PART III

FEASIBILITY STUDY

CHAPTER 1 SCOPE OF FEASIBILITY STUDY

1.1 Selection of Priority Project for Feasibility Study

The water supply master plan for Juba Capital Region targeting the year 2025 (the Master Plan) has been formulated in Part II, and phased development of the water supply system in four phases are prepared according to priority and importance of the components of master plan facilities.

A part of the components proposed in the Master Plan is selected as "priority project," which will be required to be implemented by 2015 and has a higher priority than other components. The components included in the first and second phases in proposed M/P were selected as priority project. A feasibility study has been carried out for the priority project in this part.

1.2 Target Water Supply Service of Priority Project

(1) Target Year

The target year of the priority project is set as the year 2015. A part of work components proposed in the Master Plan which should be implemented by 2015 is selected as priority project to meet the target water supply services in 2015.

(2) Target Service Area

The target area of water supply service for priority project is set as the existing major urbanized area including Juba Town, Kator and Munuki payams, and future urbanized areas including Rejaf and Gudele as shown in Figure 1.1, which is the same area as the Master Plan. The service area of Rejaf consists of Lologo in the west bank and Gumbo in the east bank. Gudele is the part of Northern Bari payam.

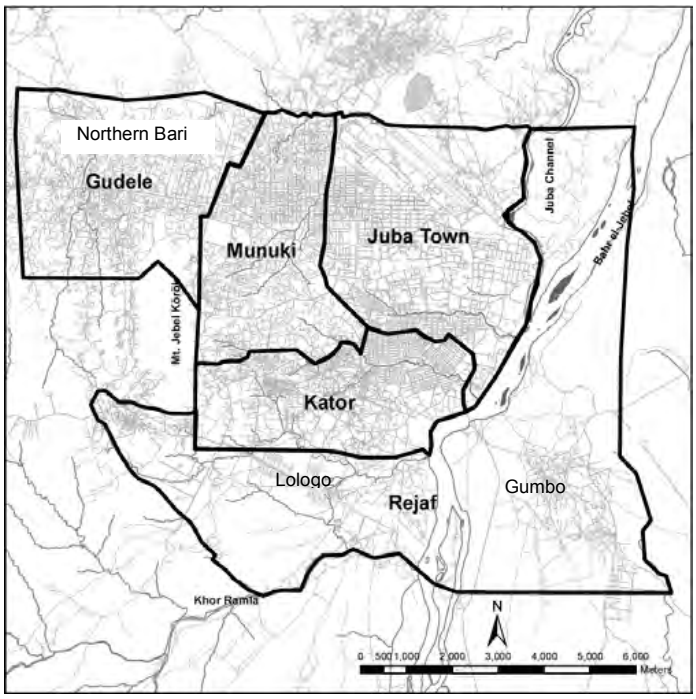


Figure 1.1 Target Service Area of Water Supply for Priority Project

(3) Overall Target Service Coverage

The overall target service coverage is set as 80 % in 2015 and should be met by means of house connection, public taps connected to the distribution network and private venders in the form of manual and water tankers. The source of water in case of all supply methods should be clean and safe water that is adequately treated in the proposed water treatment plants.

Table 1.1 Overall Target Service Coverage in 2015

Item	2009 (base year)	2015 (target year)
Treated water supply coverage	8.4 % (estimation)	80 %
Total population	406,000	680,000
Service population	34,000	544,000

(4) Target Service Area by Supply Method

The target major service area by supply method of house connection, public taps and water tanker is shown in Figure 1.3, which is delineated based on the following assumptions.

- The border of covered area by water distribution network is delineated along the existing major inhabitation area.
- Out of the network covered area, water is supplied by house connection in existing and potential organized urban areas and by public taps in unorganized urban areas are. The water source of these

modes of supply is treated piped water.

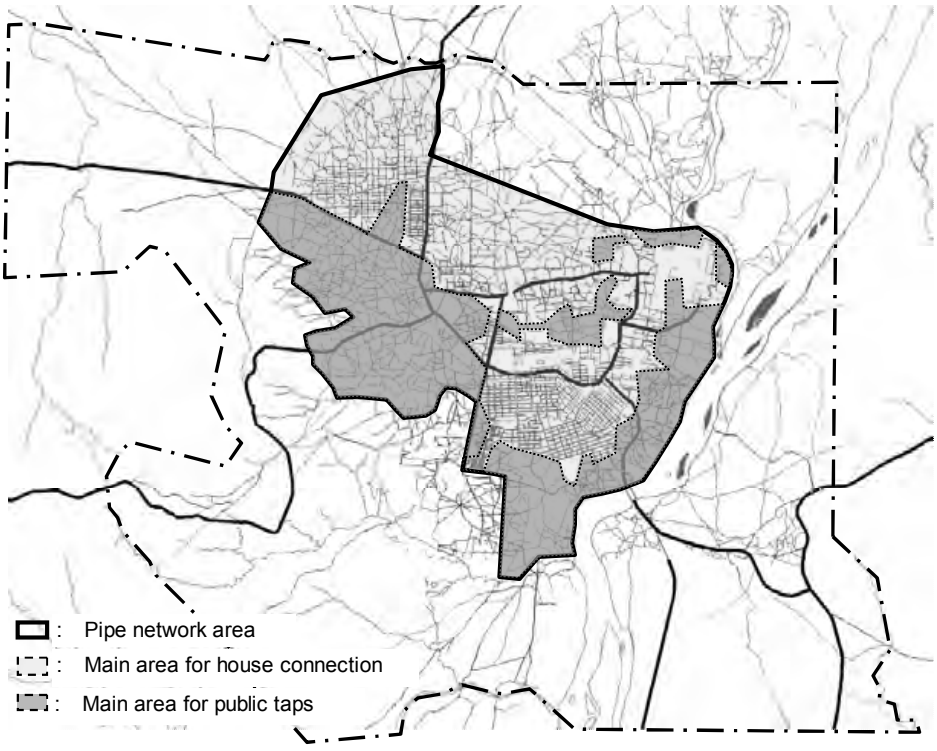
- The area outside of the distribution network covered area is served by water tanker. The source of water for this case is also treated piped water taken from proposed water tanker supply stands.

(5) Target Service Coverage

The target service coverages by different means of water supply by area in 2015 ware estimated in Table 1.2.

Table 1.2 Service Coverage Projection for 2015

Area	House connection	Public tap	Water tanker	No coverage
Juba Town	57 %	24 %	11 %	8 %
Kator	42 %	34 %	14 %	10 %
Munuki	37 %	50 %	8 %	5 %
Rejaf	0 %	0 %	60 %	40 %
Gudele	0 %	0 %	60 %	40 %
Total	28 %	22 %	30 %	20 %
Population covered	188,000	151,000	205,000	136,000



Note: In the area outside of the pipe network area, treated water is supplied by tanker.

Figure 1.2 Service Area by House Connection and Public Taps

1.3 Water Demand Estimation for 2015

(1) Estimation Conditions of Water Demand

1) Unit Water Consumption

The current average water consumption of domestic users (house connection, public tap and water tanker supply) was estimated at 33 L/c/d. The design or target water consumption per capita for domestic users in 2015 is set as shown in the Table below. The target water consumption for 2015 is set as 90 L/c/d in the case of house connection users and 40 L/c/d for cases of public tap and private vender users.

Table 1.3 Design Domestic Water Consumption per Capita

Users/ main water sources	Current water use L/c/d	Target in 2015 L/c/d
- House connection	26 (53) *	90
- Public tap	32.5	40
- Water tanker	35.5	40

Note: * 26 L/c/d, which is estimated from the results of socio-economic survey by the Study Team, is the consumption level before the inauguration of rehabilitation of the existing water treatment plant and 53 L/c/d is estimated as the consumption level after the inauguration.

It is expected that the use of existing wells equipped with hand pump will be continuously used after 2015 and the following percentage of usage is assumed. In assumption, the users of household connection will not use existing wells but the following percentage of the users of public taps or water tankers will use the existing wells as a supplemental source of water.

Table 1.4 Ratio of Continuous Use of Existing Wells Equipped with Hand Pump

Category	Target		
	2015	2020	2025
House connection	0 %	0 %	0 %
Public tap and water tanker	30 %	20 %	10 %

The non-domestic water demand in 2015 is calculated based on the ratio of the estimated domestic water demand. The total percentage of non-domestic water demand of the total demand is estimated at 37 %, and it is distributed to non-domestic user groups with the rations as shown in the following Table.

Table 1.5 Projected Ratio of Domestic and Non-Domestic Water Demand

(%)

Class/main water sources	Estimated current water use	Projected ratio of non-domestic use in 2015
1. Domestic	**63**	**62**
2. Non-domestic	**37**	**38**
- Commercial & business	9	10
- Industry	0	3
- Institution/government	28	25

2) Leakage Ratio

At the early stage of the water supply project proposed in the Master Plan, the first priority is given to the rehabilitation of existing distribution network and all existing network is proposed to be upgraded by replacement. This intervention is assumed to complete before 2015. Considering this conditions, the leakage ratio in 2015 is set as 20 %.

3) Maximum Daily Coefficient /Seasonal Peak Factor

The maximum daily water demand coefficient, i.e., the ratio of maximum to average daily water demand, is set at as 1.2.

4) Water Supply Zone in 2015

In 2015, treated water will be supplied to high and low zones, separately. The water supply zone as proposed in the Master Plan is also adopted for the water supply zone in 2015. However, the extent of zones are limited in only the area where the distribution network will be installed up to 2015, most of which is the existing urban area. The supply zone is shown in Figure 1.3

(2) Water Demand Estimation

1) Net Water Demand

The net daily water demand for 2015, which is actually consumed by the users excluding leakage in the network, and its distribution by payam and water supply method are calculated as shown in Table 1.6. The total net water demand is estimated as 46,000 m^3/d in 2015 comprising 26,900 m^3/d for domestic and 19,100 m^3/d for non-domestic users.

Table 1.6 Net Water Demand and Distribution in 2015

Area	Domestic					Non-domestic		Total (m^3/d)
	House connect (m^3/d)	Public tap (m^3/d)	Water tanker (m^3/d)	Sub-total		(m^3/d)	Ratio	
				(m^3/d)	Ratio			
Juba Town	7,657	1,015	472	9,144	0.55	7,551	0.45	16,695
Kator	4,084	1,033	437	5,554	0.64	3,156	0.36	8,710
Munuki	5,217	2,177	331	7,724	0.72	3,021	0.28	10,745
Rejaf	0	0	2,658	2,658	0.40	3,943	0.60	6,601
Gudele	0	0	1,826	1,826	0.56	1,433	0.44	3,260
Total	16,957	4,225	5,724	26,906	0.58	19,104	0.42	46,011
				58.5		41.5		

2) Average and Maximum Daily Water Demand Estimation

The average and maximum daily water demands by payam in 2015 along with the net daily water demand are estimated as shown in Table 1.7. The total average and maximum daily water demands are estimated as 57,500 m^3/d and 69,000 m^3/d, respectively.

Table 1.7 Net, Average and Maximum Daily Water Demand in 2015

(m^3/d)

Payam	Net daily demand	Average daily demand	Maximum daily demand
Juba	16,700	20,900	25,000
Kator	8,700	10,900	13,100
Munuki	10,700	13,400	16,100
Rejaf	6,600	8,200	9,900
Gudele	3,300	4,100	4,900
Total	46,000	57,500	69,000

The water demand by distribution zone is estimated as presented in Table 1.8. The maximum daily water demand in 2015 estimated at 62,600 m^3/d for the west bank and 6,400 m^3/d for the east bank, respectively.

Table 1.8 Water Demand by Zone in 2015

(m^3/d)

Zone	Average daily water demand	Maximum daily water demand
West bank		
West High	25,300	30,300
West Low	26,900	32,300
Sub-total	52,200	62,600
East bank		
Gumbo	5,300	6,400
Total	57,500	69,000

1.4 Utilization of Existing Water Supply Facilities

Newly constructed existing water supply facilities, as listed below, will be utilized in the proposed water supply system.

1) MDTF funded facilities
   - Existing water treatment plant (7,200 m^3/d)
   - Elevate tank near the parliament
   - Transmission mains from the water treatment plant to the elevated tank
2) USAID funded facilities
   - A pump station in Kator and transmission and distribution mains in Kator and Munuki
3) JICA funded facilities
   - Transmission mains and distribution mains in Munuki

The majority of existing old network was installed before 1972 and they are composed of asbestos pipes, except a few PVC and GI pipes. Those pipes have frequent leakage due to fragility to shock and their installation at shallow depth. Therefore, most of the existing distribution network shall be replaced under the priority project.

1.5 Proposed Water Supply System for Priority Project

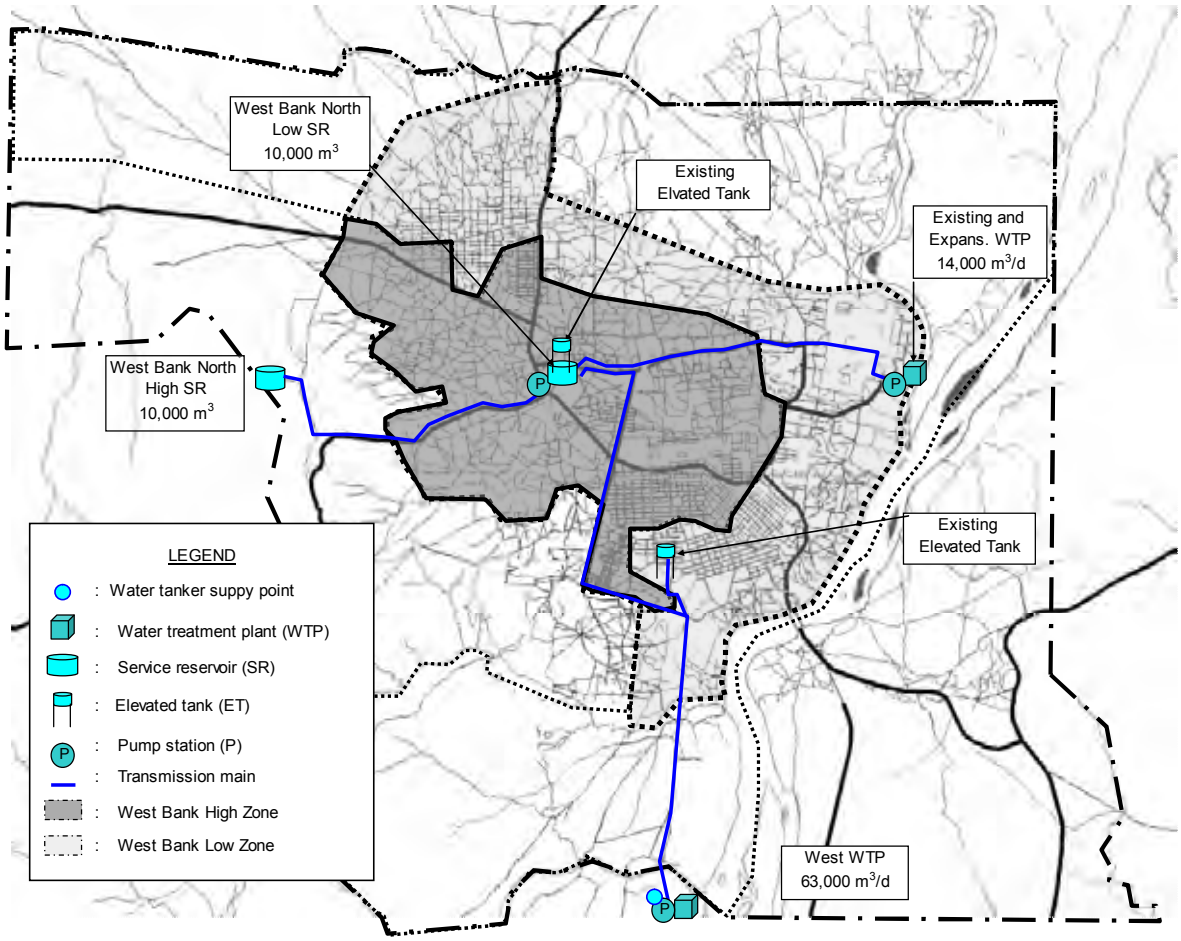
The proposed facilities for the priority project are listed below and shown in Figure 1.3

1) Expansion of the existing water treatment plant
2) West water treatment plant (1st stage of 3 stages)
3) North Low Service Reservoir
4) North High Service Reservoir
5) Transmission pump stations at water treatment plant and North Low SR (West basin)
6) Transmission mains for West North System

7) Distribution network in high and low zones

In addition to these major water supply facilities, the following service facilities are proposed to be installed in the system under priority project.

1) Service connections / house connections
2) Water tanker supply stations
3) Public stand with taps / water kiosks

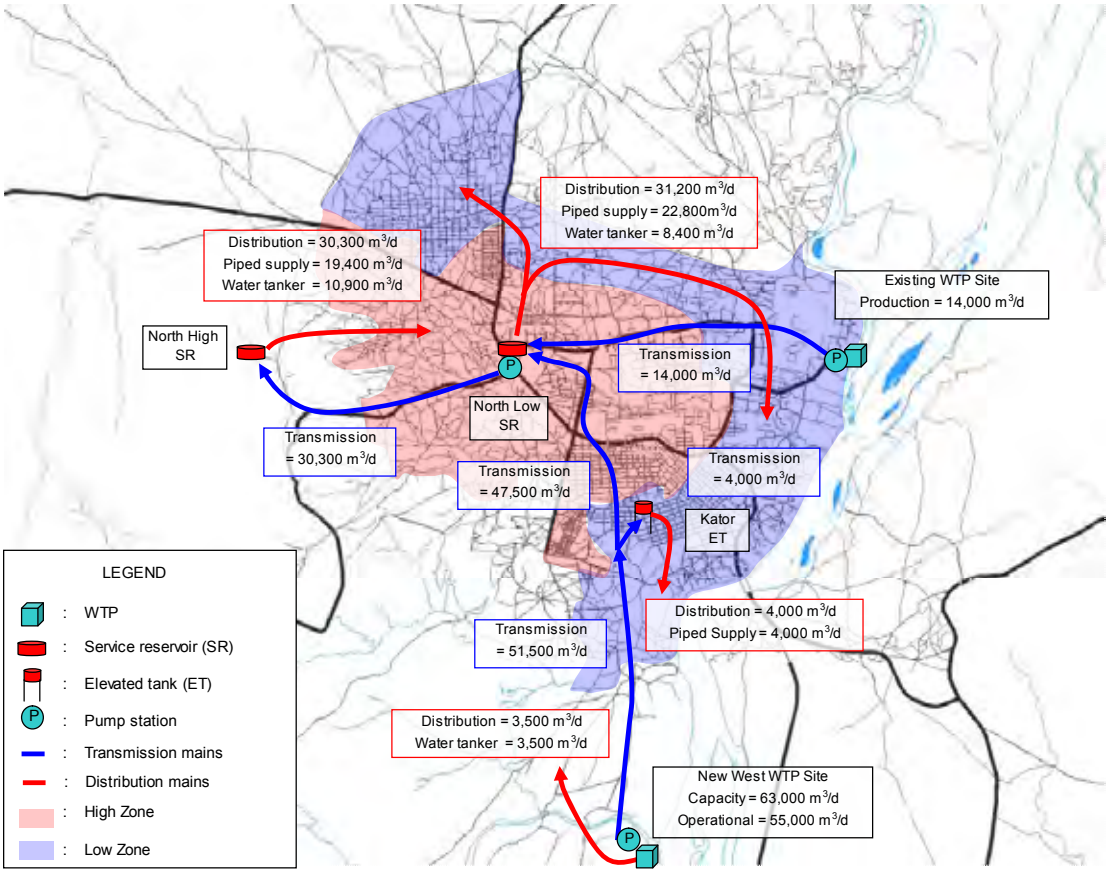


Note: Treated water is supplied by water tanker in the area outside distribution network.

Figure 1.3 Water Supply Service Zone and Proposed Facilities for Priority Project in 2015

1.6 Water Demand and Supply Balance of Proposed Water Supply System in 2015

Water treatment capacity, transmission and distribution flow in terms of maximum daily water demand in the supply area is planned as shown in Figure 1.4. This flow balance is used to calculate the capacity of the transmission facilities. The schematic elevation map of the water supply system for the priority project is illustrated in Figure 1.5.



(In Max Daily Water Demand)

Figure 1.4 Water Demand and Supply Balance of Proposed Water Supply System in 2015

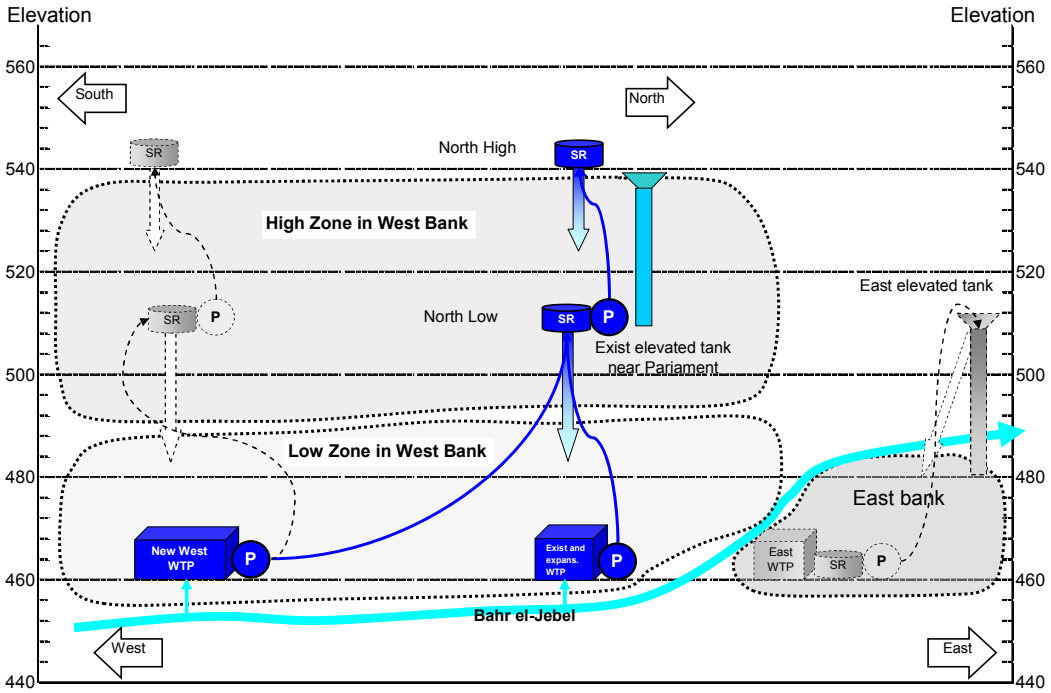


Figure 1.5 Schematic Elevation Map of Water Supply System for Priority Project

1.7 Summary of Proposed Water Supply Facilities for Priority Project

The capacity of proposed main facilities of the priority project is summarized in Table 1.9.

Table 1.9 Summary of Capacity of Water Supply Facilities for Priority Project

System	Facility	Category / Facility name	Capacity/ Quantity
1. Production	Expansion of exiting WTP	-	Capacity = 7,000 m^3/d
	New West WTP	Stage-1/3 of New West WTP	Capacity = 63,000 m^3/d
Total			70,000 m^3/d
2. Transmission	Transmission pump station in North Low SR	Stage-1/2 of pump station	Capacity = 30,000 m^3/d x 50 m head
	Transmission pipelines	Existing WTP - North Low SR	Dia. 500 mm x 4.45 km
		New west WTP - North Low SR	Dia. 1000 mm x 9.10 km
		North Low SR - North High SR	Dia. 700 mm x 3.75 km
		Branch to existing Kator ET	Dia. 200 mm x 0.20 km
	Total		17.5 km
3. Distribution	Service reservoirs	North High Service Reservoir	Capacity = 10,000 m^3
		North Low Service Reservoir	Capacity = 10,000 m^3
	Total		20,000 m^3
	Distribution network (High zone)	Distribution main & sub-main	Dia. 900 - 200 mm x 53.7 km
		Distribution tertiary pipelines	Dia. 150 - 100 mm x 102.6 km
	Distribution network (Low zone)	Distribution main & sub-main	Dia. 1000 - 200 mm x 49.6 km
		Distribution tertiary pipelines	Dia. 150 - 100 mm x 203.8 km
	Total		409.7 km
4. Supply points	House connections	-	24,100 connections
	Public taps	-	302 stands
	Water tanker supply points	-	7 points with 8 pipes per point (56 pipes)

CHAPTER 2 FACILITY DESIGN

2.1 Design Conditions of Priority Project

(1) Basic Design Conditions for Proposed Facilities for Priority Project

Basic design conditions for the priority project are summarized below.

