Appendix 5

Technical Note

Appendix 5 Technical Note

TECHNICAL NOTE

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

AGREED UPON BETWEEN LAKE VICTORIA NORTH WATER SERVICES BOARD
AND
JICA STUDY TEAM

25 SEPTEMBER, 2007

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After a series of discussions during the field survey in Kenya from 26th August 2007 through 25th September 2007, the following points were agreed between Lake Victoria North Water Services Board (LVNWSB), Ministry of Water and Irrigation, the Republic of KENYA and the JICA Study Team (Team). Based on the agreement as well as the Minutes of Discussion signed on 12 September 2007, the Team will further analyze the results of field survey in consultation with JICA and concerned parties in Japan and will prepare a draft final report which includes the layout and design of the facilities and/or equipment for the Project.

1. Planning Frame of Augmentation of Water Supply System in Kapsabet Town

(1) Target year:	2015
(2) Service area:	Kapsabet Township and its surrounding area
(3) Population to be served:	32,500
(4) Daily water demand:	3,600 m^3/day (including. water loss)

2. Request Components of the Project

Construction

(1) Improvement of intake facility
(2) Installation of raw water transmission main
(3) Construction of water treatment plant
(4) Installation of transmission pumps
(5) Installation of transmission main
(6) Construction of distribution reservoirs
(7) Installation of distribution pipelines

Equipment

(1) Water meters
(2) Water quality analysis equipment (for Residual chlorine, pH, Turbidity and Jar testing)
(3) Tools kits
(4) Spare parts
(5) Computers and software for custom services

3. Availability of Water Source from the Kabutie River

The Team explained the result of river flow analysis for the Kabutie River (ANNEX-A) which implies that there is a possibility of water shortage against the planned intake water volume of 3,800 m^3/day in 10 year occurrence probability. With regard to this, LVNWSD understood that available water source to be tapped from the Kabutie River might be suppressed in a certain period of the drought year.

4. Raw Water Transmission Main from Intake to Water Treatment Plant

The Team explained the result of hydraulic analysis of raw water transmission main (ANNEX-B) and there is no necessity of raising the weir height in rehabilitation of the existing intake weir by replacement of the pipe with a lager diameter. LVNWSB understood the said measure.

5. Diagram of Water Supply Facilities from Intake to Distribution Reservoir

The Team explained the schematic diagram of the major water supply facilities from intake to

distribution reservoir (ANNEX-C). Particularly, among them, the Team emphasized that provision of a junction chamber in raw water transmission main and introduction of surface washing to sand filters of water treatment plant would be effective for O&M. LVNWSB understood the arrangements of the proposed water supply facilities.

6. Distribution Network

The Team explained the concept of the distribution network with presenting the schematic diagram (ANNEX-D). LVNWSB understood the basic concept of water distribution network.

7. Design standards

In principle, "Practical Manual for Water Supply Services in Kenya 2005." will be adopted for designing the above water supply facilities. According to the circumstances, however, Japanese design criteria and other standards adopted internationally shall be referred to.

8. Land Acquisition

LVNWSB will undertake letter of consent for some part of the planned land for raw water main, water treatment plant, transmission main and distribution reservoirs. LVNWSB promised to submit a copy of certificate of the land acquisition to Japanese side upon acquired.

9. Strengthening Staffs for Water Services Provider

LVNWSB recognized the necessity of strengthening the structure, business administration and sustainability of Kapsabet Nandi Water Sanitation Company (KNWSC) and promised to recruit technical/administrative staff of KNWSC in due time.

10. Soft component

The necessity of following fields of soft component was recognized.

Training of O&M of water supply facilities and water leakage detection/repair/prevention
Strengthening of metering, billing and administrative capability

As for strengthening of metering, billing and administrative capability, LVNWSB will guide the staff of KNWSC in collaboration with other competent water services providers.

11. Water Rights/EIA

With regard to extraction of water from the Kabutie River, it is necessary that water rights be granted. LVNWB will take appropriate action for getting water rights as earliest. In case that EIA is a condition for applying water rights, LVNWSB shall take due procedure.

ANNEX-A. Water flows of Kabutie River in dry season

1. Kimondi river flows

Minimum flows of Kimondi River in each year

Year	Low flow m3/s	Year	Low flow m3/s
1965	0.901	1986	0.736
1966	0.686	1987	0.270
1967	0.408	1988	0.686
1968	0.736	1989	1.026
1969	0.788	1990	1.316
1970	0.736	1991	0.270
1971	0.450	1992	0.476
1972	0.962	1993	1.397
1973	0.788	1994	0.686
1974	0.843	1995	3.158
1975	0.736	1996	2.446
1976	0.962	1997	0.788
1977	0.901	1998	2.856
1978	3.317	1999	2.446
1979	2.323	2000	1.093
1980	0.686	2001	1.763
1981	0.476	2002	1.972
1982	0.377	2003	0.686
1983	1.572	2004	1.665
1984	0.686	2005	1.093
1985	0.595	2006	1.085
		2007	2.531

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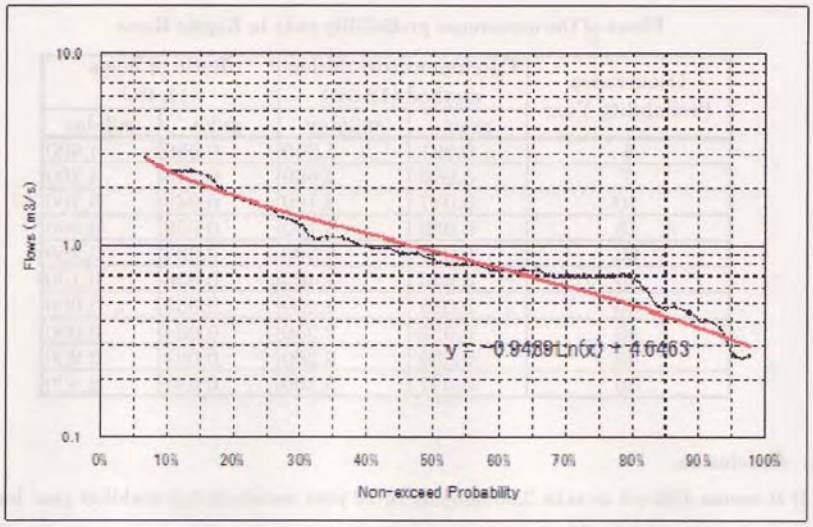
Exceed and non-exceed probability

No.	Year	Minimum Discharge	Exceed Probability W=i/(n+1)	Non-exceed Probability W=100%-i/(n+1)
1	1987	0.270	2.3%	97.7%
2	1991	0.270	4.5%	95.5%
3	1982	0.377	6.8%	93.2%
4	1967	0.408	9.1%	90.9%
5	1971	0.450	11.4%	88.6%
6	1981	0.476	13.6%	86.4%
7	1992	0.476	15.9%	84.1%
8	1985	0.595	18.2%	81.8%
9	1966	0.686	20.5%	79.5%
10	1980	0.686	22.7%	77.3%
11	1984	0.686	25.0%	75.0%
12	1988	0.686	27.3%	72.7%
13	1994	0.686	29.5%	70.5%
14	2003	0.686	31.8%	68.2%
15	1968	0.736	34.1%	65.9%
16	1970	0.736	36.4%	63.6%
17	1975	0.736	38.6%	61.4%
18	1986	0.736	40.9%	59.1%
19	1969	0.788	43.2%	56.8%
20	1973	0.788	45.5%	54.5%
21	1997	0.788	47.7%	52.3%
22	1974	0.843	50.0%	50.0%
23	1965	0.901	52.3%	47.7%
24	1977	0.901	54.5%	45.5%
25	1972	0.962	56.8%	43.2%
26	1976	0.962	59.1%	40.9%
27	1989	1.026	61.4%	38.6%
28	2006	1.085	63.6%	36.4%
29	2000	1.093	65.9%	34.1%
30	2005	1.093	68.2%	31.8%
31	1990	1.316	70.5%	29.5%
32	1993	1.397	72.7%	27.3%
33	1983	1.572	75.0%	25.0%
34	2004	1.665	77.3%	22.7%
35	2001	1.763	79.5%	20.5%
36	2002	1.972	81.8%	18.2%
37	1979	2.323	84.1%	15.9%
38	1996	2.446	86.4%	13.6%
39	1999	2.446	88.6%	11.4%
40	2007	2.531	90.9%	9.1%
41	1998	2.856	93.2%	6.8%
42	1995	3.158	95.5%	4.5%
43	1978	3.317	97.7%	2.3%



Thomas Plot

Y=-0.9489×Ln(X)+4.6463

Flows of the occurrence probability year in Kimondi River

Occurrence Probability Year	Flows	
	m3/s	m3/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

2. Kabutie River flows

Estimation of flows in Kabutie River using the Kimondi River flows.

1） Catchment correlation method: 12.6%

2） Ratio of Kabutie flow to Kimondi: 11.4%

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Flows of the occurrence probability year in Kaptie River

Occurrence Probability Year	Catchment correlation method (12.6%)		Ratio of flows (11.4%)	
	m3/s	m3/day	m3/s	m3/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

3. Conclusion

1) It seems difficult to take 3,800m3/day in 10 year occurrence probability year but 5 year's of that is possible.

Minimum-flows were appeared in 4th to 5th March 1987 and 4th to 6th March in 1991.

