No.

Lake Victoria North Water Services Board
The Republic of Kenya

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR AUGMENTATION OF WATER SUPPLY SYSTEM IN KAPSABET TOWN
IN
THE REPUBLIC OF KENYA

September 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO., LTD.

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Preface

In response to a request from the Government of the Republic of Kenya, the Government of Japan decided to conduct a basic design study on "The Project for Augmentation of Water Supply System in Kapsabet Town" and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kenya a study team from 25th August 2007 till 4th October 2007.

The team held discussions with the officials concerned of the Government of Kenya, and conducted field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Kenya in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

September 2008

Ariyuki MATSUMOTO
Vice-President
Japan International Cooperation Agency

September 2008

Letter of Transmittal

We are pleased to submit to you the basic design study report on "The Project for Augmentation of Water Supply System in Kapsabet Town" in the Republic of Kenya.

This study was conducted by NJS Consultants Co., Ltd., under a contract to JICA, during the period from August 2007 to September 2008. In conducting the study, we have examined the feasibility and rationale of the project, with due consideration to the present situation of Kenya and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Nobuki ABE
Chief Consultant
Basic Design Study Team on The Project for Augmentation of Water Supply System in Kapsabet Town in the Republic of Kenya
NJS Consultants Co., Ltd.

Summary

SUMMARY

Outline of Kenya

The Republic of Kenya (hereinafter; Kenya) is situated on the equator in east Africa and bounded on Ethiopia and Sudan in the north, Uganda and Lake Victoria in the west and Tanzania in the south. Land area is 580,000 km^2 and the population is 34.3 million in 2005. With regard to the economy, a negative growth occurred in 2006 due to the serious damages on agricultural crops and infrastructures caused by draught and/or heavy rain by El Nino phenomenon in the latter half of the 1990s, however, upswing appears in the recent years. The Gross National Income (GNI) and the GNI per capita in 2006 were 191 hundred-millions USD and 540 USD, respectively and the inflation rate was 4.3% in 2005. The proportion of each industry on the Gross Domestic Product (GDP) is respectively 27.9%, 17.4% and 54.8% of primary industry, secondary industry and tertiary industry including tourism.

Background of the Project

The Government of Kenya established a policy to drum up industrialization and/or privately operated business in parallel with the stabilization of agricultural production in "the 9th National Development Policy (2002-2008)". To attain this, the appropriate development and improvement of water supply services is raised as one of the goals. Under this policy, "National Water Policy" was issued in 1999 and the administrative reform on water sector has being progressed based upon the "Water Act" enforced in 2002 to concretise the said policy.

Kapsabet Town is located at the northwest with approximately 350km from the capital city Nairobi, and evolved at a rapid pace as an administrative and business centre of Nandi District. Water supply facilities using surface water source was constructed in 1948 and expanded in 1960 and 1980, respectively, however, its service area covers only 33% of the administrative district. In addition, current status of water service is significantly unstable due to the proceeding deterioration of facilities.

In particular, water treatment plat (WTP) had a design capacity of 820m^3/day, however, operation of the oldest unit out of total three (3) has been terminated owing to the deterioration. Therefore, only two units have been operated with a design capacity of 620m^3/day. In 2006, water supply decreased to around 550m^3/day due to the further progress of deterioration and the rationed water supply has been routinely carried out. The numbers of people who are accessible to water services are estimated as about 5,000 persons (approximately 15%) only among the urban population of 33,000. This means that water supply is extremely insufficient against the water demand. The people without water supply services rely on the springs for domestic use, and thus the improvement of the living environment became the prime task because the risks by waterborne disease and the burden of water fetching has become tangible.

The government of Kenya requested the Grant Aid by the Government of Japan to improve such circumstances and increase the population served up to 47,500 persons. JICA conducted the basic design study in 1993 to that end, however, the project was not realized after all, since the conditions (construction of sewerage system, improvement on organization and budget arrangement) to be bone by the Kenyan side were not fulfilled.

Among those three (3) issues, the construction of sewerage system was already completed in 2002. With regard to the other issues, Kapsabet Town came under the jurisdiction of Lake Victoria North Water Services Board (LVNWSB) base upon "Water Act" effected in 2002 and Kapsabet Nandi Water and Sanitation Company (KNWSC), operating actual water services on the basis of service provision agreement with LVNWSB, was established in December 2006.
Under the above situation, the Government of Kenya again requested the grant aid by the Government of Japan in accordance with well-regulated implementation system. The requested scope was to augment the supply capacity to 10 times of the existing one. Through the discussion between both countries, it was agreed that the scope was focused to the rehabilitation and expansion of the existing facilities utilizing the water source from the Kabutie River.

Outline of the Study Result and Contents of the Project

In response to a request from the Government of Kenya, the Government of Japan decided to conduct the basic design study on "The Project for Augmentation of Water Supply System in Kapsabet Town" and entrusted the study to JICA. JICA sent to Kenya the study team from 25th August 2007 until 4th October 2007. Likewise, the mission was sent to Kenya in July 2008 to discuss the draft basic design.

In the basic design study, the target service areas were identified as Kapsabet township and its surrounding areas (Kapngetuny, Kamobo, Kamurguiywa, Kimaam and Kipture) and planning frame was set up as 3,600m^3/day of water demand for the design population served of 32,500 for the target year of 2015 taking the population growth and water consumption by use into account. Consequently, 3,800m^3/day of water source (incl. the water for miscellaneous use at WTP) is absolutely required for the Project. Based on the analysis of the past discharge of the Kabutie River, it was anticipated that there might be a difficult period to secure the required water flow in 10-year return period, however, concluded that design intake flow would be secured in 5-year return period.

With regard to the intake/conveyance facilities, based on the topographic survey and hydraulic analysis, it was confirmed that flow capacity with 3,800m^3/day can be secured by increasing the diameter of raw water pipeline compared to that of the existing one without raising the existing intake weir which is requested by Kenyan side.

As for water treatment facility, it was concluded that the rehabilitation of the existing WTP which is also a requested component, is not necessary considering the required cost for re-construction of the severely deteriorated and damaged facility with a small design capacity. In addition, it was anticipated that the ineffectiveness of operation and maintenance, since new WTP is to be constructed on the opposite bank of the Kabutie River where the existing WTP is located. Thus, it was decided that the design capacity (originally 820 m^3/day) of the existing WTP will be merged to that of new WTP.

With regard to the transmission and distribution system, construction of new service reservoir at the elevation of 2,040m in Kiminda district was planned in order to distribute water to service areas by gravity, and single-stage pumping system is planned to deliver water from new WTP to the said reservoir.

As for pump equipment, 4 units (incl. 2 units of standby) of pumps is planned in order to avoid any impact on operation of WTP considering the local situation against the accident. Flywheel will also be provided as a countermeasure against the water hammer in case of sudden stop of pump run. As for transmission pipeline, steel pipe is to be employed considering the elevation difference between WTP and new service reservoir as well as water hammer. As to distribution pipe, in addition to the requested primary pipes, installation of the secondary pipes and a part of service connections are to be included in the plan, because it was considered that Kenyan side cannot afford to install such necessary pipelines in order to ensure stable water supply when the construction works complete.

With regard to the equipment procurement, provision of water meters (incl. materials for service connection), water meter testing equipment, tools for &M, water quality examination equipment and computer equipment (incl. relevant software) for billing/accounting system is to be procured in the Project.

In order to enhance the performance of business operation of water services and maintain the sustainability, it was judged that a strong engineering and management support would be effective. In line with this, the soft component program for engineering and management fields was planned.

The scope of works of the Project is summarized as below. Water supply capacity will be augmented from the current 620m^3/day to 3,600 m^3/day by the Project.

Scope of the Works of the Project

（1）Facility

Facility	Brief Description	Remarks
Intake weir	Rehabilitation of the existing weir (Height 1.0m, Length 28.0m)	Rehabilitation
Raw water pipeline	Ductile iron pipe/uPVC, Dia. 250mm, Length 0.7km	Construction
Water treatment plant	Design capacity: 3,600m^3/day Receiving well/pre-sedimentation tank, Mixing/flocculation basin, Sedimentation basin, Rapid sand filter, Wash water tank, Clear water reservoir, Sludge drying bed, Chemical house, Administration building, etc.	Construction
Transmission pump	φ150 x 1.25m^3/min x 160m x 75kW, 4 units (incl. 2 stand-by)	Construction
Transmission pipeline	Steel pipe, Dia. 250mm, Length 2.9km	Construction
Reservoir	Ground reservoir 1,050m^3 x 1 unit, 600m^3 x 1 unit	Construction
Distribution pipelines	Primary pipe: uPVC, Dia. 300-200mm, Length 4.0 km Secondary pipe: uPVC /Steel pipe, Dia. 200-50mm, Length 22.2 km Total 26.2 km	Construction
Service connection	400 nos. (Installation of water meters shall be carried out by Kenyan side.)	Construction

（2）Equipment Procurement

Item	Brief Description
Water meters	Water meters (1,700 units), Service pipe materials incl. saddle clamps, etc. (for 1,300 connections), Tapping tool (2 units), Installation works shall be done by Kenyan side.
Water meter testing equipment	Measuring tank (300 L), Rotor meter, accessories
Tools	Tools for O&M of plumbing works and Mechanical & Electrical equipment
Water quality examination equipment	Turbidity meter, pH meter, Residual chlorine checker, Jar tester, etc.
Computer equipment for billing/accounting system	Server (2 units), Desk top PC (6 units) and related equipment, Software (Windows, Billing software)

（3）Soft Component

Item	Brief Description
Engineering training	Training for O&M of water supply facilities
	Training for leakage prevention and water meter management
Management training	Training for strengthening business operation
	Training for billing and accounting system operation
	Training for public education

Project Implementation Period and Cost Estimation

With regard to implementation period, it is anticipated that 4.5 months for the detailed design, 3 months for tendering and 22.5 months will be required for the equipment procurement and construction works and. Total 33.5 months will be required for the project implementation including a conduct of soft component program. The project cost to be born by Government of Kenya is estimated to be approximately 0.161 billion Yen .

Verification of Project Adequacy

This Project aims to improve water supply services of Kapsabet Town through realizing stable supply of safe potable water and it also corresponds to the upgrading in water supply system which the Government of Kenya declared in "9th National Development Plan (2002 - 2008)" as one of the national targets. Major components of the project are construction of new water supply facilities to replace the existing deteriorated facilities and equipment procurement for O&M of water supply system and computer equipment for billing/accounting system under the Project. Further, human resource development needed for operation and management of water supply business is to be conducted both in technical and managerial aspects through Soft Component. In addition, managerial support is also provided by public education to involve the residents of Kapsabet Town as stable customers and to maintain the water supply business properly.

O&M cost for the facilities to be constructed by the Project cannot be covered by the current water tariff system, if large scale of price escalation in electricity, for instance, is accounted. To cope with this, at least 20% of tariff raise is needed and such increase range is still affordable for end users based on the social condition survey. In addition, considering that debt of KNWSC has been compensated by LVNWSB until now, O&M cost will be dully covered by collecting the water tariff with acceleration of water meter installation.

The following items can be expected as direct project effect:

- Total water treatment capacity is strengthened from current 620 m^3/day to 3,600m^3/day.
- Current 5,000 population accessible to water supply services is expected to increase to 32,500（Ratio to total population of the service area: 15%→78.5%）.
- Current 340 numbers of service connections is expected to increase to 6,500.
- Water tariff revenue will increase according to increase of service connections and water supply business becomes stable by appropriate billing brought by installation of water meter s.
- 24 hours water supply will be realized and safe drinking water will be secured as well.
- Establishment of billing and accounting system will make business operation effective.
- Capability for O&M of water supply facilities and business operation will be strengthened by management support through soft component program.

Furthermore, the following items can be expected as indirect project benefit:

- Morbidity of water-borne disease such as Diarrhea and Cholera decreases by realizing stable supply of safe drinking water

- Water fetching burden for women and children is mitigated by using individual water taps.

As aforementioned, significant project effects are anticipated and this project also contributes to the improvement in broad BHN of residents. Though current status of relevant organizations in recipient country is insufficient in terms of technical level and number of staff, such issues can be covered by endeavor in staff increase and budget allocation by the Government of Kenya and by soft component to be implemented in the course of the Project. Therefore, adequacy of the project execution by Japanese Grant Aid is verified.

For further effective and efficient project implementation, the Government of Kenya shall take the initiative upon the following items:

1) To secure the budget for the project cost to be born by the Government of Kenya.
2) To coordinate with the relevant agencies regarding necessary transactions in the project .implementation
3) To encourage the staff to participate in the training program and enforce capacity development.
4) To install the water meters (including service pipe materials) to be provided by the Project timely and promote new service connection.
5) To collect water tariff properly.

As the Government of Kenya recently requested the technical assistant project for NRW reduction to the Government of Japan, it is desirable that LVNWSB, the implementing agency of the project, be involved in the said project to further ensure the project effects.