1) Maximum daily coefficient: 1.2 (same as the Master Plan)
2) Peak /maximum hourly coefficient: 1.73
3) Water demands used for deciding the capacity of facilities:

System	Facility	Demand used for design
Production	・ Water treatment plant	Maximum daily demand
Transmission	・ Transmission pipeline ・ Transmission pump	Maximum daily demand
Distribution	・ Distribution main & sub-main ・ Distribution tertiary	Maximum hourly demand

4) Design storage hours for service reservoir: 8 hours of maximum daily water demand (1/3 of max. daily demand)
5) Distribution pressure: Minimum Hydraulic Pressure = 1.5 kgf/cm^2 (equivalent to 15 m head) in distribution main and sub-main
6) Treated water quality: Comply with WHO or Draft Southern Sudan Water Quality Guidelines for Drinking Water

(2) Power Supply Conditions

1) Existing Power Supply Conditions in Juba

Juba Power Generation Plant was constructed in the 1980s and five power generators each with a capacity of 1,250 kW were installed. The total capacity is 6,250 kW. Currently, three generators are functional and the other two (2) are not operational. Therefore, the current operational capacity is only 3,750 kW. These power generators have deteriorated mechanically and they very frequently stop working mainly due to poor maintenance. As a consequence, interruptions of operations occur frequently.

Currently, new generators are being installed at the existing site funded by Wartsila (Finland aid agency). Altogether, 9 generators are installed each with a capacity of 1,500 kW and the total capacity of the power generation plant is 12 MW.

The current total capacity of generators is not adequate for supplying power to entire Juba urban area. Most of the commercial building and houses rely on their individual generators.

The existing water treatment plant, which is located next to the power plant, receives power supply from this power plant. However, as explained above, the city general power supply is not stable and frequently terminated, the power supply to the water treatment plant is also frequently stopped. New MDTF water treatment plant is equipped with diesel generator. When the city power supply is terminated, the plant is operated by its own generator to distribute water to the service area.

After installation of new generators in the city power station, the power supply to the treatment plant as well as to the city is expected to be improved.

2) New Power Supply Project

Currently, following two hydro power projects are on going.

a. 90 MW hydro dam project
   A hydro dam is planned to be constructed in Lologo in the mainstream of the Bahr el-Jebel. A study is being carried out by Chinese consultants and it is planned to complete in 2011 if the project is implemented smoothly without any opposition by the affected communities.
b. 1380 MW hydro dam project
   4 hydro dams (420 MW, 210 MW, 210 MW and 540 MW) are planned to be constructed at the upstream of Juba in the Bahr el-Jebel between Juba and the national border. A study was started in June, 2008 and the dams are planned to be completed around 2015. At present this hydro dam project is at a feasibility study stage. The generated power will be sold to the neighboring countries too. It was informed by the consultant in charge that 300 MW from these hydropower units is planned to be assigned for the Juba urban area.

3) Power Supply for Proposed Facility

In the priority project, following facilities require major power supply. In water supply system, most of power is consumed by pumps to lift water.

- Expansion plant of existing water treatment plant to operate the plant
- A pump station in the North Low Service Reservoir to transmit treated water to the North High Service Reservoir
- West Water Treatment Plant to operate the plant and transmit treated water to the North Low Service Reservoir

The expanded water treatment plant and the pump station in the North Low Service Reservoir are currently located within the territory of city power grid. Therefore, after the improvement of power

supply condition in the city, electricity can be supplied from the city system. However, currently, there is no electricity power supply grid near the proposed site for West Water Treatment Plant. In future, however, power could be supplied to this site from planned power supply grid which is expected to pass near the treatment site after the hydro dam projects are completed.

4) Necessity of Emergency Generators for Proposed Facilities

Once new water treatment plant and distribution network are established in Juba and continuous water supply is secured for the residents, they will rely heavily on the water supply system and other means of water supply may be abandoned. With the establishment of proposed water supply facilities, continuous water supply will be an essential service to the domestic, commercial, and industrial customers and it may be difficult for them to do without it. Therefore, even if the city power supply is stopped, the operation of the water supply system should be maintained fully functional by equipping emergency generator in each site of the proposed facilities. In this plan, the generator capacity for each facility should be design so as to handle 100% of the overall load capacity of the facility to ensure continuous full water supply during power outages.

(3) Foundations of Proposed Facilities

Geo-technical survey was carried out to understand underground geological condition for the main water supply facilities, and to design foundation of facility. For this purpose, 6 boring tests in the following 3 sites were conducted. The North High Service Reservoir is included in the feasibility study, but this site was not included in the geo-technical survey as the site is located at the foot of rocky mountain and the foundation rock is visible on surface of ground.

- Proposed site for expansion of water treatment plant (2 borings)
- Proposed site for West Water Treatment Plant (3 borings)
- Proposed site for North Low Service Reservoir (1 borings)

The detail result of the survey is attached in Appendix-K. The depth to foundation rocks is summarized in the Table below. The depth of foundation from the ground surface is observed to be 7 m at most in these cases. This survey results are utilized for planning foundation of facilities. In the case of both treatment plant sites, replacement of soil is proposed to be adopted as facility foundation as this method is the most economical in this case.

Table 2.1 Depth to Foundation Rocks

Item	Site		
	Existing WTP	New West WTP	North Low SR
Depth to foundation rocks (m below ground)	1.0 - 4.5 m	4.0 – 7.0 m	0 – 2.0 m
N-value	More than 50	More than 42	More than 33

(4) Design Intake Level of River

1) Design Intake Water Level of Existing Water Treatment Plant

Only one river water level gauge in the Juba area to measure the water level of the Bahr el-Jebel is located in the existing water treatment plant. The recent and historical data of river water levels were collected and given in Chapter 4 of Part I. These data were related to the elevation measured in the topographic survey carried out under the feasibility study.

The highest and lowest water level of the Bahr el-Jebel at the existing water treatment plant site recorded during January 2007 and June 2009 are adopted as the design high and low water levels of the intake point in the existing water treatment plant. High water level and low water level is set as + 456.0 m and + 454.0 m, respectively. The lowest low water level used for intake pump design is set as + 453.5 m, which is 0.5 m below the low water level, considering the current lower water level trend.

2) Design Intake Water Level of New West Water Treatment Plant

There is no measured historical data on water level of the Bahr el-Jebel at proposed intake site of new West WTP. Therefore, the difference in the water level between the intake site of existing WTP and the intake site of the new West WTP is measured on the same day and this difference is assumed to be constant irrespective of water level of the river. By using this difference and recent water level data at the existing intake, design high and low water levels are set as + 458.7 m and + 456.7 m, respectively. The design lowest low water level is set at + 456.2 m, which is 0.5 m below the lower water level, adopting the same assumption as in case of the existing WTP site.

3) Summary of Design Intake Water Level

Table 2.2 Design Intake Water Level of Water Treatment Plant

(m above sea level)

	High	Low	Lowest low
Existing intake of existing WTP	+456	+454	+453.5
Proposed intake for West WTP	+458.7	+456.7	+456.2

Note: The base elevation was taken from the topographic map prepared in the JICA Emergency Study

2.2 Production System

2.2.1 Expansion of the Existing WTP

The capacity of expansion of existing WTP is decided as 7,000 m^3/d in the Master Plan, considering the available land for expansion at the existing site and exiting capacity (7,200 m^3/d). The same treatment process as the existing plant is adopted so that both plants can be operated coherently with the same procedure and technology.

Some of the components of the existing facilities, presented in Table 2.3 are proposed to be utilized as common facilities for the existing and proposed expansion plant to reduce cost and space, and achieve centralized operation.

Table 2.3 Existing Facilities Used as Common Facilities and New Facilities in Expansion Plant

Existing facilities used as common facilities	Proposed new facilities
• Intake and raw water mains • Chemical feeding facilities • Elevated tank and equipment for backwash of rapid sand filters • Drainage basin • Diesel generator	• Raw water pumps • Receiving well • Sedimentation basin • Rapid sand filter • Clear water reservoir

The same design criteria adopted for the existing plant are also adopted for design criteria for the proposed expansion plant as summarized in Table 2.4. The dimension and capacity of the components of the expansion plan are calculated based on these design criteria as summarized in Table 2.5.

Table 2.4 Design Criteria for Expansion of the Existing WTP

Process	Design parameter	Adopted value
Receiving well	Retention time	14 min
Chemical sedimentation basin	Surface load	23.1 mm/min
	Retention time	2.2 hour
Rapid sand filter	Filtration rate	143 m/d (1 basin as reserve)
Clear water reservoir	Retention time	1 hour (for 14,000m^3/d)

Table 2.5 Calculated Dimension and Capacity of Expansion Plant

No.	Process	Dimension/Capacity
1.	Water intake facility	(Utilize the existing facilities)
2.	Raw water pump house Raw water pump	72m^2 Q4.9m^3/min*H16.0m*18.5kw*2(1)nos.
3.	Receiving well	W4.8m*L4.8m*He3.0m*1series
4.	Chemical sedimentation basin	High rate coagulo-sedimentation W10.25m*10.25m*H7.4m*2basin
5.	Rapid sand filter	Gravity flow (Backwash and surface air wash) W4.8*L3.4m*4basin
6.	Elevated tank for backwash	(Utilize the existing facilities)
7.	Clear water reservoir	W5.0m*L16.0m*He4.0m*2basin V=640m^3
8.	Transmission pump house Transmission pump	108m^2 Q4.9m^3/min*H80.0m*90kw*3(1)nos.
9.	Diesel generator	(Utilize the existing facilities)

A general layout of expansion plant in the existing WTP site is shown in Figure 2.1 and the system flow diagram is shown in Figure 2.2.

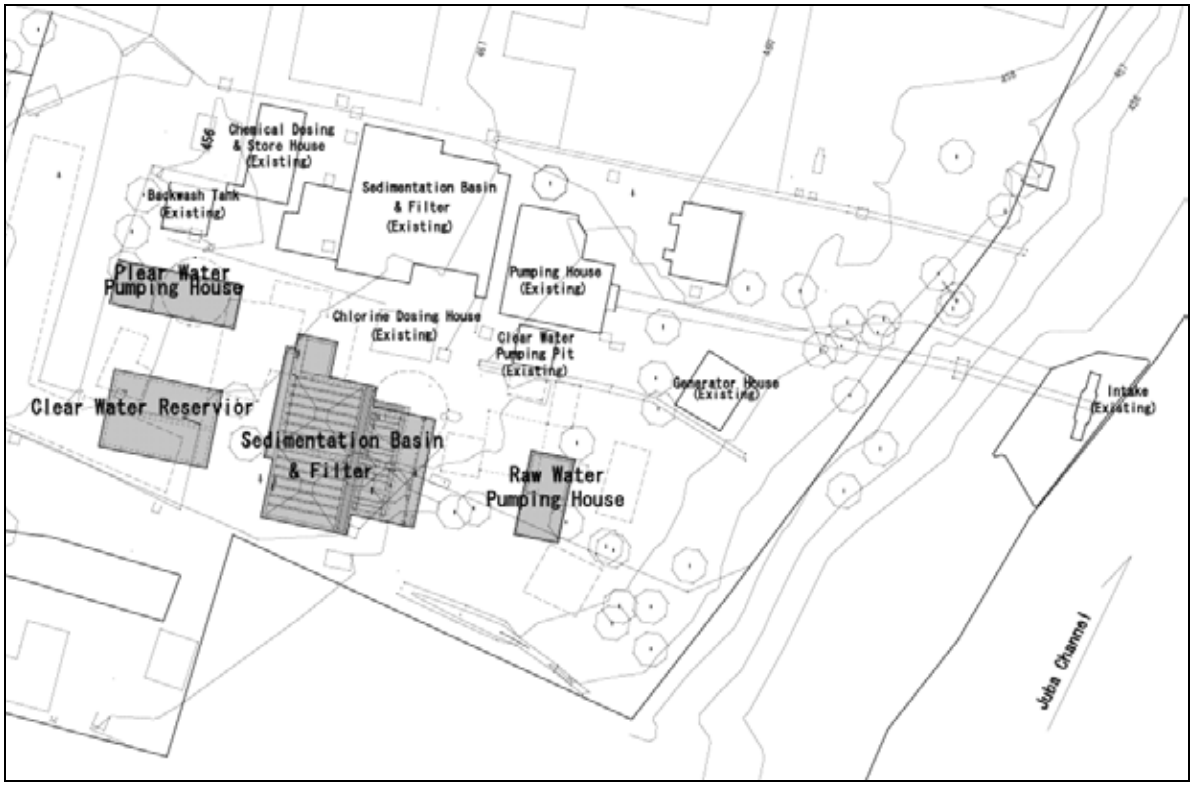


Figure 2.1 General Layout of Expansion of the Existing WTP

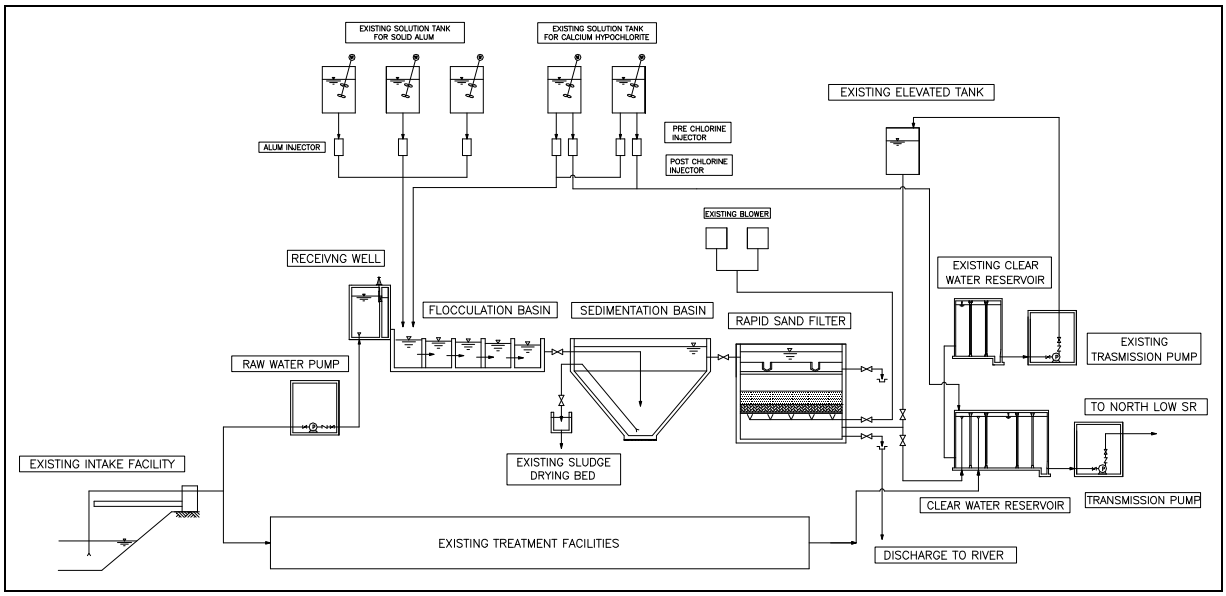


Figure 2.2 System Flow Diagram of Expansion Plant

2.2.2 West Water Treatment Plant in the West Bank

(1) Facilities Constructed in Priority Project

The conventional treatment process with horizontal flow sedimentation basin and rapid sand filter is adopted for West WTP as decided in the Master Plan. The total capacity of West Water Treatment Plant proposed in the Master Plan is 189,000 m^3/d, which is composed of 3 series and will be constructed in 3 stages. The construction schedule was decided to meet the increased water demand up to the target year of the Master Plan in 2025. In the priority project, one series with a capacity of 63,000 m^3/d will be constructed.

Relatively small facilities and common facilities for the entire plant should be constructed at one time in the priority project as the phased separated construction of these facilities is not economical and feasible. These facilities are intake, raw water mains, grid chamber, pump house, administration building, utility building and drainage basin. On the other hand, large and separable facilities; i.e. flocculation basin, rapid sand filter, clear water reservoir, and equipment such as pumps and generators, which can be constructed or installed in phases, should be implemented phase-wise to save initial cost and to avoid excess facility capacity unused for long time.

(2) Treatment Process

The treatment process for the proposed water treatment plant is outlined in Figure 2.3.

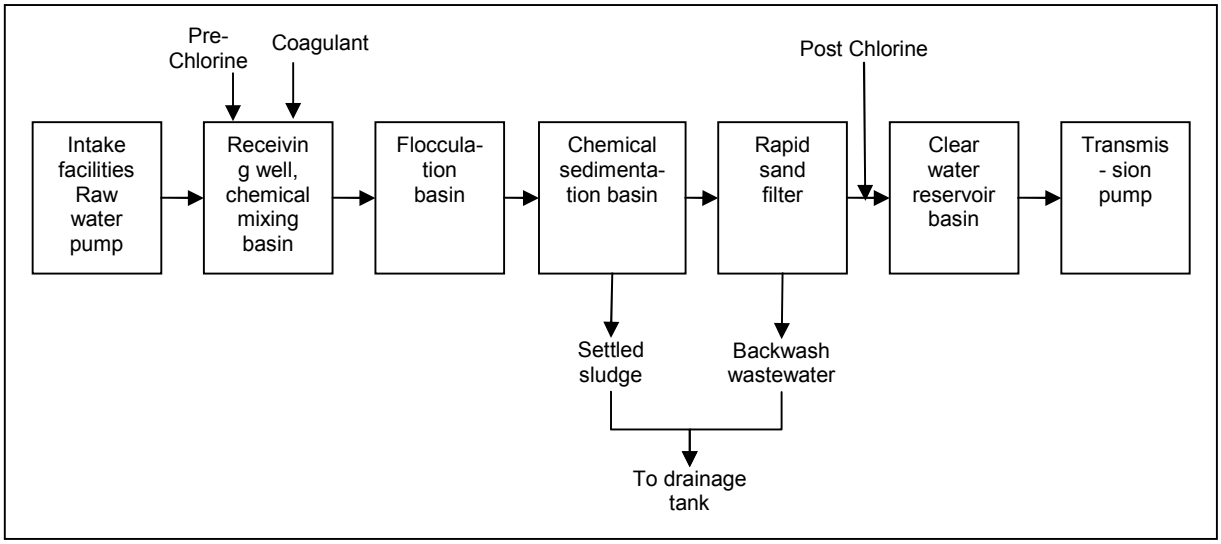


Figure 2.3 Selected Treatment Process

The following chemicals should be used in the treatment process.

- Coagulant: Coagulates turbidity and algae
- Pre-Chlorination: Control propagation of pathogens inside the water treatment plant and prevent from malfunction of the plant
- Post Chlorination: Keep residual chlorine in distribution network

Water produced in the new water treatment plant shall comply with WHO or Draft Southern Sudan Water Quality Guideline for Drinking Water. Accordingly, the water quality shown in the table below shall be adopted as the design treated water quality.

Table 2.6 Design Treated Water Quality

Parameter	Unit	WHO GV	Draft SS GV
Turbidity	NTU)	1	5
Aluminum	mg/l	0.1-0.2	0.2
Ammonia	mg/l	NS	NS
Antimony	mg/l	0.02	0.005
Arsenic	mg/l	0.01	0.05
Barium	mg/l	0.7	0.7
Boron	mg/l	0.5	0.5
Cadmium	mg/l	0.003	0.003-0.005
Chloride	mg/l	250	200
Chromium	mg/l	0.05	0.05
Copper	mg/l	2	1.5
Cyanide	mg/l	0.07	0.05
Fluoride	mg/l	1.5	1
Hardness	mg/l	200	200
Iron	mg/l	0.3	0.5
Manganese	mg/l	0.4	0.4
Lead	mg/l	0.01	0.01
Mercury	mg/l	0.006	0.006
Molybdenum	mg/l	0.07	0.07
Nickel	mg/l	0.07	0.07
Nitrate	mg/l	50	30
Nitrite	mg/l	3	0.5
Selenium	mg/l	0.01	0.01
Sodium	mg/l	ND	100
Sulfate	mg/l	250	200
Total dissolved solids	mg/l	600	1000
Zinc	mg/l	3	3

(3) Intake Facility

Intake facility of raw water is planned to be located at the upstream of the confluence of the Khor Ramla River in the Bahr el-Jebel to avoid any potential risk of future contamination from Khor Ramla River, which has a city dumping site in its catchment. The exact location of treatment plant is decided in the available land considering stability of soil.

(4) Sludge and Wastewater Disposal

Discharged sludge from sedimentation basins and wastewater of back-wash from rapid sand filters are planned to be retained in drainage basin and discharged to the Bahr el-Jebel.

As wastewater and sludge treatment and disposal method, sun dried bed and mechanical dewatering methods were studied but the former require large land, and the latter requires large initial investment and expensive operation and maintenance costs. Large land acquisition should be avoided considering increased environmental and social impact. At this stage of country's situation, the facilities that require large cost should also be avoided.

The discharged water contains high concentration of suspended solid and aluminum but do not contain any harmful matter. Therefore, its discharge to a large flow of the river does not give any negative impact on the river. However, if it is discharged at the bank, the stagnant sludge flowing along the river bank may give a bad aesthetic view. To avoid this negative environmental impact, the discharge point will be located at the center of the river so that sludge can diffuse to any direction quickly. For this purpose, the discharge pipe shall be extended to the center of the river.

(5) Facility Design for Water Treatment Plant

The design criteria adopted are decided considering experiences in Japan and other countries as summarized in Table 2.7. The dimension and capacity of the components of the proposed facilities are calculated based on these design criteria and the results are summarized in Table 2.8.

Table 2.7 Design Criteria of West WTP

Process	Design parameter	Adopted value
Intake facilities	Average velocity	1.0 m/sec
Grid chamber	Surface load	400 mm/min
	Average velocity	5 cm/sec
Receiving well	Retention time	1.5 min
Flocculation basin	Retention time	20 min
Sedimentation basin	Surface load	30 mm/min
	Average velocity	0.30 m/min
Rapid filter	Filtration rate	150 m/d (1 basin as reserve)
	Back wash water rate	0.8 $m^3/min \cdot m^2$
	Surface wash water rate	0.15 $m^3/min \cdot m^2$
Clear water reservoir	Retention time	1 hour
Drainage basin	Retention time	For 1 cycle of washing
Generator	Power load	100 % of plant power capacity

Table 2.8 Dimension and Capacity of Facility Components of West WTP in Priority Project

No.	Facility	Dimension and Capacity in Priority Project	Mater Plan
1.	Intake facility	W2.0m * H4.1m * 2 series	Same as in 2015
2.	Grid Camber	W10.0m*L19.0m*H6.7m*2series	Same as in 2015
3.	Raw water pump house Raw water pump	394m^2/min * 2floor Q43.7m^3/min * H10.0m * 110kw * 2(1)nos.	Same as in 2015 4 (1)
4.	Receiving well	W4.0m * L2.0m * H5.1m * 1 series	Same as in 2015
5.	Mixing tank	Mechanical type W4.0m * L4.0m * H3.3m * 1series	 3 series
6.	Flocculation basin	Tapered horizontal flow W15.0m * L13.8m * 2 series	 6 series
7.	Chemical sedimentation basin	Horizontal flow with mechanical sludge collector W15.0 * L50.3m * 2series	 6 series
8.	Rapid sand filter	Gravity flow (Back and surface wash) W9.0 * L12.0m * 6basin	 18 basins
9.	Elevated tank for backwash	W10.0 * L10.0 * He4.0m	Same as in 2015
10.	Clear water reservoir	W10.0m * L35.0m * He4.0m * 2 tanks V=2,800m^3	6 tanks
11.	Transmission pump house Transmission pump (North) Transmission pump (South) Backwash pump Surface wash pump	440 m^2 * 2 floor Q37.2m^3/min * H90.0m * 750kw * 3(1)nos. 0 no. Q13.3m^3/min * H25.0m * 75kw * 2(1)nos. Q13.0m^3/min * H25.0m * 75kw * 2(1)nos.	Same as in 2015 5 (1) nos 2 (1) nos. 2 (1) nos.
12.	Wastewater basin	W 6.0 m * L 16.0 m * 2 series	Same as in 2015
13.	Administration building	648 m^2 Office, laboratory, control room, meeting room etc.	Same as in 2015
15.	Utility building	756 m^2 Chemical dosing, electrical, generator room Diesel Generator 1,500 kVA * 1 no.	Same as in 2015 Same as in 2015 3 nos.

Note: ( ) indicates the number of stand-by.

A general layout of the West Water Treatment Plant is given in Figure 2.4 and the system flow diagram of the treatment plant is shown in Figure 2.5.