In 1987 year

Catchment correlation method: less than 4,000m3/day flow continued 12days and less than 5,000m3/day continued 33days

Ratio of Kabutie flow to Kimondi: less than 4,000m3/day flow continued 28days and less than 5,000m3/day continued 38days

In 1991 year

Catchment correlation method: less than 4,000m3/day flow continued 9days and less than 5,000m3/day continued 20days

Ratio of Kabutie flow to Kimondi: less than 4,000m3/day flow continued 19days and less than 5,000m3/day continued 25days

2) In drought year, 3,800m3/day water is not able to taken for about 30days.

Flows condition in 1987

1987 Year		Kimondi River		Kaptie River	
Date		m3/s	m3/day	Catchment correlation method (12.6%) m3/day	Ratio of flows (.11.4%) m3/day
Jan	26	0.514	44,400	5,600	5,100
	27	0.476	41,100	5,200	4,700
	28	0.476	41,100	5,200	4,700
	29	0.441	38,100	4,800	4,300
	30	0.441	38,100	4,800	4,300
	31	0.408	35,300	4,400	4,000
Feb	1	0.408	35,300	4,400	4,000
	2	0.408	35,300	4,400	4,000
	3	0.370	32,000	4,000	3,600
	4	0.377	32,600	4,100	3,700
	5	0.377	32,600	4,100	3,700
	6	0.347	30,000	3,800	3,400
	7	0.347	30,000	3,800	3,400
	8	0.377	32,600	4,100	3,700
	9	0.377	32,600	4,100	3,700
	10	0.408	35,300	4,400	4,000
	11	0.411	35,500	4,500	4,000
	12	0.514	44,400	5,600	5,100
	13	0.476	41,100	5,200	4,700
	14	0.441	38,100	4,800	4,300
	15	0.441	38,100	4,800	4,300
	16	0.408	35,300	4,400	4,000
	17	0.408	35,300	4,400	4,000
	18	0.408	35,300	4,400	4,000
	19	0.377	32,600	4,100	3,700
	20	0.377	32,600	4,100	3,700
	21	0.441	38,100	4,800	4,300
	22	0.476	41,100	5,200	4,700
	23	0.598	51,700	6,500	5,900
	24	0.377	32,600	4,100	3,700
	25	0.347	30,000	3,800	3,400
	26	0.347	30,000	3,800	3,400
	27	0.320	27,600	3,500	3,100
	28	0.320	27,600	3,500	3,100
Mar	1	0.320	27,600	3,500	3,100
	2	0.294	25,400	3,200	2,900
	3	0.294	25,400	3,200	2,900
	4	0.270	23,300	2,900	2,700
	5	0.270	23,300	2,900	2,700
	6	0.377	32,600	4,100	3,700
	7	0.476	41,100	5,200	4,700
	8	0.788	68,100	8,600	7,800

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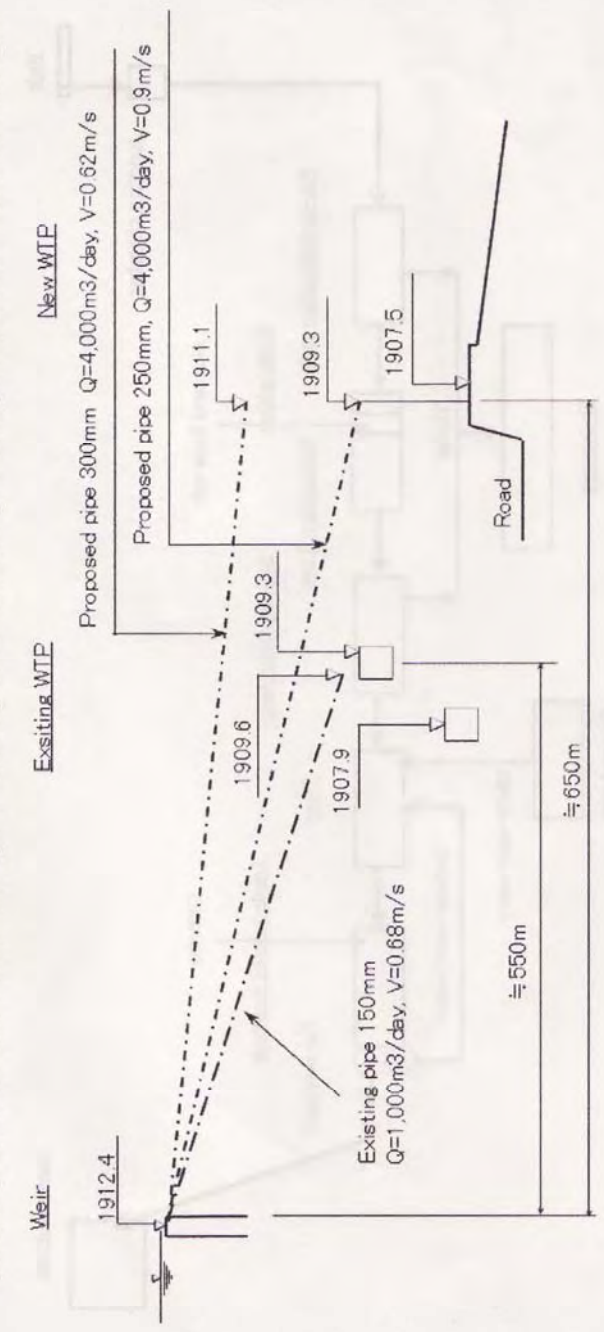
Flows condition in 1991

1991 Year		Kimondi River		Kaptie River	
Date				Catchment correlation method (12.6%)	Ratio of flows (.11.4%)
		m3/s	m3/day	m3/day	m3/day
Feb	9	0.553	47,800	6,000	5,400
	10	0.553	47,800	6,000	5,400
	11	0.514	44,400	5,600	5,100
	12	0.514	44,400	5,600	5,100
	13	0.514	44,400	5,600	5,100
	14				
	15	0.476	41,100	5,200	4,700
	16	0.476	41,100	5,200	4,700
	17	0.476	41,100	5,200	4,700
	18	0.476	41,100	5,200	4,700
	19	0.408	35,300	4,400	4,000
	20	0.408	35,300	4,400	4,000
	21	0.408	35,300	4,400	4,000
	22	0.408	35,300	4,400	4,000
	23	0.377	32,600	4,100	3,700
	24	0.377	32,600	4,100	3,700
	25	0.441	38,100	4,800	4,300
	26	0.408	35,300	4,400	4,000
	27	0.377	32,600	4,100	3,700
	28	0.347	30,000	3,800	3,400
Mar	1	0.320	27,600	3,500	3,100
	2	0.320	27,600	3,500	3,100
	3	0.294	25,400	3,200	2,900
	4	0.294	25,400	3,200	2,900
	5	0.270	23,300	2,900	2,700
	6	0.270	23,300	2,900	2,700
	7	0.294	25,400	3,200	2,900
	8	0.320	27,600	3,500	3,100
	9	0.377	32,600	4,100	3,700
	10	0.408	35,300	4,400	4,000
	11	0.476	41,100	5,200	4,700
	12	0.553	47,800	6,000	5,400
	13	0.640	55,300	7,000	6,300

ANNEX-B Raw water transmission main from intake weir to water treatment plant

1. Hydraulic gradient are shown in the next figure. Existing weir level is enough to convey the raw water to new treatment plant.



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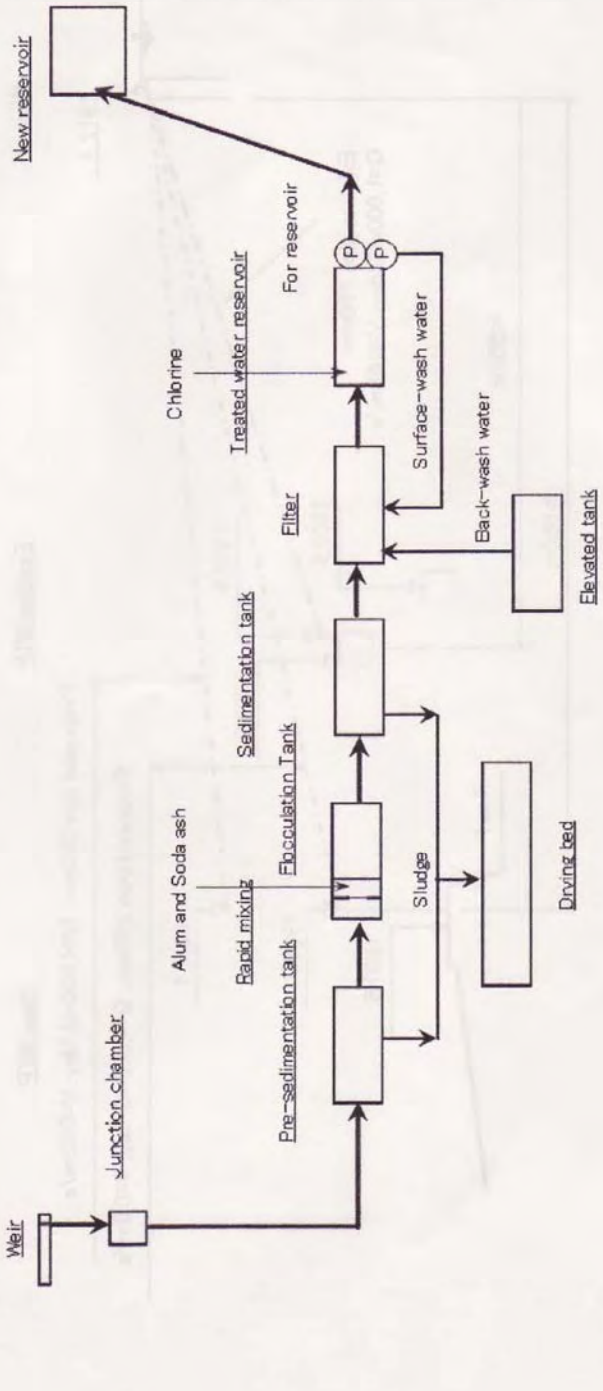
ANNEX-C Diagram from intake, water treatment plant to new reservoir.