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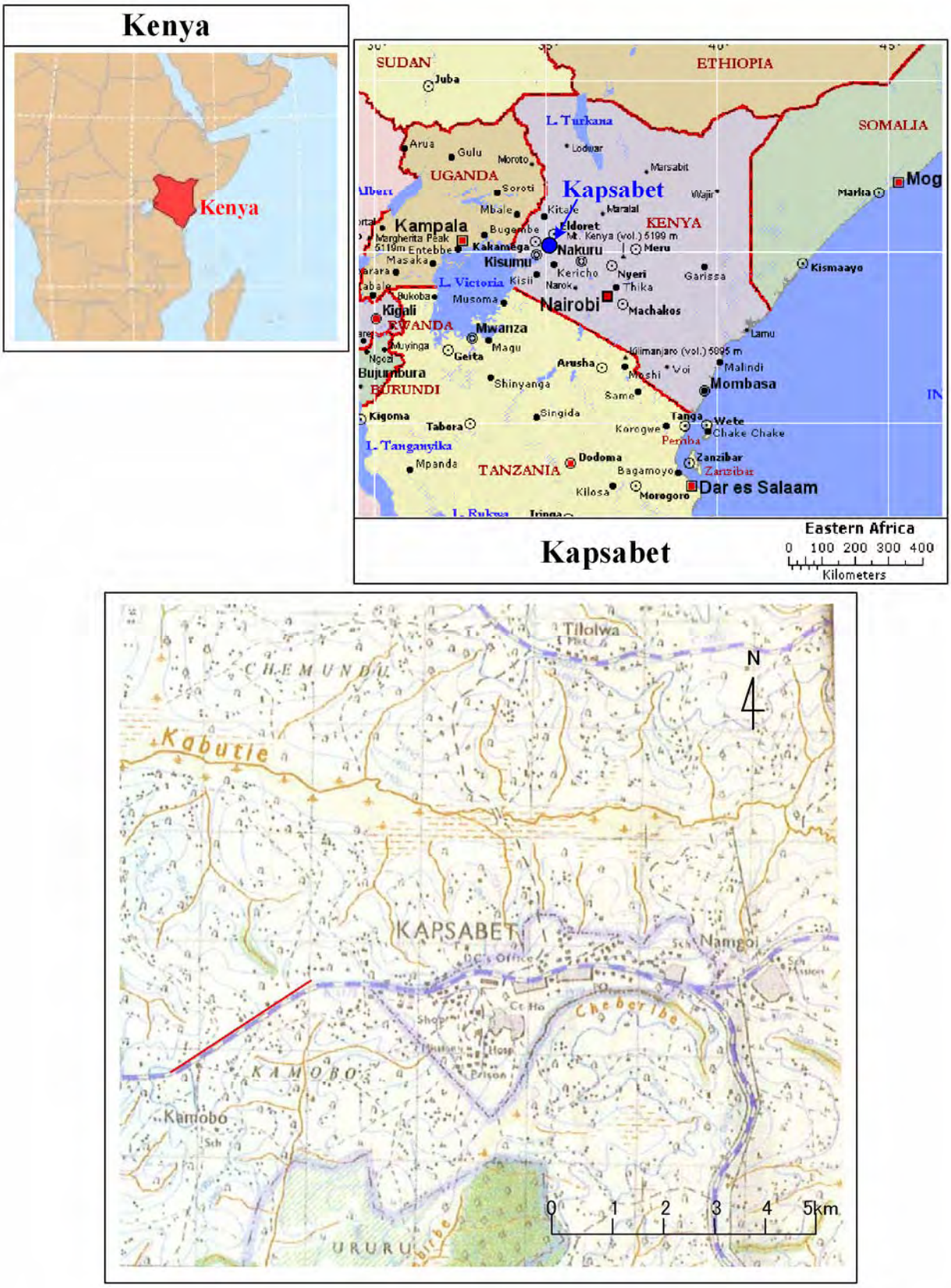

Figure-1 Location Map

Figure-2 Perspectgive

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Abbreviations

AfDB:	African Development Bank
AFD:	Agence Française de Developpement
A/P:	Authorization to Pay
B/A:	Banking Arrangement
BHN:	Basic Human Needs
CAAC:	Area Advisory Committees
DANIDA:	Denmark International Development Assistance
EAC:	East African Community
EIA:	Environmental Impact Assessment
EL:	Elevation
E/N:	Exchange of Notes
F/S:	Feasibility Study
GDP:	Gross Domestic Product
GTZ:	Deutsche Gesellschaft fur Technische Zusammenarbeit
GNI:	Gross National Income
HWL:	High Water Level
JETRO:	Japanese External Trade Organization
JICA:	Japan International Cooperation Agency
KfW:	Kreditanstalt fur Wiederaufbau
Kshs:	Kenyan Shilling
LWL:	Low Water Level
LVNWSB:	Lake Victoria North Water Services Board
M/D:	Minutes of Discussion
MoWI:	Ministry of Water and irrigation
NEMA:	National Environment Management Authority
NWRMS:	National Water Resources Management Strategy
NWCPC:	National Water Conservation and Pipeline Corporation
KNWSC:	Kapsabet Nandi Water and Sanitation Company
M/M:	Man Month
m^3/hr:	Cubic meter per hour
m^3/d:	Cubic meter per day
NGO:	Nongovernmental Organization
NRW:	Non-Revenue Water
ODA:	Official Development Assistance
OECD:	Organization for Economic Cooperation and Development
SIDA:	Swedish International Development Agency
UNDP:	United Nations Development Program
UNICEF:	United Nations Children's Fund
USD:	US Dollar
VAT:	Value-Added Tax
WAB:	Water Appeal Board
WHO:	World Health Organization
WRMA:	Water Resources Management Authority
WRUA:	Water Resources Users Association
WSRB:	Water Services Regulatory Board
WSTF:	Water Services Trust Fund
WSB:	Water Services Board
WSP:	Water Services Provider
WTP:	Water Treatment Plant

1 Background of the Project

1-1 Present Condition of Water Sector

1-1-1 Present Condition and Need for the Project

The Ministry of Water and Irrigation (MoWI) and the National Water Conservation and Pipeline Corporation (NWCPC) have historically shouldered the water services in Kenya. Presently, MoWI undertakes the national level policymaking/monitoring and coordinating, and the Water Services Boards (WSBs) under the jurisdiction of MoWI are responsible for the development of water supply facilities in accordance with the "Water Act" established in 2002. There are a total of seven (7) WSBs in the whole country. The actual water services are carried out by the Water Services Providers (WSPs) under respective WSBs on the basis of service provision agreement (SPA).

In Kapsabet Town, the object area of the Project, the water services are being managed by Kapsabet Nandi Water and Sanitation Company (KNWSC) based on SPA with Lake Victoria North Water Services Board (LVNWSB). The current condition of water services is extremely poor to tap new service connections because of chronic water supply shortage and/ or rationing due to deterioration of the facilities. Thus, there is urgent necessity of construction and rehabilitation of the water supply facilities. In addition, the appropriate operation and maintenance of water supply facilities and improvement of billing and accounting system, financial management and others are issues on pushing through sound business operation. KNWSC has not sufficient capability to deal with, since it was established only 2 years ago.

1-1-2 National and Sector Development Plans

The Government of Kenya established a policy to drum up industrialization and/or privately operated business in parallel with the stabilization of agricultural production in "the 9th National Development Policy (2002-2008)". To attain this, the appropriate development and/ or improvement of water supply services is raised as one of the goals, since the stable water supply is absolutely essential. Under this policy, "National Water Policy" was issued in 1999 and the administrative reform on water sector has being progressed based upon the "Water Act" enforced in 2002 to concretise the said policy.

In line with this, the National Water Resources Management Strategy (NWRMS) has been developed by the MoWI in January 2007. The overall goal of NWRMS is to eradicate poverty through the provision of water for domestic and water productive use. The fundamental objectives for managing Kenya's water resources are to achieve equitable access to water resources and their sustainable and efficient use through

the following measures.

- To improve water resources assessment so as to obtain more accurate figures of the annual freshwater safe yield of surface water and groundwater resources
- To put in place mechanisms that promote equal access to water for all Kenyans
- To enhance and strengthen roles of gender in Water Resources Management
- To create mechanisms for an integrated approach to land and water resources planning and management on a catchment basis
- Create mechanisms for catchment conservation and management
- To put in place measures that enhance the availability of water resources of suitable quality and quantity where and when it is needed
- To put in place strategies that will promote the production of accurate data on water use and demand for both surface water and groundwater
- To provide guidelines for private sector financing in the water sector as well as to improve opportunities for self financing and amelioration of public sector financing
- To develop water pricing policies and mechanisms which recognize water as an economic good
- Provide guidelines and incentives (e.g. Tax rebate, penalties) for adoption and implementation of rainwater harvesting through artificial ground water recharge and direct use
- To develop policies and mechanisms on disaster management
- To promote integration of sector and regional water policies
- To promote harmonization and integration of trans-boundary water resource use

1-1-3 Socio-Economic Conditions

Kenya broke away from the United Kingdom in 1963, changed as the Republic of Kenya in 1964 and became a member of the Commonwealth. Mr. Jomo Kenyatta, the first president, promoted the government policy cooperated with the United Kingdom and positively recruited the local African as public officer or managerial-level staff, and promoted the industrialization by embracing the capital from aboard. Presently, President Mwai Kibaki governs Kenya successor to Mr. Kenyatta and Mr. Moi (Daniel Toroitich Arap Moi).

The House belongs to unicameral system and the tenure for the Member of the House is set as five (5) years. The local province consists of seven states and Nairobi Special Region. State Government and State House responsible for local autonomy exist in each state respectively.

With regard to the diplomatic agenda, Kenya adopts nonaligned diplomacy as her slogan. However, Kenya

always sustains and deepens the relationship with the United Kingdom together with the various countries of Europe and America. Kenya belongs to the important stabilizing force in East Africa, and also absorbs numerous refugees from the surrounding countries. Recently, Kenya is also positively involved in peace settlement such as the dispute between Ethiopia and Eritrea, civil/national conflict between Somali and Sudan etc. Kenya also promotes the East African Community (EAC) together with Tanzania and Uganda; therefore, Kenya is responsible for a significant role in East Africa.

With regard to the economy in Kenya, the Gross National Income (GNI) and the GNI per capita in 2006 were 191 hundred-millions USD and 540 USD respectively and the inflation rate was 4.3% in 2005. Agriculture is the staple industry in Kenya with the leading exports such as black tea, horticultural crops, and coffee beans in addition to the prosperous outputs such as sugarcane, corn, cotton, and insect flower etc. However, the manufacturing and service industries show higher ratio on Gross National Product (GNP) against the relatively lower ratio in agriculture. In addition, oil refining, flour milling, textiles, sugar manufacture, battery, and automobile assembly etc. are the most ongoing industrials in East Africa. On the other hand, foreign currency earnings by those tourists from abroad have a lot to do with the comfortable climate and abundant variety of wild animals in service industries. With regard to the economy, a negative growth occurred in 2006 due to the serious damages on agricultural crops and infrastructures caused by draught and/or heavy rain by El Nino phenomenon in the latter half of the 1990s, however, upswing appears in the recent years (growth rate with 1.1%, 1.8%, and 4.3% in 2002, 2003 and 2004 respectively). Then, growth rate in 2006 became 6.1%. The proportion of each industry in the Gross Domestic Product (GDP) is 27.9% for primary industry, 17.4% for secondary industry and 54.8% for tertiary industry including tourism. Furthermore, the National Statistics Office estimated the actual growth rate as 7.0% (provisional figure) for Year 2007.

Kenya unveiled the “Economic Revival Strategy for the Wealth and Employment Creation” in June 2003, and positively tackled the promotion of trade and investment through twice holdings of investment meeting so far. In March 2004, the common external tariff was signed among the three countries of Kenya, Uganda and Tanzania.

Kapsabet Town fixed up an urban figuration during the colonial period of United Kingdom as same as other cities in Kenya, and was thus specified as the metropolis of Nandi District in1985. In addition as a district capital, Kapsabet Town possess local offices of the central government and is crowded with the people of approximately 65,000 at present. Kapsabet Town has also been developed as a distributing centre of materials, and processing of agricultural products such as black tea and milk etc. produced in the

peripheral areas. Moreover, the educational institution can also be given as a feature of Kapsabet Town, such as the Kapsabet Girls' High School, the Kapsabet Boys' High School, the AIC College, the Bible College, the school for the handicapped and nursing school exist in addition to the common elementary and high schools.

1-2 Request from Recipient Country

Kapsabet Town is located at the northwest with approximately 350km from the capital city Nairobi, and evolved at a rapid pace as an administrative and business centre of Nandi District. Water supply facilities using surface water source was constructed in 1948 and expanded in 1960 and 1980, respectively, however, its service area covers only 33% of the administrative district. In addition, current status of water service is significantly unstable due to deterioration of the facilities. Although three units of water treatment facility have been constructed with total design capacity of 820m^3/day, operation of the oldest unit has been terminated owing to the deterioration. Therefore, only two units have been operated since then. Consequently, the overloaded operation by 1,040m^3/day has been practiced for a certain period in spite of the design capacity of 620m^3/day. As a result, in 2006 water supply decreased to around 550m^3/day due to the further progress of deterioration and the rationed water supply has been routinely carried out. The numbers of people who can access to water service are estimated as about 5,000 persons (approximately 15%) only among the urban population of 33,000. This means that water supply volume is extremely insufficient against the water demand. On the other hand, residents without water service rely on the springs for domestic use, and thus the improvement in living environment becomes the prime task because the issues of the risk by waterborne disease and/or the imposition by water fetching labor has become tangible.

The government of Kenya requested the Grant Aid by the Government of Japan to improve such circumstances and to upgrade the service population up to 47,500 persons. JICA conducted a basic design study in 1993 however, the project was not implemented because the agreement for three (3) items (construction of sewerage system, improvement on organization and budget provision) stated in the Article on the "Costs to be Borne by the Government of Kenya" was not achieved.

Among these three (3) issues mentioned above, construction of sewerage system had been completed by Kenya in 2002. With regard to the two (2) remained issues, Kapsabet Town came under the jurisdiction of LVNWSB based upon the effective "Water Act" enacted on 2002 involves the project execution organizations. In addition, KNWSC conducts the actual water service business under the consignment contract from LVNWSB was established on December 2006. In such circumstances the Government of Kenya again requested the grant aid by the Government of Japan. The requested scope was to augment the

supply capacity to 10 times of the existing one. Through the discussion between both countries, it was agreed that the scope was focused to the rehabilitation and expansion of the existing facilities utilizing the water source from the Kabutie River.