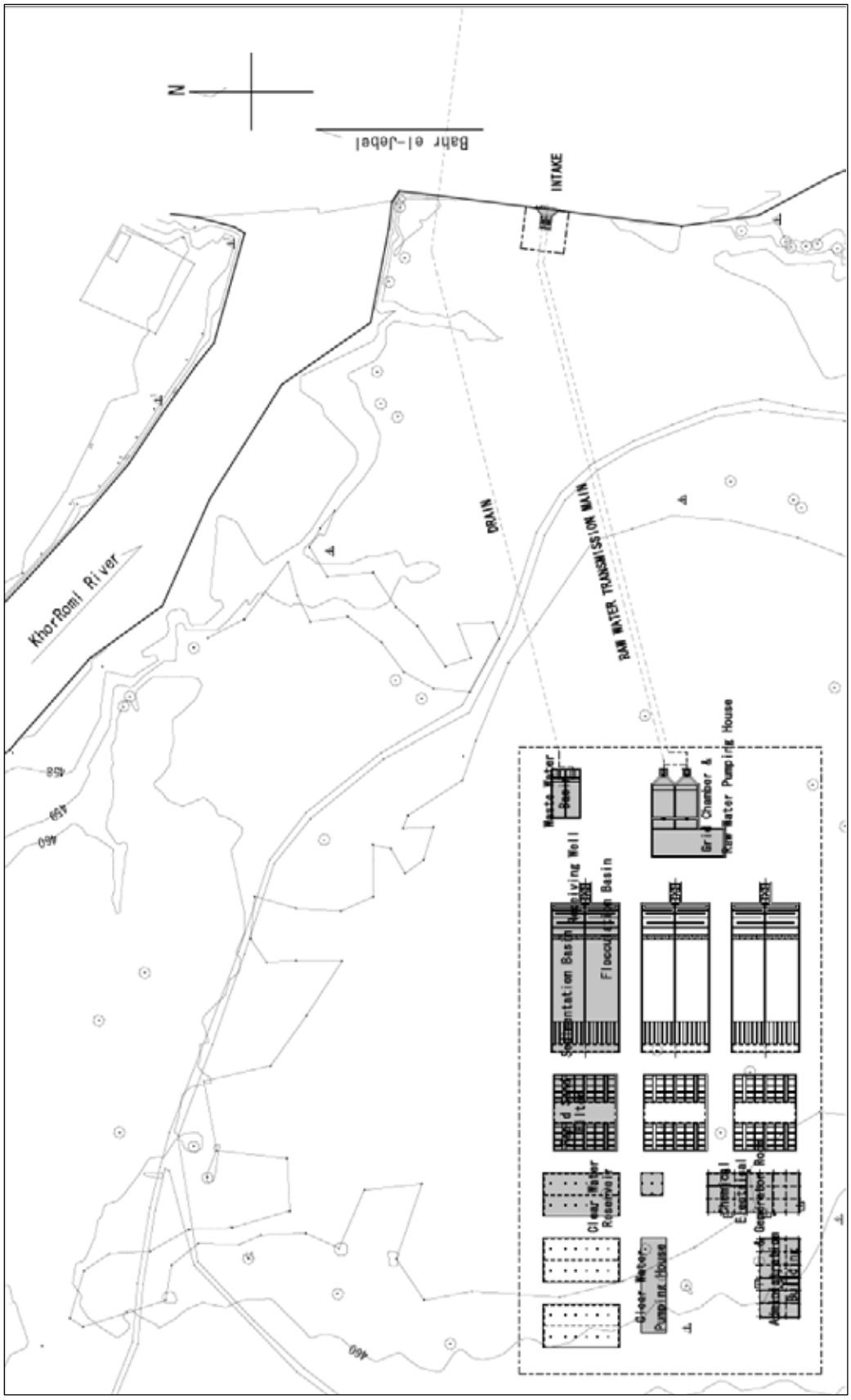


Figure 2.4 General Layout of West Water Treatment Plant

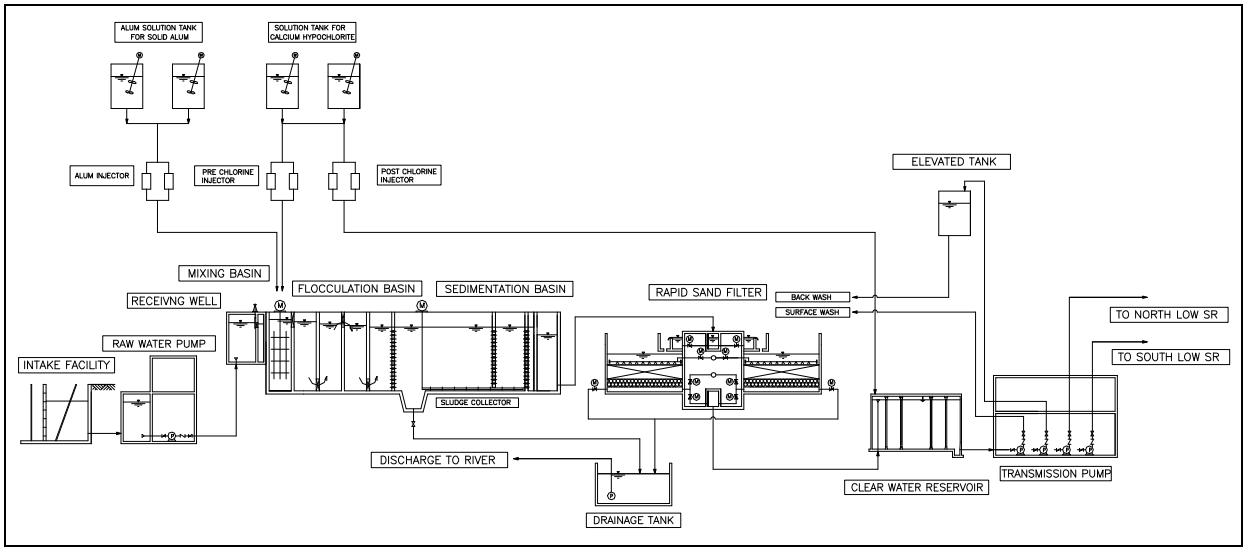


Figure 2.5 System Flow Diagram of West Water Treatment Plant

2.3 Transmission Facilities

In the priority project, transmission system is comprised of transmission pump station and transmission pipelines.

2.3.1 Pump Station in North Low Service Reservoir

The entire building of transmission pump station should be constructed one time under the priority project to accommodate all equipment required up to the Master Plan target year of 2025. The pumps and generators will be installed so as to satisfy the required capacity until 2015 at least in the priority project but the common equipment including header pipe will be constructed once in priority project so as to meet the required capacity up to 2025.

Three pumps comprising two duties (24,000 m^3/d x 2 nos.) and one standby, capacity of which is 48,000m^3/d, are required for target year of 2025. Two sets of pump comprising one duty and one standby can satisfy the required capacity of 30,000 m^3/d in the target year of 2015. Although the design discharge of a pump is 24,000 m^3/d, it can transmit 30,000 m^3/d in 2015 under the conditions in which actual operating head is lower than the design head, as the flow in transmission pipe in 2015 is much lower than the design flow in 2025. The capacity of the facilities and equipment required for the target year of 2015 together with 2025 are shown in Table 2.9

Table 2.9 Capacity of Transmission Pump Station in North SR

Facilities	Capacity in 2015 (Priority Project)	2025 (Master Plan)
Building	Pump, generator, electricity and office rooms (RC Structure = total space 384 m^2)	Same as in 2015
Pump	Q = 16.7 m^3/min (24,000 m^3/d) , H = 50 m, motor = 200 kW 2 sets (one as standby)	Same as in 2015 3 sets (one as standby)
Generator	Diesel engine generator (Capacity = 300 kVA) 1 set	Same as in 2015 2 sets

2.3.2 Transmission Pipelines

The maximum daily water demand estimated for the target year of 2025 for Master Plan is used to decide the diameter of transmission pipelines and this capacity of pipelines will be installed in the priority project as phased construction and duplication of pipeline in a short period is not economical and infeasible. Routes of transmission pipelines are selected considering the existing roads and alignment, along which a route survey was conducted in the feasibility study. Ductile cast iron pipes shall be used for transmission pipelines considering the importance of transmission function and long durability of ductile iron. The proposed alignment of transmission pipelines are shown in Figure 2.6 and specification are summarized in Table 2.10.

The existing transmission main (dia. 300 mm) constructed by MDTF will be converted into distribution mains, and transmission mains (dia. 500 mm) that can transmit the doubled capacity of the existing water treatment plant shall be newly installed.

Table 2.10 Specification of Transmission Pipelines

Route of transmission pipeline	Specification of pipeline	Nos of air valve	Nos. of wash out
Existing WTP - North Low SR	Diameter 500 mm x 4.45 km	0 nos	0 nos
New West WTP - North Low SR	Diameter 1000 mm x 9.10 km	8 nos	4 nos
North Low SR - North High SR	Diameter 700 mm x 3.75 km	0 nos	1 nos
Branch - Existing Kator ET	Diameter 200 mm x 0.20 km	0 nos	0 nos

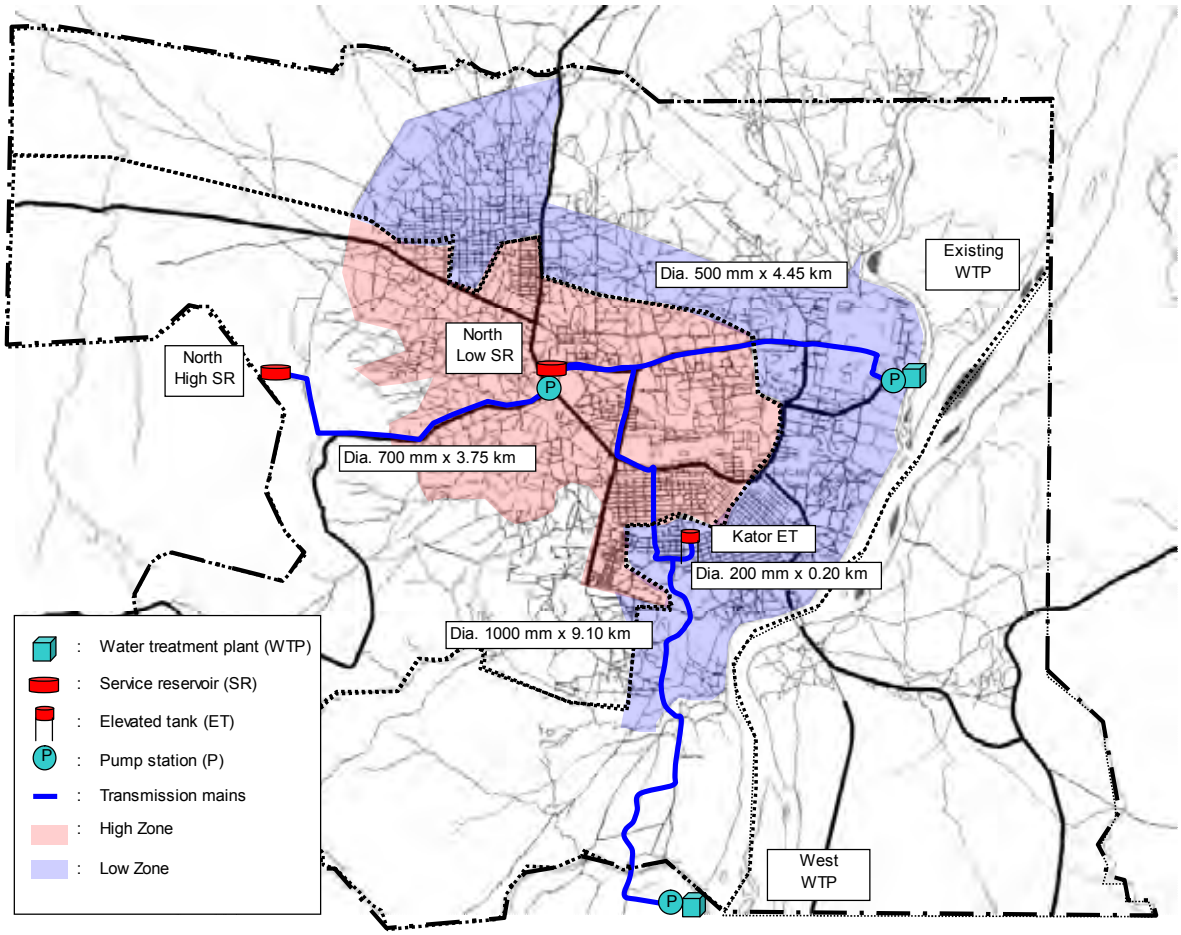


Figure 2.6 Alignment of Transmission Pipelines

2.4 Distribution Facilities

In the priority project, the distribution system is comprised of two service reservoirs and distribution network. The work of the distribution network includes rehabilitation of the existing network and expansion of the network which should be implemented by the target year of 2015.

2.4.1 Service Reservoirs

North High SR and North Low SR will be constructed with a storage capacity of 10,000 m^3 each in the priority project out of the total capacity of 16,000 m^3 and 24,000 m^3 in 2025, respectively. The capacity of these service reservoirs is calculated based on the requirement to meet the maximum daily water demand for each zone in 2015. General layout of service reservoirs are shown in Figure 2.7 for North High SR and in Figure 2.8 for North Low SR.

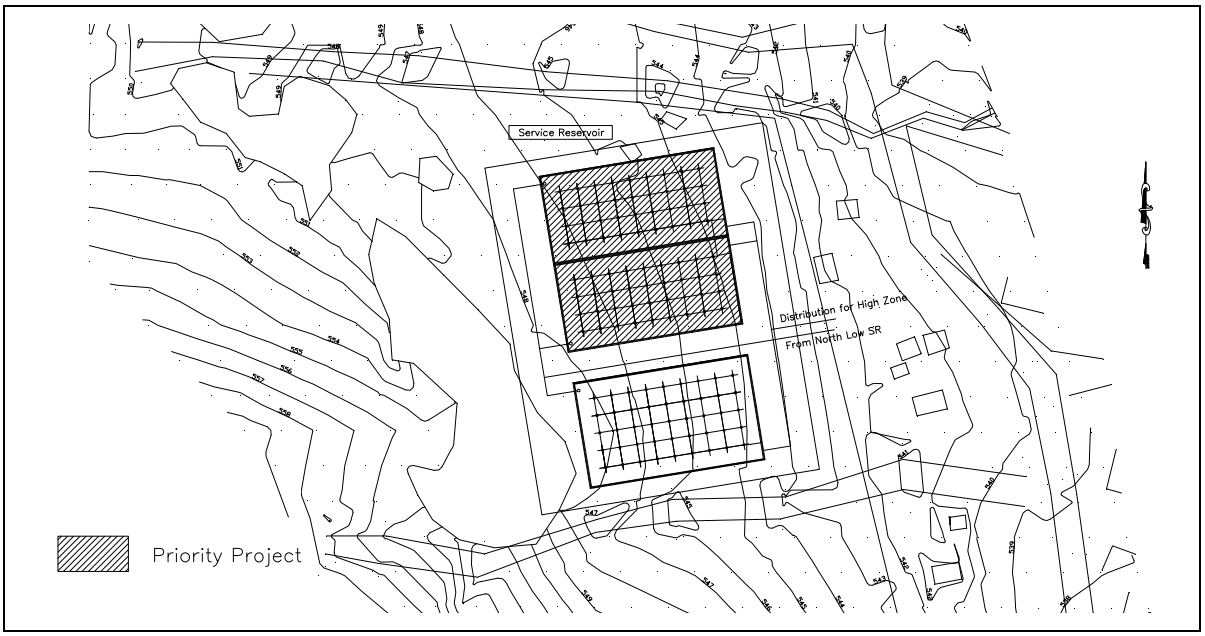


Figure 2.7 General Layout of North High Service Reservoir

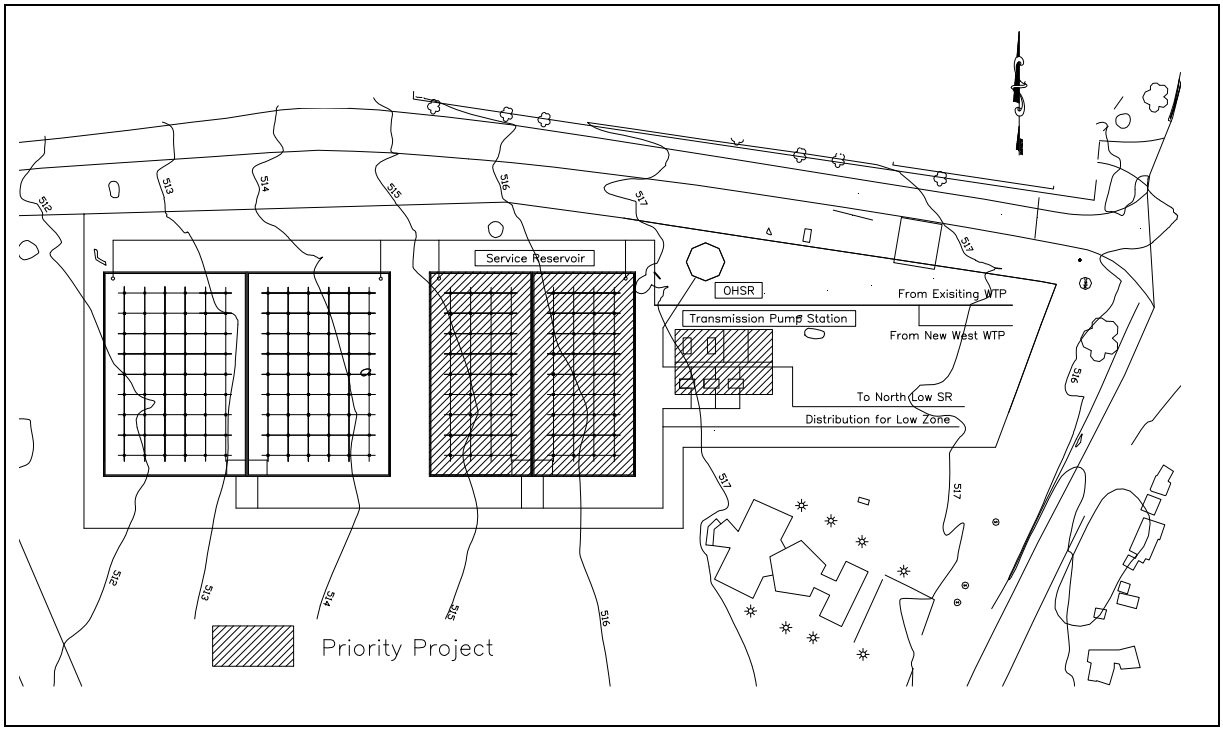


Figure 2.8 General Layout of North Low Service Reservoir

2.4.2 Distribution Network

Distribution network are designed so as to ensure appropriate distribution pressure adapting concepts of looped distribution system and district metered area (DMA). The diameter and route of distribution

mains and sub-mains are planned by hydraulic analysis while the diameter and length of distribution tertiary pipelines are estimated using typical pipeline density in a model network.

The total length of distribution network required in the target year of 2015 is 409 km that is comprised of 103 km of distribution main and sub-main and 306 km of distribution tertiary pipelines. Ductile cast iron pipes shall be used for distribution main and sub-main considering the importance of its function and long durability of ductile iron while polyvinyl chloride (PVC) pipes shall be used for tertiary pipelines considering its easy installation and economic advantage. A summary of required length by diameter of distribution network are shown in Table 2.11 and alignment of distribution main and sub-main for high and low zone are shown in Figure 2.9 and Figure 2.10, respectively.

Table 2.11 Summary of Distribution Network in 2015

Diameter (mm)	High Zone (km)	Low Zone (km)	Total (km)
Distribution main & sub-main			
1000	0.0	0.6	0.6
900	0.4	0.0	0.4
800	2.1	2.3	4.4
700	0.3	3.5	3.8
600	0.0	2.0	2.0
500	4.1	0.6	4.7
400	9.3	10.2	19.5
300	1.4	8.2	9.6
200	36.0	22.2	58.2
Total	53.7	49.6	103.3
Distribution tertiary pipeline			
150	15.4	30.5	45.9
100	87.2	173.3	260.5
Total	102.6	203.8	306.4

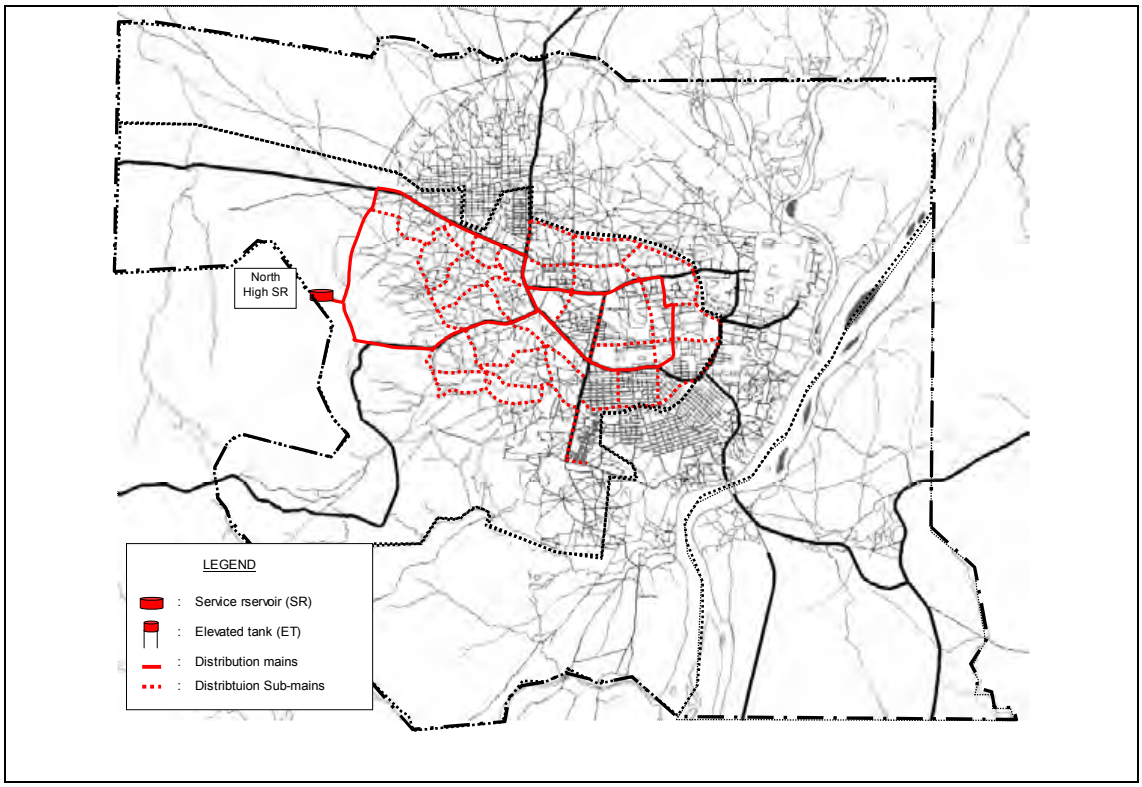


Figure 2.9 Alignment of Distribution Main and Sub-main for High Zone in 2015

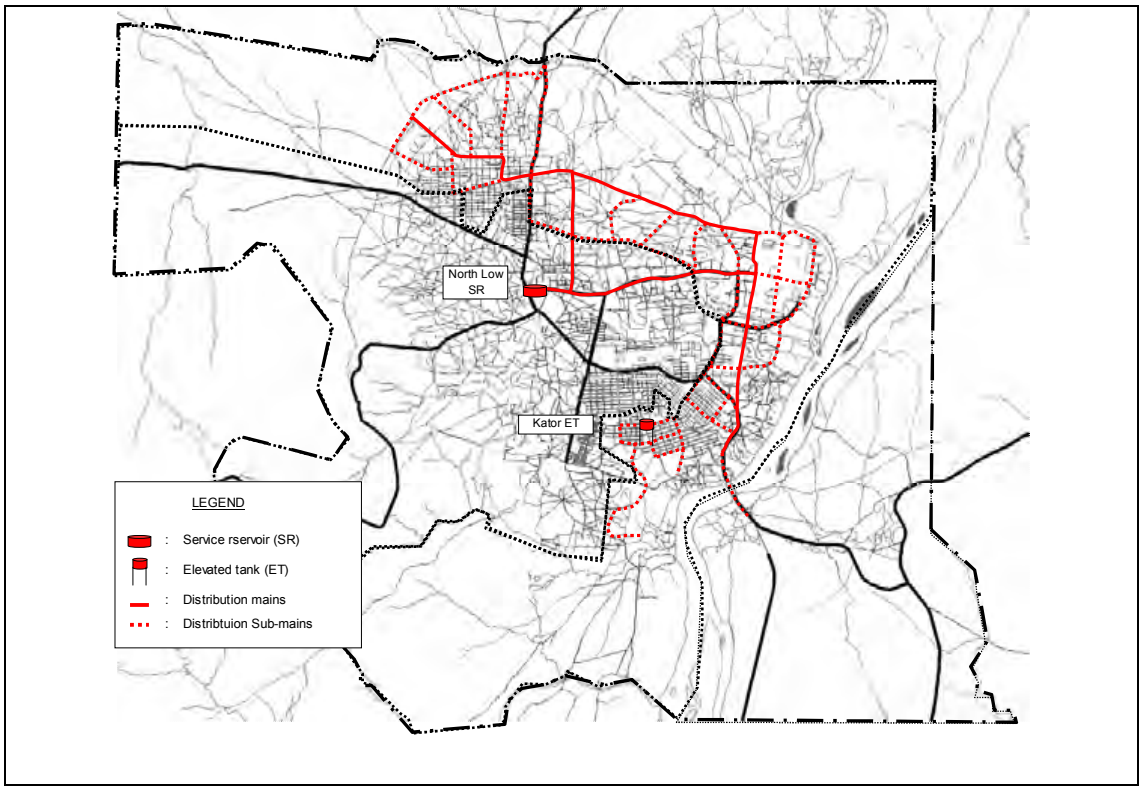


Figure 2.10 Alignment of Distribution Main and Sub-main for Low Zone in 2015

2.4.3 Public Tap Stands and Water Supply Points for Water Tankers

The net water demand for 2015 by user type is estimated as shown in Table 2.12. In 2015, the net water supplies of 7,900 m^3/d and 10,700 m^3/d should be supplied by public taps or water tankers. To meet these water demands by public taps and water tankers, the number of the required facilities is estimated in Table 2.13, and supply points for tankers are preliminarily decided as shown in Figure 2.11.