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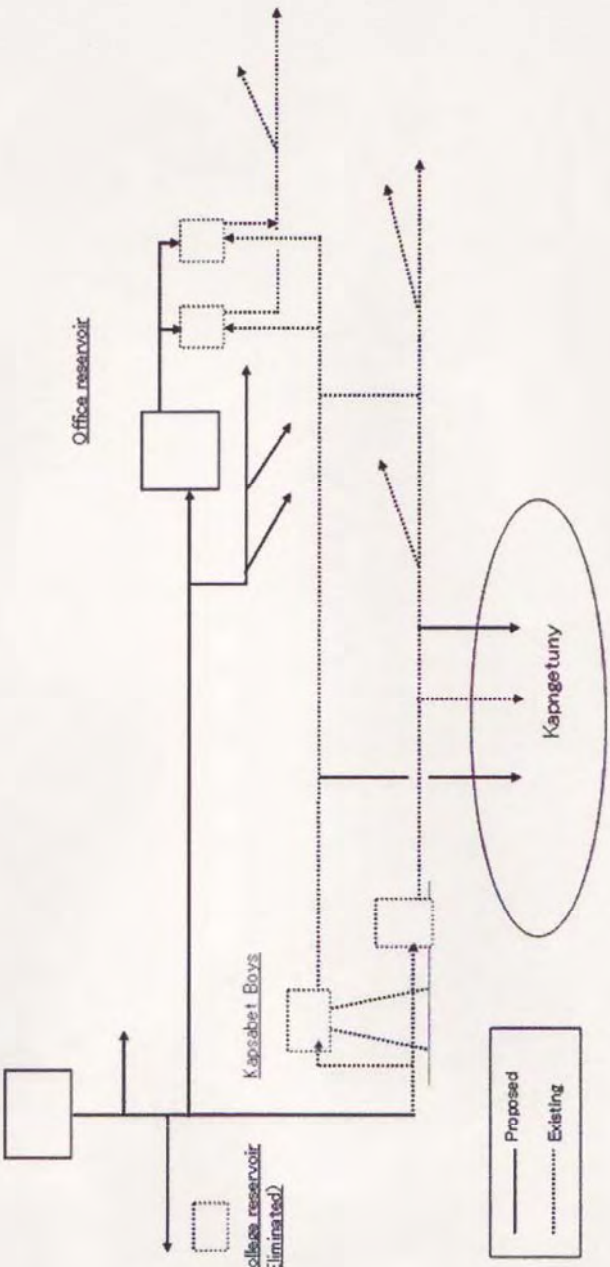
ANNEX-D Distribution network

1. Basically new distribution pipe will not be connected to existing pie except Kapngetuny area.



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Appendix 6

Soft Component Plan

Appendix 6 Soft Component Plan

Soft Component Plan

In order to enhance the performance of business operation of water services and maintain the sustainability, the KNWSC has to carry out appropriate O&M and business management with strengthening the organization. Considering the current status of Kenya, however, it is considered not easy for KNWSC to recruit personnel who possess the required knowledge and skills. To achieve the above objectives, it is decided that a strong engineering and management support would be effective and the following soft component program was planned.

- Training for O&M of Water Supply Facilities
- Management Training (Training for business operation/billing/accounting system operation)

(1) Background

At present, water supply for Kapsabet Town is conducted by KNWSC. KNWSC has 12 staff members that provide water services to current 340 connections, where approximately 50 connections have water meters. Upon completion of the Project water supply capacity is expected to increase from current water supply of 550m^3/day to 3,600m^3/day. Also the number of service connections will be expected to increase to 6,500 which is 20 times compared to current service connections.

The existing WTP including transmission pump system is being operated by only three technical staff members. However, the present capability of staff is not qualitatively and quantitatively sufficient to operate the new WTP. Even though they have equivalent operational experiences with the proposed water supply system, they do not have sufficient operational knowledge and skills for a new water supply facility that can supply 3,600 m^3/day. Likewise, it is foreseen that business operation such as meter readings, billing and collection, which are presently performed manually by only three staff members, will need augmentation given the increased number of customers.

Therefore, the KNWSC has to strengthen the organization, management and operations of the water services through securing the personnel with appropriate qualification in order to achieve the goals of the water supply services as envisioned by the Project.

However, it is considered not easy for KNWSC to recruit personnel that would possess the required knowledge and skills considering the current status of Kenya. Furthermore, there will be a need for an information and public education on the benefits of access to water supply services, thus attracting new customers as well as contributing to more stable business operations.

To achieve the above objectives, a strong management and engineering support with the soft component program to establish the operational system and technology transfer for facility operation of a new system and business operation are needed.

This soft component program will focus on the training on i) engineering component including knowledge and technology transfer for operation and maintenance for the new water supply facilities and leakage detection/ prevention and management of water meters, and ii) management component including strengthening business management, billing/accounting system operation and public education.

(2) Objectives

The objective of the Project is to provide safe, reliable and adequate water supply to the people of Kapsabet Town with sufficient facility operation and management based on sound water supply business management. This soft component program aims to support and achieve the project objective by strengthening the business management, transfer knowledge and technology for operation of new water supply facilities, conduct public education to involve people of Kapsabet Town as the customer, and create a sustainable business situation.

(3) Outputs of Soft Component Program

This soft Component Program will expect the following outputs:

i) Engineering training

- The technical staff of KNWSC will properly operate and maintain the new water supply system to be developed by the Project.
- The technical staff of KNWSC will have knowledge required for water leak survey and remedial works as well as management for water meters.

ii) Management training

- The business operation staff of KNWSC will have the necessary knowledge and techniques on business operation including accounting and customer services.
- The billing/accounting staff of KNWSC will properly operate the billing/accounting system to be introduced by the Project.
- People of Kapsabet Town will have sufficient knowledge about drinking water and hygiene.
- People of Kapsabet Town will have the willingness to connect to the water supply system and pay water tariff.

(4) Expected Results and Means of Evaluation

Objectives and outputs of each module are shown in Table-1. Instructors of the engineering training and training for business administration staff will check the training results using a check list of output columns and evaluate trainees of their knowledge and understandings of transferred technology.

Training for billing/accounting system operation will be continued until responsible persons can operate the system without assistance.

The facilitator of public education will evaluate and analyze the results of the questionnaire surveys distributed to the attendants. Based on this analysis, the chief consultant for soft component program will confirm the result of public education.

(5) Activities

The following activities will be conducted in this soft component program.

1) Engineering training

The program will transfer the basic knowledge and technology for operation and maintenance of the proposed water supply system including water intake, WTP and water transmission/distribution facilities. Japanese engineering consultants will develop the operation and maintenance guideline as training material, will conduct basic training to understand the structure and objectives of the proposed water supply system, and will conduct theoretical training and OJT with the proposed equipment/facilities. Main activities are as follows:

i) Training for O&M of the water supply system

- Teach structure and objectives of the proposed water supply system including water intake, WTP, transmission pump equipment, service reservoirs and transmission/distribution pipelines,
- Teach hydraulic capacity of each water supply facility, including raw water transmission main, WTP, service reservoirs and water transmission/ distribution pipeline,
- Conduct O&M trainings on the water supply system dependent on production capacity fluctuations.

ii) Training for water leakage survey and management of water meters

- Teach the basic knowledge of leakage detection/prevention and management of water meters
- Demonstrate leakage detection and testing accuracy of water meter

Aside from the implementation of this soft component program, the Contractor/Supplier of equipment/facility will provide operation and maintenance manuals and conduct OJT training for each

equipment/facility.

2) Management training

This component consists mainly of three parts, namely i) training for strengthening business operation; ii) training of tariff/accounting system operation for responsible staff, and iii) training for public education Management training aims to provide management knowledge to KNWSC staff, which is required for KNWSC to become a self-supporting water company. Japanese consultants will develop training manuals. The training will focus on developing problem finding skills through discussion among participants and problem solving skills.

i) Training for strengthening business operation

- Teach necessary knowledge and techniques on business operation
- Teach necessary knowledge on accounting and financial management
- Teach necessary knowledge on customer services

ii) Training for billing & accounting system operation

- Conduct on-the-job training for billing/accounting system operation

iii) Training for public education

- Promote mutual understanding of importance of public education for drinking water and proper hygiene
- Promote new service connection and tariff payment by information dissemination
- Analyze questionnaire surveys distributed to the attendants on the workshop

Details of the Soft Component Plan are summarized in Table-2.

(6) Implementation Methods

This soft component program will be conducted by Japanese consultants and local consultants (experts of IT and public education) under the supervision of Japanese consultants in class-room training, exercise training and on-the-job training. Especially, as there are not sufficient engineering experts of water supply system in Kenya, Japanese consultants will be assigned in this field as engineering trainers.