The requested contents are summarized as below:

1) Facility

- Rehabilitation of the existing intake weir and water treatment plant (820m^3/day)
- Construction of new water treatment plant (3,000m^3/day) and service reservoirs (ground reservoir and elevated tank), Installation of transmission pump (2 units), raw water pipeline, transmission pipeline and distribution pipelines.

2) Equipment Procurement

- Water meters, Water meter testing equipment, Spare parts, Water quality examination equipment (pH meter, Turbidity meter, Residual chlorine checker, Jar tester), tools and Computers

3) Technical assistance

- Organization strengthening and Customer services (Improvement of billing and accounting system, Promotion of water meter installation, Trainings, Public education)

1-3 Japanese Assistance

The assistance on the water supply sector in Kenya is summarized in Table 1-1 and Table 1-2 which indicate the implementation on Development Study, Loan Assistance, and Grant Aid respectively. The experts have been dispatched all these years since 1977. Recently, the project not only providing the equipment and facilities but also emphasizing the soft component field has being positively progressed. For instance, "The Meru City Water Supply Project" taking particular note of the community-based management and the dispatch of the expert to the pilot water supply projects with sustainable operation was successfully implemented.

Table 1-1 Technical Assistance and Loan Project Assisted by Japanese Government

Type	Year	Project/others	Remarks
Dispatch of Experts	-1990	Water supply experts (11) Water resources development expert (1)	
	1991-	Water supply experts (4) Water resources development (7) Water supply business experts(2)	
Development Study	1981	The Study on Augmentation of Water Supply System for Mombasa	F/S for augmentation of water supply system for Mombasa City including neighboring towns for target year 2000

Type	Year	Project/others	Remarks
	1988-1990	The Study on Construction of Marewa Dam	F/S for dam construction to secure water source for Nakuru and other cities in Rift Valley Province
	1995-1997	The Study on Water Supply for Meru	Master plan and F/S on Development of Meru Water Supply System
	1995-1997	The Study on Kisumu Water Supply and Sewerage System	Master plan and F/S for expansion and rehabilitation of Water supply and sewerage system in Kisumu
	1995-1998	Aftercare Study on Water Resources Development in Kenya	
	2000	The Study on improvement of water supply business for rural cities	Development study carried out by JICA Kenya office
Loan	1986-1994	Greater Nakuru Water Supply Project	Construction of intake facility, treatment plant (18,000m^3/day)
	1988-1994	Nairobi Water Supply Project	Construction of water supply facility including dam to augment supply capacity (194,000m^3/day), Co-finance with WB, AfDB, etc.

Table 1-2 List of Grant Aid Project by Japanese Government

(Unit: Billion Yen)

Fiscal Year	Project Name	Limit of Grant Aid Amount (E/N)	Remarks
1977	Water Supply Development for Itanga	0.4	
1981	Groundwater Development	1.2	
1982	Expansion of Water Supply System for Itanga	0.04	
1988	Groundwater Development Project	1.2	
1988	Water Supply Development for Tabeta and Lumi	0.99	
1999-2000	Groundwater Development for Raikibia Province (Phase1, Phase 2)	1.03	Construction of deep wells (total 90 units), technical assistance for 90 nos. water utility associations and public education
2001-2003	Meru Water Supply Project (Phase1, Phase 2)	1.37	Improvement of water supply system in Meru, technical assistance for NRW reduction
2004-2007	Rural Water Supply Project (Phase1, Phase 2)	0.81	Construction of deep wells (total 53 units) for 4provinces (Machakos,

Fiscal Year	Project Name	Limit of Grant Aid Amount (E/N)	Remarks
			Kitui, Mwingi, Makueni), soft component program for O&M of water supply facility

1-4 Activities of Other Donors

Table 1-3 shows the recent projects for water sector assisted by the other donors such as WB, AfDB, UNICEF, GTZ, KfW, DANIDA etc. In particular, KfW, among them has been extending assistance to LVNWSB through providing loan for construction of the water supply facilities as well as grant aid for institutional enhancement including billing system improvement.

Table 1-3 Recent Project Assisted by Other Donors (Water Supply Sector)

（Unit：thousand US$）

Year	Donor	Project	Amount	Type	Remarks
2004-2007	WB	Institutional Strengthening of Nairobi Water Supply and Sewerage	18,781	Grant	Institutional support for Nairobi Water and Sanitation company
2004-2008	UNICEF	Water Supply and Sanitation Program	4,695	Grant	Improvement of access to water, hygiene and sanitation in ASAL districts
2004-2008	GTZ	Program for Legal and Institutional Reform in the Water Sector	6,829	Grant	Support for establishment and operation of new institutions
2004-Present	DANIDA, SIDA	Kenya Water Supply and Sanitation Program	60,952	Grant	Improve access to water and sanitation in rural community
2006-2007	AFD	Urgent Rehabilitation Project for Nairobi Water Supply and Sewerage	51,221	Soft loan	Rehabilitation of Sasumwa Dam and water and sewerage infrastructure
2007-2008	AfDB	Kisumu Water Supply and Sanitation Project (Phase 1)	29,025	Loan	Rehabilitation and expansion of water and sewerage system
2007-2008	AFD	Nakuru Water Supply and Sanitation Project	18,781	Loan/Grant	Rehabilitation and expansion of water system

On-going	KfW	Nzoia Cluster Water Sector Development Project	44,391	Loan/Grant	Institutional capacity building, expansion of water supply system

1-5 Natural Conditions

(1) Topology

Kapsabet Town is located in the equator. The lowest elevation is 1,894 m above sea level at Kabutie River rising steeply to 2,030 m at the existing water storage area in town of co-ordinates; N=0.2066^{o}; E=35.11768^{o}. The terrain is mostly rolling hilly ground creating valleys with steep slopes. The township sub-location is formed in a long and slender ridgeline of 1.9 km in the north – south and 3.2 km in the east and west.

(2) Geology

The geological history of Kapsabet Town can be divided into three geological ages. The oldest rocks are early Precambrian in age and are represented by gneisses of the basement system, which are highly metamorphosed by vast, mainly basaltic lava intrusions of the Nyanzian system. During the tertiary age, volcanic movements resulted in uplifts and formation of sub-miocene lake-beds. Volcanic rock extrusions formed in the late tertiary age resulted in the formation such cones as the Tindret Highlands. In recent age, erosion of these formations has resulted in the present land surface with well drained, red, loamy and friable clays being the pre-dominant soil types. Where drainage is poor, e.g. in the Kingwal swamps, black cotton soils are prevalent. In the field study period, the plate loading test was conducted to confirm the bearing capacity of the proposed sites of WTP and service reservoirs for selection of appropriate construction method. As a result, it was observed that the nature of soil in the proposed sites for service reservoirs were quite similar at a depth of 2.0 m, being red silty clay. The bearing capacities at the said depth are also quite close; 194 and 182 kPa respectively. Site for WTP has a higher bearing capacity of 220 kPa, presumably due to the prospects of underlying weathered rock and alluvial deposits of silty clay soil.

(3) Climate

The climate is determined by the equatorial low-pressure belt known as the Inter Tropical Convergence Zone (ITCZ) and its situation between two pressure belts produced in the north and south hemispheres. According to the exaltations of the pressure system following the earth position in relation to the sun, the weather associated with the ITCZ will produce one rainy season in the tropics, and two rainy season under the equator.

The average temperature is 20^{o}C, the highest is 23^{o}C which occurs in the month of December and January

and lowest is 12°C which occurs in the month of July/August. This corresponds with occurrence of the dry and wet seasons. The relative humidity ranges from 87% to 96% at sunrise and 35% to 61% in the afternoon, with maximum in July and minimum in February. The average daily evaporation is estimated at 4.80mm with the monthly at 145mm. The prevailing winds are northerly and southerly. The northerlies are stable throughout the year and recede completely in May and August. The northeasterly and southerly winds are fairly stable all year round. The former being most intense during November while the latter during August. The highest wind velocities occur with north easterlies. Predominating speed intensity is 0.5-5.6 meters per second. On average, Kapsabet receives an average annual rainfall of 2,179 mm, which occurs in 136 wet days per year and in two rainy seasons: Long rains, which occur from March to June, and short rains, which occur from September to November. Table 1-4 and Figure 1-1 show the average monthly rainfall in Kapsabet and Eldoret for recent 3 years.

Table 1-4 Average Monthly Rainfall (2004 – 2007)

(Unit: mm)

Place/Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Kapsabet	97	88	166	280	257	191	276	276	153	134	209	96
Eldoret	44	57	106	176	153	100	194	256	103	50	136	66

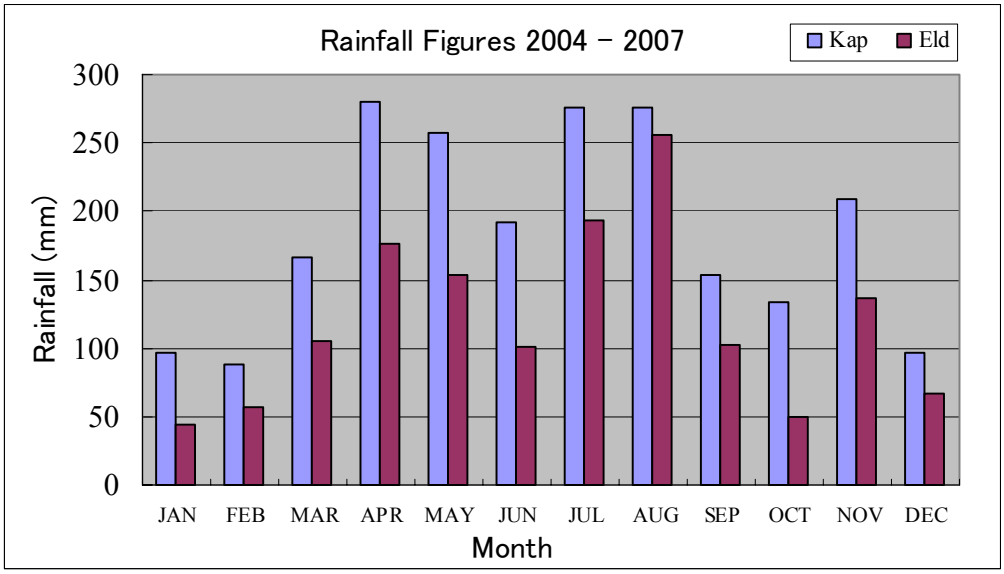


Figure 1-1 Average Monthly Rainfall (2004-2007)

(4) River Water Quality

The Kabutie River, a water source for Kapsabet Town, flows into the Kimondi River. During rainfall the river water contains a lot of clay and silt and looks red brown. In the field study period, water quality examination was conducted. There was no sign of the hazardous matters (cyanide, mercury) contained in

the river water. Considering the result (pH, turbidity, Alkalinity), it was confirmed that conventional water treatment process is applicable for raw water of the Kabutie River. The concentration of iron and manganese exceed the WHO Guidelines, however, there were no experiences of water quality problem such as red water arising from iron and black water due to manganese. Therefore, the constitution of iron is regarded as dissolved type which can be removed by sedimentation and filtration process. On the other hand, it is considered the analysis of manganese might have error in comparison of the past records. Therefore, it is necessary to verify in the detailed design stage.

Table 1-5 Result of Water Quality Examination

Item	Unit	Sampling Date		WHO Guidelines
		Sep. 20 '07	Dec. 21 '007	
pH		7.4	7.4	-
Turbidity	FTU	17	85	5
Electric Conductivity	µS/ cm	80	79	-
Iron	mg/L	2.02	1.55	0.3
Manganese	mg/L	2.52	2.27	0.1
Total Hardness	mg$CaCO_3$/1	10.4	10.8	-
Total Alkalinity	mg$CaCO_3$/1	49	53	-
COD	mg/L	26	28	-
Cyanide	mg/L	ND	ND	0.07
Mercury	mg/L	ND	ND	0.001
Copper	mg/L	ND	ND	1.0
Suspended Solid	mg/L	12.3	18.8	1000
Calcium	mg/L	8.49	-	-
Phosphorous (PO_4)	mg/L	0.13	-	
Magnesium	mg/L	2.52	-	-
Sulfide	mg/L	5.59	-	-
Nitrogen Nitrate	mg/L	0.01	-	50 (Nitrate + Nitrite)
Nitrogen Nitrite	mg/L	0.15	-	
Chloride	mg/L	1.40	-	250

1-6 Social and Environmental Considerations

(1) Water Right

Water right was issued from Water Resources Management Authority (WRMA) to LVNWSB on 13th November 2007. There are no particular conditions specified in the license which may restrict construction works and abstraction of river water.（See Appendix 7-2）

(2) EIA

Regarding EIA for the Project, the license was issued by National Environment Management Authority (NEMA) to MoWI on 11th October 2006. There are no particular conditions pointed out for the implementation of the Project. （See Appendix 7-1）

During the field survey, however, the followings were confirmed.

1) Hydrometry of the Kabutie River, forecast of flow fluctuation and its impact by intake weir's rehabilitation

The required intake water volume by the Project will increase up to 3,800m^3/day. The measured discharge of the Kabutie River, the tributary of the Kimondi River was 2.64m^3/s (280,000m^3/day) during rainy season. The same of the Kimondi River was 5.21m^3/s (450,000m^3/day) during dry season. On the other hand, it was analyzed that the discharge of the Kimondi River is 8 - 9 times in comparison with the same of the Kabutie River. Moreover, The kabutie River has a lot of springs and tributaries between the intake weir and the confluence with the Kimondi River. Therefore, it can be considered that there will be no significant impact to the downstream reach of the intake works except for the drought year with 10-year return period. (Refer to the details in Sub-Section 2-2-2-2.)

2) Land acquisition and resettlement

The proposed sites for the new WTP and service reservoir belong to municipal and private property respectively. Presently there are no residents within both sites and the procedure for the land acquisition was already finished. Similarly, there are no inhabitants along the proposed pipeline routes. Therefore, there is no necessity of resettlement by the Project.