Table 2.12 Net Water Demand Estimation for 2015 by User Type

Item	House connection	Public tap	Water tanker	Total
Population covered	188,000	151,000	204,000	543,000
Per capita consumption (L/c/d)	90	40	40	-
Net domestic demand (m^3/d)	16,900	6,000	8,200	31,100
Local well use (m^3/d)	0	-1,800	-2,500	-4,300
Net domestic use excluding local use (m^3/d)	16,900	4,200	5,700	26,800
Non-domestic (%)	38	38	38	-
Net non-domestic demand (m^3/d)	10,400	3,700	5,000	19,100
Net total demand (m^3/d)	27,300	7,900	10,700	45,900

Table 2.13 Demand Points by Service Type in 2015

Service type	Numbers	Assumptions and calculation
House connections	24,100 connections	188,000 people divided by the average family size (7.8 persons/household)
Public tap stands	302 stands	500 people shall be supplied from one stand (151,000/500)
Tanker supply points	7 points with 8 pipes per point (56 pipes)	10,700 m^3/d shall be supplied from 56 pipes and each 4 m^3 tanker shall be filled in 15 minutes (2,675 times/d)

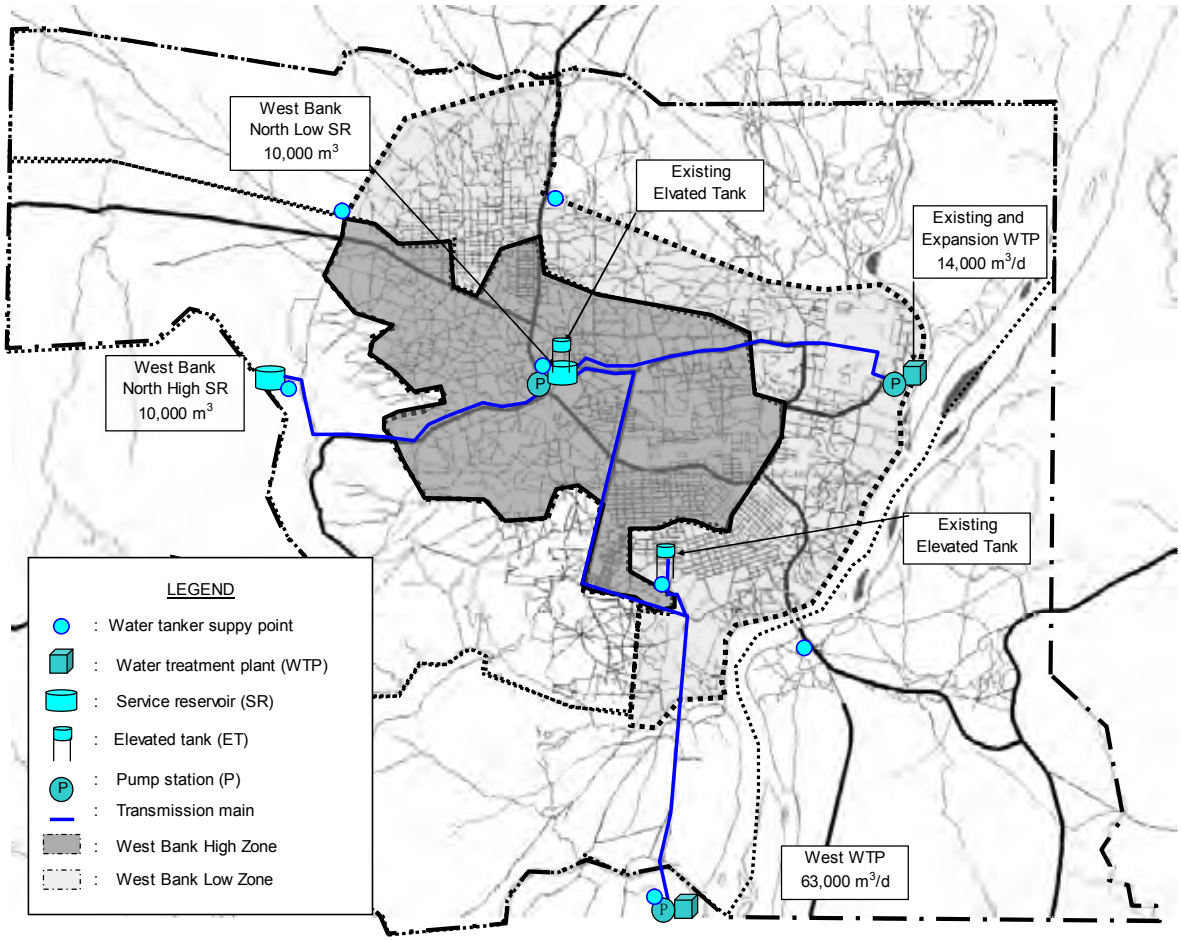


Figure 2.11 Water Tanker Supply Points

CHAPTER 3 MANAGEMENT, OPERATION AND MAINTENANCE

3.1 Management Policy and Target

(1) Primary Focus on Financial Strengthening

As discussed in the Master Plan, UWC of Juba aims at being a self-sustaining organization with autonomy in future. To that end, financial strengthening should be primarily focused for capacity development of UWC as the financial constrain is the biggest constraint of water works management.

In the Master Plan, it is planned to phase out the subsidy from GOSS until the year 2015. To achieve this goal, great efforts would be required by UWC through improvement of profitability of the service, by means of increasing water revenue significantly. To increase water sales, production capacity as well as the number of connections should be expanded together with proper operation and maintenance and ensuring of water quality of treated water. Furthermore, the water tariff should be set to cover operating expenses and a part of depreciation. Given this perspective, it is urgently required to upgrade billing & revenue collection system based on metering system.

(2) Setting up of New Tariff System based on Universal Metering System

Although more than 2,000 water meters have been procured under the MDTF project, none of them has been installed yet as of July 2009. It seems that UWC is not capable of installing these meters properly, as they lack appropriate plumbing tools and workmanship. It is, therefore, required to set up meter installing program, although this installation should be reportedly made under the scope of the contractor of the MDTF project.

Prior to installing meters, administrative processes are also required. In particular, a revision of water tariff based on metering system should be firstly implemented. In that case, the tariff should be designed in due consideration with three principles which have been mentioned in the Master Plan. In addition, the legislations related to water supply contract with customers should be upgraded.

To perform these administrative reforms, foreign technical assistance is recommended.

(3) Upgrading of Billing and Revenue Collection System

In parallel with setting up new tariff system, billing and revenue collection system should be restructured and upgraded, as metering system requires more work processes than the current flat rate

system.

In this case, a proper billing system by using software should be developed and the staff of revenue section of UWC should be trained to ensure every work process functioning. For this purpose, foreign technical assistance is recommended, as these kinds of practical knowledge and skills can be effectively learnt through demonstration of the actual cases in the other waterworks.

(4) Enhancement of Customer Service and Authorization to Disconnect

It has been discussed in the Master Plan that UWC should work closer to customers in a customer oriented manner. In that case, it is recommended to establish customer service offices in several areas in order to take care of customers by dividing service areas into manageable scale. Then, the customers can lodge claims to the office and the service office must fix the problem as soon as possible, which leads to higher work performance and better customer satisfaction, and eventually customers' supportive manner would be expected in water use and payment.

On the other hand, authorization of UWC to suspend water supply against defaulters, such as non-payment and outstanding arrears is also necessary. This right of UWC to disconnect and fine to defaulters should be legislated and stipulated in the water supply contract.

To step forward, a kind of taskforce should be set up in the Government in order to draft the legislation. In that case, assistance by foreign expert is also recommended.

(5) Debt Management Strengthening

Seriousness of the accumulated bad debt is pointed out in the Master Plan. In order to move towards sound financial status, bad debt should be cleared as early as possible. Since the debt amount is quite huge, discussion should be made by the Government to decide how to clear it.

Besides the above bad debts, UWC should strengthen the debt management for future. For this, clear monitoring method should be put in place. Also, the use of private debt collectors for old debts should be considered as in the case of Nairobi Water Company. Penalty and preferential policy should also be enforced, e.g. penalty for defaulters and discount for advance/early payment.

3.2 Performance Targets

3.2.1 Application of Performance Indicators

Unlike limited term investment project for physical assets, improvement of management quality

requires a lot of continuing efforts. Hence, it is more important to establish a process of improving performance within management practices of UWC, rather than to design and implement capacity development program for short term. To address this, performance indicators (PIs) are recommended to use, which are published by ISO/TC224 and other water associations like JWWA (Japan Water Works Association). PIs are designed to set up management goal by numerical targets as the commitments of waterworks. If PIs are measured properly, it is possible to evaluate the service quality by comparing with benchmarks of other waterworks and to formulate practical improvement plan. The PIs should also be opened to public and monitored by any stakeholders to ensure accountability of the management.

3.2.2 Performance Target by using PIs

Typical PIs are selected in consideration of four domains of key management aspects: service, operational process, finance and human resource. The position of each PI is illustrated in Figure 3.1. The selected PIs and target by year 2015 are presented hereafter.

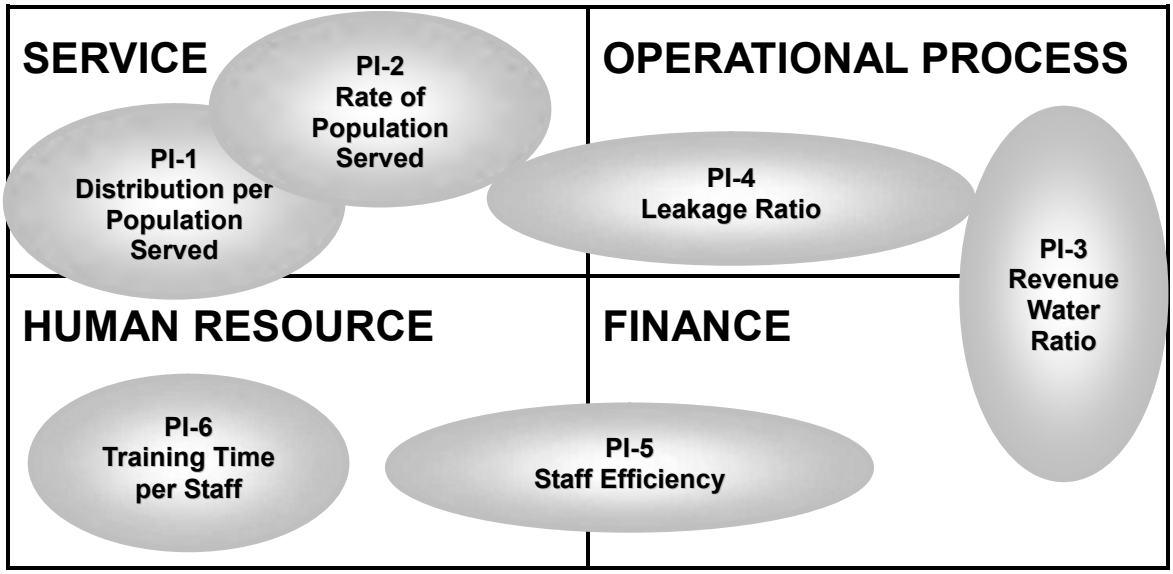


Figure 3.1 Position of PIs in Four Management Domains

(1) Water Distribution per Population Served

It is an indicator of potential capacity of supplying water to single customer, which represents a factor of service quality. Normally the larger figure is considered to be the better service. However, it doesn't take into account of water leakage. In that case, leakage ratio (as described below) should be considered as well. The PI is projected in Table 3.1, and as a referential benchmark, the value of Kampala as of 2008 is also presented in the table.

Table 3.1 PI Projection of Water Distribution per Population Served

Year	[1] Average daily distribution capacity (m^3/d)	[2] Population served with clean water (1000 persons)	[3] (=[1] / [2]) Water distribution per population served (L/c/d)
2009	6,364	93.5	68.0
2012	12,727	202.6	62.8
2015	57,513	544.0	105.7
2025	195,884	1,161.1	168.7
(Kampala)	*(125,951)*	*(1,151.0)*	*(109.4)*

(Note)
[1] Average daily distribution capacity: It is equivalent to system input water volume which includes authorized consumption and water losses. Figures for 2009 and 2012 are estimated from production capacity divided by daily maximum coefficient of 1.2, in which operating hours are also assumed to be 24 hours.
[2] Population served: It includes population having access to clean water by house connection, public tap and water tankers served by UWC, although it normally doesn't include water supply by water tankers in the common definition.

(2) Coverage rate of population served with clean water

It is one of the most important parameters in water supply planning, since it is often used as the target of the government administration. In calculation, population served with clean water of UWC through water tankers are counted, although normally only population having access to piped water is considered. The PI projection is shown in Table 3.2, with referential value of Kampala.

The value of Kampala as of 2008 is 74%, which counts population access to piped water supply only. In comparison to it, the ratio of population served by water tanker should be deducted from the target in 2025, which is 30% in 2025. If it is deducted, the PI should be 70% in 2025.

Table 3.2 PI Projection of Coverage Rate of Population Served

Year	[1] Population served with piped water (1000 persons)	[2] Total population in service area (1000 persons)	[3] (=[1] / [2] x 100) Coverage rate of population served (%)
2009	93.5	406.4	23.0
2012	202.6	555.0	36.5
2015	544.0	680.0	80.0
2025	1,116.1	1,116.1	100.0
(Kampala)	*(1,151)*	*(1,555)*	*(74)*

(Note)
[2] Population in service area: based on population forecast in M/P

(3) Revenue Water Ratio

It is a parameter of management efficiency in terms of water volume, which doesn't include financial factor such as water tariff. It has the opposite meaning of NRW ratio (Non-revenue water ratio). The management should always seek for the higher ratio (lower NRW ratio), by means of leakage reduction, enhancement of bill collection rate, etc.

Since NRW management includes technical and commercial activities, cross-sectoral taskforce group should be formed. In this regard, NRW management unit should be formed to plan the work process and mobilize the cross-sectoral members, who could belong to different sections.

Table 3.3 PI Projection of Revenue Water Ratio

Year	[1] Revenue water volume (1000 m^3/year)	[2] Total distribution volume (1000 m^3/year)	[3] (=[1] / [2] x 100) Revenue water ratio (%)
2009	806.0	2,322.9	34.7
2012	1,767.0	4,645.4	38.0
2015	11,920.2	20,992.2	56.8
2025	52,110.1	71,497.7	72.9
(Kampala)	*(26,674)*	*(45,972)*	*(58.0)*

(Note)
[1] Revenue water volume: It is estimated from average distribution capacity (m^3/d), leakage ratio (%), and water charge collection ratio (%), which varies depending on type of water supply and year. For detail, refer to water revenue forecast in M/P.
[2] Total distribution volume: It is calculated from average distribution capacity (m^3/d) multiplied by 365 days.

(4) Leakage Ratio

Leakage ratio focuses on physical efficiency in distribution system. It should be less for better efficiency. However, it should be noted that direct measurement of leakage volume is practically impossible. Therefore, in many cases, leakage ratio is estimated by analyzing components of NRW, which is measurable with accuracy if water meters are installed.

Table 3.4 PI Projection of Leakage Ratio

Year	[1] Annual leakage volume (1000 m^3/year)	[2] Annual distribution volume (1000 m^3/year)	[3] (=[1] / [2] x 100) Leakage ratio (%)
2009	929.2	2,322.9	40%
2012	929.1	4,645.4	20%
2015	4,198.4	20,992.2	20%
2025	14,299.5	71,497.7	20%

(Note)
[1] Annual leakage volume: Since there is no flow measurement in the existing system, it is estimated by using assumed leakage ratio ([3]) multiplied by distribution volume ([2]).
[3] Leakage ratio: It is estimated in M/P to be 40% in 2009 and 20% after 2012.

(5) Staff number per 1000 connections

It is often used to express productivity of the waterworks, based on assumption that more customers and less staff would reflect the better management. However, it represents only single aspect of staff efficiency. It varies depending on management policy by waterworks. For example, if some task is done by outsourcing to a subcontractor, the number will be smaller, because the PI counts only permanent staff. And it doesn't necessarily ensure the management quality. Therefore, it should be used mainly for referential purpose in order to compare with the past years or other urban centers.

Table 3.5 PI Projection of Staff Number per 1000 connection

Year	[1] Total staff number (staff)	[2] Total number of connection (connections)	[3] (=[1] / [2] x 1000) Staff number per connection (staff per 1000)
2009	167	2,467	68
2012	204	3,403	60
2015	378	25,197	15
2025	824	117,716	7
(Kampala, Uganda)			*(7)*
(Nagoya, Japan)			*(2.3)*
(Akita, Japan)			*(1.3)*

(Note)
[1] Total staff number: Figures for 2012 and 2015 is estimated from the staff efficiency presented as [3]. For detail, refer to cost estimation on personnel of O&M cost presented in M/P.
[2] Total number of connection: As estimated in M/P. Refer to revenue forecast for detail.

(6) Training Time per Staff

In the Study, needs of training for all levels and fields of UWC staff were identified. And training for new employees are also required in future. Therefore, every staff should be given opportunity to participate in training program, based on his carrier development plan. To do this, staff should be guaranteed with some training time (e.g. 20 hours/year) and UWC must provide or at least subsidy the cost for training.

In fact, the training hours itself does not guarantee performance improvement of the staff. Therefore, the PI should be reviewed based on achievement of training program. The most important thing is to ensure the human resources development program as a vital management policy. Otherwise training is often overlooked and only little budget is allocated in many cases. As a result, service quality would fall down. As such, this indicator should be established and committed by the top management.

As reference, training hours accomplished under this Study was calculated in Table 3.7.

Table 3.6 PI Projection of Training Time per Staff

Year	[1] Training hours (hours x attendants)	[2] Total staff number (staff)	[3] (=[1] / [2]) Training time per staff (hours/year)
2009	1,777	167	10.6
2012	4,080	204	20.0
2015	9,450	378	25.0
2025	24,720	824	30.0

(Note)
[1] Training hours: That of 2009 is estimated from the accomplishment of capacity development under the Study, as listed in the following table. The figures for 2012 and 2015 are estimated from training time assumed as the above column [3].

Table 3.7 Training hours accomplished under this Study

Component	Training hours per person (1 day = 7 hours)	Number of attendants from UWC (CES) Juba	Training hours
PCM workshop (UWC)	6 hours	34 persons	204 hrs
Seminar (Juba)	14 hrs(2 days)	10 persons	140 hrs
Study tour (Kenya)	35 hrs (5 days)	3 persons	105 hrs
Oversea training (Kenya)	105 hrs (15 days)	8 persons	840 hrs
O&M theory (UWC)	8 hrs	30 persons	240 hrs
O&M record (UWC)	12 hrs	10 persons	120 hrs
PC training (UWC)	16 hrs (2 hrs x 8 days)	8 persons	128 hrs
		Total	1,777 hrs

3.3 Organization Plan

3.3.1 Possible Organization Structure

(1) Workforce Outlook

Future workforce of UWC was estimated in the Master Plan by projecting staff efficiency per connection. As a result, staff number in 2015 is estimated to be 378 persons, while that in 2009 is 167 staff. Given this, probable workforce by section is tentatively projected as presented in Table 3.8.

Table 3.8 Probable Workforce Outlook by Section for year 2015

Office/ Section	Position	Estimated staff number	Total
Head office	Area Manager	1	3
	Deputy area manager	1	
	Secretary	1	
Financial department (head office)	Head of department	1	20
	Deputy head	1	
	Budget planning section	5	
	Accounting section	10	
	Cost control section	3	
Administration & general affairs department (head office)	Head of department	1	30
	Office clerk	10	
	Public relations section	3	
	Office maintenance	5	
	Security guard	6	
	Driver	5	
Human resource development department (head office)	Head of department	1	10
	Personnel section	5	
	Career development section	4	
Production department			124
	Head of department	1	(1)
- Supply chain management section	Section chief	1	(12)
	Procurement team	4	
	Logistics support team	4	
	Store keeper	3	
- Water quality management section	Section chief	1	(10)
	Laboratory staff	9	
- Technical maintenance section	Section chief	1	(15)
	Mechanic	4	
	Electrician	5	
	Forging worker	5	
- New WTP operation section	WTP chief	1	(40)
	Water supply inspector	1	
	WTP operator	15	
	Pump attendant	6	
	Chemical attendant	6	
	Water guard/ patroller	6	
	Grounds man/ security guard	5	
- Existing WTP operation section	WTP chief	1	(33)
	Water supply inspector	1	
	WTP operator	12	
	Pump attendant	5	
	Chemical attendant	5	
	Water guard/ patroller	5	
	Grounds man/ security guard	4	
- Distribution control section	Section chief	1	(13)
	Reservoir / Pump station attendant	12	
Customer service department			191
	Head of department	1	(1)
- Customer service offices (3 offices)	Chief of service office	3	(106)
	Meter reader	56	
	Ledger keeper	12	
	Casher	9	
	Customer care	16	
	Office clerk	5	
	Security guard	5	
- Distribution unit	Head of unit	1	(55)
	Service connection team	20	
	Leakage control team	10	
	Pipe repair team	18	
	Draftsman	2	
	Store keeper	4	
- NRW management unit	Head of unit	1	(4)
	NRW management coordinator	3	
- Water feeding stations (5 stations)	Water tanker attendant	20	(25)
	Casher	5	
	Grand Total		378

(2) Proposed Organizational Reform

A business scale of UWC will expand rapidly as new water supply system will be constructed by 2015. At that time, there will be several independent offices and plants, such as workshop, existing WTP, new WTP, and customer service offices. In order to manage these business units efficiently, each unit should be granted with a certain authority and responsibility. Especially authorization to use budget should be given to the unit level, on condition that these financial transactions are done within the approved budget.

In this regard, reorganization of the existing organizational structure is recommended for future, since it is envisaged that increase in staff number without reorganization often causes inefficiency of any business transaction, such as slow decision making, unclear responsibility, sectionalism, etc.

In this case, redefinition of business unit with profit responsibility is recommended as discussed in Chapter 4 of Part II. The recommended reorganization of the existing structure is illustrated as Figure 3.2.

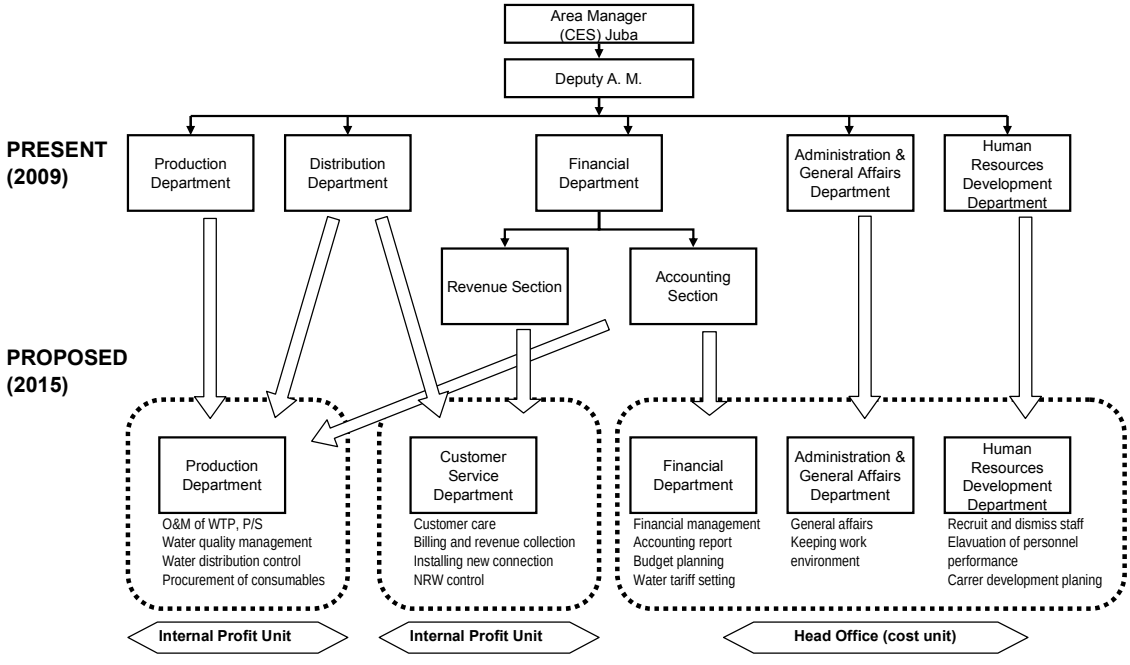


Figure 3.2 Proposed Organization Structure in 2015

In this structure, customer service department is newly established by merging the existing distribution department and revenue section, and the production and customer service departments are defined as internal profit units, whereas the remaining departments belong to head office as cost units.