Basic roles and responsibility of Japanese consultants and local consultants are as follows:

<u>Basic Roles of Japanese Consultants</u>

i) Chief consultant for soft component

- Supervise implementation of the soft component program
- Plan the training program
- Develop the technical-training materials (O&M Guideline) referring to the manual prepared by

"Meru City Water Supply Project"

- Conduct technical training on O&M for the entire water supply facilities (water intake, water conveyance, WTP and water transmission/distribution facilities)

ii) Engineer for leakage-prevention

- Conduct technical training on leakage-prevention and management of water meter
- Support technical training to be provided by the above-mentioned chief consultant

iii) Business management consultant

- Supervise the entire training activities on strengthening business operation
- Conduct training on business management
- Support the training on public education to be conducted by the local consultant

Basic Roles of Local Consultants

i) IT (billing/accounting system operation) consultant

- Prepare operation manual on Billing/Accounting System to be introduced in the Project
- Conduct system operator training

ii) Public education consultant

- Prepare the training materials for drawing awareness of people of Kapsabet on drinking water, hygiene and tariff payment referring to the practices in "Meru City Water Supply Project"
- Conduct workshops based on public education program

Conduct public education and analyze the questionnaires to survey reactions of attendants

(7) Schedule

The training for management (except for training for billing/accounting system operation) should be conducted first, followed by the training for engineering staff. As construction of the proposed water supply system and billing/accounting system will be completed at the end of June 2011, preparation for the management training will start by the middle of April 2011, and followed by the actual training from May 2011. The training for engineering and billing/accounting system operation will coincide with the completion of the construction works.

The preparing work for strengthening business operation and public education should be started by November 2010 and followed immediately by the workshop. A series of public education will continue once every week from the beginning of November to December 2010, six times in total.

The described above means that KNWSC has to recruit and provide necessary staff before completion of construction works.

Item			Month	2010 9	10	11	12	1	2	3	2011 4	5	6	7	8	9	10	11
Management Training	Japanese Consultants	Strengthening Business Operation	2			■	■											
	Kenyan Consultants	Public Education	2			■	■											
		Billing & Accounting System Operation	2										■	■	■			
Engineering Training	Japanese Consultants	O&M of Water Supply	2										■	■	■			
		Leakage Prevention & Water Meter Management	1											■	■			

Figure 1　Schedule

(8)　Outputs

1) Engineering training

Training plan, Training material, O&M guideline, Evaluation report by trainers

2) Management training

Management raining plan, Training material, Evaluation report by trainers, Evaluation report by workshop attendants

(9) Cost Estimates for Soft Component

Total Cost Estimates: 18,000 thousand Yen

Total Cost Estimates for local recommission: 1,200 thousand Yen

(10) Responsibility of Recipient Country

KNWSC will collect staff for soft component and arrangement them properly.

KNWSC will also implement public education continually, and will connect new water supply and install water meter. For this purpose, KNWSC will collect staff in technical/management for preparing for increasing the water supply and water pipe connection.

Table 1 Modules of Soft Component

	Module	Objectives	Expected Output
1. Engineering Training	1-1 Training on O&M of Water Supply Facilities	To operation and maintain appropriately the facilities by understanding the component contents and objectives on facilities (water intake, water conveyance, water treatment and water transmission/distribution)	- To possibly understand the component of water supply facilities & objectives/function of each facilities
			- Adequate O&M (operation on screen & wash-out valve) on intake weir & water conveyance pipe
			- To possibly determine design intake flow depending upon demand
			- To possibly comprehend the detention time on respectivle facility of water treatment plant
			- To possibly operate filter tank (basin) depending upon the design intake flow
			- To adequately perform chemical solution processing
			- To possible operate chemical feeding equipment by setting up chemical feeding quanitity depending upon design intake flow & raw
			- To possibly carry out jar test
			- To ppssibly judge advisability on flocculation conditionds
			- To possibly check water quality on turbidity, pH and residual chlorine for respective process
			- To possibly conduct desludging from settling tank
			- To adequately clean filter tank (basin)
			- To possibly conduct O&M on drying bed
			- To ppssibly operate water pump
			- To possibly control water level of service reservoir
			- To carry out &M (valve operation & pipeline inspection) on water transmission/distribution pipe
			- To possibly grasp water volume for respective block
			- To possibly draw up the performance and O&M records (kinds of checklist, daily report and monthly report etc.)
			- To possibly manage kinds of documents/drawings & data books
	1-2 Training on Leakage-prevention & Water Meter Management	To manage pipeline with appropriate O&M by undestanding leakage survey/repair/leakage-prevention measures and management method of water meter	- To possibly understand leakage detect method & leakage-prevention measures
			- To possibly operate required tools for connecting water meter
			- To possibly operate water meter calibrating appliance
2. Management Training	2-1 Training on Business Operation	KNWSC's management level employees and staff in charge of business/accounting gained business kanowledge and operation know-how required for operational management on water supply project and hence can carry out the project operation such as financial management (budget management & cost analysis) and business management.	- To possibly draw up financial statements
			- To possibly carry out budget management by comprehending budgeting know-how
			- To possibly propose draft revisions with adequate water tariff by appropriately analysing cost through comprehension of method on cost analysis
			- To possibly apply necessary measures by comprehending the reduction measures on nonrevenued eater
			- To possibly manage public relations (PR), education and public awareness campaign
	2-2 Training on Billing/Accounting System Operation	KNWSC' staff in charge of tariff/accounting can alone manipulate tariff application/accounting system	- To ppossibly comprehend method on tariff application/collection management
			- To possibly operate traiff application/accounting system
			- To possibly perform water tariff application/collection management (issue on demand note/bill-payment receipt and collection records) by tariff application/accounting system
			- To possibly perform account processing (income/expenditure procesing & sorting processing) by tariff application/accounting
			- To possibly complete management data book on consumers
			- To possibly proceed registration on new consumers
	2-3 Training on Public Education	- Residents gain adequate knowledge on relation between drinking water and health.	- Participants attending enlightenment assembly understand sanitary significanceor role on water supply/sewerage systems
		- To contribute the promotion on willings payment of water tariff by enlightening the intension on water service connection	- To accelerate water service connection
			- KNWSC's staffs gain the technology on planning/operation of enlightenment assembly

Table 2 Details of Soft Component Plan

Classification		Description	Archievements	Method	Required Input	Remark
1. Engineering Training	1.1 Training on O&M of Water Supply Facilities	- To give a course on framework of water intake/conveyance, water treatment and water transmission/distribution facilities - To train O&M on water intake/conveyance facilities (operation on screen, desludging valves) - To give a course on structure of water treatment facilities & objectives on respective processing - To train until KNWSC's staff can adequately performance water treatment plant depending upon required intake flows and raw water quality (control on discharge, jar test, water quality inspection, chemical feeding rate regulation, filtration water volume regulation, cleaning water volume regulation, desludging operation and sludge treatment/disposal) - To train the operation method of water pump equipmemt (automatic operation & hand-operated - To train the water level control on service reservoir - To train O&M on water transmission/distribution pipes (control on discharge & water pressure, pipeline inspection and dewatering method) - To train until every facilities can draw up performance and O&M records - To give a course on management of drawings and data book	- Training Plans - Tarining Teaching Materials (O&M Guideline) - Chemical Feeding Ratio Lists - Recording Lists on Performance and O&M (kinds of Cheklist, Daily Report & Monthly Report) - Evaluation on trainees who take the course by trainees themselves	- Classroom training by applying deatiled design drawings and design books - OJT by use of Actual Facilities - Intended Attendance: 1 management level employee & 14 staffs in charge of technical division (9 staffs incharge of performance and O&M on facilities, and 5 staffs in charge of O&M on piping): 15 staffs in total	- Technical Engineer of Waterworks (Japanese Consultant) Planning/Arrangement: 1person×0.5month Implementation: 1person× 0.5month	Person in charge shall be assigned prior to soft components.
	1.2 Training on Leakage-prevention & Water Meter Management	- To give a course on leakage survey method of pipeline network and demonstrate by OJT - To give a course on connection method of water meter - To train the calibration method on water meter	- Training Plans - Tarining Teaching Materials - Evaluation on trainees who take the course by trainees themselves	- Classroom Training - OJT by use of Actual Facilities - Intended Attendance: 1 management level employee of technical division & 5 staffs in charge of O&M on piping: 6 staffs in total	- Leakage-prevention Engineer of Waterworks (Japanese Consultant) Planning/Arrangement: 1person×0.25month Implementation: 1person× 0.75month	

(Continued)

Classification		Description	Archievements	Activities Method	Required Input	Remark
2. Management Training	2.1 Technical Assistance on Business Operation	- To give a course on required knowledge of business management and management know-how - To give a course on accounting service & financial management - To give a course on business/customer management (acceleration on willingness to buy/pervasion & water service) - To give a course on reduction countermeasures of nonrevenued water - To give a course on how to read management information derived from management associated data - To give a course on customer service (publication, public relations & communication with customers)	- Training Plans - Tarining Teaching Materials - Management Information - Evaluation on trainees who take the course by trainees themselves	- Classroom Training - Intended Attendance: 2 management level employee in chareg of general affairs & business respectively, 4 staffs in charge of business/accounting: 6 staffs in total	- Water Utility Management Experts (Japanese Planning/Arrangement: 1person×0.25month Implementation: 1person× 1.5month	
	2.2 Training on Billing/Accounting System Operation	- To give a course on procedures of tariff application/accounting service & required know-how on accounting business - To give a course on internship (business studies) of traiff application/accounting system manipulation/operation (Training will be carried out until staff in charge of tariff/accounting can manipulate alone the said system)	- Training Plans - Tarining Teaching Materials - Manual on System Operation - Evaluation on trainees who take the course by trainees themselves	- Classroom Training - Training on System Operation by OJT - Intended Attendance: 2 management level employee in chareg of general affairs & business respectively, 5 staffs in charge of tariff/accounting: 7 staffs in total	- Tariff/Accounting System Expert (Local Consultant) Planning/Arrangement: 1person×0.5month Implementation: 1person× 1.5month	To gain the similar system is in operation by other providers' assistance
	2.3 Training on Public Education	- Enlightenment on water service pervasion to local residents by workshop (sanitary significance, role or framework of water service & tariff system etc.)	- Training Plans - Tarining Teaching Materials - Educational Campain Implementation Plans - Questionnaire Survey Results from Enlightenment Assembly Particpants - Evaluation on trainees who take the course by trainees themselves	- Intended Attendance: 1 management level employee in chareg of business division, 2 staffs in charge of business: 3 staffs in total Enlightenment Assembly Participants Anticipated: 30 - 40 Kapsabet townspersons as the target to be invited for each assembly: assembly with 6 times in total	- Expert on Water Supply Management & Community Development (Local Consultant) Planning/Arrangement: 1person×0.5month Implementation: 1person× 1.5month	