3) Disposal of wastewater and sludge

The sludge yielded from the sedimentation basin will be dried at he drying beds of WTP and finally disposed to the dumping site of the Kapsabet Town. Accordingly, there is no unfavorable impact to the environment. Furthermore, discharging of the back washing water into the Kabutie River was reconfirmed by NEMA through LVNWSB that there is no problem as described in EIA.

4) Impact on commercial activities and others

Road's excavation by piping works within the commercial areas may temporarily cause inconvenience such as no availability of car parking, etc. However, such inconvenience with time limit can be considered within an acceptable level for the inhabitants.

5) Cultural heritage

There is no existence of cultural heritage in the Project area.

2 Contents of the Project

2-1 Basic Concept of the Project

The Government of Kenya, through its 9th National Development Policy (2002-2008), established a policy to facilitate industrialization and/or privately operated business in parallel with the stabilization of agricultural production. In this connection, ensuring the stability and reliability of water supply is necessary to support the national objective, where having appropriate development and improvement of water supply is now a goal. The National Water Resources Management Strategy (NWRMS), which was formulated in January 2007, also identified sustainable water supply for domestic and industrial users as one means to eradicate poverty. The basic purpose is ensuring equitable access to water resources as well as sustainable and efficient water utilization.

This Project aims to provide safe, reliable and stable drinking water supply to Kapsabet Town, targeting a population of 32,500 (out of 41,400 people living in the target area) utilizing the Kabutie River as a water source. The target year for the project is 2015.

Towards this end, the important project components are the construction of a new water treatment plant, service reservoirs, raw water/transmission/distribution pipelines as well as the rehabilitation of intake facility. Personnel will also be given training on operation and maintenance (O&M) of the water supply facilities and business operation while the equipment procurement and materials is being carried out. The scope of works of the Project is summarized as below.

Table 2-1 Scope of the Works of the Project

Items	Brief Description of the Project
1. Rehabilitation	Rehabilitation of intake weir
2. Construction	1) Raw water pipe: dia.300 mm x 0.7 km length
	2) Water treatment plant: design intake flow 3,800 m^3/day 1 set
	3) Water transmission pump: 1.25 m^3/sec×160 m×75 kW 4 units
	4) Water transmission pipe: dia. 250 mm×2.9 km length
	5) Service reservoir: ground type, 1,050 m^3×1 unit, 600 m^3×1 unit
	6) Water distribution pipe: primary distribution pipe, dia. 300 – 200 mm×4.0 km length
	Secondary distribution pipe, dia. 200 – 50mm 22.2 km length
	Total Pipe Length 26.2 km
3.Equipment Procurement	1) Water meter (1,700 units), service connection materials (for 1,300 connections)
	2) Water meter testing equipment 1 set
	3) Water quality examination equipment 1 set
	4) Tools 1 set
	5) Computer equipment (incl. relevant software) for billing/accounting system 1 set
4. Soft Component	1) Trainings for O&M of water supply facilities
	2) Trainings for strengthening business operation

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

The target year for the Project is set for 2015 and the facilities shall be planned to cope with the predicted increased water demand.

(2) Policy of Natural Condition

For several years now, the annual rainfall in Kapsabet has exceeded 2,100mm on an average. Its climate can be divided into i) long-term rainy season (March - September); ii.) short-term rainy season (October - December); and iii) dry season (January - February). Rain mainly falls from the early evening till night; and there are thunderstorms sometimes during the long-term rainy season. On the other hand, rain generally falls in the daytime during the short-term rainy season, and drizzles are always relatively mild. Construction efficiency may be low during rainy days considering a volume of rain of 10mm/day within the entire rainy season. Furthermore, complete countermeasure on the indispensable mechanical and electrical equipment for the water supply system shall be implemented taking the report by thunderstorm damage into account.

(3) Policy of Social Economy Condition

With regard to the working conditions in Kenya, this is a 45-hour workweek (8-hour on weekday and 5-hour on Saturday) is managed by labor regulations. There is a five-day week system (day off on Saturday & Sunday) is firmly fixed by the public institutions in Kenya. There are more than 10 national holidays, where Mondays are substituted as holidays if the actual holiday falls on a Sunday. In addition, Muslims are granted a leave of absence for several days during the period of id ul-fitr. These work conditions shall be taken into consideration in preparing the construction plan.

(4) Policy of Law, Institution and Standard

Pipe laying and installation works within urban area should be basically done along with vacant land space outside of rainwater street gutter because the underground pipe laying on a paved road is not authorized. Moreover, concrete pipes protection which crosses the national highway and/or major roads inside of urban area shall be executed in accordance with the regulations by the Road Department. The LVNWSB and KNWSC should also provide requisite compensation in case private land will be utilized or occupied for some sites. The EIA will spell out procedures and required environmental considerations during project implementation until its completion. All the responses on environmental conditions such as

the restoration of material procurement site, countermeasures on dusts/noise/turbid water treatment, and disposal of surplus soils, shall be in accordance with the regulations of the National Environment Management Authority (NEMA).

(5) Policy of Utilization of the Local Construction Company and Material

Local construction companies have had past and current experience on similar-scale water supply projects implemented by the Government of Kenya. In addition, there is no problem for the supply on physical labor. With regard to the major materials on civil/building works, domestic procurement is possible for the commonly used materials such as cement, crushed stone, sand, brick, timber (square timber/ plate material), petrol, and oil etc. However, there is concern over a shortage of reinforcing steel bar produced in Kenya which is now being used for the rush construction for the FIFA World Cup site in South Africa which will be opened by 2010. Steel may have to be procured from a third country or from Japan. The expansion of staff is going to plan up to 2015 which is targent year (39 person in total).

(6) Policy of Operation/Maintenance Administrative Ability for Enforcement Organization

There are a total of 12 staff members working in KNWSC under the engineering and administrative divisions. In terms of operation and maintenance, expertise is inadequate impairing the successful implementation of the Project. There is a need, therefore, to strengthen organizational capability in O&M.

(7) Policy of Grade Setting of the Equipment, Machinery and Materials

The water treatment method to be employed in the water treatment facilities must satisfy the drinking water guidelines of the World Health Organization. The O&M standard will be manual with minimum automatic control and limited use of electric power.

(8) Policy of Construction Method, Procurement Method and the Construction Period

During the construction period, quality control and safety control will be paramount. The construction schedule will take into consideration the composition and adequacy of staff and labor, as well as the natural conditions and other socio-economic requirements.

2-2-2 Basic Plan

Figure 2-1 shows the conceptual diagram of the proposed water supply system.

2-2-2-1 Basic Data

(1) Design Service Area

Design service areas are Kapsabet township, Kapngetuny and its adjacent areas to include Kamobo,

Kamurguiywa, Kimaam, and Kipture.

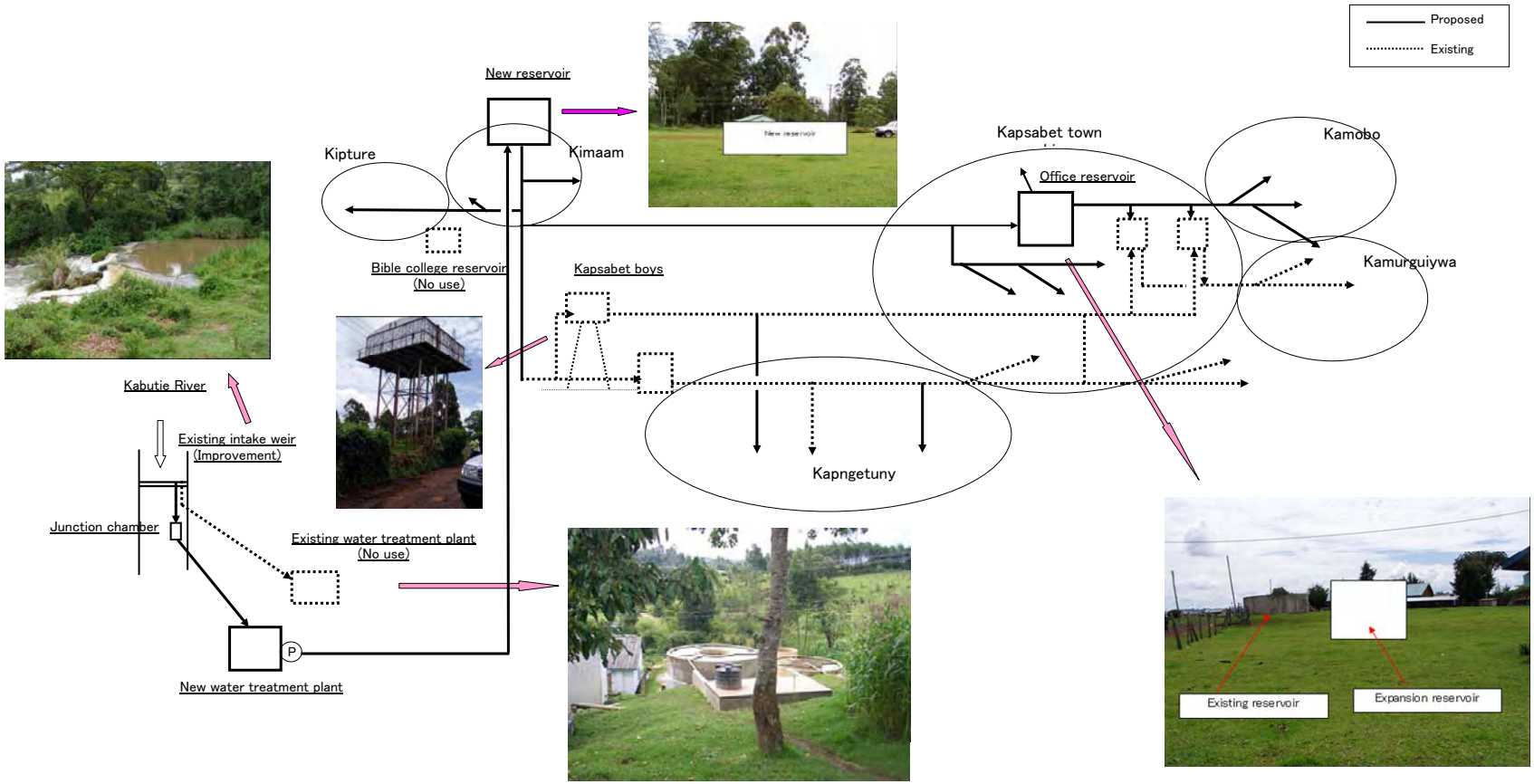
(2) Water Demand Projection

1) Population projection

i) Past trend of population

Population statistics is prepared by the National Census every ten years, where the latest count was done in 1999. The 1989 and 1999 annual population growth rate for Kapsabet Town was 4.0% (from 45,050 to 66,700 people). Correspondingly, the annual population growth rate for Nandi District, including Kapsabet Town is 3.9% (from 398,000 to 582,000 people), and annual population growth rate on Lift Valley Province including Nandi District is 1.7% (3,116,000 to 3,705,000 people).

The higher rate of population growth in Kapsabet Town can be attributed to the establishment of university in 1994, which came with approximately 3,000 students and related people. On the other hand, the population was estimated by the District Statistical Office, Central Bureau of Statistics under Ministry of Planning and National Development, and the population growth rate of Kapsabet Town is anticipated at 2.4% per year. Table 2-2 shows the population in design service area based on the census and estimates by the District Statistical Office.



Basic Data

1. Target year: 2015
2. Service area: Kapsabet town ship and its neigboring areas
3. Service population: 32,500
4. Design distribution amount:3,600m3/day

5. Major facility
   - 5-1 Intake facility: Improvement of existing weir
   - 5-2 Water treatment plant: Rapid sand filtration system, capacity 3,800m3/day
   - 5-3 Service reservoir: 2 units
   - 5-4 Pipelines: Water conveyance/transmission/distribution mains

Figure 2-1 Schematic Diagram of the Proposed Water Supply System

Table 2-2 Population in Service Area

Administrative District	1999			2006
	Population	Household	Family size	Population
Kapsabet township	11,234	3,039	3.7	13,271
Kapngetuny	4,932	1,139	4.3	5,828
Kamobo	5,898	1,237	4.8	6,070
Kamurguiywa	3,045	686	4.4	3,598
Kimaam	1,037	198	5.2	1,226
Kipture	2,215	352	6.3	2,618
Total	28,361	6,651	Average 4.3	33,511

Source: Population and household number for Year 1999: Census 1999, Population for Year 2006: projected by Ministry of Planning and National Development

ii) Future population

Kapsabet Town demonstrates an increase trend on population, however, the future population shall be estimated by applying the annual population growth rate of 2.4% utilized by above-mentioned District Statistical Office, that will take into consideration the existing land-use plan that will prevent uncontrolled land development.

Table 2-3 Future Population in Service Area

Administrative District	2007	2010	2013	2015
Kapsabet township	13,600	14,600	15,700	16,600
Kapngetuny	6,000	6,400	6,900	7,200
Kamobo	7,100	7,700	8,200	8,600
Kamurguiywa	3,700	4,000	4,200	4,500
Kimaam	1,300	1,300	1,400	1,500
Kipture	2,700	2,900	3,100	3,200
Total	34,400	36,900	39,500	41,400

iii) Design service population

Based on the current water supply conditions and the design manual of Kenya (Practical Manual for Water Supply Services in Kenya, October 2005), the water service ratio in the target year (2015) shall be set up at 100 % for Kapsabet township and Kapngetuny and 50% for the other areas as shown in Table 2-3.

2) Water demand projection

i) Domestic water

Until now, sufficient water services could not be provided due to the extreme shortage of water supply against the water demand. During the field study period, the data on water consumption of the households having relatively good water services was obtained as below.