Both of these profit units are given clear objectives and responsibility. That is, the production department will be responsible for water production and transmission to service reservoir, and the customer service department will be responsible for water distribution after reservoir and revenue collection from customers. In this case, it is recommended to set up internal wholesale tariff which includes production cost of WTPs, transmission cost and small profit margin of the production unit. The cost related to distribution and customer services should not be included owing to the wholesale transaction. Any incentive mechanism is also recommendable to introduce, e.g. bonus, in accordance with the business performance of the unit.

(3) Customer Service Office

Under the project, expansion of the existing WTP and new construction of the West WTP is proposed. As water production increases, the number of customers will increase to approx. 25,000 connections in 2015 by estimate. Consequently, it is also proposed to establish customer service offices in order to handle customers demand and complaints by dividing the entire area into commercial zones.

These offices would be located in some strategic points in the service area. In this case, technical service related to pipe maintenance is recommended to be attached in the office in addition to its commercial activity. The office will be able to work closer to the customers, by provision of maintenance service within the area. For instances, the offices could be located at the sites of the existing WTP, the proposed North Low SR and the Kator elevated tank.

3.3.2 Involvement of Private Sector

Population served by public taps and water tankers in 2015 is estimated to be approx. 150,000 people and 205,000 people respectively. For supplying water and revenue collection from these customers, private sector should be involved in the form of authorized water vendor, such as water kiosk as practiced in Kenya. In this case, the vendors are to be granted with license by UWC in order to ensure the water quality and retail price. Otherwise, if they are not regulated by law, water quality and retail price may not be ensured. It is therefore necessary to formulate legislation related to licensing system for private water vendor. Roles of UWC and private vender are outlined in Table 3.9.

Table 3.9 Roles of UWC and Private Vendor

Item	UWC	Private vendor
License	− Authorized to give license to private water vendor	− License to sell water to public at the retail price
Water supply service	− Duty to provide clean water to the vendor − Right to inspect the facility anytime	− Duty to maintain the own facility to be functional and prevent contamination
Water charge	− Charge tariff to vendor according to consumption	− Pay for water charge to UWC − Get profit through water selling

3.4 Operation and Maintenance Plan

(1) Introduction

The core value of water supply service is provision of clean water with sufficient volume, which is ensured through appropriate O&M practice. In other words, water quality management and distribution control should be performed appropriately, as discussed hereafter.

(2) Water Quality Management

Water quality management is a practice to ensure water quality of the tap end to be always potable by means of monitoring and controlling water quality from the water source to the tap end. The potable water in this context means water which satisfies the drinking water quality standard and disinfected. The following activities are required to perform water quality management properly.

− To monitor water quality of water source and distributed water
− To control chemical dosing in the treatment process according to the raw water quality
− To prevent water from contamination in the distribution system

In practice, water inspection policy should be prepared, which should be observed in daily operation. The policy should stipulate the work procedures of water sampling points, test parameters, testing frequency, and evaluation criteria. The sample of water quality inspection policy is shown in Table 3.10. The inspection results should be reflected to the treatment process.

Table 3.10 Example of Water Quality Inspection Policy

Parameter	Criteria	Frequency	Sampling point
pH	6.5-8.0	Daily	• Raw water • Filtered water • Tap water
Temperature	-	Daily	
Turbidity	< 5 NTU	Daily	
Odor	NIL	Daily	
Taste	NIL	Daily	
Residual Chlorine	> 0.2 mg/L	Daily	• Filtered water • Tap water
Total coliform	0 / 100 mL	Monthly	• Filtered water • Tap water
Faecal coliform	0 / 100 mL	Monthly	
Conductivity	-	Monthly	
TDS	1000 mg/L	Monthly	• Raw water • Filtered water • Tap water
Total Alkalinity		Monthly	
Total Hardness	200 mg/L	Monthly	
Aluminum	0.2 mg/L	Monthly	
Calcium		Monthly	
Iron	0.5 mg/L	Monthly	
Sodium	100 mg/L	Yearly	• Raw water • Filtered water • Tap water
Chloride	200 mg/L	Yearly	
Sulphate	200 mg/L	Yearly	
Fluoride	1.0 mg/L	Yearly	
Zinc	3.0 mg/L	Yearly	
Nitrate	30 mg/L	Yearly	
Cadmium	0.003 mg/L	Yearly	
Copper	1.5 mg/L	Yearly	
Cyanide	0.05 mg/L	Yearly	
Lead	0.01 mg/L	Yearly	
Manganese	0.4 mg/L	Yearly	

Among practices in water quality management, inspection of water source is the most important. In case any abnormal situation is observed, the evaluation of health hazard risk should be required as early as possible. In case possibly high risk is evaluated, water intake should be stopped.

(3) Water Distribution Control

Distribution control is a practice to ensure water flow, pressure and quality of treated water to be transmitted and distributed to the place of demand. The facilities to control include: clear water reservoir, transmission pumps, transmission pipelines, service reservoirs and distribution pipelines.

Distribution control includes the following tasks:

- To protect clean water from contamination
- To keep water flow and pressure at the required level by operating pump and valve
- To set up management system to take necessary measures to handle emergency (accidental) cases
- To maintain drawings and monitoring records of the facilities for proper asset management

In practice, water levels of service reservoirs, which vary depending on water consumption, should be monitored to maintain between low water level (LWL) and high water level (HWL) by controlling operation of transmission pumps. In principle, water level should be kept more than LWL. However, in case that there is a possibility of storing insufficient water in the nighttime due to excessive consumption in the daytime, restriction of water supply in the nighttime should be allowed by closing the outlet valve of reservoir in order to store water before morning hours when water demand become peak.

Every facility of tanks, pipes, valves, pumps and meters should be regularly inspected to maintain in a functional condition, by using check lists, which should be prepared in maintenance plan.

3.5 Customer Services

Activities of customer services include acceptance of application for new connection, meter reading, billing and revenue collection, customer management and complaint processing. The number of customers is projected to be over 25,000 in 2015, which is about ten times bigger than existing number of customers. In addition, considering that flat rate is currently applied and revenue collection ratio is quite low, priority of customer service strengthening is very high. Necessary measures to be taken are described below.

(1) Enacting New Tariff Policy

It is necessary to revise water tariff based on metering system. In the Master Plan, new tariff structure is proposed considering the three principles of affordability, fairness and sustainability. Then the increasing block tariff (IBT) with base tariff is proposed, which should be reviewed by SSUWC and officially proposed to the parliament for approval.

(2) Improvement of Work Process

In order to deal with increasing number of customers efficiently, work process should be systematically done and reasonably monitored. Samples of standard work process for future are illustrated in Figure 3.3 and Figure 3.4.

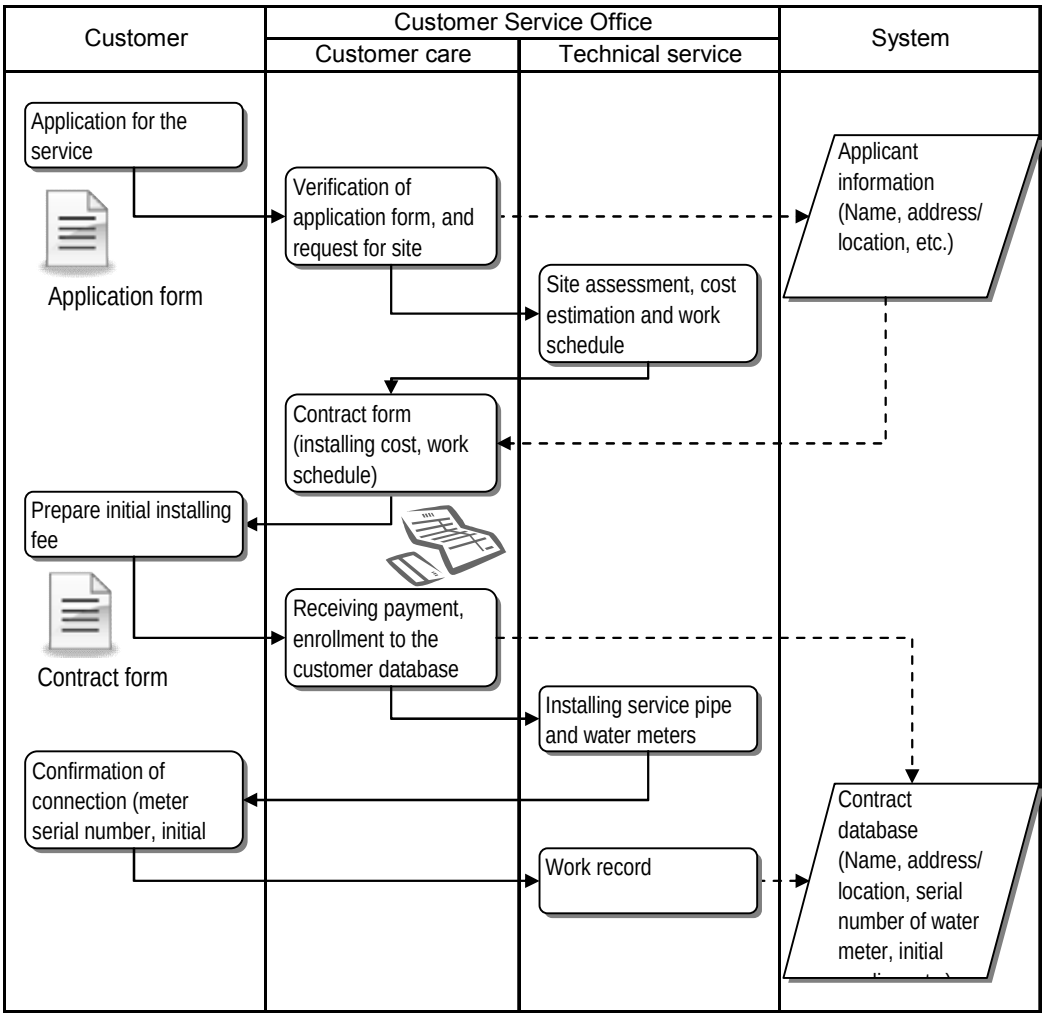


Figure 3.3 Work Process Flow of New Connection

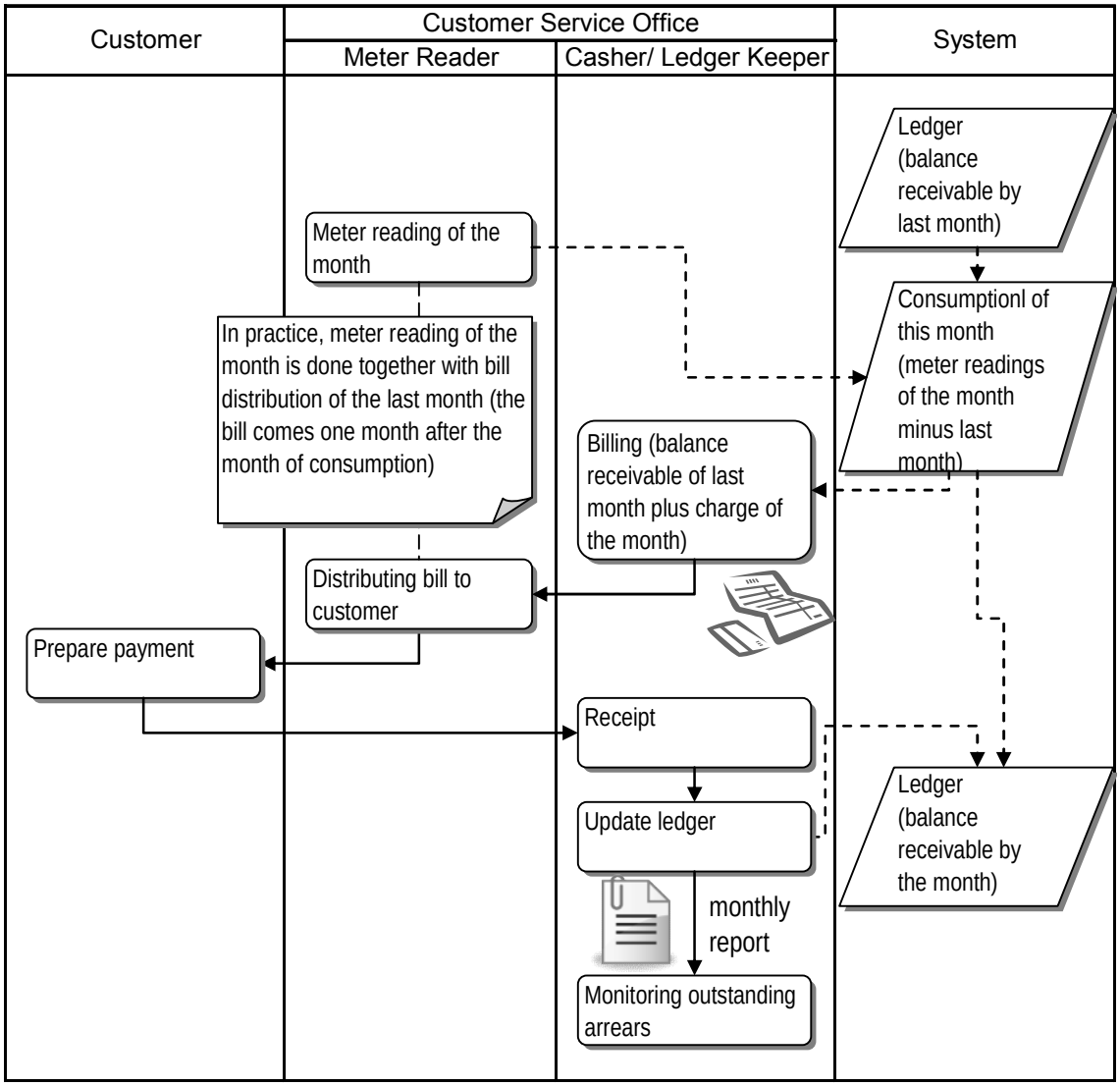


Figure 3.4 Work Process Flow of Billing and Revenue Collection

(3) Debt Management

Debt management is practiced to minimize customers' debts to improve cash flow. Considering that significant arrears are accumulated in revenue account although they are practically recognized as bad debts, bad debts management should be prioritized for future.

Monitoring and collecting system should be set up. As a monitoring parameter, "Day's Receivable" should be monitored, which is a financial indicator of ratio of account receivable to net sales expressed by the following formula.
[Day's Receivable (days)] = [Account Receivable (SDG/year)] / [Net Sales (SDG/year)] x 365

On calculation, Day's receivable of 2008 is estimated to be 4,524 days (= [SDG 8,204,039 (arrears as of 2008)] / [SDG 661,866 (est. revenue of 2008, UWC)] x 365). It is remarkably high whereas it is

generally said it should not be more than 90 days.

In this regard, UWC should introduce debt collection measures, e.g. installment plans for poor households, private debt collectors for old debts, introducing penalties for the defaulters.

(4) Authorization to Water Suspension

Strong penalty policy for defaulters should be enacted by laws, since most outstanding arrears are reportedly borne by public institutes/government sector and politically influential persons. In fact, the right of disconnecting the defaulters is currently regulated, practically it is hardly done due to current insufficient autonomy of UWC which is so dependent on the Government. Therefore, governance should be secured by the Government so that UWC is able to enforce the right to fine and disconnect the defaulters, regardless of their social status.

(5) Complaint Processing

Complaint processing is often regarded as unprofitable activity. However, it is inevitable for customer satisfaction. For future, complaint by customers should be taken care in order to raise customer satisfaction, which leads to customers' cooperative behavior to water supply business. Two types of complaints are roughly categorized: they are, (i) complaints on water supply service (volume, quality and pressure) and (ii) complaints on water charge. Firstly, UWC should establish processing system to these complaints.

Firstly, the interface for complaint lodging should be set up, e.g. customer care desks in the customer service offices, telephone desk which is notified through public advertisement. In case the complaint is related to technical service, technical staff should assess the problem and cope with trouble as soon as possible since quicker action leads to higher customer satisfaction. And if the complaint is about water charge, the customer service officer should first examine whether the monthly consumption is reasonable by comparing to the past trend. Then if it is normal consumption, sufficient information should be provided for customers' understanding. In case consumption seems excessive, the cause should be assessed technically. Then if special reason is found, water charge should be reasonably reconsidered according to situation. Communication should be continued until customer is satisfied.

3.6 Non Revenue Water (NRW) Management

By 2015, most distribution system is planned to be replaced with new facilities. Leakage ratio (physical loss) is estimated to be 20 % at that time. And the commercial loss is estimated to be 24 %. For the short term, NRW management should focus on commercial loss reduction, which consists of customer meter inaccuracies, unauthorized consumption; illegal connections, theft and fraud,

customer data base errors, data collection and transfer errors.

As the first step, district metering is recommended by installing a bulk meter to the inlet of the district metered area (DMA), which enables to measure the water flow of the DMA. Then the water balance of DMA should be assessed by comparing the total water consumption of the area and measurement of minimum night flow.

Based on the assessment, appropriate measures for NRW reduction should be planned and implemented. The detailed NRW control measures are described in the Master Plan.

3.7 Action Plan of Capacity Development for Priority Projects

3.7.1 Proposed Action Plan

In the Master Plan, capacity development plan was formulated based on capacity assessment. Also some components of the program were implemented under the Study. Capacity development plan for the priority project is proposed in consideration of the required capacity for the priority project targets. The proposed capacity development action plan is presented as Table 3.11.

3.7.2 Activities of Capacity Development Project

(1) Target Groups

For implementation of the action plan, foreign technical assistant program is recommended. On recognition that management capacity should be primarily developed, the project objective is set as management capacity strengthening of urban water sector in Southern Sudan. In this case, the target group should include not only UWC-Juba but also personnel engaged in the urban water sector in Southern Sudan as a whole, since development of Juba water supply is recognized as a model case to imitate in other urban center of the nation. Field activities, such as in-house training and pilot project, will be limited to Juba, but training opportunity should be given to personnel of the other urban centers.

(2) Project Design Matrix (PDM) of Capacity Development Project

The proposed technical assistance project is outlined in the project design matrix presented in Table 3.12.

Table 3.11 Proposed Capacity Development Action Plan by 2015

Category	Objective	Activity	Evaluation criteria
Autonomy	Autonomy of UWC is enhanced for more management efficiency	− UWC is officially granted with authorities for personnel affairs, budget planning, bad debt collection and disconnection against non-payment customers.	− Clear statement in legally valid official documents (law, decree, ordinance, etc.)
Organization	Roles and responsibilities of UWC and each section are clarified	− Roles and responsibility is defined in written format, with regard to job description, O&M manuals, Staff ethical code	− SSUWC Provisional order(2008) is approved by the parliament − Job description, O&M manual, staff ethical code are prepared
	Private sector is involved in public water supply system	− Legislative provision of licensing private sector for water supply business, such as water tanker supplier, water kiosk, etc. − UWC enrolls private sectors to participate in public water supply system	− Licensing system on private water supplier is functioning
	Business activity is monitored by performance based evaluation	− Introducing performance indicators	− Performance indicators are used and monitored properly
O&M	O&M work is done properly according to O&M manual	− Staff training on O&M manual and working record	− Work record and reporting system is properly done on time
	Required water volume is produced and distributed	− O&M work is performed − Necessary budget is allocated	− Comparison between planned and actual figure of monthly water production volume (m^3/month) and monthly water distribution volume (m^3/month)
Finance	O&M cost is recovered without the government subsidy	− Billing and revenue collection system is upgraded by introducing computer software − Staff training for operating new system − Water meters are installed to customers − New water tariff is proposed by SSUWC and approved by the parliament	− New billing system is operating − Number of trained staff − Number of water meters installed − New tariff takes effect
	Bad debt is reduced	− Policy on bad debt management is made by the government − Bad debt management is done	− Policy making on bad debt management by the government − Amount of bad debt is reduced from the UWC account
Human Resources Development	Knowledge and skill of UWC staff is improved	− Required competency and knowledge by target group is identified for planning training program − Staff training by using external resources is carried out	− Training program is prepared and implemented − Training time (=[number of trainees] x [training hours]) is increased
Public Relations	Public awareness on water supply is raised	− Public awareness campaign, event, etc. is carried out	− Days (period) of campaign carried out − Estimated number of target group

Table 3.12 Project Design Matrix of the Proposed Capacity Development Project

Name of Project: Management capacity strengthening of urban water sector in Southern Sudan
Target Group: Personnel engaged in urban water sector in Southern Sudan

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: − SSUWC is managed under self-financing system	− Operational cost is covered by water revenue without subsidy by GOSS	− Financial statement	
Project Objective: − Management capacity of SSUWC is improved	− Monthly and annual reports is appropriately prepared by SSUWC − Performance improvement is appropriately planned and verified by SSUWC	− Monthly report / annual report − Annual report/ development plan	− Water infrastructure will be developed as M/P − Government will continue to support the policy on UWC to be self-sustaining organization
Outputs: - Management practice of UWC will be improved, related to waterworks management and revenue collection - Water Kiosk will be constructed and managed under the Pilot project - Non-Revenue Water in the pilot area will be reduced	− Performance indicators are improved (number of customers per staff, revenue water ratio, training time per staff, etc.) − Water sales of Kiosk is increased − NRW ratio in the pilot area will be reduced	− Monthly/ annual report − Account report of UWC − Pilot project activity report	− Customers will choose treated water and pay for water charge − Necessary budget for O&M is allocated
Activities: (1) Improvement of training facility 1-1) Provision of reference books/ documents 1-2) Provision of training equipment (2) Implementation of staff training 2-1) Capacity development of customer service and revenue collection section 2-2) Instruction to financial and accounting Section 2-3) Instruction to human resources development section 2-4) Instruction to distribution section (3) Implementation of model pilot project in some distribution areas 3-1) Construction and management instruction of water kiosk and water feeding station 3-2) Assistance for public awareness campaign 3-3) Non-Revenue Water control in the pilot area	**Inputs** [Foreign Country] Foreign experts: − Team leader 12M/M − Financial planning / tariff setting 10M/M − Billing / Revenue collection 10M/M − NRW control 10M/M − Customer database / customer management 5M/M − Distribution control 5M/M − Plumbing technique 4M/M Facility: − Water kiosk 5 nos. − Water feeding station 1 station Equipment: − Training facility, Reference books, Plumbing tools, Meters and fittings for DMA pilot area	[Southern Sudan] Counterpart staff Training room Fuel, consumables for implementing training Workforce for pilot project Tax exemption	− Water meters provided under MDTF will be installed in the pilot project area − Private water vendors are involved in public water supply system − Clean water is produced by WTP **Pre-conditions** − New water tariff policy by metering is enacted

(3) Proposed Activities of Capacity Development

The proposed activities are described in detail subsequently as follows.

1) Improvement of training facility

Through improvement of training facility, training environment is accommodated which is a fundamental for human resources development. It potentially contributes to improve the PI of [PI-6: Training time per staff] effectively.

1-1) Provision of reference books/ documents

- Learning space for staff
- Seminar by using documents

1-2) Provision of training equipment

- Projector, Photocopy machine, White board, Flipchart, Engine generator, etc.

（# Building should be provided by GOSS）

2) Implementation of staff training

2-1) Capacity Development of Customer Service and Revenue Collection Section

This activity aims to improve [PI-3: revenue water ratio], which is a key factor for financial soundness.

- Improvement of work process from application of service connection to recording water ledger
- Technical instruction on customer ledger management
- Recommendation on billing system improvement
- Recommendation on meter reading process improvement
- Recommendation on bad debt management

2-2) Instruction to Financial and Accounting Section

As an essential capacity of financial management, this activity is necessary.

- Lecture on finance/accounting
- Instruction on how to prepare financial statements and financial plan
- Recommendation on accounting system improvement
- Assistance to formulate water tariff system

2-3) Instruction to Human Resources Development Section

It helps to develop capacity of human resources development section, which indirectly contributes to [PI-5: Staff efficiency] and [PI-6: training time per staff].

- Instruction to formulate human resources development plan
- Recommendation on personnel system improvement

2-4) Instruction to Distribution Section

This component mainly focus on distribution control and leakage reduction, which contributes to [PI-3: revenue water ratio] and [PI-4 leakage ratio].