Appendix 7

Other Relevant Data

Appendix 7 Other Relevant Data

Appendix7-1 EIA

Application Reference No. PR/238
Registration No: 0000746
For official use

MINISTRY OF WATER AND IRRIGATION ★ RECEIVED ★ CENTRAL REGISTRY ★ BOX 30521 NAIROBI ★

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT LICENCE

This is to certify that the Project Report/Environmental Impact Assessment Study Report received from .....MINISTRY OF WATER AND IRRIGATION..... (name of individual/firm).....P.O. BOX 19720 - 00100, NAIROBI.....(address) submitted to the National Environment Management Authority in accordance with the Environmental Impact Assessment & Audit Regulations regarding..REHABILITATION & AUGMENTATION OF WATER SUPPLY (title of project) whose objective is to carry on.....REHABILITATION AND EXPANSION/BUILDING ...OF THE WEIR, TREATMENT WORKS, LAYING OF RISING MAIN AND AUGMENTATION ...NETWORK TO SUPPLY 3000m3 / DAY OF WATER FROM KABUTIE RIVER..... .... (briefly describe purpose) located ...KAPSABET TOWNSHIP, NANDI NORTH DISTRICT.....(locality and district) has been reviewed and a licence is hereby issued for implementation of the project, subject to attached conditions.

Dated this.....11TH.....day OCTOBER, ... of 20.06....

Signature.....

(SEAL)

Director General
The National Environment Management Authority

CONDITIONS OF LICENCE

1. This licence is valid for a period of .24..MONTHS....(time within which the project should commence) from the date hereof.
2. The Director-General shall be notified of any transfer/variation/surrender of this licence.

P.T.O.

3. The proponent shall sensitize the community and take all practical measures to conserve the catchment area of Tulon Swamp, Kabutie River and the tributary springs.

4. The proponent shall fill the dam during the rainy season when there is an ample flow.

5. The proponent shall ensure strict adherence to the Environmental Management Plan developed throughout the project cycle.

6. The proponent shall collaborate with the EIA Expert(s) and the contractor(s) to ensure that proposed mitigation measures are adhered to during the construction phase and where necessary appropriate mending – up activities undertaken and a report of the same submitted to NEMA.

7. The proponent shall comply with the relevant principal laws, by-laws and guidelines issued for the development of such a project within the jurisdiction of Ministry of Health, Water Resources Management Authority, Municipal Council of Kapsabet, Ministry of lands and Settlement, Ministry of Culture and Social Services and other relevant Authorities.

8. The proponent shall ensure that during construction phase the operations should adhere to legal notice No. 40. The Factories (Building Operation and Work of Engineering Construction) Rules, 1984.

9. The proponent shall ensure that environmental protection facilities or measures to prevent pollution, and ecological deterioration and conflict such as conventional 3000m^3 full water treatment plant, compensation and resettlement scheme, Kabutie River buffer zone observance plan are designed, constructed and employed simultaneously with the proposed Project.

10. The proponent shall ensure that records on conditions of licences / approval and project monitoring and evaluating shall be kept on the project site for inspection by NEMA's Environmental Inspectors.

11. The proponent shall submit an Environmental Audit Report in the first year of operation to confirm the efficacy and adequacy of the Environmental Management Plan.

12. The proponent shall comply with NEMA's improvement orders throughout the project cycle.

Appendix7-2 Water Right

Water Resources Management Authority

Telephone: 056 – 30834
Fax 056 - 30826
Email: wrmalvn@wananchi.com

LVNCAO
P.O. BOX 77
KAKAMEGA

Ref : WRMA/LVNCA/122/(6)

Date: 13th Nov., 2007

Chief Executive Officer
Lake Victoria North Water Services Board
P. O. Box 673 – 50100
KAKAMEGA.

RE:- AUTHORIZATION TO CONSTRUCT WORKS ON GOVERNMENT LAND IN KABUTIE AREA IN NANDI NORTH DISTRICT.

Following your application for an authorization to construct works, you have now been issued with an authorization No. WRMA/LVNCA/122 of 13th Nov., 2007 to enable you to construct works on Government parcel in Kabutie area in Nandi North district for abstraction of 4700 m^3/d to meet your public use only.

In this connection, your attention is drawn to all the conditions indicated at the back of the attached WRMA 004 under which the proposed works is authorized.

Please take necessary action.

E.S.Wanyonyi,
Regional Manager
Lake Victoria North Catchment Area

CC: Sub-Regional Manager,
ELDORET.

The Chief Executive Officer,
Water Resources Management Authority,
P. O Box 45250 - 00100,
NAIROBI.,

Form: WRMA 004
Catchment: **LVNCA**
WRMA ID: **11**
File:**WRMA/LVNCA//122**

Water Resources Management Authority

AUTHORISATION TO CONSTRUCT WORKS FOR THE USE OF WATER

Dear Sir/Madam; *(Rule 33)*

I have the honour to inform you that the Water Resources Management Authority has given you approval to construct the proposed works based on your application dated ***5th September, 2007*** *for a Water Permit.*

Authorization No. WRMA	**LVNCA//122**	*Dated*	**13th November, 2007**

Type of Water Use	**Surface Water**				**Groundwater**		**Effluent Discharge**	**Swamp Drainage**
	Diversion	**Abstraction**	**In-stream Works**	**Storage**	**Shallow well**	**Borehole**		
Tick Box		√						

PARTICULARS OF APPLICANT		**DETAILS**	
1. Full name of applicant(s) (In Block Letters)		C.E.O. LV.N.W.S.BOARD (KAPSABET WATER SUPPLY).	
3. Category of Applicant - Individual, Group [Association, Society], Company, Institution		COMPANY	
4. ID Number of Applicant (Individual) or Certificate of Incorporation or Registration for Groups or Companies		TO FOLLOW	
5. PIN Number (where available)		TO FOLLOW	
Physical Address where water is to be used		**Contact Address of Applicant**	
6. L/R Number(s)	GOVERNMENT PARCEL	7. Box Number	673, KAKAMEGA
8. Village(s)/Ward(s)	KABUTIE	9. Town	KAKAMEGA
10. Sub-location(s)	KAPSABET	11. Post Code	50100
12. Location(s)	KAPSABET	13. Telephone Contact (Landline)	056-302095
14. Division(s)	KAPSABET	15. Telephone Contact (Mobile)	0722351254
16. District(s)	NANDI NORTH	17. Email Contact	Lvnwsb@yahoo.com

WATER RESOURCE DETAILS

18. Name of Body of Water or Aquifer where water is to be diverted, abstracted or stored	KABUTIE RIVER
19. Is the point of abstraction or storage in a Protected Area or a Groundwater Conservation Area? (yes/no)	NO
20. Sub-catchment Number	1FC
21. Class of Water Resource	
22. Name of Body of Water or Aquifer where effluent is to be discharged	-
23. Sub-catchment Number (Effluent)	-
24. Class of Water Resource (Effluent)	-
25. Category of Application (Class of Permit)	D

Supplement to Permit/Authorization	
26. Are there any supplements approved under Section 21 of WRMA Rules (yes/no)	NO
27. Supplement No.	N/A

28. Brief Description of Project and Intended Use for Water				
Type of Water Use	**Groundwater (m3/day)**	**Surface Water (m3/day)**		
		River - Normal Condition	**River - Flood Condition**	**Lake**
29. Public		4700		
30. Domestic		N/A		
31. Livestock		N/A		
32. Subsistence Irrigation		N/A		
33. Commercial Irrigation		N/A		
34. Industry/Commercial		N/A		
35. Hydropower		N/A		
36. Others		N/A		
37. Sub-total		4700		
38. Quantity Returned		N/A		
39. Water Abstracted (row 34-row 35)		4700		
40. Effluent Discharge	-	NIL		

Having filed the necessary application, maps and plans, and having complied with the provisions of the Water Act 2002, and the Rules there under relating to the applications for Water Permit is hereby authorized to construct, subject to the acquisition of the necessary rights of way or easements therefore, if any, the works shown by the said applications, maps and plans in accordance with provisions of the Water Act 2002, the Rules there under, and the following conditions: -

1 *The construction of the works hereby authorized shall commence within a period of **1 MONTH** and shall be completed within a period of **24 months** from the date of this authorization.*

2 *(a)Any person who erects or constructs temporary works shall be entitled to divert, abstract, impound, obstruct, store or use water to such extent only as may be necessary for the construction or erection of the works, and whenever it shall be necessary to divert, abstract or impound water during the erection or construction of the works authorized, such diversion, abstraction, obstruction, impounding, or use of water shall be made at such time and in such manner that the works of other operators are interfered with as little as possible and that no damage will be caused to property of another landholder. Provided that if any damage is caused it shall, failing agreement between the parties concerned, be settled by arbitration under the Arbitration Act.*

(b)Unless empowered thereto by the Water Resources Management Authority in writing, all temporary works shall be removed within a period of three months from the date of completion of the works authorized or from the date of determination of the authorization (whichever be the earlier) and where any temporary works exist, such as quarries, burrow-pits, excavations, cuttings, tunnels or things of a like nature which cannot be economically removed, efficient precautions to the satisfaction of the Water Resources Management Authority shall be taken, by the person named in the authorization, to render and to maintain all such temporary works safe in the interest of life and property.