Table 2-4 Water Consumption per Household

(m^3/month)

Household	June	July	August	Average (L/capita・day)
A	19	12	23	133
B	19	18	No data	137
C	20	6	No data	96
D	23	7	6	89
E	10	5	6	52

Note: Calculated by residents with 4.5 persons / household

In the design manual of Kenya, unit water consumption for urban areas is specified as below.

- High class housing: 250 L/capita/day
- Medium class housing: 150 L/capita/day
- Low class housing: 75 L/capita/day

As for Kapsabet Town, however, it is considered that the above figures are not applicable in comparison of the living standards of the people in large cities such as Nairobi. Therefore, the unit water consumption in Kapsabet township and Kapngetuny shall be designed as 150L/capita/day, 100L/capita/day, and 55L/capita/day for high, medium and low class housing, respectively referring to Table 2-5 and the design manual of Kenya. The ratio of high, medium and low class housing in the urban area (Kapsabet township and Kapngetuny) in 2006 is estimated as 10%, 35% and 55% respectively.

While, 48L/capita/day (as accounted-for water) shall be set up for the other areas, which is the mean of 40 L/capita/day in the design manual and the above 55 L/capita/day for the low class housing in the center of Kapsabet Town.

Table 2-5 Domestic Water Demand Forecast

Administrative District	Unit consumption	2007		2010		2013		2015	
	L/Capita/day	Population served	Water demand (m^3/day)	Population served	Water demand (m^3/day)	Population served	Water demand (m^3/day)	Population served	Water demand (m^3/day)
Kapsabet township									
High Class	150	1,360	200	1,460	220	1,570	240	1,640	250
Medium Class	100	4,760	480	51110	510	5,495	550	5,740	570
Low Class	55	7,480	410	8,030	440	8,635	470	9,020	500
Sub-total		13,600	1,090	14,600	1,170	15,700	1,260	16,400	1,320
Kapngetuny									
High Class	150	600	90	640	100	690	100	720	110
Medium Class	100	2,100	210	2,240	220	2,415	240	2,520	250
Low Class	55	3,300	180	3,520	190	3,795	210	3,960	220
Sub-total		6,000	480	6,400	510	6,900	550	7,200	580
Kamobo	48	3,550	170	3,850	185	4,100	197	4,300	206

Administrative District	Unit consumption	2007		2010		2013		2015	
	L/Capita/day	Population served	Water demand (m^3/day)	Population served	Water demand (m^3/day)	Population served	Water demand (m^3/day)	Population served	Water demand (m^3/day)
Kamurguiywa	48	1,850	89	2,000	96	2,100	101	2,250	108
Kimaam	48	650	31	650	31	700	34	750	36
Kipture	48	1,350	65	1,450	70	1,550	74	1,600	77
Sub-total		7,400	355	7,950	382	8,450	406	8,900	427
Total		27,000	1,925	28,950	2,062	31,050	2,216	32,500	2,327

ii) Water consumption by other purpose

- Future water consumption by other purpose will be estimated as shown below, based on the survey made in 2005.
- As to schools, government offices, public offices and businesses, future water consumption will be estimated by adopting the same growth rate as the annual population growth rate of 2.4%.
- As to hospital and industry, the same figures in 2005 will be adopted in calculating future water consumption.

Table 2-6 shows the estimated results. (Details are referred to Appendix 7-3)

Table 2-6 Water Demand Forecast on Other Purposes

(m^3/day)

Administrative District	Year				
	2005	2007	2010	2013	2015
Kapsabet township	265	276	291	309	321
Kapngetuny	87	91	96	102	106
Kamobo	111	112	116	119	122
Kamurguiywa	13	14	15	16	16
Kimaam	0	0	0	0	0
Kipture	0	0	0	0	0
Total	476	493	518	546	565

iii) Ineffective water volume

Water losses generated from leakage and O&M activities is assumed at 20% of the total distribution amount.

iv) Design water distribution volume

Water demand projection for the design service area is summarized in Table 2-7. Table 2-8 shows the design water distribution volume including the ineffective water volume.

Thus, the design water distribution volume is estimated to be 3,600 m^3/day in the target year.

Table 2-7 Future Water Demand (Accounted-for Water)

Administrative District	2007	2010	2013	2015
Kapsabet township	1,366	1,461	1,569	1,641
Kapngetuny	571	606	651	686
Kamobo	282	301	316	328
Kamurguiywa	103	111	117	12
Kimaam	31	31	34	36
Kipture	65	70	74	77
Total	2,418	2,580	2,762	2,892

Note: Water volume in 2007 and 2010 before the beginning of water supply by new facilities shows the potential demand.

Table 2-8 Design Distribution Water Volume

(m^3/day)

Administrative District	2013	2015	
Kapsabet township	1,961	2,051	
Kapngetuny	815	858	
Kamobo	395	410	
Kamurguiywa	146	155	
Kimaam	43	45	
Kipture	93	96	
Total	3,453	3,615	3,600

2-2-2-2 Water Intake/Water Conveyance Facility Plan

(1) Possible Intake Volume

1) Measured discharge on the Kabutie and Kimondli River

Number of available discharge data on the Kabutie River is very few. Hydrometry has been carried out occasionally as shown as Table 2-9. (Details are referred to Appendix 7-4)

Table 2-9 Measured Discharge of the Kabutie River

Date	Discharge (m^3/s)	Depth (m)
22/03/2007	0.445	0.28
01/02/2007	0.780	0.33
06/10/2005	0.928	0.41
13/10/2005	1.095	0.40
21/10/2005	1.307	0.44
08/11/2005	0.771	0.35

On the other hand, continual water level measurement has been carried out for the Kimondi River, a main river of the Kabutie River. However, conversion on water level into discharge has been conducted only up to 1992. “The Kapsabet Water Supply Rehabilitation and Augmentation” which was prepared by MoWI had estimated the discharges up to October 2005 by analyzing the relationship between the water level and discharge up to 1992 as shown in Figure 2-2. Applying the same method, JICA Study Team estimated the respective monthly minimum discharge from 1965 until 2007.

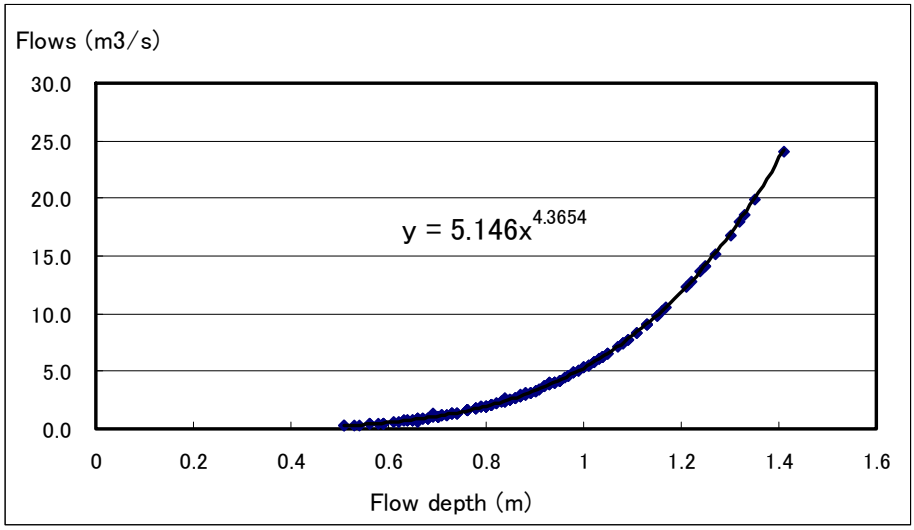


Figure 2-2 Water Level and Discharge of the Kimondi River

2) Minimum discharge of the Kimondi River

Excess probability was computed by using the following Thomas equation, based upon the annual discharge of the Kimondi River from 1965 until 2007, and thus the annual minimum discharge by return period is estimated as Table 2-10.

Thomas equation: $Y = -0.9489 \times Ln(X) + 4.6463$

Y: Discharge (m^3/sec), X: Non-excess probability (%)

Table 2-10 Annual Minimum Discharge by Return Period (By Thomas Method)

Return period (Years)	Discharge	
	m^3/sec	m^3/day
5	0.49	42,200
7	0.42	36,500
10	0.38	32,500
15	0.34	29,500
20	0.33	28,100
25	0.32	27,200
30	0.31	26,700
40	0.30	25,900
45	0.30	25,700
50	0.30	25,600

3) The minimum Discharge of the Kabutie River

The minimum discharge of the Kabutie River is estimated by applying the following methods to the discharge of the Kimondi River.

i) Catchment area correlation method

Catchment area of Kabutie River = 105km^2

Catchment area of Kimondi River = 835km^2

Thus, catchment area of the Kabutie River is 12.6% (105/835) of that of the Kimondi River.

ii) Discharge comparison method

By hydrometry, the discharge of the Kabutie River was found to be 11.4% of the average of the discharge of the Kimondi River. Table 2-11 shows the estimated minimum discharge of the Kabutie River by applying this ratio.

Table 2-11 Annual Minimum Discharge by Return Period

Return period (Years)	Catcment area correlation method (12.6% of Kimondi River)		Discharge comparison method (11.4% of Kimondi River)	
	m^3/sec	m^3/day	m^3/sec	m^3/day
5	0.061	5,300	0.056	4,800
7	0.053	4,600	0.048	4,200
10	0.047	4,100	0.043	3,700
15	0.043	3,700	0.039	3,400
20	0.041	3,500	0.037	3,200
25	0.040	3,400	0.036	3,100
30	0.039	3,400	0.035	3,000
40	0.038	3,300	0.034	3,000
45	0.038	3,200	0.034	2,900
50	0.037	3,200	0.034	2,900

While, the estimated minimum discharges by return period with applying the actual discharge, is summarized as Table 2-12.

Table 2-12 Annual Minimum Discharge for Kimondi River by Applying Actual Discharges Measured

Return period (years)	Discharge	
	m^3/sec	m^3/day
5	0.671	58,000
7	0.476	41,100
10	0.427	36,900
15	0.373	32,200

As a result, the minimum discharges of the Kabutie River with a 10-year return period, are calculated as 4,649m^3/day (36,900 m^3/day x 12.6%) by catchment area correlation method and 4,207m^3/day (36,900 m^3/day x 11.4%) by discharge comparison method respectively.

The design intake flow from Kabutie River is 3,800m^3/day. However, it can be predicted that there will be some difficult periods to secure such design intake flow with 10-year return period, taking into account the overflow and leakage from the intake weir. On the contrary, the design intake flow can be secured from the viewpoint of a five-year return period.

In addition, the minimum discharge was recorded on 4th - 5th March 1987 and 5th - 6th March 1991, respectively.

With regard to discharges before and/or after the above-mentioned date, the duration, in case of discharges below 4,000m^3/day, were 12 days and 28 days respectively during low discharge period in 1987 by catchment area correlation method and discharge comparison method. On the other hand, the duration in case of discharges less than 5,000m^3/day was 33 days and 38 days respectively by the same condition. Similarly, the duration in case of discharges less than 4,000m^3/day were 9 days and 19 days during low discharge period in 1991, respectively, by catchment area correlation method and discharge comparison method. While, the duration in case of discharges below 5,000m^3/day was 20 days and 25 days respectively, by the same condition. As a result, the design intake flow may not be secured for more or less one month, in case a large-scale drought occurs, judging from the above mentioned.

(2) Rehabilitation of the Existing Intake Weir

Water leakage from the bottom of weir shall be reduced by strengthening the weir structure in order to secure the required water volume. In addition, a drain pipe and screen shall be installed at intake box of the existing weir.

(3) Construction of Junction Chamber

The junction chamber with screen and blow-off shall be constructed at the downstream of intake weir to enable the removal of floating materials like chunks of wood and deposits like silt etc.

(4) Raw Water Pipeline

1) Route of raw water pipeline

The pipe-laying route of the new raw water pipeline shall be planned along the existing one. The pipeline will be installed on the river bed right after the intake weir, and then laid in a privately-owned upland field having an elevation difference. This pipeline will cross over the Kabutie River from the left to the right bank through a pipe bridge planned at the upstream of the existing WTP, and finally reach the proposed WTP.

2) Determination of Pipe Diameter

The relation of water levels of the intake weir, receiving well of the existing and new WTPs is illustrated in Figure 2-3. From the hydraulic point of view, the raw water pipe with a diameter of 250mm can deliver the design intake water volume to the new WTP, however, the pipe with a diameter of 300mm shall be

adopted taking account of further minimizing the pipe friction losses, diminishing the clogs caused by extraneous substances together with the installation of the junction chamber mentioned above.

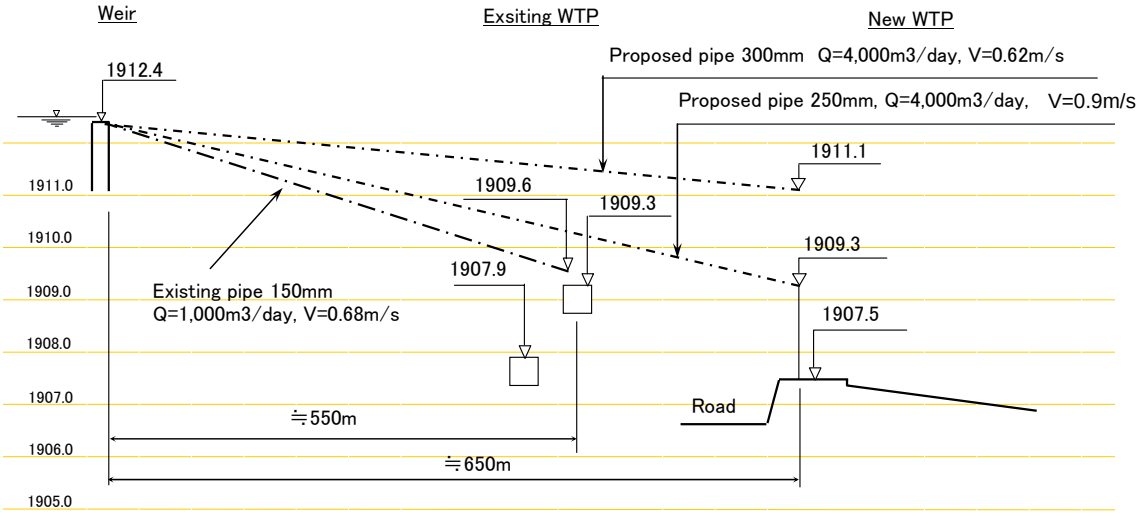


Figure 2-3 Water Level of Intake Weir and Existing/New Water Treatment Plant

3) Selection of Pipe Material

The uPVC pipe shall be utilized for the majority of laying route (within the upland field) in order to retain proper pipe pressure considering small elevation difference between the intake weir and the proposed WTP. While, the ductile iron pipe shall be adopted at the downstream of the intake weir considering its strength and durability, since it is inevitable to install the pipeline within the river bed. In addition, a pipe bridge with single span steel pipe (Approximately 13m in length) will be planned for the river transverse section taking maintenance work into account.