- Procurement of materials for construction of water pipes/ service pipes
- Technical instruction on pipe construction techniques
- Instruction on how to prepare checklist of pipe laying work
- Technical assistance to prepare pipe inventory and drawings

3) Implementation of model Pilot project in some distribution areas

3-1) Construction and Management Instruction of Water Kiosk and Water Feeding Station

Through provision of water kiosk and feeding station, PI of [PI-2: rate of population served] will be increased. And [PI-3: revenue water ratio] will also be improved under proper management.

- Technical assistance on public announcement for inviting private vendors and preparation of contract documents
- Planning, designing and construction of some Water Kiosk
- Technical assistance for water vendor and UWC staff
- Technical assistance on issuance of license to vendors and water tankers, and preparation of contract documents

3-2) Assistance for Public Awareness Campaign

Through this activity, understandings by customers, [PI-3: revenue water ratio] might be improved. And it should contribute to raise number of customers for better performance of [PI-5: staff efficiency].

- Instruction and implementation on objective of campaign and method
- Technical assistance to prepare public relations magazines

3-3) Non-Revenue Water Control in the Pilot Area

This is a practice to improve [PI-3: Revenue water ratio].

- Provision of materials (stop valves, pipes, plumbing tools, etc.)for isolating district meter areas (DMAs)
- Installation of bulk water meter for the DMAs
- Installation of water meters in the DMAs（e.g. 500 meters）
- Instruction on establishing customer database within the DMA
- Instruction on water balance analysis
- Instruction and implementation of improvement plan on revenue collection system
- Monitoring effects of NRW control

3.7.3 Tentative Implementation Schedule

Implementation schedule is tentatively prepared as presented in Table below, in which the capacity development project is implemented in two phases; namely pilot and enrolling phases.

Table 3.13 Tentative Implementation Schedule

Activity	Year-1												Year-2												Year-3					
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
PREPARATORY WORK																														
Formation of implementing organization	●	●																												
Review of needs assessment and CD implementation planning	●	●																												
Baseline assessment	●	●																												
Procurement of equipment		●	●	●	●																									
CD IMPLEMENTATION																														
(1) Improvement of training facility					Pilot phase								Enrolling phase																	
1-1) Provision of reference books/ documents					●	●																								
1-2) Provision of training equipment					●	●																								
(2) Implementation of staff training																														
2-1) Capacity development of customer service and revenue collection section					●	●	●	●					●	●	●	●					●	●	●	●						
2-2) Instruction to financial and accounting Section							●	●	●	●	●	●	●	●	●	●					●	●	●	●						
2-3) Instruction to human resources development section									●	●	●	●			●	●	●	●					●	●						
2-4) Instruction to distribution section					●	●	●	●	●	●	●	●			●	●	●	●												
(3) Implementation of model pilot project in some distribution areas																														
3-1) Construction and management instruction of water kiosk and water feeding station					●	●	●	●	●	●	●	●									●	●	●	●						
3-2) Assistance for public awareness campaign									●	●	●	●							●	●	●	●								
3-3) Non-Revenue Water control in the pilot area							●	●	●	●	●	●	●	●	●	●					●	●	●	●						
MONITORING AND EVALUATION											●	●											●	●					●	●

CHAPTER 4 IMPLEMENTATION PLAN AND COST ESTIMATION OF PRIORITY PROJECT

4.1 Implementation Plan of Priority Project

4.1.1 Implementation Strategy

In the Master Plan, the project implementation schedule was prepared with four phases. The priority project components are equivalent to the phase 1 and 2 of the Master Plan. The basic frame of the implementation schedule of the priority project is same as the Master Plan but it is formulated in more detail than the Master Plan, especially at the initial stage of the priority project which requires more elaborated implementation schedule.

The strategy of implementation of the priority project is shown in Figure 4.1. In the implementation of the project, the project is separated into two phases and facility and non-facility (management) measures should be simultaneously implemented.

Considering the present management, financial and technical capacity of UWC, it is not possible for UWC to implement a large investment project at the initial stage. However, it could be possible after UWC's management is strengthened and UWC becomes an autonomous and profitable organization. For this purpose, the phase-1 project is formulated to give larger benefits in terms of improvement of facilities and management utilizing relatively small scale investment.

For the implementation of the phase 1 project, small or medium scale grant aid for rehabilitation of the existing water supply system along with technical cooperation to strengthen the management capability should be invited from international donors. Through the implementation of rehabilitation project along with technical cooperation project, UWC should establish sound management fundamentals and become a capable organization to attract the large investment irrespective of public or private fund to materialize the new water supply system proposed in the phase-2 of the priority project. Based on the established sound management fundamentals, UWC could manage the large investment project, expand the service area, and improve their services.

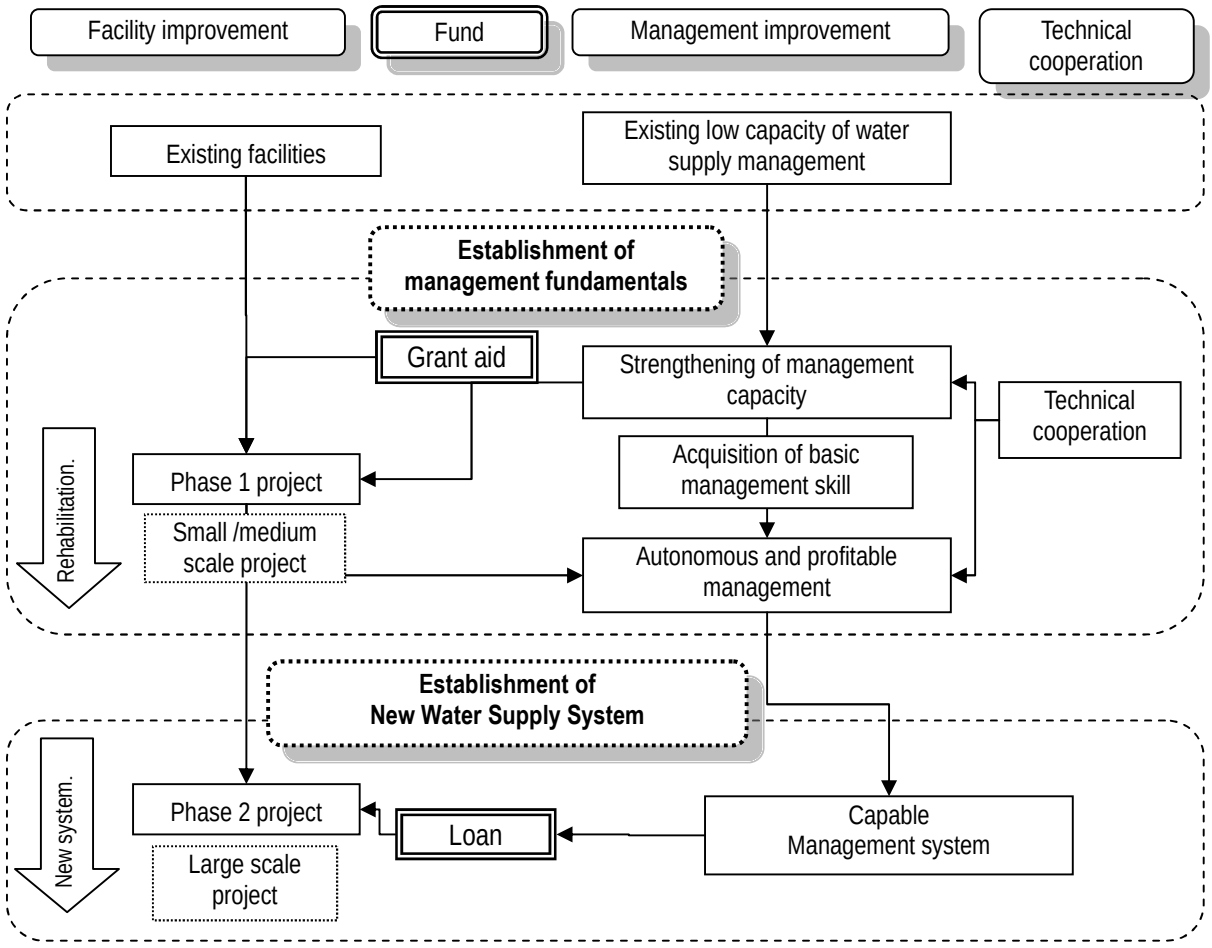


Figure 4.1 Implementation Strategy of Priority Project

4.1.2 Concept of Implementation Schedule

The basic concept of project implementation schedule for the priority project is explained in Table 4.1 and the water supply schemes in the phase 1 and 2 are shown in Figure 4.2. Furthermore, the phase 1 is divided into following three packages to facilitate funding and accelerate the implementation of the project.

Package-A: Development of trunk facilities including the expansion of the exiting WTP

Package-B: Development of distribution network in the center of Juba mainly composed of residential area

Package-C: Development of distribution network in mainly non-residential area and the residential area of Kator in the outskirts of the existing urban center.

In the phase 1, installation of distribution tertiary and house connection is limited within the current organized plot area, as pipeline is not installed in non-organized plot area, where the road network is not fixed and may be modified in future. Public tap stands should be constructed in these

non-organized plot areas along proposed distribution main and sub-main, and the residents in these areas can obtain water from these public tap stands.

Table 4.1 Concept of Implementation of Priority Project

Phase	Concept	Facility	Total production
1	This phase is an emergency improvement phase, in which a project is implemented to give larger benefits with small investment. This phase includes expansion of exiting WTP and replacement of existing distribution network aiming to distribute limited water effectively and equitably to users through improved network in the existing urban center including the residential area of Juba Town and Kator and governmental and commercial area.	Package-A ・ Expansion of the existing WTP by 7,000 m^3/d ・ North Low service reservoir ・ Transmission pump station ・ Transmission pipeline from the existing WTP to North Low SR Package-B ・ Distribution main & sub-main (22.7km) ・ Distribution tertiary (73.6km) Package-C ・ Distribution main & sub-main (13.0km) ・ Distribution tertiary (66.5km)	14,000 m^3/d
2	This phase is an initiation of construction of the new water supply system of the M/P. The project aims to increase water treatment capacity drastically and mainly to supply water to the existing urban area with adequate amount of water.	・ Stage-1 of West WTP ・ North High Service Reservoir ・ Transmission pipelines from West WTP to North Low SR / from North Low SR to North High SR ・ Expansion of distribution main and network to realize targeted water supply service coverage	77,000 m^3/d

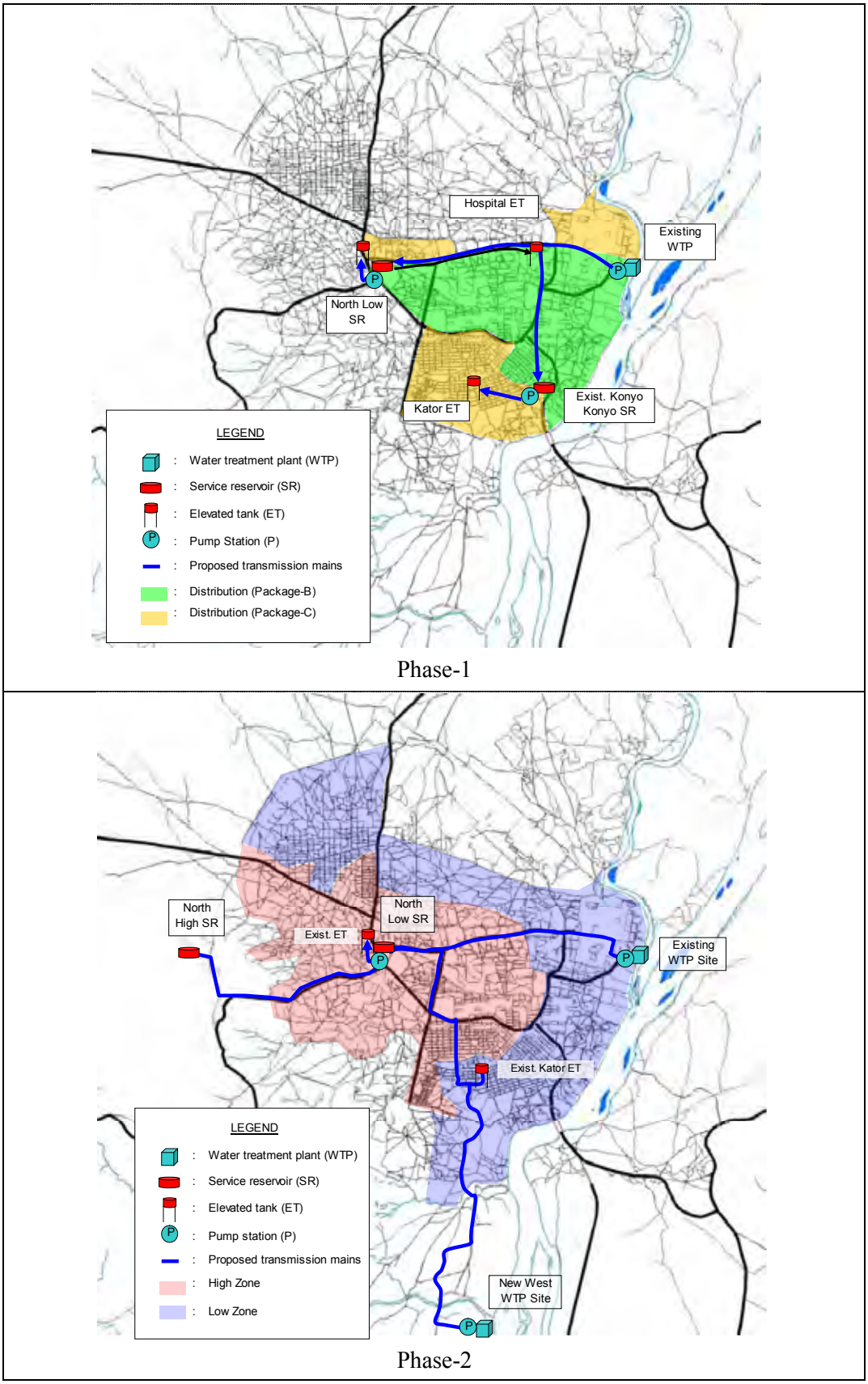


Figure 4.2 Trunk Facilities and Service Coverage of Priority Project by Phase

4.1.3 Water Supply Scheme during Transitional Period between Phase 1 and 2

In the target year of the priority project in 2015, treated water will be separately distributed in high zone and low zone at appropriate distribution pressure. However, this new water supply scheme cannot be achieved before the completion of the phase 2 project. During the transitional period between the phase 1 and 2, the water supply system will be operated in following schemes separating 3 distribution zones and utilizing the existing facilities at maximum. The concept of the water supply scheme in the transitional period is shown in Figure 4.3.

- Supply to Juba high zone

  Treated water will be distributed from the existing elevated tank near the Parliament as its height is appropriate to distribute water in this zone.

- Supply to Juba low zone

  In the Juba low zone, the height of the existing elevated tank near the Parliament is too high and unnecessary high distribution pressure result in high leakage and increase of water wastage in customer taps.

  Therefore, treated water is transmitted from the elevated tank near the Parliament through existing pipe (dis. 300 mm) to the existing elevated tank in the hospital, from where the water is distributed to this zone.

- Kator zone

  In this zone, a pump station in the exiting Konyo Konyo service reservoir, transmission pipeline from the Konyo Konyo service reservoir to Kator elevated tank, and distribution pipeline are currently being constructed by USAID fund.

  Treated water is transmitted from the elevated tank in the hospital to the existing Kator elevated tank through the Konyo Konyo pump station, from where the water will be distributed to this zone.

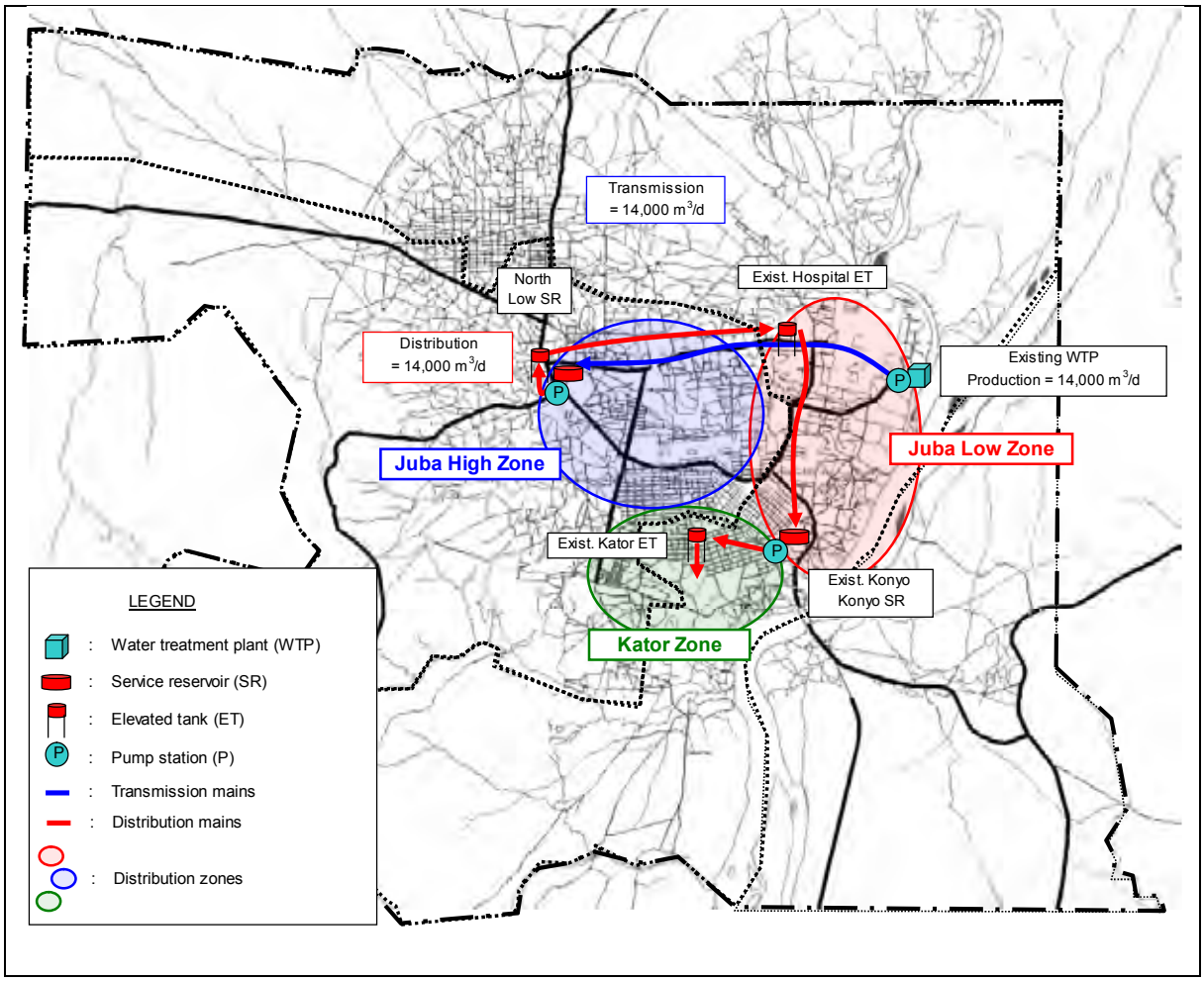


Figure 4.3 Water Supply Scheme in Transitional Period between Phase 1 and 2

4.2 Cost Estimation

4.2.1 Conditions of Cost Estimation

The project capital cost of the priority project is estimated based on the basic conditions summarized in Table 4.2, which are the same conditions as in case of the Master Plan. The quantity of the facilities for priority project are estimated in more detail than the Master Plan to give more accurate cost estimation. The estimated costs for the Master Plan are also replaced by the estimated costs for the priority project.

Table 4.2 Conditions of Cost Estimation

Item	Conditions
1) Price level	・ As of February 2009.
2) Foreign exchange rate	・ 1.0 US Dollar = 2.21 Sudanese Pound (SDG) = 98.33 Japanese Yen
3) Administration cost	・ Project administration cost of the Southern Sudan side is 2 percent of the construction cost.
4) Engineering cost	・ 10 percent of the construction cost.
5) Physical contingency	・ 10 percent of the total cost of construction, administration and engineering costs.
6) Price contingency/ escalation	・ Price contingency is 7.0 percent per year for local currency portion and 4.1 percent for foreign currency portion.

4.2.2 Implementation Schedule of Construction

The same implementation schedule as presented in the Master Plan until target year of 2015 is used for the priority project with packaging (Table 4.3).

Table 4.3 Construction Schedule of Priority Project

	2010	2011	2012	2013	2014	2015
Phase-1 (Package-A)						
Phase-1 (Package-B)						
Phase-1 (Package-C)						
Phase-2						

4.2.3 Estimation of Project Capital Cost

The project capital cost for the priority project is estimated and summarized in Table 4.4.

Table 4.4 Capital Cost Estimation of Priority Project

(thousand USD)

No.	Item	Local currency	Foreign currency	Total
1.	Construction cost			
1.1	Water treatment plant	7,167	31,734	38,901
(a)	Expansion of existing WTP	748	1,979	2,727
(b)	West WTP	6,419	26,944	33,363
1.2	Transmission pipeline	1,944	18,770	20,714
1.3	Transmission pump station	242	2,416	2,658
1.4	Distribution main facilities	1,445	5,304	6,749
(a)	North Low facilities	763	2,948	3,711
(b)	North High facilities	682	2,356	3,038
1.5	Distribution main & sub-main	6,644	31,470	38,114
(a)	High Zone	3,312	14,306	17,618
(b)	Low Zone	3,332	17,164	20,496
1.6	Distribution Network	2,634	11,762	14,396
(a)	High zone	882	3,939	4,821
(b)	Low zone	1,752	7,823	9,575
(c)	Kiosk/Tanker station	3,000	0	3,000
	Sub-total	23,076	101,456	124,532
2.	Administration cost	462	2,029	2,491
3.	Engineering cost	2,308	10,146	12,454
4.	Physical contingency	2,585	11,363	13,948
5.	Price contingency	9,209	22,145	31,354
	Sub-total	14,564	45,683	60,247
	Total	37,640	147,139	184,779

The percentages of components of the estimated construction cost and the estimated capital cost are analyzed as shown in Figure 4.4 and Figure 4.5, respectively. The distribution system including service reservoirs and distribution network constitute 50% of the total constriction cost, followed by the construction cost of water treatment plants (31%) and the transmission system including transmission pipeline and pump station (19%). The direct and indirect construction costs are 67 % and 33 % of the total capital cost, respectively.

The capital cost by construction phase and package of the priority project is estimated as shown in Table 4.5 and the disbursement schedule based on the implementation schedule is prepared as shown in Table 4.6.

