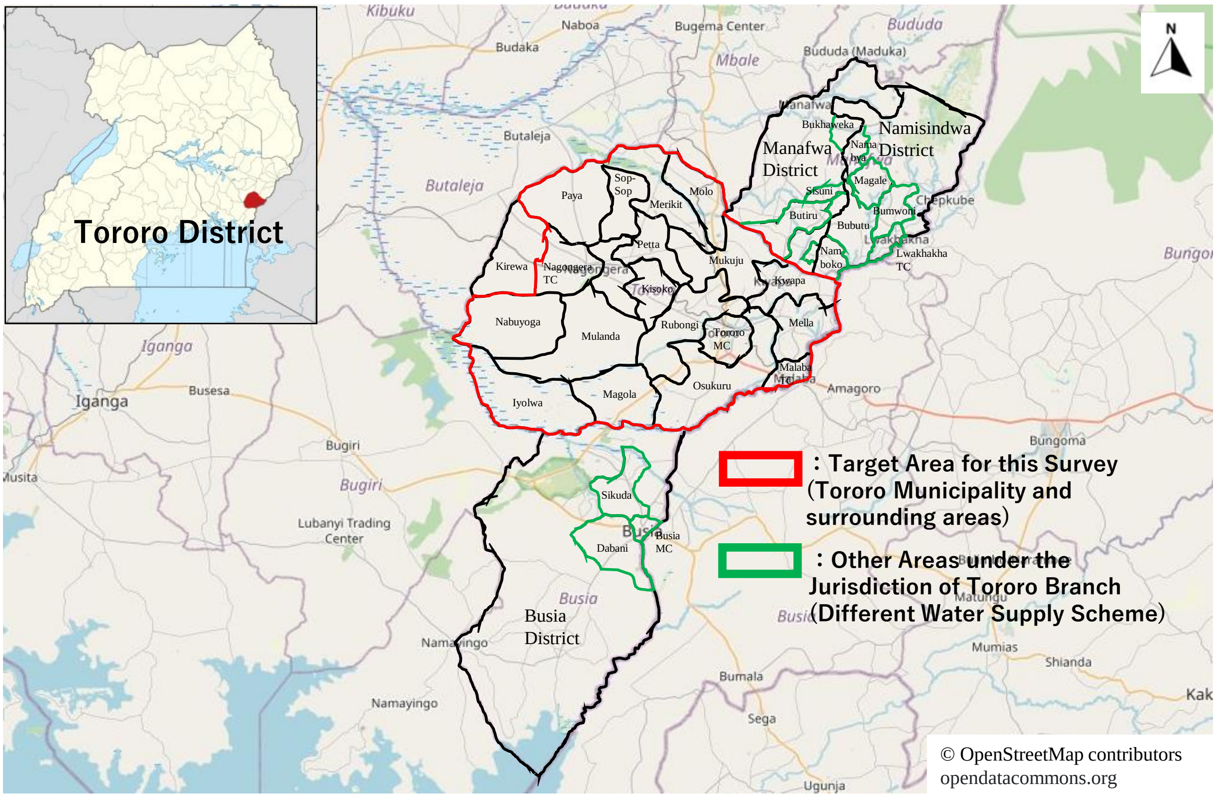
Table 3.4.42 NRW Rate of Tororo Branch

FY	2015/16	2016/17	2017/18	2018/19	2019/20
NRW	14.6%	8.6%	10.5%	14.1%	17%

Source: NWSC

(4) Distribution Zone of Tororo Branch

The distribution zone of Tororo Branch is located on the Kenyan border and consists of four water distribution systems. As of 2021, the first system is responsible for water supply to Tororo Municipality and its surroundings areas (Iyolwa Sub-county, Kisoko Sub-county, Kwapa Sub-county, Magola Sub-county, Mella Sub-county, Merikit Sub-county, Molo Sub-county, Mukuju Sub-county, Mulanda Sub-county, Osukuru Sub-county, Paya Sub-county, Petta Sub-county, Rubongi Sub-county, Sop-Sop Sub-county, Nakongera Town Council); the second system supplies water to Busia District (Busia Municipality, Dabani Sub-county, Sikuda Sub-county) by boreholes; the third system supplies water to Manafwa District (Butiru Sub-county, Sisuni Sub-county, Bukhaweka Sub-county, Buyinza Town Council) by gravitational flow; and the fourth system supplies water to Namisindwa District (Bubutu Sub-county, Bumwni Sub-county, Magale Sub-county, Namabya Sub-county, Namboko Sub-county, Lwakhakha Town Council) by gravitational flow. Figure 3.4.26 shows the distribution zone of Tororo Branch.



Source: Compiled by JST based on data collected from NWSC

Figure 3.4.26 Distribution Zone of Tororo Branch

(5) Outline of Water Supply Facilities of Tororo Water

1) Water Source and Water Treatment System

Source: JST

Photo 3.4.22 River Malaba

Although Tororo Branch has jurisdiction over four water distribution systems, the outline of the water treatment system in this section will focus on the first system that supplies the Tororo Municipality and its surrounding areas. Tororo Water has River Malaba (Photo 3.4.22) as its water source. Raw water from River Malaba is treated at Malaba WTP and distributed to Tororo Municipality and its surroundings, as well as to the border of Mabala Town. Table 3.4.43 provides the outline of the water treatment system. The details will be confirmed at the third field survey. Photo 3.4.23 shows the sedimentation basins and rapid sand filter of Malaba WTP constructed in 1956 and 1986.

Table 3.4.43 Outline of Water Treatment System of Tororo Water

Item	Specifications
Water Source	River Malaba (capacity: 325 m^3/hour) Construction year: 1956 (Phase 1) (Abandoned), 1986 (Phase 2)
Water Production Capacity	Malaba WTP Malaba WTP (old): 2,300 m^3/day (constructed in 1956) Malaba WTP (new): 5,100 m^3/day (Funded by WB, constructed in 1986) Total: 7,400 m^3/day
Treatment Method and Main Facilities	1) Mixing basin, flocculation basin, 2) Sedimentation basin, 3) Rapid sand filter, 4) Backwash facility, 5) Water reservoir, 6) Chemical house, 7) Pumping station, 8) Emergency generator station, 9) Water quality test laboratory, etc.
Water Quality Test	Water quality test has been conducted based on the water quality testing schedule (4 times per day) and test items. The main parameters tested are color, turbidity, residual chlorine, and coliforms. Aluminum Sulphate, mixture of Aluminum Sulphate and polymer, or polymer will be used depending on the quality of raw water.
Treatment Conditions	• Frequent floods during rainy season, cause the water source, which is the River Malaba, to flood the intake facilities. • Sedimentation basin at the intake site is not functioning; thus, stable intake is not possible. • Mixing basin is not utilized, and chemical dosing is done to the secondary side of the raw water pump. • Proper dosing is not being achieved as the chemical dosing amount depends on the capacity of the pump. • Sedimentation basin is overloaded (high turbidity, short sedimentation time, inadequate design, etc.), and the filtration basin is blocked due to carryover of turbid water from the sedimentation basin. • Backwash time is shortened due to inflow of muddy water into the filtration basin, resulting in inefficient operation. • Based on the above reasons, the current maximum water production capacity is about 5,500 m^3/day against the design water production capacity of 7,400 m^3/day, resulting in a low operation rate.
Wastewater Treatment	There is no wastewater treatment facility, and the wastewater is directly discharged.
O&M and Others	• It is considered that the aging facilities are being maintained to the best of their ability. • Although the facilities built in 1956 are being rehabilitated and utilized, they are past their useful life and are difficult to operate continuously from the standpoint of efficiency. • The water treatment facility built in 1988 does not address the current water demand and water quality. • The entire facility, not just the water treatment facilities, but also the pipes, raw water pumps, water transmission pumps, chemical dosing facilities, etc., are obsolete and need to be rehabilitated or newly built. • Water supply is not sufficient to meet the water demand in the future.

Source: Compiled by JST based on interview with NWSC and collected data

Source: JST

Photo 3.4.23 Malaba WTP (Constructed in 1956) (Sedimentation Basin (Upper Left), Sedimentation Basin (Upper Center), Rapid Sand Filter (Upper Right)), Malaba WTP (Constructed in 1986) (Sedimentation Basin (Lower Left), Sedimentation Basin (Lower Center), Rapid Sand Filter (Lower Right))

2) Water Transmission System

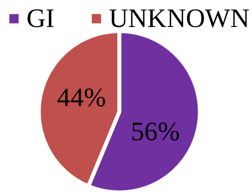
Source: JST

Photo 3.4.24 Pumping Station

Water treated at the Malaba WTP is distributed from the pumping station (currently four water pumps in operation) as shown in Photo 3.4.24 to Tororo Reservoir (4,800 m^3) and distributed to Tororo Municipality and its surrounding areas. Also, water is distributed to the border town of Malaba via the Malaba Tank (340 m^3). At present, the amount of treated water is not enough to meet the water demand; therefore, water is not distributed to Uganda Revenue Authority (URA) Tank (150 m^3) due to inadequate water supply. As an emergency measure, the URA is developing its own boreholes. The transmission mains are made of galvanized iron (GI) with diameter of 150 mm and a length of 10.3 km (installed between 1980 and 1987). Transmission mains with diameter of 300 mm and the total length of 8 km is laid although some of the materials is unknown. Table 3.4.44 shows the total length and materials of the transmission mains as of 2021. The information on the transmission and distribution mains is managed by the GIS unit of Kampala Water (other than Kampala Water Supply), but other than the number of connections, the information has not been updated since 2018 and as it differs significantly with what was interviewed, the transmission mains was organized based on information provided by Tororo Water.

Table 3.4.44 Transmission Mains of Tororo Water (As of 2021)

Diameter	Transmission Pipe Length by Material (km)			
	GI (km)	UNKNOWN (km)	Total (km)	Share (%)
300	-	8.0	8.0	43.7%
150	10.3	-	10.3	56.3%
Total	10.3	8.0	18.3	100%



Source: Compiled by JST based on information collected from NWSC

3) Water Distribution System

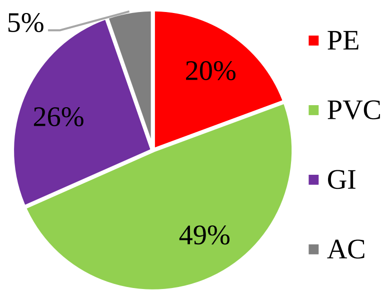
Figure 3.4.27 shows the Tororo water distribution network. Water is distributed by gravitational flow from Tororo Reservoir (Photo 3.4.25) which was constructed in 1986. One of the characteristics of the distribution network of Tororo Water is that although the distribution network is constructed in the center of Tororo Municipality, the distribution mains are extended along the roads in a radial pattern and do not spread over an area. The total length of the distribution mains is 449 km (as of 2021), and they are made of HDPE, PVC, galvanized iron (GI), and asbestos (AC) pipes with diameters ranging from below 100 mm to 200 mm. Table 3.4.45 shows the diameter and length by material type of the water distribution mains (as of 2021).

Source: JST

Photo 3.4.25 Tororo Reservoir

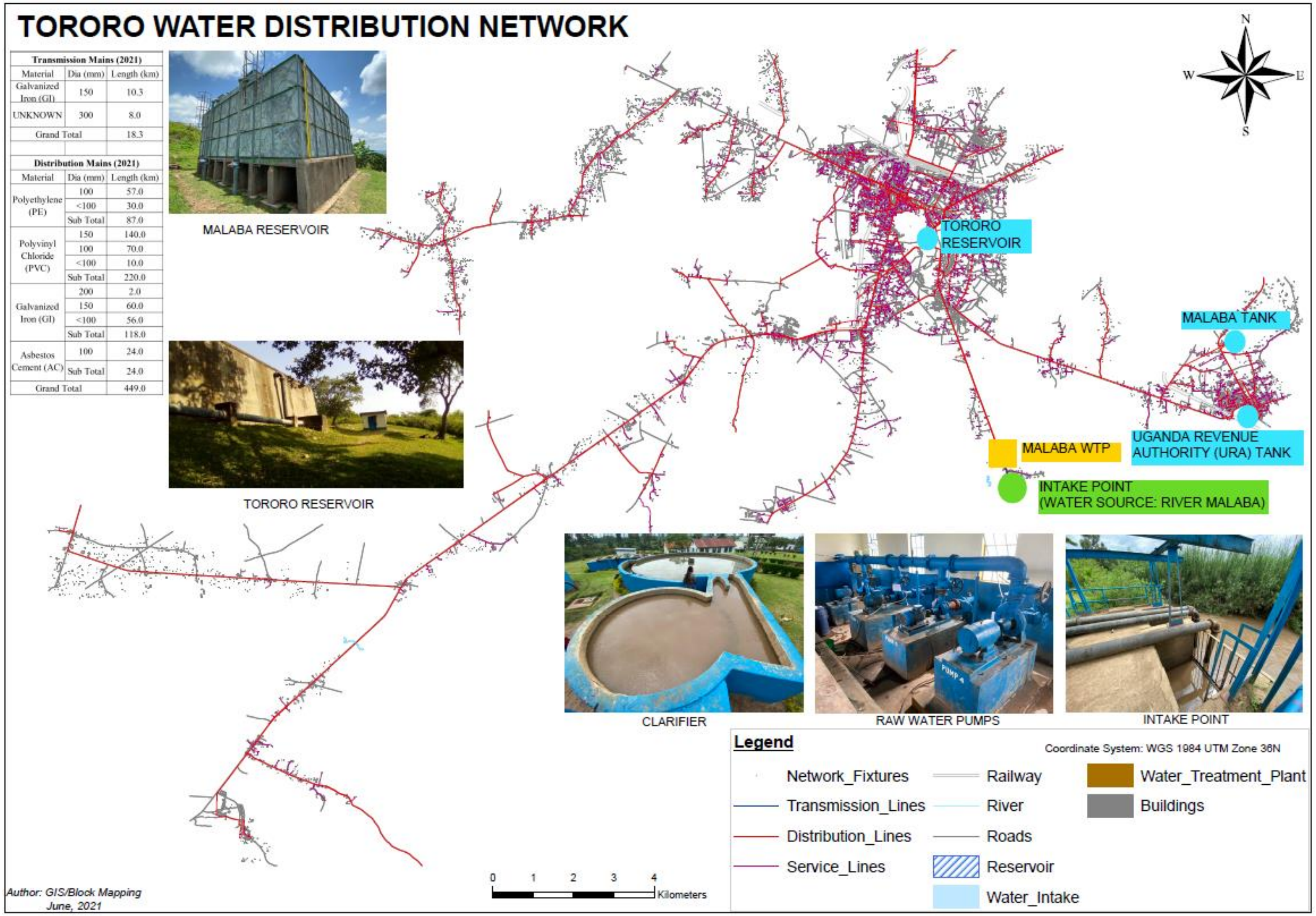
Table 3.4.45 Distribution Mains of Tororo Water (As of 2021)

Diameter	Distribution Pipe Diameters and Material Water Network					
	PE (km)	PVC (km)	GI (km)	AC (km)	Total (km)	Share (%)
200	-		2	-	2	0.4%
150	-	140	60	-	200	44.5%
125	-	-	-	-	-	-
100	57	70	-	24	151	33.6%
<100	30	10	56	-	96	21.4%
Sum	87	220	118	24	449	100%



Source: Compiled by JST based on information collected from NWSC

PVC and HDPE pipes are mainly used for household connections, and gate valves and water meters are installed. The ratio of each connection in Tororo Branch as of November 2020 was 81% for domestic, 8% for PSP, 8% for commercial and industrial, and 3% for institutional and government. Prepaid PSP and smart meters are not installed in Tororo Branch. Also, the installation of tanks on the premises is widely practiced in situation where stable water supply cannot be expected due to water supply restrictions and burst pipes.



Transmission Mains (2021)		
Material	Dia (mm)	Length (km)
Galvanized Iron (GI)	150	10.3
UNKNOWN	300	8.0
Grand Total		18.3

Distribution Mains (2021)		
Material	Dia (mm)	Length (km)
Polyethylene (PE)	100	57.0
	<100	30.0
	Sub Total	87.0
Polyvinyl Chloride (PVC)	150	140.0
	100	70.0
	<100	10.0
	Sub Total	220.0
Galvanized Iron (GI)	200	2.0
	150	60.0
	<100	56.0
	Sub Total	118.0
Asbestos Cement (AC)	100	24.0
	Sub Total	24.0
Grand Total		449.0

Source: NWSC GIS Unit

Figure 3.4.27 Tororo Water Distribution Network

4) Population and Water Demand Projection

As described in the Population and Water Demand Projections of Kampala Water, NWSC divides the population projections for each water supply area into urban and rural areas for the calculation of the population served, and within Tororo Water, Tororo Municipality and Malaba Town Council are classified as urban areas and the other sub-counties are classified as rural areas. Based on the population projections by UBOS, NWSC has projected the target population of 143,478 for Tororo Municipality and Malaba Town Council and 309,042 for the other sub counties, a total of 452,520 as of 2020. The water demand in 2040 is estimated to be 44,332 m^3/day for average water demand and 50,980 m^3/day for maximum water demand.

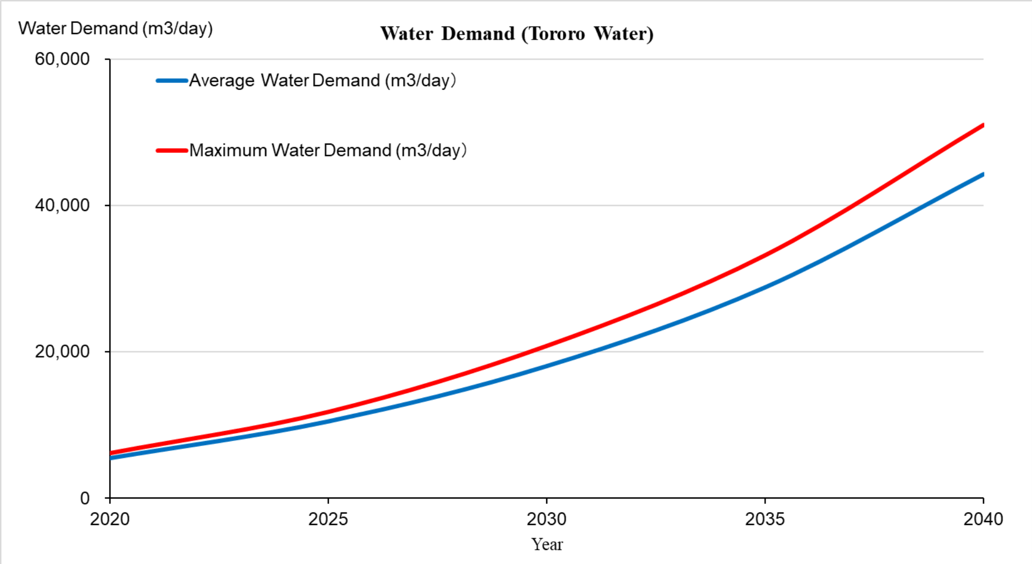
The water demand projection for Tororo Water is shown in Table 3.4.46 and Figure 3.4.28. There are many assumptions in this water demand projection; therefore, it is essential to collect, organize, as well as to consult with related organizations on the population served, expansion of water supply areas in the future, unit consumption, connection rate of each household and PSP, NRW rate, etc., to study the future demand projection in detail.

Table 3.4.46 Water Demand Projection of Tororo Water

Indicator	2020	2025	2030	2035	2040
Target Population (People)	452,520	509,130	572,822	644,482	725,107
Service Population*1 (People)	96,513	208,723	347,497	517,725	725,107
Domestic (m^3/day)	1,950	3,902	6,728	10,376	15,041
PSP (m^3/day)	863	2,120	3,740	5,903	8,759
Commercial & Industrial (m^3/day)	586	988	1,665	2,805	4,727
Institutional & Government (m^3/day)	1,136	1,913	3,224	5,433	9,155
NRW (%)	17	15	15	15	15
Average Water Demand (m^3/day)	5,463	10,498	18,066	28,844	44,332
Maximum Water Demand (m^3/day)	6,120	11,760	20,780	33,170	50,980

*1: The Service Population is calculated by the population of domestic and PSP. The Service Population in Table 3.3.2 is calculated by the population of domestic, PSP, commercial & industrial, institutional & government.
1. Service Population: 21.3% in 2020, assumed to be 100% by 2040 (3.9% annual growth).
2. Connection rate for domestic and PSP: Calculated using trends from 2015 to 2020
3. Unit consumption per capita for domestic and PSP: 50 liters and 15 liters in 2020, with an annual growth of 1%.
4. Commercial & industrial, institutional & government water consumption: Assumed to increase by 11% per year based on actual results from 2015 to 2020.
5. NRW: Assumed to decrease by 1% per year to 15% based on the actual results of 17% in 2020.

Source: JST



Source: JST

Figure 3.4.28 Water Demand Projection of Tororo Water

(6) Issues in the Development of Water Supply Facilities

1) Development of Water Source

The current water source which is River Malaba has a large potential as a water source as the river has sufficient water volume even during the dry season. However, the water quality has been deteriorating in recent years due to the accumulation of silt in River Malaba caused by environmental degradation. River Malaba seems to be the most effective source of water intake for the future population growth in Tororo Municipality and its surrounding areas, as well as for Malaba Town which is at the border of Kenya. It is important to formulate a comprehensive water source development plan that includes environmental aspects such as reforestation and educational activities on water quality for upstream residents to secure the current water quantity and quality.

2) Water Treatment System

Malaba WTP has not undergone a full-scale renovation since 1986 and is still operating on aging facilities built during the colonial period. The current maximum water production capacity has been reduced to 5,500 m^3/day against the design production capacity of 7,400 m^3/day. The water demand increases annually as the population grows, and from the perspective of O&M, it is essential to increase the volume of water production by rehabilitating and expanding the facilities.

3) Water Distribution System

Water is distributed from Mabala WTP to the reservoirs in Tororo Municipality, which is then distributed to the cities and surrounding areas, as well as to the border town of Malaba. In addition, the distribution mains are extended in a radial pattern along the road as the distribution area is expanded. Water is currently unable to be distributed to Malaba due to inadequate water supply. It is important to discuss and examine the planning year and water distribution area with the relevant organizations, and a comprehensive rehabilitation and expansion plan for distribution mains, including replacement of asbestos pipes and aging steel pipes, as well as expansion of capacity of the water treatment plant.

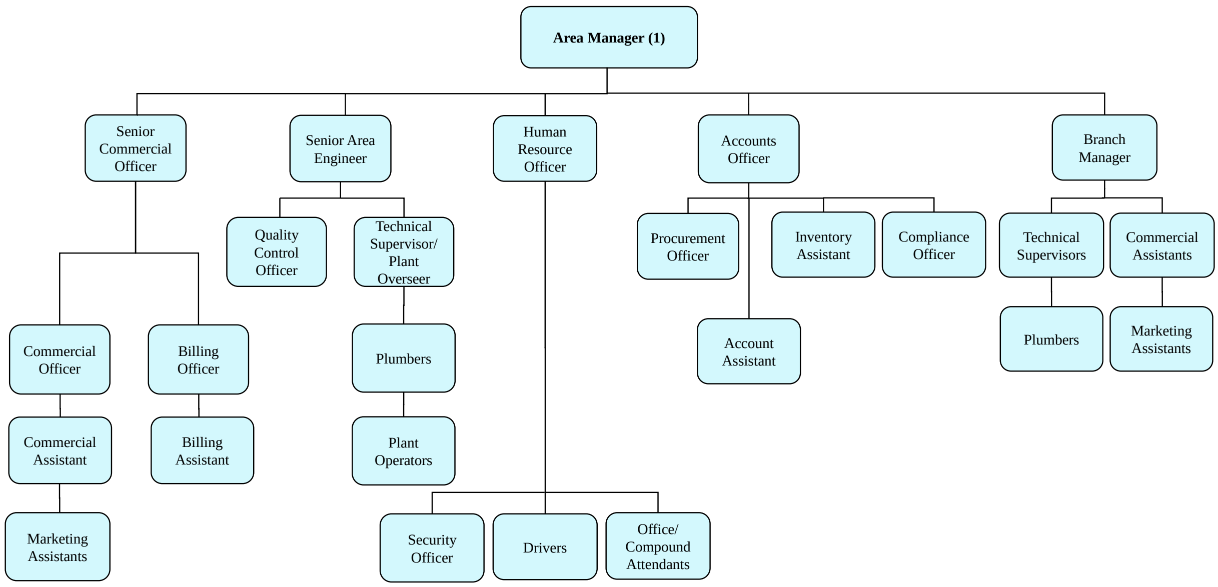
4) Countermeasures for Non-Revenue Water (NRW)

The non-revenue water (NRW) rate at Tororo Branch is less than 20%, which is relatively excellent, but has been increasing annually. Therefore, it is important to conduct awareness-raising activities in cooperation with related organizations for residents against water theft, etc., and asset management for the planning of systematic rehabilitation of aging pipes (asbestos pipes, steel pipes), water meters, etc. Also, leakage management is essential in this situation and countermeasures such as those proposed in Section 3.4.2 Hoima Water are to be expected.

3.4.6 Soroti Water

(1) Organizational Structure of Soroti Branch

Soroti Water was transferred to NWSC in 2002. Soroti Branch is responsible for the operation and maintenance of four water supply systems in Soroti Municipality and its surrounding areas, as well as in Serere District, Kaberamaido District, and Amuria District. Also, Soroti Branch is responsible for water quality test, rehabilitation and expansion of the distribution network, installation of transmission network with water meter, construction of PSP, meter reading, preparation and sending of water bills, collection of water bills, dealing with water bills arrears, finding illegal connection, repair of leakage, etc. Under the supervision of the Area Manager, Soroti Branch consists of a Senior Commercial Engineer, Senior Area Engineer, Human Resource Officer, Account Officer, and Branch Manager, and has 53 employees as of FY 2019/20. Figure 3.4.29 shows the organizational structure of Soroti Branch.



Source: NWSC Soroti

Figure 3.4.29 Organizational Structure of Soroti Branch

(2) Management, Financial Status

1) Number of Connections, Water Billing and Collection

Table 3.4.47 shows the number of connections in Soroti Branch. As of November 2020, Soroti Branch had total connections of 9,972. Of these, 70% are active connections and 30% are inactive connections. The main reasons for the inactive connection are non-payment of water tariff, intermittent water supply areas, and changing to alternative water sources (boreholes). Based on the number of NWSC staff (53) and the number of connections, it is estimated that the number of staff per 1,000 connections is 5.3, which indicates that Soroti Branch has good staff productivity.

Table 3.4.47 Number of Connections in Soroti Branch (As of November 2020)

Type of Connections	Active	Inactive	Total
Domestic (nos.)	4,787	1,724	6,511
PSP (nos.)	345	96	441
Commercial & Industrial (nos.)	1,451	1,038	2,489
Institutional & Government (nos.)	384	147	531
Total	6,967	3,005	9,972
Ratio	70%	30%	100%

Source: Compiled by JST based on interviews with NWSC and collected data

Table 3.4.48 shows the water billing and collection for FY 2017/18, FY 2018/19, and FY 2019/20. The collection efficiency for FY 2018/19 decreased by 1% from the previous year and further decreased by about 9% in FY 2019/20. The reasons are lockdown of the town as a result of COVID-19 and customers' inability to pay the water tariff. Meanwhile, billing increased despite the increase of non-revenue water (NRW). The reasons for this are the increase in water production, the expansion of water supply areas to attract more customers, and the extension of water supply hours.

Table 3.4.48 Water Billing and Collection of Soroti Branch

Item	2017/18	2018/19	2019/20
Billing (UGX '000)	4,060,339	4,939,021	5,144,790
Collection (UGX '000)	3,925,382	4,735,665	4,482,647
Collection Efficiency	97%	96%	87%

Source: NWSC Integrated Annual Report 2019/20

2) Income and Expenditure

Table 3.4.49 shows the income and expenditure of Soroti Branch for FY 2017/18, FY 2018/19, and FY 2019/20. The expenditure/income ratio was the same in FY 2017/18 and FY 2018/19 but worsened to 1.4 in FY 2019/20. Despite the increase in water supply capacity, the reasons for this are that income were affected by the lockdown of accommodation and commercial business premises due to COVID-19, increase in non-revenue water (NRW), and customers' inability to pay the water tariff. The increase in expenditure was due to the expansion of the water supply area and the increase in the water production, which resulted in an increase in staff costs, operation and maintenance costs, and electricity costs.

Table 3.4.49 Income and Expenditure of Soroti Branch

Item	2017/18	2018/19	2019/20
Income (UGX '000)	3,481,922	4,307,121	4,565,240
Expenditure (UGX '000)	2,963,929	3,724,095	6,164,070
Expenditure/Income Ratio	0.9	0.9	1.4

Source: NWSC Integrated Annual Report 2018/19, 2019/20

(3) Countermeasures for Non-Revenue Water (NRW)

The NRW rate of Soroti Branch is shown in Table 3.4.50. The non-revenue water (NRW) in Soroti Branch increased drastically from 11.7% in FY 2018/19 to 28% in FY 2019/20. Commercial losses include faulty meters, poorly installed pipes, and water theft. However, the meter installation rate is 100%. Meanwhile, physical losses include leakages from aging reservoirs, and leakages and burst due to increase in water distribution. The current NRW control includes detection of illegal connections and prompt detection of leakage through pipe patrols, and inspection of the accuracy of water meters. However, detection of underground leaks is not being carried out at present.

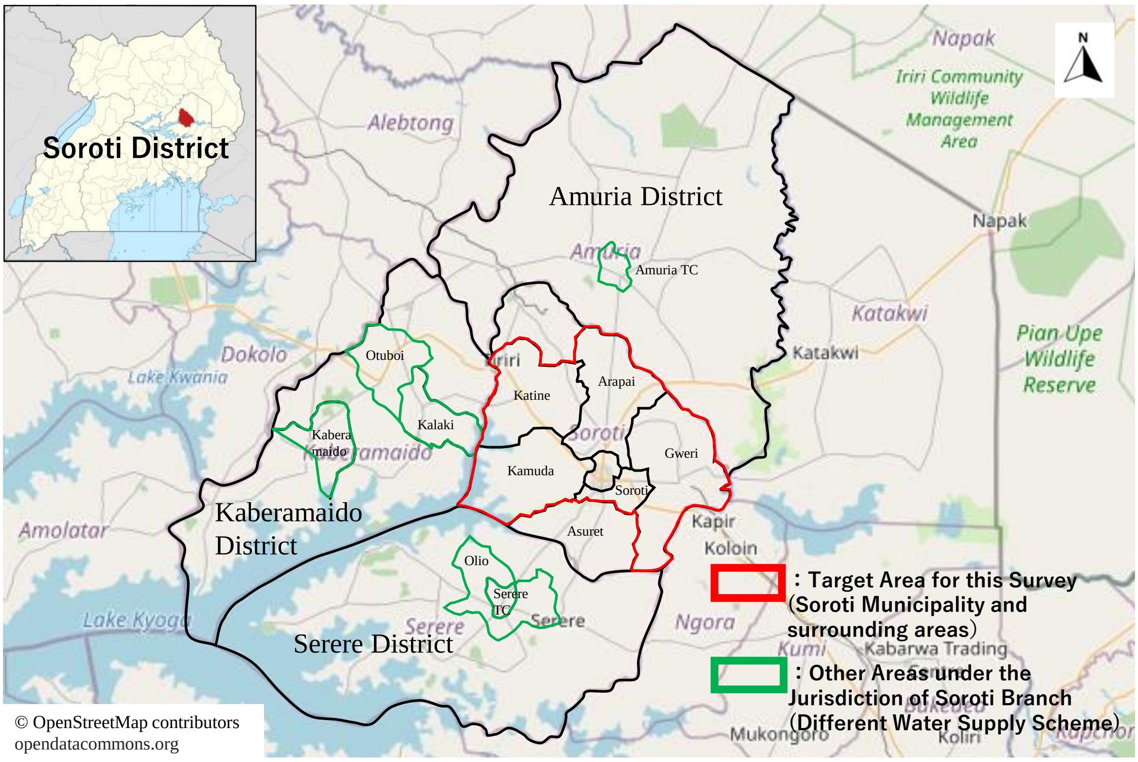
Table 3.4.50 NRW Rate of Soroti Branch

FY	2015/16	2016/17	2017/18	2018/19	2019/20
NRW	13.7%	14.9%	12.1%	11.7%	28%

Source: NWSC

(4) Distribution Zone of Soroti Branch

The distribution zone of Soroti Branch consists of four water distribution systems. As of 2021, the first system is responsible for water supply to Soroti Municipality and its surroundings areas (Soroti Sub-county, Arapai Sub-county, Gweri Sub-county, Katine Sub-county, Kamuda Sub-county); the second system supplies water to Serere District (Olio Sub-county, Serere Town Council) by boreholes; the third system supplies water to Kaberamido District (Otuboi Sub-county, Kalaki Sub-county, Kaberamaido Town Council) by boreholes; and the fourth system supplies water to Amuria District (Amuria Town Council) by boreholes. Figure 3.4.30 shows the distribution zone of Soroti Branch.



Source: Compiled by JST based on data collected from NWSC

Figure 3.4.30 Distribution Zone of Soroti Branch

(5) Outline of Water Supply Facilities of Soroti Water

1) Water Source and Water Treatment System

Source: JST

Photo 3.4.26 River Awoja

Although Soroti Branch has jurisdiction over four water distribution systems, the outline of the water treatment system in this section will focus on one system that supplies the Soroti Municipality and its surrounding areas. Soroti Water has River Awoja (Photo 3.4.26) as its water source. The water intake from River Awoja is about 17 km east of Soroti Municipality and water is treated at Awoja WTP, which is then distributed to Soroti Municipality and its surrounding areas. Table 3.4.51 provides the outline of the water treatment system. The details will be confirmed at the third field survey. Photo 3.4.27 shows the sedimentation basin, rapid sand filter, and chemical dosing appliance of Awoja WTP.

Table 3.4.51 Outline of Water Treatment System of Soroti Water

Item	Specifications
Water Source	River Awoja (capacity: 368 m^3/hour)
Water Production Capacity	Awoja WTP: 8,500 m^3/day (Funded by GoU, constructed in 2008)
Treatment Method and Main Facilities	1) Water well, 2) Mixing pond and flocculation basin, 3) Sedimentation basin, 4) Rapid sand filter, 5) Backwash facility, 6) Water reservoir, 7) Chemical house, 8) Pumping station, 9) Emergency generator station, 10) Water quality test laboratory, etc.
Water Quality Test	Water quality test has been conducted twice per day based on the water quality testing schedule and test items. The main parameters tested are color, turbidity, iron concentration, residual chlorine, and coliforms.
Treatment Conditions	• Water intake is blocked due to inappropriate design. In some cases, the specified water volume cannot be abstracted. • Aluminum Sulphate is not used during the dry season due to good water quality. • Insufficient backwash water due to leakage. • Algae blooms in water wells, flocculation basins, and filtration ponds. • Backwash interval is shortened to about 12 hours. • The average water production is 6,500 to 7,500 m^3/day against the design production capacity of 8,500 m^3/day, resulting in capacity utilization of 76% to 88%. The reasons include insufficient capacity of the water pump and as mentioned above, inefficient treatment.
Wastewater Treatment	There is no wastewater treatment facility, and the wastewater is directly discharged.
O&M and Others	• Cleaning of the WTP is taken place (once per month). However, improvement is needed as algae is present in the water wells, sedimentation basins, and filtration basins. • Countermeasures against algae, such as pre-chlorination is required. • Rehabilitation of the water intake facilities to ensure the specified intake volume. • Repair leaks in the backwash tank to ensure sufficient backwash water. • Installation of pre-chlorination system to prevent algae blooms.

Source: Compiled by JST by JST based on interview with NWSC and collected data

Source: JST

Photo 3.4.27 Awoja WTP (Sedimentation Basin (Left), Rapid Sand Filter (Center), Chemical Dosing Appliance(Right))

2) Water Transmission System

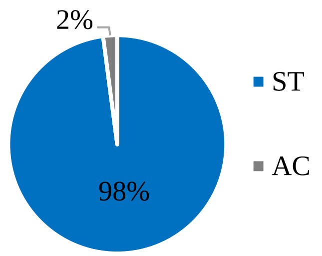
Source: JST

Photo 3.4.28 Pumping Station

Water treated at Awoja WTP is distributed from the pumping station (three units) as shown in Photo 3.4.28 to ten steel tanks (total capacity: 7,800 m^3). The transmission mains are made of steel (ST), AC (asbestos) with diameter of 200 mm and 300 mm, and a total length of 33.7 km (installed in 1950). Table 3.4.52 shows the total length and materials of the transmission mains, as of 2021. The information on the transmission and distribution mains is managed by the GIS unit of Kampala Water (other than Kampala Water Supply), but other than the number of connections, the information has not been updated since 2019 and as it differs significantly with what was interviewed, the transmission mains were organized based on information provided by Soroti Water.

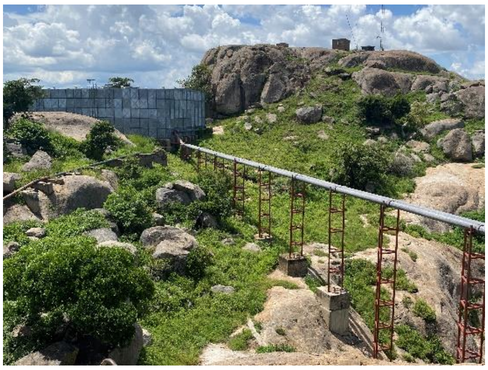
Table 3.4.52 Transmission Mains of Soroti Water (As of 2021)

Diameter	Transmission Pipe Diameters and Material Water Network			
	ST (km)	**AC (km)**	**Total (km)**	**Share (%)**
300	18.0	0.7	18.7	55.5%
250	-	-	-	-
200	15.0	-	15.0	44.5%
Total	33.0	0.7	33.7	100%



Source: Compiled by JST based on information collected from NWSC

3) Water Distribution System



Source: JST

Photo 3.4.29 Opiyai Rock Tank 3

Figure 3.4.31 shows the Soroti water distribution network. Water is distributed by gravitational flow from ten steel tanks to Soroti Municipality and its surrounding areas. Table 3.4.53 shows the outline of the distribution tanks of Soroti Water. However, Opiyai Rock Tank 1, which has the largest water storage capacity, is currently not being used due to severe leakage. Also, leakages occur at Teso College Tank and Amurai Tank. One of the characteristics of Soroti water supply network is that although the network is constructed in the center of Soroti, water is distributed to distant towns such as Kaberamaido (70 km) and Amuria (36 km). The total length of the distribution mains is 415.9 km and they are made of HDPE, PVC and galvanized iron (GI), steel (ST), and asbestos (AC) pipes with diameters ranging from below 100 mm to 300 mm. The distribution mains were installed in the 1950s. Table 3.4.54 shows the diameter and length by material type of the water distribution mains (as of 2021).

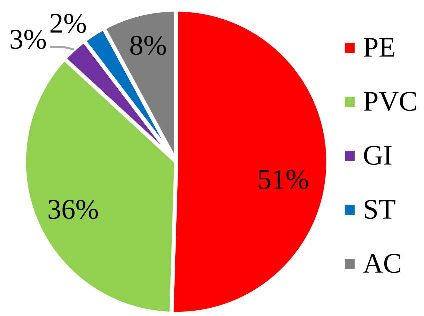
Table 3.4.53 Distribution Tanks of Soroti Water

Name	Size	Construction Year
Opiyai Rock Tank 1	Steel tank, above ground, 2,000 m^3	1950
Opiyai Rock Tank 2	Steel tank, above ground, 2,000 m^3	1950
Opiyai Rock Tank 3	Steel tank, above ground, 2,000 m^3	2008
Teso College Tank	Steel tank, above ground, 1,200 m^3	1980
Kaberamaido Tank	Steel tank, above ground, 200 m^3	2008
Otuboi Tank 1	Steel tank, above ground, 75 m^3	2008
Otuboi Tank 2	Steel tank, above ground, 75 m^3	2008
Kalaki Tank	Steel tank, above ground, 40 m^3	2008
Atitir Tank	Steel tank, above ground, 40 m^3	2008
Amurai Tank	Steel tank, above ground, 160 m^3	2010

Source: Compiled by JST by JST based on interview with NWSC and collected data

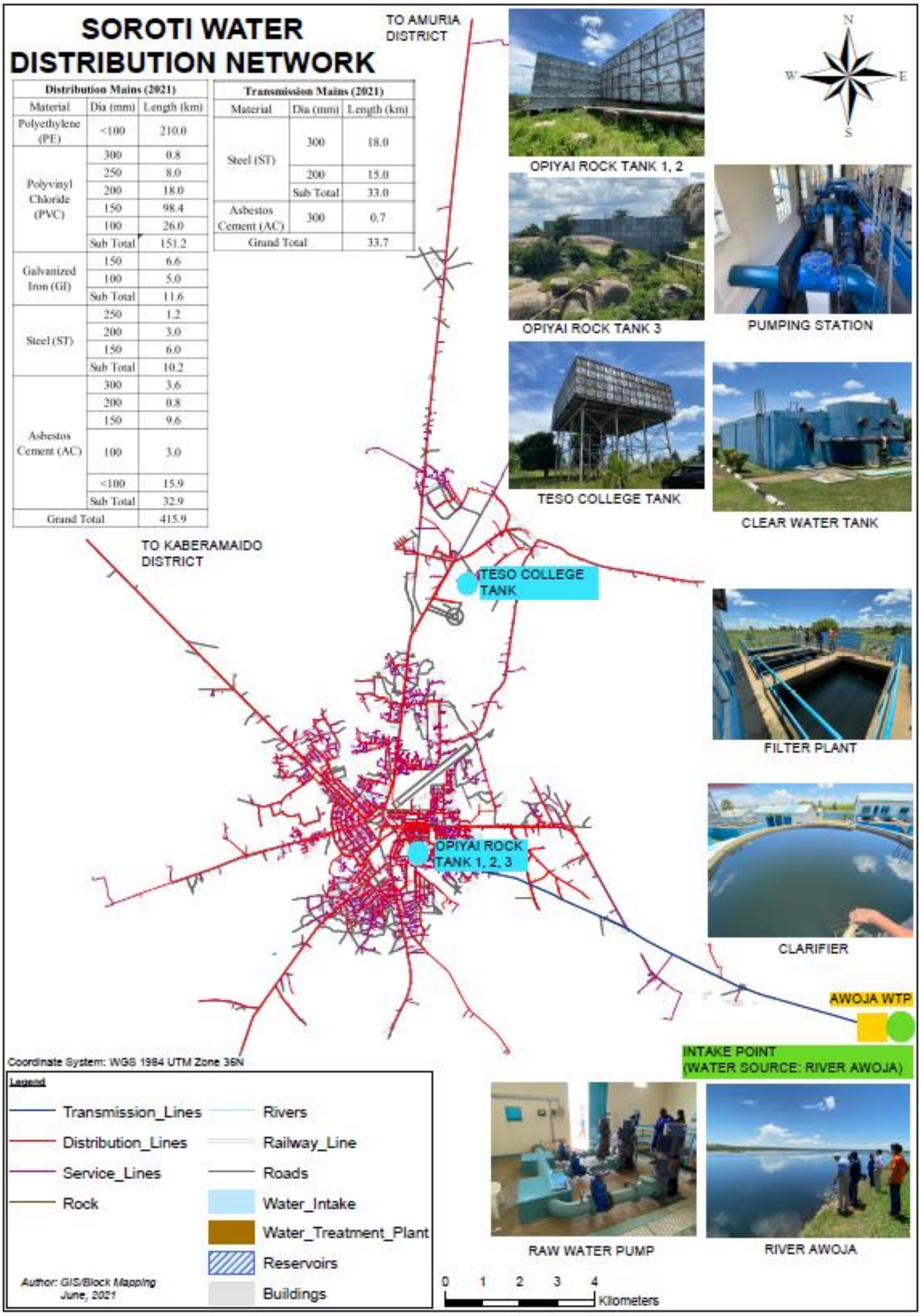
Table 3.4.54 Distribution Mains in Soroti Water (As of 2021)

Diameter	Distribution Pipe Diameters and Material Water Network						
	PE (km)	PVC (km)	GI (km)	ST (km)	AC (km)	Total (km)	Share (%)
300	-	0.8	-	-	3.6	4.4	1.1%
250	-	8.0	-	1.2	-	9.2	2.2%
200	-	18.0	-	3.0	0.8	21.8	5.2%
150	-	98.4	6.6	6.0	9.6	120.6	29.0%
125	-	-	-	-	-	-	-
100	-	26.0	5.0	-	3.0	34.0	8.2%
<100	210.0	-	-	-	15.9	225.9	54.3%
Sum	210.0	151.2	11.6	10.2	32.9	415.9	100%



Source: Compiled by JST based on information collected from NWSC

HDPE pipes are mainly used for household connections, and gate valves and water meters are installed. The ratio of each connection in Soroti Branch as of November 2020 was 65% for domestic, 4% for PSP, 25% for commercial and industrial, and 6% for institutional and government. Prepaid PSP and smart meters are not installed in Soroti Branch. Also, the installation of tanks on the premises is widely practiced in situation where stable water supply cannot be expected due to water supply restrictions and burst pipes.



Source: NWSC GIS Unit

Figure 3.4.31 Soroti Water Distribution Network

4) Population and Water Demand Projection

As described in the Population and Water Demand Projections of Kampala Water, NWSC divides the population projections for each water supply area into urban and rural areas for the calculation of the population served, and within Soroti Water, Soroti Municipality is classified as urban area and the other sub-counties are classified as rural areas. Based on the population projections by UBOS, NWSC has projected the target population of 106,909 for Soroti Municipality and 191,069 for the other sub counties, a total of 297,978, as of 2020. The water demand in 2040 is estimated to be 40,508 m^3/day for average water demand and 46,580 m^3/day for maximum water demand.