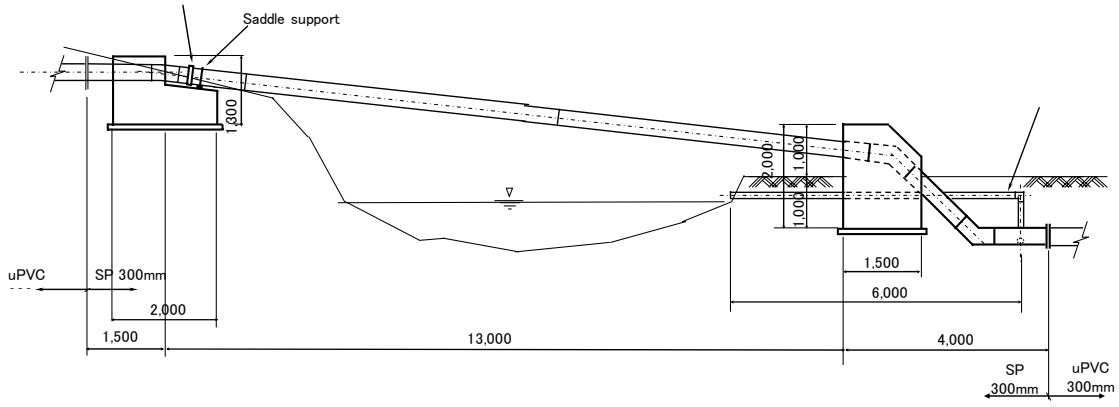


Figure 2-4 River Transverse Section

(5) Outline of Intake and Water Conveyance Facilities

Table 2-13 Outline of Intake and Water Conveyance Facilities

Facility/Equipment	Dimensions/Specifications	Remarks
1. Intake Weir		
(Civil works)		
Intake Weir	Rehabilitation of the existing intake weir	for prevention of water leak from weir
	Installation of blow-off valve, Dia. 150mm x 2 units	for blow-off
	Realignment of the existing pipe	
(Mechanical)		
Screen	Bar screen、0.5m x 0.5m, Mesh 50mm	for removal of debris
	Installation of coarse screen	
2. Junction Chamber		
(Civil works)		
Junction chamber	RC structure	for removal of debris, sand
	W 1.5m x L 3.3m x D 1.5m x 1 unit	
(Mechanical)		
Screen	Bar screen、0.5m x 0.5m, Mesh 30mm	
	Installation of fine screen	
3. Raw Water Pipeline		
(Civil works)		
Pipe	Junction Chamber - new WTP	
	Dia. 300mm x Approx. 0.7km Length	
	Ductile Iron Pipe: L=60m (river bed)	
	Steel Pipe:L=20m (pipe bridge)	
	uPVC: L=620m（upland field）	

2-2-2-3 Water Treatment Facility Plan

(1) Design Flow of the Water Treatment Plant

The design flow of the new WTP is set up at 3,800m^3/day.

(2) Water Treatment Process

A conventional type of rapid sand filtration system, same as the existing one, will be adopted for new WTP. As a pretreatment facility, the pre-sedimentation tank is planned. After feeding coagulant (Aluminum sulfate) and coagulation aid (Soda ash) into the rapid mixing tank, water is treated through the flocculation tank, sedimentation tank and rapid sand filter. Disinfection is done by feeding the solution of Powder chlorine (bleaching powder) into the inlet channel of the clear water reservoir. Filter washing is carried out by two processes, i.e. surface washing by pumping and backwashing by the water supplied from the washing water tank. Backwashed effluent is then discharged to the Kabutie River. The sediment/sludge generated in pre-sedimentation tank and sedimentation tank is transferred to a drying bed for final disposal.

In designing the facilities for each treatment process, the layout of the facilities and minimizing a use of

electric power are fully considered aiming at practical use of the existing site conditions and easy operation and maintenance of the WTP. The design contents are shown in Table 2-14.

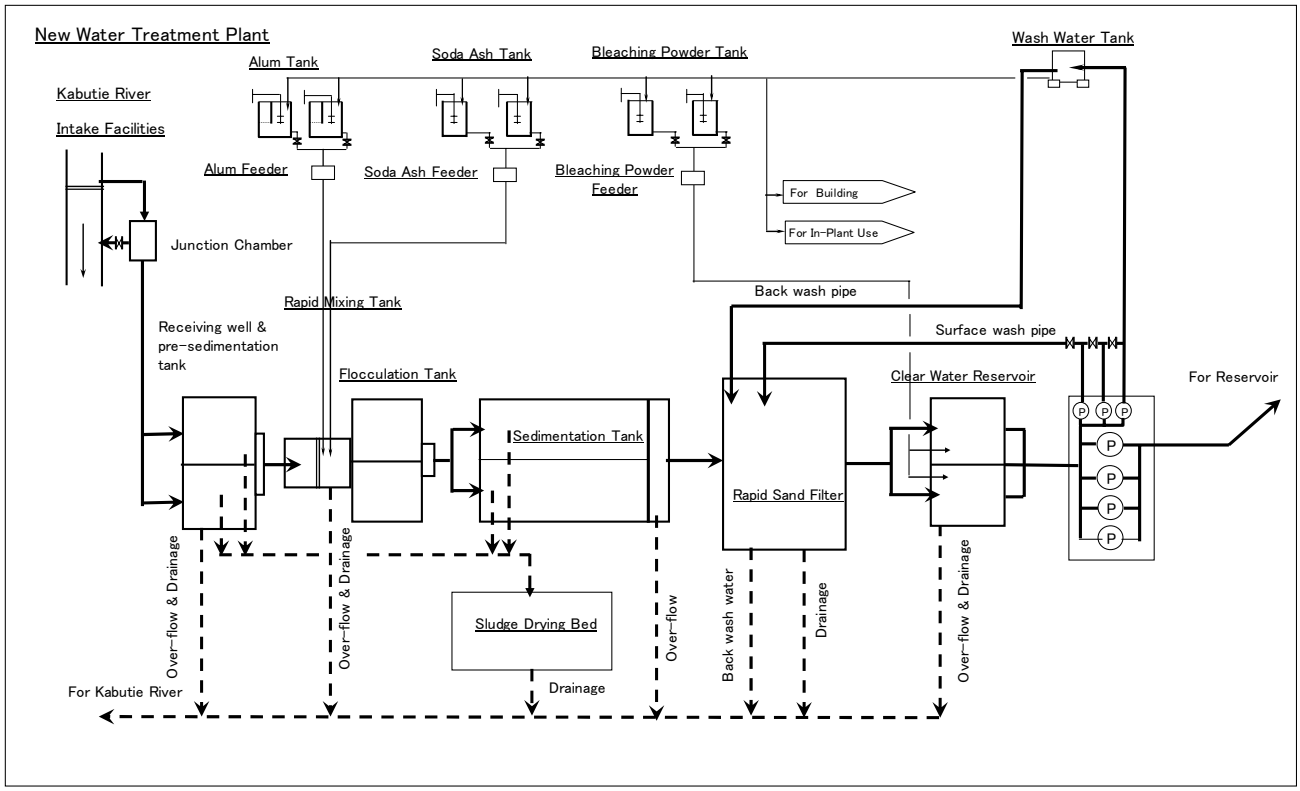


Figure 2-5 Water Treatment Flow

Table 2-14 Design Contents of the Facilities

Facility	Design contents
Rapid mixing tank	Rapid mixing by hydraulic jump, Detention time 5min.
Flocculation tank	Mixing by baffle plate, Detention time 20min.
Sedimentation tank	Horizontal basin, Detention time 3hrs, Sludge removal and transfer to drying bed by manual valve operation
Rapid sand filter	Filtration by gravity flow, Filtration rate 120m/day, Backwashing by water from washing water tank and surface washing by pump
Chemical feeding equipment	Chemicals (Aluminum sulfate, Soda ash, Bleaching powder), Feeding by gravity flow, Mechanical hand mixer for preparing solution
Sludge drying bed	Drying sludge generated from sedimentation tank

(3) Chemicals Feeding Rate

Presently, the existing WTP is operated with a constant feeding rate of 60 mg/L of Aluminum sulfate regardless of the fluctuation in raw water turbidity. In addition, Soda ash was not being used during field study period (September 2007). This resulted in inadequate coagulation and flocculation. In this connection, the Study team carried out a simple coagulation test to verify the appropriate chemicals

feeding rates, of which result implied that a Soda ash feeding rate of almost 1/6 to that of Aluminum sulfate would be recommended to achieve appropriate coagulation/ flocculation performance.

Table 2-15 Results of Simple Coagulation Test

Date	Sample	Raw water quality			Chemical feeding rate (mg/L)		Flocculation performance			
		Temperature (℃)	pH	Turbidity (FTU)	Alum	Soda ash	Time of floc forming	Floc size	Settling	Coagulation pH
9/16	Kabutie River	23	7.5	34	40	4	Fastest 1	Small	△4	6.7
					40	6.5	Faster 2	Medium	○Faster 2	6.8
					40	10	Faster 2	Medium	◎Fastest 1	6.9
					40	20	4	Medium	△3	7.1
					30	3	Fastest 1	Small	△4	6.9
					30	5	Faster 2	Medium	◎Fastest 1	7.0
					30	7.5	3	Medium	○Faster 2	7.1
					30	15	3	Medium	△3	7.3

According to the past records, the turbidity of raw water shows almost 80-90 FTU during the rainy season and 10-30 FTU during dry season. The feeding rates of aluminum sulfate and soda ash are proposed as shown in Table 2-17, referring to the results of beaker test and the practices at the Kosaku WTP in Tokyo. In addition, the feeding rate of chlorine (bleaching powder) will be proposed as shown in Table 2-18 according to water quality to be treated.

Table 2-16 Alum Feeding rate at Kosaku WTP in Tokyo

Turbidity	Liquid aluminum sulfate*feeding rate (mg/L)	as Al_2O_3 (mg/L)
20	30	2.4
50	40	3.2
80	50	4
200	70	5.6

*Liquid Aluminum Sulfate: Content of 8% of Aluminum Oxide
Source: Design Criteria for Waterworks Facilities in Japan

Table 2-17 Chemicals Feeding Rate

Turbidity (FTU)	Aluminum sulfate feeding rate (mg/L)		Soda ash feeding rate (Alum×1/6)	Production volume (m^3/day)	Amount to be used (Kg/day)	
	Solid Alum*	as Al_2O_3			Solid Alum	Soda ash
< 20	20	2.8	3.3	3,800	76	13
20 - 50	30	4.2	5.0	3,800	114	19
50 - 80	40	5.6	6.7	3,800	152	25
100<	50	7.0	8.3	3,800	190	32

Note: * Solid Aluminum Sulfate: Aluminum Oxide 14%

Table 2-18 Chlorine (Bleaching Powder) Feeding Rate

Feeding rate (mg/L)	as effective chlorine (mg/L)	Production volume (m^3/day)	Amount to be used (Kg/day)
1.7	1.0	3,800	6.3
3.3	2.0	3,800	12.7
5.0	3.0	3,800	19.0

Note: * Bleaching powder with effective chlorine concentration of 60%

(4) Outline of Water Treatment Facilities

Table 2-19 Outline of Water Treatment Facilities

Facility	Type/Dimensions/Specifications	Remarks
[Civil and Architectural]		
1.Receiving well/ pre-sedimentation tank	RC structure	
	W 2.5m× L5.4m×D3.0m×2units	
2. Rapid mixing chamber/Flocculation tank	RC structure	
	（Rapid mixing chamber） W 2.5m×L 3.0m×D1.4～1.0m ×1unit, Weir (W 0.8 m)	Mixing by hydraulic jump
	(Flocculation tank) W 5.0m×L 5.5m×D 0.8m ×2 units	Baffled wall
3. Sedimentation tank	RC structure	Horizontal flow
	W 5.0m×L 15.6m×D 3.0m×2units	
4. Rapid sand filter	RC structure	Gravity flow, Filtration rate:120m/day
	W 2.0m×L 4.0m× 4units	
	Thickness of gravel layer: 0.55m	
	Thickness of sand layer: 0.7m	
	Drain system: perforated pipe	
	Surface washing equipment	
5. Back washing tank	RC structure	for backwashing, maintenance water
	W 4.5m×L 4.5m× D 3.5m×1unit	
6. Clear water tank	RC structure	Including Pump House and Electrical Room
	W 4.3m×L 7.0m×D 3.0m×2units	
	Pump room: W 14.0m×L 9.0m	
	Electricity room: W 14.0m×L 9.0m	
7. Drying bed	RC structure	
	W 6.0m×L 14.0m×D 1.0m×5 units	
8. Chemical house	RC structure	
	W 7.2m×L 12.85m	
	Solution tank: 2.5m^3 ×6 units	for Alum. Soda ash, Powder chlorine
9. Administration building	RC structure	
	W 10.0m×L10.0m Office: 25m^2 Workshop: 25m^2 Laboratory, utility, toilet, etc: 50m^2	
10. Piping work	Piping	
11. Landscaping	Wall/Leveling/Road	
12. Miscellaneous		
[Mechanical Equipment]		