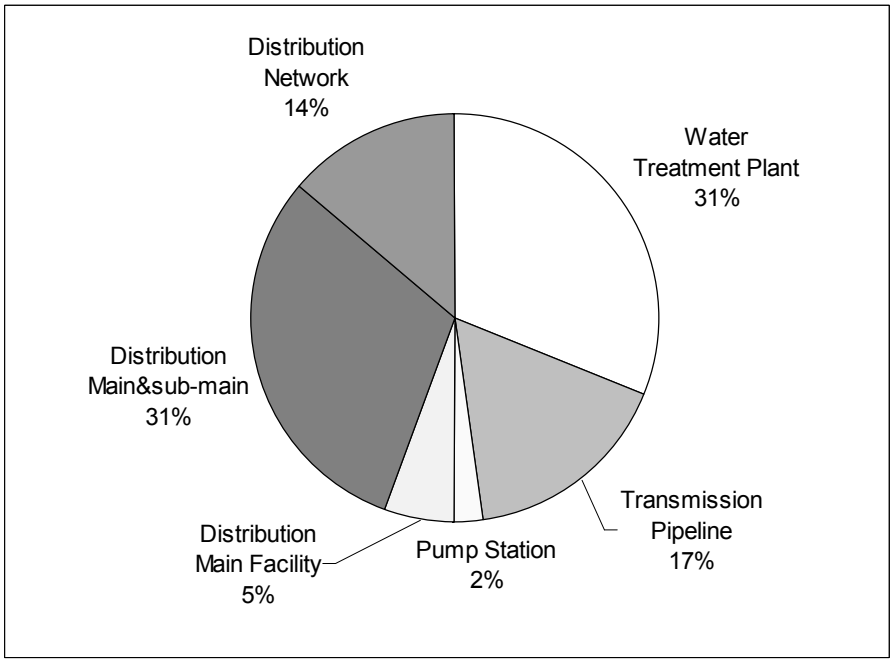


Figure 4.4 Percentage of Categories of Estimated Construction Cost

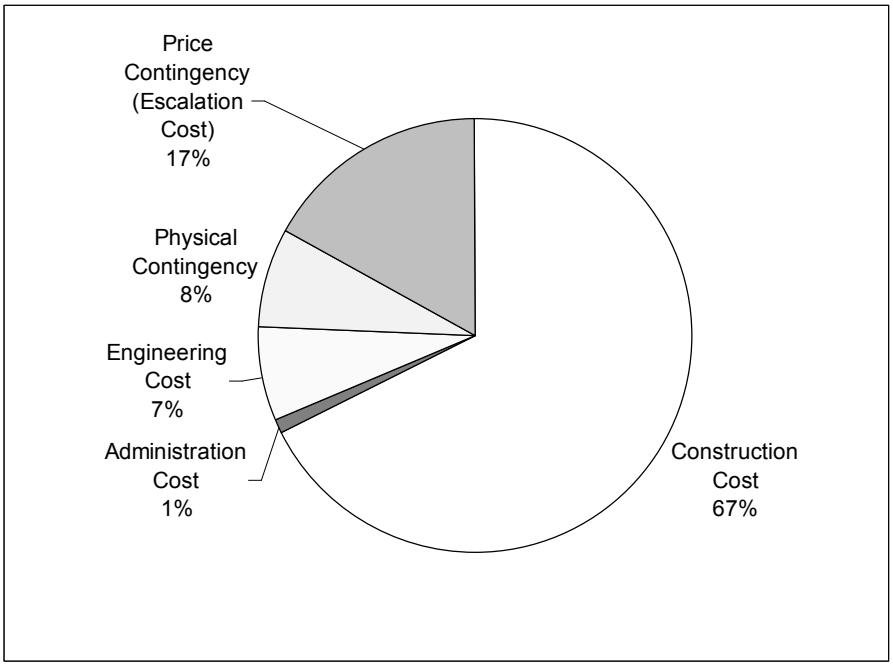


Figure 4.5 Percentage of Components of the Estimated Project Capital Cost

Table 4.5 Estimated Capital Cost by Construction Stage of Priority Project

(thousand USD)

No.	Local currency	Foreign currency	Total
Phase - 1 (Package-A)	2,549	15,183	17,732
Phase - 1 (Package-B)	2,844	10,666	13,510
Phase - 1 (Package-C)	1,920	7,196	9,116
Total of Phase - 1	7,313	33,045	40,358
Phase - 2	30,327	114,094	144,421
Total	**37,640**	**147,139**	**184,779**

Table 4.6 Disbursement Schedule of the Priority Project

(million USD)

Item	Currency	2010	2011	2012	2013	2014	2015	Total
Direct Construction Cost	Local	0.0	2.5	2.5	6.0	6.0	6.0	23.1
	Foreign	0.0	12.2	12.2	25.7	25.7	25.7	101.5
	Sub-total	0.0	14.8	14.8	31.7	31.7	31.7	124.5
Indirect Construction Cost	Local	0.0	1.0	1.2	3.5	4.1	4.8	14.6
	Foreign	0.0	4.0	4.6	11.0	12.3	13.8	45.7
	Sub-total	0.0	5.0	5.8	14.4	16.4	18.5	60.2
Total	Local	0.0	3.5	3.8	9.5	10.1	10.8	37.6
	Foreign	0.0	16.2	16.8	36.6	38.0	39.5	147.1
	Total	0.0	19.8	20.6	46.1	48.1	50.2	184.8

4.2.4 Operation and Maintenance and Capacity Development Cost

The operation and maintenance cost required for operating facilities after implementation of the priority project is estimated based on the same condition as in case of the Master Plan. The estimated operation and maintenance cost up to 2025 is summarized in Table 4.7 and the percentage of the items in 2015 is analyzed as shown in Figure 4.6.

Table 4.7 Annual Operation and Maintenance Cost

Year	Annual revenue water (m^3/year)	O&M Cost (thousand USD/year)							O&M cost per revenue water (USD/m^3)
		Personnel	Electricity	Chemical	Spare parts	Staff training	Others	Total	
2009	851,667	0.0 (0%)	165.7 (30%)	86.0 (16%)	158.5 (29%)	0.0 (0%)	135.1 (25%)	545.3	0.64 (SDG1.41)
2012	2,044,000	630.4 (40%)	463.0 (29%)	172.0 (11%)	106.5 (7%)	63.0 (4%)	143.5 (9%)	1,578.5	0.77 (SDG1.70)
2015	13,115,667	1,899.0 (28%)	2,696.6 (40%)	946.1 (14%)	421.5 (6%)	189.9 (3%)	615.3 (9%)	6,768.3	0.52 (SDG1.15)
2020	14,989,333	1,876.0 (28%)	2,696.6 (40%)	946.1 (14%)	421.5 (6%)	187.6 (3%)	612.8 (9%)	6,740.6	0.45 (SDG0.99)
2025	16,863,000	1,985.1 (29%)	2,696.6 (39%)	946.1 (14%)	421.5 (6%)	198.5 (3%)	624.8 (9%)	6,872.5	0.41 (SDG0.91)

(Price level of March 2009)

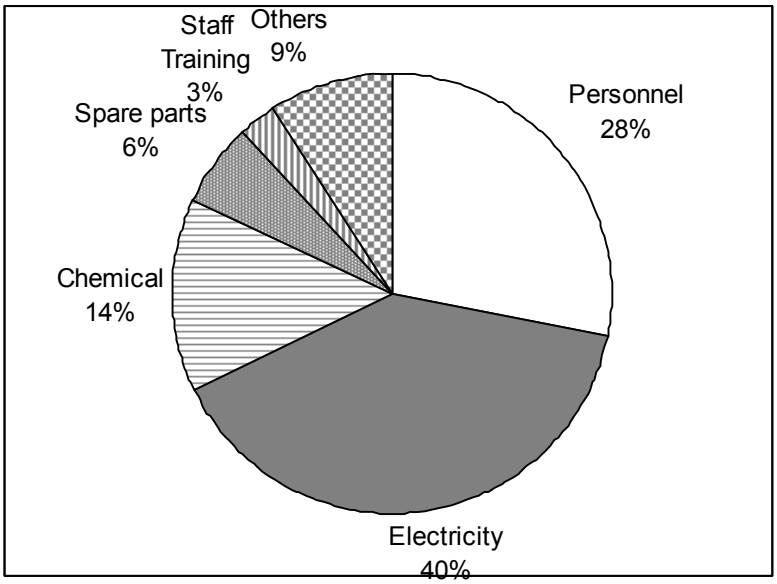


Figure 4.6 Percentage of Items of the Estimated Operation and Maintenance Cost in 2015

4.2.5 Disbursement and Repayment Schedule

Based on the annual fund requirement as presented in the previous section, fund inflow is prepared, assuming the same conditions as in case of Scenario 2 in the Master Plan. These conditions are: fund source of Phase 1 is grant aid and that of Phase 2 is the loan from ADF (African Development Fund). Based on these assumptions, a repayment schedule is prepared and presented in Table 4.9.

Table 4.8 Fund Disbursement for Priority Project

Year	Foreign currency	Local currency	Total	Fund source
2011	19,466	296	19,762	Grant
2012	20,302	296	20,598	Grant
2013	45,473	633	46,106	ADF Loan
2014	47,472	633	48,105	ADF Loan
2015	**49,573**	**633**	**50,206**	**ADF Loan**
Total	39,768	592	40,360	Grant
	142,518	1,899	144,417	Loan
	182,286	2,491	184,777	Fund Total

Table 4.9 Funds Flow and Repayment Schedule (Scenario-2: Grant + ADF Loan)

(x1000 USD)

	Fund Disbursement				Repayment of Foreign Portion		
					Loan		
	Foreign Portion	Local Portion	Total	Source	Principal	Charge & Commit.	Total
2011	19,466	296	19,762	Grant	0	0	0
2012	20,302	296	20,598	Grant	0	0	0
2013	45,473	633	46,106	Loan	0	826	826
2014	47,472	633	48,105	Loan	0	945	945
2015	**49,573**	**633**	**50,206**	**Loan**	**0**	**1,069**	**1,069**
2016	0	0	0		0	1,069	1,069
2017	0	0	0		0	1,069	1,069
2018	0	0	0		0	1,069	1,069
2019	0	0	0		0	1,069	1,069
2020	**0**	**0**	**0**		**0**	**1,069**	**1,069**
2021	0	0	0		0	1,069	1,069
2022	0	0	0		0	1,069	1,069
2023	0	0	0		4,751	1,069	5,820
2024	0	0	0		4,751	1,033	5,784
2025	**0**	**0**	**0**		**4,751**	**998**	**5,749**
2026	0	0	0		4,751	962	5,713
2027	0	0	0		4,751	926	5,677
2028	0	0	0		4,751	891	5,642
2029	0	0	0		4,751	855	5,606
2030	0	0	0		4,751	819	5,570
2031	0	0	0		4,751	784	5,535
2032	0	0	0		4,751	748	5,499
2033	0	0	0		4,751	713	5,464
2034	0	0	0		4,751	677	5,428
2035	0	0	0		4,751	641	5,392
2036	0	0	0		4,751	606	5,357
2037	0	0	0		4,751	570	5,321
2038	0	0	0		4,751	534	5,285
2039	0	0	0		4,751	499	5,250
2040	0	0	0		4,751	463	5,214
2041	0	0	0		4,751	428	5,179
2042	0	0	0		4,751	392	5,143
2043	0	0	0		4,751	356	5,107
2044	0	0	0		4,751	321	5,072
2045	0	0	0		4,751	285	5,036
2046	0	0	0		4,751	249	5,000
2047	0	0	0		4,751	214	4,965
2048	0	0	0		4,751	178	4,929
2049	0	0	0		4,751	142	4,893
2050	0	0	0		4,751	107	4,858
2051	0	0	0		4,751	71	4,822
2052	0	0	0		4,751	36	4,787
	39,768	592	40,360	Grant			
Total	142,518	1,899	144,417	Loan			
	182,286	2,491	184,777		142,530	26,890	169,420

CHAPTER 5 PROJECT EVALUATION

5.1 Water Tariff Settings and Financial Evaluation

5.1.1 Water Tariff Setting

The proposed water tariff for the priority project is set based on the tariff table presented in the Master Plan and is presented in Table 5.1.

Table 5.1 Proposed Water Tariff

Category	Type	Tariff	2012	2015	2020	2025
Domestic	House connection	Base rate per month	10.0	10.0	11.6	13.4
		Block rate per m^3 (< $15m^3$)	0.7	0.7	0.8	0.9
		Block rate per m^3 (15 - 30 m^3)	1.5	1.5	1.7	2.0
		Block rate per m^3 (> 30 m^3)	2.0	2.0	2.3	2.7
	Public tap and water tanker	Base rate per month	N/A	N/A	N/A	N/A
		Rate per m^3	0.7	0.7	0.8	0.7
Non-domestic	Commercial and industry	Base rate per month	30.0	30.0	34.8	40.3
		Block rate per m^3 (< 50 m^3)	3.7	3.7	4.3	5.0
		Block rate per m^3 (50 – 100 m^3)	4.5	4.5	5.2	6.0
		Block rate per m^3 (> 100 m^3)	5.2	5.2	6.0	7.0
	Institution	Base rate per month	30.0	30.0	34.8	40.3
		Block rate per m^3 (< 50 m^3)	2.2	2.2	2.6	3.0
		Block rate per m^3 (50 – 100 m^3)	3.0	3.0	3.5	4.0
		Block rate per m^3 (> 100 m^3)	3.7	3.7	4.3	5.0

(Note)
The tariff is assumed to increase at the annual growth rate of 3.0 per annum (real growth, at current price level) from year 2015 until 2025. From year 2025 onwards, water tariffs are assumed to remain same for calculation purposes.

5.1.2 Revenue Forecast

The revenue of the priority project is calculated by prorating the total revenue projected in the Master Plan according to the ratio of the treatment capacity of the priority project to the entire capacity in the Master Plan. The calculated revenue flow for the priority project is presented in Table 5.2.

Table 5.2 Revenue Forecast of Priority Project

(x1000 SDG/year)

	Master Plan				Priority project	
Year	Average daily water consumption (m3/day)	Total Revenue from water sales	Service revenue		Ratio of F/S system to total capacity	Prorated revenue of F/S facility (priority project)
2009	**3,923**	**1,162**	**0**		**100%**	**1,162**
2010	4,749	1,407	179		100%	1,586
2011	5,720	1,727	229		100%	1,956
2012	**6,750**	**2,767**	**3,263**		**100%**	**6,030**
2013	12,204	5,132	1,001		100%	6,133
2014	13,729	5,831	1,107		100%	6,937
2015	**43,608**	**25,603**	**1,228**		**100%**	**26,831**
2016	50,831	31,172	3,828		85%	26,340
2017	58,904	38,097	3,945		69%	26,287
2018	67,903	47,050	4,071		61%	28,544
2019	77,911	56,704	4,199		52%	29,675
2020	**89,033**	**67,566**	**4,338**		**44%**	**29,729**
2021	100,403	80,055	4,477		42%	33,303
2022	112,820	96,150	4,618		39%	37,691
2023	126,393	112,486	4,769		37%	41,395
2024	141,189	130,786	4,923		34%	44,991
2025	**157,238**	**151,026**	**5,087**		**32%**	**48,328**
2026	157,238	151,026	0		32%	48,328
～						
2040	157,238	151,026	0		32%	48,328

(Note) Ratio of F/S system to total capacity
Year 2017 : [F/S system: 77,000 m3/day] / [Total: 111,000 m3/day] = 69%
Year 2020 : [F/S system: 77,000 m3/day] / [Total: 174,000 m3/day] = 44%
Year 2025 : [F/S system: 77,000 m3/day] / [Total: 237,000 m3/day] = 32%
Service revenues after 2016 are not accounted in the revenue of the priority project.

5.1.3 Project Costs

(1) Investment Cost

The construction cost for the priority project is estimated in Chapter 4. The investment costs from 2011 to 2015 are given in Table 5.3.

(2) O&M Costs

O&M Costs are presented in Section 4.2.4.

5.1.4 Financial Evaluation

(1) Free Cash Flow Analysis (FIRR)

Given the above costs estimated, the free cash flow until year 2050 is presented in Table 5.3, in which the investment cost of the phase 1 is deducted from the cash flow since that portion would be financed under grant aid. The calculated FIRR resulted in reasonable IRR of 8.79%.

Table 5.3 Free Cash Flow of Priority Project

(in thousand USD)

Year	Cash In Flow	Cash Out Flow		Free Cash Flow
	Total Revenue	Investment	O&M	
2011	885	0	545	340
2012	2,729	0	1,578	1,151
2013	2,775	39,006	1,578	-37,809
2014	3,139	39,006	1,578	-37,445
2015	**12,141**	**39,006**	**6,768**	**-33,633**
2016	11,919	0	6,763	5,156
2017	11,895	0	6,757	5,138
2018	12,916	0	6,752	6,164
2019	13,428	0	6,746	6,682
2020	**13,452**	**0**	**6,741**	**6,711**
2021	15,069	0	6,767	8,302
2022	17,055	0	6,793	10,262
2023	18,731	0	6,820	11,911
2024	20,358	0	6,846	13,512
2025	**21,868**	**0**	**6,873**	**14,995**
2026	21,868	0	6,873	14,995
～				
2050	21,868	0	6,873	14,995
Total	725,060	117,018	251,730	356,312

FIRR	8.79%

(2) Profit & Loss Projection

The Profit and Loss Statement of the priority project until year 2050 is presented in Table 5.4. The result shows that break-even point is estimated year 2019, which is a little late mainly due to early start of depreciation. Although operating ratio, the ratio of O&M plus depreciation costs to revenue, will exceeds 100% during 2013-2018, entire O&M costs and a part of depreciation will be covered throughout the period. After 2019, when the project profit will become surplus, the profit performance will be favorable owing to sufficient revenue to be generated by increased tariff and higher revenue collection ratio.

Table 5.4 Profit & Loss Statement

(in thousand USD)

Year	Total Revenue	O&M	Depreciation	Interest	Profit & Loss	Operating Ratio
2011	885	545	222	0	118	87%
2012	2,729	1,578	222	0	929	66%
2013	2,775	1,578	1,404	826	-1,033	107%
2014	3,139	1,578	1,404	945	-788	95%
2015	**12,141**	**6,768**	**1,404**	**1,069**	**2,900**	**67%**
2016	11,919	6,763	5,203	1,069	-1,116	100%
2017	11,895	6,757	5,203	1,069	-1,134	101%
2018	12,916	6,752	5,203	1,069	-108	93%
2019	13,428	6,746	5,203	1,069	410	89%
2020	**13,452**	**6,741**	**5,203**	**1,069**	**439**	**89%**
2021	15,069	6,767	5,203	1,069	2,030	79%
2022	17,055	6,793	5,203	1,069	3,990	70%
2023	18,731	6,820	5,203	1,069	5,639	64%
2024	20,358	6,846	5,203	1,033	7,276	59%
2025	**21,868**	**6,873**	**5,203**	**998**	**8,794**	**55%**
2026	21,868	6,873	5,203	962	8,830	55%
2027	21,868	6,873	5,203	926	8,866	55%
2028	21,868	6,873	5,203	891	8,901	55%
2029	21,868	6,873	5,203	855	8,937	55%
2030	21,868	6,873	5,203	819	8,973	55%
2031	21,868	6,873	5,203	784	9,008	55%
2032	21,868	6,873	5,203	748	9,044	55%
2033	21,868	6,873	5,203	713	9,079	55%
2034	21,868	6,873	5,203	677	9,115	55%
2035	21,868	6,873	4,981	641	9,373	54%
2036	21,868	6,873	4,981	606	9,408	54%
2037	21,868	6,873	4,981	570	9,444	54%
2038	21,868	6,873	3,799	534	10,662	49%
2039	21,868	6,873	3,799	499	10,697	49%
2040	21,868	6,873	3,799	463	10,733	49%
2041	21,868	6,873	0	428	14,567	31%
2042	21,868	6,873	0	392	14,603	31%
2043	21,868	6,873	0	356	14,639	31%
2044	21,868	6,873	0	321	14,674	31%
2045	21,868	6,873	0	285	14,710	31%
2046	21,868	6,873	0	249	14,746	31%
2047	21,868	6,873	0	214	14,781	31%
2048	21,868	6,873	0	178	14,817	31%
2049	21,868	6,873	0	142	14,853	31%
2050	21,868	6,873	0	107	14,888	31%

(Note) Depreciation is assumed by straight line method with lifetime 25 years for all construction cost.
- Existing facility: Referred to construction cost of expansion of WTP planned in phase-1 USD 5,538,000 / 25 years = USD 221,520 (2010-2035)
- Facility of phase-1: USD 29,550,000 / 25 years = USD 1,182,000 (2013-2037)
- Facility of phase-2: USD 94,983,000 / 25 years = USD 3,799,320 (2016-2040)

(3) Fund Application and Source Projection

Applications and sources of funds until year 2050 is projected in Table 5.5, on assumption that reinvestment will be done after 30 years using the same fund resource. Overall, the table implies smooth cash flows throughout the project period. And re-investment after 2041 could be financed under the retained financial profits without external funds.

Table 5.5 Applications and Sources of Funds Projection

(in thousand USD)

Year	Application				Source			Net cash position
	O&M	Investment	Interest	Loan repayment	Cash Position form the previous year	Water Revenue	Grant and Loan Advance	
2011	545	18,203	0	0	0	885	153,424	135,561
2012	1,578	18,203	0	0	135,561	2,729		118,509
2013	1,578	39,006	826	826	118,509	2,775		79,048
2014	1,578	39,006	945	945	79,048	3,139		39,713
2015	**6,768**	**39,006**	**1,069**	**1,069**	39,713	**12,141**		**3,942**
2016	6,763	0	1,069	1,069	3,942	11,919		6,960
2017	6,757	0	1,069	1,069	6,960	11,895		9,960
2018	6,752	0	1,069	1,069	9,960	12,916		13,986
2019	6,746	0	1,069	1,069	13,986	13,428		18,530
2020	**6,741**	**0**	**1,069**	**1,069**	18,530	**13,452**		**23,103**
2021	6,767	0	1,069	1,069	23,103	15,069		29,267
2022	6,793	0	1,069	1,069	29,267	17,055		37,391
2023	6,820	0	1,069	5,820	37,391	18,731		42,413
2024	6,846	0	1,033	5,784	42,413	20,358		49,108
2025	**6,873**	**0**	**998**	**5,749**	49,108	**21,868**		**57,356**
2026	6,873	0	962	5,713	57,356	21,868		65,676
2027	6,873	0	926	5,677	65,676	21,868		74,068
2028	6,873	0	891	5,642	74,068	21,868		82,530
2029	6,873	0	855	5,606	82,530	21,868		91,064
2030	6,873	0	819	5,570	91,064	21,868		99,670
2031	6,873	0	784	5,535	99,670	21,868		108,346
2032	6,873	0	748	5,499	108,346	21,868		117,094
2033	6,873	0	713	5,464	117,094	21,868		125,912
2034	6,873	0	677	5,428	125,912	21,868		134,802
2035	6,873	0	641	5,392	134,802	21,868		143,764
2036	6,873	0	606	5,357	143,764	21,868		152,796
2037	6,873	0	570	5,321	152,796	21,868		161,900
2038	6,873	0	534	5,285	161,900	21,868		171,076
2039	6,873	0	499	5,250	171,076	21,868		180,322
2040	6,873	0	463	5,214	180,322	21,868		189,640
2041	6,873	18,203	428	5,179	189,640	21,868		180,825
2042	6,873	18,203	392	5,143	180,825	21,868		172,082
2043	6,873	39,006	1,182	5,933	172,082	21,868		140,956
2044	6,873	39,006	1,266	6,017	140,956	21,868		109,662
2045	6,873	39,006	1,354	6,105	109,662	21,868		78,192
2046	6,873	0	1,318	6,069	78,192	21,868		85,800
2047	6,873	0	1,283	6,034	85,800	21,868		93,478
2048	6,873	0	1,247	5,998	93,478	21,868		101,228
2049	6,873	0	1,211	5,962	101,228	21,868		109,050
2050	6,873	0	1,176	5,927	109,050	21,868		116,942

(4) Sensitivity Analysis

As the biggest influential factor, water tariff is selected for sensitivity analysis. FIRR has been calculated with variable water tariff by changing ratio to the proposed water tariff, as shown in Table below.

The average water charge and ratio of the water charge to monthly expenditure is also presented in the Table, as the normal case of middle income class household with house connection.

Table 5.6 Sensitivity Analysis

Item	Multipliers of water tariff							
	x 0.6	x 0.8	x 1.0 (Base)	x 1.2	x 1.4	x 1.6	x 1.8	x 2.0
FIRR (%)	2.17	5.80	8.79	11.51	14.13	16.72	19.35	22.05
Average water charge of typical case (SDG/month)	17.7	23.6	29.5	35.4	41.3	47.2	53.1	59.0
Ratio of water charge to monthly expenditure (%)	1.5	2.0	2.5	3.0	3.4	3.9	4.4	4.9

Notes:
1) Multiplier factor: Ratio of water tariff varied in analysis to the proposed water tariff
2) Average water charge: As the typical case, average family size is assumed to be 7.8 persons. Daily water consumption is to be 90 L/c/d in 2015. And service level is house connection.
3) Ratio of water charge: 1200 SDG is assumed as the average monthly expenditure of middle income class household, according to socio-economic survey result.

(5) Conclusions

The proposed priority project resulted in reasonable FIRR of 8.79 %, owing to assumption of deducting investment cost of phase 1 which would be financed under grant aid. The repayment of the loan principal and interest can be covered by the anticipated free cash flows. The suggested water tariff table would be accepted from the viewpoint of affordability. Therefore, from the results of financial analysis, the priority project is viable.

5.2 Project Benefits and Economic Evaluation

5.2.1 Introduction

Economic analysis is carried out by calculating economic internal rate of returns (EIRR) of the project based on the economic project costs and economic benefits [or willingness to pay/willingness to accept the compensation].

The economic net benefits from the project will reflect the summation of the changes in the net income of the society as a whole, resulting from the situation with the project compared to that without the project. Therefore, the net economic benefits and costs are estimated as the economic benefits and costs with the project minus those without the project. In general, it is recognized by international financial institutions that the project is judged feasible if EIRR of the project is more than about 10 %.

5.2.2 Economic Benefits

To estimate economic benefits, the willingness to pay (WtoP), which was obtained by the socio-economic survey, is used. The net economic benefit is estimated as the deduction of the WtoP for the current water supply service from the WtoP for the improved service. The beneficial population is estimated using the service population with treated water as projected in the priority project. The following table summarizes these economic benefits.