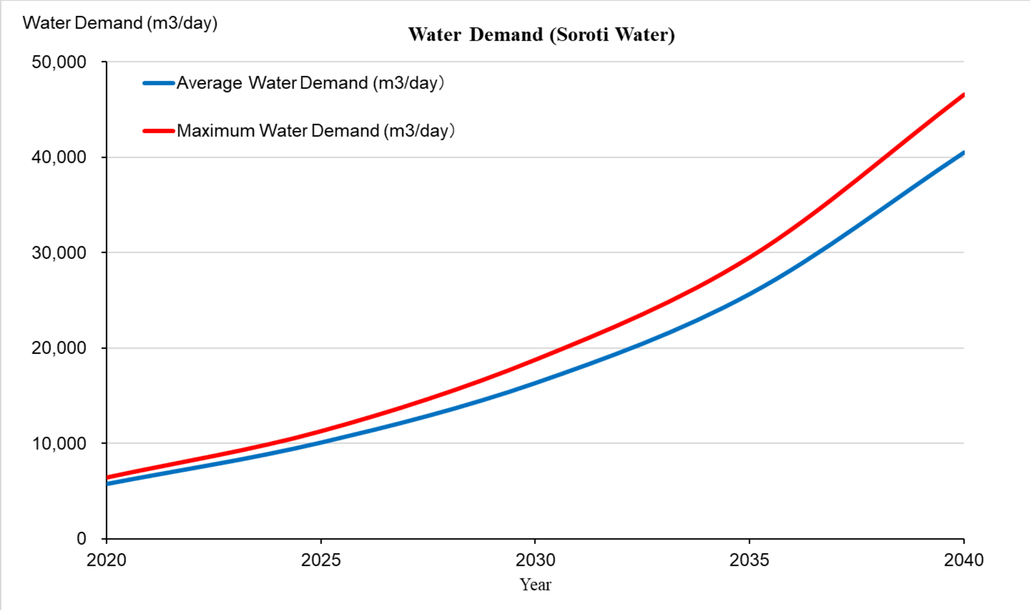
The water demand projection for Soroti Water is shown in Table 3.4.55 and Figure 3.4.32. There are many assumptions in this water demand projection; therefore, it is essential to collect, organize, as well as to consult with related organizations on the population served, expansion of water supply areas in the future, unit consumption, connection rate of each household and PSP, NRW rate, etc., to study the future demand projection in detail.

Table 3.4.55 Water Demand Projection of Soroti Water

Indicator	2020	2025	2030	2035	2040
Target Population (People)	297,978	354,881	422,649	503,359	599,480
Service Population*1 (People)	79,509	159,740	267,712	411,097	599,480
Domestic (m^3/day)	1,869	3,557	6,148	9,734	14,630
PSP (m^3/day)	632	1,451	2,591	4,239	6,583
Commercial & Industrial (m^3/day)	665	1,121	1,889	3,184	5,365
Institutional & Government (m^3/day)	974	1,641	2,766	4,661	7,854
NRW (%)	28	23	18	15	15
Average Water Demand (m^3/day)	5,750	10,092	16,335	25,668	40,508
Maximum Water Demand (m^3/day)	6,440	11,300	18,790	29,520	46,580

*1: The Service Population is calculated by the population of domestic and PSP. The Service Population in Table 3.3.2 is calculated by the population of domestic, PSP, commercial & industrial, institutional & government.
1. Service Population: 26.7% in 2020, assumed to be 100% by 2040 (3.7% annual growth).
2. Connection rate for domestic and PSP: Calculated using trends from 2015 to 2020
3. Unit consumption per capita for domestic and PSP: 50 liters and 15 liters in 2020, with an annual growth of 1%.
4. Commercial & industrial, institutional & government water consumption: Assumed to increase by 11% per year based on actual results from 2015 to 2020.
5. NRW: Assumed to decrease by 1% per year to 15% based on the actual results of 28% in 2020.

Source: JST



Source: JST

Figure 3.4.32 Water Demand Projection of Soroti Water

(6) Issues in the Development of Water Supply Facilities

1) Development of Water Source

The current water source which is the River Awoja has a large potential to cover Soroti Water in terms of water volume and quality. The intake pipes are clogged during the rainy season and need to be cleaned by divers due to inappropriate design of the water intake facilities. It is necessary to upgrade and expand the intake facilities to enable the abstraction of the specified intake volume.

2) Water Treatment System

The current average water production capacity has decreased to between 6,500 and 7,500 m^3/day against the design production capacity of Awoja WTP which is 8,500 m^3/day. The reasons include the inability to abstract the specified water intake volume due to clogging of intake pipes, inability to perform sufficient backwashing due to leakage of backwash tank, and extremely short backwashing cycle (12 hours) due to clogging of filtration basin by algae growth. Countermeasures against water leakage and algae in the backwash tank (pre-chlorination, etc.) can be addressed by small-scale rehabilitation work and should be carried out by NWSC as a short-term remedial action. In addition, expansion of the existing water treatment plants is expected due to the annual increase of water demand as the population grows, and the existing water production capacity will be insufficient in the future.

3) Water Distribution System

Water is distributed from Awoja WTP to the distribution tanks in Soroti Municipality. Soroti Water is also responsible for supplying water to areas more than 70 km away. Therefore, a comprehensive rehabilitation and expansion plan, including the division of the distribution area, is required from the viewpoint of efficient O&M of Soroti Water. Also, the use of asbestos pipes and aging steel pipes needs to be replaced.

4) Countermeasures for Non-Revenue Water (NRW)

The NRW rate in Soroti Branch worsened drastically to 28% in FY 2019/20. The reasons are mainly leakages from aging distribution reservoirs, and leakages and bursts from pipes due to increased water distribution. As for NRW countermeasures, in addition to the detection of illegal connections and early detection of leaks through the pipe patrols that are currently being implemented, asset management for the planning of systematic rehabilitation of aging pipes (asbestos pipes, steel pipes), water meters, etc. is also important. Also, leakage management is essential in this situation and countermeasures such as those proposed in Section 3.4.2 Hoima Water, are to be expected.

3.5 Issues on Management and O&M for NWSC

The following seven issues were identified as the main challenges for NWSC based on the understanding of the current situation:

<u>Challenge 1: The water coverage is not high in regional cities. While there are many high-growth cities in rural areas, water supply is not up to par and funding is inadequate. (Insufficient water production and distribution capacity caused by increased in water demand due to population growth)</u>

NWSC has expanded the target cities from 170 cities to 258 cities in the five years from 2015/16, and has increased water production, water supply, and water sales to 132%, 129%, and 118%, respectively. On the other hand, water coverage is low in some cities (84% for all NWSC jurisdictions). The reasons why the water supply coverage rate is not high are the scarcity of water sources, the deterioration of raw water quality, the deterioration of facilities, and the inadequate distribution network. It is expected that the population of NWSC's existing service areas will continue to grow and the water supply area will continue to expand. Therefore, systematic infrastructure development is an important issue.

<u>Challenge 2: There are many areas where water source quality is poor in rural areas (high concentration of color, iron, etc.), and the operation and maintenance costs are high due to the increased amount of chemicals required at the water treatment plants, and the prices are not stable due to dependence on imported products. (Change in treatment method and increase in treatment costs due to deterioration of raw water quality)</u>

High concentration of iron and color in raw water is more common in rural areas, as is the case in Hoima, Mubende, and Mityana water supply facilities. The chemical costs for treating these, such as liquid chlorine for pre-chlorination and coagulant (Aluminum Sulphate, Polyaluminium Chloride) for coagulation and sedimentation treatment, are high. Since these chemicals are dependent on imports, they are greatly affected by currency rate, which is an unstable factor that can significantly increase or decrease maintenance costs.

<u>Challenge 3: The non-revenue water (NRW) rate, especially leakage rate, is high in Kampala Water, and NWSC has not been able to take proactive countermeasures for NRW (e.g., leak detection and rehabilitation of aging pipes). (High non-revenue water (NRW) rate)</u>

The non-revenue water rate in Kampala Water in FY 2019/20 was 39.5%, and it has remained at a high level, such as 44.2% in July 2021. Furthermore, after starting operation of the Katosi Water Treatment Plant, the non-revenue water rate has been on the rise due to the increase of pipe pressure in the 24-hour water supply area. Since there is no specialized non-revenue water (NRW) department and dedicated staff, there have been no systematic NRW reduction activities not only in Kampala Water but also in regional water areas. There is no specific medium- to long-term plan that has been formulated specifically for NRW reduction even though NWSC has set a target of reducing the NRW rate to 28% or less overall (33% or less in Kampala Metropolitan Area) Corporate Plan 2018-2021. In addition, although there seems to be an annual reduction plan in place, it is mainly routine work such as pressure management, prompt leak repair, etc. However, no specific review has been conducted on the proactive reduction activities and results of the activities. These factors are thought to be due to lack of human resources and capacity, limited time for reduction activities due to other work, and inability to take concrete action due to lack of funds. Besides software measures, hardware measures such as renewal of aging pipes and construction of DMA are required to prevent water leakage; however, NWSC internally generated funds measures are limited to rehabilitation and replacement of burst and leaking pipes and NWSC does not have sufficient funds to systematically replace aging pipes over long distances. Currently, NWSC is carrying out the detailed design of the water distribution network rehabilitation plan funded by the LV-KW WATSAN project, and the water distribution network will be rehabilitated. However, only a portion of the water distribution network rehabilitation plan proposed in the Kampala Water Supply Master Plan has been implemented due to budget constraints. In Kampala Metropolitan Area, NRW is expected to increase further with the operation of the new Katosi Water Treatment Plant and securing the financial resources necessary to implement the ongoing NRW reduction plan will be a challenge.

Challenge 4: Most of the water service areas in rural areas do not have sufficient facility and customer ledgers, and there is a lack of facility ledger data in Kampala Water. (Insufficient asset management systems)

The information on aging pipes is insufficient even though Kampala Water manages the information on transmission and distribution mains (pipe diameter, material, and year of construction) using Map Kit in GIS. Apart from Kampala Water, the information of water distribution mains for the target areas of this survey have not been updated since 2019. Although Map Kit will be introduced in areas outside of Kampala in the future, it is essential to survey and update the existing pipelines and obtain the existing geographic information due to insufficient pipelines and geographic information. These problems are thought to be caused by the lack of smooth coordination among related departments, such as the Water Supply Department, Asset Management Section, and Commercial Department (branch office), etc., which handle completion drawings, and the shortage of human resources and funds. Therefore, improvement of the organization and management, and securing of human resources are required. In terms of facilities, updating of old computers and other hardware and purchase of dedicated terminals for the work site are also required.

Challenge 5: Methods of procurement of NWSC funding for future facilities development and capacity building in Kampala Metropolitan Area, where the population is growing rapidly, and in rural areas where the service area is expanding. (Insufficiency of NWSC's own capital investment capacity observed from the current financial condition)

The NWSC needs a huge amount of funds for the future development of facilities in Kampala Metropolitan Area, where the population is rapidly increasing, and in rural areas across the country, where the service area is expanding. Therefore, it is essential to arrange funds from grant aid and loan aid from GoU and various donors for the capital investment and operation and maintenance. Borrowing funds from financial institutions is essential, but at present, NWSC does not have sufficient borrowing capacity. Also, PPP can be considered to procure funds and implement projects; however, the PPPs of Kampala Water (A three-year water distribution management contract was signed from 1998 to 2001 with H P Gauff, consultants from Germany to improve tariff collection and reduce NRW. Also, a contract was signed from 2002 to 2004 with Ondeo (now Suez) from France for two years to manage the entire water and sewage pipeline facilities.) utilized by NWSC to date have not been successful in improving the non-revenue water (NRW) situation. Even if PPPs are to be implemented, PPPs that focus on areas where the operation and maintenance of NWSC can be further improved are being considered. At present, donor funds such as EIB/AFD/EU-ITF and KfW/WB have already been actively introduced; therefore, collaboration of donors including JICA or collaboration between donors and private sector needs to be considered in the future.

<u>Challenge 6: Provide continuous training and deployment of staff with sufficient skills in the expanding NWSC service area and facilities, including in rural areas. (Lack of human resources and training to cope with water service expansion)</u>

The NWSC is rapidly expanding its operation and maintenance to 258 regional service areas and it is planned to be 283 areas by 2025/26. Along with this, the number of staff will increase from around 4,000 in 2020/21 to around 5,000 over the next five years, but human resource development has not caught up sufficiently. The training of technically qualified personnel has not kept pace. Therefore, it is essential to expand a certain level of technical capacity in new areas through efficient human resource development through the regional deployment of Vocational Skills Training and Development at Ggaba Water Treatment Plant; however, the vocational training system and educational materials at rural water level have not been sufficiently expanded.

The role of NWSC rural water supply areas is mainly to provide water supply and sewerage services through the operation and maintenance of water supply and sewerage facilities, and there are no personnel who can formulate water supply facility improvement investment plans or business plans. These operations are being carried out by NWSC Headquarters; however, support is needed to develop technical and financial personnel as there is a lack of human resources to plan which is caused by the rapid increase in workload due to the increase in the number of water service areas.

<u>Challenge 7: NWSC staff with high level of knowledge in the operation and maintenance of water treatment plants and reduction of commercial losses shall continue to be dispatched to overseas water utilities through the expansion of education system, thereby contributing to the improvement of technical capabilities. Also, NWSC will establish a strong presence in the African region. (NWSC's overseas development)</u>

Currently, NWSC is in the process of establishing Africa Water Sanitation Academy (AWASA) to play the role of education and training for the Africa Water Association; however, NWSC lacks the human resources and capacity to prepare business plans and development plans. The education and training for AWASA are also considering the utilization of resources of NWSC External Service (ES) (human resources, curriculum, materials and equipment); however, the target audience for education and training will include not only technicians but also executives such as CEOs and management of water companies. Therefore, it is essential to support the creation of technical training curriculums and to create educational materials that will contribute to the training of the executive staff of each water company.

3.6 Aid Status from Other Donors and Neighboring Countries and Potential for Collaboration

3.6.1 Status of Support from Other Donors and Potential for Collaboration

(1) Ongoing Project Implemented by Other Donors

As mentioned in Section 3.2.4, NWSC expanded the target cities from 110 cities to 258 cities between 2014/15 and 2019/20, increasing water supply, water sales, and annual sales by 137%, 131%, and 219%, respectively. On the other hand, in some cities, the water supply coverage rate is low due to insufficient development of water distribution networks. In addition, the non-revenue water (NRW) rate is as high as 34% for the entire NWSC. In order to solve these problems, NWSC has been implementing infrastructure development such as construction of water treatment plant and reconstruction of water distribution block system with the support of other donors as shown in Table 3.6.1.

Table 3.6.1 Financial Cooperation Projects by NWSC in Urban Water Supply Sector

Name	Area	Scope	Donor	Status
Kampala Water Lake Victoria Water and Sanitation (WATSAN) Project (Phase I – III)	Kampala Region	• Estimated project cost: EUR 372 million • Rehabilitation and upgrading of Ggaba I & II water treatment plant (230,000 m^3/day) • Construction of the Katosi Water Treatment Plant (Phase 1: 160,000, Phase 2: 240,000 m^3/day), construction of the Katosi transmission main and distribution system (54 km) • Institutional Support/Capacity Building and Program Management	・EIB (Loan) ・AFD (Loan) ・EU-ITF (Grant) ・KfW (Grant)	Completion: 2023
Adjumani - Integrated Water Management and Development Project	Eastern & Northern Region	・Improvement of water supply system	IDA-WB (Loan)	・Procurement of consultant ・Completion: December 2024
Mbale - Integrated Water Management and Development Project	Eastern & Northern Region	• Construction of new water system • Rehabilitation of existing systems	IDA-WB (Loan)	・Procurement of consultant ・Completion: December 2024
Development of WATSAN Infrastructure for the Mbarara, Masaka and Isingiro Areas, South Western Cluster	Western & South Western Region	・ Estimated project cost: EUR 126 million ・ Construction of new water intake and water treatment plant (Mbarara、Isingiro) ・ Rehabilitation of existing water systems	AFD (Loan)	・Ongoing ・Completion: June 2024
Integrated Program to Improve Living Conditions in Gulu (Phase II Nile Option)	Eastern & Northern Region	・ Construction of water treatment plant and bulk transfer, distribution system	・KfW (Grant) ・WB (Loan)	Completion: June 2025
Wakiso West	Central	・ Development of the water	IDA-	Completion: April

Name	Area	Scope	Donor	Status
WATSAN Project (WWWSP)	Region	supply system	DANIDA（Loan）	2023

Source：NWSC Integrated Annual Report 2019/20

(2) Support Status and Interview Results of Other Donors

The following is a summary of the support status of other donors in individual technical themes (especially reduction of non-revenue water and introduction of prepaid meters) to NWSC, and the results of direct interviews with each donor. Details of the results of hearings with each donor are shown in Table 3.6.2.

1) World Bank (WB)

NRW reduction： No interest

Introduction of PPWM： No interest

2) African Development Bank (AfDB)

NRW reduction: Financing for UWA (extension or replacement of piping)

Introducing PPWM: None (The reason is that it is necessary to deal with system maintenance for failure of PPWM meters and tokens.)

Capacity development: Primarily carry out capacity development to strengthen the sector and enhance ownership. Looking at the systems built by each sector, they are working with that sector to develop capacity building programs. Since AfDB's support is targeted at the urban and rural areas, some capacity building programs involve local governments. Regarding water supply in rural areas, there are district water offices in each local government, which supply water in urban and rural areas with subsidies from MoF.

3) Agence Frangaise de Developpement (AFD)

The WATSAN project is divided into packages such as water treatment plant construction, water supply and distribution pipe laying (around 287 km), rehabilitation and replacement of existing transmission and distribution network (around 26 km), small-scale SCADA system and establishment of some DMAs, informal settlements, and capacity development. The capacity development package also includes non-revenue water reduction, asset management of water transmission and distribution pipes, etc. (see (3) below for detail). The increase in overall construction costs has led to a budget reallocation for all components, resulting in a budget deficit of around EUR 30 million for water transmission and distribution components.

4) Government of France

The Government of France is trying to replace the aging pipes in the Kampala metropolitan area with the remaining budget of the WATSAN project (about JPY 3 billion).

With the French government fund, the dispatching of expert has been conducted on a survey of the current status of non-revenue water (NRW), the water flow and NRW analysis based on existing data entry, and dispatch of experts on asset management (analysis of areas that require pipe renewal and investment amount required for pipe renewal). One engineer from Altereo, France, which sells dedicated software for water pipe assessment and asset management, has been staying in Kampala for 18 months from June 2021. (The contract amount is about EUR 600,000.) In the interview with the engineers of Altereo, the study does not include leak detection by equipment, water pressure analysis, and link with commercial loss. Therefore, the company mentioned that it is possible to cooperate with the support from Japan in such field.

5) Kreditanstalt für Wiederaufbau (KfW)

KfW has implemented many capacity development programs.

Table 3.6.2 Interviews with Various Donors and Results

Item	World Bank (WB)	African Development Bank (AfDB)	Agence Frangaise de Developpement (AFD)	Kreditanstalt für Wiederaufbau (KfW)
1. Importance of Uganda among all the target countries in Africa	WB has been in Uganda for 50 years and there is no talk of exit. SSCD is under review.	An important country among all the target countries in Africa. The process for the preparation of the next CSP for Uganda is ongoing which will go under approval and will be cleared latest early 2022.	AFD had an office established in Uganda in 2009 and Uganda remains a priority in the East African region.	Uganda remains a very important partner for the German government and the cooperation has been quite cordial for a very long time.
2. High priority sectors	Health, roads, energy, education, environment and water supply including irrigation are the high priority sectors in Uganda. WB is interested in projects under the water supply sector in both the urban and rural areas. Refugee areas assistance as well.	Roads, agriculture, and water supply & sanitation both in urban and rural areas of Uganda.	50% of the investment from AFD in the last five years is in the water and energy sector	Water supply, road & bridge, agriculture, air, renewable energy
3. Future collaboration with JICA on urban water supply sector	WB is not in the process of developing new projects but hopefully will start in one or two years from now. WB is open for collaboration with JICA if there is a possibility in water supply sector.	It is welcome if there is any good project. However, the AfDB prefers planning incl. F/S would be done by other donors like JICA.	For any collaborations with other donors it is discussed during the development sector meeting groups.	Flexible for cooperation with other donors. Using several methods to cooperate with other development partners. For example, MRI (Mutual Reliance Initiative).
4. Ideathon	Online participation	Online participation	Online participation	Online participation
5. Water Project 【Finance】	① IWMDP(Gulu, Adjumani, and Mbale) 【USD 92.5 million(Loan)】 ② IPILC in Gulu (Phase II Nile Option)【USD 28 million (Loan)】	① The Lake Victoria Protection II Project (LVP II) 【EUR 65.5 million (Loan)】 ② Strategic Towns Water Supply and Sanitation Project (STWSSP) 【USD 62 million(Loan)】	① KW WATSAN Project 【EUR 225 million(Loan)】 ② Development of WATSAN Infrastructure Project 【EUR 120 million(Loan)】	① KW WATSAN Project 【EUR 30 million（Grant）】 ② IWMDP (Gulu) 【USD 19 million(Grant）)】 ③ IPILC in Gulu (Phase II Nile Option) 【USD 25 million（Grant）】
6. Progress of projects	① Adjumani、Mbale：Procurement of consultant in	①：Sewer network and pumping station were completed.	①: Water distribution pipe construction: Detailed design	①：WASH facilities in illegal settling area：Under

Item	World Bank (WB)	African Development Bank (AfDB)	Agence Frangaise de Developpement (AFD)	Kreditanstalt für Wiederaufbau (KfW)
	water supply project. To be completed in Dec. 2024. Gulu was in 2020. ② Procurement of water supply facility construction. To be completed in June 2025.	Wastewater treatment plant was completed as of June 2020. ②Increase of water production (not yet started), laying of transmission and distribution network (under procurement), construction of septage treatment plant (detailed design consultant is under procurement)	stage, new water treatment plant / transmission pipe: Scheduled to be completed in July 2021. Capacity Building: EOI Stage ②: Detailed design stage	implementation partly ②：Completed in 2020 ③：Procurement of consultant for water supply facility construction project. Will be completed in June 2025.
7. Financial flow in projects	A loan agreement is signed between WB and the Ministry of Finance (borrower) which then has a subsidiary agreement with NWSC and the Ministry of Water and Environment (MoWE) who are the executing agents for grant.	-	EN signed between WB and the Ministry of Finance. Granted from the Ministry of Finance to NWSC.	A financing agreement is signed between KfW and the Ministry of Finance (MOF) where MOF also signs an on-granting agreement with NWSC or MoWE where money is given directly to NWSC.
8. Finance conditions	Any special condition for the loan such as financial covenant but a project operational manual is required.	-	No special conditions. Land acquisition and tax payment by the GoU	No special condition but there are conditions for financing which are inserted in the financing and implementation agreements.
9. Technical issues in projects	Restudy and change of water source due to low quality of F/S etc. Change of water source.	-	The WATSAN Project applies a special treatment method due to the deterioration of water quality in Lake Victoria. Land acquisition problem.	-
10. NRW, Prepaid water meter（PPWM）, Capacity building	NRW reduction：No interest PPWM：No interest Capacity building：organization improvement and capacity building in UWA	NRW reduction：Rehabilitation and expansion of distribution network in UWA PPWM：No interest at present Capacity building: Under implementation of capacity development program in water sector	NRW reduction: WATSAN Project plans to implement NRW measures, management of water transmission and distribution pipes, DMA, etc.	-

Item	World Bank (WB)	African Development Bank (AfDB)	Agence Frangaise de Developpement (AFD)	Kreditanstalt für Wiederaufbau (KfW)
11. Project and target area in future urban water supply sector	No plan due to ongoing projects. Will consider in 1-2 years as required.	Received proposals of Water Supply and Sanitation Programme Phase III. The target area is entire Uganda.	Three cities will be added to the development of WATSAN infrastructure project.	The new financing streams are largely focusing on water for refugees, water for peri-urban areas and small towns and rural growth centers.
12. Possibility of introducing PPP	Not considered at this moment	Not considered at this moment	Not considered at this moment	-

Source: JST based on interviews to donors

6) Vitens-Evides International (VEI)

Although VEI is not a donor, the contents of support are described here because it has a close relationship with the Dutch government.

VEI is in the process of technical cooperation on the following items as the "Waterwork Program" based on the agreement with NWSC. (Current Phase 1: 2017 to 2021) The details of the technical cooperation are shown as follows:

i. Asset management

a. Improvement of asset management method * Introduction of Map Kit and hydraulic analysis software

b. Improving water supply system performance (e.g., non-revenue water reduction methods and initiatives)

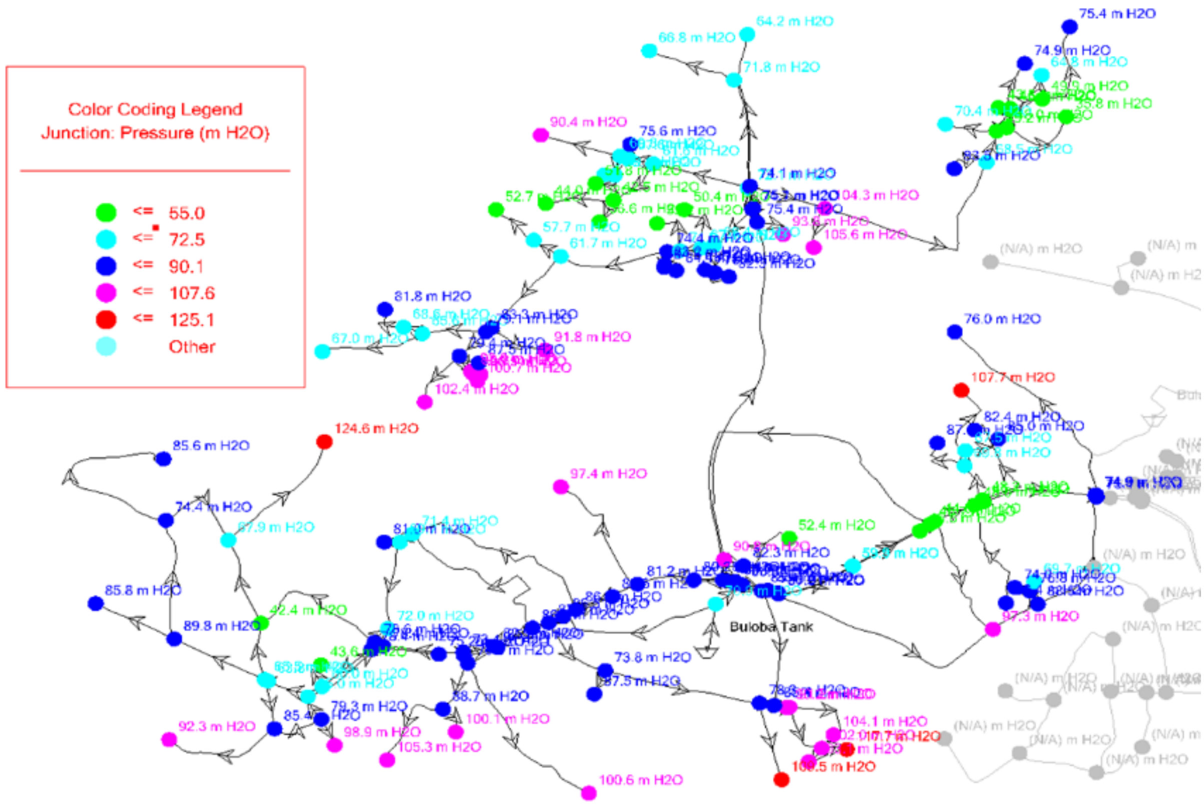
* Planned to install a pressure reducing valve (PRV) in the western Bulenga distribution area, but the budget is insufficient.

c. Improvement of maintenance program, etc.

ii. Mediation of investment programs to improve water services

iii. Technical cooperation to Kampala Water as a pilot for technical cooperation and expansion to other areas

The above hydraulic analysis software supports the creation of water quality analysis models as shown in Figure 3.6.1.



Source：NWSC

Figure 3.6.1 Example of Flow Analysis Model

- However, NWSC bears the labor costs and travel costs related to the dispatch of staff.
- Phase 1 is until 2021. Implementation of Phase 2 is undecided.

(3) Projects and Supports by Other Donors

1) Kampala Water - Lake Victoria (KW-LV) WATSAN Project（EIB/AFD/EU-ITF）

Package 6E: EOI of the Capacity Building and Project Management Support (Technical Assistance) mainly describes the following about human resource development. However, according to NWSC, the business content is undecided because RfP is not available.

① Investment plan management

② O&M improvement (water quality management, SCADA, hydraulic monitoring, customer management, asset management system, non-revenue water management, human resources management, information technology)

③ Short-term experts (water and sewage hydraulic modeling, GIS, non-revenue water management, leak detection, etc.)

2) Support Framework by Dutch Government

Through the mediation of VEI, NWSC is seeking financial assistance from the following Dutch governments, but it is undecided at this time.

・ DRIVE (Development Related Infrastructure Investment Vehicle) by the Dutch Ministry of Foreign Affairs

* Being applied to projects ranging from EUR 5 to 60 million. Grant aid is possible up to 50%. NWSC is trying to utilize this DRIVE for free.

・ DFCD (Dutch Fund for Climate and Development): Loan

* VEI submitted a proposal to NWSC to apply DFCD, but since it is a loan, there is a high possibility that it will be disapproved or postponed within the government. In addition, the reason for applying non-revenue water measures to climate change funds is weak.

⇒ NWSC is particularly positive to DRIVE, which is grant aid.

(4) Possible Cooperation with Other Donors

Based on the above surveys and hearing results, the possibility of cooperation with each donor will be examined as follows:

1) World Bank (WB)

The JST would like to continue exchanging opinions, including Ideathon, regarding the development policy of local areas.

2) African Development Bank (AfDB)

Cooperation is possible in the capacity development program (nationwide).

3) Agence Frangaise de Developpement (AFD)

Cooperation with non-revenue water reduction, DMA construction, etc., in the WATSAN project is possible.

When establishing pilot DMAs in a technical cooperation project and repairing / renewing a part of old pipes, or when renewing old pipes in an official development assistance (ODA) loan project in the future, it is necessary to coordinate the target areas with the WATSAN project in which AFD is the main lender. Specifically, it is necessary to avoid duplication of target areas and target pipes when repairing or renewing old pipes in technical professionals or ODA loan projects. As mentioned earlier, there is a budget shortage in the water pipe components of the WATSAN project, so it is necessary to pay attention to the final contents of the implementation.

4) Government of France

Collaboration with the technical cooperation for the leak data analysis / pipeline renewal plan support software can be currently considered. It is possible to complement each other with Japanese leak detection technology, detailed leak monitoring by constructing DMA, water pressure control technologies, and software support for GIS and hydraulic analysis by VEI described below.

5) Kreditanstalt für Wiederaufbau (KfW)

A questionnaire was sent because KfW has conducted many capacity development projects, but it was not answered.

6) Vitens-Evides International (VEI)

Cooperation is possible in GIS, hydraulic analysis, and asset management. It is conceivable to introduce the most suitable asset management planning software, including Dutch and other European software, to NWSC and provide technical guidance.

3.6.2 Status of Project Implementation in Neighboring Countries and the Potential for Collaboration

The status of project implementation by other donors and public institutions, and the possibility of cooperation with them in countries around Uganda and in multiple countries including Uganda are described below.

(1) Possibility survey for application of prepaid water meters in urban areas of Africa（World Bank、2014）

Interviews with service providers, governments, and NGOs had been confirmed from July 2013 to April 2014 to confirm whether prepaid water meters are effective for the World Bank to supply water to poor urban communities. A field survey was conducted on the usage status. The following eight cities in Sub-Saharan Africa were selected as case studies:

① Kampala (Uganda), ② Lusaka (Zambia), ③ Windhoek (Namibia), ④ Mogale (South Africa), ⑤ Maseru (Lesotho), ⑥ ⑦ Nairobi, Nakuru (Kenya), ⑧ Maputo (Mozambique)

According to a survey report, Kampala introduced prepaid public faucets for the first time in 2007 to improve tariff collection in poor areas, and as of 2014, 1,600 prepaid public faucets had supplied water to 200,000 people. Furthermore, it was planned to increase 3,000 public faucets by 2017.

Regarding prepaid water meters, questionnaires were sent to the cities and water companies listed in the above World Bank Survey Report in "Jenin City Water Supply Project Implementation Capacity Enhancement Project" in Palestine (JICA Technical Cooperation, September 2017 – September 2021). and the consultants are considering the introduction of prepaid meters in the future JICA project.

As for the possibility of cooperation, NWSC focused on the battery life of prepaid public faucets being about three years, and in Kampala, solar panels handled by Ugandan companies are retrofitted to the public faucets, so it can be installed in rural areas in the future. On the other hand, it is conceivable to promote the spread of prepaid public faucets + solar panels as a set. (The utilization status of prepaid public faucets in Kampala is described in Section 3.2.4.)

(2) Establishment Plan of Africa Water Sanitation Academy（AWASA） by AfWA

The African Water Association (AfWA), headquartered in Côte d'Ivoire, plans to establish the Africa Water Sanitation Academy (AWASA), and NWSC has so far collaborated with AfWA in India, Bangladesh, Trinidad and Tobago, etc. With technical assistance and several water utilities from various African countries visiting NWSC for training, the host has become NWSC and its External Service is currently working on the establishment of the academy. The headquarters of the academy will be NWSC, and Burkina Faso, Morocco, Cameroon, South Africa, and Ethiopia are candidates for satellite offices. NWSC asked for support regarding Strategy Financial and Technical. It was supported by the German Water Partnership as a small-scale support, but it seems that it has ended now.

The academy's working capital will be funded by consultant service costs to NWSC. It is also possible that multiple donors will work together to support this activity.

It is necessary to discuss with NWSC in the next field survey and summarize the outline, but the contents of JICA's support and cooperation that can be considered at this time are, for example:

1. Support for the creation of teaching materials in Uganda and provision of equipment for online distribution (technical cooperation) so that each target organization of supports can take lectures online without visiting Uganda.
2. Provide ongoing support, including training of instructors through training in third countries or issue-specific training
3. Implementation of a wide-area technical cooperation project targeting multiple countries with the base in Uganda so that education at the above satellite offices can be enhanced (guidance from multiple countries by Japanese experts)
4. (If possible) NWSC travels to educational activities for institutions in each country, or establishes a fund to raise funds for visiting NWSC from each country

3.6.3 Development and Potential for Collaboration with Private Companies

(1) Study and Arrangement of Products, Technologies, and Knowhows of Private Companies

The following categories can be considered as the targets of private companies among the companies that handle products in the water services field:

① Japanese companies with a sales record in Uganda;

② Japanese companies that have overseas sales records and are interested in the African region including Uganda;

② Domestic start-up company in Uganda; and

④ Start-up companies in neighboring countries of Uganda.

Of the above, sort out (1) and (2) first and contact the relevant companies and promising companies. The results are described below. In addition, although interviews with NWSC have been conducted for ③ and ④, no innovative cases in the water services field have been confirmed.

1) Contacts to Companies

a) Water Business Study by Ministry of Finance

The following companies were targeted for study:

③ The companies which have an overseas track record in the water supply field

④ The companies which are interested in the African region in a questionnaire on overseas sales and future development policies for around 70 Japanese companies in a survey and examination work (Ministry of Land, Infrastructure, Transport and Tourism, Sewerage Department) by Nippon Koei Co., Ltd.

b) JICA Private Sector Collaboration Project

The JICA Survey Team searched for the past private sector collaboration projects in the water supply field and development support projects for small-scale companies (project formulation surveys, dissemination / demonstration / commercialization projects, and needs surveys) in "Project Case Search" (https://www2.jica.go.jp/ja/priv_sme_partner/index.php) on JICA website for private sector collaboration project.

The JICA Survey Team checked each report and confirmed the company name and the name of the technology that is planned to expand overseas.

c) Number of Contacts

Table 3.6.3 summarizes the company names and technology names surveyed in a and b above.

The JICA Survey Team contacted 14 of these Japanese companies. Eleven of them were interested in doing business in Uganda and were able to cooperate with the questionnaire.

2) Contents of Questionnaire

The JICA Survey Team sent a questionnaire consisting of the following items to each company and collected the answers:

Orders received in Africa, future sales activities in Africa, sales and marketing system in Africa,

Recommended products (product name, features / advantages, patents / certifications, etc.), interest in workshops / seminars,

Challenges for expanding into Africa, requests for JICA, etc.

Table 3.6.3 Private Technologies and Companies, Past JICA's Private Cooperation Projects（Water Supply Sector）

No.	Product Name	Company	Past Private Cooperation Project	Contact	Response
Non-revenue Water Reduction					
Hard countermeasure（Leak detection, Optimization of distribution）					
1-1	Automated Leak Detector	Suidou Technical Service Co., Ltd.	Dissemination and demonstration project of water leakage detection system using automatic water leakage sound detector（India, 2013 to 2016）	Not necessary	—
1-2	TS (Tokyo Supply) Leak Checker	TSS Tokyo Water Co., Ltd.	Project formulation survey on non-revenue water reduction technology for water supply using TS leak checker	Not necessary	—
1-3	Amplifier for listening rod (KIKUZO)	Goodman Co., Ltd.	None	Done	Positive
1-4	PVC Pipe Leakage Detector D305（PVC Locator）	Goodman Co., Ltd.	・Survey on water supply management improvement projects through the sophistication of water infrastructure management system（Indonesia, 2016） ・Dissemination and demonstration projects with non-revenue water reduction measures using a leak detector specializing in resin pipes and O&M of water distribution network（Indonesia, 2013 to 2015）	Done	Positive
1-5	Leak Detection System with Hydrogen and Nitrogen Generators (Hydro Tracer HT-55/50)	Goodman Co., Ltd.	None	Done	Positive
1-6	PSV System（Pressure Sustaining Valve）	Kane Kogyo Co., Ltd.	Project formulation survey to build a PSV system that contributes to the realization of proper water distribution and reduction of non-revenue water（Sri Lanka, until 2018） **※Demonstration project is ongoing**	Done	Positive
1-7	Flow Control Valve	Maezawa Industries Inc.	None	Done	Positive
1-8	Leakage Detection, Meter Replacement,	Tesco Asia	Dissemination / demonstration project of package-type non-revenue water reduction measures（Sri Lanka, till 2017）	Not necessary	—

No.	Product Name	Company	Past Private Cooperation Project	Contact	Response
	Plumbing Technical Guidance				
Hard measure（Apparent Loss）					
2-1	Customer meter (small)	Aichi Tokei Denki Co., Ltd.	None	Done	Negative
2-2	Electromagnetic Flow Meter（large）	Yokogawa Electric Tokyo Keiki	None	Done	Positive
2-3	Portable Water Meter Test Kit	Aichi Tokei Denki Co., Ltd.	None	Done	Negative
Soft measure（Software, SCADA, etc.）					
3-3	DCS／SCADA	Yokogawa Solution Service	None	Done	Positive
3-4	Water Distribution Control System	Hitachi	None	Done	Negative
3-5	Water Loss Management (WLM) System	Yokogawa Solution Service	None	Done	Positive
3-6	Water Supply Mapping System	Aichi Tokei Denki Co., Ltd.	None	Done	Negative
3-7	Pipe Network Management System	Hitachi	None	Done	Negative
3-8	・Water Supply Ledger System ・ GeoSpatial Analysis（GSA）	Geoplan Namtech	None	Done	Cannot export to Africa
3-9	Software Package for	Pipe Design	Project formulation survey on water management improvement projects	Not	

No.	Product Name	Company	Past Private Cooperation Project	Contact	Response
	Data Creation and Design on Pipe Network		through the sophistication of water infrastructure management system （Indonesia, 2016）	necessary	
Other than Non-revenue water reduction					
4-1	Rainwater Harvesting Using Plastic Underground Storage Facilities	Totetsu Co., Ltd.	Verification Survey with the Private Sector for Disseminating Japanese Technologies for Gap Resolution of Water Demand/Supply by Plastic Underground Rainwater Storage System（India、2016）	—	—
4-2	PC Tank	Abe Nikko Kogyo Co., Ltd.	Dissemination and demonstration project of PC tanks that contribute to economical water supply development（Sri Lanka,　till 2019）	—	—
4-3	Water-Saving Reverse Osmosis (RO) Membrane Water Purifiers	Emax	Project Formulation Survey for Drinking Water Purification Equipment Project Survey（2018）	—	—
4-4	RO Membrane Filtration Systems	Kansui Koubou Co., Ltd.	Basic survey on the manufacture and sale of lightweight, compact, and energy-saving RO membrane filtration equipment in areas where water services are not widespread　（Indonesia, 2018）	—	—
4-5	Activated Carbon and Ultra-Filtration (UF) Membrane Filtration Systems	Ishikawa Engineering Co., Ltd.	Feasibility Survey for Improving Service of Drinking-water in Surabaya（Indonesia、2017）	—	—
4-6	Desalination Unit with Solar Power Generation	Suidou Kiko, Toray Industries Inc. Kitakyushu City	Drinking water supply project using solar power generation and small desalination water purification equipment (BOP Business Collaboration Promotion Survey) （Indonesia, 2011）	—	—
4-7	Water Treatment Plant EPC（Grant aid etc.）	JFE Engineering	None	Done	Positive

No.	Product Name	Company	Past Private Cooperation Project	Contact	Response
4-8	Ozone Generators	Toshiba Infrastructure Systems & Solutions Corporation	None	Done	Positive
4-9	Gas Chlorination System	OKAMURA	None	Done	Positive
4-10	Sludge Scrapper	Swing	None	Done	Negative
4-11	Mobile (In-Vehicle) Ceramic Membrane Filtration Equipment	Metawater	None	Done	Positive
4-12	Package Type Ceramic Membrane Filtration System	Metawater	None	Done	Positive
4-13	Filter Press Sludge Dehydrator	Ishigaki	None	Done	Positive
4-14	Volute-type Sludge Dehydrator	Amcon	None	Done	Negative
4-15	Aqua Pig Method (Specialized in Cleaning Water Pipes)	Nakazato Construction	Survey on cleaning of water supply and distribution pipes to improve the quality and supply capacity of urban water supply（Indonesia, 2019～2020.1）	—	—
4-16	Natural Inorganic Coagulant and Sedimentation Agent	HALVO	Dissemination / demonstration project with small-scale water purification project using a new natural inorganic coagulation sedimentation agent	—	—
4-17	Ultra-High-Speed Chemical-Free Water Treatment System "Chemiles"	Nagaoka	Project formulation survey on the water supply business using the purification technology of the ultra-high-speed chemical-free water injection treatment device "Chemiles" in rural areas	Done	Positive
4-18	Water Supply Pumps	Kubota	None	Done	Positive

No.	Product Name	Company	Past Private Cooperation Project	Contact	Response
4-19	Light Weight Pipe Material	Kubota	None	Done	Negative
4-20	Updated Series Valves	Maezawa Industries	None	Done	Positive
4-21	pH Meter	Yokogawa Electric Corporation/ Yokogawa Solution Service Corporation	None	Done	Positive
4-22	Hybrid Type Compact Water Purification Device	Kyowakiden Co., Inc.	Data collection survey on the possibility of utilizing private technology in developing countries that received COVID-19 in the global environmental field (environment, water resources, disaster prevention)	—	—
4-23	Small-sized Desalination Device	Sanso Electric Co., Ltd.	Ditto	—	—
4-24	Rapid Iron Removal System (HI-LOX)	Hitachi	Ditto	Done	Negative
4-25	Remote Monitoring System (WeLLDAS)	Mitsubishi Chemical Aqua Solutions Co., Ltd.	Ditto	Done	Positive
4-26	Small-scale Decentralized Water Supply System with Membrane Treatment System using Solar Power Generation	Wellthy (Mitsubishi Chemical Aqua Solutions Co., Ltd. At present)	Water purification dissemination and demonstration project using solar power generation（Kenya、till 2016.9）	Done	Positive

Source: JICA Survey Team

3) Useful Devices for Non-revenue Water Reduction

In the Kampala metropolitan area, the non-revenue water rate (especially the leak rate) is high, and the non-revenue water reduction project is listed as a candidate project in the future in Section 3.6.5. From the report of "Project Research: Key Points for Finding, Formulating and Implementing Non-Revenue Water Reduction Projects" (JICA Global Environment Department) conducted by Nippon Koei Co., Ltd. from 2018 to 2019, the following leak countermeasure devices were extracted as generally promising technologies:

Leak detector, leak detection system (compact hydrogen / nitrogen generator, smart ball), metal pipe detector

Leak detector and metal pipe detector are shown in Figure 3.6.2.