The Water Resources Management Authority reserves the right to inspect the works authorized by this authorization, and attention is drawn to section 90 of the Act.

3. Any changes between the original proposed design and final as-constructed arrangement has been documented and such documentation submitted to the Authority.

3.CONDITONS OF AUTHORISATION	DETAILS
Measuring device	Installation of master meter
Controlling device	Installation of Valves
Water Quality Report	Submission of report
Evidence of EMCA Compliance	-
Soil and Water Conservation Plan	To be submitted
Compensation Flow (m3/day)	
Inspection Milestones	
1	-
2	
3	
4	
Notification Requirements	
1 Registration certificate	Submission
2 PIN	---do----
3	
4	
Storage	
Airline	
Test pumping	-
Other Technical Details	-
Effluent Discharge Requirements	-

1 This Authorization will be automatically cancelled, when the authorized period expires, without any further reference to you unless extension of time limit is applied for prior to date of expiry.
2 The following details/documents are required to complete your application before a Permit may be issued:

☐ (a) Form WRMA 008 must be returned dully signed when works have been installed.
☐ (b) Registration certificate and PIN

SIGNATURE

Yours faithfully,

Signature of WRMA Officer	
Name of Officer	E. S. WANYONYI
Position	REGIONAL MANAGER
Date of Signature	16/11/2007

Appendix7-3 Other Water Volume

Other Water Volume

Water Consumption: Estimation on Other Water Volume (excluding Domestic Use)

Other water volume on future demand was estimated as below base upon the studies in 2005.

- School service water, government and public offices service water, and commercial use water were estimated assuming the similar ultimate elongation will be same as the population growth rate (2.4%/yr).
- Hospital service water and factory water adopted the same figure in 2005.

1) School Service Water

Year / Administrative Name	2005 Student's Number of School	2005 Consumption per Capita (l/day)	2005 Water Demand (m^3/day)	2007 Water Demand (m^3/day)	2010 Water Demand (m^3/day)	2013 Water Demand (m^3/day)	2015 Water Demand (m^3/day)
Kapsabet Town Ship	3,749	20	75	79	84	91	95
Kapngetuny	2,873	20	57	60	64	69	72
Kamobo	1,464	20	29	30	33	35	37
Kamurguiywa	656	20	13	14	15	16	16
Kimaam	0	20	0	0	0	0	0
Kipture	0	20	0	0	0	0	0
Total	8,742		174	183	196	211	220

2) Government and public offices service water

(Unit: m^3/day)

Administrative Name	Year 2005	2007	2010	2013	2015
Kapsabet Town Ship	32	34	36	39	41

3) Commercial Use Water

Commercial use water includes the water consumed by shop, petrol station, bar & restaurant, and bank etc.

(Unit: m^3/day)

Administrative Name	Year 2005	2007	2010	2013	2015
Kapsabet Town Ship	102	107	115	123	129
Kapngetuny	14	15	16	17	18
Kamobo	10	10	11	12	13
Total	126	132	142	152	160

4) Hospital/Health Center Service Water

(Unit: m^3/day)

Kapsabet Town Ship	Year				
	2005	2007	2010	2013	2015
District Hospital	16	16	16	16	16
Health Centres	40	40	40	40	40
Total	56	56	56	56	56

5) Factory Water

(Unit: m^3/day)

Administrative Name	Year				
	2005	2007	2010	2013	2015
Kapngetuuny	16	16	16	16	16
Kamobo	72	72	72	72	72
Total	88	88	88	88	88

6) Total Other Water Volume

(Unit: m^3/day)

Administrative Name	Year					
	2005	2007	2010	2012	2013	2015
Kapsabet Town Ship	265	276	291	303	309	321
Kapngetuny	87	91	96	100	102	106
Kamobo	111	112	116	118	119	122
Kamurguiywa	13	14	15	16	16	16
Kimaam	0	0	0	0	0	0
Kipture	0	0	0	0	0	0
Total	476	493	518	536	546	565

Appendix7-4 Kabutie River's Discharges

Kabutie River's Discharges

The discharges at Kabutie River were not measured non tanto; however, some historical measurements were sometimes carried out as next table in these years.

Table-A1 Measured Discharges at Kabutie River

Measured Date	Discharge (m^3/s)	Depth (m)
22-Mar-07	0.445	0.28
1-Feb-07	0.780	0.33
6-Oct-05	0.928	0.41
13-Oct-05	1.094	0.40
21-Oct-05	1.307	0.44
8-Nov-05	0.771	0.35

On the other hand, the discharge conversion on Kimondi River, the main stream of Kabutie River, was just done up to 1992 even the water stage measurement and observation had being conducted without interruption. "KABSABET WATER SUPPLY REHABILITATION AND AUGMENTATION" completed by Ministry of water and irrigation estimated those discharges till October 2005 applying the relationships between the stages and discharges up to 1992. Therefore, the Study Team also estimated the monthly minimum discharges after October 2005 by applying the same approach. The relationship between stages and discharges was illustrated as the next figure.

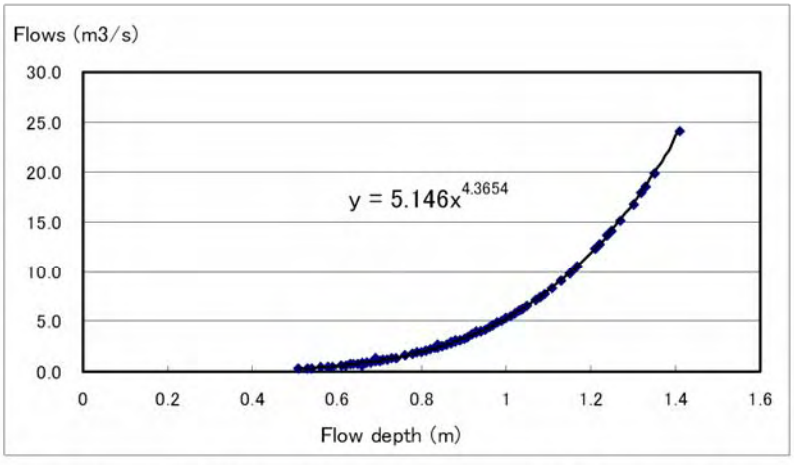


Figure-A1 The Relationship between Stages and Discharges at Kimondi River

1. Minimum Discharge at Kimondi River

Table-**A2** shows the annual minimum discharges at Kimondi River from 1965 up to 2007 and Figure-**A2** shows the excess probability on annual minimum discharges by Thomas equation.

Table-A2 Annual Minimum Discharges

Year	Low flow m3/s	Year	Low flow m3/s
1965	0.901	1986	0.736
1966	0.686	1987	0.270
1967	0.408	1988	0.686
1968	0.736	1989	1.026
1969	0.788	1990	1.316
1970	0.736	1991	0.270
1971	0.450	1992	0.476
1972	0.962	1993	1.397
1973	0.788	1994	0.686
1974	0.843	1995	3.158
1975	0.736	1996	2.446
1976	0.962	1997	0.788
1977	0.901	1998	2.856
1978	3.317	1999	2.446
1979	2.323	2000	1.093
1980	0.686	2001	1.763
1981	0.476	2002	1.972
1982	0.377	2003	0.686
1983	1.572	2004	1.665
1984	0.686	2005	1.093
1985	0.595	2006	1.085
		2007	2.531

Table-A3 Excess Probability by Annual Minimum Discharges

No.	Year	Minimum Discharge	Exceed Probability W=i/(n+1)	Non-exceed Probability W=100%-i/(n+1)
1	1987	0.270	2.3%	97.7%
2	1991	0.270	4.5%	95.5%
3	1982	0.377	6.8%	93.2%
4	1967	0.408	9.1%	90.9%
5	1971	0.450	11.4%	88.6%
6	1981	0.476	13.6%	86.4%
7	1992	0.476	15.9%	84.1%
8	1985	0.595	18.2%	81.8%
9	1966	0.686	20.5%	79.5%
10	1980	0.686	22.7%	77.3%
11	1984	0.686	25.0%	75.0%
12	1988	0.686	27.3%	72.7%
13	1994	0.686	29.5%	70.5%
14	2003	0.686	31.8%	68.2%
15	1968	0.736	34.1%	65.9%
16	1970	0.736	36.4%	63.6%
17	1975	0.736	38.6%	61.4%
18	1986	0.736	40.9%	59.1%
19	1969	0.788	43.2%	56.8%
20	1973	0.788	45.5%	54.5%
21	1997	0.788	47.7%	52.3%
22	1974	0.843	50.0%	50.0%
23	1965	0.901	52.3%	47.7%
24	1977	0.901	54.5%	45.5%
25	1972	0.962	56.8%	43.2%
26	1976	0.962	59.1%	40.9%
27	1989	1.026	61.4%	38.6%
28	2006	1.085	63.6%	36.4%
29	2000	1.093	65.9%	34.1%
30	2005	1.093	68.2%	31.8%
31	1990	1.316	70.5%	29.5%
32	1993	1.397	72.7%	27.3%
33	1983	1.572	75.0%	25.0%
34	2004	1.665	77.3%	22.7%
35	2001	1.763	79.5%	20.5%
36	2002	1.972	81.8%	18.2%
37	1979	2.323	84.1%	15.9%
38	1996	2.446	86.4%	13.6%
39	1999	2.446	88.6%	11.4%
40	2007	2.531	90.9%	9.1%
41	1998	2.856	93.2%	6.8%
42	1995	3.158	95.5%	4.5%
43	1978	3.317	97.7%	2.3%