Facility	Type/Dimensions/Specifications	Remarks
1. Inlet gate	□500mm x 1.0mH × 2 units	
2. Chemicals feeding equipment (Alum)	Drip type feeder, hand mixer, 2 sets (incl. 1 standby)	
3. Chemicals feeding equipment (Soda ash)	Drip type feeder, hand mixer, 2 sets (incl. 1 standby)	
4. Chemicals feeding equipment (Powder chlorine)	Drip type feeder, hand mixer, 2 sets (incl. 1 standby)	
5. Inlet valve	Butterfly valve (Manual operated), Dia. 200mm, 4 units	
6. Clear water reservoir inlet valve	Butterfly valve (Manual operated), Dia. 300mm, 2 units	
7. Transmission pump	Horizontal Bidirectional Centrifugal Pump （equipped with flywheel） φ150 × 1.25m^3/min × 160m × 75kW× 4 units	(incl. 2standby)
8. Delivery valve	Motored butterfly valve, Dia. 300mm φ150 × 0.2kW ×4 units	
9. Service pump	Horizontal single suction multi-stage volute pump φ125mm ×1.0m^3/min ×20m× 7.5kW ×3units	for surface washing (incl. 1standby)
10. Drain pump	Drain pump φ80mm×0.15m^3/min ×10m× 0.75kW ×2 units	
12. Drain pump	Portable type, engine-driven, 1 unit	
13. Hoist	Chain block, 1t ×1unit	
14. Piping	Piping work for pump room	
[Electric Equipment]		
1. Transformers	11kV／415V, 300kVA×1unit	
2. Power receiving Panel	Steel/Indoor/Wall-mounted 600W×600H×300D×1 unit	
3. Power distribution/Control panel	Steel/Indoor/Self-standing 1000W×2300H×1000D×1 unit	
4. Pump control panel	Steel/Indoor/Self-standing 1000W×2300H×1000D ×4 units	No1～4 transmission pump
5. Low voltage panel	Steel/Indoor/Self-standing 1200W×2300H×1000D ×1unit	
6. Instrumentation Panel	Steel/Indoor/Self-standing 1000W×2300H×1000D×1unit	
7. Switch box	Indoor/Wall-mounted 500W×700H×300D × 3 units 600W×800H×300D × 2 units 600W×700H×300D × 1 unit	No1～4 transmission pump
8. Switch box	Outdoor/Self-standing 600W×700H×300D ×1unit	No.1,2 service pump
9. Flow meter	Electromagnetic type: φ150mm×1 unit Turbine type: φ300×1unit, φ150×1unit	

Facility	Type/Dimensions/Specifications	Remarks
10. Pressure gauge	1 unit	
11. Level gauge	Float type: 1 unit	
12. Communication device	1 set	
13. Piping/wiring	Piping, wiring for Pump room	

2-2-2-4 Water Transmission Facility Plan

The water transmission system is planned applying a single-step pumping system to deliver water from the new WTP (EL. Approx. 1,900 m) up to the new service reservoir (EL. Approx. 2,040 m).

(1) Water Transmission Pump

1) Design Transmission Flow

The design flow for water transmission facility is set up at 3,600m^3/day.

2) Capacity and Number of Pump Unit

Pump capacity per unit is set up as below.

3,600m3/day×1/2×1/24×1/60 = 1.25m3/min

At present, immediate measures cannot be taken for pump failure, since it is difficult to obtain spare parts and to call the competent technicians for repair work. During the field study period, KNWSC was managing with a use of secondhand pump, instead of repairing malfunctioned pump unit. Therefore, it is recommended two standby pumps are to be provided in order to secure continuous operation of the WTP and service reservoirs, if ever it requires a considerable time for repair work when the pump failure occurs.

Capacity of 1,25 m^3/min × 4 units（including 2units of standby pumps）

3) Total Pump Head

H = Actual Head + pipe Head Loss

= (Maximum hydraulic grade of Transmission Pipe - LWL of Receiving Tank)
+Friction Loss of Transmission Pipe + Head Loss by Pump Revolving

= (2,044m – 1,900m) + 12m + 2m = <u>158m</u>

4) Specification of Pump

Based on the above, the pump unit is specified as below.

Type: Horizontal Double Suction Centrifugal Pump

Specification: ϕ150mm × Capacity 1.25m^3/min × Pump head 160m × Motor power 75kW

5) Proposed Countermeasure against Water Hammer

Since a negative pressure is anticipated in the transmission pipeline due to large pumping head, an examination on water hammer was made with conceivable three countermeasures applying i)Surge vessel, ii)Flywheel and iii)Combination of Surge vessel and Flywheel. As a result, it concluded that the countermeasure adopting flywheel would be appropriate, since it does not require auxiliary equipment (pressure tank and compressor) using electric power.

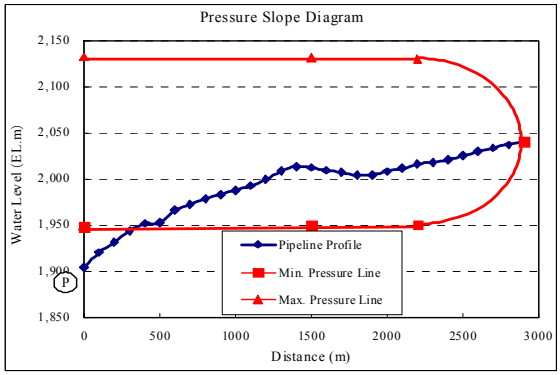


Figure 2-6 Hydraulics with Countermeasure

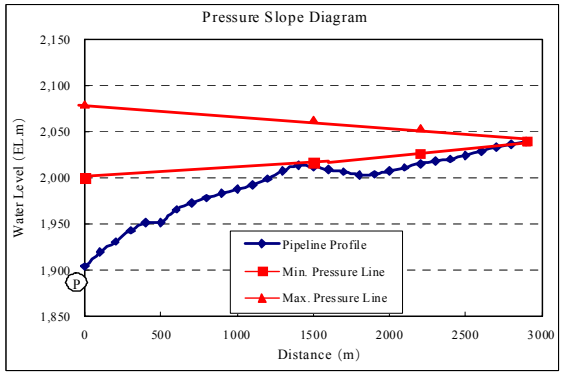


Figure 2-7 Hydraulics without Countermeasure

6) Pump Operation Method

The existing pumps are being operated manually with continuous 24-hours running. However, water storage of the service reservoirs cannot be monitored, since the level gauges are not installed. In the Project, therefore, an automatic operating system will be established as below.

- Digital float gauges are installed for the existing service reservoirs.
- Pressure type level gauge is installed for new service reservoir to control pump operation.
- Three water levels shall be set for pump operation: for 1 pump operation (MWL2), for two pumps operation (MWL1) and for stop pump operation (HWL).
- Telephone line is adopted for transmitting the signal to the WTP for on-off of the pump.

2 pumps operation at MWL1 → Stop pump operation at HWL → 1 pump operation at MWL2 → Two pumps operation at MWL1

Basically, the difference between HWL and MWL1, MWL1 and MWL2 will be set at 0.5 m, respectively. However, such water levels are to be set at will according to the operating status.

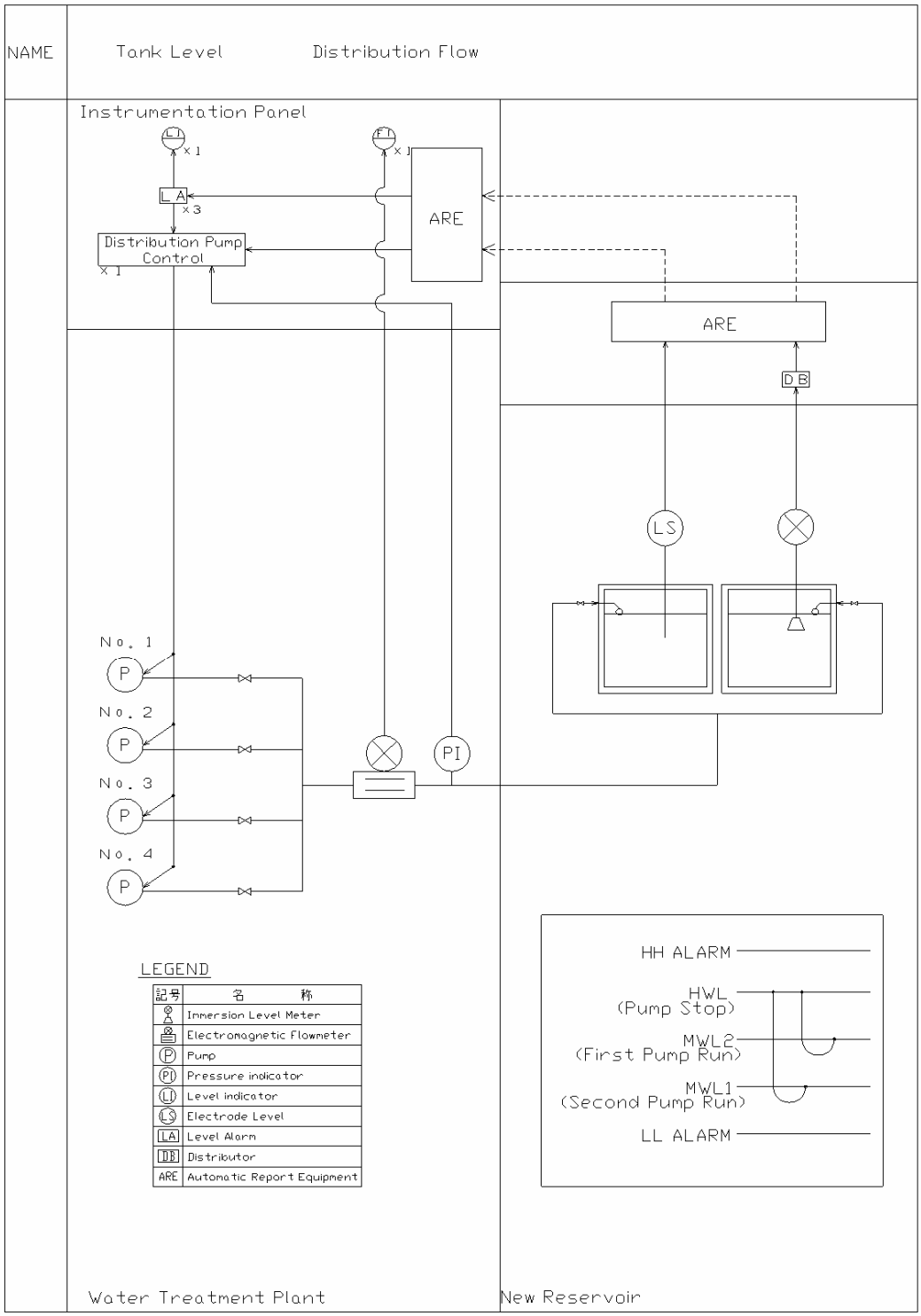


Figure 2-8 Flowchart of Instrumentation

(2) Transmission Pipeline

1) Route of Transmission Pipeline

The water transmission pipeline shall be installed along the same route of the existing one from the new WTP to the main road and further extended to reach the new reservoir along the national highway towards Nandi Hill.

2) Selection of Pipe Material and Diameter

Based on examining the elevation difference between proposed WTP (EL. 1,905m) and new service reservoir (EL. 2,040m) and analyzing pump surge, it was concluded that the steel pipe will be appropriate for transmission pipe. The adopted pipe diameter is 250mm based on the design water distribution flow of 3,600m^3/day and other hydraulic conditions such as friction loss and velocity of the pipe.

3) Outline of the Water Transmission Facilities

Table 2-20 Outline of the Water Transmission Facilities

Facility	Type/Dimensions/Specifications	Remarks
Water Transmission Pipeline		
[Civil works]		
Transmission pipe	New WTP – New service reservoir	
	Steel pipe, Dia. 250mm x Approx. 2.9km Length	
	Steel pipe: L=2,910m	
	Steel pipe: L=20m (Pipe bridge)	

* Transmission pump equipment: included in Table 2-18

2-2-2-5 Distribution Facility Plan

(1) Distribution Method

Water is distributed by gravity from the proposed new reservoir. This also optimizes the water supply with fully utilizing the existing service reservoir/elevated tank located at Kapsabet high school compound and the Office reservoirs (including expansion) at KNWSC office compound.