 Source: Fujitecom	 Source: Fujitecom	 Source: Emerson Japan
Leak detector	Correlated leak detector	Metal pipe detector

Figure 3.6.2 Example of Useful Devices for Leak Countermeasures

(2) Possible Technologies for Collaboration

From the following three points, the possibility of collaboration with private companies and the issues were considered:

・ List of technologies, products and services of private companies expected to be effective in improving urban water supply services, and the activity examples (local / third country / Japan)

・ Advancement and project implementation status of private companies that provide technologies, products, and services in Uganda

・ Possibility and issues of cooperation with JICA projects in Uganda with private companies

The local needs, applicability, target areas, and applicable schemes were examined from the following situation as shown in Table 3.6.4:

1. High non-revenue water rate (especially water leakage rate) in the Kampala metropolitan area;

2. It is related with aging pipes and high pressure due to the large elevation differences in the water distribution area;

3. Preliminary information that MoWE is interested in the mapping system; and

4. High iron concentration has been confirmed in the raw water of many cities in rural areas.

Table 3.6.4 Study of Private Company Technologies to be Utilized（Water Supply Sector）

No.	Technology／Device	Local Needs /Applicability	Target Area	Applicable Scheme (Draft)
Non-revenue Water Reduction				
1-1	Smart Listening Device for Water Leak Detection - Amplifier for Listening Rod	Low	（Kampala/Local Area）	（TC/GA）
1-2	**PVC Pipe Leakage Detector**	**High（Add）**	**Kampala**	**TC**
1-3	**Leak Detection System with Hydrogen and Nitrogen Generators (Hydro Tracer)**	**High**	**Kampala**	**TC/Loan**
1-4	Pressure Reduction Valve (PRV)	**High**	**Kampala**	**TC/Loan**
1-5	PSV System（Pressure Sustaining Valve）	Middle	Kampala	TC/Loan
2-1	Water Meters, Electromagnetic Flowmeter (Large Size)	High（Add, Replacement）	Kampala	TC/Loan
2-2	Portable Water Meter Test Kit	Medium	Kampala／Local Area	TC／GA
3-1	**DCS/SCADA System**	**High**	**Kampala／Local Area**	**GA/Loan**
3-2	**Water Loss Management (WLM) System**	**High**	**Kampala／Local Area**	**GA/Loan**
3-3	GIS Mapping System for Water Supply	Medium（Existing）	（Kampala/Local Area）	―
3-4	**Asset Management System （Foreign）**	**High**	**Kampala／Local Area**	**TC/GA**
Other than Non-revenue Water Reduction				
4-1	Ozone Generator	Low	Kampala／Local Area	LA/GA
4-2	**Rapid Iron Removal System Ultra-High-Speed Chemical-Free Water Treatment System**	**High**	**Local Area**	**GA**
4-3	Filter Press Industrial Sludge Dewatering	Low	（Kampala/Local Area）	-
4-4	Updated Series Valves	Middle	Kampala	Loan
4-5	**Remote Monitoring System (WeLLDAS)**	**Middle**	**Local Area**	**GA**
4-6	Small-scale Decentralized Water Supply System with Membrane Treatment System using Solar Power Generation	Middle	-	-
4-7	Water Supply Pump	Low（Common）	（Kampala/Local Area）	-

4-8	**Prepaid-type Public Standpost with Solar Panel （Foreign）**	**High**	**Kampala／Local Area**	**GA/Loan**

Note: TC: Technical Cooperation Project, GA: Grant Aid Project
Source：JICA Survey Team

The following technologies, which are mentioned to have high local needs / applicability in Table 3.6.5, are assumed to be promising, and the JICA Survey Team specifically continued to consider whether or not they can be introduced in grant aid or technical cooperation projects:

Table 3.6.5 Private Technologies and Companies which can be Expected for Collaboration （Water Supply Sector）

No.	Technology	Company	Local Issue
1	Leakage Management System with SCADA System	Yokogawa Solution Service	Water leakage and pressure management
2	Pressure Reduction Valve (PRV)	Foreign company	Pressure control （reduction）
3	Pressure Sustaining Valve (PSV)	Kane Kogyo	Pressure control （sustaining）
4	Leak Detection Devices	Goodman Fujitecom	Lead detection
5	Water Supply Ledger System, GeoSpatial Analysis	Foreign company	GIS Mapping
6	Ultra-High-Speed Chemical-Free Water Treatment System "Chemiles"	Nagaoka	High iron concentration in groundwater (Mityana etc.)
7	Remote Monitoring System	Mitsubishi Chemical Aqua Solutions	Monitoring of water quality, flow, level, rainy/dry seasons

Source：JICA Survey Team

Brief of above technologies are as follows;

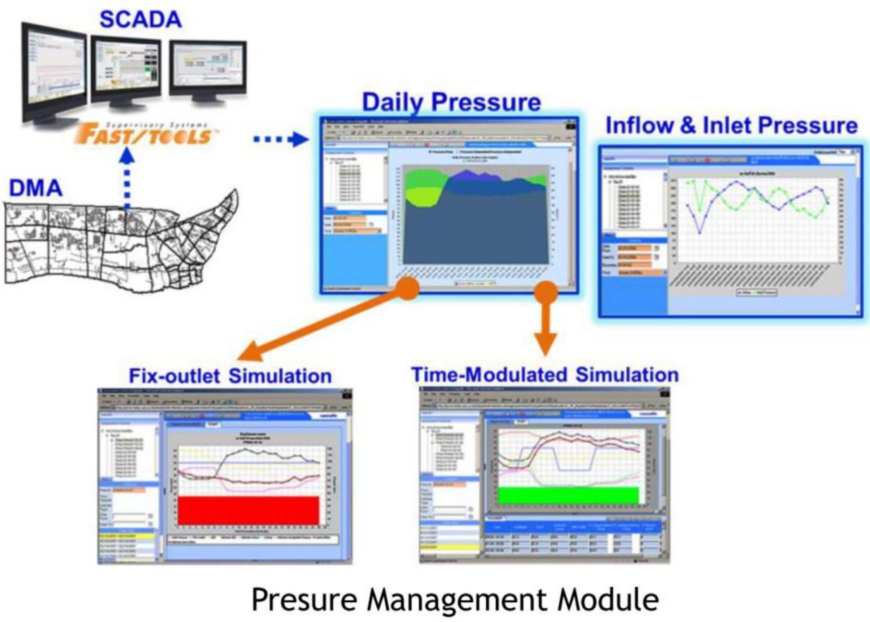
1) Leakage Management System with SCADA System

The SCADA system, IWA-compliant leak management system software, and flow meter are integrated to contribute to reducing the leak rate.

・ Water Balance (calculation of water leakage rate)
・ Night Flow Analysis (detection of new water leakage parts by night flow analysis)
・ Pressure Management (Water pressure can be graphed and used for water pressure simulation)

* see Figure 3.6.3.

* Until the analysis of water pressure situation. Water pressure control by remote valve control from the treatment plant is not realistic due to the large number of valves, and it can be used for fine adjustment of valves.



Note：Confidential（cannot disclose in the JICA website）
Source：Yokogawa Solution Service

Figure 3.6.3 Image of Pressure Management Module in Leak Management System

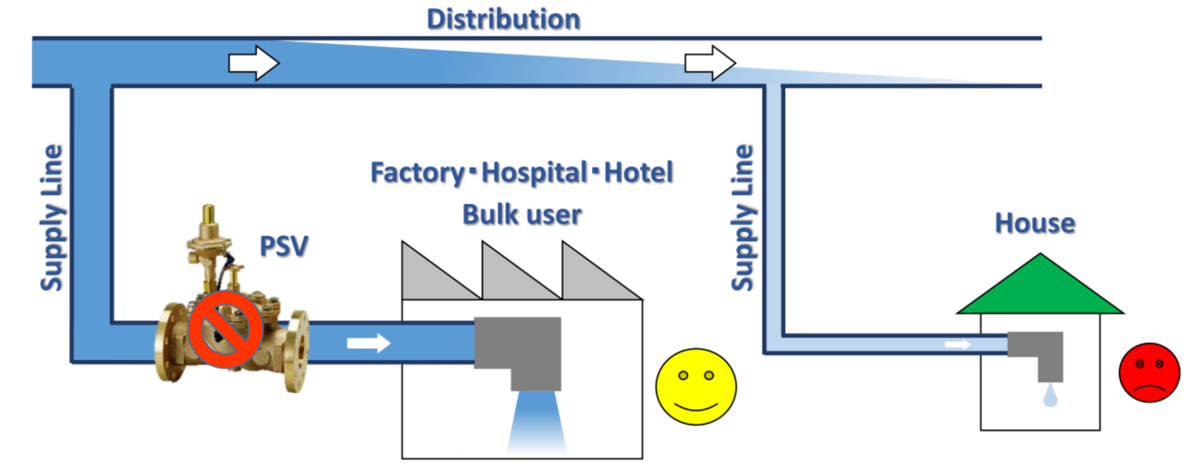
2) Pressure Reduction Valves (PRV)

In the Kampala area, there are many places where the water distribution pressure is quite high due to the elevation differences between the distribution reservoir and the distribution area, and water leakage is likely to occur in aging pipes. Therefore, the introduction of a pressure reduction valve (PRV) was planned in the master plan. Japanese valve suppliers are compatible with large-diameter pressure reducing valves such as those installed at water treatment plants, and PRVs at the entrance of water distribution area are not supported as an overseas product. Therefore, foreign products would be applied for this equipment.

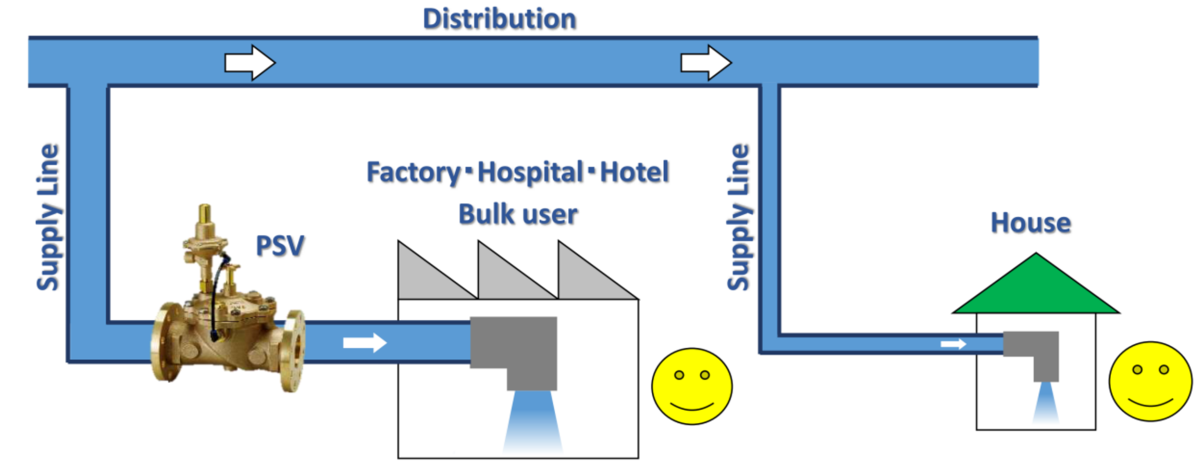
3) PSV System (Pressure Sustaining Valve) that Contributes to the Realization of Proper Water Distribution and Reduction of Non-revenue Water

In the water supply distribution system with pumps that should be operated with appropriate water distribution planning and renewal, water pressure shortage occurs in the downstream area due to excessive expansion of water distribution area, pipe extension that does not fully consider pressure drop in highlands, insufficient measures against water leakage, etc., and it leads to a problem that water supply becomes difficult. However, "PSV" is appropriately installed on the piping that branches and passes from the upstream area to the downstream area of the target area / district where the problem is occurring, and the "PSV" can adjust the valve opening in accordance with the pressure on the upstream side. By automatically adjusting and controlling the amount of water distributed to the downstream area, an automatic valve that maintains the pressure inside the piping in the upstream area, which is the cause of the problem, and enables fair and stable distribution of water to the downstream area (see Figure 3.6.4).

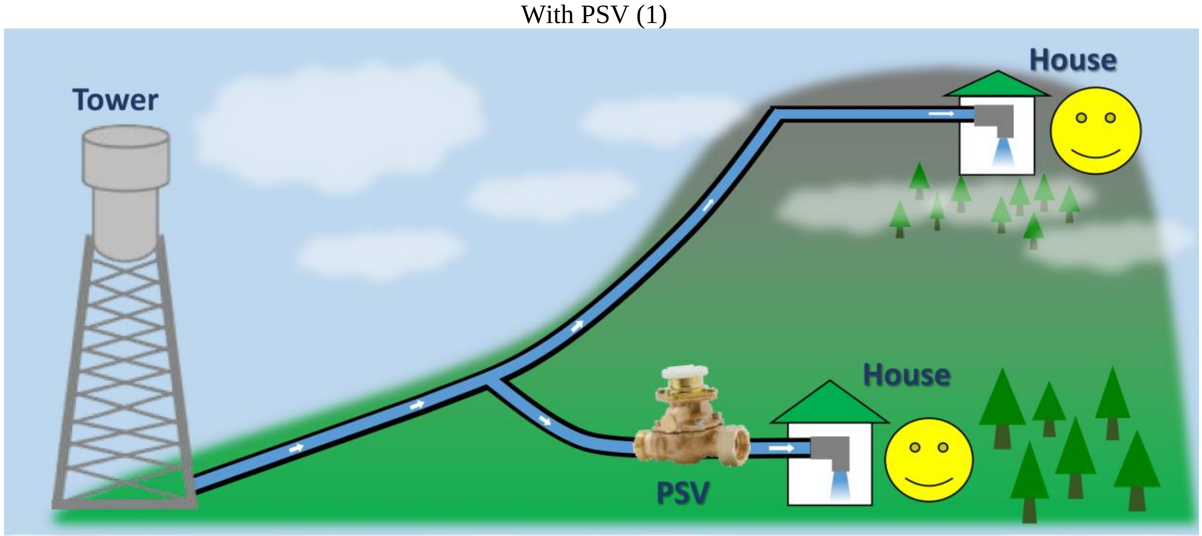
It is a system that enables efficient water distribution operation in a short time (only valve installation) at a very low cost.



Without PSV



With PSV (1)



With PSV (2)

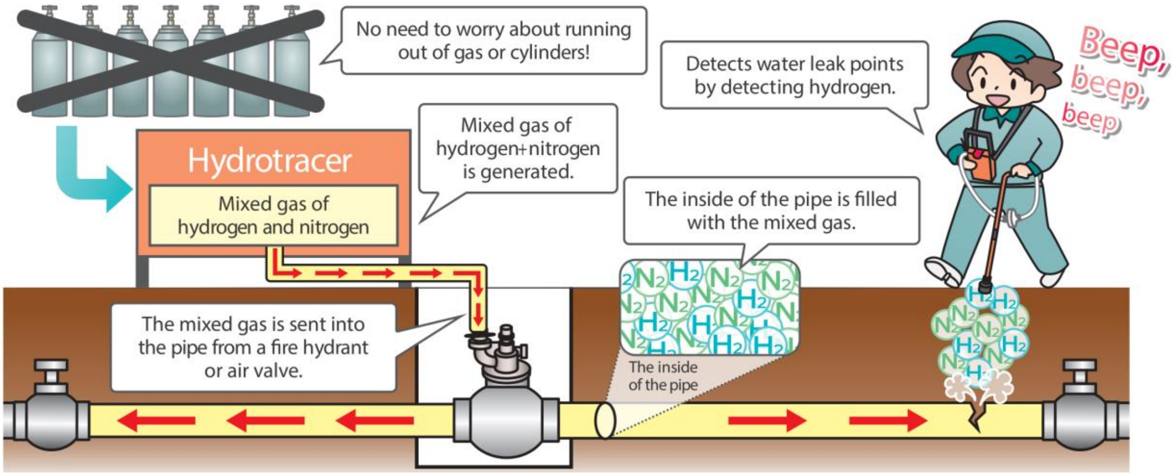
Source：Fair Water Distribution "PSV system" (KANE Kogyo)

Figure 3.6.4　Effect Image of PSV System

4) Various Leak Detection Equipment

①Compact Hydrogen and Nitrogen Generator Type

Drain the water from the pipe, inject 5% nitrogen-based hydrogen gas into the pipe, detect the hydrogen gas leaking from the leak point with a gas detector, and identify the leak point. It is especially effective for hourly water supply pipes because it searches without water in the pipes (see Figure 3.6.5).



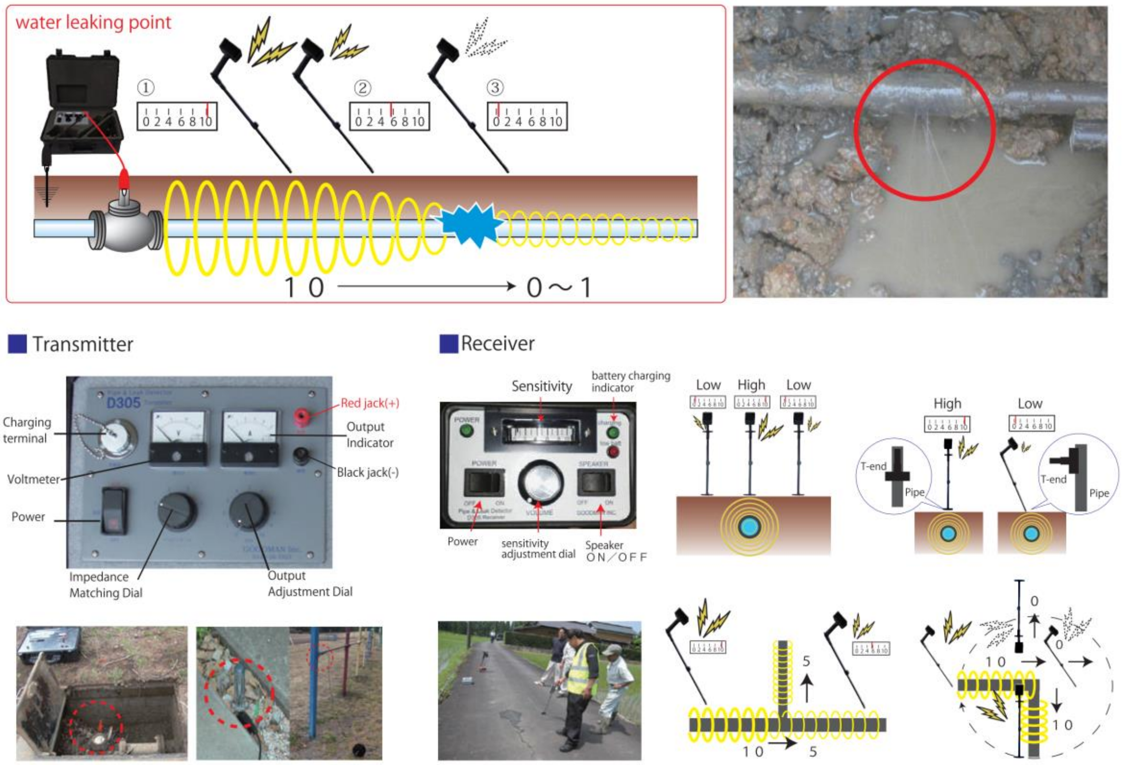
Source：Goodman Product Catalog

Figure 3.6.5 Leak Detection Image of Compact Hydrogen and Nitrogen Generation Equipment

②Inductive Leak Detector for Plastic Pipes

An electromagnetic induction wave is transmitted to water in a PVC pipe or a polyethylene pipe (resin pipe, non-metal pipe), and the induction wave is detected by a receiver to search for a piping route. A location where the reaction suddenly weakens due to signal attenuation is assumed to be a leak location. (see Figure 3.6.6) Leakage points can be detected even under the condition of low water pressure in developing countries without being affected by ambient noise. It is also possible to measure the pipe depth.

However, if there are reinforcing bars or cables that generate magnetism around them, or if the groundwater level is high, the detection accuracy would drop.



Source：Goodman Product Catalog

Figure 3.6.6 Image of Leak Detection with Inductive Leak Detector for Plastic Pipes

③Amplifier for Listening Rod

When installed, the sound of water leakage becomes easier to hear, which is especially effective when the worker is inexperienced or when the ambient noise is severe (see Figure 3.6.7).

Source: Goodman Product Catalog

Figure 3.6.7 Leak Detection Image with Amplifier for Listening Rod

5) Water Supply Ledger System, GeoSpatial Analysis (GSA)

①Water Supply Ledger System

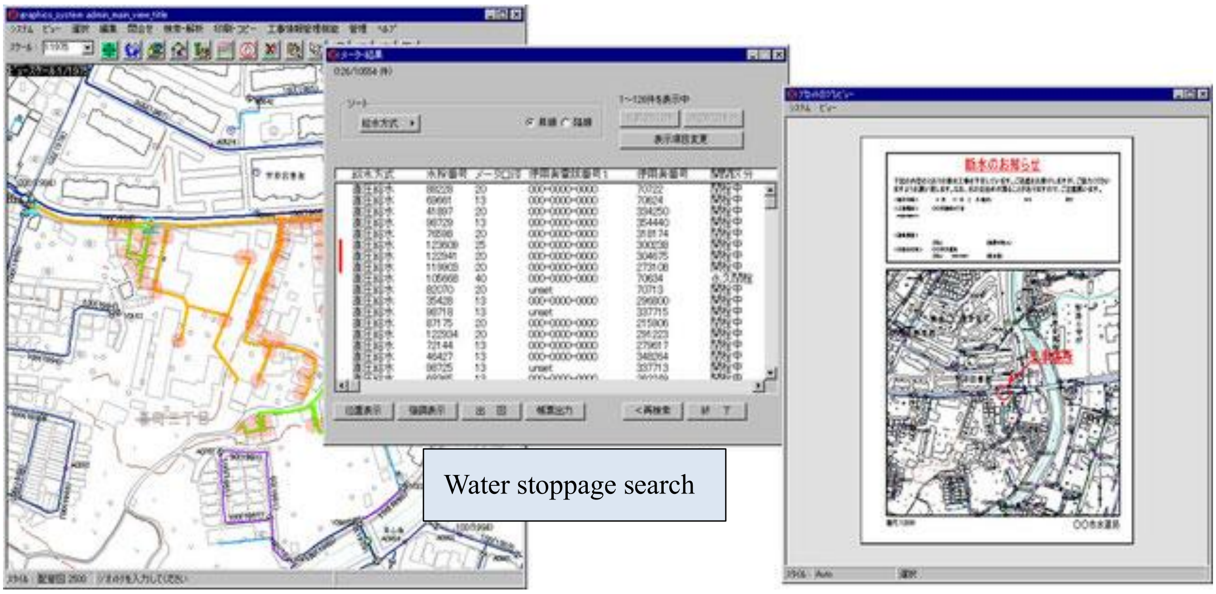
Japanese products are introduced below as an example of technology, but since the supplier mentions that it is difficult to expand to Uganda from the aspect such as after-sales service, it is necessary to utilize a technology from other countries.

・ View general pipeline maps, system diagrams, pipeline attributes, and internal data in pumping stations.

・Data can be updated sequentially as a ledger. Facility information, construction information, accident and complaint information, customer information.

・ From daily functions such as address search and meter search, water outage search to support construction and maintenance work, water consumption aggregation for district yield analysis, pipe network analysis to support planning and water operation, etc., Provides business support functions to realize the sophistication of water supply business (see Figure 3.6.8).

* It is assumed that GIS data of facility information exists. If not, start with digitizing paper data, land surveying, detecting underground pipes, etc. (Basically, a local institution needs to handle it.)



Source: Geoplan Namtech Website

Figure 3.6.8 Image of Water Supply Ledger System

②Simple GIS Mapping Tool：GeoSpatial Analysis（GSA）

・ GSA can centrally manage large volumes of data in wide-area infrastructure = availability to use the platform.

・ Various mappings, CAD, GIS, DB, complaint information, water tariff information, construction information of other companies, etc.

・ Data integration is easy with the standard compatible data specifications (SHAPE file) of the pipeline regardless of the ledger system of the contractor or vendor.

・ Can be used on various devices such as smartphones.

6) Extremely High Speed Chemical-Less Groundwater Treatment System（CHEMILES）

・Applicable if raw water is low turbidity such as groundwater. CHEMILES is comprehensive technology of “non-chemical use”, “biological treatment”, and “extremely high filtration speed”, providing safe and sustainable drinking water production.

・Biological treatment at a higher speed than that of common rapid filtration. It is achieved by the development of a unique washing method and optimizing the performance of the contact oxidation and biological treatment processes.

・The unique combination of whole backwash and portion backwash can reduce the water consumption for filter washing and minimize the damage caused by washing to the bacteria in the biological treatment layer.

・CHEMILES does not require chemicals like chlorine for oxidation, so it eliminates problems of harmful byproducts such as chlorine acid or trihalomethane formation. Operation is also simple and easy to adjust with changes in raw water quality.

・CHEMILES can remove iron even at very high concentrations up to 40 mg/L. Arsenic is also removed by contact oxidation and coprecipitation with iron.

・CHEMILES has outdoor column type for mainly small scale and RC type for large scale (see Figure 3.6.9).

Outdoor Column Type

Reinforced Concrete Type（Large Scale）

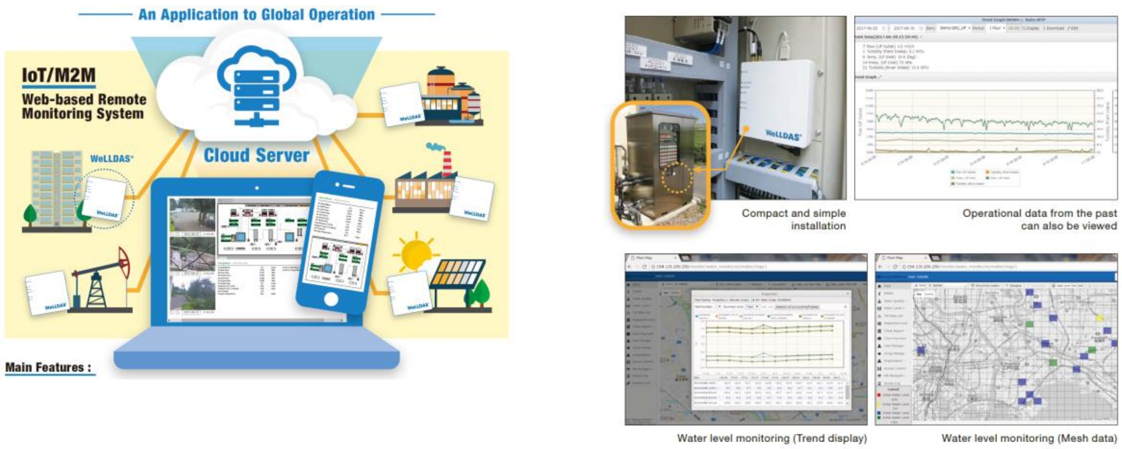
Source: Nagaoka Brochure

Figure 3.6.9 Water Treatment Plants with CHEMILES

7) Remote Monitoring System (see Figure 3.6.10)

・ Monitoring of raw water quality and water level in areas where seasonal fluctuations are large in the rainy season and dry season, and areas where salt water contamination is confirmed.

・ Operation monitoring of water treatment (raw water quality / influent, treated water quality / effluent, water supply pressure / flow rate, etc.).



Source: "Survey on the Possibility of Utilization of Private Technology in Developing Countries responding to COVID-19" (Global Environment Sector) Internal Seminar Material

Figure 3.6.10 Remote Monitoring System Image

(3) Consideration on Necessity of Assistance with Each Technology

1) Introduction of Japanese Technology for GIS Mapping

a) Kampala Metropolitan Area

Since GIS software (Map Kit) has already been introduced a year and a half ago and operations have begun to take off, introducing alternative software for Map Kit is not as realistic as resetting previous efforts. The particularly necessary support requested by the person in charge of GIS is pinpoint content such as purchasing a PC with high specifications for smooth use of Map Kit and introducing terminals for the field works, which alone is not so suitable for JICA support.

Although it is conceivable to add these as part of the measures against non-revenue water, the Dutch VEI has continued to provide advisory (but not free of charge, but based on purchases of products and consulting fees for dispatching experts) in the GIS field, and the Phase 2 is also planned to be implemented. Therefore, daring to input JICA funds into GIS field might cause confusion.

There is no company in Japan that has a good asset management (investment) planning, is globally competitive, and has an English program. And Japanese products cannot fully meet local needs. However, it is possible for experts of asset management and finance to support the improvement of ledgers of aging pipes and customers, and the formulation of asset management plans with technical professionals. Depending on the knowledge of the experts, it is possible to ask NWSC to purchase highly reliable asset management software in Europe and the United States and support the asset management works of NWSC.

b) Local Regions

Following the Kampala Water area, the Map Kit is planned to be fully introduced, and there is no major problem with its function as a map, so it is of little significance to include JICA support in this field. Although the software is not possible to create a facility investment plan from the status of existing facilities, it is supposed that the first step is to hurry to develop and maintain the ledger.

2) Non-revenue Water Reduction Project in Kampala Metropolitan Area (Technical Cooperation + Loan Project)

a) Possible Project Scheme

Technical Cooperation Project:

・ Construction of about three pilot DMAs (flow meter room, meter replacement, accurate identification of non-revenue water rate)

・ Improvement of non-revenue water management capacity (organization, equipment, leak detection / pipe repair technology, pressure management)

・ Preparation of asset management planning, technical manual creation, long-term plans for DMA construction, etc.

Loan Project: Flow rate / water pressure monitoring system using SCADA system (about 200 distribution areas)

Recommended Japanese technology: SCADA system, water leakage management system, ultrasonic flowmeter, water pressure gauge, leakage detector, non-metal pipe detector, pressure reducing valve (PRV) / pressure valve (PSV)

Other technologies: Prepaid type public standpipes with solar panels

b) Possible Donor and Component for Collaboration

① WATSAN project: DMA, human resources development

② AFD, etc.: Replacement of old pipes

(Pipe installation and renewal component in WATSAN project)

⇒ Avoid duplication when renewing old pipes in DMAs in technical cooperation and grant aid project

③ Dutch Vitens-Evides International (VEI)

Cooperation in GIS / asset management. Introducing optimal asset management planning software to NWSC, including Dutch and other European software, technical guidance for NWSC staff on utilization

3) Introduction of Japanese Technologies in Water Treatment Plants in Kampala Water

As a result of an interview with the water quality department (in charge of water quality monitoring and water treatments) of the NWSC headquarters, the following two requests were raised for the existing Ggaba Water Treatment Plant;

1. The water source is Lake Victoria, where a large amount of sewage flows in, and a large amount of chemicals such as coagulants are consumed to treat organic matter and color. If this can be solved by Japanese technology, it is desirable to reduce the O&M cost.

2. Since the volume of coagulated sediment sludge is large and the sludge disposal site is not sufficient, the reduction of the sludge volume by introducing a filter press dehydrator is considerable.

However, although ozone treatment is an example of a technology that can contribute to 1. at present, NWSC has little interest due to its high cost. Regarding 2., when the survey team inspected the Ggaba Water Treatment Plant, the dehydrator room was already under construction. Therefore, the dehydrator is not applicable.

Therefore, it is not realistic to formulate a project for the Ggaba Water Treatment Plant.

4) Introduction of Japanese Technologies for Water Treatment Plants in Local Areas

As mentioned above, many chemicals are used to treat unsatisfactory raw water quality in Hoima, Mityana, Mubende, etc., in local areas (especially in the central region). Of these, Hoima is excluded due to the planned cooperation by another donor, and for Mubende, surface water such as Katoma Dam is the water source, so Japanese chemical-free water treatment for groundwater cannot be applied.

For Mityana in the central region, water from Nakatongoli Swamp and two boreholes is currently mixed, but since Nakatongoli Swamp has a high concentration of humic acid, the use of groundwater would be increased in the future. In addition, since the water quality data of the boreholes could not be obtained, it is necessary to determine its applicability through detailed water quality tests, but according to the interviews with NWSCf, the groundwater contains high concentrations of iron. "Chemiles" (Nagaoka), a Japanese technology for chemical-free groundwater treatment in Japan, is effective in removing iron, and it can be expected that maintenance costs will be significantly reduced by not using chemicals.

The water sources for both Tororo and Soroti in the eastern region are rivers. When the water quality test results were confirmed, the turbidity of raw water, total suspended solids (TSS), iron content, and the number of E-coliform in Tororo exceeded the standard values, but although they were generally treated, it cannot be said that the sedimentation and filtration are functioning well as far as the site conditions are seen, and the treatment is unstable in the seasons when the turbidity and silt are high. Regarding Soroti, there are some months when the iron content exceeds, but it can be treated without any significant problems. Therefore, for water treatment, it is conceivable to introduce Japanese technology that can handle high turbidity and silt for Tororo, and it is possible to introduce technologies such as SCADA and water leakage management system. In addition, due to the existence of old pipes, leak detectors and metal pipe detectors can be introduced.

3.6.4 Potential of External Funding from PPP

The development projects by NWSC are carried out in accordance with the NDP III plan, with the Ugandan government's budgetary measures or funding from other donors. However, the funds required to implement all the works in the Corporate Plan have not been obtained, and as described in Section 3.1.4, the projects have been delayed recently. For this reason, raising the funds necessary to achieve the Corporate Plan has become an issue, and strengthening governance, public-private partnership (PPP), and obtaining medium- to long-term loans have become high priorities.

Private-sector cooperation in water services means that water utilities utilize the financial and technological capabilities of the private sector to construct and maintain water facilities.

There are several contract patterns for private sector cooperation, which are as follows:

- ✧ Full Privatization…All water facilities will be sold to the private sector and management rights will be completely transferred.
- ✧ Concession Method…The operation, maintenance, and investment of water services are carried out by the private sector for the number of years specified in the contract. In addition, the right to be involved in water management is left to the public sector also.
- ✧ Lease-Affermage Method…A newly established private operator operates a water facility owned by the public sector and collects fees. The income will be distributed between the public and private sectors, and the public will remain responsible for investment such as maintenance of water facilities and new construction.
- ✧ Management Contract…A form in which a private operator manages a water supply business based on a consignment contract. It is often introduced for the purpose of improving the management and financial structure of public water utilities by utilizing the experience and knowhow of private company management.
- ✧ Co-owned Company…Investors on the private side become minority shareholders of the water company, operate on behalf of public sector, and share profits with the public side.

As mentioned above, the responsibilities and risks of the public and private sectors differ depending on the contract method, but the main advantages and issues are as follows:

【Advantages of implementing private sector cooperation】

- ➢ Efficient services that utilize the technological and financial capabilities of the private sector can be expected.
- ➢ The private sector attempts to provide efficient and effective services in pursuit of profits.

【Issues in implementing private sector cooperation】

- ➢ A mechanism is needed to appropriately regulate and supervise the level of services and tariffs provided by the private sector.

- Water tariffs may increase as the private sector pursues profits. In addition, since water tariffs and service levels differ depending on the operators, there is a possibility that unfairness may occur between regions (in case PPP will be implemented area-wise).
- There is a risk that services to low-income groups who cannot pay water tariffs will be reduced.
- If the private sector lacks the track record and knowledge of operating a water supply business, the service may temporarily decline.
- If the contract does not properly stipulate the setting of achievement targets and penalties for non-achievement, costly investment (such as renewal of pipelines) will be postponed, and there is a possibility that only improvement of collection rate of water tariffs with small investment and large return will be focused.

As mentioned above, there are advantages and disadvantages in private sector cooperation. At present, in hearings with NWSC, NWSC is thinking of continuing the direct management of water supply business without aiming for private sector participation, but the possible private cooperation methods and target regions in the future through Ideathon. In recent years, the Ministry of Foreign Affairs and JICA have been positive to form "business / operating rights-based grant aid financial cooperation (grant aid with business rights)," which is a form of private sector cooperation. However, it is quite unlikely that any Japanese company will be interested in operating a water treatment plant in Uganda. Also, considering the risk of collecting funds by tariff collection, etc., investment by Japanese companies is not realistic. From the NWSC's position as a nationwide water services corporation, which is required by the government and customers to improve its performance level, and risks to the private company, facility management contracts seem to be realistic for both parties, but the possibility of utilizing external (private sector) funds is also discussed at Ideathon.

3.6.5 Issues, Cooperation Needs and Priorities Regarding Collaboration with Other Donors

Based on the information collected and confirmed in the works in Japan and field survey, after discussing with NWSC and organizing the issues related to cooperation with other donors, the following projects are proposed as having high cooperation needs and priorities. Issues related to collaboration with other donors have not been clarified in discussions with major donors so far, but they will be sorted out while discussing the specific collaboration contents at Ideathon and others.

(1) Water Supply Project in Local Urban Cities (Grant Aid)

Other donors, such as the World Bank and AfDB, have been actively supporting water supply and sanitation projects in local area in recent years. However, since there is a shortage of funds to cope with the expansion of the service areas in local area, NWSC has high expectations for financial assistance.

Option 1: Water Supply Project in Tororo City

Scope:

① Construction of a new water treatment plant using river water as water source and development of transmission and distribution networks.

② Introduction of SCADA system to reduce non-revenue water.

Recommended Japanese technology: Depending on the water quality of the water source (under confirmation), SCADA, remote monitoring system

Possibility of collaboration with other donors: World Bank, AfDB, KfW (* No other donor is implementing/planning project in Eastern Region)

⇒NWSC has very high expectations as the city is close to the Kenyan border and has high growth potential.

Option 2: Water Supply Project with Chemical Free Groundwater Treatment Technology in Mityana

Scope:

① New construction / expansion of a water treatment plant that uses groundwater with a high iron concentration as a water source (reduction of O&M cost).

② Introduced SCADA system and upfront investment for non-revenue water.

Recommended Japanese technology:

Ultra-high-speed chemical-free water injection treatment device "Chemiles", water intake technology, SCADA system, water leakage management software

Possibility of collaboration with other donors: World Bank, AfDB, KfW

⇒ Optimal conditions for applying Japanese technology, but low growth among candidate cities is an issue for financial cooperation.

(2) Non-revenue Water Reduction Project in Kampala Region (Technical Cooperation Project)

In Kampala, the NRW rate is as high as 40% or more, and there is a shortage of equipment such as leak detectors and pressure gauges and skilled staff to carry out leak detection and pressure control. In addition, although the GIS mapping system has already been introduced with support by VEI, the information itself is insufficient due to lack of information on aging pipes, and the strategic facility maintenance / renewal plan has not been implemented.

Scope:

① Provision of necessary equipment (new/additional) such as leak detection equipment and portable pressure gauge, and necessary training of technical staff.

② Support for strengthening of facility inventory data and preparation of facility renewal plans, etc., for improvement of asset management.

Recommended Japanese technology:

Leakage detector, metal pipe detector, non-metal pipe detector, knowhows of efficient facility inventory management / facility renewal planning

Possibility of collaboration with other donors: AFD, VEI

⇒1) Coordination with non-revenue water reduction activities to be implemented in the WATSAN project, 2) Strengthening of aging pipe inventory information and cooperation to future pipe replacement works by NWSC and other donors, and 3) Collaboration on supports for asset management with VEI that has already supported the GIS mapping system.

CHAPTER 4. Current Status and Problems in Air Pollution Sector

4.1 Additional Survey of Air Pollution Status

4.1.1 Legislation, Regulations, and Status of Operation, Compliance, Monitoring, and Guidance

(1) Environment-related Law

The National Environment Policy, which is the first environment-related law in Uganda, was enacted in 1994. The purpose of this policy is to promote environmental protection by the government collecting and analyzing reliable information on environmental issues in Uganda and providing the results to the public. The National Environment Act was enacted in 1995, and the National Environmental Management Authority (NEMA) was organized as the organization that oversees environmental management in Uganda. After that, the law was revised on 7 March 2019, and it composed of Articles 1 to 17 as shown below. The main items stipulated are environmental planning, pollution control, waste management, funds, environmental and social assessment, litigation procedures and penalties, etc.

Table 4.1.1 Structure of the National Environment Act

PART I—PRELIMINARY
PART II—INSTITUTIONAL ARRANGEMENTS
PART III—FUNDS OF THE AUTHORTY AND THE NATIONAL ENVIRONMENT FUND
PART IV—ENVIRONMENTAL PLANNING
PART V—MANAGEMENT OF THE GREEN ENVIRONMENT
PART VI—SOUND MANAGEMENT OF CHEMICALS AND PRODUCT CONTROL
PART VII—CONTROL OF POLLUTION AND ENVIRONMENTAL EMERGENCY PREPAREDNESS
PART VIII—MANAGEMENT OF WASTE
PART IX—ESTABLISHMENT OF ENVIRONMENTAL STANDARDS
PART X—ENVIRONMENTAL AND SOCIAL ASSESSMENT
PART XI—ENVIRONMENTAL EASEMENTS
PART XII—ENVIRONMENTAL COMPLIANCE AND ENFORCEMENT
PART XIII—JUDICIAL PROCEEDINGS
PART XIV—ENVIRONMENTAL INFORMATION AND LITERACY
PART XV—INTERNATIONAL OBLIGATIONS
PART XVI—OFFENCES, PENALTIES, FEES, FINES AND OTHER CHARGES
PART XVII—GENERAL PROVISIONS

Source: THE NATIONAL ENVIRONMENT ACT, 2019

Within this Act, the description about air pollution is in Article 9 "Establishment of Environmental Standards", Section 103 "Air Quality Standards". In this paragraph, the establishment and operation of environmental standards and emission standards related to air pollution for the purpose of controlling pollutants from vehicle and fixed sources, and measures for fixed sources (redesign of existing plants aimed at reducing greenhouse gas emissions and introduction of appropriate technology) and issuance of guidelines are stipulated. The items described in Section 103 are shown below.

Table 4.1.2 Items of Section 103 "Air Quality Standards"

(1) The Authority shall, in consultation with the relevant lead agencies— (a) Establish the criteria and procedure for the measurement of air quality; (b) Prescribe ambient air quality standards and other air quality standards; (c) Prescribe emission standards for various sources; and (d) Establish criteria and issue guidelines for air pollution control for mobile, stationary and other sources. (2) The Authority shall, in collaboration with the relevant lead agency, take measures to control air pollution by— (a) Requiring the redesign of existing industrial plants or the introduction of new and appropriate technology or both; (b) Requiring the reduction or elimination of existing sources of air pollution; and (c) Making guidelines to minimize emissions of greenhouse gases.

Source: THE NATIONAL ENVIRONMENT ACT, 2019

In addition, Article 12 describes the implementation of environmental monitoring, certification of analytical institutions, environmental audits as environmental legal compliance and enforcement.

Regarding air quality management, in addition to the National Environmental Law, the main provisions of the Public Health Act of 1964, the Mining Act of 2003, and the National Physical Planning Act of 2010 include environmental protection and improvement of air pollution. For example, the Mining Act stipulates that "mining companies should take the necessary steps to prevent and minimize environmental pollution in accordance with the standards and guidelines established under the National Environmental Law (1995)". In addition, mining companies are required to carry out environmental impact assessments and annual environmental audits based on the law.

(2) The National Environment (Air Quality) Regulations (Draft)

In Article 9 "Establishment of Environmental Standards", NEMA is stipulated to be responsible for establishing emission standards for vehicle and fixed sources and for developing guidelines for air pollution control. NEMA also created the Draft National Air Quality Standards in 2006 and Draft Emission Standards for Automobiles in 2007.

After that, the draft standards were not reviewed until 2019, when the National Environmental Law was revised. However, based on Section 103 of the law, the National Environment (Air Quality) Regulations (Draft) was promulgated on 28 November 2020, and each draft standard is under review.

Therefore, NEMA is considering the finalization of the draft regulation through regular stakeholder meetings with other ministries and organizations related to air pollution (details in Table 4.1.8). According to NEMA's presentation at the Business Matching Workshop (details in Chapter 5), the contents are being updated, and the finalization of the draft regulation is assumed to be after December 2021.

In addition to the environmental standards and emission standards related to air pollution, the main items to be described include indoor air quality standards, air quality monitoring, emission regulations, and penalties for violations. The structure of the draft regulation is shown below.

Table 4.1.3 Structure of The National Environment (Air Quality) Regulations (Draft)

PART I—PRELIMINARY
PART II – GENERAL PROHIBITIONS
PART III – REGULATION OF AIR EMISSIONS FROM DIFFERENT SOURCES
PART IV– OCCUPATIONAL AIR QUALITY LIMITS
PART V – INDOOR AIR QUALITY
PART VI – AIR QUALITY MONITORING AND MANAGEMENT BY THE AUTHORITY AND LEAD AGENCY
PART VII – AIR QUALITY MONITORING AND MANAGEMENT BY THE OPERATOR OF A FACILITY
PART VIII – AIR POLLUTION CONTROL LICENCE
PART IX – ADMINISTRATIVE PROVISIONS AND OTHER MEASURES
PART X – OFFENCES AND PENALTIES

Source: THE NATIONAL ENVIRONMENT (AIR QUALITY) REGULATIONS, 2020

In addition, the draft regulations include draft air quality standards and emission standards (fixed and vehicle sources). According to an interview survey with NEMA, it referred to the existing environmental standard values and guideline values such as World Health Organization (WHO), the European Union (EU), and the US Environmental Protection Agency (EPA). First, the draft air quality standards are shown below.

Table 4.1.4 Ambient Air Quality Standards in Uganda (Draft)

No	Pollutant	Time-weighted Average	Standard for Ambient Air
1.	Carbon monoxide (CO)	8 hours	9 mg/m^3
		1 hour	35 mg/m^3
2.	Hydrogen sulphide (H_2S)	1 hour	42 µg/m^3
3.	Lead (Pb)	3 months average	0.15 µg/m^3

No	Pollutant	Time-weighted Average	Standard for Ambient Air
4.	Ground level ozone (O_3)	1 hour	235 μg/m^3
		8 hours (instant peak)	120 μg/m^3
5.	Particulate matter $PM_{2.5}$	Annual average	25 μg/m^3
		24 hours	35 μg/m^3
6.	Particulate matter PM_{10}	Annual average	40 μg/m^3
		24 hours	60 μg/m^3
7.	Sulphur dioxide (SO_2)	1 hour	75 μg/m^3
		24 hours	20 μg/m^3
8.	Nitrogen dioxide (NO_2)	Annual average	40 μg/m^3
		One hour	200 μg/m^3
9.	Total VOCs	24 hours	600 μg/m^3
10.	Benzene (C_6H_6)	Annual	5 μg/m^3
11.	Benzo(a)pyrene (PAH)	Annual	1 ng/m^3
12.	Polycyclic aromatic hydrocarbons (Total PAHs)	Annual	5 ng/m^3
13.	The determination of odor is that it should not be acceptable to the recipient and should be verified by an occupational hygienist or authorized officer.		
14.	And any other parameter as may be prescribed by the Authority from time to time.		

Source: THE NATIONAL ENVIRONMENT (AIR QUALITY) REGULATIONS, 2020

In the above draft environmental standards for air pollutants, $PM_{2.5}$ (particulate matter with a particle size of 2.5 μm or less) has an annual average value of 25 μg/m^3 and a daily average value of 35 μg/m^3. These values are looser or equivalent compared with the WHO guideline value (Before revision in September 2021, annual average value: 10 μg/m^3, daily average value: 25 μg/m^3) and Japanese environmental standard value (annual average value: 15 μg/m^3, daily average value: 35 μg/m^3). For nitrogen dioxide (NO_2), the annual average value is 40 μg/m3 and the hourly average value is 200 μg/m^3, which are equal to the WHO guideline value. In the case of sulfur dioxide (SO_2), the daily average value is 20 μg/m^3, and the hourly average value is 75 μg/m^3. This is stricter than other 1-hour average standards (WHO guideline value: 500 μg/m^3, EU: 350 μg/m^3, Japan: 267 μg/m^3 (= 0.1 ppm)).

Based on the above, the current draft standards are being considered with reference to the environmental standard values or guideline values of various countries and regions for each item. In addition, items other than $PM_{2.5}$, PM_{10}, and NO_2 are not monitored in Uganda and are set without actual measurement. Therefore, it will be necessary to promote the expansion of the air quality monitoring system, understand the current state of air pollution in Uganda and its impact on human health, and review the environmental standard values based on the results in the future.

Next, the draft emission standards for fixed and vehicle sources are shown below.