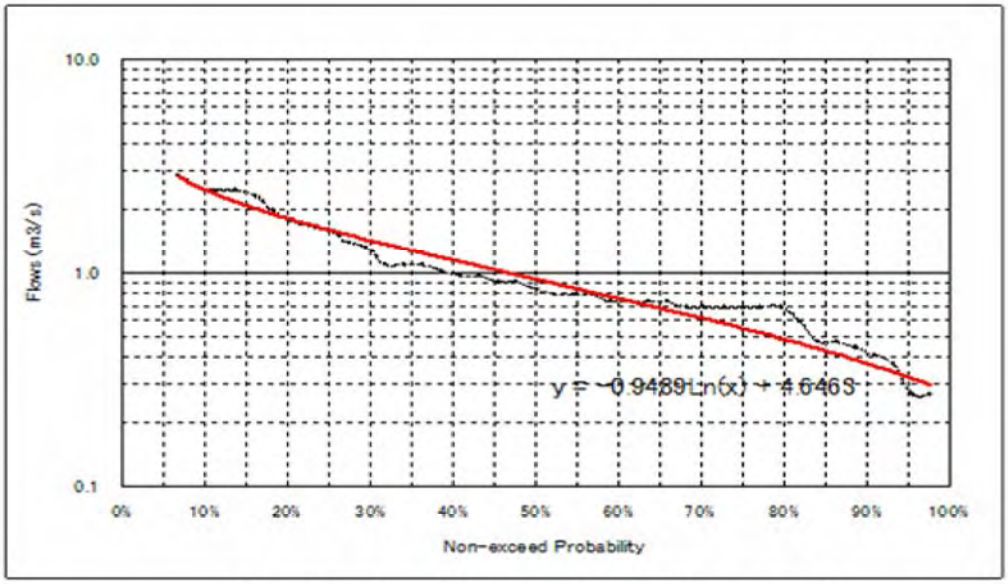


Figure-A2 Annual Minimum Discharges by Thomas Plot

Minimum discharges estimated by return period on the basis of the above chart were summarized as below.

Equation : Y=-0.9489×Ln(X)+4.6463

Table-A3 Minimum Discharges by Return Period

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

2. Discharges at Kabutie River

The minimum discharges at Kabutie River will be estimated by the discharges at Kimondi River with the next two approaches.

1) Approach by ratio of basin area

Basin area of Kabutie River = 105 km^2

Basin area of Kimondi River = 835 km^2

Therefore, the basin area of Kabutie River is approximately 12.6% (=105÷835) of that of Kimondi River.

2) Approach by past measured discharge records

The measured discharges at Kabutie River are 11.4% of that of Kimondi River on the average. The discharges at Kabutie River can be estimated applying such ratio and were summarized as next table.

Table-A4 Minimum Discharges with Return Period by Thomas Plot

Return Period	Basin Area Correlation Method (12.6%)		Comparison Discharge Method (14%)	
	(m^3/s)	(m^3/day)	(m^3/s)	(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

On the other hand, annual discharges having return periods with actual measured discharges not by prediction relation were summarized as next table.

Table-A5 Minimum Discharges with Return Period at Kimondi River by Measured Data

Return Period	Minimum Discharge	
	(m^3/s)	(m^3/day)
5-yr	0.671	58,000
7-yr	0.478	41,100
10-yr	0.427	36,900
15-yr	0.373	32,200

The discharges with 10-yr return period at Kabutie River adopting the above table were estimated as 4,649m^3/day and 4,207m^3/day by Basin Area Correlation Method and Comparison Discharge Method respectively.

2. Study

The design intake flow from Kabutie River is 3,800 m^3/day, therefore, it can be assume that there will exist a difficult period to secure the design intake flow with 10-yr return period taking the flooding and leakage from the intake weir into consideration. Accordingly, it can be considered that the design intake flow with 5-yr return period can be secured. On the other hand, the minimum discharges were respectively recorded on 4th/5th March 1987 and 5th/6th March 1991, and those discharges around such date were summarized as next table.

Table-A6 Discharge Conditions around the Minimum Discharge in 1987

1987 Year		Kimondi River		Kaptie River	
Date				Catchment correlation method (12.6%)	Ratio of flows (.11.4%)
		m3/s	m3/day	m3/day	m3/day
Jan	26	0.514	44,400	5,600	5,100
	27	0.476	41,100	5,200	4,700
	28	0.476	41,100	5,200	4,700
	29	0.441	38,100	4,800	4,300
	30	0.441	38,100	4,800	4,300
	31	0.408	35,300	4,400	4,000
Feb	1	0.408	35,300	4,400	4,000
	2	0.408	35,300	4,400	4,000
	3	0.370	32,000	4,000	3,600
	4	0.377	32,600	4,100	3,700
	5	0.377	32,600	4,100	3,700
	6	0.347	30,000	3,800	3,400
	7	0.347	30,000	3,800	3,400
	8	0.377	32,600	4,100	3,700
	9	0.377	32,600	4,100	3,700
	10	0.408	35,300	4,400	4,000
	11	0.411	35,500	4,500	4,000
	12	0.514	44,400	5,600	5,100
	13	0.476	41,100	5,200	4,700
	14	0.441	38,100	4,800	4,300
	15	0.441	38,100	4,800	4,300
	16	0.408	35,300	4,400	4,000
	17	0.408	35,300	4,400	4,000
	18	0.408	35,300	4,400	4,000
	19	0.377	32,600	4,100	3,700
	20	0.377	32,600	4,100	3,700
	21	0.441	38,100	4,800	4,300
	22	0.476	41,100	5,200	4,700
	23	0.598	51,700	6,500	5,900
	24	0.377	32,600	4,100	3,700
	25	0.347	30,000	3,800	3,400
	26	0.347	30,000	3,800	3,400
	27	0.320	27,600	3,500	3,100
	28	0.320	27,600	3,500	3,100
Mar	1	0.320	27,600	3,500	3,100
	2	0.294	25,400	3,200	2,900
	3	0.294	25,400	3,200	2,900
	4	0.270	23,300	2,900	2,700
	5	0.270	23,300	2,900	2,700
	6	0.377	32,600	4,100	3,700
	7	0.476	41,100	5,200	4,700
	8	0.788	68,100	8,600	7,800

Table-A7 Discharge Conditions around the Minimum Discharge in 1991

1991 Year		Kimondi River		Kaptie River	
Date		m3/s	m3/day	Catchment correlation method (12.6%) m3/day	Ratio of flows (.11.4%) m3/day
Feb	9	0.553	47,800	6,000	5,400
	10	0.553	47,800	6,000	5,400
	11	0.514	44,400	5,600	5,100
	12	0.514	44,400	5,600	5,100
	13	0.514	44,400	5,600	5,100
	14				
	15	0.476	41,100	5,200	4,700
	16	0.476	41,100	5,200	4,700
	17	0.476	41,100	5,200	4,700
	18	0.476	41,100	5,200	4,700
	19	0.408	35,300	4,400	4,000
	20	0.408	35,300	4,400	4,000
	21	0.408	35,300	4,400	4,000
	22	0.408	35,300	4,400	4,000
	23	0.377	32,600	4,100	3,700
	24	0.377	32,600	4,100	3,700
	25	0.441	38,100	4,800	4,300
	26	0.408	35,300	4,400	4,000
	27	0.377	32,600	4,100	3,700
	28	0.347	30,000	3,800	3,400
Mar	1	0.320	27,600	3,500	3,100
	2	0.320	27,600	3,500	3,100
	3	0.294	25,400	3,200	2,900
	4	0.294	25,400	3,200	2,900
	5	0.270	23,300	2,900	2,700
	6	0.270	23,300	2,900	2,700
	7	0.294	25,400	3,200	2,900
	8	0.320	27,600	3,500	3,100
	9	0.377	32,600	4,100	3,700
	10	0.408	35,300	4,400	4,000
	11	0.476	41,100	5,200	4,700
	12	0.553	47,800	6,000	5,400
	13	0.640	55,300	7,000	6,300

With regard to the small discharges in 1987, 12 days and 28 days for the discharges less than 4,000 m^3/day were respectively confirmed by Basin Area Correlation Method and Comparison Discharge Method. Furthermore, 33 days and 38 days for the discharges less than 5,000 m^3/day were correspondingly confirmed respectively.

As a conclusion, the design intake flow may not be secured lasting about one month if any large-scale small discharge occurs.