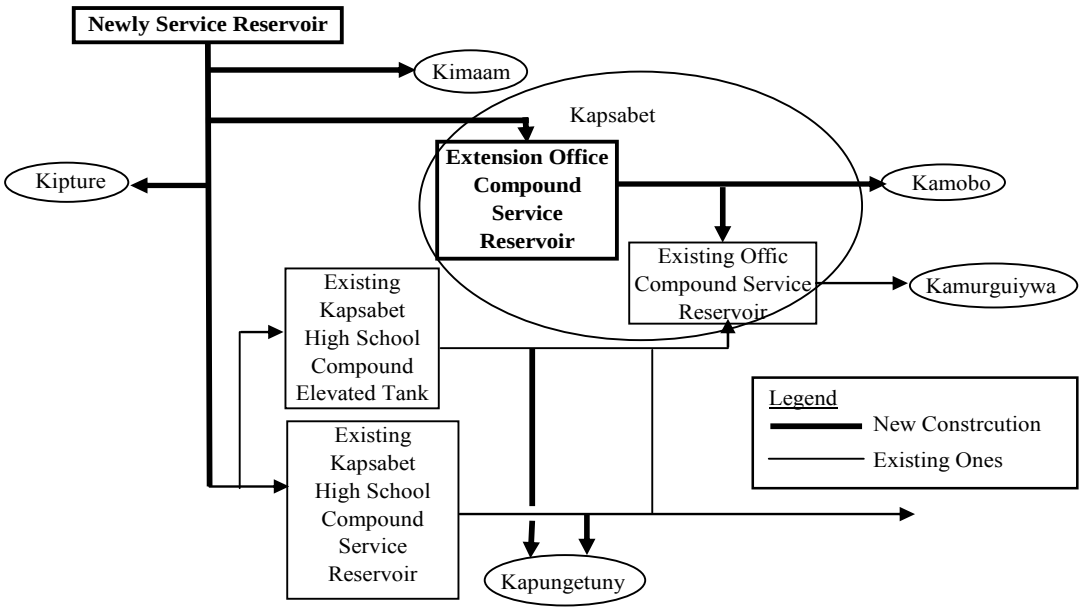


Figure 2-9 Flow Diagram of Water Distribution System

(2) Service Reservoir

In planning the service reservoir, its capacity has to be 12-hours storage volume as set by the design manual of Kenya. This storage volume is also criteria for small-scaled water supply system in Japan.

<Capacity of Service Reservoir for Small-scaled Water Supply System in Japan>

Capacity of the service reservoir shall be calculated as shown below, considering that the duration of hourly maximum water distribution continues until the whole daily distribution amount is delivered.

Peak factor	α	
Maximum daily supply per hour	q_o	(m^3/hr)
Maximum hourly supply	$\alpha \times q_o$	(m^3/hr)
Maximum daily supply	$Q_0 = 24q_o$	(m^3/day)
Duration of Maximum hourly supply	$t = Q_0/(\alpha \times q_o) = 24q_o/(\alpha \times q_o) = 24/\alpha$	(hr)
$V_{max} = \alpha \times q_o \times t - q_o \times t$	(Outflow - Inflow during t hours.)	
$= (\alpha-1) \times q_o \times 24/\alpha = 24 \times (1-1/\alpha) \times q_o$		

V_{max} is equivalent to 12 hours duration because the peak factor is set up at 2.0 in the Project.

Thus, the required capacity of the service reservoir arrives at 1,800m^3, since the design distribution amount is 3,600m^3/day. While, the capacity of the existing Kapsabet High School reservoir and the Office reservoir is 220m^3 and 150m^3 respectively, or 370m^3 in total (equivalent to 2.5 hours water supply).

Therefore, additional capacity for new service reservoir is designed to meet 10 hours duration (12 hours - 2.5 hours). Aside from this, additional capacity for one hour will be considered as a countermeasure for the emergency of power failure. (Details are referred to Appendix 7-5)

- New Reservoir : 1,050m^3 (including 150m^3 for countermeasure against power failure)
- Extension of the existing Office Reservoir: 600m^3

(3) Distribution Pipelines

1) Design Principle

In planning pipe network layout, the followings are considered as design principle.

- Primary distribution pipelines will be planned for the route from the new service reservoir to the Office reservoir. Service pipes are not allowed to connect to the primary pipelines in principle.
- Secondary distribution pipes are those other than the above primary pipelines.
- The existing uPVC distribution pipe (diameter of 100 mm) installed along main road are to be connected with the new distribution pipelines at appropriate locations.

2) Pipe Material and Diameter

In principle, the uPVC Pipe is adopted for new distribution pipelines, however, the steel pipe is also adopted for the pipes to be installed in unpaved roads with steep slopes considering the erosion during rainy season. In determining pipe diameters, some capacity allowance will be considered to meet the increasing water supply in the future.

Selection of the Diameter for Primary Distribution Pipelines

The schematic diagram of the distribution pipelines and distribution amount are shown in Appendix 7-6. As a primary distribution pipelines, the pipeline between the New Reservoir and the Office Reservoir will be planned. Other distribution pipelines are planned within the design service areas.

To deliver the design distribution flow in 2015, the pipe with a 250 mm diameter pipe between the proposed New Reservoir and Office Reservoir will be applicable. However, considering the abolition of the existing Kapsabet High School Reservoir and/ or increased distribution flow in the future, the distribution pipe with a diameter of 300 mm will be recommended to supply approximately 8,000m^3/day, which can increase hourly maximum distribution amount by 40% in 2015. (Details are reffered to Appendix 7-7)

3) Other Related Facilities

- Gate valves shall be provided for branch of distribution pipelines and the other appropriate locations.
- Air release valves and wash-out valves shall be provided for the appropriate locations necessary for O&M.
- Pressure reducing chamber shall be provided at the pipelines having elevation difference of more than 50 m from the service reservoir.
- Fire hydrants shall be installed at the appropriate locations within the urban area (There is a fire station and fire hydrants in Kapsabet Town at present).

4) Installation of Service Pipes

In order to promote full benefits of the Project, it is desirable to install some service pipes up to the boundary of the private property in the highly populated areas, in parallel with the distribution pipes construction works as shown in Figure 2-10. In the service pipes installation, the subsequent works (Installation of water meters) shall be undertaken by the Kenyan side using the materials to be procured by the Japanese side. Approximately 400 of service connections are to be tapped to the new distribution pipes within the center of Kapsabet township and Kapngetuny.

As described in Subsection 2-2-2-6, provision of a total of 1,700 water meters is planned in the Project. Around 1,300 nos. of water meters excluding the above-mentioned 400 nos. shall be installed together with service pipes installation works by Kenyan side after the completion of construction works of the Project. The required materials for 1,300 nos. of service connections are to be provided by Japanese side. Table 2-21 shows the contribution of both sides on service pipes installation works.

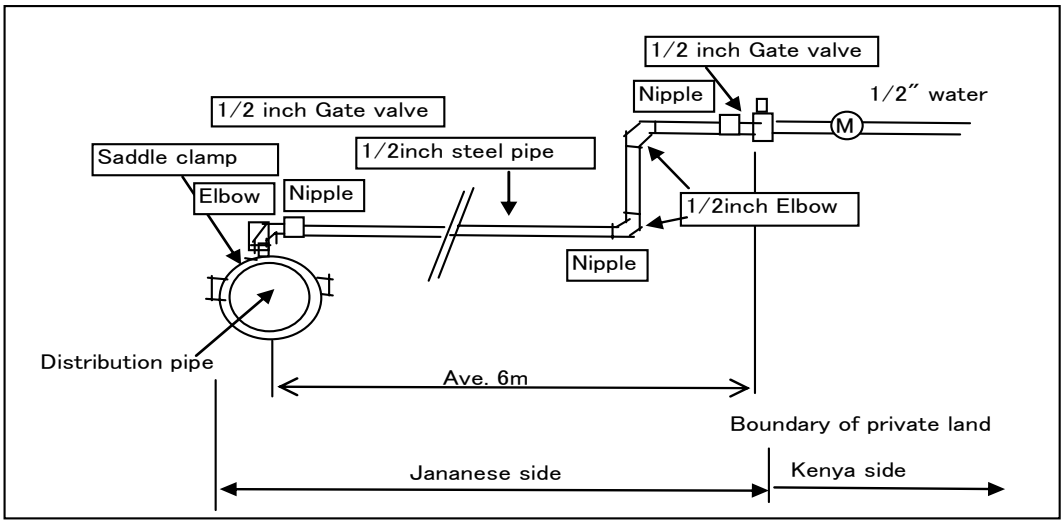


Figure 2-10 Demarcation on Service Pipes Installation by Japanese and Kenyan Side

Table 2-21 Contribution by Japanese and Kenyan Side on Service Pipes Installation Works

Item		Nos.	Contribution on Material and Installation Works
Service pipes	Fitting of saddle type ferrule and pipe laying plus stop valves up to border of private land	400 nos.	Japanese side contributes the permanent works including pipe materials.
		1,300 nos.	Japanese side provides pipe materials (saddle type ferrule, service pipes and valves, etc.). Kenyan side undertakes installation works.
Water meters procurement	Meters and meter boxes	1,700 nos.	Japanese side provides water meters with meter boxes, and Kenyan side undertakes installation works.

(4) Outline of the Distribution Facilities

Table 2-22 Outline of Distribution Facilities

Facility	Type/Dimensions/Specifications	Remarks
1. New Reservoir		
[Civil works]		
Reservoir	RC structure	
	W 8.0m×L 20.0m×D 3.5m×2 units Capacity: 1,050m^3	
[Mech. / Elect. Equipment]		
Water level regulation valve	Decentering structure float type	
	φ250mm ×2 unit	
Power receiving panel	Steel/Indoor/Self-standing 1000W×2300H×1000D ×1 unit	
Level gauge	1 unit	
Flow meter	Turbine type:φ300mm ×1 unit	
Level switch	1 set	
2. Office Reservoir		
[Civil works]		
Reservoir	RC structure	for expansion
	W 7.3m×L 12.5m×D 3.5m×2 units Capacity: 600m^3	
	Piping work	Connection to existing reservoirs
[Mech. / Elect. Equipment]		
Water level regulation valve	Decentering structure float type	
	φ200mm ×2 units φ 75mm ×2 units	
Level gauge	Float type, 4 units	
Flow meter	Turbine type: φ250mm ×1unit	
Distribution panel for lighting	Outdoor type, LS	
3. Kapsabet High School Reservoir		
[Civil works]		
Rehabilitation of ground reservoir/elevated tank	Piping	
[Mech. / Elect. Equipment]		
Water level regulation valve	Decentering structure float type	
	φ100mm ×1 unit φ 75mm ×1 unit	
Level gauge	Float type, 2 sets	

Facility	Type/Dimensions/Specifications	Remarks
Flow meter	Turbine type, φ150mm ×1 unit	
Distribution panel for lighting	Outdoor type, LS	
4. Distribution Pipelines		
[Civil works]		
Primary pipe	uPVC pipe, Dia. 300 - 200 mm × approx. 4.0km Length	
Secondary pipe	uPVC/Steel pipe, Dia. 200 - 50 mm × approx. 22.2k m Length	
	Total approx. 26.2km	
5. Service Pipes		
Installation of service pipe	Distribution pipe～boundary of private land, approx. 400 sites	

2-2-2-6 Equipment Procurement Plan

As for the requested items of equipment procurement, the Study team evaluated the needs as below.

(1) Water Meter

Since the number of metered connections is very few at present, KNWSC imposes flat rate billing to most of customers with underestimating water consumption compared to actual use. Such a billing system has made KNWSC's business operation worse because appropriate billing by meter readings cannot be carried out. In addition, the customers actually receiving the water services are only about 30% of the registered customers due to the shortage of water supply.

This water supply shortage will be solved by implementing the Project; however, the flat-rate billing by underestimating water consumption may increase, unless the installation of water meter is progressed. Therefore, the installation of water meters is indispensable from the viewpoint of the risks on business management due to the pile up deficits instead.

Consequently, it is satisfactory to consider the procurement of water meters by Japanese side in order to ensure the project effects. A total of 1,700 units of 1/2" water meters will be procured by taking the following factors into account because the water service ratio by the Project was targeted as 100% especially in the existing service areas such as Kapsabet Township and Kapngetuny. Moreover, the some materials such as saddle clamps and drilling tool necessary for tapping new service connections will be included in parallel with the procurement of water meters.

Targeted households of high-class and middle-class within Kapsabet Township and Kapngetuny area (the population served: 10,620 persons) were as assumed approximately 2,100 assuming 5 persons per household in average.

The present registered customers are around 1,160, however, the numbers of actual service connections are about 340 including about 50 of metered connections. Presently KNWSC has a plan of installation of

about 400 units mainly for users of commercial activities.

Finally, the numerical quantity of water meters to be provided arrives at 1,700 units (2,100 - 50 - 400 1,700).

(2) Water Meter Testing Equipment

Perpetuating the predetermined accuracy and precision on water meter is the requirement for appropriate tariff collection. In addition to the visual inspection, water meter testing equipment is considered as necessary to possibly screen out the undesirable meters and judge the necessity on the point repairs/calibration, and thus verify the function after repairs/calibration. One unit of water meter testing equipment including rating tank, rotor meter and other accessories officially used in Japan will be provided because there is no availability in Kenya. As for the manner of use of the equipment, training will be procured through soft component program.

(3) Water Quality Examination Equipment

Due to lack of water quality examination equipment at KNWSC, so far water quality control to verify safety of drinking water and proper operation of WTP has not been practiced. Considering the importance of water quality control, water quality examination equipment such as residual chlorine checker, pH meter, turbidity meter and relevant tools including scale, jar tester and glass wares are minimum requirements for water supply in Kapsabet. It is reasonable to consider that these equipment be procured timely to meet commissioning stage of newly-built WTP.

(4) Tools

Due to insufficient tools available at present, one set of tools required for O&M of piping, mechanical and electrical works will be procured by the Project.

(5) Computers and Relevant Software on Billing /Accounting System

In the Project, it is planned that the number of service connections increases from current 340 to 6,500 and the installation of water meters also increase from current 50 to 2,100. Considering the magnitude of expansion of water services, the current billing/tariff collection and accounting system being done by paper based hand-writing is considered to be difficult to deal with. Therefore, introduction of the computerized billing /accounting system will be absolutely required for the efficient business management. It is reasonable to consider that required equipment and materials be procured by Japanese side.

In procurement of the equipment and materials, it is desirable to select the hardware and software equivalent to those currently used by the other service providers as much as possible. Particularly, the

billing/accounting software, “Dataflex” being used by “Western Water & Sanitation Company” which operates the water services in Kakamega City under jurisdiction of LVNWSB is considered most appropriate, since the cooperation/advices by the said provider can be expected for smooth launch and daily operation of the billing /accounting system.