Table 4.1.5 Emission Standards from Each Fixed Source in Uganda (Draft)

PARAMETERS AND MAXIMUM VALUES (all units are in mg/Nm³, unless otherwise specified)						
SOURCE		PARAMETERS				
		PM	SO_X or SO_2	NO_X or NO_2	HF	OTHER/ COMMENTS
Aluminum production and manufacturing (all installations)	New	30	50	-	0.5	Total F: 2; VOCs: 20; Hydrocarbons: 20 As: 0.1; Cd: 0.05; Cu: 0.5; Hg: 0.05); Pb: 0.5; Zn: 1
	Existing	80	250	-	1	
Iron and steel manufacturing	New	50	500 (sintering)	180	-	F: 5
	Existing	120	-	200	-	
Lead and zinc, nickel or cadmium smelting	New	20 (40 for Zn and Cd)	400	500	-	As: 0.1; Cd: 0.05; Cu: 0.5; Hg: 0.05); Pb: 0.5; Zn: 1
	Existing	100 (Zn or Cd): 100 too high	-	-	-	
Copper smelting		20 (smelters), 50 (other sources)	1,000	-	-	As: 0.5; Cd: 0.05; Cu: 1; Pb: 0.2; Hg: 0.05
Electronics manufacturing	New and Existing	50	-	-	5	VOCs: 20; phosphine: 1; arsine: 1; HCl: 10, As: 0.1; Cd: 0.05; Cu: 0.5; Hg: 0.05); Pb: 0.5; Zn: 1
Electroplating industry	-	-	-	-	-	VOCs: 90% recovery
Foundries	New	20	400	400	5	-
	Existing	50	-	400	-	
Furnace: blast oxygen, electric arc furnaces in the steelmaking industry, blast furnace (all installations)	New	30	500	500	-	-
	Existing	100	-	-	-	-
Glass manufacturing	New	20	1500 (Oil fire), 700 (Gas)	1,000		Pb + Cd: 5; heavy metals (other, total): 5; As: 1 ; F: 5; HCl: 50
	Existing	50		2000		
Ceramic production (tiles bricks, refractory bricks, stoneware or porcelain ware by firing excluding clamp kilns)	New	150	400	-	50	-
	Existing	150	400	-	-	-
Cement manufacturing and lime production	New	30 (Separate raw mill and clinker grinding, kiln); 100 (Cooler ESP); 50 (Cooler BF)	50	600	1	Total Organic Compounds: 10; HC: 10l; Cadmium plus Thallium: 0.05; Hg: 0.05; Sum of arsenic, antimony, lead, chromium, cobalt, copper, manganese, vanadium, nickel: 0.5; Dioxins and furans: 1 ng/l
	Existing	50 (Separate raw mill and clinker grinding); 80	250	600	1	-

		(Kiln); 150 (Cooler ESP); 50 (Cooler BF)				
Mixed fertilizer plants: superphosphates, ammonium nitrate, ammonium phosphates and or ammonium sulphates (all installations)	New	50	-	500 (nitro phosphate unit) 70 (mixed acid unit)	5	NH_3: 5 (new) ,50 (existing);
	Existing	100	-		30	-
Nitrogenous fertilizer plants	New / Existing	50		300		NH_3: 50; urea: 50
Phosphate fertilizer plants	New / Existing	50	2 kg/t acid (sulphuric acid plant)	-	-	SO_3: 0.15 kg/t acid
Pesticides formulation and manufacturing	New / Existing	20 (5 where very toxic compounds are present)	-	-	-	VOCs: 20; Cl: 5, VOCs: 20; Cl: 5, TOC: 50, Cl: 5, HBr: 3, HCN: 3, HF: 3, H2S: 3, Cl: 3, NH_3: 30, HCl:30,
Pharmaceutical manufacturing	-	20	-	-	-	Active ingredients (each): 0.15; Class A compounds (total): 20; Class B compounds (total):80: Benzene, Vinyl Chloride, Dichloroethane (each) 1,VOC 20, Bromides (as HBr):3,Chlorides (as HCl):30, (NH_3):30, As: 0.05, Ethylene Oxide: 0.5, Mutagenic Substance:0.05
Petrochemicals manufacturing	-	20	500	300	-	HCl: 10; benzene: 5 (emissions), 0.1 ppb (plant fence); 1,2-dichloroethane: 5 (emissions), 1.0 ppb (plant fence); vinyl chloride: 5 (emissions), 0.4 ppb (plant fence); NH_3: 15
Wastewater treatment plants	-	-	-	-	-	NH_3:100-400; Hydrocarbons:400-2000; H_2S: 50-200
Textile industry	New / Existing	50	-	-	-	VOC: 20; Hydrocarbons: 20
Dye manufacturing		50	-	-	-	Cl: 10: VOCs: 20
Tanning and leather finishing	New / Existing	50	1,000	1,200 (possibility to ignore)	-	Odor: acceptable to neighbors; Hydrocarbons: 20; H_2S: 15
Printing industry, and pulp and paper mills	New / Existing	100 (recovery furnace)	-	2 kg/t ADP (Air-Dried Pulp)	-	Hydrocarbons: 20; VOC: 20; HCl: 10
Wood preserving	-	-	-	-	-	VOC: 20

Meat processing and rendering	-	150 (Smokehouses with a carbon content of less than 50) (potential to use another approach)	-	-	-	Odor: minimize impacts on residents
Sugar manufacturing	-	100	2,000	460 (130 ng/J or 225 ppm) Liquid fuels; 750 (260 ng/J or 365 ppm) Solid fuels	-	Odor: acceptable to residents
Dairy industry	-	50	-	-	-	Odor: acceptable to neighbors
Vegetable oil processing	-	50	-	-	-	Odor: acceptable to neighbors
General environmental guidelines (refine the description)	-	50	2,000 (SO_2)	Coal: 750 (260 ng/J or 365 ppm) Oil: 460 (130 ng/J or 225 ppm) Gas: 320 (86 ng/J or 155 ppm)	-	Dioxins: 2 ,3,7,8-TCSS equivalent): maximum of 1 ng/Nm^3 Total F: 2; VOCs: 20, Hydrocarbons 20 As: 0.1; Cd: 0.05; Cu: 0.5; Hg: 0.05; Pb: 0.5; Zn: 1, PAHs 5 ng/m^3,
Thermal plants and processes/combustion installations used for steam or electricity generation						
Solid fuels >=50MW	New	50	150	-	-	-
	Existing	100	200	-	-	-
Liquid fuels, e.g., heavy fuel and gas oil	New	50	50	75	-	-
	Existing	75	100	100	-	-
Gas fired plants	New	10	400	50	-	-
	Existing	10	500	200	-	-
Reciprocating engine (>10 MW)	New	50	45	400	-	-
	Existing	50	100	400	-	-
Reciprocating engine (>50 MW)	New	10	45	100	-	-
	Existing	35	100	125	-	-
Solid biomass	New	50 (all sizes)	70 (>=50 MW); 50 (100-300 MW); 35 (>300 MW)	70 (>=50 MW); 50 (>=100 MW)	5 (all sizes)	HCl: 5 (all sizes)
	Existing	100 (all sizes)	1000 (>50 MW); 70 (100-300 MW); 50 (>300 MW)	200 (>=50 MW); 150 (>=100 MW)	10 (all sizes)	HCl: 10 (all sizes)
Petroleum industry activities						
Combustion installations used for steam or electricity generation (all refinery furnaces and heaters)	New	50	800	400	-	H_2S: 15; Ni + V: 2
Catalytic cracking units (all installations)	New	100	1200	400	-	-

Vapor recovery units (loading and off-loading facilities with a throughput greater than 50000 m^3)	-	-	-	-	-	Total VOCs from vapor recovery /destruction units using thermal treatment: 150 Total VOCs from vapor recovery units/destruction units using non-thermal treatment: 40000
Industrial fuel oil recyclers with a throughput greater than 5000 ton/month	New	-	500	-	-	CO:100; Total VOC from vapor recovery /destruction units: 30
All sulphur recovery units	-	-	-	-	-	Should achieve 95% efficiency with 99% availability
Oil and gas development (onshore)	-	-	1,000	Oil: 460 (130 ng/J or 225 ppm) Gas: 320 (86 ng/J or 155 ppm)	-	VOCs: 20; H_2S: 30; odor: not offensive at receptor end (H_2S at the property boundary should be less than 5 µg/m^3)
And any other parameters and processes as may be prescribed from time to time						

Source: THE NATIONAL ENVIRONMENT (AIR QUALITY) REGULATIONS, 2020

Table 4.1.6 Emission Standards from Each Vehicle Source in Uganda (Draft)

	Emission limits/g/km					**Notes**
Engine type	**CO**	**THC**	**HC+NOx**	**NOx**	**PM**	-
Diesel	0.5	-	0.30	0.25	0.025	-
Gasoline (Petrol)	1.0	0.1	-	0.08	-	-

Source: THE NATIONAL ENVIRONMENT (AIR QUALITY) REGULATIONS, 2020

From the above, the draft standard values for major air pollutants (PM, NO_2, SO_2) are set for each industry in fixed sources, and the values for automobile-specific pollutants are also set for each engine type in mobile sources.

In addition, the draft regulations also include the draft air quality standards for indoors as follows. No specific standard values have been set for asbestos and benzene, and the standard values for major air pollutants are equivalent to the air environmental standards shown in Table 4.1.4.

Table 4.1.7 Draft Indoor Air Quality Standards in Uganda

No.	Pollutant	Averaging time	Concentration (mg/m^3)
1.	Asbestos	-	No safe level of exposure can be recommended.
2.	Benzene	-	No safe level of exposure can be recommended.
3.	Carbon monoxide	15-minute	100 mg/m^3
		1-hour	35 mg/m^3
		8-hour	10 mg/m^3
		24-hour	7 mg/m^3
4.	Formaldehyde	30-minute	0.1
5.	Naphthalene	Annual average	0.01
6.	Nitrogen dioxide	1-hour	200 μg/m^3
		Annual average	40 μg/m^3
7.	Ozone	8-hour	100 μg/m^3
8.	PM_{10}	24-hour	60 μg/m^3
		Annual average	40 μg/m^3
	$PM_{2.5}$	24-hour	35 μg/m^3
		Annual average	25 μg/m^3
9.	Polycyclic Aromatic Hydrocarbon (PAH)	-	No safe level of exposure can be recommended.
10.	Radon	-	100 Bq/m^3
11.	Sulphur dioxide SO_2	24-hour	20 μg/m^3
		10-minute	500 μg/m^3
12.	Tetrachloroethylene	Annual average	0.25
13.	Trichloroethylene	Annual average	4.3 × 10–7 per μg/m^3

Source: THE NATIONAL ENVIRONMENT (AIR QUALITY) REGULATIONS, 2020

4.1.2 Implementation System of Air Pollution Management Administration

As mentioned earlier, NEMA is the organization that oversees the overall environmental management in Uganda, but the Ministry of Water and Environment (MoWE) is the supervisory body for various projects related to overall environmental pollution, including air pollution. Other administrative organizations are also implementing air pollution control, measures, and information provision. The table below shows the administrative organizations responsible for air pollution.

Table 4.1.8 Administrative Organizations for Air Pollution Control and Their Responsibilities

Organizations		Responsibilities
National	MoWE: Ministry of Water and Environment	Supervision of various businesses related to environmental pollution including air pollution
	NEMA: National Environmental Management Authority	・ Supervision of environmental management in Uganda ・ Establishment of standards for air pollution
	MoH: Ministry of Health	Protecting and promoting health of Ugandan people from environmental pollution, including air pollution
	MoWT: Ministry of Works and Transport	・ Securing paved roads to prevent air pollution caused by PM, etc. ・ Import restrictions on used cars that contribute to worsening air pollution
	NMA: National Meteorology Authority	Providing information on air pollution status
	MoEMD : Ministry of Energy and Mineral Development	・ Improvement of fuel to reduce traffic-derived air pollutants and GHGs ・ Promotion of energy saving
	MoGLSD: Ministry of Gender, Labor and Social Development	Protecting the rights of workers and vulnerable in their home and workplace from the aspect of air pollution
	UNBS: Uganda National Bureau of Standards	Standardization of fuel products
Local Government, etc.	KCCA: Kampala Capital City Authority	Guidance on urban development through planning, implementation, and monitoring of public service provision in Kampala City
	AirQo Project (Makerere Univ. and KCCA)	Development of air quality sensors and building of monitoring system

Source: Prepared by JST based on the website of each administrative organization

4.1.3 Plans Such as Policies and Master Plans

(1) Kampala Climate Change Action Plan

The Kampala Climate Change Action strategy is a plan aimed at mainstreaming climate change response in all city services in order to put the city on a low carbon development path (as shown in Figure 4.1.1). The Kampala Climate Change Action strategy is KCCA's flagship program for the city to achieve its sustainability ambitions.

The strategy addresses three problems:

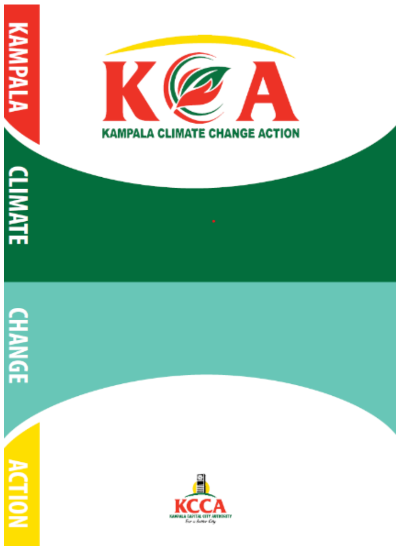
1) Short and long-term adaptation of the city to climate change impacts,

2) Charting a low emissions development path for the city, and

3) Transforming the threat of climate change into an opportunity for residents.

The strategy has been developed through a transversal and participatory approach involving all stakeholders. The guiding principle is that of shared responsibility which ensures that climate change is fully integrated in all development policies and service delivery at all levels whilst supporting citizens to take action.

- Energy Efficiency
- Waste and Wastewater
- Mobility
- Buildings and Land Use
- Renewable Energies
- Biodiversity
- Green Procurement and Investment
- Research and Innovation
- Communication and Participation
- Financing and Project Support



Source: Business matching workshop material by KCCA, 30th September 2021

Figure 4.1.1 KCCAP

Through various activities in the energy and mobility sectors, the effect of improving air quality is expected. Air quality management will be implemented by KCCA, and the development of air quality monitoring systems will be implemented by KCCA, schools, industries, partners, and institutions.

(2) Clean Air Action Plan

The KCCAP describes the need for air pollution improvement in Kampala City, and KCCA is focusing on efforts related to air pollution control. Currently, KCCA has set the formulation of a Clean Air Action Plan (CAAP) as a priority, and is promoting the implementation of air pollution monitoring for this formulation.

This initiative is being implemented as part of the "Supporting Countries to Monitor and Improve Urban Air Quality" by the Environmental Compliance Institute (ECI) in United Nations Environment Program (UNEP). UNEP supports air quality monitoring and improvement in cities in Africa and Latin America, and strengthening air quality monitoring in target countries and building best practices for similar projects in other countries and cities are the main outputs of this support project. The outline of the UNEP support project is shown below.

Table 4.1.9 Outline of the UNEP Support Project

Component	Contents
Air Quality Monitoring	The aim of this component is to provide technical support to target cites to set up affordable air quality monitoring networks. The general approach in each city will be to deploy between 5 to 10 sensors to monitor at least PM_{10} and $PM_{2.5}$. Uganda has expressed a need for UNEP to assist in acquiring air quality monitoring data to establish a baseline for its air pollution, determining major sources of the emissions, and establishing a basis for planning further monitoring and enforcement of air quality standards. In July/August 2019, UNEP and the Kampala Capital City Authority (KCCA) started a sensor colocation study near the US Embassy reference station with a view to helping Kampala in deciding on suitable approaches for sensor calibration and data validation. This component is complimentary to the ongoing air quality monitoring by KCCA.
Strategy and Action Plans	Based on the monitoring data available in each city, UNEP will work with regional and national partners to identify sources of air pollution, and in doing so build capacity for developing a source apportionment. Support for Kampala focuses on sectoral targets and interventions to reduce air pollution. A capacity building workshop for Clean Air Action Planning for KCCA and stakeholders forming the Pollution Task Force was held from 17–18 December 2019, which resulted in an agreed outline of the proposed Kampala City Clean Air Action Plan and a work plan to guide its delivery.
Tool Development	UNEP will develop a set of tools and methodologies to support cities with the implementation of components 1 and 2. The first tool will provide information on how to set up affordable air quality monitoring networks using affordable sensors as well as information on how to calibrate and maintain these networks. A second tool will support countries in conducting data analysis on specific applications. A third tool will support cities in developing city-wide air quality improvement strategies.
Dissemination	Near the end of the project, a regional meeting will be organized in Africa to showcase the city projects in Addis Ababa and Kampala so that other interested cities will have an opportunity to hear about progress made, opportunities for affordable air quality monitoring, the development of strategies and action plans, and the tools and methodologies developed from this work.

Source: UNEP (2021) Supporting countries to monitor and improve urban air quality

https://www.kcca.go.ug/media/docs/TORs_Kampala%20CAAP_14-04-2021_ECI.pdf

In this support project, UNEP places an order with a consultant and outsources consulting services to support KCCA's CAAP formulation. It was started in May 2021 and will formulate a CAAP plan based on air pollution-related information in Kampala City, and will finalize it after reflecting comments from stakeholders. The deadline for implementing this support project is 30 August 2021, but the stakeholder consultation could not be held and there was a delay as of October 2021 due to lockdown for six weeks from mid-June 2021.

4.1.4 International Commitments and Achievement Status

Throughout Africa, the African Union (AU) Agenda 2063 is an international commitment that provides concrete visions and plans for the development of Africa in 50 years from its inception in 2013. The 2030 Agenda is recognized as essential to the achievement of AU Agenda 2063. [1]

The Government of Uganda, led by the Prime Minister's Office, developed a framework for achieving the 2030 Agenda and related SDGs in 2016. This framework has been approved by the Cabinet, and the national and local governments are working together to realize the SDGs and the 2030 Agenda. On the other hand, it has not confirmed the commitment regarding air pollution control.

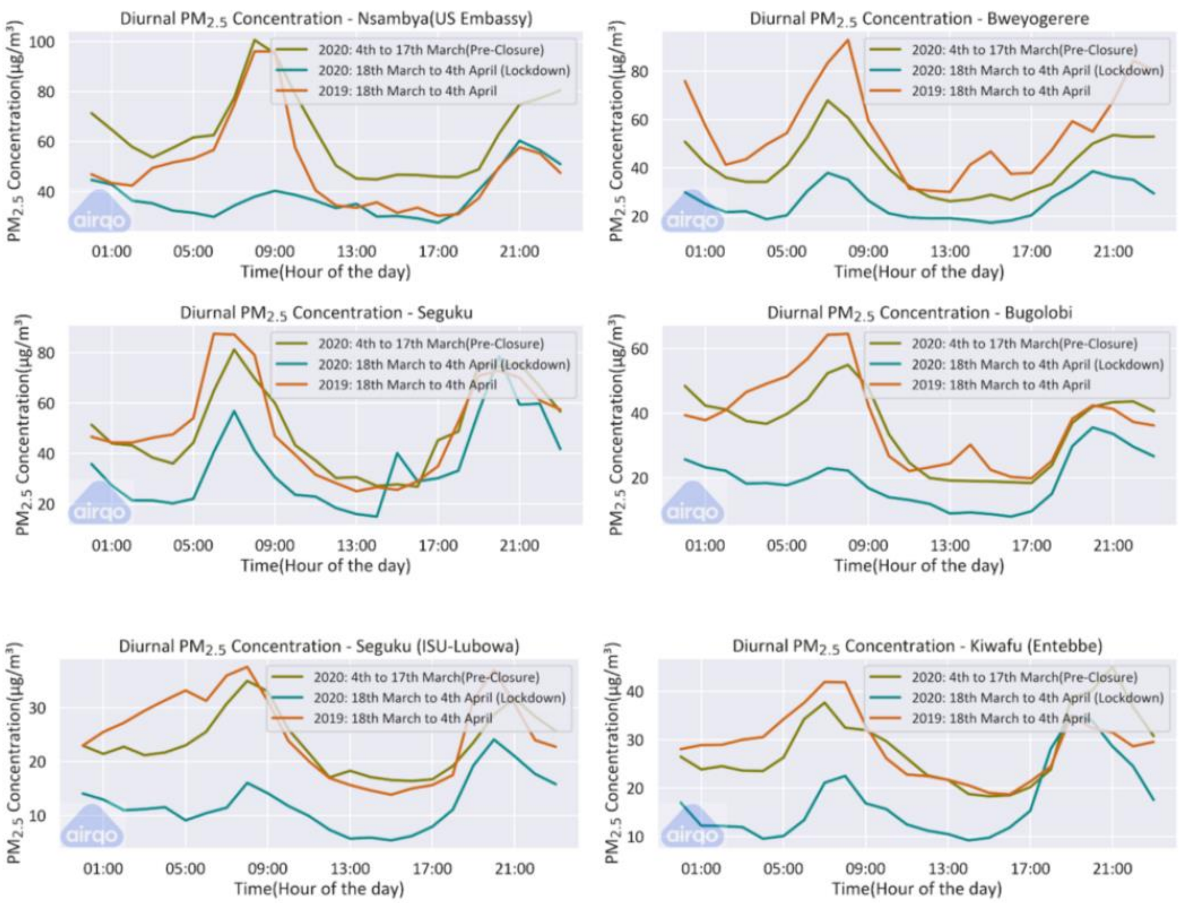
4.1.5 Status and Impact of COVID-19 in the Field of Air Pollution

(1) Confirmation by AirQo Project

The lockdown was carried out by the Government of Uganda from 18 March to 4 April 2020. The AirQo Project analyzed the monitoring data using air quality sensors to confirm changes in $PM_{2.5}$ concentration by time zone due to lockdown. (Details of air pollution monitoring by the project are described in Section 4.2.3.)

The main monitoring points in Kampala are Nsambya (US Embassy in Uganda), Bugolobi, Seguku (2 points), Bweyogerere, and Kiwafu (Entebbe). The analysis results of period 1) 4 March to 17 March 2020 (2 weeks before the lockdown), period 2) 18 March to 4 April 2020 (2 weeks during the lockdown), and period 3) 18 March to 4 April 2019 (the same period of the previous year of 2)) are shown in the following figure.

[1] Source: African Union Website, https://au.int/en/agenda2063



Source: AirQo Project (2020), Kampala Air Quality Improves By Up To 40% During The Covid-19 Lockdown

Figure 4.1.2 Changes in $PM_{2.5}$ Concentration by Time Zone at Each Point in Kampala City (Measurement by AirQo Project)

From the above results, it was confirmed that the $PM_{2.5}$ concentration was significantly reduced during the lockdown at all points. Especially during the rush hour from 6:00 am to 9:00 am, it decreased by about 60% compared with the previous two weeks. On the other hand, it was confirmed that the $PM_{2.5}$ concentration did not easily decrease during the evening hours. The reason for this is that $PM_{2.5}$ emissions from households as well as from traffic are high. In Uganda, more than 90% of the households use solid biomass such as charcoal and firewood for cooking and heating, and since these contribute greatly to air pollution, it is necessary to promote the suppression of $PM_{2.5}$ generation from households.

After the lockdown is released, the situation of air pollution is gradually returning to the previous one, but this means that it is very effective to eliminate traffic jam and regulate vehicle intrusion into the city as a measure against air pollution.

$PM_{2.5}$ may increase the risk of respiratory tract infection of COVID-19, and there is a concern that the risk of infection will increase in areas with worse air pollution. According to the monitoring data from the project website, $PM_{2.5}$ measurements in the city are still high in a wide area (as of July 2021), and as a measure against COVID-19 infection, it is necessary to control air pollution continuously.

(2) Confirmation by KCCA

From 1 February to 9 May 2020, KCCA evaluated the air quality index (AQI) of $PM_{2.5}$ and nitrogen dioxide (NO_2) at 24 points in Kampala City. AQI is an index showing the degree of air pollution and is adopted in multiple countries and regions. If the daily average concentration of $PM_{2.5}$ is under 15.4 µg/m3, AQI is under 50, "Good (no contamination)" (shown in Table 4.1.10).

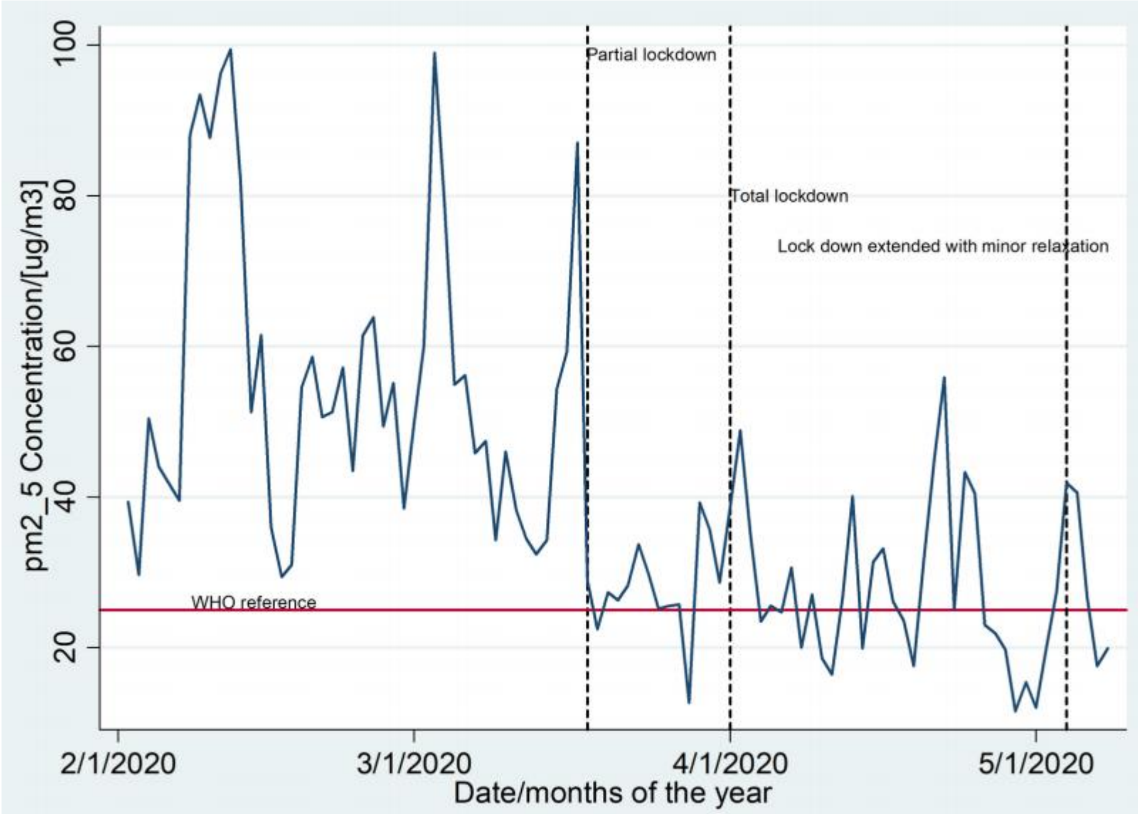
Table 4.1.10 Classification of Air Pollution Degree by AQI (Example of $PM_{2.5}$)

AQI Category	AQI Value	24-hr Average $PM_{2.5}$ Concentration (µg/m³)
Good	0 - 50	0 - 15.4
Moderate	51 - 100	15.5 - 40.4
USG	101 - 150	40.5 - 65.4
Unhealthy	151 - 200	65.5 - 150.4
Very Unhealthy	201 - 300	150.5 - 250.4
Hazardous	301 - 500	250.5 - 500.4

Source: EPA AQI workshop material, https://www.epa.gov/sites/default/files/2014-05/documents/zell-aqi.pdf

The concentration of air pollutants, which is the original data for AQI calculation, was continuously measured by air quality sensors (Details of air pollution monitoring by KCCA are described in Section 4.2.2.)

$PM_{2.5}$ concentration in the range of 0-1,000 µg/m³ and NO concentration in the range of 0-3,000 ppb can be evaluated, and temperature and humidity can be measured at the same time. The operation of the sensor could be visualized on PC via the internet, and the measurement data was downloaded directly from the monitor via web application using the PC and analyzed. The figure below shows the transition of the daily average value of $PM_{2.5}$ concentration during this target period.



Source: KAMPALA'S HEALTH AND ENVIRONMENT IN THE MIDST OF COVID-19,
https://www.kcca.go.ug/media/docs/KCCA-DPHEBulletin_issue1.pdf

Figure 4.1.3 Transition of Daily Average Value of $PM_{2.5}$ Concentration at 25 Points in Kampala City (Measurement by KCCA)

Average (± standard deviation (SD)) temperature from 1February to 9 May 2020 is 25.6 ± 0.16 °C (maximum 29.4 °C, minimum 21.8 °C), average humidity is 71.6% ± 0.61 (maximum 82.9%, minimum 45.0%). $PM_{2.5}$ concentration dropped sharply after the lockdown, and the 24-hour average concentration of $PM_{2.5}$ during the period before lockdown (from 1 February to 20 March) and during the lockdown period (after 20 March) were 51.8 ± 2.9 μg/m^3 and 28.1 ± 1.6 μg/m^3, respectively. Therefore, it was confirmed that the $PM_{2.5}$ concentration level decreased by 41% during the lockdown. However, the 24-hour average concentration of $PM_{2.5}$ during the lockdown of 28.1 ± 1.6 μg/m^3 still exceeded the WHO guideline value of 25 μg/m^3 for the daily average of $PM_{2.5}$ concentration.

Also, the average concentration of NO_2 decreased by 85% during the lockdown. Comparing the AQI values before and during the lockdown period, it was confirmed that the air quality in Kampala improved by 34%. The average AQI value during the lockdown period was 117.6, which is still classified as "bad for health" by WHO guidelines, even if air quality improved. It became clear that the air pollution level is still high in Kampala.

KCCA has also set up a team of experts to respond to telephone consultations from citizens suspected of being infected with COVID-19[2]. This team consists of doctors, clinicians, researchers, etc., and is active in five districts (Makindye, Rubaga, Nakawa, Central, Kawempe) in Kampala.

4.2 Overview of Organizations Related to Air Pollution

4.2.1 KCCA

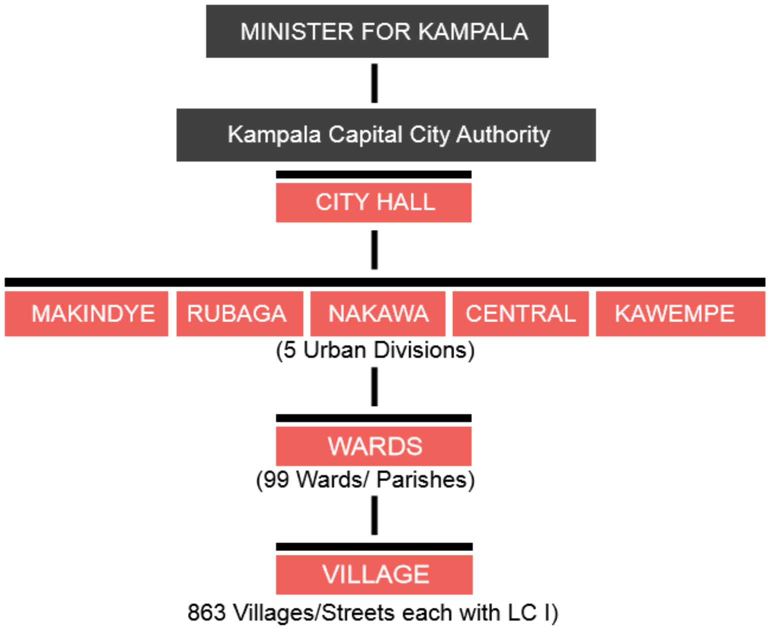
(1) Organizational Structure and Personnel Composition

The KCCA was established in 2010 as a successor to the Kampala City Committee (KCC) and is a government agency with the same authority as a national institution. KCCA's responsibility is to guide urban development through planning, implementation, and monitoring of the provision of public services in Kampala. The main duties of KCCA are as follows:

- Enactment of various policies and laws
- Setting standards for service provision
- General management and monitoring service provision within the department
- Construction and maintenance of highways and major drainage channels
- Installation and maintenance of street lights
- Traffic control
- Maintaining order and safety in the city
- Regional development
- Acceptance and registration of birth and death notifications for residents

Figure 4.2.1 shows the organizational structure of KCCA. Kampala is administered by the Kampala Capital City Authority on behalf of the central government. It is divided into 5 urban division, 99 wards, and 863 villages. The Greater Kampala Metropolitan Area includes KCCA, Entebbe Municipality, and parts of Wakiso and Mukono districts.

[2] COVID-19: KCCA sets up rapid response teams, https://www.independent.co.ug/covid-19-kcca-sets-up-rapid-response-teams/



Source: Promoting Green Urban Development in African Cities Kampala, South Africa, Urban Environmental Profile, 2015

Figure 4.2.1 Organizational Structure of KCCA

The department in charge of air pollution control work is the Environment Management Unit under the Directorate of Public Health and Environment, which has eight officers. However, they are also in charge of managing water quality and waste other than air pollution, and there is no specialist officer for air pollution, so the shortage of human resources is an issue. In particular, human resources who have the ability to analyze air quality monitoring data are required.

The roles of the Directorate of Public Health and the Environmental Management Unit are shown below.

Table 4.2.1 Roles of the Directorate of Public Health and the Environmental Management Unit

Directorate of Public Health	Environmental Management Unit
➢ Develop, monitor, and evaluate the effectiveness of the KCCA Public Health Legislation; and institute frameworks and standards to ensure the promotion of health and wellbeing of the community. ➢ Plan, conduct research, develop, and monitor the implementation of strategies on epidemiology and disease control including emergency management, vaccination/immunization, testing treatment and health impact assessment surveys.	➢ Environmental compliance technical assistance, Monitoring and enforcement for proposed, ongoing, and existing city developments/ projects. ➢ To guide and streamline the control of pollution and management of domestic and industrial waste including hazardous material. ➢ To implement sound and sustainable natural resources (water, wetlands, forests, and biodiversity) conservation and management.

➢ Plan, set benchmarks, and monitor the implementation of health and wellbeing promotion through periodic inspections and intensive health education. ➢ Plan and monitor the provision of efficient and appropriate health screening and treatment services at all the City Maternal, Child Health, and Medical Health Centres. ➢ Plan and monitor the implementation of the Environmental and City Ambience Management through the Water, Sewerage & Sanitation, Waste, Parklands, and Cemeteries Inspection and Management.	➢ Develop and implement a public/community participation action plan in environment management. ➢ Develop proposals, implement, and participate in environmental management basic and applied research to inform strategic decisions and policy. ➢ Provide technical support to KCCA in integrating best practices of environmental management and climate change in infrastructure development, gender and community services, spatial planning, education, and other key city development projects

Source: KCCA Web site, https://kcca.go.ug/public-health-services-and-environment

(2) Management, Financial Status, and Business Plan

The medium-term budget plan of KCCA is shown in Table 4.2.2. According to the results of interviews with air personnel of KCCA, the budget has not been clarified in particular regarding air pollution control measures. The only budget clearly required for air pollution was the maintenance cost of the air quality sensors (USD 25,000 per year) installed with the support from UNEP. KCCA is considering the introduction of additional air quality sensors in Kampala City in order to better grasp the air pollution status, but the major issue is that the budget is insufficient.

Table 4.2.2 Medium-term Budget Plan of KCCA

Kampala Capital City Authority Ministerial Policy Statement FY 2020/21

Vote:122 Kampala Capital City Authority

V. Summary of Past Performance and Medium Term Budget Allocations

Table 5.1: Overview of Vote Expenditures (UShs Billion)

		2018/19 Outturn	2019/20 Approved Budget	2019/20 Expenditure by End Dec	2020/21	MTEF Budget Projections 2021/22	2022/23	2023/24	2024/25
Recurrent	Wage	0.000	8.390	4.143	8.390	8.390	8.390	8.390	8.390
	Non Wage	0.009	7.369	3.622	7.369	8.843	10.611	12.734	15.280
Devt.	GoU	0.000	0.175	0.009	0.175	0.175	0.175	0.175	0.175
	Ext. Fin.	0.104	0.310	0.000	0.000	0.000	0.000	0.000	0.000
	GoU Total	**0.009**	**15.934**	**7.775**	**15.934**	**17.408**	**19.176**	**21.299**	**23.845**
	Total GoU+Ext Fin (MTEF)	**0.113**	**16.244**	**7.775**	**15.934**	**17.408**	**19.176**	**21.299**	**23.845**
	Arrears	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Total Budget	**0.113**	**16.244**	**7.775**	**15.934**	**17.408**	**19.176**	**21.299**	**23.845**
	A.I.A Total	**17.149**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	Grand Total	**17.262**	**16.244**	**7.775**	**15.934**	**17.408**	**19.176**	**21.299**	**23.845**
	Total Vote Budget Excluding Arrears	**17.262**	**16.244**	**7.775**	**15.934**	**17.408**	**19.176**	**21.299**	**23.845**

Source: Ministerial Policy Statement FY 2020/21

(3) Status of Efforts Related to Air Pollution

The KCCA is implementing air pollution control projects mainly from traffic, both soft and hard, with the support of various donors for air pollution as of August 2021. In particular, the AirQo Project, which has been jointly implemented with Makerere University since 2015, is an important project aimed at building the air pollution monitoring system. In addition, UNEP is also providing support to KCCA for the purpose of improving the air monitoring capacity of Kampala City, and has been promoting the CAAP formulation support project since May 2021 as described in Section 4.1.3.

Table 4.2.3 Air Pollution Control Project Implemented by KCCA (as of August 2021)

Project Overview	Donor/Partner
➢ Paving of 201 km of Marram Road to prevent the generation of road dust	WB
➢ Widening of roads and the introduction of traffic lights to reduce congestion and emissions from vehicles	JICA, etc.
➢ Installation of 25 monitoring stations at 5 locations in each division ➢ Providing real-time air pollution status to residents	AirQo Project (Makerere University, Google, WB, etc.)
➢ Promotion and development of sustainable alternatives such as trains, BRT, and bicycle	JICA, WB, GIZ, UN

Project Overview	Donor/Partner
➢ Introduction of Uganda's first ever nonmotorized traffic route on Namirenmbe Road to promote cycling and walking	UN-HABITAT, UNEP, Dutch NGO
➢ Private plant sector participation in waste collection to reduce combustion waste	Private companies
➢ Support for monitoring and improving air quality in Kampala	UNEP

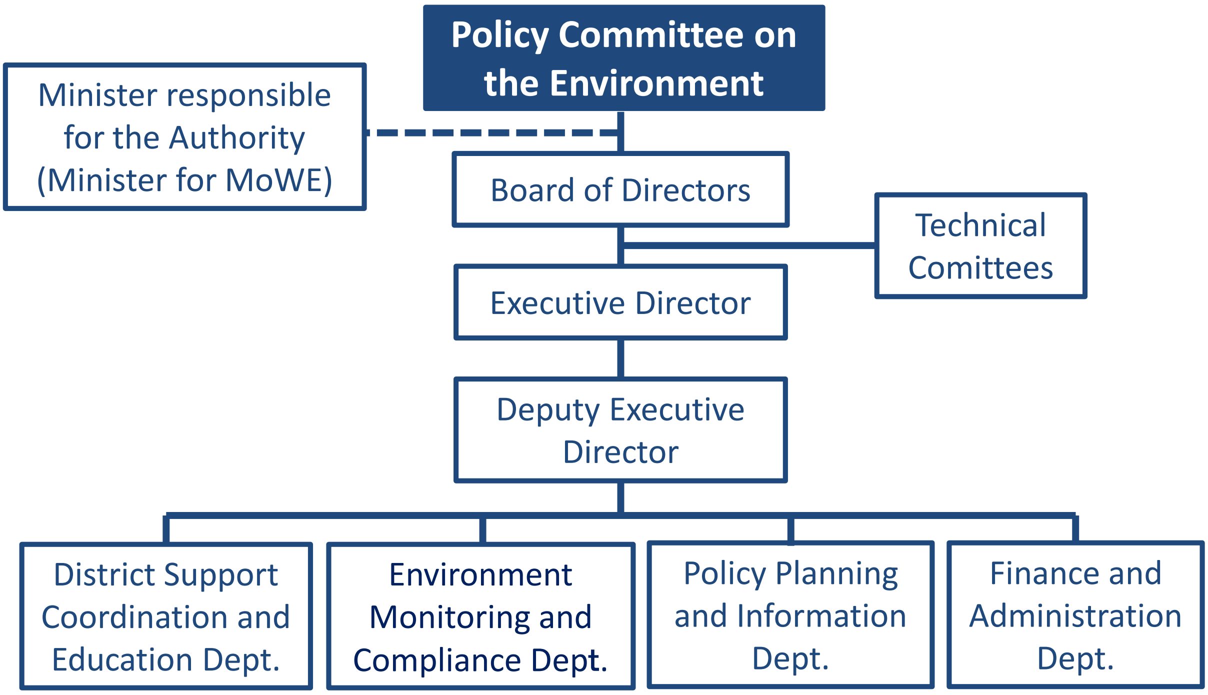
Source: Organized and edited by Nippon Koei Co., Ltd. based on the KCCA website

The effect of the project mentioned above will be verified in the future, but it includes local projects and is not considered to be sufficient to cover the entire city of Kampala. In addition, there are few measures for sources from household and industrial activity, and further measures such as reduction of harmful pollutants from emission gas, promotion of diffusion of dust collectors and alternative fuels, and environmental education in schools and communities are important issues.

4.2.2 NEMA

(1) Organizational Structure and Personnel Composition

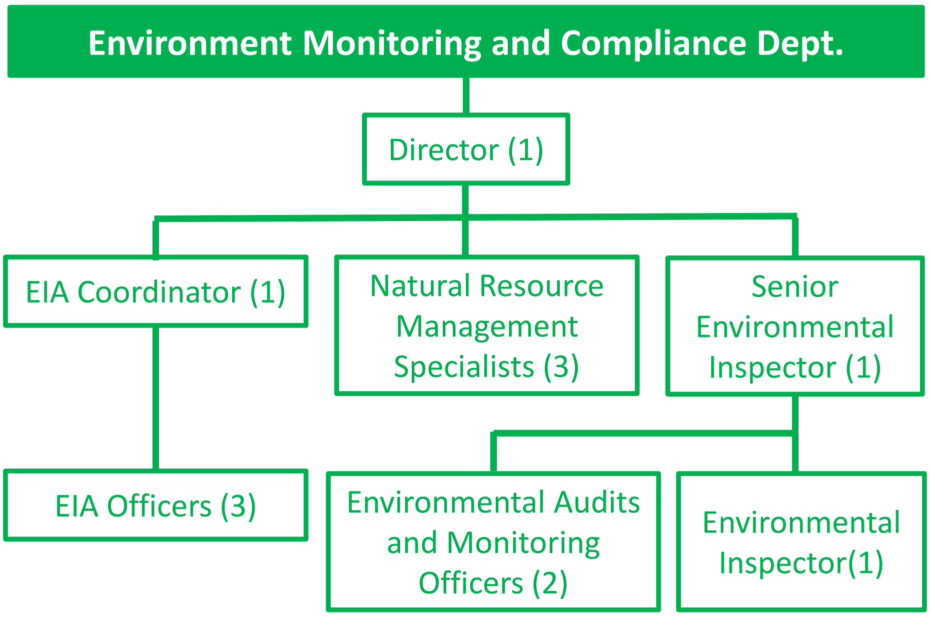
The NEMA is responsible for environmental management and nature conservation in Uganda and is an autonomous body independent of MoWE with the enactment of the National Environmental Law in 1995. NEMA is in charge of regulations and measures against air pollution in various projects, and is currently focusing on efforts toward the finalization of the National Environmental (Air Quality) Regulations (Draft) as described in Section 4.1.1. The number of officers is about 120, as of June 2021. However, this is including clerical staff, and the number of technical staff is limited. In particular, the shortage of staff with expertise in air pollution required to finalize the draft regulations was pointed out as a problem. The organizational structure of NEMA is shown below.



Source: Prepared by JST based on the NEMA website

Figure 4.2.2 Organizational Structure of NEMA

The Environment Monitoring and Compliance Department has specialists in environmental impact assessment (EIA), natural resource management, and environmental inspection, and is also engaged in air pollution-related work. The structure of this department is shown below.



Source: Prepared by JST based on the NEMA website

Figure 4.2.3 Composition of Environmental Monitoring and Compliance Department in NEMA

(2) Management, Financial Status, and Business Plan

The medium-term budget plan of NEMA is shown in Table 4.2.4. According to the results of interviews with air personnel of NEMA, the budget has not been clarified in particular regarding air pollution control measures same as KCCA. NEMA's air pollution officers are also not sure about the annual budget.

Table 4.2.4 Medium-term Budget Plan of NEMA

Water and Environment Vote Budget Framework Paper FY 2019/20

Vote:150 National Environment Management Authority

V1: Vote Overview

(i) Snapshot of Medium Term Budget Allocations

Table V1.1: Overview of Vote Expenditures

Billion Uganda Shillings		**FY2017/18**	**FY2018/19**		**FY2019/20**	**MTEF Budget Projections**			
		Outturn	**Approved Budget**	**Spent by End Sep**	**Proposed Budget**	**2020/21**	**2021/22**	**2022/23**	**2023/24**
Recurrent	Wage	4.832	6.116	1.323	6.116	6.422	6.743	7.080	7.434
	Non Wage	5.297	7.573	0.998	7.573	8.709	10.451	12.541	15.050
Devt.	GoU	0.853	0.915	0.052	0.915	1.098	1.098	1.098	1.098
	Ext. Fin.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	GoU Total	**10.982**	**14.605**	**2.372**	**14.605**	**16.229**	**18.292**	**20.720**	**23.582**
	Total GoU+Ext Fin (MTEF)	**10.982**	**14.605**	**2.372**	**14.605**	**16.229**	**18.292**	**20.720**	**23.582**
	A.I.A Total	9.123	11.731	1.914	12.927	13.927	14.927	15.927	16.927
	Grand Total	**20.104**	**26.336**	**4.286**	**27.532**	**30.157**	**33.220**	**36.647**	**40.509**

Source: Vote Budget Framework Paper FY 2019/20

(3) Status of Efforts Related to Air Pollution

The NEMA's main business is environmental impact assessment and review / approval of environmental audits. Through these, they understand the impact of various businesses on air pollution. In addition, NEMA is considering the finalization of the National Environment (Air Quality) Regulations (Draft) promulgated on 28 November 2020 as described in Section 4.1.1. As a result of the interview survey with NEMA in June 2021, it was said that it will be finalized and enforced after December 2021.