Appendix7-5 Capacity of the Service Reservoir

New reservoirs (Water demand) (m3/day)

Area	2015 year	New reservoir		Office reservoir	
Kapsabet town ship	2,051	80%	1,641	20%	410
Kapngetuny	858	50%	429	50%	429
Kamobo	410			100%	410
Kamurguiywa	155			100%	155
Kimaam	45		45		
Kipture	96		96		
Total	3,615		2,211		1,404
Ratio			≒60%		≒40%

Total capacity of reservoirs =1500m3 (=3,600/24*10)
Additional capacity for blackout=150m3(=3,600/24)

(m3)

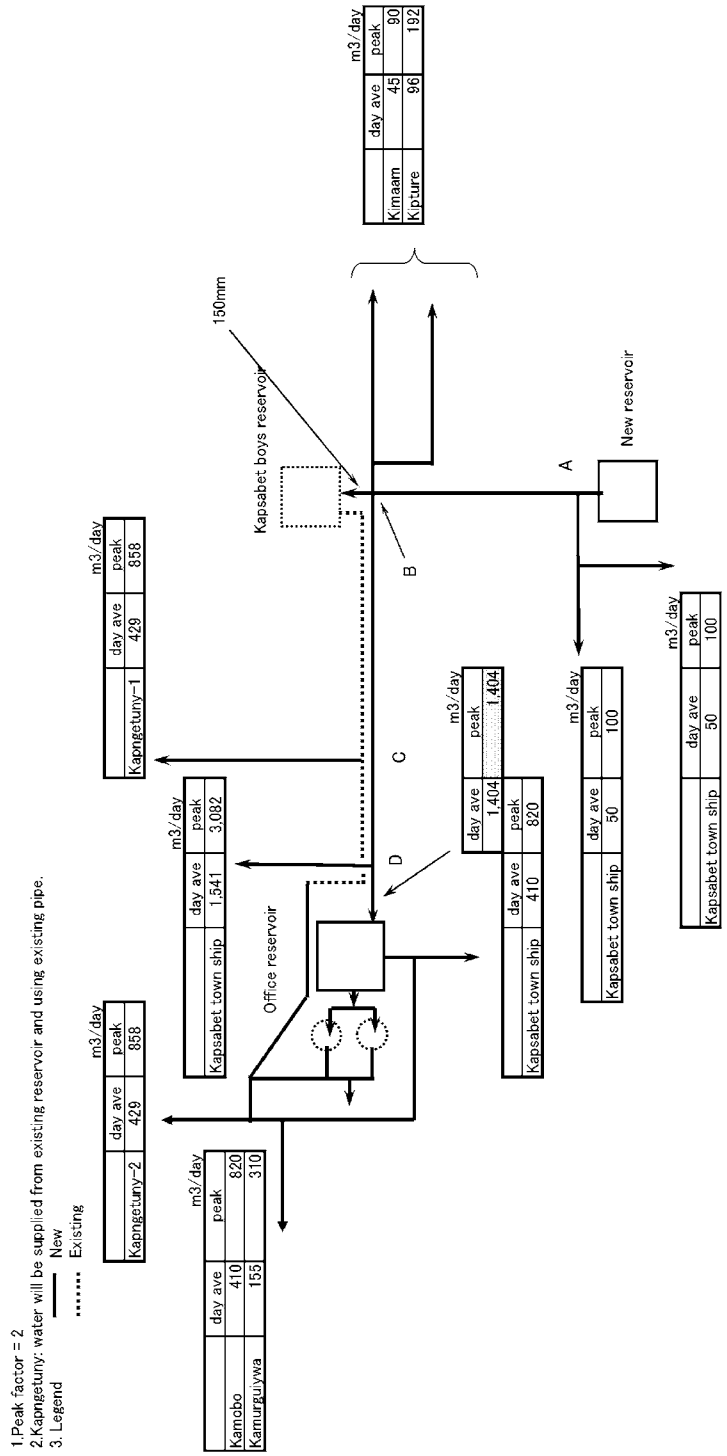
Capacity of each new reservoir	1,050	600

Existing reservoirs

Name	Capacity (m3)
Kapsabet boys	90
	130
Sub total	220
Office reservoir	50
	100
Sub total	150
Total	370

Total capacity(New + Existing)
2,020m2
Detention time
13.5 hours

Appendix7-6 Water DistributionSystem



Appendix7-7 Pipe Diameter from New Reservoir to Office Reservoir

Head Loss in Pipe Diameter

	Head Loss (m)				
	400mm pipe	350mm pipe	300mm pipe	250mm pipe	200mm pipe
	0.1	0.2	0.3	0.8	2.4
	1.2	2.3	4.9	11.9	35.1
	↕ 1.4	2.6	5.6	13.5	40.0
	0	0.1	0.2	0.4	1.2
Total Head Loss	2.7	5.1	11.0	26.6	78.7
Remaining pressure	37.3	34.9	29.0	13.4	-38.7

<Results>

1. For use pipe diameter 250mm, head loss is 13.4m for distribution to Kapsabet township.
2. For use pipe diameter 300mm, head loss is as follows;
   ①Head loss is 10m in Kapsabet township (GL2000m).
   ②Head loss is 30m if water level of New reservor is 2040m(2040-2010m).
   The amount of water supply is 92L/s=7949m3/day in this condition.
   It can be distributed the amount of water in approx. +36% in planed water supply in 2015.
   (5826m3/day)

Flows of main pipe

		m3/day		Approximate	Elevation	
		day ave	peak	Length	GL(m)	
New reservoir	to A	3,615	5,845	80	2,040	67L/s
A	to B	3,515	5,645	1,220		65L/s
B	to C	3,374	5,363	↕ 2,100		52L/s
C	to D	2,516	3,647			16L/s
D	to Office reservoir	1,385	1,385	550	2,008.6	16L/s
			Total	3,950		

Appendix7-8 Analysis of Water Hammer Protection

It is need to take measure to protect water hammer due to water hammer protection

The measures are Serge Vessel Fry wheel Serge Vessel+ Fry wheel

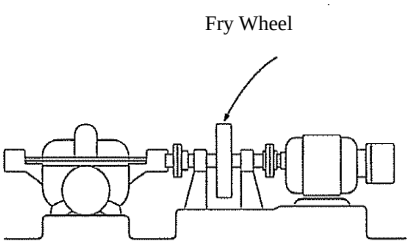
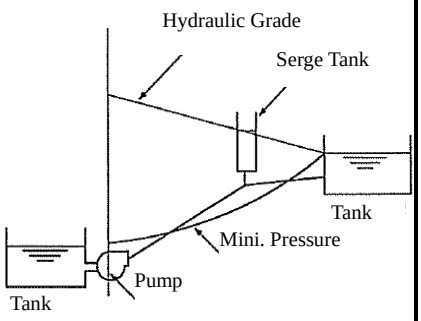
Necessary equipment is as follows;

Table 1 Comparison of Water Hammer Protection

	Fry wheel	Serge Vessel	Serge Vessel + Fry wheel
Necessary equipment	Fry wheel (4Nos)	Serge Vessel (1 No) Compressor (1 No)	Serge Vessel (1 No) Compressor (1 No) Fry wheel (4Nos)

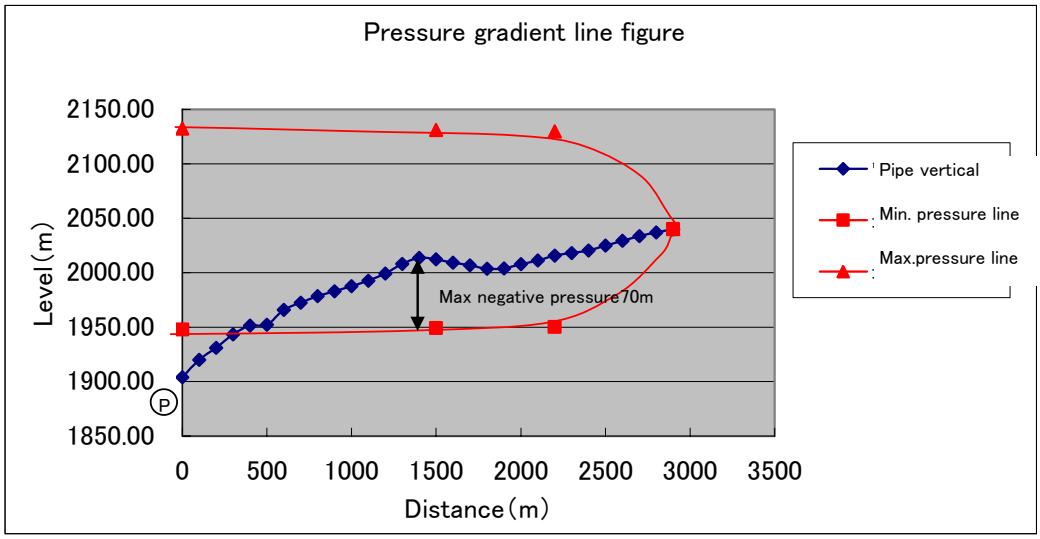
Fry wheel is no need to maintenance due to advantage for no sub-equipment (Pressure Tank, Compressor) and no need to pay of electricity use. Therefore it is used only fly wheel installation

Table 2 Fry wheel and Serge Vessel

	Fry wheel	Serge Vessel
Principle	Fry wheel can increase rotating body. Engine can be gradual of changing rotation number and changing velocity inside of the pipelines after shut off.	Hydrostatic pressure in Serge Tank protects changing push-in pressure for pipelines after shut off.
Figure		
charactor	- High reliability - No need sub-equipment - Need larger space depend on size of fry wheel	- There is protection of pressure increasing together with negative pressure - Higher cost than fry wheel When it is not possible to correspond by fly wheel, it is often adopted.

Kapsabet　Analysis of Water Hammer Protection

1. No Pretection



2. After taking measures （Fry Wheel GD2＝55kg･m2/No）