4.2.3 AirQo Project

(1) Organizational Structure and Personnel Composition

The AirQo Project was organized by Makerere University in 2015 and is currently being jointly implemented with KCCA. In this project, air quality monitoring has been carried out mainly in Kampala since 2018. In 2019, it received a USD 1.3 million grant from Google to improve the prediction accuracy of existing systems using AI and strengthen the information notification system of air pollution to residents through mobile apps.

The World Bank (WB) and academic organizations such as the Engineering and Physical Science Research Council (EPSRC) are also supporting the project, and the United States (US) Embassy in Uganda and the Swedish Embassy are also supporting to install air quality sensors developed by the project. Furthermore, in order to eliminate chronic traffic jam, which is one of the main causes of air pollution, a traffic sector master plan has been created by WB, and BRT projects based on this master plan are planned by UN-HABITAT and GIZ.

The project team consists of about 20 core members, including air pollution and data scientists, software engineers, marketing experts, and students from Makerere University, and they have a high degree of expertise in each field.

(2) Project Objective and Outline

The project is carrying out activities that contribute to build the air quality monitoring system with the aim of acquiring highly accurate air quality monitoring data throughout Uganda and sub-Saharan Africa. The outline of the project is shown below.

1) Development of Low-cost Air Quality Sensor

The air quality sensor originally developed by the project is designed to withstand the environment in sub-Saharan Africa, so it is not easily affected by dust and high temperatures, and it can function even in low power and weak internet connections.

2) Installation of Air Quality Sensors in Urban Areas

Air quality sensors are installed at 85 points in Uganda's urban areas, mainly in Kampala, and they constantly monitor $PM_{2.5}$, PM_{10}, location information, temperature, barometric pressure, and humidity using the latest cloud-based technology. They also store and manage large volumes of data that show the spatial and temporal behavior of air pollution.

This sensor transmits data over 2G networks available in many parts of Africa and can be installed in fixed-point monitoring, motorcycle taxis, and automobiles to capture instantaneous spatiotemporal values. In addition, simultaneous measurement with an automatic continuous measuring instrument (BAM1020) by β-ray absorption method installed at the US Embassy in Uganda is also performed, and the R2 value correlates well between 0.87 and 0.90.

Two air quality sensors for $PM_{2.5}$ and PM_{10} are installed near BAM1020 in Makerere University, and the measurement accuracy is managed by comparing the data between each sensor and with BAM1020. This monitoring point is also designated as a meteorological observation point in Kampala (as shown in the photos below).

Source: JST

Photo 4.2.1 Air Quality Sensors Installed in Makerere University

4.3 Information Related to Air Pollution Control

4.3.1 Ambient Air and Emission Gas Monitoring System and Information Disclosure, etc.

(1) Implementation Status of Ambient Air Quality Monitoring, Measurement Items, and Prospects

Currently, air quality monitoring is being conducted by KCCA, AirQo Project, ASAP (A Systems approach to Air Pollution), GeoHub Project (Makerere University School of Public Health), and the US Embassy in Uganda. Here, ASAP is a project aimed at improving air quality management in three cities in East Africa (Addis Ababa, Kampala, and Nairobi).

The measurement items are mainly particulate matter ($PM_{2.5}$ and PM_{10}), but KCCA measures NO_2 in addition to particulate matter. However, the existence of measurement results of other gaseous components (SO_2, CO, etc.) has not been confirmed. Regarding the measurement of particulate matter, BAM1020 is used at the campus of Makerere University, Nakawa Ward, and the US Embassy in Uganda. Other measurement points are using air quality sensors for measurement.

Information on the ASAP, GeoHub Project, and the US Embassy in Uganda are described.

1) Ambient Air Quality Monitoring by KCCA

As mentioned earlier, the Environmental Management Unit under the Directorate of Public Health is in charge of air pollution, and by developing an air quality information management system at the Kampala City level, it is useful for formulating the air quality management plan. In addition to overall activities aimed at building a framework for air quality monitoring and management, technical capabilities for monitoring air quality are being strengthened. The Kampala Air Quality Management Project is one of the components of the EU-supported “Kampala Climate Change Action Plan”. With this international support, KCCA will develop and operate the action plan.

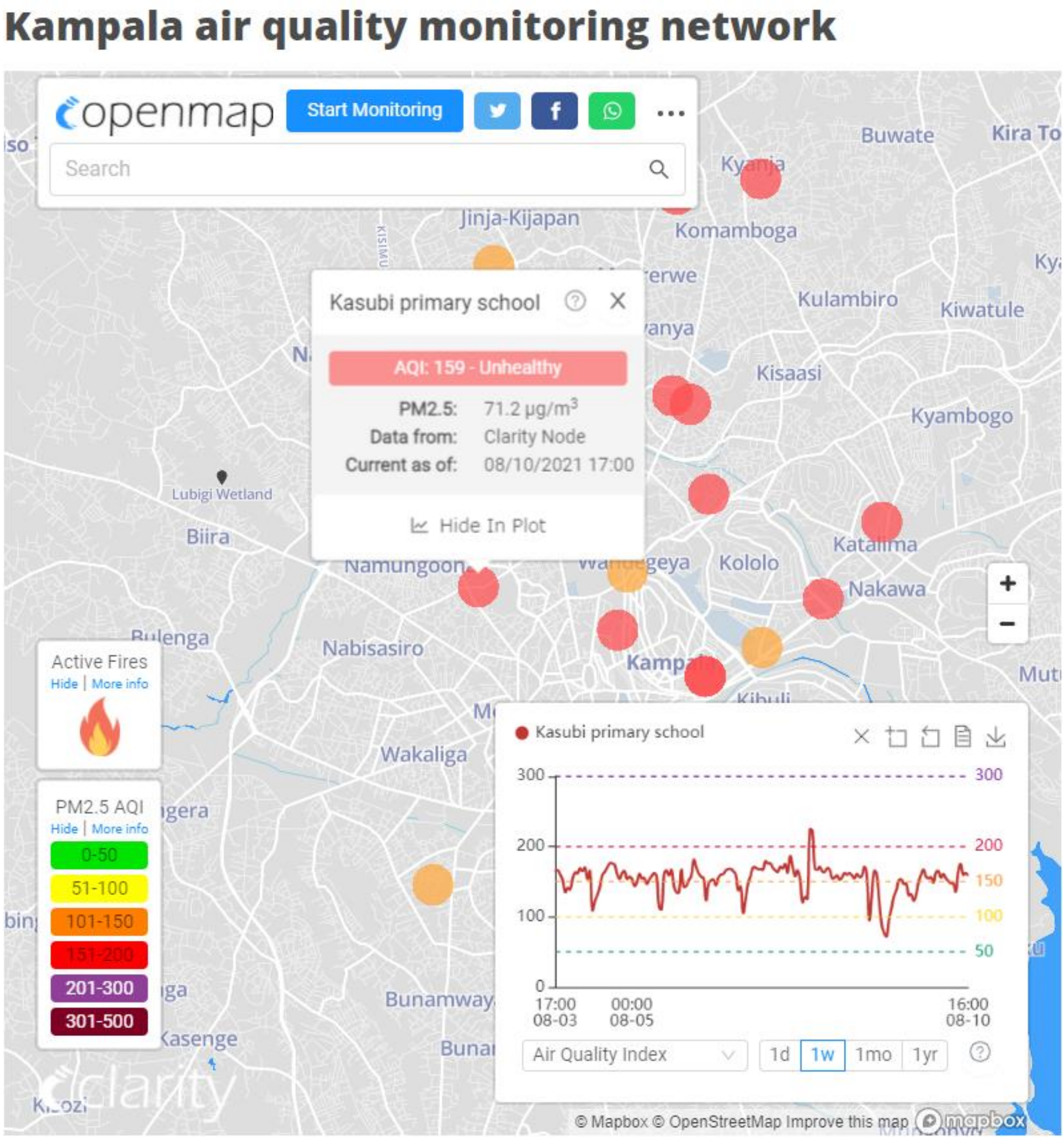
As a current activity for improving the air quality of KCCA, air quality monitoring is being carried out by utilizing air quality sensors and network different from the AirQo Project.

The air quality sensors are manufactured by Clarity of the United States, and the monitoring items are $PM_{2.5}$, PM_{10}, nitrogen dioxide (NO_2), and weather conditions. Twenty-five sensors have been installed at 24 locations in Kampala.

The following points were taken into consideration when selecting these 24 points:

- Human activity level around the installation points: Area type such as industrial area, commercial area, residential area, status of traffic jam, and time zone.
- Homogeneity of installation points: Installation evenly throughout Kampala City to grasp the overall pollution status.
- On the premises of government organizations: Kampala City Council Building, Ministry of Health Headquarters, etc. To promote the securing of the budget required for monitoring.

The monitoring point map in Kampala and the available measurement data are shown below.



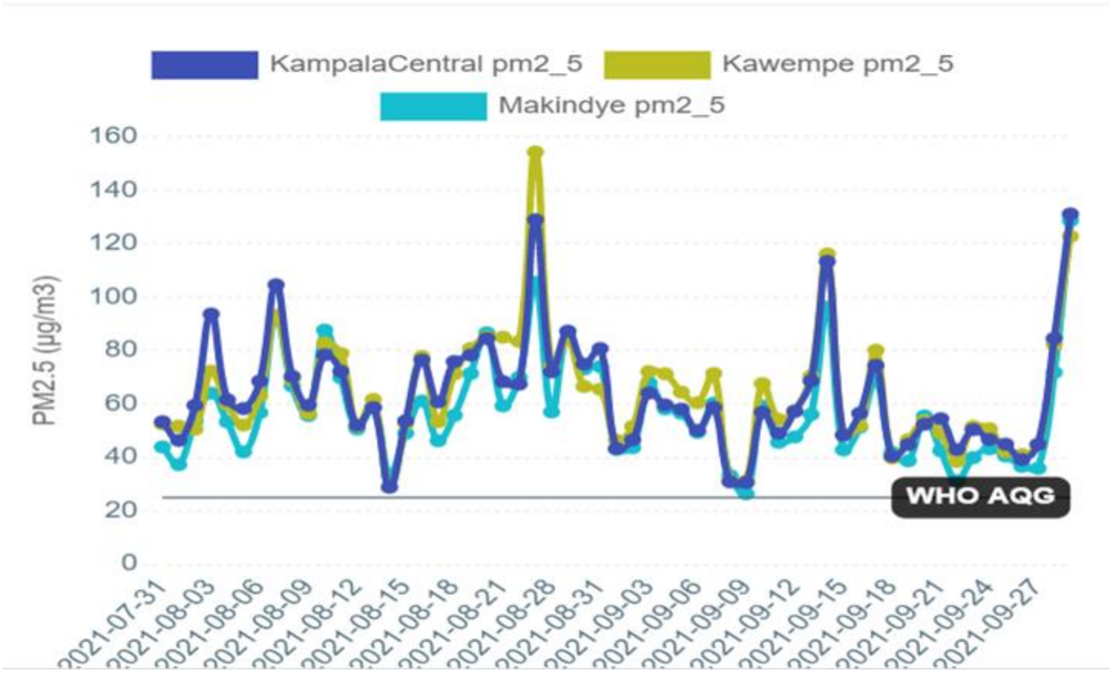
Source: KAMPALA'S HEALTH AND ENVIRONMENT IN THE MIDST OF COVID-19,

https://www.kcca.go.ug/media/docs/KCCA-DPHEBulletin_issue1.pdf

Figure 4.3.1 Monitoring Points and Measurement Data in Kampala

Next, the daily average concentrations (end of July to end of September 2021) of $PM_{2.5}$ at the main monitoring points (Central Ward, Kawempe Ward, Makindye Ward) in Kampala City acquired from the Environmental Management Unit of KCCA are shown in the figure below.

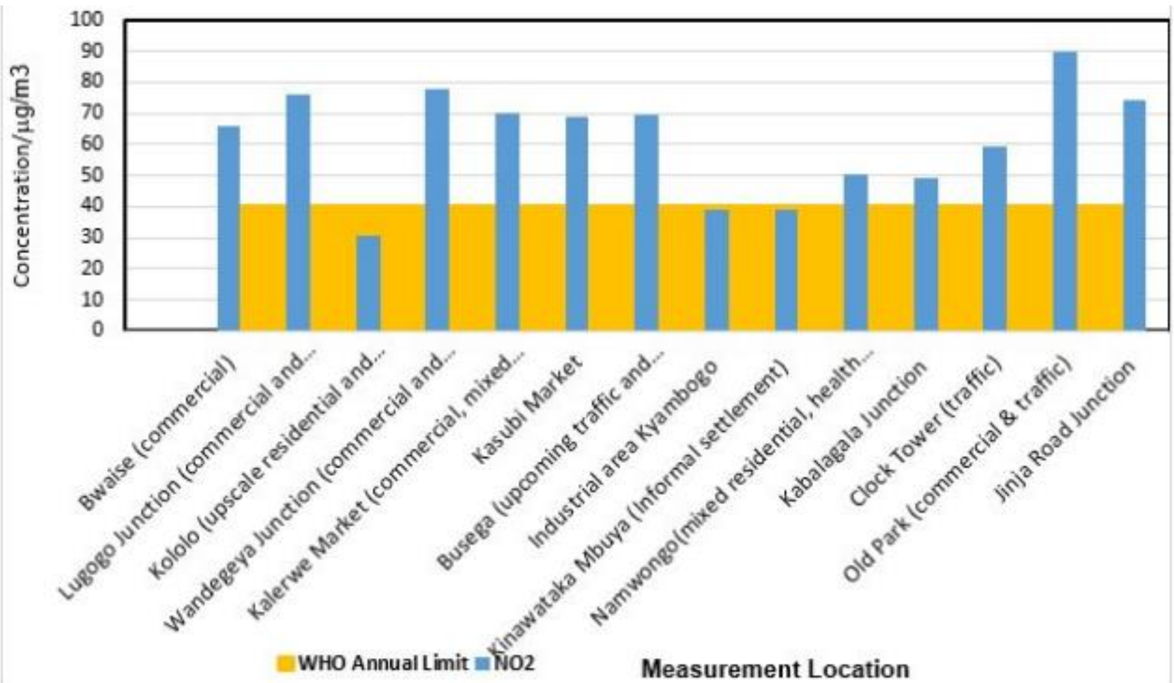
From this result, the WHO guideline value (before revision in September 2021, daily average value: 25 μg/m^3) was always exceeded. Furthermore, the concentration (daily average value: 70 μg / m3) which is indicated as a warning to "reduce unnecessary and unurgent going out and strenuous exercise outdoors as much as possible" in Japan was frequently exceeded.



Source: Business matching workshop material by KCCA, 30th September 2021

Figure 4.3.2 $PM_{2.5}$ Measurement Data at Major Monitoring Points in Kampala

Unlike the AirQo Project, KCCA is monitoring NO_2. As a result, it was clarified that NO_2 concentration exceeded the WHO guideline value (Before revision in September 2021) at many points, and it was found that air pollution was serious in Kampala other than $PM_{2.5}$. The figure below shows the measurement results of NO_2 at the main measurement points.



Source: KAMPALA'S HEALTH AND ENVIRONMENT IN THE MIDST OF COVID-19, https://www.kcca.go.ug/media/docs/KCCA-DPHEBulletin_issue1.pdf

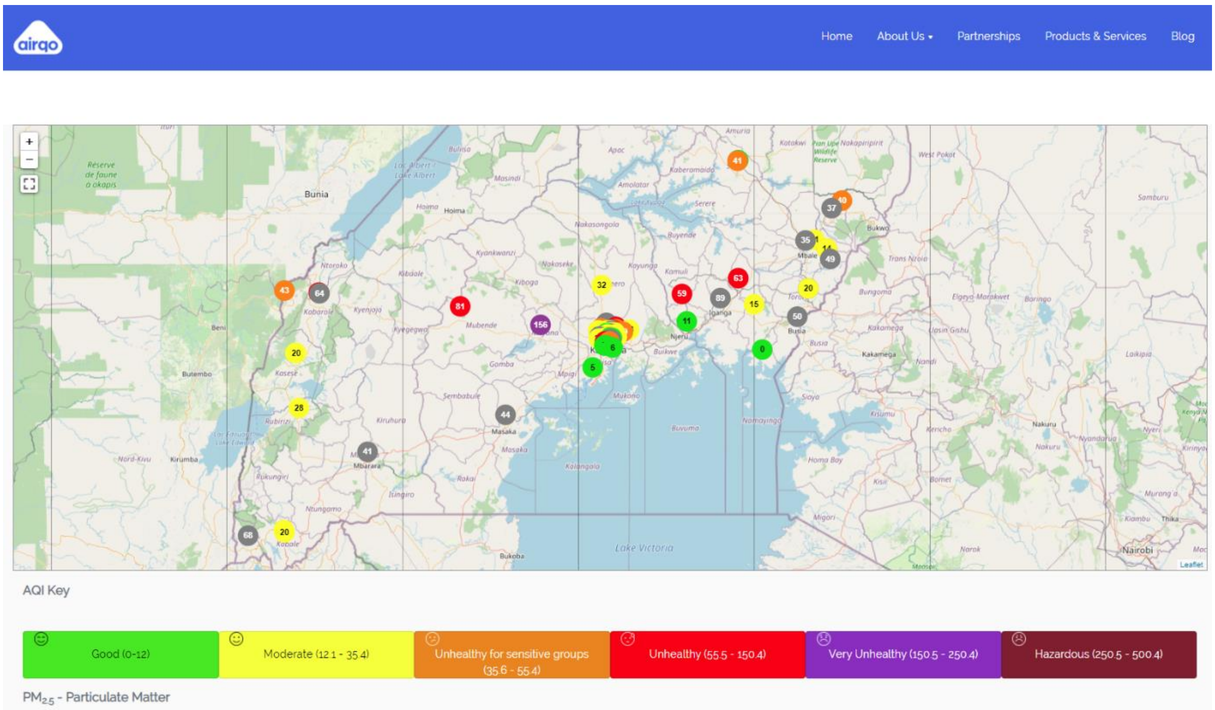
Figure 4.3.3 Measurement Results of NO_2 at the Main Measurement Points

2) Ambient Air Quality Monitoring by AirQo Project

As described in Section 4.2.3, the AirQo Project is conducting air quality monitoring using air quality sensors mainly in Kampala. In order to improve the measurement accuracy of air quality sensors, the project is also implementing the modeling of air pollution conditions using artificial intelligence (AI) and troubleshooting when errors occur. In addition, they are also disseminating information for grasping the air pollution situation in a wide area and mitigating air pollution through predicting the pollution level in areas where sensors are not installed. Currently, forecasts are possible from 24 hours to 48 hours ahead.

In addition, it is possible to obtain data in a customizable state regarding air quality monitoring results and prediction results by registering with AirQo Analytics. The AirQo API is a service for developers who want to embed air quality data in their applications, allowing registered data users to extract their own data or embed it in their code without going through the data mastering process. It can also be integrated into CMS plugins, open source projects, browser extensions, mobile apps, JS libraries, JQuery plugins, desktop apps, and web apps.

As an example of analyzing the monitoring results, the following figures show a graph of the daily average value of $PM_{2.5}$ concentration at each point in Kampala from June to July 2020. From this result, it became clear that the guideline value of WHO $PM_{2.5}$ daily average concentration was significantly exceeded at all points.



Source: AirQo Project (https://www.airqo.net/)

Figure 4.3.4 Publication Status of Air Quality Monitoring Results by AirQo Project

Source: AirQo Project, Stakeholder Workshop Materials obtained from AirQo Project (from 8th to 10th July 2020)

Figure 4.3.5 Daily Average Value of $PM_{2.5}$ Concentration at Each Point in Kampala City (from June to July 2020)

3) Ambient Air Quality Monitoring by ASAP

ASAP measured $PM_{2.5}$ and PM_{10} at multiple points in Kampala with low-cost sensors from September 2017 to June 2020. The survey points are in the urban background (Business Studies Building on the Kampala Campus of Ndejje University), on the roadside in the urban area (Uganda National Road Authority Headquarters), and in the rural background (Engineering Building on the Luweero Campus of Ndejje University). ASAP also utilizes the measurement results of KCCA and the US Embassy in Uganda to summarize the air quality conditions in Kampala as shown below.

According to the measurement results of 25 locations in Kampala by KCCA, $PM_{2.5}$ always exceeds the WHO guideline value (24-hour value: 25 µg / m^3).

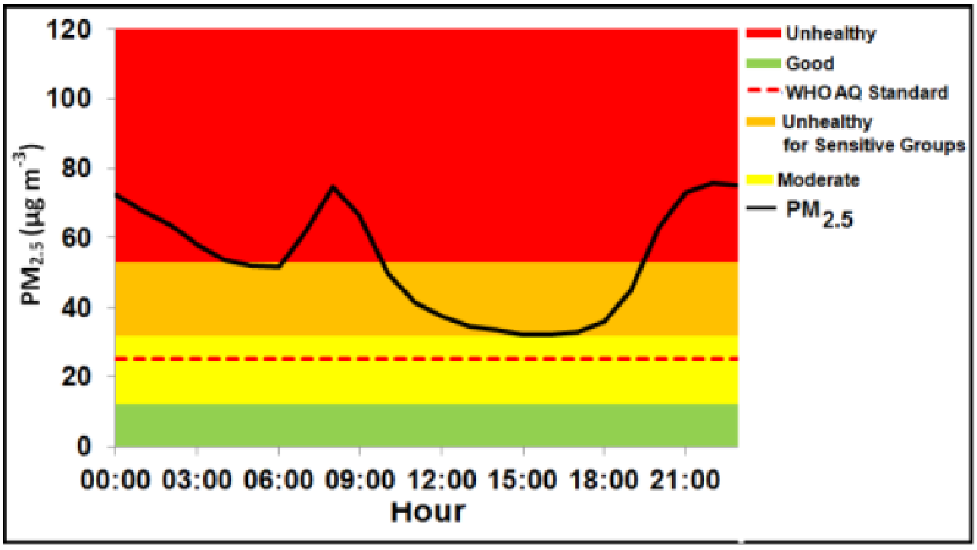
Archived $PM_{2.5}$ data collected from the US Embassy indicates that air quality in Kampala is typically at levels considered ‘unhealthy for sensitive groups’ to ‘unhealthy’ (Figure 1) according to the United States Environment Protection Agencies AQI. (Figure 4.3.6)

The ASAP-East Africa team has supplemented available long-term air quality monitoring with spot measurement campaigns at selected outdoor (Uganda National Road Authority Headquarters) and indoor (household) locations and mobile monitoring on motorcycle taxis (Boda Boda). Alongside this, analysis of visibility data has been undertaken to fill historical data gaps and suggests that air quality levels are poor and declining.

Visibility has been routinely recorded at airports worldwide and allows for analysis of past patterns of PM air pollution. ASAP researchers have collated hourly visibility data for the period 1974-2018 alongside meteorological factors (relative humidity, temperature, and wind) at Kampala Entebbe International Airport to investigate long-term historical air quality trends. A significant loss (0.45 km

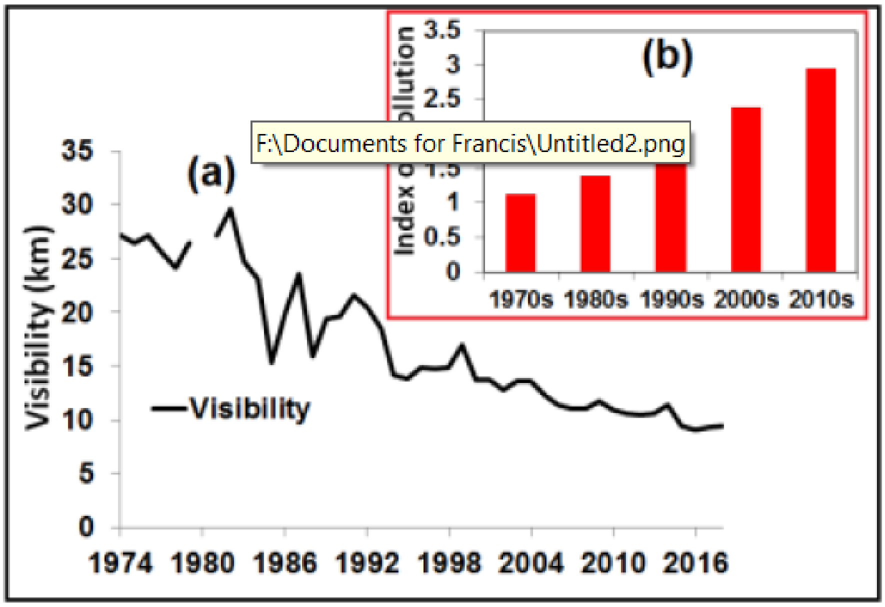
/ year) in visibility was observed in Kampala between 1974 and 201. Findings suggest that air pollution levels have increased by 162% between the 1970s and 2010 (Figure 4.3.7).

Household studies and spot measurement campaigns have been implemented across Kampala to explore spatial and temporal variation of air quality in the micro-environments where people spend significant periods of time. Household monitoring highlights that indoor air pollution is an issue of concern with a large proportion of households reliant on a fuel mix that includes charcoal and firewood. Measurements highlight that air quality during cooking in many households reaches an alarming level. Average levels of air quality monitored across households were 205 μg/m^3 24-hour mean (very unhealthy levels). Mobile air quality monitoring on-board Boda indicates that certain occupations, particularly transport providers, spend significant periods of time (up to 25% of journey times) in locations where air quality is at a level considered ‘unhealthy’ (Figure 4.3.8).



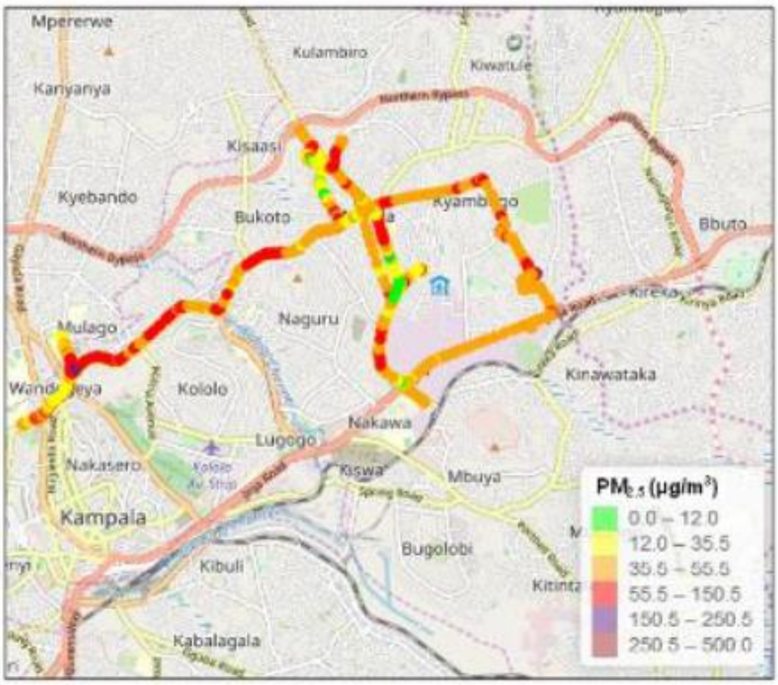
Source: ASAP East Africa Teams (https://assets.publishing.service.gov.uk/media/5eb16f3286650c4356562f92/ASAP_-_East_Africa_-_Air_Quality_Briefing_Note_-_Kampala.pdf)

Figure 4.3.6 $PM_{2.5}$ Concentration by Time Zone in Kampala



Source: ASAP East Africa Teams (https://assets.publishing.service.gov.uk/media/5eb16f3286650c4356562f92/ASAP_-_East_Africa_-_Air_Quality_Briefing_Note_-_Kampala.pdf)

Figure 4.3.7 Transition of Visibility Data in Kampala



Source: ASAP East Africa Teams (https://assets.publishing.service.gov.uk/media/5eb16f3286650c4356562f92/ASAP_-_East_Africa_-_Air_Quality_Briefing_Note_-_Kampala.pdf)

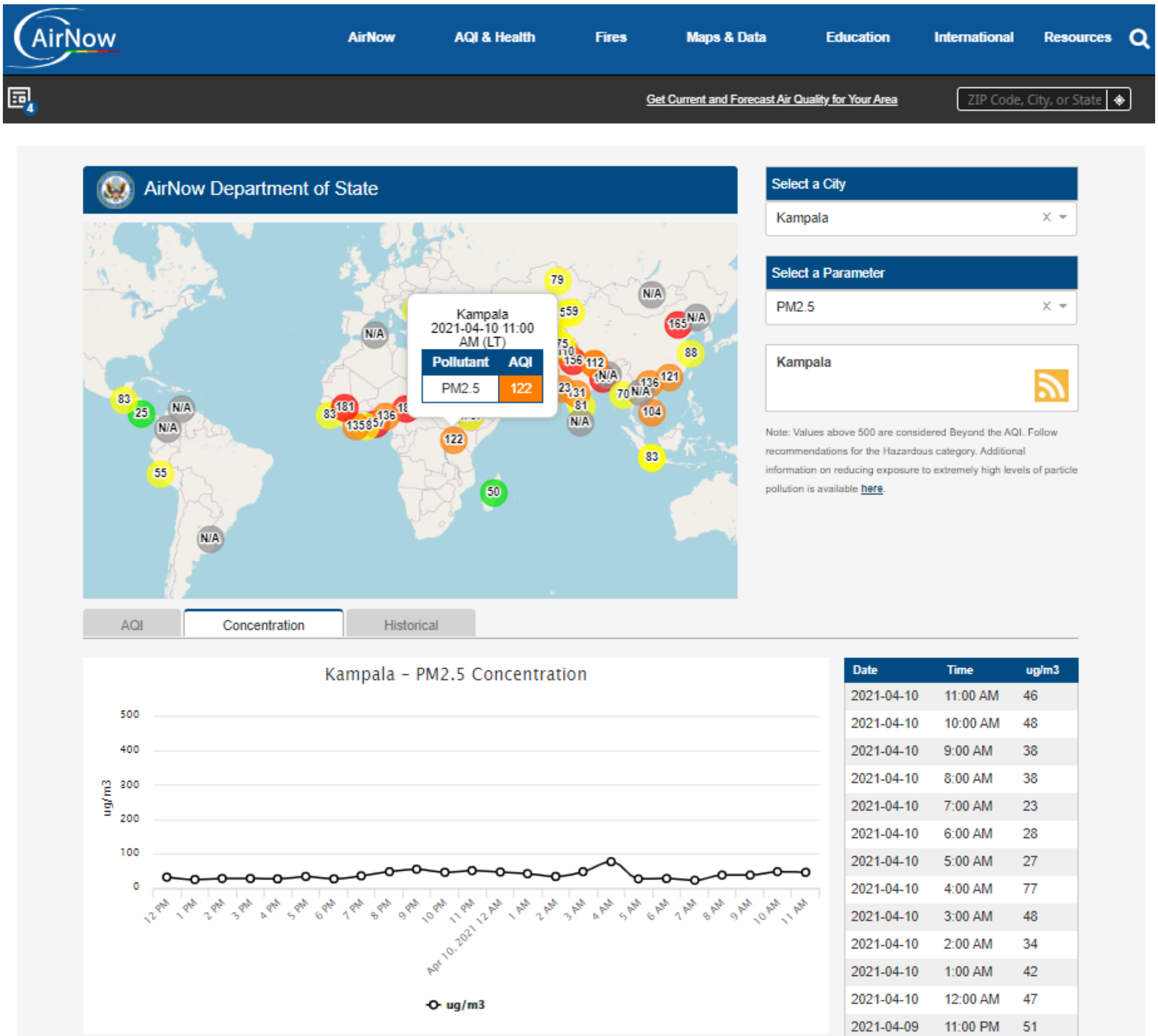
Figure 4.3.8 $PM_{2.5}$ Concentration by Mobile Monitoring in Kampala

4) Ambient Air Quality Monitoring by Geohub Project

In the GeoHub Project of the Makerere University School of Public Health, air pollutants have been measured by case studies in Kampala City since 2017. The measurement was carried out by BAM1022 (β-ray absorption method) and E-sampler (light scattering method), which are automatic measurement equipment manufactured by Met One Instruments Inc. installed on the roof of the school building.

5) Ambient Air Quality Monitoring by the US Embassy in Uganda

The US State Department, in collaboration with the US Environmental Protection Agency, has installed air quality monitors at several embassies and consulates around the world. In Uganda, $PM_{2.5}$ is measured at the US Embassy in Uganda, and $PM_{2.5}$ concentration and AQI are published (shown in the figure below).



Source: US Embassy in Uganda (https://www.airnow.gov/international/us-embassies-and-consulates/#Uganda$Kampala)

Figure 4.3.9 Disclosure of Monitoring Results by the US Embassy

(2) Implementation Status of Emission Gases Monitoring, Measurement Items, and Prospects

Regarding emission gas monitoring in Kampala, the JICA Survey Team (JST) heard that KCCA conducts inspections of 24 environment-related items (including four items of air pollution) and NEMA conducts inspections of compliance-related items at factories.

On the other hand, the National Environment (Air Quality) Regulations (Draft) include inspections of mobile sources such as automobiles and fixed sources such as factories, and NEMA will carry out inspections as necessary in consultation with major organizations. The items described are shown below.

Table 4.3.1 Items Related to Inspection of the National Environment (Air Quality) Regulations (Draft)

<u>12. Inspection of mobile emission sources</u> (1) The Authority may, in consultation with the lead agency responsible for mobile emission source inspection, at any time cause the inspection of a source releasing emissions. (2) The lead agency responsible for mobile emission source inspection shall, in consultation with the Authority, ensure that— (a) commercial, public service vehicles and private vehicles undergo emission tests in accordance with these Regulations, the Traffic and Road Safety Act and the Traffic and Road Safety (Motor Vehicle Inspection) Regulations, 2016; (b) emissions from other conveyance vessels and portable equipment are tested in accordance with these Regulations and other written law. (3) The emission tests referred to in sub regulation (2) shall be undertaken by the relevant lead agency. (4) The emission tests shall be undertaken in accordance with the Traffic and Road Safety Act, other written law and standard approved by the Uganda National Bureau of Standards.
<u>53. Inspection and monitoring</u> The Authority, occupational hygienist, environmental inspector or authorized officer may conduct regular inspections and monitoring of the facility or other area to— (a) Enforce compliance by the operator of the facility or any other person with the Act, these Regulations, the Occupational Safety and Health Act, 2006, any other written law and environmental standards; (b) Ascertain that appropriate measures are in place for avoidance or minimization of air pollution; (c) Ensure that information contained in reports and other documents submitted or availed to the Authority or relevant lead agency by the operator of a facility reflects the performance of the facility; (d) Assess the quality of air, including by inspecting air pollution control log-frames and technologies at the facility; or (e) Perform such other tasks as may be necessary to bring the facility into compliance.

Source: THE NATIONAL ENVIRONMENT (AIR QUALITY) REGULATIONS, 2020

Table 4.3.2 Items Related to Inspection Plan of the National Environment (Air Quality) Regulations (Draft)

B: Emissions inspection schedule

Vehicle Category	Initial Inspection	Periodic Inspection (Frequency)	Modification Inspection	On-road Random Inspection
All categories	All	After every 12 months	Yes	Yes
NOTE: All private passenger cars to be inspected after two years. This schedule applies also to inland, air and rail transport, as appropriate, in the absence of specific units.				

Source: THE NATIONAL ENVIRONMENT (AIR QUALITY) REGULATIONS, 2020

(3) Information Disclosure of Monitoring Data

It was confirmed that the results of monitoring by AirQo Project, KCCA, and the US Embassy are published on the website. Each monitoring point and data have already been described in the previous section.

4.3.2 Emission Inventory Survey, etc.

(1) Emission Inventory by ICF International

First, the emission inventory is a list showing the amount of air pollutants emitted by source. It is calculated by multiplying the emission factor (average emission of pollutants per unit activity) and activity (magnitude of activity that causes emission). This makes it possible to take measures to control emissions for each source. The existing emission inventory of Kampala City was prepared by ICF International in 2009, but there is no quantitative data on the sources and emissions since then. The air pollutant emissions by source in Kampala City estimated by ICF International are shown below.

Table 4.3.3 Estimates of Air Pollutant Emissions by Source in Kampala

	Emissions (% of Total Pollutants)				
Source Type	PM_{10} (t/y)	$PM_{2.5}$ (t/y)	NO_x (t/y)	SO_x (t/y)	Benzene (t/y)
Roadway Dust	14,686 (47.5%)	1,627 (10.0%)	-	-	-
Domestic Sources	15,587 (50.4%)	14,028 (86.5%)	2,676 (39.9%)	-	273 (30.9%)
Vehicle Sources	618 (2.0%)	556 (3.4%)	3,984 (59.3%)	1,747 (68.8%)	610 (69.1%)
Industrial Sources	10 (0.0%)	9 (0.1%)	55 (0.8%)	793 (31.2%)	-
Total (tpy)	30,901 (100.0%)	16,220 (100.0%)	6,715 (100.0%)	2,540 (100.0%)	883 (100.0%)

Source: Final Report Sub-Saharan Africa Refinery Project Health Study: Volume I-A (2009), ICF International

In the table above, 86.5% of $PM_{2.5}$ is from households, and nitrogen oxides (NO_X) and sulfur oxides (SO_X) are from traffic. However, it is possible that the emissions and proportions of air pollutants have changed significantly due to economic growth up to 2021. Therefore, it is important to update the emission inventory based on the latest exhaust gas monitoring.

(2) Estimating the Ratio of Air Pollution-Causing Substances and Sources

The following information related to the proportion of air pollutants sources are confirmed. It is mainly the hoisting of soil particles and exhaust gas from traffic, but it is considered that the contribution of industry and open burning of waste cannot be ignored.

View by Engineer Bainomugisha of AirQo Project:

Generally, the main drivers of air pollution in Kampala are transport, industry, burning of wood or charcoal, and burning of waste. Kampala is Uganda's political capital and financial district contributing to over 30% of Uganda's GDP. The city hosts more than 32% of the country's manufacturing facilities and so industrial emissions from activity – such as metal processing, furniture, textiles, and plastics – will contribute a significant amount of pollution to the air.

In addition to this, more than 90% of households in Kampala rely on charcoal and firewood as an energy source for cooking. And because there's poor solid waste disposal, another key contributor of air pollution is the open burning of garbage.

Source: https://theconversation.com/how-were-measuring-air-quality-in-kampala-and-why-it-works-for-african-cities-143006

Ambient Particulate Matter Air Pollution in Mpererwe District, Kampala, Uganda: A Pilot Study, Stephan Schwander, Journal of Environmental and Public Health Volume 2014, Article ID 763934 :

Air quality in Kampala, the capital of Uganda, has deteriorated significantly in the past two decades. We made spot measurements in Mpererwe District for airborne particulate matter $PM_{2.5}$ (fine particles) and coarse particles. PM was collected on Teflon-membrane filters and analyzed for mass, 51 elements, 3 anions, and 5 cations. Both fine and coarse particle concentrations were above 100 $\mu g/m^3$ in all the samples collected. Markers for crustal/soil (e.g., Si and Al) were the most abundant in the $PM_{2.5}$ fraction, followed by primary combustion products from biomass burning and incinerator emissions (e.g., K and Cl). Over 90% of the measured $PM_{2.5}$ mass can be explained by crustal species (41% and 59%) and carbonaceous aerosol (33%–55%). Crustal elements dominated the coarse particles collected from Kampala. The results of this pilot study are indicative of unhealthy air and suggest that exposure to ambient air in Kampala may increase the burden of environmentally induced cardiovascular, metabolic, and respiratory diseases including infections. Greater awareness and more extensive research are required to confirm our findings, to identify personal exposure and pollution sources, and to develop air quality management plans and policies to protect public health.

According to the Uganda National Environment Management Authority (NEMA), all the resulting daily traffic jams result not only in loss of valuable health and time but also lead to a loss of about UGX 500 million (about USD 200,000) in burnt fuel; that is, about 140,000 liters of fuel are burnt by idling cars every day.

Source: https://www.hindawi.com/journals/jeph/2014/763934/

(3) Inventory Preparation and Update Status for Each Source and Pollutant

As mentioned above, quantitative inventory has not been prepared based on the measurement results of emission gas, but ASAP is conducting a study considering the weather and emission sources.

Air quality modeling in Kampala:

The meteorological and chemical dispersion patterns are simulated by a modelling system that comprises the Weather and Research for Forecast Model coupled with the chemistry-transport model CHIMERE. Improvement of the urban road network and policies aimed at reducing emissions will be simulated and assessed in terms of improving urban air quality.

Source: https://assets.publishing.service.gov.uk/media/5eb16f3286650c4356562f92/ASAP_-_East_Africa_-_Air_Quality_Briefing_Note_-_Kampala.pdf

Also, according to the U.S. Air Quality Capacity Building Fellowship website, support for Kampala City's air quality improvement project is stated. The kick-off meeting was held in January 2020 and support is expected to be provided until 2021. However, since KCCA's environmental staff have not participated in this project, the content of the training is not shared within KCCA as of October 2021.

Goal of Uganda-KCCA Project

High Level Goal 1: Develop an emission inventory for air pollution in Kampala

- Gather the necessary activity data and estimate emissions from emission sources.
- Develop technical capacity in source apportionment.
- Conduct 8 stakeholder workshops to present the emission inventory report and solicit feedback.
- Provide information to the public and industry to encourage compliant behavior and activities to reduce emissions and pollution.

High Level Goal 2: Develop the capacity for air quality monitoring in Kampala

- Develop KCCA technical capacity on air quality monitoring technology.
- Advise KCCA on air quality monitoring network organization and station siting.
- Advise KCCA on air quality monitoring within the context of regulatory framework development compliance.

High Level Goal 3: Modeling, forecasting, and data analysis

- Improve air quality decision-making by local, regional, and national planners.
- Advise AirQo (project stakeholder) on data analysis techniques to leverage the data from their sensor network.

- Use data analysis and air quality modelling to better understand the air quality environment of Kampala and the emissions and processes that lead to poor air quality.

Project Stakeholders:

Other Ugandan groups that participate in the air quality project, in addition to the lead agency Uganda KCCA, include Uganda National Environment Management Authority (NEMA), the Makerere University, AirQo, East African Geo Health Hub, Ministry of Water and Environment, and Uganda Manufacturers Association.

Support and Training:

The Fellow and the Uganda-KCCA project team have arranged to meet remotely every other week, alternating each time with training events and then a project technical discussion and working meeting to address questions and work on practice problems in tandem. The Fellow for Uganda-NEMA also participates in the KCCA training sessions and meetings.

2020 Technical Training Sessions for KCCA

- Introduction to Air Quality Science and Introduction to Emission Inventory Work – Technical Framework
- Air Quality Network Development - Considerations for Siting Air Quality Monitor Stations
- Emissions Inventory Quantification

2020 Technical Training Sessions for NEMA

- Air Quality Science, Air Quality Standards, and Air Quality Management – presented in collaboration with Ms. Amy Zimpfer

Source: https://aqfellows.rti.org/Host-Country/Uganda-Kampala-Capital-City

According to NEMA, the emission inventory will be examined and prepared after the National Environment (Air Quality) Regulations are finalized and the environmental standards and emission standards for air pollution are established. According to KCCA, the CAAP project supported by UNEP will consider the sources of pollutant emissions.

4.3.3 Impact of Air Pollution

(1) Exposure Assessment of Air Pollutants and Health Damage Caused by Air Pollution

Air pollution in Kampala is deteriorating at a high rate causing serious threat to the health of the population across the city. Children, older people, and those with pre-existing heart and lung conditions are amongst the most vulnerable to the effects of air pollution, many of whom are exposed daily to poor air quality in Kampala during their daily commute to work and school.

Studies by Ugandan scientists suggest about 13.8 percent of children between the ages of 8 and 14 living in Kampala have bronchial asthma. [3]

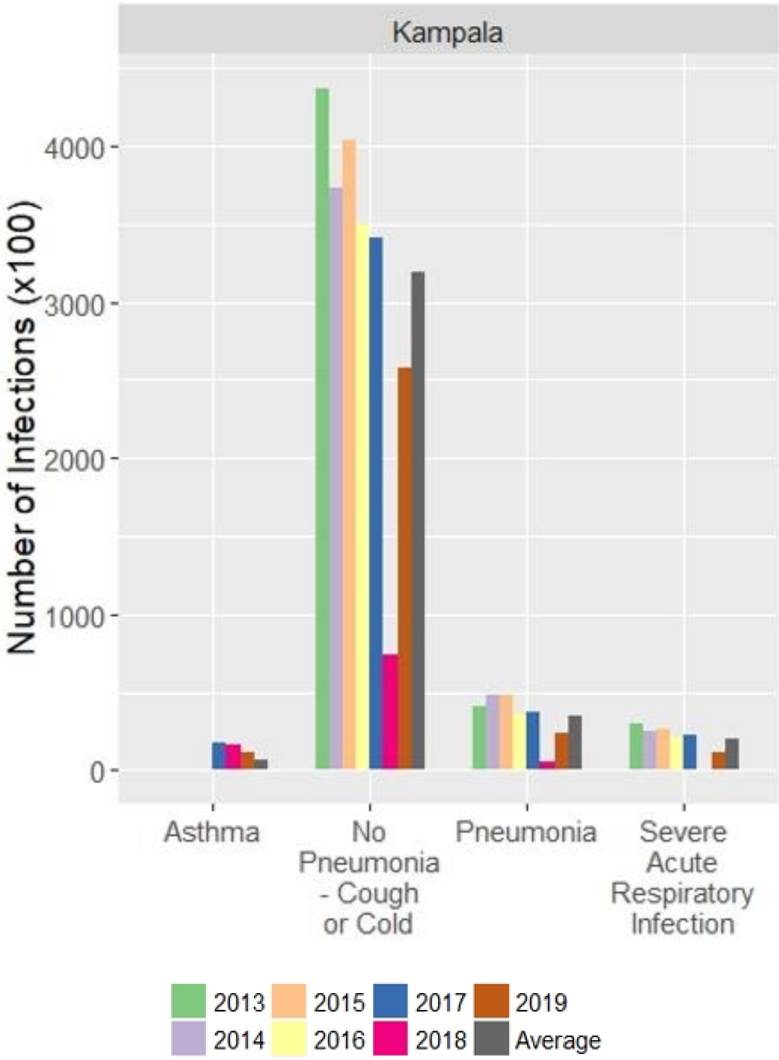
In addition, as a result of interview about the health effects of air pollution with MoH, the biggest problem is that the number of people who cannot stop coughing due to worsening air pollution increased. The number of patients with various diseases caused by air pollution in Kampala City is reported as shown in the figure below, and the average number of people who developed coughs and colds other than pneumonia was about 320,000 per year from 2013 to 2019. This is equivalent to about 20% of the population of Kampala, which is 1.68 million (2020 forecast).

In particular, there are concerns about the health effects of indoor air pollution associated with the use of biomass fuel as mentioned before. According to the results of indoor air quality survey, the average concentration of $PM_{2.5}$ was 72.61 ± 64.42 µg/m^3 in households using charcoal and firewood, but it was 43.46 ± 33.44 µg/m^3 in households using LPG and electricity. In addition, air pollution levels tended to peak during cooking, consistently recording levels above air quality indicators. [4]

Under these circumstances, the number of inquiries from citizens regarding health effects and cost burdens caused by air pollution is increasing.

[3] Source: UNEP (2021) Supporting Countries to monitor and improve urban air quality, https://www.kcca.go.ug/media/docs/TORs_Kampala%20CAAP_14-04-2021_ECI.pdf

[4] Source: Vulnerability Scoping Study: Air Pollution Exposure in Low Income Households in Kampala ASAP_-_East_Africa_-_Vulnerability_Scoping_Study_-_Low_Income_Households_in_Kampala_Final_13_03_20.pdf (publishing.service.gov.uk)



Source: AirQo Project, Stakeholder Workshop Material (from 8th to 10th July 2020)

Figure 4.3.10 Number of Patients with Various Diseases Caused by Air Pollution in Kampala

(2) Estimated Economic Loss due to Air Pollution

According to a report released by Greenpeace in February 2020, global economic losses due to air pollution caused by fossil fuels were USD 2.9 trillion in 2018, equivalent to about 3.3% of GDP. The report analyzes the global burden of fossil fuel air pollution by country on economic losses and estimates of the number of premature deaths. Median estimates were USD 57 million in economic losses and 700 premature deaths in Uganda. For reference, Japan has an economic loss of USD 130 billion and early deaths of 100,000. [5]

[5] Source: Green Peace Website, https://www.greenpeace.org/static/planet4-southeastasia-stateless/2020/02/da1c8e5c-toxic-air-report-110220.pdf

4.3.4 Status of Measures against Fixed Sources and Vehicle Sources (Traffic Air Pollution)

(1) Status of Measures against Fixed Sources

Although there are provisions in the National Environment (Air Quality) Regulations that stipulate the implementation of efforts to reduce greenhouse gases (GHG) from fixed sources, specific reduction technologies and methods have not been sufficiently examined. In particular, it has not been confirmed that measures for fixed sources have been implemented for major factories in Kampala City, and it is considered to introduce desulfurization, denitration, and dust collection technology as necessary. In Uganda, about 90% of households use biomass fuel, and it is considered that PM generated when the fuel burns contribute significantly to air pollution. Therefore, with the support of WB, the Private Sector Foundation Uganda (PSFU) is implementing a project to popularize improved cooking stoves (high thermal efficiency and low emission gas). On the other hand, gas pipes are not laid, and gas cylinders are expensive in Kampala City, so they are not widely used in households. Therefore, the problem is that conversion from biomass fuel is not easy.

(2) Status of Measures for Vehicle Sources

Although MoWE and MoWT have been considering the measures against air pollution derived from vehicles as the highest priority, traffic jam occurs mainly in the evening due to heavy traffic of passenger cars and motorcycles in the center of Kampala City. In addition, exhaust gas (black smoke) from old-model cars and dust being rolled up on unpaved roads are occasionally seen. Therefore, it is important to take measures against vehicle sources in Kampala. The National Environment (Air Quality) Regulations also include provisions related to automobile emission regulations, and it is considered that there is an urgent need to promote future measures.

The following shows the traffic jam in Kampala City and the dust hoisting from unpaved roads.

Source: JST

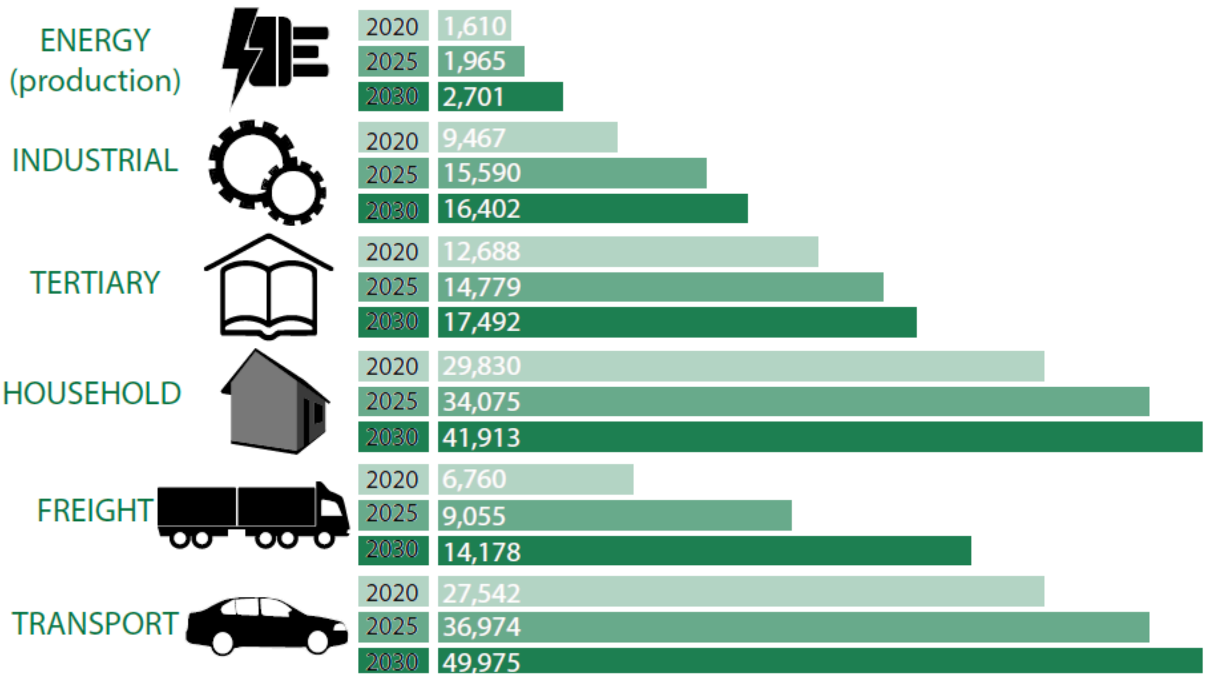
Photo 4.3.1 Traffic Jam in the Center of Kampala City

One of the effective measures for vehicle sources in Kampala is the spread of electric motorcycles. In particular, 3WM Uganda Ltd. (a used car import and sales company in Japan), Bodawerk International Ltd., and Yamaha Uganda Ltd. (both are motorcycle sales and repair companies) who conducted the interview showed high interest. On the other hand, when importing electric motorcycles from Japan, a tariff of JPY 200,000 to 300,000 is required for each motorcycle, and when manufacturing and selling in Uganda, it is more expensive than a normal motorcycle. In addition to taking 5 to 8 hours to fully charge, it is a big problem that tire wear becomes severe due to unpaved roads.

In addition, although the Traffic and Road Safety Act does not include air quality regulations, the revised law effected on 1 October 2018 prohibits the import of old vehicles that are more than 15 years old from the date of manufacture. The import prohibition of old vehicles is considered to be effective in dealing with vehicle sources in the long run.

4.3.5 Future Scenarios of Air Pollution Considering Increased Vehicle Traffic and Industrial Activities

Considering the recent economic growth rate and population growth rate in Uganda, it is expected that the traffic volume of automobiles will continue to increase in the future. As shown in the figure below, the KCCAP contains future energy demand forecasts, and it is predicted that energy demand in the freight and transportation fields will double in ten years to 2030.



Source: KCCA (2016), Kampala Climate Change Action Plan

Figure 4.3.11 Energy Demand Forecast for Each Field in Kampala (unit: tJ)

On the other hand, due to restrictions on the import of used cars under the Traffic and Road Safety Act, the proportion of old cars that contribute to air pollution is expected to decrease, and the increase in energy consumption is not necessarily proportional to the amount of air pollutants emitted. In particular, the gradual replacement of existing motorcycles with electric motorcycles may reduce air pollutant emissions in the transportation sector and improve air pollution in the long run.

4.3.6 Residents' Awareness of Air Pollution Control

The air pollution status in Kampala is often reported on the internet, etc., and necessity for measures may be recognized. According to a survey conducted by ASAP on low-income earners, they recognize that low-income earners are more vulnerable to air pollution, but it is shown that their knowledge of the sources of air pollution is relatively lacking. [6]

4.4 Current Major Problems in Air Pollution

The main problems based on the current state of air pollution in Kampala are listed below.

4.4.1 Environmental Policy

- Environmental standards and emission standards for air pollution have not been finalized as of October 2021.
- Official measurement method for air pollutants measurement has been established, and it is not possible to properly grasp and evaluate the validity and achievement status of the standard values.
- There is a shortage of human resources and equipment to monitor the achievement status after the standard value is established.
- Regulations or specific policies regarding fixed sources have not been established.
- Used cars within 15 years of manufacture can be imported, but they are rarely imported due to high tariffs (USD 300,000 to 500,000/unit) (according to interview with used car importers and distributors in Uganda). Also, the vehicle inspection system is almost non-functional.

4.4.2 Ambient Air and Emission Gas Monitoring, Air Pollution Control

- There are about 20 core members of the AirQo Project (professor at Makerere University, equipment development engineer, IT engineer, etc.), but due to budgetary constraints, the future expansion of AirQo Project's activities is limited.
- It is considered difficult to properly maintain and evaluate the accuracy of air quality monitors installed in a wide area by a limited number of personnel. Accuracy evaluation requires calibration with other standard equipment (BAM1020 in the case of AirQo Project).
- Due to the lack of project budget, financial cooperation from the government or donors is indispensable for expanding the monitoring system after 2022.

[6] Vulnerability Scoping Study: Air Pollution Exposure in Low Income Households in Kampala

- Measurement of gaseous substances (SO_2, O_3, CO) has not been carried out. NO_2 measurement is also limited. Monitoring of these gaseous substances is important for understanding the current state of air pollution and evaluating health effects.
- There is no Air Quality Monitoring Station (AQMS) in Uganda. As one idea, there is a possibility of introducing an AQMS of Japanese company, but it is necessary to consider the cost for transportation, installation, and maintenance.
- Although the measurement network for PM is being enhanced, it is difficult to grasp the breakdown and contribution of pollution sources because PM component analysis equipment has not been introduced and there are no analysis methods and laboratories for analysis. Therefore, it is difficult to consider narrowing down the target of specific measures.
- Emission source monitoring has not been carried out and emission inventory has not been updated.
- Since the existing emission inventory is old (ICF International, 2009) and the source contribution ratio is unknown, it is not possible to extract items that should be prioritized.

4.5 Status of Support from Other Donors and the Potential for Collaboration

4.5.1 Status of Support from Other Donors and the Potential for Collaboration

Table 4.5.1 shows the status of support provided by other donors for activities related to air pollution control. In particular, the U.S. Air Quality Capacity Building Fellowship is underway for KCCA. However, KCCA's air pollution officer does not understand the details of the fellowship, and it is targeted at the secretariat's office within KCCA's Business Strategy Bureau. Therefore, training for technical officers has not been implemented, and the possibility of cooperation and complementation with JICA is considered.

On the other hand, KCCA has set the formulation of CAAP as a top priority, and is focusing on the implementation of support projects related to air quality monitoring and improvement by UNEP.

Table 4.5.1 Status of Support from Other Donors (Air Pollution Sector)

Project Overview	Donor/Partner
➢ Paving of 201 km of Marram Road to prevent the generation of road dust	WB
➢ Widening of roads and the introduction of traffic lights to reduce congestion and emissions from vehicles	JICA, etc.
➢ Installation of 25 monitoring stations at 5 locations in each division ➢ Providing real-time air pollution status to residents	AirQo Project (Makerere University, Google, WB, etc.)
➢ Promotion and development of sustainable alternatives such as trains, BRT, and bicycle	JICA, WB, GIZ, UN
➢ Introduction of Uganda’s first ever nonmotorized traffic route on	UN-HABITAT, UNEP,

Project Overview	Donor/Partner
Namirenmbe Road to promote cycling and walking	Dutch NGO
➢ Private plant sector participation in waste collection to reduce combustion waste	Private companies
➢ Inventory of air pollution emissions in Kampala, capacity building for air quality monitoring, modeling, forecasting and data analysis in Kampala	US Air Quality Capacity Building Fellowship
➢ Support for implementation of monitoring programs such as nitrogen dioxide	Mapping for Change
➢ Support for monitoring and improving air quality in Kampala	UNEP

Source: Organized and edited by Nippon Koei Co., Ltd. based on the KCCA website

JST conducted web interviews with AfDB, WB, ADF, KfW, and UNICEF to collect additional information. In the interview, JST mainly asked the following points:

1. Experience in implementing projects to improve air pollution (ambient air, emission gas, indoors, etc.) in Uganda.
2. Future plans to implement projects for improving air pollution in Uganda or neighboring countries.
3. Possibility of cooperation with JICA in air pollution in the future.

As a result of asking the person in charge of each organization the above questions, JST has not been able to confirm projects related to air pollution improvement in Uganda and African countries except for WB, and the future implementation plans of these donors have not been clearly decided at this time. AfDB Nairobi Office has environmental and safeguard personnel, but no air pollution experts are enrolled in any of the organizations.

As for WB, since it has provided financial cooperation for the AirQo Project, it is considered that they may be interested in air pollution improvement projects in Uganda or African countries.Therefore, it is expected that there will be a possibility of cooperation in future efforts to expand the air monitoring system.

4.5.2 Project Implementation Status and Possibility of Cooperation in Neighboring Countries

As mentioned above, air pollution-related projects in neighboring countries are limited, and only WB's support for South Africa has been confirmed. This project, "Air Quality Management in the Great Johannesburg Area (GJA) in South Africa", is improving capacity for air pollution control and supporting the formulation of Air Quality Management (AQM) plan in GJA, South Africa. The project period is from 16th October 2020 to 31st October 2021. JST tried to collect detailed information such as business contents and results from the person in charge of WB, but it was not possible to collect them as of October 2021.

4.5.3 Development and Potential for Collaboration with Private Companies

(1) Survey and Organization of Products, Technologies, and Knowhow of Private Companies

The following categories can be considered as targets of private companies among companies that handle products or services for improving air pollution:

1) Japanese companies with experience in collaboration program with the private sector by JICA

2) Uganda domestic start-up company

Regarding (1), JST searched for cases in the fields of environment, waste management, infrastructure development and transportation, information and communication technology, and urban or regional development that were carried out in the past on the "Project Case Search" on JICA's website. (https://www2.jica.go.jp/ja/priv_sme_partner/index.php)

The JST also contacted these companies to confirm their interest in attending Business Matching Workshop and Seminar (Ideathon). The following table shows the company name, technology name, and their interest.

Table 4.5.2 List of Private Technology and Companies, Experience of Collaboration Program with the Private Sector by JICA (Air Pollution Sector)

No.	Technology / Product	Company	Experience of Collaboration Program	Contact	Response
Environmental monitoring technology					
1-1	$PM_{2.5}$ components analyzer and air quality monitoring system	HORIBA, Ltd.	Dissemination, demonstration and commercialization project for introduction of $PM_{2.5}$ components analyzer and air quality monitoring system (Morocco, 2019)	Done	Cooperation is possible
Air purification technology					
2-1	ACF Air Purification Unit	Osaka Gas Co., Ltd.	ACF Air Purification Unit Promotion Project (Indonesia, June 2018 to May 2020)	Done	Cooperation is possible
Air quality load reduction (other than transportation)					
3-1	Hybrid rocket cooking stove and eco-fuel	Project Satoyama Energy	Basic Survey on Manufacturing and Sales Business of Hybrid Rocket Cooking Stove and Eco Fuel (Madagascar, July 2016 to July 2017)	Done	No interest (in terms of profitability)
3-2	Gas stove	Rinnai Corporation	Survey on the spread of gas stoves (Zambia, 2019)	Done	Interested (when cooperation with a local gas company can be expected)
3-3	Carbonated hybrid painting system	Kami Electronics Ind. Co., Ltd.	Survey on the promotion of reduction of air environmental load by carbon dioxide hybrid coating system (People's Republic of China, November 2017 to December 2018))	—	—
3-4	Waste plastic fuel technology	Joint venture of CFP Co., Ltd. and Kanemiya Co., Ltd.	Dissemination and demonstration project of waste plastic fuel conversion technology for sustainable waste management (South Africa, March 2014 to September 2016)	—	—
3-5	Insulation paint	SHIMIZU CORPORATION	Survey on the reduction of heating demand and air pollution by utilizing heat insulating paint (Mongolia, June 2019 to June 2021)	—	—
Air quality load reduction (transportation)					
Hardware measures					
4-1	Warp Air Clean	TASIN Co., Ltd	Survey on reduction of air pollution from automobiles and improvement of fuel efficiency in Beijing (China, May 2016 to	Done	No interest (Business

No.	Technology / Product	Company	Experience of Collaboration Program	Contact	Response
			June 2018)		development in Uganda is unplanned)
4-2	Retrofit cassette type DPF Mocobee CT	COMOTEC CO., LTD	Survey on the black smoke reduction plan by DPF of diesel route bus in Ulaanbaatar (Mongolia, September 2015 to November 2016) Dissemination and demonstration project on black smoke reduction plan by DPF of diesel route bus (Mongolia, November 2017 to September 2019)	Done	No interest (overseas business development is unplanned)
4-3	Lithium-ion battery	ITSEV Electric Vehicle Technology Company	Survey on urban air quality improvement projects using lithium-ion batteries suitable for high temperatures (India, 19 July 2019 to 30 June 2020)	—	—
4-4	Electric motorcycle	Joint venture of Terra Motors Corporation and Quantum Leap Co., Ltd.	Survey on Electric Motorcycle Sales Business (Promotion of SME Collaboration) (Vietnam, September 2012 to February 2013)	Unnecessary	—
4-5	Electric tricycle (E-trike)	Terra Motors Corporation	Project-based survey for solving traffic problems in Dhaka metropolitan area using electric three-wheeled vehicles (E-trike) (Bangladesh, February 2016 to August 2017)	Done	No interest
4-6	Electric three-wheeled vehicle (E-tricycle) Urban transportation system	BEMAC Corporation	Dissemination and demonstration project for electric three-wheeled vehicle (E-tricycle) urban transportation system to reduce environmental load (Philippines, March 2016 to June 2019)	—	—
4-7	Medium-sized EV bus	PUES Corporation	Survey on development and dissemination of medium-sized EV buses (Malaysia, October 2014 to October 2015)	Done	No interest (Business development in Africa is unplanned)
4-8	Medium-sized electric bus system for low-emission public transportation	PUES Corporation	Dissemination and demonstration project for medium-sized electric bus system for low-emission public transportation (Malaysia, September 2016 to September 2021)	Unnecessary	—

No.	Technology / Product	Company	Experience of Collaboration Program	Contact	Response
4-9	Hybrid route bus	Hino Motors, Ltd.	Hybrid route bus promotion project (Thailand, May 2018 to June 2019)	—	—
4-10	Strengthening of automobile inspection and maintenance system	Anzen Motor Co., Ltd.	Survey on project development to strengthen automobile inspection and maintenance system (India, March 2020 to February 2022)	—	—
4-11	Dissemination and demonstration of vehicle inspection equipment for strengthening the operation capacity of the vehicle inspection system	Joint venture of Anzen Motor Co., Ltd. and Omori Shokai Co., Ltd.	Dissemination and demonstration project for vehicle inspection equipment aimed at strengthening the operational capacity of the vehicle inspection system (Myanmar, April 2017 to May 2019)	—	—
4-12	Permanent magnet type oil filter for automobile engine	Joint venture of Takabayashi Industry Co., Ltd. and TAGEN TECX Co., Ltd.	Survey on air pollution, energy saving, and global warming countermeasures using permanent magnet oil filters for automobile engines (Thailand, 2020-)	Done	Interested
Software measures					
5-1	Technology for traffic data utilization analysis for integrated transportation system	Joint venture of Hitachi, Ltd. and East Nippon Expressway Co., Ltd.	Dissemination, demonstration and commercialization project for technology of transportation data utilization analysis for integrated transportation system (Peru, 2019)	Done (Hitachi, Ltd.)	No interest
5-2	Traffic control system maintenance and management technology	Sumitomo Electric Industries, Ltd.	Dissemination promotion project for traffic control system maintenance and management technology to improve traffic jam in Bangkok (Thailand, July 2015 to July 2016)	Done	No interest
5-3	Traffic flow simulation technology for road planning	Joint venture of Hitachi, Ltd. And Hitachi, Ltd.	Project for promoting traffic flow simulation technology for formulating road plans in Yangon City (Myanmar, September 2014 to March 2015)	Done (Hitachi, Ltd.))	No interest
5-4	Public transport bus ICT	NEC Corporation	Promotion Project for Ho Chi Minh City Public Transport Bus ICT (Vietnam, August 2015 to September 2016)	Done	No interest
5-5	System for public transportation information provision	Hitachi, Ltd.	Dissemination promotion project for system of public transport information provision (India, October 2017 to March 2018)	Done	No interest
5-6	Bus management and	Joint venture of Michinori	Project for promoting bus management and operation know-how	Not yet	

No.	Technology / Product	Company	Experience of Collaboration Program	Contact	Response
	operation knowhow	Holdings, Inc. and Industrial Growth Platform, Inc	(Vietnam, December 2018 to February 2020)		
5-7	ITS business that contributes to traffic jam measures	Joint venture of Mitsubishi Heavy Industries, Ltd. and Mitsubishi Research Institute, Inc.	ITS Business Preparatory Survey (PPP Infrastructure Project) that Contributes to Jakarta Congestion Countermeasures (Indonesia, November 2013 to March 2015)	Done (Mitsubishi Heavy Industries, Ltd))	No interest
5-8	Project for transportation and urban structure maintenance	Nikken Sekkei Civil Co., Ltd., Nikken Sekkei Co., Ltd., Nikken Sekkei Research Institute Co., Ltd., Oriental Consultants Co., Ltd., Tokyu Land Corporation	Project Preparatory Survey (PPP Infrastructure Project) for Jakarta Transportation and Urban Structure Improvement Modeled on the Area Around Duquatas Station (Indonesia, December 2011 to March 2013)	Not yet	

Source: JST

Regarding (2), the table below shows the results organized by the survey in Japan and Uganda utilizing the local expert.

Table 4.5.3 Products and Services that Contribute to Improving the Air Quality of Ugandan Companies

Product / Service	Company	Outline
Electric motorcycle	Feiying Electric Vehicles Uganda	The company sold the first electric motorcycle in Uganda in 2016. In partnership with China's sister company Liu Zhou KENAIER Vehicle Industry, it manufactures electric bicycles that can be assembled in Uganda.
	Bodawerk International Ltd.	The company conducts research and development, manufacturing, sales and repair of electric motorcycles, agricultural machinery, and wheelchairs. They are also focusing on the renewable energy field such as solar power generation.
	Yamaha Uganda Ltd.	A local subsidiary of Yamaha Corporation that manufactures and sells motorcycles, generators, outboard motors, etc. They are promoting sales of electric motorcycles.
	Zembo	The company name is derived from "Zero Emission Motorcycle Boda", which is an electric motorcycle startup founded in 2019. They manufacture and sell electric motorcycles.
Import and sale of used cars	3WM Uganda Ltd.	A used car importer and distributor headquartered in Nagoya, it established a local subsidiary in Uganda in 2012. It imports and sells trucks and electric motorcycles, repairs used cars, etc., and is interested in the spread of electric motorcycles.
Cooking stove	Supa Sigiri	An improved cooking stove that was encouraged to be used in the Project for Uganda Clean Cooking Supply Chain Expansion carried out by the Private Sector Foundation Uganda (PSFU). It is designed to cook faster than ordinary cooking stoves used in households.
Energy (gas / oil)	Total Uganda Ltd.	It is an oil and gas procurement and supplier founded in 1955. They sell gas cylinders, but these are more expensive than biomass fuel and demand is limited.
	Shell Uganda	A company responsible for the procurement, distribution, sales, and supply of fuel (mainly lubricating oil) founded in 1953. It has a network of more than 2,100 service stations in 23 African countries and exports lubricants to other African countries.

Source: JST prepared based on each company's website and interview survey

In addition, Table 4.5.4 summarizes the interest in Business Matching Workshop and Ideathon confirmed through questionnaire responses and interview survey. The JST regularly discussed and exchanged information with these Japanese companies for the introduction of their technology and products at the Workshop.

Osaka Gas Co., Ltd. and HORIBA, Ltd. responded that they could participate in the workshop online, but Rinnai Corporation indicated that it would participate if there was a high possibility of cooperation with local gas supply companies. Therefore, the JST visited a gas supply company (Total Uganda Ltd.) and requested participation in the second field survey, but the company declined to participate in the Workshop. As a result, Rinnai Corporation declined to participate in the Workshop.

Table 4.5.4 Interest in Workshop and Ideathon of Each Company (Air Pollution Sector)

No.	Company	Technical Field	Interest	Presentation	Ideathon	Business Trip
1	Osaka Gas Co., Ltd.	Air purification	○	○	○	×
2	HORIBA, Ltd.	Air quality monitoring	○	○	○	×
3	Rinnai Corporation	Gas stove	○	○	○	×

Source: JST

(2) Possibility of Cooperation

The technologies of the companies that have interest are as shown in Table 4.5.4. According to the field survey, the air pollution managers of MoWE and NEMA, and the professor of Makerere University participating in the AirQo Project are interested in Japanese technology (air purification equipment of Osaka Gas Co., Ltd. and air quality monitoring equipment of HORIBA, Ltd.). In addition, at the Business Matching Workshop, the technologies of both companies were introduced, and a question and answer session was held with the participants on the Ugandan side. In the future, it is important to make adjustments to promote cooperation while grasping the needs of both parties.

4.5.4 Possibility of External Fund Utilization (PPP)

Financing private companies is important for promoting air pollution control in Kampala. The JICA Uganda Office is providing support to local startups and expects to collaborate with startups that will contribute to solving air pollution problems. Therefore, it is important to collect information on the companies listed in Table 4.5.3 and examine the applicability of JICA's scope.

In addition to this, the JST will also consider the feasibility of the project for companies considering expansion to Uganda, centering on the Japanese companies listed in Table 4.5.4, by utilizing SDGs business support survey.

4.5.5 Problems, Needs and Priorities Related to Cooperation with Donors and Neighboring Countries

From the results of the web interviews with each donor, there is a possibility of cooperation between UNEP and WB in air pollution. In particular, UNEP is implementing support for air pollution improvement for KCCA to formulate CCAP, and from the perspective of strengthening air monitoring capacity (spreading of measuring equipment, expansion of monitoring network, human resource development, etc.), and there is a possibility of cooperation with JICA's project. Therefore, it is important to collect information from UNEP, but JST has not been in contact with UNEP as of October 2021. Also, WB has experience in supporting the AirQo Project and other countries (South Africa), and it is thought that they are interested in air pollution measures in Africa. Therefore, the JST will consider the possibility of future cooperation.

On the other hand, compared with the urban water supply sector, the problem is that there are few donors who have or plan to implement support projects in Uganda and African countries, and cooperation with JICA may be limited.

CHAPTER 5. Results of the Workshop and Seminar

5.1 Business Matching Workshop

The workshop was held to share the results obtained from this survey and seek the business matching between Japanese companies and Ugandan counterpart agencies. It was held in different conference rooms for urban water supply and air pollution sectors in a hotel in Kampala City. The numbers of participants in workshop were 57 persons and 33 persons for the urban water supply and air pollution sectors, respectively, including the Japan International Cooperation Agency (JICA) Survey Team, JICA officials, and online participants. Considering the impact of the coronavirus-19 (COVID-19) and opinion of counterpart agencies, the main members in the counterpart agencies and operation staff (15 persons and 25 persons, respectively, for the urban water supply and air pollution sectors) assembled in the hotel and the webinar style meetings with online participation by local counterpart staff and Japanese participants were also utilized.

5.1.1 Urban Water Supply Sector

(1) Participants and Program

The invitees to the workshop and participants were the Ministry of Water and Environment, National Water and Sewerage Corporation (NWSC), other concerned agencies and donors, and Japanese companies. Table 5.1.1 shows the workshop program and the brief of participants for the urban water supply sector. Due to the restricted number of participants at the hotel venue, many NWSC staff members gathered in the large conference room of the NWSC IREC office, so it was connected to the venue via the internet. The companies in Japan that are unable to travel to Uganda were interconnected online to the workshop if they applied to participate in the workshop beforehand. As a result, a total of 58 persons participated with 15 persons in the hotel venue and 43 persons who participated online. A detailed list of attendees is shown in Appendix-4. In addition, the presentation materials by each presenter are shown in Appendix-5.1.

Table 5.1.1 Workshop Program – Urban Water Supply

Title: Uganda-Japan Business Matching Workshop (Webinar Style)
Date and Time: 30 September 2021 (Thursday) 10:00 – 16:00 * 16:00-22:00 (JPT)
Host: Japan International Cooperation Agency (JICA)
Co-Host: National Water and Sewerage Corporation (NWSC)
Venue: Golden Tulip Canaan Kampala, Luwero Conference Room
Facilitator: Dr. Martin Kalibbala (NWSC Asset Management Kampala) and the JICA Survey Team

Program:

10:00 – 13:00 (Morning Session) * 16:00-19:00 (JPT)

(1) 10:00-10:10 Common for Water Supply and Air Pollution * shown on the screens

10:00 Opening remarks and explanation of the objectives by the JICA Uganda Office (5 minutes)

10:05 General explanation of the venue and program by the JICA Survey Team (5 minutes)

(2) 10:10-13:00 Urban Water Supply

10:10 Speech by JICA Uganda staff in charge of water (5 minutes)

10:15 Presentation by NWSC (expectation for Japan and advanced technologies) (15 minutes)

10:30 Presentation by the JICA Survey Team on the results of the survey on the current issues in the urban water supply sector, possibilities for cooperation with private companies (30 minutes)

11:00 Presentation by the Japanese companies (20 minutes incl. Q&A x 6 companies)

11:00 SCADA System & Water Loss Management System (Yokogawa Solution Service)

11:20 Pressure Sustaining Valve (PSV) System (Kane Kogyo)

11:40 Utilization of Ultrasonic Flow Meters for NRW Control (Tokyo Keiki)

12:00 Water Leakage Detection Equipment (Goodman)

12:20 Ultra-High-Speed Chemical-Free Water Treatment System (Nagaoka)

13:00 - 14:00

Lunch and exchange of opinions (※Stand-up meal in the space between Victory Hall and Luwero, and to be seated at the round tables in Victory Hall)

14:00 - 16:00 (Afternoon Session) * 20:00-22:00 (JPT)

14:00-15:00 Introduction of products in the urban water supply sector through presentations by the Japanese companies

14:00 Water Treatment and Remote Monitoring System for Urban Water Supply (Mitsubishi Chemical Aqua Solutions)

14:20 Mobile Ceramic Membrane Water Supply (Metawater)

14:40 Water Leak Detection Devices and Pipe Locators (Fuji Tecom Inc.)

15:00 Business matching between public (including NWSC) and Japanese companies at each booth through live streaming

15:55 Closing remarks by NWSC representative (5 minutes)

Participants: * inside ( ) is the number of participants

Operation members in the hotel:

NWSC (ES/IREC 1, HQ 2, Kampala Water 6) (9)
JICA-related persons: JICA Uganda (2), JICA Survey Team (4)
(**15 persons in total**)
NWSC IREC/Online participants:
Ministry of Water and Environment (1), NWSC HQ, Kampala Water, Regional (21)
VEI (1), NGO (1)
Japanese companies (19)
(**43 persons in total**)

Source: JST

(2) Outline of Workshop Results

1) Opening Speech and Explanation of the Objectives by JICA Uganda Office

Mr. Fukuhara, Senior Representative of JICA Uganda Office, explained the background of conducting this survey in response to the current water supply situation and air pollution situation in Uganda and the Kampala Metropolitan Area. He mentioned that they expect the lively discussions by many stakeholders at this workshop and Ideathon.

2) Speech by JICA Uganda Staff in charge of Water

The JICA Uganda Office's Ms. Kaweesa Mariam, Assistant Programme Officer for Water Sector, introduced that JICA has been implementing various projects in cities and rural areas to help improve access to safe water not only in Uganda but also in many developing countries around the world.

3) Presentation by NWSC on Expectation for Japan and Advanced Technologies

Mr. Kaford of NWSC External Service made a presentation on themes such as (1) Development plan for water services by the Government of Uganda and NWSC, (2) Capacity development and infrastructure development projects for staff by NWSC, (3) Major issues such as current lack of funds, and (4) Expectation of technical cooperation such as measures for non-revenue water.

4) Presentation by the JICA Survey Team on the Results of the Survey

The JICA Survey Team explained the outline of the survey results in the Kampala Metropolitan Area and local cities, the draft aid policy, and the possibility of cooperation with the private sector and other donors.

5) Presentation by Japanese Companies

Eight Japanese companies which were shown in the program above introduced their products.

1. SCADA System & Water Loss Management System (WLMS)

Yokogawa Solution Service explained the company, SCADA system and water loss management system, and system introduction cases in Metro Cebu, Philippines.

2. Pressure Sustaining Valve (PSV) System

Kane Kogyo introduced the company, technology of the PSV system, a case study in Sri Lanka, and the effect of the system by video.

3. Utilization of Ultrasonic Flow Meters for NRW Control

Tokyo Keiki introduced the utilization of ultrasonic flow meters for non-revenue water control and the monitoring system.

4. Water Leakage Detection Equipment

Goodman Inc. introduced their products such as 1) a new water leakage detector (Hydro-Tracer) using a compact generator of hydrogen and nitrogen (tracer gas), 2) PVC pipe leakage detector, 3) amplifier for listening rod, and 4) PVC pipe leak stopper tape.

5. Ultra-High-Speed Chemical-Free Water Treatment System

Nagaoka introduced the water intake screen technology, the ultra-high-speed chemical-free water treatment system "Chemiles", and a case study when these technologies would be introduced in the Mityana City.

6. Water Treatment and Remote Monitoring System for Urban Water Supply

Mitsubishi Chemical Aqua Solutions introduced an on-site water treatment system using ultrafiltration (UF) membranes and a remote monitoring system (WeLLDAS) for raw water turbidity, water treatment plants, and groundwater level.

7. Mobile Ceramic Membrane Water Supply

METAWATER introduced the company, packaged ceramic membrane filtration device, and mobile ceramic membrane filtration equipment.

8. Water Leak Detection Devices and Pipe Locators

Fujitecom explained the outline of leak investigation procedure, devices for locating underground pipeline, water flow / pressure measuring devices, and leak detection devices.

6) Business Matching between Public and Japanese Private Companies at Each Booth through Live Streaming

Six Japanese companies below conducted questions and answers (Q&A) and business talks with local organizations such as NWSC as an online virtual booth. Almost all companies had visitors, and Q&A sessions were held. The questions received by each company and outline of their answers are shown in Appendix-6.

Table 5.1.2 Japanese Companies who Opened Online Virtual Booths

No.	Company	Product
1	Yokogawa Solution Service	SCADA, WLMS
2	Kane Kogyo	PSV System
3	Tokyo Keiki	Ultrasonic Flow Meters
4	Goodman	Leak Detectors
5	Fuji Tecom	Leak Detectors, Pipe Locators
6	Mitsubishi Chemical Aqua Solutions	On-site Treatment System Remote Monitoring System

Source: JST

7) Closing Speech by NWSC Representative

Dr. Frank Kizito, Asset Management Department of NWSC Kampala Water, summarized the business matching workshop. He expressed his gratitude for selecting and introducing the technical fields required by NWSC.

8) Sceneries in Workshop

The sceneries of the above contents are shown in Figure 5.1.1.

Photo 5.1.1 Workshop Venue

Photo 5.1.2 Online Distribution

Photo 5.1.3 Presentation by NWSC

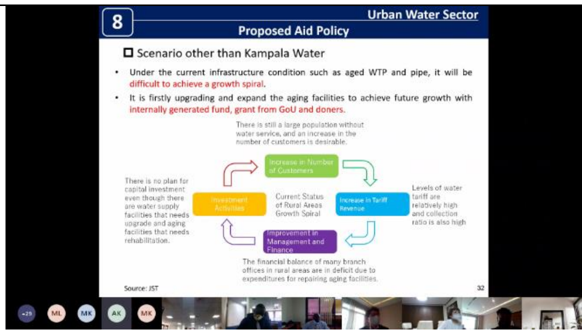


Photo 5.1.4 Presentation by JST

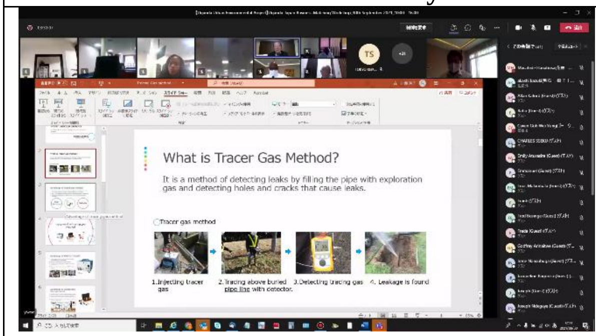


Photo 5.1.5 Presentation by the Japanese Companies

Photo 5.1.6 Q&A in Business Matching (Virtual Company Booth)

Source: JST

Figure 5.1.1 Sceneries in the Business Matching Workshop for the Urban Water Supply Sector

5.1.2 Air Pollution Sector

(1) Participants and Program

There were 33 participants from the Ministry of Water and Environment, NEMA, other related organizations, and Japanese / Ugandan private companies. Table 5.1.3 shows the workshop program and the brief of participants for the air pollution sector. The JICA Survey Team solicited participation requests from Japanese companies that could not travel to Uganda in advance and distributed the workshop online. A detailed list of attendees is shown in Appendix-4. In addition, the presentation materials by each presenter are shown in Appendix-5.2.

Table 5.1.3 Workshop Program – Air Pollution

Title: Uganda-Japan Business Matching Workshop (Webinar Style) Date and Time: 30 September 2021 (Thursday) 10:00 - 16:00 * 16:00-22:00 (JPT) Host: JICA Co-Host: MoWE Venue: Golden Tulip Canaan Kampala (Asmara Conference Room (10F)) Facilitator: JICA Survey Team
Program: 10:00 - 13:00 (Morning Session) * 16:00-19:00 (JST) 1) 10:00 - 10:10 Common for Water Supply and Air Pollution * shown on the screens 10:00 Opening remarks and explanation of the objectives by Mr. Ichiro Fukuhara, Senior Representative, JICA Uganda Office (5 minutes) 10:05 General explanation of the venue and program by Ms. Margaret Namagera, JICA Survey Team (5 minutes) 10:10 - 13:00 Air Pollution 2) 10:10 Message by Mr. Yuki Inoue, Representative, JICA Uganda Office (5 minutes) 3) 10:15 Presentation by Mr. Shunichi Okahisa, JICA Survey Team for outline of the survey and current issues in air pollution (15 minutes) 4) 10:30 - 11:30 Presentation by Ugandan side (each 15 minutes) 10:30 Ministry of Water and Environment (MoWE): Current status of air pollution in Uganda, expectation for the Japanese companies (Presentation by Mr. Mununuzi Nathan, Senior Environment Officer) 10:45 National Environmental Management Authority (NEMA): Current status of laws regulations, monitoring in air pollution in Uganda (Presentation by Ms. Kutesakwe Jennifer, Senior Environment Inspector)

11:00 Ministry of Health (MoH): Current status of health effects from air pollution in Uganda (Presentation by Mr. Fred Mulabya, Principal Environmental Health Officer)

11:15 *Q&A session* (15 minutes)

11:30 *Break* (10 minutes)

5) 11:40 - 13:00 Presentation of products and technology that contribute to air pollution control by the Japanese companies (25 minutes each)

11:40 Osaka Gas Co., Ltd. (ACF Air Purification Unit), Presentation by Mr. Masaaki Yoshikawa, Manager of Energy Technology Laboratories

12:05 *Q&A session (*15 minutes)

12:20 HORIBA, Ltd. (Air Quality Monitoring Equipment), Presentation by Mr. Leo Yasukawa, Representative of International Sales Dept.

12:45 *Q&A session* (15 minutes)

13:00 - 14:00 *Lunch,* exchange of opinions

14:00 - 16:00 (Afternoon Session) * 20:00-22:00 (JST)

6) 14:00 - 15:00 Presentation by Ugandan side (15 minutes each)

14:00 Ministry of Energy and Mineral Development (MoEMD): Activities and efforts for air pollution (Presentation by Mr. Birimumaso David C.E.A, Senior Energy Officer)

14:15 Kampala Capital City Authority (KCCA): Current status of air pollution in Kampala (Presentation by Mr. Alex Ndayabakira, Epidemiologist of Directorate of Public Health and Environment)

14:30 AirQo Project: Air quality monitoring system in Kampala (Presentation by Mr. Deo Okure, Air Quality Scientist and Programme Manager)

14:45 *Q&A session* (15 minutes)

7) 15:00 - 15:55 Presentation of products and technology that contribute to air pollution control by local companies (20 minutes each)

15:00 Bodawerk International Ltd. Presentation by Mr. Jakob Hornbach, CEO

15:20 Zembo Online Presentation by Ms. Moreen, staff * Absent due to urgent work

15:40 *Q&A session* (15 minutes)

8) 15:55 Closing remarks by Mr. Mafumbo Julius, Assistant Commissioner, MoWE

Participants (Assumption)
Participants (Hotel):
MoWE (3), NEMA (3), MoH (4), MoWT (2), MoERD (1), KCCA (1), AirQo Project (2)
JICA Uganda (1), JICA Survey Team (2), Bodawerk (3), UMA(1), Makerere Univ. (2)
(**25 persons in total**)
Participants (Online):
JICA Survey Team (1), Japanese companies (7)
(**33 persons in total**)

Source: JST

(2) Outline of Workshop Results

1) Opening Speech and Explanation of the Objectives by JICA Uganda Office

As a common program with the urban water supply sector, Mr. Fukuhara, Senior Representative of JICA Uganda Office, explained the background of conducting this survey in response to the current water supply situation and air pollution situation in Uganda and the Kampala Metropolitan Area. Attendees in the air pollution sector watched from a monitor at another venue.

2) Opening Speech by JICA Uganda Staff in charge of Air Pollution

Mr. Inoue of JICA Uganda Office explained the background and significance of this survey, the purpose of this workshop, and the expected results for the Ugandan attendees. He also mentioned his expectations for future public-private partnerships in JICA Uganda Office.

3) Presentation by the JICA Survey Team on the Results of the Survey

The JICA Survey Team explained about the overall outline and survey method of this survey, the main issues clarified through the survey (organizational structure, environmental policy, monitoring (ambient air / exhaust gas), and air pollution countermeasures (vehicle sources / fixed sources)). In particular, the JICA Survey Team emphasized the importance for related ministries and organizations to continuously discuss with JICA to identify priority issues while considering the urgency, importance, and validity of existing issues in deciding the future support policy.

4) Presentation by Ugandan Ministries and Organizations

1. MoWE

Mr. Mununuzi Nathan, Senior Environment Officer, explained about MoWE's efforts, the current state of air pollution in Kampala, and the expectations of Japanese companies for technical development in Uganda.

2. NEMA

Ms. Kutesakwe Jennifer, Senior Environment Inspector, explained about NEMA's responsibilities related to air pollution control, the current status of the process of formulating air quality standards and regulations, NEMA's future efforts, and technical support items from donors in the air pollution sector.

3. MoH

Mr. Fred Mulabya, Principal Environmental Health Officer, explained about the health effects of air pollutants, countermeasures, and future MoH efforts (improvement of indoor air pollution, improvement of public health awareness, etc.).

4. MoEMD

Mr. Birimumaso David CEA, Senior Energy Officer, explained about the contribution to energy consumption and air pollution in Uganda and MoEMD's efforts (improvement of transportation system, promotion of electric motorcycles and electric vehicles, improvement of fuel for transportation, etc.).

5. KCCA

Mr. Alex Ndayabakira, Epidemiologist, explained about KCCA's responsibility for air pollution control, air pollution status (change of $PM_{2.5}$ concentration), issues in Kampala City, and KCCA's efforts (climate change action plan, clean air action plan, improvement of traffic, etc.).

6. AirQo Project

Mr. Deo Okure, Air Quality Scientist and Program Manager, explained the air quality monitoring status by AirQo Project, data disclosure to the website, current issues, and future activity plans.

5) Presentation by Japanese Companies

1. Osaka Gas Co., Ltd.

Osaka Gas Co., Ltd. explained about the business outline, the features of air purification equipment using activated carbon filter (ACF), the effect of removing air pollutants, and installation examples in Japan and Indonesia.

2. HORIBA Ltd.

HORIBA, Ltd. explained about the business outline, features of air quality monitoring equipment, overseas expansion status, importance of operation and maintenance, and points to keep in mind when installing in Uganda.

6) Presentation by Local Companies

The CEO of Bodawerk International Ltd. explained about the business outline and products that contribute to air pollution control and energy saving (electric motorcycles, electric tractors, etc.).

7) Closing Speech by MoWE Representative

Mr. Mafumbo Julius, Assistant Commissioner of MoWE, summarized the business matching workshop. In particular, it was stated that it is important for related ministries, organizations, and private companies to work together to promote air pollution control measures in Uganda.

8) Sceneries in Workshop

The sceneries of the above contents are shown in Figure 5.1.2.

Photo 5.1.7 Workshop Venue

Photo 5.1.8 Opening Remarks by JICA

Photo 5.1.9 Presentation by the JST

Photo 5.1.10 Presentation by MoWE

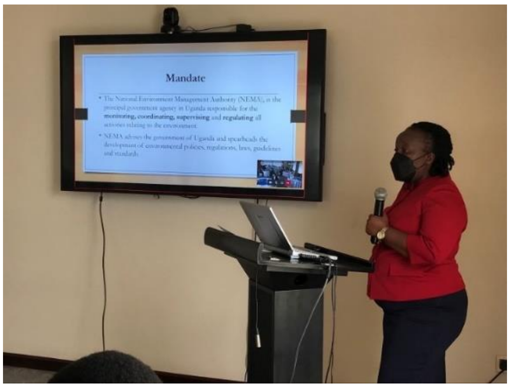


Photo 5.1.11 Presentation by NEMA

Photo 5.1.12 Presentation by MoH

Photo 5.1.13 Presentation by MoEMD

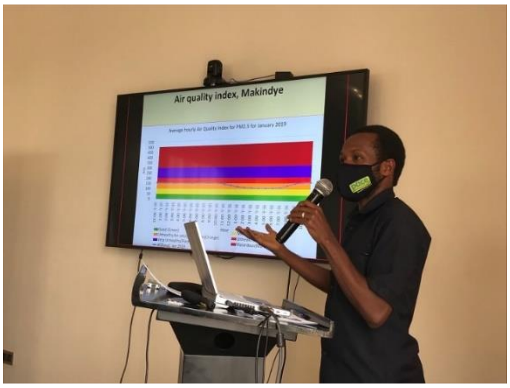


Photo 5.1.14 Presentation by KCCA

Photo 5.1.15 Presentation by AirQo Project

Photo 5.1.16 Presentation by Osaka Gas Co., Ltd

Photo 5.1.17 Confirmation of Osaka Gas's ACF Unit Sample

Photo 5.1.18 Presentation by HORIBA, Ltd.

Photo 5.1.19 Presentation by Bodawerk

Photo 5.1.20 Closing Remarks by MoWE

Source: JST

Figure 5.1.2 Sceneries in the Busines Matching Workshop for the Air Pollution Sector

5.2 Public-Private Joint Ideathon

A seminar, namely, "Public-Private Joint Ideathon", was held to encourage new ideas and to form a Public-Private Joint Action Plan after identifying the sector where PPP and innovative approaches are expected through the Survey. It was held in the next day of the business matching workshop above and the venues will be separated for the urban water supply sector and the air pollution sector. The numbers of participants in the ideathon were 46 and 24 persons for the urban water supply sector and air pollution sector, respectively, including the JICA Survey Team, JICA officials, and online participants.

Start-up companies introduced by JICA Uganda Office were included as target companies. As it is desirable to have a wide variety of members participating in the Ideathon, the preliminary invitations were sent to universities, NGOs, etc., after consultation with counterparts on which organizations should be invited. The themes of Ideathon were three (groups) for each sector and each theme (group) discussed about 3 to 6 agendas after coordination with the major counterparts.

5.2.1 Urban Water Supply Sector

(1) Participants and Program

Table 5.2.1 shows the program and attending organizations for the Public-Private Joint Ideathon in the urban water supply sector. A total of 46 persons participated, including online participants. A detailed list of attendees is shown in Appendix-4. In addition, the presentation materials by each presenter in the morning section are shown in Appendix-5.1. Group discussion was divided into three groups: Group 1: NRW Reduction and Improvement of O&M and Implementation Regime, Group 2: Improvement of Kampala Water Supply (WTP, PPP), and Group 3: Urban Water Supply in Local Areas Outside Kampala. After preparing the Action Plans with current issues and countermeasures, each leader gave an explanation at the end of the afternoon.

Table 5.2.1 Public-Private Joint Ideathon Program – Urban Water Supply

Title: Ideathon “Japan×Uganda, Private×Public, Jointly Creating Uganda's Urban Environment” (tentative) (Webinar Style)

Date and Time: 1 October 2021 (Friday) 10:00- 16:00 * 16:00-22:00 (JPT)

Host: Japan International Cooperation Agency: (JICA)

Co-Host: National Water and Sewerage Corporation (NWSC)

Venue: Golden Tulip Kampala, Luwero Conference Room

Facilitator: Dr. Martin Kalibbala (NWSC Asset Management Kampala) and JICA Survey Team

Program:

10:00 - 13:00 (Morning Session) * 16:00-19:00 (JPT)

(1) 10:00-10:10 Common for Water Supply and Air Pollution * shown on the screens

10:00 Explanation of the objective by Mr Yuki Inoue, Representative, JICA Uganda Office (5 minutes)

10:05 General explanation of the program by the JICA Survey Team (5 minutes)

(2) 10:10-13:00 Urban Water Supply

Theme: Improving Water Supply in Uganda's Cities

10:10 Summary of the outcomes in previous business matching workshop and explanation of Ideathon topics by the JICA Survey Team (10 minutes)

10:20 Introduction of the water production and supply situation by NWSC Kampala Water representative (10 minutes) Engr. Mahmood Lutaaya, General Manager, Kampala Water, NWSC

10:30 Introduction of the non-revenue water and asset management situation by NWSC Kampala Water representative (10 minutes) Engr. Godfrey Arinaitwe, Senior Manager, NRW Management, Kampala Water, NWSC

10:40 Introduction of the water supply situation of NWSC local areas (10 minutes) Engr. Julius Kato, Principal Engineer, Operations Dept., NWSC

10:50 Coffee Break

11:00 Group discussion and work: Challenges of Uganda's urban water supply summarized by the participants

Group 1: NRW Reduction and Improvement of O&M and Implementation Regime

Group 2: Improvement of Kampala Water (WTP, PPP)

Group 3: Urban Water Supply in Local Areas Outside Kampala

13:00 - 14:00

Buffet-style lunch in restaurant space

14:00 - 16:00 (Afternoon Session) * 20:00-22:00 (JPT) 14:00-15:10 Group discussion and work: Joint public-private action plan created by the participants 15:10 Coffee break 15:20 - 16:00 (Conclusion) 15:20 Presentation by each group and exchange of opinions (10 minutes x 3 groups) Group 1: Engr. Godfrey Arinaitwe, NRW Dept., NWSC Group 2: Engr. Mahmood Lutaaya, General Manager, KW, NWSC Group 3: Engr. Julius Kato, Principal Engineer, Operations Dept., HQ, NWSC 15:50 Closing remarks by NWSC Representative
Participants Participants in the Hotel: NWSC (ES/IREC 1, HQ 2, Kampala Water 7) (10) JICA related persons: JICA Uganda (1), JICA Survey Team (4) (**15 persons in total**) Online participants: Ministry of Water and Environment (1), NWSC (ES/IREC, HQ, Kampala Water, local cites) (22), World Bank Uganda Office (1), AfDB Uganda (1), NGO (1) Japanese companies (5) (**31 persons in total**)

Source: JST

(2) Outline of Ideathon Results

1) Explanation of Group Discussion Program and Agendas by the JICA Survey Team

The survey team explained the proposed individual themes for discussions in each group. The themes of the three groups were organized under the following major categories. The sub classifications and agendas were reviewed at the start of each group discussion.

Group 1: NRW Reduction and Improvement of O&M and Implementation Regime

1. Understanding and organization of current situation
2. Best practices of technical countermeasures to achieve the target NRW rate in other countries
3. Actions on infrastructure development to cope with physical loss
4. Actions for commercial loss
5. Economic/financial, organizational aspect

Group 2: Improvement of Kampala Water Supply (WTP, PPP)

1. Historical and current situation and issue of Kampala water region
2. Improvement of management, operation and maintenance of facilities
3. Investment requirement for new expansion, upgrade, replacement
4. Capacity development
5. Commercial revenue

Group 3: Urban Water Supply in Local Areas Outside Kampala

1. General situation
2. Best practice for regional area development
3. Infrastructure development
4. How to reduce NRW in small towns
5. Investment requirement
6. Capacity building

2) Introduction of the Water Production and Supply Situation by NWSC Kampala Water Representative

Engr. Mahmood Lutaaya, General Manager, Kampala Water, NWSC, introduced the water production and supply situation in Kampala Metropolitan Area.

3) Introduction of the Non-revenue Water and Asset Management Situation by NWSC Kampala Water Representative

Engr. Godfrey Arinaitwe, Senior Manager, NRW Management, Kampala Water, NWSC, introduced the issues of non-revenue water and asset management, and status of conducting their countermeasures.

4) Introduction of the Water Supply Situation of NWSC Local Areas

Engr. Julius Kato, Principal Engineer, Operations Dept., NWSC, introduced the current status of water production and supply particularly in Tororo and Soroti cities.

5) Group Discussions and Preparation of Action Plans

The discussions were conducted in three groups, namely, Group 1: NRW Reduction and Improvement of O&M and Implementation Regime, Group 2: Improvement of Kampala Water Supply (WTP, PPP), and Group 3: Urban Water Supply in Local Areas Outside Kampala. At least one member from the JICA Survey Team joined each group and facilitated and took notes of the discussions. The Action Plans were prepared by the members in each group as shown in Appendix 7.1.

6) Presentation by Each Group

The group leaders of each group made presentations of the Action Plans. The outlines of the Action Plans are summarized below.

Group 1: NRW Reduction and Improvement of O&M and Implementation Regime

Short-term Plan (5 Years): Reduce NRW rate to 33% or less

Long-term Plan (10 Years): Reduce NRW rate to 30% or less

The outline of the focus areas and the activities and requirements are shown in Table 5.2.2.

Table 5.2.2 Outline of Action Plan – Urban Water Supply Sector Group 1

No.	Focus Area	Short Term: 5 Years (NRW < 33%)	Long Term: 10 Years (NRW < 30%)
1	Creation of District Metered Areas (DMAs)	50 DMA	200 DMA
2	Prioritized replacement of aged and vandalized/detective customer meters	100,000 nos.	400,000 nos.
3	Procurement of leak detection equipment and establishment of leakage control activities	Procurement: Leak Correlators 12 nos. etc.	Need for replacement
4	Creation and monitoring of pressure managed areas with pressure control valves	Priority 30 Areas PRVs, PSVs etc.	Priority 100 Areas PRVs, PSVs etc.
5	Introduction of telemetric system for flow and pressure controls within distribution network	20 Points	50 Points
6	Reinstatement of Automated Meter Reading (AMR) system for large consumer accounts	750 Large Accounts	1,500 Large Accounts
7	Prioritized network renewal of aged pipe sections with experienced frequent failures	10 km	100 km
8	Renewal and reinstatement of critical network fixtures	1,200 nos.	3,000 nos.

Source: NWSC, JST

Group 2: Improvement of Kampala Water Supply (WTP, PPP)

The points of discussions and action points in Group 2 are shown in Table 5.2.3.

Table 5.2.3 Outline of Action Plan – Urban Water Supply Sector Group 2

No.	Theme	Discussion Points	Action Points
1	Historical and current situation and issue of Kampala Water region (Integrated with improvement of management and O&M)	1) Deterioration of water quality in Lake Victoria 2) Three times Increase in chemical cost 3) Manual dosing of chemical in Gaba WTP 4) Challenge with distribution network 5) No big difference in water consumption per capita after Katosi WTP commissioning	1) Partnership with JICA for economical water treatment 2) Change chemical and technology to chlorine dioxide and use of oxidation 3) Automated dozers like stream current detectors 4) Expansion of distribution network with modern technologies like PSVs 5) Expand the network where growth of the city is going in the west, east, and north of Kampala
2	Investment requirement for new expansion, upgrade, replacement	1) Replacement of aging pumps and installation of new pipes at Gaba and Boosters in Kampala 2) Lack of flow and quality monitoring equipment in distribution network 3) Needs to upgrade laboratories (Type C, D to A, B) 4) O&M workshop machines and tools 5) Green technologies and equipment to reduce the energy consumption	1) Replace at least 6 pumps in Ggaba WTP, fitting with VFDs, pipe resizing to match the current and future water demand 2) Install online monitoring sensors and link with existing SCADA at Ggaba 3) Upgrade the labs for improved water quality monitoring across the country 4) Upgrade the Ggaba workshop machines and also regional workshop machines 5) Explore the use of solar street lighting for Ggaba plant complex and KW reservoirs and booster stations
3	Staff capacity development	1) Methods on maximizing the capacity of current staff 2) Proper equipping of existing training centers 3) Increase number of teachers and trainers in VTCs	1) Make use of VSDF and specialized training abroad for existing staff 2) Install training prototypes, equipment and tools to expand the scope of trainings offered in the established VSDF in Ggaba and across the regions 3) Training of Trainers to equip the VSDFs with sufficient trainers, Collaboration with other training institutions in the country and abroad
4	Commercial revenue	1) Arrears and PSP revenue 2) Spare parts to repair the faulty prepaid PSP 3) Prepaid PSPs not only for pro-poor but also for other group of large customers.	1) Increase of prepaid PSP with more investment funds from partners 2) Explore partnerships with local manufacturers or NWSC workshops 3) Funds to fast-track local manufacturing of prepaid meters by NWSC. PPP option would be best if opportunities come up.

Source: NWSC, JST

Group 3: Urban Water Supply in Local Areas Outside Kampala

The issues, status, and action plans which were discussed and prepared in Group 3 are shown in Table 5.2.4. The group discussed Tororo and Soroti cities which are the possible places for JICA's assistance.

Table 5.2.4 Outline of Action Plan – Urban Water Supply Sector Group 3

Issue	City	Current Status	Action Plan
1. General Situation			
Water treatment capacity	Common	Insufficient capacity	Upgrade the WTP
Water quality	Tororo	Poor due silt accumulation in the River Malaba	Construction of debris sieve
Water supply, pressure, NRW	Tororo	Lack of capacity, old pipes, inaccurate old meters, leaking reservoirs	Replace old AC and GI pipes Replacement of meters Replacement of reservoirs
GIS mapping, ledgers, asset management	Common	Lack of comprehensive asset management database	Update of GIS mapping Asset management software
Financial situation	Common	No breakeven situation	Minimize O&M cost
Investment from central government	Common	Unpredictable	Need for financial support
Specific activities by donor, NGO	Tororo	Majenje Project under GoU (production well)	Follow up team
	Soroti	ATWATSAN Project	Follow up team
2. Best Practice for regional area development			
Low-cost development	Common	Nothing	(Ensure most use of peak hours)
Financial flow from government/capital city	Common	GoU to NWSC	(Involvement of government)
3. Infrastructure Development			
Finding reliable water source	Tororo	Insufficient pumping capacity Seasonal river	Improve capacity of raw water pump, Adjustment of intake valves
	Soroti	Sufficient water source	Protection of catchment area
Expansion of facilities (WTP, network)	Common	Lack of existing WTP capacities	Need additional system Improve treatment process
Low-cost treatment or network development	Common	Conventional facility	Need to apply new technology
Optimization of distribution (pumping)	Common	Optimized with elevated reservoirs then by gravity	Installation of more booster stations
Distribution to remote area	Common	Partly inefficient distribution from central system	Need installation of more boreholes
PSPs (ordinal, prepaid)	Common	Post-paid PSPs available	Installation of prepaid meters
Possibility of PPP	Common	Not applied for a long time	Applicable to Headquarters administrative
4. Reduction of NRW			
Countermeasure for water theft	Common	1) Aged pipelines 2) Old meters	1) Replacement of old pipes 2) Meter replacement 3) Judiciary engagement
Reduction of arrears (water tariff setting appropriate?)	Common	Water tariff setting not appropriate	Monthly follow up of customers
5. Capacity Building			
Increase new staff for rapidly expanding area	Common	Use of temporary, graduate, and support staffs	1) Absorption of temporary and support staffs 2) Training of more graduate trainees
How to train the new staff (VTCs, etc.)	Common	NWSC has several training centres	Increase the number of centres

Source: NWSC, JST

7) Sceneries in Ideathon

The sceneries in the Ideathon are shown in Figure 5.2.1.

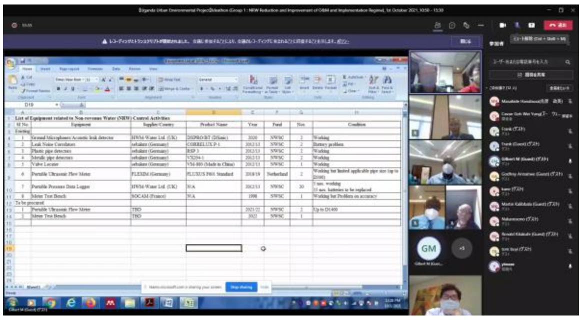


Photo 5.2.1 Venue of Ideathon	**Photo 5.2.2 During Online Discussion**

Source: JST

Figure 5.2.1 Sceneries in the Ideathon for the Urban Water Supply Sector

5.2.2 Air Pollution Sector

(1) Participants and Program

Table 5.2.5 shows the program and attending organizations for the Public-Private Joint Ideathon in the air quality sector. A total of 24 persons participated, including online participants. A detailed list of attendees is shown in Appendix-4. In addition, the presentation materials by each presenter in the morning section are shown in Appendix-7.2.

Table 5.2.5 Public-Private Joint Ideathon Program – Air Pollution

Title: Ideathon "Japan×Uganda, Private×Public, Jointly Creating Uganda's Urban Environment" (tentative) (Webinar Style) Date and Time: 1 October 2021 (Friday) 10:00- 16:00 * 16:00-22:00 (JPT) Host: JICA Co-Host: MoWE Venue: Golden Tulip Canaan Kampala (Asmara Conference Room (10F)) Facilitator: JICA Survey Team
Program: 10:00 - 13:00 (Morning Session) * 16:00-19:00 (JST) 1) 10:00 - 10:10 Common for Water Supply and Air Pollution * shown on the screens 10:00 Explanation of the objective by Mr. Yuki Inoue, Representative, JICA Uganda Office

(5 minutes)

10:05 General explanation of the program by Ms. Ruth Mubeezi Neebye, JICA Survey Team (5 minutes)

10:10 - 13:00 Air Pollution

2) 10:10 Summary of the outcomes in the Business Matching Workshop by Ms. Ruth Mubeezi Neebye, JICA Survey Team (5 minutes)

3) 10:15 - 13:00 Group discussion and preparation of presentation (1)

10:15 Explanation of how to proceed with the discussion by Mr. Shunichi Okahisa, JICA Survey Team (10 minutes)

10:25 Grouping, participation in Teams link, self-introduction, and division of roles (25 minutes)

10:50 *Break* (10 minutes)

11:00 Topic 1: Laws, Regulations and Standards Related to Air Pollution (40 minutes)

11:40 Topic 2: Air Quality Monitoring (40 minutes)

12:20 Topic 3: Air Quality Control and Measure (40 minutes)

13:00 - 14:00 *Lunch* and exchange of opinions

14:00 - 16:00 (Afternoon Session) * 20:00-22:00 (JST)

5) 14:00 – 15:55 Group discussion and preparation of presentation (2)

14:00 Topic 4: Future Roles and Efforts of Each Organization (40 minutes)

※Continuation from the morning session

14:40 Free discussion and preparation of presentation (20 minutes)

15:00 *Break* (10 minutes) ※Move to “Teams link (Air Pollution)”

15:10 Joint presentation and exchange of opinions (15 minutes x 3 groups)

6) 15:55 Closing remarks by Mr. Yuki Inoue, Representative, JICA Uganda Office (5 minutes)

Participants (Assumption)

Participants (Hotel):

MoWE (1), NEMA (2), MoH (4), MoWT (2), KCCA (2), AirQo Project (1)

JICA Uganda (1), JICA Survey Team (2), Bodawerk (2), UMA (1), Makerere Univ. (2)

(<u>20 persons in total</u>)

Participants (Online):

MoERD (1), AirQo Project (1), JICA Survey Team (1), Japanese companies (1)

(<u>24 persons in total</u>)

Source: JST

(2) Outline of the Ideathon Results

1) Explanation of Group Discussion Program and Agendas by the JICA Survey Team

The JICA Survey Team explained the purpose and procedure of the group discussion and divided them into three groups. Care was taken to ensure that participants from each organization were evenly divided. The table below shows the grouping list of the Ugandan attendees. In addition, JICA Uganda Office, the JICA Survey Team, and online attendees from the Japanese side participated in the discussion while freely moving along each group.

Table 5.2.6 Grouping List

	Group 1	Group 2	Group 3
1	Mr. Dickson Wandera (MoH)	Mr. Ndibirema Dadinoh (MoWE)	Mr. John Okatch (NEMA)
2	Mr. Bob Omoda Amodan (MoH)	Ms. Nsereko Patience (NEMA)	Mr. Fred Mulabya (MoH)
3	Ms. Winifred Anna Adoch Gena (MoWT)	Mr. Moses Kabangi Mwigo (MoH)	Ms. Atino Juliet (MoWT)
4	Ms. Fortunate Bis (KCCA)	Mr. Alex Ndayabakira (KCCA)	Mr. Birimumaso David (MoEMD)
5	Ms. Priscah Adrine (AirQo)	Mr. Deo Okure (AirQo)	Mr. Kyalimpa Joseph (UMA)
6	Mr. Jakob Hornbach (Bodawek)	Mr. Senkubuge Shafik (Makerere Univ.)	Mr. Janos Bisasso (Bodawerk)
7			Mr. Mahad Muhammad (Makerere Univ.)

Source: JST

In addition, the JICA Survey Team explained the agenda, time schedule, and points to be noted in each group.

【Topic】

1. Laws, Regulations and Standards Related to Air Pollution
2. Air Quality Monitoring
3. Air Quality Control and Measure
4. Future Roles and Efforts of Each Organization

【Important Points】

- For online participants, please connect at least one laptop to Teams in each group.
- Please discuss about priority issues and action plans for the solution on each topic.
- The format of group discussions and presentations (Powerpoint) is free. (1-2 slides / topic is desirable)

- Regarding the division of roles, it is better to decide on a facilitator, a recorder, and a presentator, etc.

2) Group Discussions and Preparation of Action Plans

The discussion results are organized as shown in the table below based on the presentations by each group.

Table 5.2.7 Discussion Results of Group 1

Topic	Priority Issues	Action Plans for Solution
1	Regulations and standards are at a draft level.	Finalize R&S and disseminate to all key stakeholders with a special focus on multi-language support.
	Current efforts have not been inclusive of all key stakeholders.	Include all key stakeholders in future discussions about air quality.
	NEMA is the overall responsible, but the implementation cuts across many different stakeholders.	Build capacity of all implementing partners (e.g., government, funding partners, private sector).
2	Data is not shared to all stakeholders and the analysis of data is not trivial.	・ Support data-driven decision making with user-friendly, interpreted, and analyzed data. ・ Bridging the gap between raw data and informed decision making.
	Coverage and resolution of air quality sensing network is insufficient.	・ Drive innovation for low-cost equipment. ・ Eventually start a pilot of mobile sensing by putting measuring equipment on vehicles, motorcycles, etc. ・ Eventually install equipment in district head offices.
	Low capacity of district environment officers in air quality monitoring.	Involve such key officers and build capacity.
3	Insufficient awareness and knowhow of control and measure process and benefits.	・ Train partners on how to attract climate change funds. ・ Develop DO's and DON'Ts to protect air quality.
	Lack of 'green belts' in cities	・ City planning should include air quality goals, e.g., establishment of parks.
	Laws, standards, and regulations are not followed and systems for enforcement are lacking.	・ Implement and follow up of laws through development and funding of enforcement plans. ・ Early involvement of high-level politicians to ensure project support.
	Lack of affordable alternatives.	Government and private sector could cooperate in order to develop innovative, affordable alternatives.
	Poor sighting of landfills and general waste management planning.	Improve waste management including location and composition of landfills.
	Traffic jam is a major contributor to emissions in Kampala.	Flyovers and reduction of absolute number of cars entering the city through adequate measures.
	Lack of countermeasure projects, e.g., air purification filters.	Countermeasure projects can be implemented after a successful cost-benefit analysis for the equipment used.
4	Organization	Future Roles and Efforts
	KCCA	Promote sustainable travel, electric buses, reduce congestions through policy, improve boda and matatu-based transport systems, enforce rules, install more monitoring equipment in Kampala and conduct trend studies, control traffic

		management and taxi parking.
	MoWT	Policy, regulations, and standards for monitoring and reporting of air quality, vehicle inspection with adequate emission testing equipment, indoor air quality monitoring, private sector co-operations to electrify vehicles, implement mass transport systems.
	MoH	Reduce the spread of diseases related to air pollution-awareness creation, formulation of guidelines and policies on air pollution, continuous surveillance of diseases, proper management of medical waste to reduce air pollution.
	AirQo	Expand monitoring network, start manufacturing indoor air quality sensing equipment designed for the African market, increase the priority of mobile sensing approaches, support customers of the generated data in the analysis, interpretation and deriving action points from it.
	Bodawerk International Ltd.	Innovate and develop technical solutions that are tailor-made to the Ugandan or East African market that can avoid, measure, or reduce air pollution. Special focus is given to the transport sector with electric mobility solutions and the energy sector to drive rural electrification with emission free technology.

Source: JST

Table 5.2.8 Discussion Results of Group 2

Topic	Priority Issues and Action Plans for Solution	
1	･ Establish a law and a policy on air pollution. The National Environment Act -2019, putting more focus on implementing laws. Expedite the regulations of air quality management, review the Public Health Act of 2000 that concerns air pollution. Review and strengthen the existing, laws, and standards. ･ Every relevant sector to develop guidelines and standards for air pollution control. ･ Ensure uptake, create awareness through media, print or electronics. ･ Implement the set guidelines and standards. ･ Strengthen coordination and collaboration for the buy in by the different stakeholders, line MDAS, academia. ･ Enforcement of the standards for all, increasing the accessibility to the air monitoring data to inspectors.	
2	･ Establish nationwide air quality monitoring stations and database and link it to a central repository. ･ Increase access to air quality data. ･ Facilitate different sectors and agencies to carry out monitoring concerning air pollution from their sectors. ･ Nationwide capacity building. ･ Provide air quality monitoring gadgets for inspectors.	
3	･ Strengthen the annual environmental audit process to target air pollution control. ･ Integrate air pollution control activities in different sector work plans and budgets. ･ Enforce installation air monitoring equipment in different entities/facilities, e.g., industries. ･ Involvement of the private sector in the development and uptake of technology for air pollution control.	
4	Organization	Future Roles and Efforts
	MoWT	Develop policies with regard to emissions by the transport sector, and regulate.
	MoWE	･ Oversight in the management of the laws and standards concerning water and environment pollution. ･ Policy development; the minister passes the regulations into law and standards.
	MoH	･ Development of guidelines towards air pollution control. ･ Reviewing of the public health act to address air pollution in the health sector.

	NEMA	・ Develop standards. ・ Undertake nationwide monitoring, facilitate the air quality data monitoring and information sharing, regulation and control air pollution.
	MoED	Interpolation of different issues in the curriculum.
	UMA	Monitoring, development, and implementation of air management action plans, enforcement of what other agencies have developed.
	Courts of Law	Distribute resolution including the application of the penalties to those against the law.
	Academia	Research to inform policy.

Source: JST

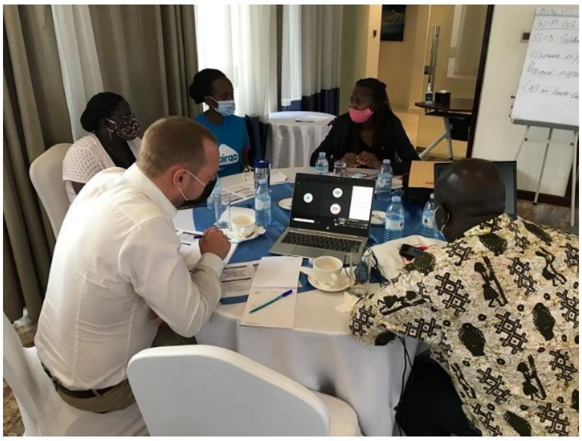
Table 5.2.9 Discussion Results of Group 3

Topic	Priority Issues and Action Plans for Solution	
1	[Current Situation] ・ Uganda Constitution of 1995, Article 39 ・ Energy Policy of Uganda 2002 ・ Air Quality Policy 2005 ・ National Environmental Act 2019 ・ Air Quality Regulations of 2021 (Draft)	
2	[Current Situation] Existing standards guiding air quality monitoring are being defined and planned for by the public stakeholders, NEMA, KCCA, AirQo [Issues] ・ Limited equipment and capacity for monitoring ・ Limited area of data collection (point probe vs. continuous measurement) [Solutions] ・ Sharing responsibility for monitoring activities between the public and private sectors	
3	[Current Situation] Shift into clean energy generation and productive use (at grid and consumer scale) [Issues] ・ Public knowledge ・ Enforcement of guidelines [Solutions] ・ Continuous monitoring and periodic evaluation (like audits) ・ Public sensitization on impact of air quality management	
4	Organization	Future Roles and Efforts
	MoWT	Finalize emission sector, mandatory vehicle inspection, build partnerships for AQ, wholesome infrastructure development
	MoEMD	Specification of systems, carbon tax, cleaner fuels, mass transport systems
	NEMA	Compliance and monitoring, formulate national air quality policy guidelines
	UMA	Promoting PPPs, improving education, promoting self-assessment, supporting implementation of environmental management systems, conduct of Ideathon
	Bodawerk	Battery-based productive use ecosystem development and manufacture, piloting future solutions in partnership with the public sector

Source: JST

3) Sceneries in the Ideathon

The sceneries in the Ideathon are shown in Figure 5.2.2.

	
Photo 5.2.3 Venue of Ideathon	**Photo 5.2.4 Opening and Closing Remarks by JICA**
	
Photo 5.2.5 Discussion (Group 1)	**Photo 5.2.6 Discussion with Online Attendees through Teams (Group 1)**
	
Photo 5.2.7 Discussion (Group 2)	**Photo 5.2.8 Discussion (Group 3)**

Source: JST

Figure 5.2.2 Sceneries in the Ideathon for the Air Pollution Sector

CHAPTER 6 Proposed Aid Policy

6.1 Proposed Aid Policy in the Urban Water Supply Sector

6.1.1 Organize, Analyze, and Prioritize Cooperation Needs and Issues in the Urban Water Supply Sector

The current status and issues in the urban water supply sector in Uganda and the expectations from the relevant organizations such as the National Water and Sewerage Corporation (NWSC) were described in Chapter 3. In this chapter, the JICA Survey Team (JST) reviews these issues comprehensively and further summarizes the need for cooperation with NWSC and its significance, and the issues that need to be addressed in order to develop a proposed aid policy.

(1) Analysis of Current Situation and the Needs for Cooperation

The NWSC is responsible for the water supply of cities/areas in 97 out of 136 districts in Uganda, covering 258 cities/areas including Kampala Capital City in FY 2019/20. The level of water utilities and types of support by the Japan International Cooperation Agency (JICA) can be categorized into ① Emphasis on human security, ② Support for improvement of basic services, ③ Support for growth of water utilities, and ④ Support for sector governance. Based on the following circumstances, it can be said that NWSC is not at the stage where the Corporation needs support of "② Support for improvement of basic services" considering JICA's stage of development of water utilities and cooperative approaches (Figure 6.1.1).

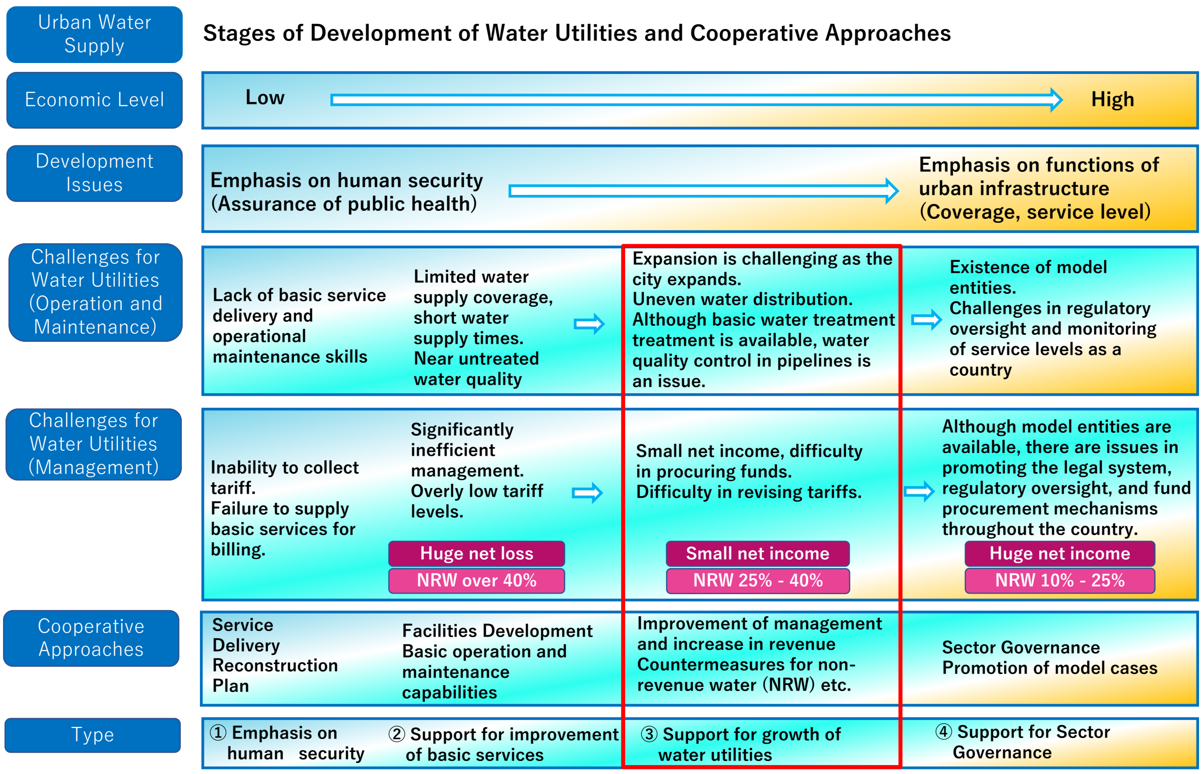
- 24-hour water supply has been available in Kampala City and some regional centers.
- Installation rate of water meters is almost 100% in the water supply areas of NWSC.
- According to the FY 2019/20 Performance Report, the collection efficiency averaged at 92% despite water tariffs (UGX 3,516/m^3 (about JPY 110/m^3)) being more expensive than other African countries.
- Compliance with drinking water quality standards is high at 98%, a level that enables provision of basic water services.
- Water and sewerage income in Kampala Metropolitan Area is significantly higher than the operation and maintenance costs.

Meanwhile, based on the following circumstances, it is necessary to provide support for improvement of management and increase in revenue through "③ Support for growth of water utilities ".

- It was proven difficult to construct new facilities, expand and upgrade existing facilities, and maintain and improve the level of water supply services in response to the expansion of urban areas and population growth in areas surrounding the rapidly expanding urban areas (especially in Kampala Metropolitan Area) and rural areas served by NWSC.
- Although projects are currently funded by grant aid from the Government of Uganda (GoU) and

donors, it is essential to borrow from financial institutions to finance the huge capital investment in the future; however, there is not enough borrowing capacity at present.

- There is room for improvement in income as the non-revenue water (NRW) rate for the entire service region, including the Kampala Metropolitan Area, for FY 2019/20 is 34%.
- While NWSC as a whole remains profitable, about 50% of NWSC regional branches in the water supply areas outside of Kampala Capital City in FY 2018/19 and 80% in FY 2019/20 had income lower than the operation and maintenance costs.



Source: JICA

Figure 6.1.1 Level of Water Utilities and Types of Support

For NWSC to overcome these challenges, the Corporation continues to expand its water supply in peri-urban areas and local cities, and to become a water utility that can grow independently, NWSC needs to be able to expand its capital investment independently in the future, not only to cover the operation and maintenance costs, but also by procuring funds through borrowing, etc., based on water tariff revenue.

Therefore, it is necessary to support NWSC in its growth spiral, both in terms of financial cooperation for further facility development and technical cooperation for improvement in the technical level and operation of NWSC.

(2) Analysis of the Challenges, Risks, and Strengths of NWSC

1) Efforts to Resolve Challenges and Risks for NWSC

The following sevenare the major challenges and risks that need to be overcome in the technical and operational aspects of NWSC that emerged from the understanding of the current situation mentioned in Chapter 3.

① Inadequate asset management system due to lack of facility information and aging facilities
② Change in treatment method and increase in treatment costs due to deterioration of raw water quality
③ High non-revenue water (NRW) rate
④ Inefficient operation and maintenance of water supply facilities due to insufficient asset management systems
⑤ Insufficiency of NWSC's own capital investment capacity observed from the current financial condition
⑥ Lack of human resources and training to cope with water service expansion
⑦ Lack of manuals and other quality control systems

The following initiatives are needed to solve these issues and reduce the risks:

- Rehabilitation/expansion of large-scale water supply facilities
- Further improvement of water service level
- Strengthening of operational and financial management
- Effective use of Information and Communication Technology (ICT) and other new technologies

2) Strength of NWSC and Initiatives to Leverage Those Strengths

The key strengths that will serve as the foundation for the further growth of NWSC are as follows:

- Relatively high water tariffs and high willingness to pay in Africa
- Sufficient income generation in Kampala urban areas
- Capacity and structure of staff capable of providing basic services (operation and maintenance of water treatment plants, pumping stations, etc., and accounting/financial services)
- NWSC has an excellent External Services (ES) Department, which is a consultancy arm of NWSC that provides capacity building programs such as technical assistance to the Corporation and other national and international organizations
- Strong network with African Water Association
- Financial and technical assistance from GoU and development partners

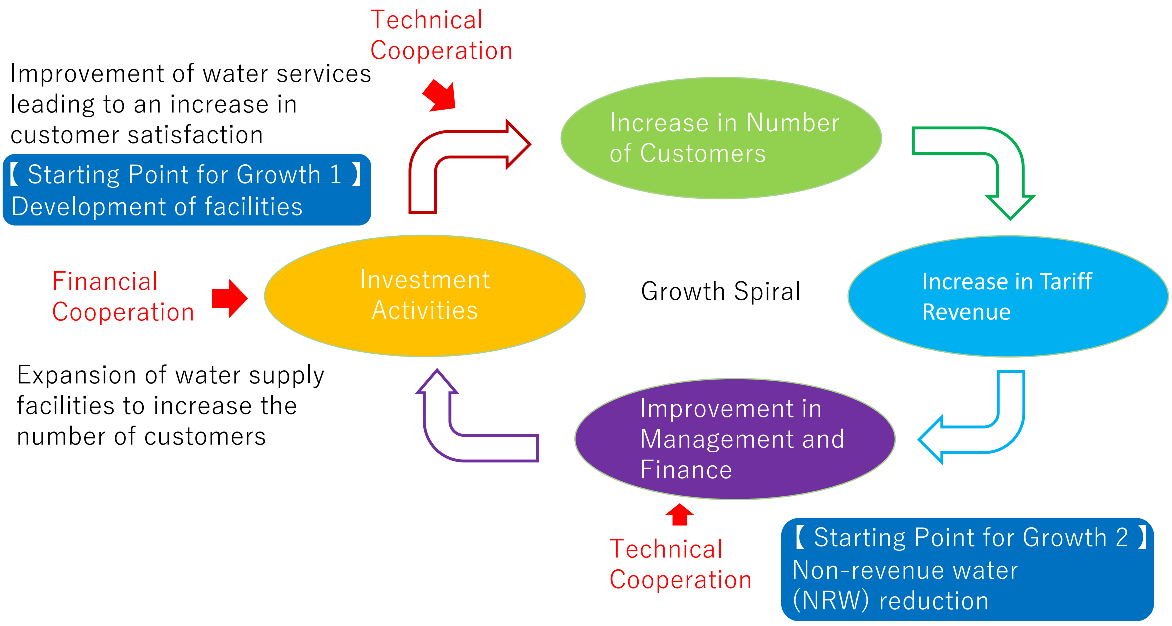
In addition, the following initiatives are necessary to further utilize those strengths:

- Further strengthening of organizational and business management and improvement of staff productivity

- Strengthening of NWSC's financial independence and profitability
- Expansion of NWSC's activities to neighboring countries

(3) Consideration of NWSC Growth Scenarios

As shown in Figure 6.1.2, to place water utilities on a growth trajectory in urban water supply, it is necessary to put the water utilities on a growth spiral of "increase in number of customers" → "increase in tariff revenue" → "improvement in management and finance" → "investment activities (facility improvement)". Therefore, technical cooperation and financial cooperation are required in the areas of "expansion of water supply facilities to increase the number of customers", "improvement of water supply services to increase customer satisfaction", and "improvement of management and financial including reduction of non-revenue water (NRW)". It is necessary to coordinate these activities in order to create synergies as Loan Aid and Technical Cooperation is currently being provided by several donors.



Source: JICA

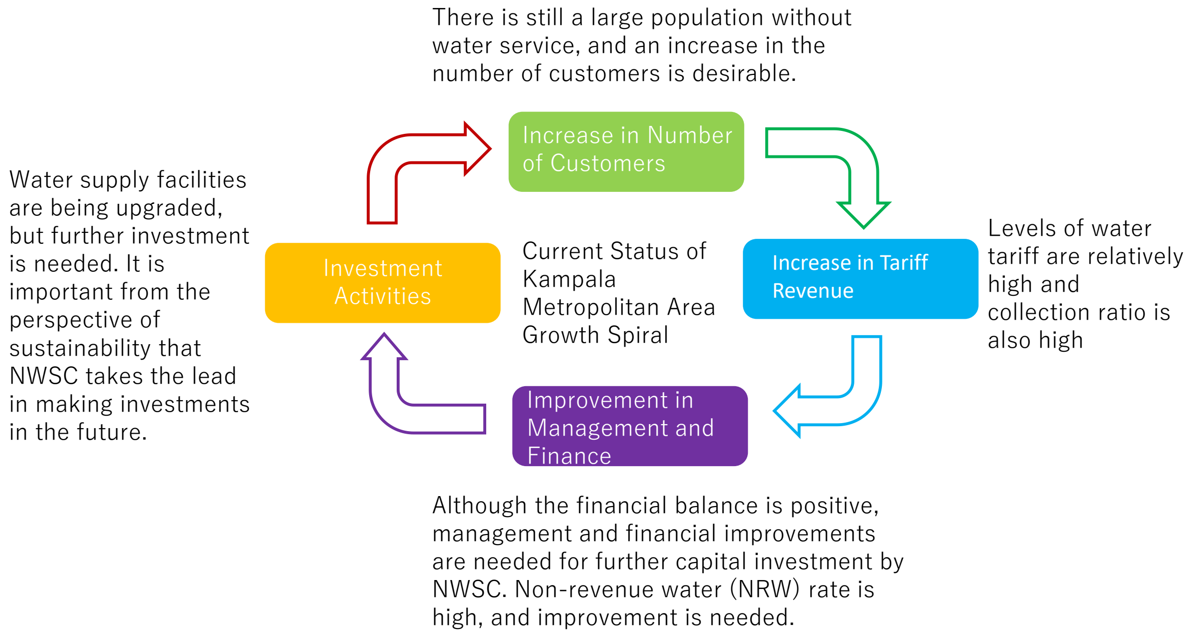
Figure 6.1.2 Growth Spiral and Support of Urban Water Supply

It is necessary to consider Kampala Metropolitan Area and the rural areas separately in their growth scenarios as the status of facility development, operation and maintenance differ greatly between the Kampala Metropolitan Area and the rural areas under the jurisdiction of NWSC.

1) Scenario of Kampala Metropolitan Area

Urban areas, especially Kampala Metropolitan Area, are the core water utilities of NWSC, and it is important for Kampala Metropolitan Area to first get into a growth spiral in order to become a water utility that can grow independently. In Kampala Metropolitan Area, basic water services have been achieved and that the growth spiral is beginning to revolve. Therefore, it is important to carry out ongoing activities to further expand water services, strengthen finances and management, increase billing revenues, and strengthen human resource development with the aim of increasing the number of customers by expanding the water supply area, increasing the population, and acquiring potential customers to accelerate the growth spiral.

The current situation of Kampala Metropolitan Area is shown in Figure 6.1.3.



Source: JICA

Figure 6.1.3 Current Status of the Growth Spiral of Kampala Metropolitan Area

The following initiatives are already underway to place Kampala Metropolitan Area in a growth spiral.

【Investment Activities】

Intensive investment activities are ongoing in Kampala Metropolitan Area, including the Kampala Water Lake Victoria WATSAN Project (KW-LV WATSAN Project) with the support of the GoU and other donors. Infrastructure development is mainly aimed at increasing water supply capacity, such as rehabilitation and expansion of water treatment plants and reconstruction of distribution facilities and part of the distribution networks. The KW-LV WATSAN Project will increase the water production from 230,000 m^3/day to 390,000 m^3/day (470,000 m^3/day in the future) in Kampala Metropolitan Area. Expansion of the water supply area and stable water supply will lead to an increase in the number of customers who are not receiving water service and will also attract potential customers whose service has been suspended due to low pressure or other reasons.

【Increase in Number of Customers】

The number of customers can be increased further as the population growth rate is high, and there is a large population that does not have access to water service in the existing distribution areas, and there are still areas that are not yet being served.

【Increase in Tariff Revenue】

Water tariffs in NWSC are at a high level, with collection efficiency of 100% in FY 2018/19 and 97% in FY 2019/20, which is very high even for the COVID-19 pandemic.

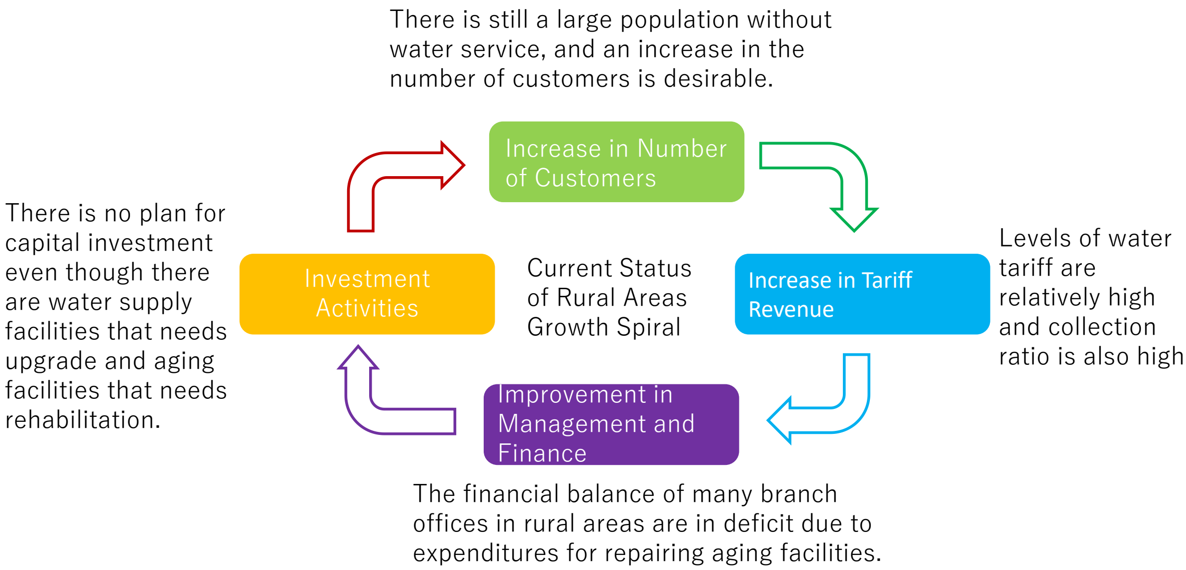
【Improvement in Management and Finance】

Countermeasures for non-revenue water (NRW) reduction and asset management that contribute to management and financial improvement are also planned for Kampala Metropolitan Area through the KW-LV WATSAN Project.

2) Scenario of Rural Areas

There are 50 branch offices in the rural areas of NWSC, and these branch offices are entrusted with the operation and maintenance of 257 water supply facilities; however, many of the water supply facilities become obsolete at the time they are entrusted. It will be difficult to achieve a growth spiral under the existing facility conditions, and it is important to upgrade and expand the aging facilities to achieve future growth with internally generated funds of NWSC and grant aid from the GoU and donors, to ensure the cost of repairing the facilities will not worsen the financial balance.

The current situation of rural areas is shown in Figure 6.1.4.



Source: JICA

Figure 6.1.4 Current Status of the Growth Spiral of Local Cities

【Investment Activities】

Some areas have been rehabilitated and expanded in terms of water supply system infrastructure with the support of NWSC, GoU, and other donors, but the current situation is that the number of aging facilities is too large to keep up. In addition, a systematic capital investment plan for the entire local cities water supply facilities has not been formulated. For the formulation of the capital investment plan, it is necessary to formulate a capital investment plan specific to the rural areas by summarizing the priorities and sources of funding (e.g., internally generated funds of NWSC for the upgrade and expansion of small-scale water supply facilities, and grant aid from donors for the upgrade and expansion of a certain scale of water supply in local cities).

【Increase in Number of Customers】

The number of customers can be further increased in the future as the population growth rate is high, and there are still areas that do not have access to water service.

【Increase in Tariff Revenue】

Water tariffs in NWSC are at a high level, with collection efficiency of 100% in FY 2018/19 but 85% in FY 2019/20 which was largely due to the COVID-19 pandemic.

【Improvement in Management and Finance】

In rural areas, it is important to make capital investments first and then improve the structure of the entire branch office in rural areas to be capable of cost recovery in order to revolve the growth spiral. Also, branch offices in rural areas are said to be short of qualified personnel to improve water services due to the rapid expansion of the jurisdictional areas. Therefore, it is necessary to build a foundation that will enable the rural areas to gradually get on a growth track by strengthening the Vocational Skills Development Facility (VSDF), which is scheduled to be established in the rural areas to increase productivity through training and secure excellent human resources which will be needed as the facilities are upgraded and expanded.

6.1.2 Recommendations for Proposed Aid Policies

Based on the above challenges and potential aid measures, the following aid policies are recommended for the support of NWSC to become a water utility that can grow independently:

(1) Long-term Strategies and Initiatives to Resolve Challenges

In addition to the initiatives categorized under "people, goods, and money", initiatives for the spillover effects throughout Uganda and neighboring countries are added and categorized into the following four initiatives:

「Initiative 1」 Expansion of "Water Supply Services" for Safe and Sufficient Water Supply

Since there are still many residents who do not have water supply, it is desirable to increase the service population (number of customers) of NWSC and expand the water services for safe and sufficient water supply. The following initiatives need to be implemented to increase the number of customers and expand water services:

1. Development of Water Supply Facilities

Further expansion and rehabilitation of water distribution network in Kampala Metropolitan Area, survey of water supply facilities in rural areas/local cities, and planning and implementation of development plan

2. Improvement of Operation Efficiency in Water Treatment Plants

Optimization of chemical usage through rehabilitation or construction of new water treatment plants in accordance with the raw water qualities

「Initiative 2」 Strengthening of " Finance and Management" for Independence of NWSC

It is necessary to "increase tariff revenues" and "improve management and finances", as shown in Figure 6.1.2, and the following efforts are required to carry out investment activities that expand water supply services:

1. Maximization of Water Revenue

Securing of customers, reduction of non-revenue water (NRW) rate, and countermeasures for non-revenue water (NRW)

2. Development of Asset Management

Appropriate operation and maintenance, and improvement on accuracy through management of information on transmission and distribution mains, water meters, etc.

3. Improvement of Staff Productivity

Appointment of right personnel for the right positions and appropriate personnel management

4. Water Supply Innovation through Effective Utilization of New Technologies

Innovation through the utilization of ICT (SCADA, smart meter, etc.)

5. Establishment of Quality Control System for All Aspects of Daily Operations

Revision and thorough implementation of operation and maintenance manuals

「Initiative 3」 Strengthening of "Human Resource Development" for the Future of NWSC

"Human Resource Development" is important for implementing measures, and the following initiatives are desirable to achieve the growth spiral shown in Figure 6.1.2:

1. Improvement of Customer Service

Expansion of water supply areas and hours in Kampala Metropolitan Area and rural areas, securing staff to maintain service levels in existing areas, strict compliance with meter reading, pipeline repair hours within regulations, etc.

2. Strengthening of Organizational Capabilities through Human Resource Development

Improvement of staff capabilities and establishment of technology transfer through TOT at the Vocational Skills Development Facility (VSDF)

「Initiative 4」 Strengthening of Resource Utilization Management

The following initiatives are measures to improve water supply services not only in Uganda but also in neighboring countries:

1. Utilization of Vocational Skills Development Facility (VSDF)
   Establishment as a base for south-south cooperation, domestic training, etc.
2. Expansion of the External Services (ES) Department (ES)
   Domestic and international business development through consultancy services from the World Bank, AfDB, and other donors, reliable operation and implementation of major projects, and operational support to AWASA

(2) Short-term Plans and Medium- to Long-term Plans

The above initiatives are divided into infrastructure development and capacity building (technical cooperation), which are planned to be implemented at an early stage (short-term plan), and medium- to long-term plans that should be implemented after the management improvement through the short-term plan, as proposed below.

1) Sectors that Need to be Implemented Promptly (Short-Term Plan: 2022-2026)

There is a strong need for early implementation of rural infrastructure development and management improvement, which will greatly affect the future development of the urban water supply sector in Uganda, and NWSC has also positioned it as such.

The establishment of AWASA is not directly related to the urban water supply sector in Uganda, but rather based on the idea that NWSC can develop independently by transferring the knowledge the Corporation has learned in its own country to other African countries. As AWASA is expected to be established in the near future, it is desirable to provide technical cooperation to NWSC during the initial launch of AWASA with a long-term perspective.

a) Infrastructure Development Projects

【Projects currently being implemented or to be implemented with NWSC internally generated funds, funds from GoU and other donor】

- KW-LV WATSAN Project (Rehabilitation of water distribution network in Kampala Metropolitan Area, rehabilitation of water supply and sewerage systems for resettlement areas)
- Wakiso West WATSAN Project (Development of water supply facilities in Wakiso Region)
- Local Cities Water Supply System Infrastructure Development Project
- SCAP100 Project (100% Service Coverage Project Acceleration Project)

【Support by JICA (Draft)】

- Local Cities Water Supply Grant Aid Project (Project formulation through dispatch of experts as described below)

b) Capacity Development

【To be implemented by NWSC internally generated funds, funds from GoU or donor】

- Countermeasures for non-revenue water (NRW) within the KW-LV WATSAN Project

- Asset management (Cooperation with Vitens-Evides International (VEI) from Netherlands)

【Support by JICA (Draft)】

- Technical cooperation for non-revenue water (NRW) measures in Kampala (expecting synergy effects through, for example, establishing a pilot DMA and providing practical education, which other donors are not considering implementing)
- Strengthening and expansion of VSDF (Strengthening of vocational training schools and support for regional development)
- Dispatch of experts (Confirmation of policies of central government on investment in water supply facilities, survey of local water supply facilities inventory, project formulation, establishment of AWASA, and confirmation of the progress of its activities)
- Technical cooperation projects (Finance, management and non-revenue water (NRW) of NWSC, strengthening of VSDF, proposals of new technologies and improvement on customer service, and support for the establishment and strengthening of AWASA)

2) Sectors Requiring Support in the Future (Medium- to Long-Term Plan: 2022-2031)

The short-term plan aims to get the growth spiral of NWSC up and running, followed by further infrastructure development by the NWSC or donors. In addition, although the support to AWASA is not directly related to the urban water supply sector, it is based on the idea that NWSC can develop independently by transferring the knowledge the Corporation has learned in its own country to neighboring countries in Africa.

a) Infrastructure Development

【Implementation by NWSC or Donors】

- Continuation of development policies of the Five-Year Plan by NWSC

【Support by JICA (Draft)】

- Local Cities Water Supply Grant Aid Project (Construction following the project formulation mentioned above)
- Loan Aid Project (Kampala Metropolitan Area / local cities)

b) Capacity Development

【Implementation by NWSC or Donors】

- Implementation of human resource development program by NWSC

【Support by JICA (Draft)】

- Strengthening of AWASA

Figure 6.1.5 shows a flowchart organized from the above analysis on the current situation and identification of issues (described in Section 6.1.1), to long-term strategies and initiatives to resolve the issues, and the contents of the short-term plan and medium- to long-term plans to achieve them.

To Become A Self-Sustaining and Growing Water Utility (2022 - 2031)

Analysis Of Current Situation And Identification Of Issues

Key Challenges And Risks To Be Overcome
- Increase in water demand due to population growth
- Inadequate water production and distribution capacity to meet water demand
- Risk of deterioration in the quality of treated water
- High non-revenue water (NRW) rate
- Inadequate asset management systems
- Current financial situation does not allow NWSC to make sufficient capital investments on its own.
- Lack of human resources and training due to growth in busines

Problem Solving And Risk Reduction Initiatives
- ➢Large-scale expansion of water supply facilities
- ➢Further improvement on level of water supply services
- ➢Strengthening of operational and financial management

Efforts To Further Utilize The Strengths of NWSC
- ➢Further strengthening of organizational and management control
- ➢Strengthening of NWSC's financially independent management
- ➢Expansion of NWSC's activities to neighboring countries

Key Strengths And Opportunities As A Basis For Growth
- Willingness to pay for high water tariffs
- Sufficient profit in Kampala Metropolitan Area
- Staff and systems are in place to provide basic services
- Presence of an excellent External service (ES) in NWSC
- Financial and technical assistance from the GoU and development partners

Long-Term Strategies And Initiatives To Resolve Issues

Initiative 1 : Expansion of "Water Supply Services" For Safe And Sufficient Water Supply

1. Development Of Water Supply Facilities
   - Further expansion and rehabilitation of water distribution network in Kampala Metropolitan Area, survey of water supply facilities in rural areas/local cities, and planning and implementation of development plan
2. Improvement of Operation Efficiency in Water Treatment Plant
   - Optimization of chemical usage through rehabilitation or construction of new water treatment plants in accordance with the raw water qualities

Initiative 2 : Strengthening of "Finance and Management" for Independence of NWSC

1. Maximization of Water Revenue
   - Securing of customers, reduction of NRW rate, and countermeasures for NRW
2. Development Of Asset Management
   - Appropriate operation and maintenance, and improvement on accuracy through management of information on transmission and distribution mains, water meters, etc.
3. Improvement of Staff Productivity
   - Appointment of right personnel for the right positions and appropriate personnel management
4. Water Supply Innovation through Effective Utilization of New Technologies
   - Innovation through the utilization of ICT (SCADA, smart meter, etc.)
5. Establishment of Quality Control System for All Aspects of Daily Operations
   - Revision and thorough implementation of operation and maintenance manuals

Initiative 3: Strengthening Of "Human Resource Development" For The Future Of NWSC

1. Improvement Of Customer Service
   - Expansion of water supply areas and hours in Kampala Metropolitan Area and rural areas, securing staff to maintain service levels in existing areas, strict compliance with meter reading, pipeline repair hours within regulations, etc.
2. Strengthening Of Organizational Capabilities Through Human Resource Development
   - Improvement of staff capabilities and establishment of technology transfer through TOT, etc. at Vocational Skilled Development Facility (VSDF)

Initiative 4: Strengthening Of Resource Utilization Management

1. Utilization of VSDF
   - Establishment as a base for South-South Cooperation, domestic training, etc.
2. Expansion of External Services (ES) Department
   - Domestic and international business development through consultancy services from the World Bank, AfDB, and other donors, operational support to AWASA
3. Utilization Of Development Funds From Donors
   - Reliable operation and implementation of major projects

Planned Projects

Five-Year Plan (2022-2026): Short-Term Plan

1. Infrastructure Development
- Kampala Water Lake Victoria WATSAN Project (Rehabilitation of water distribution network in Kampala Metropolitan Area, rehabilitation of water supply and sewage systems for resettlement areas)
- Wakiso West WATSAN Project (Development of water supply facilities in Wakiso District)
- Development of water supply system infrastructure in regional cities
- **Support by JICA (draft): Local Cities Water Supply Grant Aid Project**

2. Capacity Development
- Kampala WATSAN Project (Countermeasures For NRW)
- Expansion of VSDF (Regional development of vocational training schools)
- Asset Management (Support by VEI)
- **Support by JICA (draft)**
  - ➢ **Dispatch of experts (Confirmation of central government's policies on investment in water supply facilities, inventory survey on local cities water supply facilities, formulation of Technical Cooperation project)**
  - ➢ **Technical Cooperation Project (Finance, management, and NRW, strengthening of VSDF, proposing of new technologies, improvement of customer service)**

10-Year Plan (2022-2031): Medium to Long-Term Plan

1. Infrastructure Development
- Continuation of development policies of the 5-Year Plan
- **Support by JICA (draft): Loan Aid Projects**

2. Capacity Development
- Implementation of human resource development programs by NWSC
- **Support by JICA (draft): Strengthening of AWASA**

Source: JST

Figure 6.1.5 Issues, Strategies, Initiatives, and Plans for NWSC to Become an Independent Growing Water Utility

Based on the above issues, strategies, and measures, a total of six projects, including the dispatch of experts, have been proposed. An outline of the proposed projects in the urban water supply sector is shown in Table 6.1.1.

Table 6.1.1 Proposed Projects in the Urban Water Supply Sector

No.	Name of Project	Form of Aid
Short-Term Plan		
1.	Dispatch of JICA Expert (data collection, relationship building)	Dispatch of Individual Experts
2.	NWSC Management Infrastructure Strengthening Project	Technical Cooperation
3.	Local Cities Water Supply Development Project	Grant Aid
Medium- to Long-Term Plan		
4.	Kampala Metropolitan Area Transmission and Distribution Mains Replacement Project	Loan Aid
5.	Local Cities Water Supply Expansion Project	Loan Aid
6.	Strengthening of African Water and Sanitation Academy (AWASA) and Regional Collaboration Project (※Establishment will be supported by individual experts and subsequent continuous strengthening will be supported by third country training program and Knowledge Co-Creation Program)	Third Country Training Program and Knowledge Co-Creation Program

Source: JST

The projects listed in Table 6.1.1 are divided into the following categories: Support for Whole Country, Support for Kampala Metropolitan Area, and Support for Local Cities.

(3) Support for Whole Country

The increase in the income and financial soundness of Kampala Metropolitan Area, which accounts for more than half of the total income of NWSC, is very important for the development of waterworks projects in the entire country of Uganda, including spillover effects to rural areas and diversion of operating capital. The main activity is to provide technical cooperation in Kampala Metropolitan Area for effective management improvement, and to support the development of technical capabilities and management knowhow cultivated there to the rural area.

1) Dispatch of JICA Expert

Purpose: To support relationship building and project formulation.

Objectives:

- Cooperation with NWSC for future support will be established.
- Technical and financial cooperation projects will be planned based on the request of NWSC.

Overview:

- Basically, the individual expert will be dispatched to the Ministry of Water and Environment

(MoWE) and will be based to help strengthen the relationship with NWSC and improve the water supply situation nationwide (two years).

- Confirmation of policies of central government on investment in water supply facilities, survey of local water supply facilities inventory, formulation of technical cooperation project (financial, management, non-revenue water (NRW), strengthening of VSDF, proposal on new technologies, improvement on customer service, support for establishment of AWASA, and confirmation of the progress of its activities).

2) Technical Cooperation Project

Project: NWSC Management Infrastructure Strengthening Project

Overarching Objective: To ensure ongoing implementation of sound and stable urban water supply services throughout Uganda.

Project Objective: To strengthen the management base of NWSC and put the urban water supply services on a growth spiral in both metropolitan areas and local cities.

Expected Outcome:

- Improvement of management and finance through non-revenue water (NRW) reduction and enhancement of asset management.
- Improvement of the operation and maintenance capacity of NWSC staff across the country by enhancing the capacity of VSDF instructors.

Contents:

An overview of the project scope is as follows:

The project will start with activities in Kampala Metropolitan Area but will shift to expansion of vocational training to rural areas in the second half of the project or in Phase 2. (Technical cooperation will include asset management to reduce non-revenue water (NRW) and strengthen VSDF.)

- Countermeasures for non-revenue water (NRW) project in Kampala Metropolitan Area (Cooperation with KW-LV WATSAN Project).
- Further development of Vocational Training School (VSDF) in Kampala and its extension to rural areas.
- Strengthening of asset management (Cooperation with VEI from Netherlands)

(4) Support for Kampala Metropolitan Area

1) Technical Cooperation Project (Short-Term Plan)

Technical cooperation project on countermeasures for non-revenue water (NRW) will be implemented in Kampala Metropolitan Area as part (or Phase 1) of the "NWSC Management Infrastructure Strengthening Project" mentioned above.

2) Load Aid Project (Medium- to Long-Term Plan)

Project: Kampala Metropolitan Area Transmission and Distribution Mains Replacement Project
Contents:

- The implementation of the project will be carried out when the cooperation with NWSC has been strengthened and the financial situation has been further improved through the above-mentioned technical cooperation project. A renewal plan will be developed after the status of non-revenue water (NRW) and obsolescence in the entire Kampala Metropolitan Area becomes apparent than it is now during the period of the technical cooperation project, etc.
- Replacement of old pipelines in the entire Kampala Metropolitan Area (Total length: several hundred kilometers) *Cooperation with KW-LV WATSAN Project, other donors.
- Flow and pressure gauges will be installed in small and medium DMAs through loan aid project as the scale of grant aid project is limited to monitoring flow and pressure at the entrance of a wide range of water distribution areas. The pressure at the end of the water distribution network is also monitored.

3) Combination of Technical and Financial Cooperation Projects

Non-revenue water (NRW) cannot be significantly reduced as technical cooperation projects are subject to budgetary and time constraints. In many cases, it is better to replace as many aging pipes as possible in the city through loan aid project than replacement in limited area, such as a pilot DMA, with technical cooperation, as there is less delay in the project due to the cost incurred by the other party, and a clear result can be achieved.

Therefore, it is desirable to implement the above-mentioned cooperation between technical cooperation and loan aid projects at the optimal timing expected by NWSC, and to have both projects proceed in parallel for part of the period to increase the effectiveness of the aid. (※It would be more effective if NWSC staff had a good understanding of the basics of NRW countermeasures through technical cooperation, and then implement SCADA and some pipelines replacement through financial cooperation.)

(5) Support for Local Cities

1) Technical Cooperation Project

Support will be provided to expand the strengthened VSDF in Kampala Metropolitan Area to local cities as part (or Phase 2) of the NWSC Management Infrastructure Strengthening Project described above.

2) Grant Aid Project

a) Tororo Municipality and its Surrounding Areas Water Supply Development Plan (Tentative Option 1)

Tororo Municipality, located in the Eastern Region of Uganda where the survey was conducted, has the following characteristics, and will be proposed as a target city:

- It is located in the Eastern Region of the country where access to safe water is generally low. Tororo Municipality has a low water coverage.
- The water treatment system was built in the 1950s and are already past their useful life, therefore, prompt rehabilitation and expansion is desirable.
- The population growth rate is high and NWSC has high expectations for JICA support.
- Tororo Water also supplies water to Malaba Town, which is a border area, however, there is no sufficient water supply. Adequate water supply to the Malaba Town will also contribute to the waterborne control of COVID-19 by improving the sanitation environment.
- The non-revenue water (NRW) rate is rapidly increasing, and the knowhow on NRW reduction for local cities can be transferred.

Although the estimated cost of the project in Tororo has not yet been calculated, it is estimated that the project for the rehabilitation and expansion of water treatment facilities and transmission/distribution mains are of a scale that can be implemented with grant aid.

b) Mityana Municipality and its Surrounding Areas Water Supply Development Plan (Tentative Option 2)

A new water treatment plant equipped with Japanese technology will be built to reduce the amount of chemicals used as large amounts of chemicals are used to treat groundwater due to its high iron content in Mityana Municipality, located in the Central Region of the country. Mityana Municipality was chosen as a tentative option in the hope that Japanese technology would be introduced to other cities with similar problems.

c) Spillover to Other Local Cities after the Implementation of Grant Aid

After the support from the grant aid mentioned above, NWSC will be able to utilize or apply its own development methods to cities in other regions that are experiencing similar problems, such as (1) projects in the Eastern Region (surface water sources), where water supply development is particularly lagging and the population is expected to increase rapidly, and (2) projects in the Central Region (groundwater sources), which has problems with raw water quality and water treatment, and is possible to utilize or apply the development methods used in these cities in the projects as described below for which financial assistance is provided.

3) Loan Aid Project (Medium- to Long-Term Plan)

The project will support NWSC, which has improved its operational and financial status as a result of grant aid and technical cooperation, to improve its facilities by taking out loans on its own instead of relying on grants from the Ministry of Finance, Planning and Economic Development (MoFPED). It is expected that many more counties will be converted to cities in the future. The focus of support will be mainly in the Eastern Region, implementation of construction of new water treatment plants and water transmission and distribution networks in cities with multiple growth prospects according to local needs in the future.

(6) Support Aimed at Creating a Spillover Effect from Kampala Metropolitan Area to Neighboring Countries

1) Third Country Training Program and Knowledge Co-Creation Program

Project: Strengthening of African Water and Sanitation Academy (AWASA) and Regional Collaboration Project

Overarching Objective: Ongoing implementation of sound and stable urban water supply services not only in Uganda but also in neighboring countries.

Project Objective: NWSC will grow into a role model water utility for neighboring countries, and AWASA's activities will be extended to neighboring countries.

Expected Outcome: The training program of AWASA will be enhanced and synergistic growth of NWSC and water utilities in neighboring countries will be achieved.

Contents:

To provide ongoing support to strengthen the educational program of AWASA, which was established under the leadership of NWSC, and expand the educational program to neighboring countries through Third Country Training Program and Knowledge Co-Creation Program. To enhance training curriculums and provide training support by strengthening the capacity of NWSC staff and instructors in satellite offices in neighboring countries.

(7) Future Cooperation Projects in the Urban Water Supply Sector in Uganda

The contents of the support to the urban water supply sector in Uganda (Tentative name, implementation effects and main scope) are summarized in Table 6.1.2.

Table 6.1.2 Long List of Tentative Projects for Future Cooperation in the Urban Water Supply Sector in Uganda

Target Area	Form of Cooperation	Cooperation Project Name	Effects	Main Scope	Remarks
Whole Country	Dispatch of Individual Expert	National Urban Water Supply Development	Relationship building and support for project formulation.	・Non-revenue water (NRW) advisory ・Support for planning of operation and maintenance ・Fund Procurement Plan for NWSC ・Support for establishment of AWASA (Appropriately)	The French government has already started dispatching consultants to Kampala.
	Technical Cooperation	NWSC Management Infrastructure Strengthening Project	Non-revenue water (NRW) reduction. Operational improvement.	Kampala Metropolitan Area ・Improvement of staff training system ・ Improvement of countermeasures for non-revenue water (NRW capacity) ・Construction of pilot DMA (about 3 locations) ・Support for the establishment of AWASA ・Regional expansion of VSDF	VEI from Netherlands is now providing asset management support in Kampala (Loan Aid)
Kampala Metropolitan Area	Loan Aid	Kampala Metropolitan Area Transmission and Distribution Mains Replacement Project (Medium- to Long-term Plan)	Non-revenue water (NRW). Water distribution pressure management. Asset management.	・ Rehabilitation of aging transmission and distribution mains throughout the region ・Construction of DMA (more than 20 locations) ・ Expansion of monitoring system (some valve control) by SCADA system	Medium- to Long-term Plan
Local Cities	Grant Aid	Local Cities Water Supply Development Project (Example: Tororo) (Tentative Option 1)	Improvement of the low water coverage in the Eastern Region.	・Construction of water intake facilities ・ Construction of water treatment plant ・ Installation of water transmission and distribution mains ・ Countermeasures for NRW (SCADA, commercial losses)	Short-term Plan
		Local Cities Water Supply Development Project (Example: Mityana) (Tentative Option 2)	Improvement of the low water coverage in the rural areas. Solving groundwater quality issues with Japanese technology.	・Construction of water intake facilities ・ Construction of water treatment plant (by Japanese technology) ・ Installation of water transmission and distribution mains ・ Countermeasures for NRW (SCADA, commercial losses)	Short-term Plan
	Loan Aid	Local Cities Water Supply Development Project	Comprehensive water infrastructure development in cities with growth potential.	・ Construction of water treatment plant ・Development of transmission and distribution mains	Medium- to Long-term Plan
Regional Collaboration	Third Country Training Program and Knowledge Co-Creation Program	Strengthening of African Water and Sanitation Academy (AWASA) and Regional Collaboration Project	Enrichment of academy. Expansion to neighboring countries.	・ Support after the establishment of AWASA ・ Enhancement of lecture materials at satellite offices in neighboring countries	Medium- to Long-term Plan

Source: JST

The long list of projects in Table 6.1.2 as cooperative programs, including the project name, applicable scheme, and estimated period, are summarized in Table 6.1.3. The choice of which of these projects to focus on and which to implement will need to be made through further discussions with the NWSC and JICA.

Table 6.1.3 Uganda Urban Water Supply Sector Long List

<table>
<tr><th>Cooperation Program</th><th>Project</th><th>Scheme</th><th>Estimated Period (Years)</th></tr>
<tr><td>Support of Relationship Building and Project Formulation</td><td>National Urban Water Supply Development</td><td>Individual Expert</td><td>2</td></tr>
<tr><td>Management Improvement of Entire NWSC</td><td>NWSC Management Infrastructure Strengthening Project</td><td>Technical Cooperation</td><td>3</td></tr>
<tr><td>Improvement of Kampala Metropolitan Area Water Supply</td><td>Kampala Metropolitan Area Transmission and Distribution Mains Replacement Project</td><td>Loan Aid</td><td>5</td></tr>
<tr><td rowspan="2">Local Cites Water Supply Development Program</td><td>Local Cities Water Supply Development Project (Example: Tororo)</td><td>Grant Aid</td><td>2</td></tr>
<tr><td>Local Cities Water Supply Expansion Project</td><td>Loan Aid</td><td>6</td></tr>
<tr><td>Regional Collaboration</td><td>Strengthening of African Water and Sanitation Academy (AWASA) and Regional Collaboration Project</td><td>Third Country Training Program and Knowledge Co-Creation Program</td><td>2</td></tr>
</table>

Note: Preparatory survey for cooperation, detailed planning survey, etc., are not included.

Planning priorities will need to be adjusted through future discussions between JICA and NWSC.

Source: JST

6.2 Proposed Aid Policy in the Air Pollution Sector

6.2.1 Organize, Analyze, and Prioritize Cooperation Needs and Issues in the Air Pollution Sector

The current status and issues in the air pollution sector in Uganda were described in Chapter 4. In this chapter, the JST will review these issues comprehensively and summarize the needs and significance for cooperation with the related ministries and organizations such as MoWE, NEMA, MoH, MoWT, MoEMD, KCCA, and AirQo Project.

(1) Needs for Cooperation

First, the 169 targets of SDGs include items related to mitigation of environmental and health effects due to air pollution, and considering the air pollution situation in Kampala, it is very important to implement countermeasures against air pollution in Uganda. On the other hand, JICA has not implemented any projects related to air pollution improvement in African countries including Uganda. Therefore, in order to promote support for air pollution improvement centered on Kampala City, priority fields are currently being reviewed based on the Third National Development Strategy in Uganda (2020). It is planned to clarify environmental issues including air pollution.

As described in Chapter 4, the current situation and issues related to air pollution were clarified by the field survey. In addition, as a result of the interviews with ministries and organizations which are related to air pollution control, it is confirmed that they are particularly expected to improve and strengthen air quality monitoring and train engineers specializing in air pollution.

However, environmental standards and emission standards have not been established, and law enforcement methods and duties of related organizations have not been sufficiently clarified. Furthermore, considering the current situation in which technical supports are partially conducted by other donors, it is very difficult to design meaningful and concrete support by JICA.

In order to realize the support provided by JICA, it is necessary for Ugandan counterpart (C/P) institutions to proactively exchange opinions with JICA on priority support areas and status of coordination with other donors.

(2) Individual Issues

The requirements for general air pollution management are roughly divided into the following four items: 1) organizational system, 2) environmental policy, 3) monitoring (ambient air and emission gas), and 4) air pollution countermeasures (vehicle source and fixed source). Then, for each of the identified issues, the solutions that can be covered with the support of JICA are summarized in the table below. However, it should be noted that these solutions cannot be implemented at the same time in a short period. This is because the Ugandan government needs to establish a basic system such as organization, personnel, and operation management in order to implement the solutions. With the support of other donors and the improvement of Ugandan government's management capabilities in the future, it is fully expected that some of the issues can be solved by themselves. Therefore, it is important that the solutions are scrutinized under continuous communication between JICA and the Ugandan C/P institutes.

Table 6.2.1 Issues and Solutions in Air Pollution (Draft)

Issues		Aid Policy (Draft)
Organizational Structure	Insufficient securing and training of human resources for considering and implementing air pollution measures.	Technical Cooperation Project
	Air pollution duties between organizations are not clearly defined.	Technical Cooperation Project
Environmental Policy	Environmental standards and emission standards for air pollution have not been finalized.	Technical Cooperation Project
	Official measurement method for air pollutants measurement has been established.	Technical Cooperation Project
	Regulations or specific policies regarding fixed sources have not been established.	Technical cooperation Project
	The vehicle inspection system is almost non-functional.	No proposal in this survey (because it is necessary to discuss about the viewpoint of transportation policy)
Monitoring (Ambient Air)	Due to budgetary constraints, the future expansion of AirQo Project's activities is limited.	Technical Cooperation Project
	Difficult to properly maintain and evaluate the accuracy of air quality sensors.	Technical Cooperation Project
	It is essential to secure the budget to expand the air quality monitoring system.	Technical Cooperation Project
	Measurement of gaseous substances (SO_2, O_3, CO) has not been carried out. NO_2 measurement is also limited.	Technical Cooperation Project, SDGs Business Supporting Surveys
	There is no air quality monitoring station (AQMS). There is a possibility of introducing air quality measurement equipment and AQMS of Japanese companies, but it is necessary to consider the cost of transportation, installation, and maintenance.	Grant Aid
	High-precision PM component analysis equipment has not been installed, and there are no analysis methods and laboratories.	Grant Aid
Monitoring	Emission source monitoring has not been carried out and	Technical Cooperation

(Emission Gas)	emission inventory has not been updated.	Project or No proposal (because the contents are advanced)
	Since the existing emission inventory is old (ICF International, 2009) and the source contribution ratio is unknown, it is not possible to extract items that should be prioritized.	
Air Pollution Control (Vehicle Source)	Some ministries have prioritized measures against vehicle sources, but traffic jam in Kampala has not been sufficiently improved.	Support to Startups
	Even if private companies sell electric motorcycles, it is not profitable enough.	
Air Pollution Control (Fixed Source)	Implementation of fixed source measures for major factories has not been confirmed. It is important to introduce desulfurization, denitration, dust collection technologies, etc. and GHG emission reduction measures.	Technical Cooperation Project
	Since gas pipelines are not laid in Kampala and gas cylinders are expensive, it is not easy to switch from biomass fuel.	SDGs Business Supporting Surveys

Source: JST

(3) Priorities for Services that can be Offered

Improvement and strengthening of air quality monitoring and training of engineers, which are expected to be particularly supported by air pollution related organizations, are considered to be important for improving air quality in Kampala. However, it is not possible to immediately determine the priority of JICA's support at this time. Therefore, it is necessary to give top priority to continuing communication between JICA and Uganda side for the realization of support under the ownership of Uganda as mentioned earlier.

6.2.2 Recommendations for Proposed Aid Policies

(1) Participation in Issue-Specific Training

For Uganda and JICA to start discussions on support measures related to air pollution control, it is necessary to build a mutual human network. Participation of Uganda in the issue-specific training conducted by JICA is the most effective and efficient means currently envisioned. In the issue-specific training, the Japanese side plans the training content and proposes it to the developing countryside. It can be divided into training to limit the area and respond to issues by region, and group training that accepts trainees from multiple countries for one issue without limiting the area. The purpose is to share Japan's unique values, concepts, systems, and organizational structures, etc., by implementing training programs such as lectures, practical trainings, inspections, and discussions for trainees from each country. The result of this training is the formulation of an action plan, and the Japanese side will support the work of the person in charge of the other organization to identify the issues in their own country. There are several cases in which this training has led to JICA's support in the field of air pollution management.

The training in 2020 was held online due to the worldwide spread of COVID-19, but it will be held online as well as in the field if it becomes possible to visit Japan in 2021.

The group training in 2023 needs to be considered by the Government of Japan after receiving a request from the Government of Uganda by the end of August 2022. The number of attendees from one country may be limited to one or two, but participants in the training will consider work and action plans to identify issues in their own country and will continue to work with JICA after the training. Participant selection should be carefully considered as it is expected to be a key person in communication. Regarding the formation of future network between JICA and Uganda side, both parties have confirmed and discussed at the Workshop.

(2) Implementation of Technical Cooperation Projects and Grant Aid

If the need for JICA's support in the field of air pollution control in Uganda is confirmed through the above-mentioned efforts, it will lead to the implementation of technical cooperation projects and grant aid as shown in the table below.

Table 6.2.2 Support Contents (Draft) when Implementing a Technical Cooperation Project

Reasons for Needing Support (Issues)
➢ The officer of the implementing agency for air pollution control does not have sufficient knowledge and experience regarding air pollution, and human resource development is indispensable for the effective implementation of measures in the future. ➢ Environmental standards and emission standards for air pollution have not been finalized as of October 2021. Therefore, concrete measures have not been taken. ➢ The official method has not been established for the measurement of air pollutants, and accuracy cannot be guaranteed unless the air quality sensors are calibrated with other standard equipment (BAM1020). ➢ Ambient air quality monitoring is being carried out, but the monitoring items are mainly $PM_{2.5}$ and PM_{10}, and monitoring of major gaseous substances such as SO_2, NO_2, O_3, and CO is insufficient. ➢ Google is currently providing financial cooperation for the AirQo Project, but the major donors after 2022 are undecided, and it will be difficult to expand the monitoring system financially. ➢ Since the existing emission inventory is old (ICF International, 2009) and the source contribution ratio is unknown.
Goal
To enable the air personnel of the C/P organization to properly carry out air monitoring, measurement, analysis, and evaluation.
Target Organization (Candidate)

MoWE、NEMA、KCCA、AirQo Project	
Support Contents	
Ambient Air Quality Monitoring	➢ Support for establishment of official method to ensure high accuracy and continuous measurement. ➢ Promotion of air quality sensors for AirQo Project and establishment of the system that contributes to understand the detailed pollution status in wider area. ➢ Technical transfer for air pollution personnel to properly manage and analyze existing monitoring data and utilize it for policies. ➢ Introduction of automatic measurement equipment for monitoring gaseous substances such as SO_2, NO_2, O_3, and CO in addition to $PM_{2.5}$ and PM_{10}. ➢ Technical transfer of measurement principles, methods, data analysis and evaluation methods, etc. to air pollution personnel.
Air Pollution Control (Fixed Source)	➢ Support for grasping the emission status of air pollutants through appropriate inspections of factories and formulating and implementing air pollution control policies from each source. ➢ Support for grasping the emission status from fixed sources by measuring and taking appropriate measures.
Training in Japan	The purpose is to deepen knowledge of air pollution policy formulation, ambient air and exhaust gas monitoring, countermeasure technology, etc. It is assumed to include the background of air pollution countermeasures in Japan, explanation of specific countermeasure technologies, visits to air quality monitoring station, etc.
Others (Assuming appropriate selection based on detailed planning survey)	➢ Support for preparing emission inventory based on monitoring data to NEMA. ➢ A trial introduction of a gas stove by a Japanese company that contributes to the reduction of PM generated when burning biomass fuel at household and a survey of the reduction effect. ➢ Survey of air quality improvement effect by installing air purification equipment along the road (Considering the situation that $PM_{2.5}$ has already exceeded the WHO guideline value). ➢ Nationwide support for the installation of air quality sensors, which are being expanded by the AirQo Project.

Source: JST

Support from technical cooperation projects is considered important in order to address various issues comprehensively. However, since it is difficult to solve all the issues with one project, it is effective to approach the issues with high priority step by step.

For example, the following flow of support can be considered:

1) First, implementation of project specializing in the establishment of the air quality monitoring system to understand the current status of air pollution.

2) In the next project, promotion for the establishment of environmental policies based on the air pollution status, and the examination and implementation of measures to comply with them.

Table 6.2.3 Support Contents (Draft) when Implementing Grant Aid

Reasons for Needing Support (Issues)	
➢ Ambient air monitoring is being carried out using the air quality sensors, but it does not satisfy the measurement items required to grasp the pollution status, and calibration with other standard equipment is required to ensure accuracy. ➢ Since analysis equipment for PM component has not been introduced and there are no analysis methods and laboratories for analysis, it is not possible to grasp the breakdown and contribution of pollution sources. Therefore, it is not possible to narrow down the targets to be focused on.	
Goal	
The goal is to be able to properly carry out ambient air quality monitoring and PM component analysis in Kampala City, and to be able to grasp the pollution status and identify the source.	
Target Organization (Candidate)	
MoWE、NEMA、KCCA, AirQo Project	
Support Contents	
Air Quality Monitoring Station (AQMS)	Transportation and installation of Japanese AQMS to representative points in Kampala City.
Analysis Equipment for PM Component	The facility owned by the air pollution organization will be remodeled into a laboratory for PM component analysis, and analysis equipment for carbon, water-soluble ions, metals, etc., which are the main components of PM, will be transported and installed from Japan.
Common	Technical transfer to air pollution personnel about the principles and operation methods of measurement and analysis equipment, data management, analysis, and maintenance methods.

Source: JST

Air pollution control using the AQMS and analysis equipment for PM component are advanced considering the current system of air pollution-related ministries and agencies in Uganda, and it is considered difficult to implement them in the short term. In the future, if the local C/P organization requires the same level of measurement and analysis accuracy as in Japan, it will be necessary to provide these equipment. However, it should be decided after considering the sustainability of local operation, maintenance, and input costs.

(3) SDGs Business Supporting Surveys

This scheme aims to solve the problems faced by developing countries and to realize overseas expansion of Japanese companies by using their excellent technologies, products, and ideas.

First, Japanese companies that contribute to solving the problems of air pollution need to apply for and be adopted by this scheme. Through this survey, it was confirmed that Osaka Gas Co., Ltd. and HORIBA, Ltd. consider expanding their business into Uganda. As described in Chapter 5, both companies gave presentations online at the workshop. The outline of each company's products is shown below.

1) Osaka Gas Co., Ltd. (Air Purification Equipment)

At the Energy Technology Laboratories in this company, air purification equipment using Activated Carbon Fiber (ACF) as shown in photo below was developed and installed along the main road in Indonesia in 2019 by JICA's business demonstration project to measure the removal rate of nitrogen dioxide (NO_2). As a result, it was confirmed that NO_2 concentration decreased by 43% to 95% after the installation of ACF, and the effect of improving air pollution by installing ACF could be proved. In addition, pollutants such as NO_2 adsorbed on ACF are washed away by rain, so that ACF exerts its adsorption effect again and maintenance costs can be suppressed. Similar to this project, improvement of air pollution is expected even if ACF is installed along the main road in Kampala City.

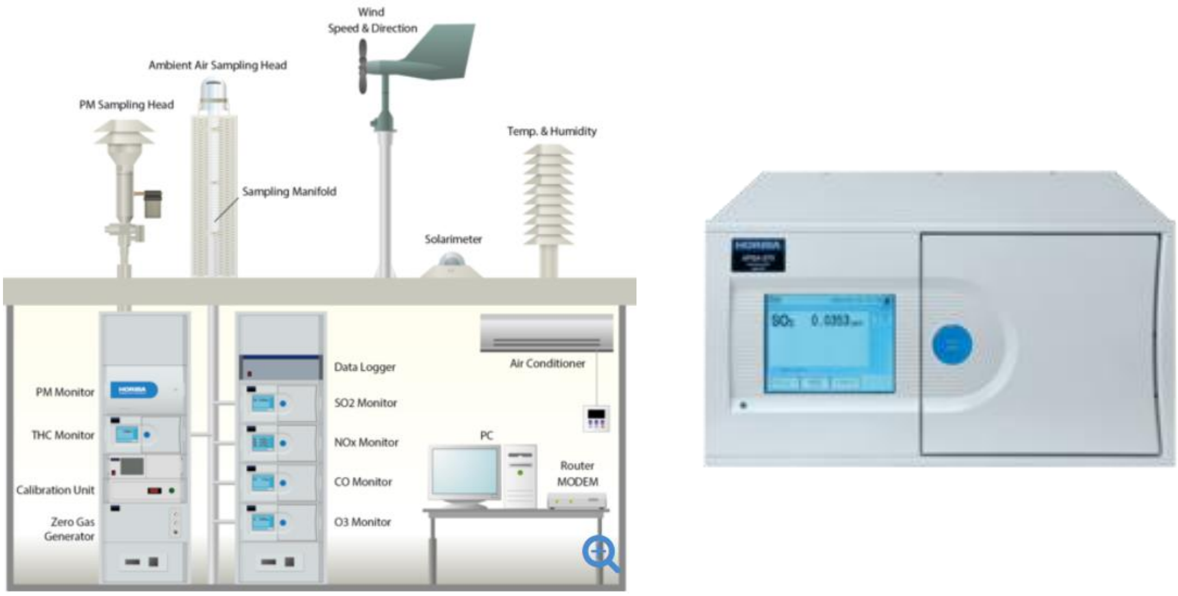
Source: JICA (2019) Measurement Result of Activated Carbon Fibers (ACF) Air Purification Unit in Jakarta

Photo 6.2.1 ACF Installed Along the Main Road in Indonesia by JICA Project

2) HORIBA, Ltd. (Air Quality Monitoring Equipment)

The company develops, manufactures, and sells air quality monitoring equipment, and has experience in selling and maintaining automatic continuous measurement equipment for air pollutants (as shown in

Figure 6.2.1) in developing countries such as Myanmar. Monitoring with air quality sensors is common in Kampala City, but when introducing this equipment for calibrating air quality sensors in the future, it is necessary to discuss not only with MoWE and NEMA but also with KCCA and AirQo Project that are conducting monitoring.



Source: HORIBA, Ltd.,
https://www.horiba.com/en_en/process-and-environmental/products/detail/action/show/Product/aqms-1560/

Figure 6.2.1 HORIBA, Ltd.'s AQMS (Left) and Automatic Continuous Measurement Equipment (Right)

(4) Support to Startups

The JICA Uganda Office provides support to local startups to promote the resolution of development issues through innovation. The startups to be supported are selected through the Business Plan Contest (NINJA) held by JICA in 19 African countries including Uganda, and the support period is about half a year. In the future, JICA anticipates support for startups that provide technologies and services that contribute to solve air pollution issues in Uganda, and electric motorcycle companies that promote the reduction of traffic-derived air pollutants can be considered as candidates. Examples are Bodawerk International Ltd., which gave a presentation on low-emission products using batteries charged by solar power generation at the workshop, and Zembo, which is promoting a pilot project related to the spread of electric motorcycles with KCCA.

(5) Dispatch of Expert

The officers of the implementing organizations for air environment policy and air pollution control in Uganda do not have sufficient knowledge and experience, and it is important to develop human resources in order to implement air pollution countermeasures as soon as possible. Therefore, not only the implementation of projects such as technical cooperation projects and grant aid, but also the dispatch of expert in the same field from Japan to provide direct guidance will enable efficient and effective human resource development and contribute to solving problems. The table below shows the draft outline of the dispatched expert.

Table 6.2.4 Draft Outline of the Dispatched Expert

Responsible Work	Air Environment Policy / Air Pollution Control (Ministry of the Environment)
Dispatched Organization	MoWE or NEMA
Role	➢ Advice on practical work such as formulation of air environment policy, implementation of measures, budget measures, etc., based on Japan's experience. ➢ Supporting the formation of projects related to air pollution control in the future by acting as an intermediary between JICA and the local C/P organization. * Actually, it is assumed that the expert will be in charge of all environmental fields other than air pollution.

Source: JST