Table 5.7 Indicators Used for Quantitative Economic Analysis

Indicator	Value	Source
Average family size	7.8 persons per household	Socio-economic survey
Average WtoP for the current water supply	80 SDG/household/month	Socio-economic survey
	13.6 SDG/m^3 = [Monthly WtoP per household: 80 SDG] / [Current consumption: 26 L/c/d x 7.8 persons/hh x 30 days/month]	Assumption/ calculation
Average WtoP for improved water supply (at current service level; e.g. public tap and tanker)	110 SDG/household/month	Socio-economic survey
Average WtoP for 24 hours water supply	134 SDG/household/month	Socio-economic survey
	4.8 - 22.0 SDG/m^3 = [Monthly WtoP per household: 134 SDG] / [Projected consumption: 26 - 120 L/c/d x 7.8 persons/hh x 30 days/month]	Assumption/ calculation

The summary of economic benefits is presented in Table 5.8 and the detailed calculation is attached in Appendix-M.

Table 5.8 Summary of Economic Benefits

(x1000 SDG/year)

Year	House Connection	Public Tap	Water Tanker	Non-domestic	Total
2011	0	0	0	3,178	3,178
2012	10,609	1,537	0	13,115	25,261
2013	12,171	1,643	1,371	16,627	31,812
2014	13,899	1,759	1,468	19,573	36,698
2015	**15,818**	**6,904**	**9,415**	**31,769**	**63,907**
2016	15,818	6,904	9,415	35,850	67,988
2017	15,818	6,904	9,415	40,015	72,153
2018	15,818	6,904	9,415	44,234	76,372
2019	15,818	6,904	9,415	48,479	80,616
2020	**15,818**	**6,904**	**9,415**	**53,829**	**85,966**
2021	15,818	6,904	9,415	57,544	89,681
2022	15,818	6,904	9,415	62,438	94,576
2023	15,818	6,904	9,415	65,950	98,087
2024	15,818	6,904	9,415	70,834	102,972
2025	**15,818**	**6,904**	**9,415**	**75,703**	**107,841**
2026 ~ 2040	15,818	6,904	9,415	75,703	107,841

5.2.3 Economic Cost

To convert the project cost into the economic cost, all distorted factors in the costs shall be removed. The prices of goods and services are distorted by many factors such as government regulations and these distorted prices shall be converted into economic price. In the Study, physical and price contingencies are excluded in analysis.

5.2.4 Results of Economic Evaluation

The results of economic evaluation are summarized in Table 5.9. The calculation resulted in EIRR of 24.71%.

Table 5.9 Economic Cost – Benefit Analysis

(in thousand USD)

Year	Economic Benefit	Economic Cost		Cash Flow
		Investment (Base cost)	O&M	
2011	1,438	16,548	545	-15,655
2012	11,430	16,548	1,578	-6,696
2013	14,395	35,460	1,578	-22,643
2014	16,605	35,460	1,578	-20,433
2015	**28,917**	**35,460**	**6,768**	**-13,311**
2016	30,764	0	6,763	24,001
2017	32,648	0	6,757	25,891
2018	34,557	0	6,752	27,805
2019	36,478	0	6,746	29,732
2020	**38,899**	**0**	**6,741**	**32,158**
2021	40,580	0	6,767	33,813
2022	42,794	0	6,793	36,001
2023	44,383	0	6,820	37,563
2024	46,594	0	6,846	39,748
2025	**48,797**	**0**	**6,873**	**41,924**
～				
2050	48,797	0	6,873	41,924
Total	1,689,204	139,476	251,730	1,297,998

EIRR	24.71%

5.2.5 Conclusions

The calculated EIRR resulted in sufficient value of 24.7 %, owing to considerably high WtoP for improved water supply services. Hence, from the national economic perspectives, the viability of the priority project is quite high.

CHAPTER 6 PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Project Components for Pre-EIA

A result of preliminary environmental impact assessment (Pre-EIA) on the priority project is described in this chapter. The evaluation is made based on baseline surveys and impact analysis, and a environmental management and monitoring plan are prepared. The legislations on environmental and social considerations are compiled in the Master Plan and its appendix.

In the Master Plan, the impacts of the Master Plan projects are forecasted mainly qualitatively. In the Pre-EIA of the feasibility study, the impacts on the priority project are defined, analyzed and forecasted as quantitatively as possible and their mitigation measures and monitoring plans are prepared.

Proposed major facilities of the priority project and their related activities are summarized in the following table and figure.

Table 6.1 Components for Priority Projects

Facility/Location	Area (ha)	WTP	SR	PUMP	Major activities
1. Expansion Existing WTP in UWC compound (Juba Payam)	-	●		●	・ Expansion of existing WTP including pump, sedimentation tank, chlorine dosing house, rapid sand filter, clear water reservoir and pump station. ・ Operation and maintenance of the plant
2. North Low SR in the Memorial Ground near parliament (Juba Payam)	1.7		●	●	・ Construction of a service reservoir and a pump station including generator ・ Operation and maintenance of pumping stations
3. North High SR in North of Jebel Körök (Northern Bari)	0.7		●		・ Construction of a service reservoir ・ Operation and maintenance of facilities
4. West WTP in Tokiman area after crossing the Khor Ramla River (Rejaf Payam)	4.1	●		●	・ Construction of a new water treatment plant including intake at the river side, receiving well, sedimentation basin, rapid sand filter, backwashing tank, washing drain basin, clear reservoir and pump station including generator ・ Operation and maintenance of the plant
5. Transmission and distribution network	-	-	-	-	・ Installation of pipelines ・ Maintenance of network

Note) WTP: Water treatment plant, SR: Service reservoir, Pump: Pumping station

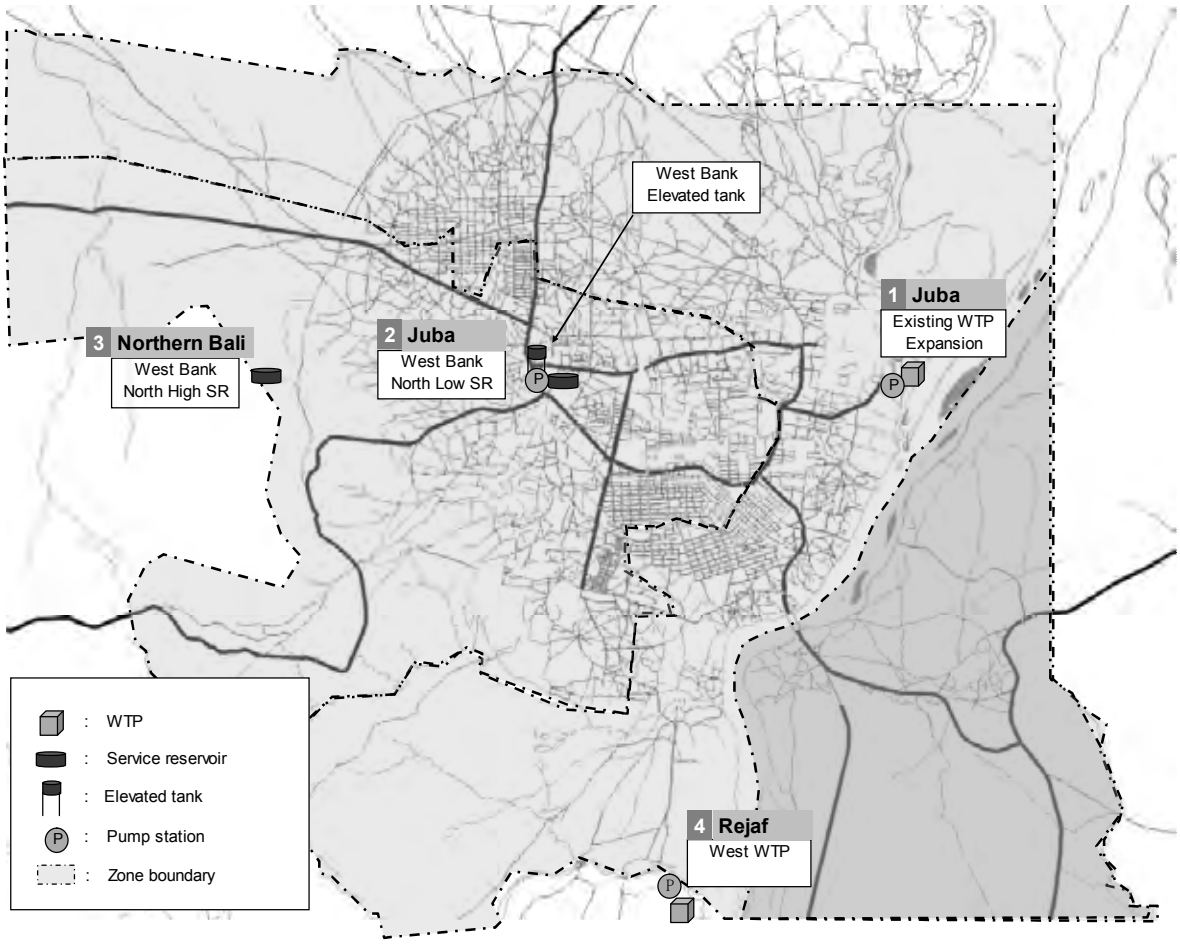


Figure 6.1 Location Map of Priority Project Sites

6.2 Scoping Matrix for Priority Project

The degree of negative impacts of the priority project by impact item and impact factor by stage is preliminarily assessed in the scoping matrix and the result is given in Table 6.2, in which only the items for which impact is recognized are taken from an original complete scoping matrix. Impacts on these items are further assessed. Major likely impacts are described in Table 6.3. The methodologies of the baseline surveys and impact forecast are described in Table 6.4.

Table 6.2 Result of Scoping for Priority Project by Matrix

Impact Items			Impact factors by stage																
				Planning stage		Construction stage								Post construction stage				
		Likely impacts	**Overall Rating**	Land acquisition/compensation	Change of land use plan, control of various activities by regulations for the construction	Reclamation of wetland, etc.	Deforestation/land clearance	Alteration to ground by cut land, filling, etc.	Operation of construction equipment and vehicles	Construction of facilities	Traffic restriction in construction area	Influx of construction workers, construction of base camp	Removal of old pipelines	Increase of water supply	Increase of discharged water	Appearance/ occupancy of facility and related building structures	Operation of facilities	Operation of water tankers
Social	No. (1)	Resettlement (or Loss of Properties)	**B+**	B			B											
	(2)	Land use and utilization of local resources	**B**	B			B											
	(3)	Sanitation	**B+**												B			
	(4)	Hazards (Risks) Infectious diseases such as HIV/AIDS	**B**									B	B	B	B			
	(5)	Accidents	**B**						B									B
Natural	(6)	Flora, Fauna and Biodiversity	**B-**				B											
Pollution	(7)	Air Pollution (dust)	**B-**					B	B									B
	(8)	Water Pollution	**B+**					B							B			
	(9)	Noise and Vibration	**B-**					B	B	B							B	B
	(10)	Bottom sediments	**B-**												B			

Rating: A: Serious adverse impacts are expected. B: Some adverse impacts are expected. No Mark: Little impacts are expected. EIA is not necessary.

Table 6.3 Major Impacts of Priority Project

Impact Items			Overall Rating	Major Impacts
Social	(1)	Resettlement (or loss of properties)	**B+**	Construction sites for a new water treatment plant, service reservoirs, pumping stations and pipelines may cause resettlement and loss of properties.
	(2)	Land use and utilization of local resources	**B**	Land clearance for construction of facilities may cause losses in farming lands, crops and forests, in particular mango trees, to which higher values are given by the local inhabitants.
	(3)	Sanitation	**B+**	Increased supply of treated water will increase wastewater discharged, and may cause negative impact on the water environment without a proper sewerage system.
	(4)	Hazards (risks) Infectious diseases	**B**	Most construction workers will be hired in Juba and the surrounding villages, while other technicians will be hired from the outside areas or countries. The risk of infection of sexually transmitted diseases (STDs) such as HIV/AIDS may be increased among these workers through increased sexual relations in the area. Additionally, discharged water will also increase the amount of puddles surrounding the residential areas and provide a habitat of malaria-carrying mosquitoes during dry seasons.
	(5)	Accidents	**B**	Completion of the proposed water supply priority project may increase the risk of traffic accidents due to the operation of many water tankers.
Natural	(6)	Flora, fauna and biodiversity	**B**	Land clearance by construction of facilities may have an impact on ecotones and habitats in the new WTP sites.
Pollution	(7)	Air pollution (dust)	**B**	The operation of construction machines and other equipments will increase diffusion of dust in the surrounding area during construction.
	(8)	Water pollution	**B+**	Discharged wastewater due to increase of water supply may affect the water quality of Bahr el-Jebel without sewerage system. In addition, sludge discharged from the water treatment plants to the river may affect the river water quality or loss of beauty of the Bahr el-Jebel.
	(9)	Noise and vibration	**B**	Construction machines will cause noise and vibration during construction. The operation of water supply facilities such as pump stations with generators will cause noise and vibration at the post construction stage.
	(10)	Bottom sediments	**B**	Sludge from the new water treatment plant will be disposed into Bahr el-Jebel and may increase bottom sediments.

Table 6.4 Methodologies of the Baseline Survey and Impact Forecast for Pre-EIA

Impact items			Methodology of baseline survey	Methodology of impact forecast
Social	(1)	Resettlement or loss of properties	Confirmation of existing buildings, farm lands, and properties based on a site survey and recent satellite images taken in March, 2009.	Identification of affected buildings and properties such as mango trees and farmlands based on the facility plan and baseline survey.
	(2)	Land use and utilization of local resources	Confirmation of existing local resources such as forests, fountains and wells based on a site survey and recent satellite images.	Identification of affected local resources based on the facility plan and baseline survey.
	(3)	Sanitation	Confirmation of current situation of discharged water in the streams in the center of the city.	Estimation of the volume of discharged wastewater from the water users at the post construction stage of water treatment plants.
	(4)	Hazards (risks) Infectious diseases	Confirmation of current infection rate in Juba.	Qualitative forecast based on the construction plan.
	(5)	Accidents	Confirmation of the current number of cases in Juba.	Qualitative forecast based on the construction plan.
Natural	(6)	Flora, fauna and biodiversity	Current categorization of vegetation types based on recent satellite images.	Quantitative forecast of area lost due to land clearance based on the construction plan.
Pollution	(7)	Air pollution (dust)	Baseline survey was not carried out due to lack of data.	Qualitative forecast based on the construction plan.
	(8)	Water pollution	The water quality of the Bahr el-Jebel was tested.	Quantitative forecast of increased sludge discharge from water treatment plants to the Bahr el-Jebel based on the facility plan. Estimation of the volume of discharged wastewater from the water users at the post construction stage of water treatment plants based on the facility plan.
	(9)	Noise and vibration	Baseline survey is carried out by a sound level meter at planning areas and roadsides.	Estimation of noise level by "ASJ Model 1998" based on the facility plan.
	(10)	Bottom sediments	Baseline survey is not carried out due to nonexistent data.	Qualitative forecast based on the construction plan.

6.3 Results of Baseline Survey and Impact Forecast

The results of the baseline survey and impact forecast are described in this section.

(1) Resettlement or Loss of Properties

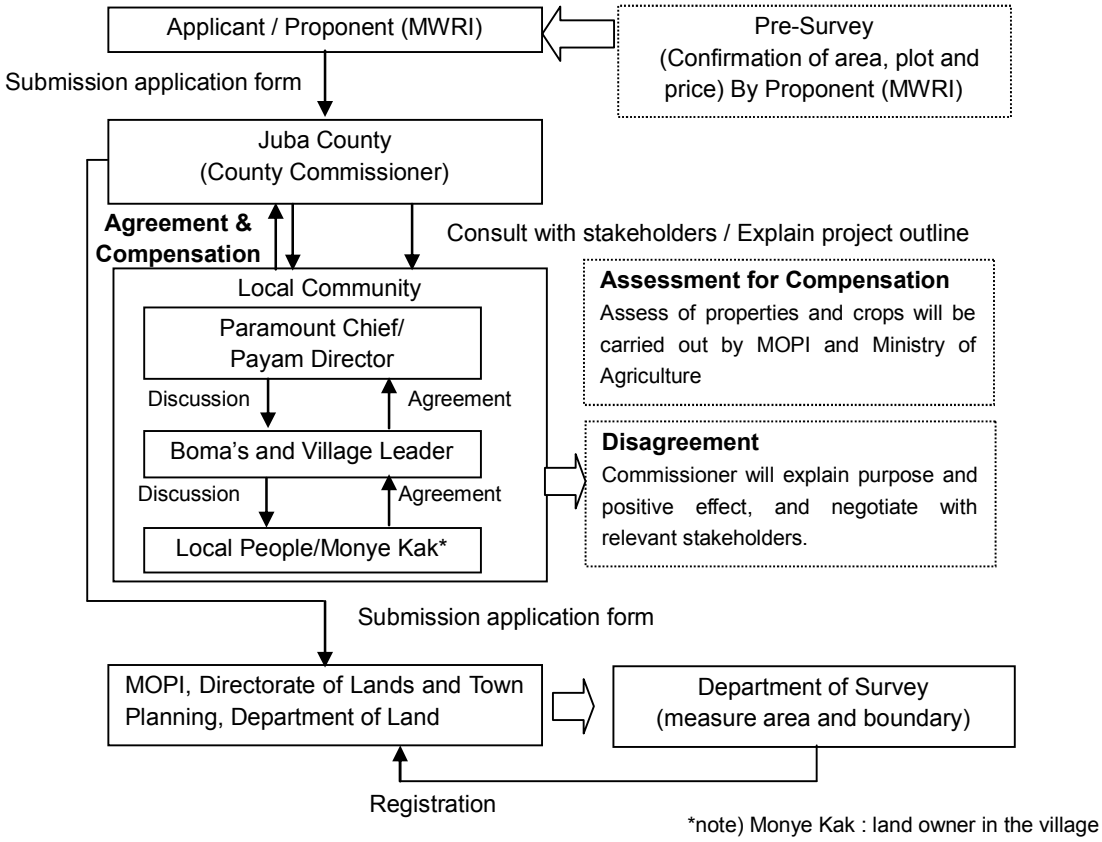
According to the result of the baseline survey as shown in Table 6.5, there are no building and occupied land such as areas with mango trees and farm land in the proposed construction sites.

Table 6.5 Affected Buildings and Properties in Planned Area

Facility/location	Number of affected buildings/ crops/ farms/ natural resources	Land owner
1. Existing WTP expansion / UWC compound	There is neither affected private building nor private property because all facilities are constructed in government land.	Government
2. North Low SR / Memorial ground near the parliament	There is neither affected private building nor private property because all facilities are constructed in government land.	Government
3. North High SR / Northeast of the Mt. Jebel Körök	The proposed area is located in grassy, rocky areas, which is not currently used as residential area. There is no affected private building at the moment. There is neither affected property nor resource although some inhabitants collect crushed stones and pebbles from the Jebel Körök out of the proposed site.	Northern Bari Community
4. West WTP / Tokiman area south of the Khor Ramla River	The proposed site is located in seasonal grassy or swampy areas, which is not currently used as residential area. Hence, there is no affected private building at the moment. There is neither forest nor farming land. Hence, there is neither affected property nor natural resource.	Tokiman Community
5. Transmission and distribution network	Pipelines will be installed under existing paved or unpaved roads or right of way and a new bridge crossing the Khor Ramla River for operation of the new water treatment plant will be constructed. There is neither affect on private building nor on private property because all facilities are to be installed in underground of the public roads.	Government

The proposed sites of North High Service Reservoir in Jebel Körök and West Water Treatment Plant belong to the community land and should be acquired from the communities. In the stakeholder meeting in April 2009, the relevant stakeholders including the paramount chief of Tokiman, Payam directors and village leaders agreed on this project and requested that a law-based process for land acquisition should be adopted by the government.

According to the Land Act of 2009, loss of properties and lands must be compensated by the government. Law-based land acquisition processes which were prepared by the Study Team based on an interview of the Department of Lands of Ministry of Physical Infrastructure (MOPI) and Southern Sudan Land Commission are shown in Figure 6.2.



Source: Prepared based on interview to MOPI and Southern Sudan Land Commission

Figure 6.2 Land Acquisition Process for Public-Use

According to the Department of Lands of MOPI, compensation for loss of lands and properties shall be done by the government based on the Land Act, 2009, which will be established in 2009. A description of compensation was written in the draft version of the Land Act of Southern Sudan as given in Appendix-K. Compensation for land is assessed by MOPI and agricultural products and crop fields are assessed by the Ministry of Agriculture. As for agricultural products, there is no standard price list; all compensation prices are concluded through an assessment by the compensation committee in the Ministry of Agriculture. Therefore, the prices of agricultural products are not the same in price. The most expensive product is mango tree. The price a mango tree is approximately 20,000-500,000 SDG according to the Ministry of Agriculture.

On 24th April, 2009, the stakeholder meeting for the proposed site for West Water Treatment Plant was carried out in the proposed water treatment site with participants of the paramount chief of Tokiman and the community people to disclose project information and to build consensus for the project. The following are memorandum of the meeting.

- The paramount chief of Tokiman and the community at large agree the treatment plant project.
- The chief also added that the project should bring benefits to the community benefit, e.g.

creation of employment; and development in the area.

- The community said they wanted road to their garden because the proposed site of treatment plant is close to their road.
- The site was identified by every member in the meeting and they said it okay for the community.
- The chief said the second meeting will be facing the development committee also to comment /agree on the project

(2) Land Use and Utilization of Local Resources

As a result of the baseline survey and assessed degree of impact described in "Resettlement and Loss of Properties", the priority project will not pose any impact on land use and local resources.

(3) Sanitation

The project will increase safe and clean water supply to the residents and will improve sanitary conditions in the service area, which essentially decrease the threat of water related diseases. On the other hand, the increased water consumption will increase used water or wastewater discharged from users' premises. This increased wastewater discharge may exacerbate unsanitary condition in the service area without appropriate wastewater disposal system.

Wastewater discharged is estimated as shown in Table 6.6, assuming 80% of the water consumed by the users turns in wastewater and discharged from the user's premises. The wastewater discharged is 10,500 m^3/d in 2009 and 37,700 m^3/d in 2015. The wastewater discharged will increase to about two folds in 2015.

Table 6.6 Estimation of Discharged Wastewater in 2009 and 2015

Category	Type of water user	2009			2015			Increase of wastewater discharged from water users after 2009
		Per capita Consump-tion	Service population	Wastewater discharged from water users	Per capita Consump-tion	Service population	Wastewater Discharged from water users	
		L/c/d	person	(m^3/d)	L/c/d	person	(m^3/d)	(m^3/d)
Domestic	House Connection	26.0	34,000	707	90	188,000	13,536	12,829
	Public Tap	32.5	147,000	3,822	40	151,000	4,832	1,010
	Tanker	35.5	69,000	1,960	40	204,000	6,528	4,568
	Sub-total		250,000	6,489	170	543,000	24,896	18,407
Non-Domestic		38 % of total supply		3,977	34 % of total supply		12,825	8,848
Total				10,466			37,721	27,255

The wastewater from domestic use mainly contains organic matter and that from industrial use may

contains hazardous matters such as heavy metals. The discharge of polluted wastewater to the environment without a proper collection and treatment system will cause an unsanitary living environment in the service area, causing bad smell, habitats of harmful bacteria and insects, degradation of the streams flowing through the river. This results in the increase of water related diseases, and impairs aesthetics of the living environment.

To mitigate this impact, development of drainage and sewerage systems are required after treated water from new water treatment plant is supplied.

(4) Infectious Diseases

According to the data of 2008, the carrier rate of HIV is averaged at 1.4 to 2.0 percent nationwide in Sudan, and 2.6 % in Yei and this rate may increase as human migration and interaction increase.

During the construction stage of the project, many construction workers in Juba and the surrounding villages will be hired, while main and sub contractors will be hired from outside areas or foreign countries. There is a possibility that these workers may contract sexually transmitted diseases (STDs) through sexual relations due to increased interaction in the area, unless mitigation measures such as HIV awareness campaigns and health education are carried out.

Discharge of wastewater will increase puddles in the area, which provide habitats of malaria-carrying mosquitoes during even dry seasons. To reduce malaria risk, a drainage and sewerage system is required.

(5) Accidents

The number of traffic accidents may increase every year in Juba area although statistical data of traffic accidents are not available. It is estimated that about 600 water tankers will be operated every day in 2015 after the supply of clean water through the project, which increases the risk of traffic accidents. Appropriate traffic education and regulations should be given to drivers and relevant companies.

(6) Flora, Fauna and Biodiversity

As described in the initial environmental examination (IEE) in the Master Plan, there is no reserved land such as national park and forest reserve found in the projects area. Furthermore, there are only a few rare habitats and endangered species such as those listed in IUCN and CITES in the area. One of major such species listed in the IUCN and living in the project area is Nile crocodile.

In the new WTP sites along the Bahr el-Jebel, the construction of intake of water treatment plant may affect the habitat of Nile crocodiles but the intake facility is quite small and Nile crocodiles are able to live in the same environment within the surrounding area of the Bahr el-Jebel.

The site of North High service reservoir is located at the foot of the Mt. Jebel Körök, where only seasonal short grass grow in rocky mountain.

The current vegetation and land use is summarized in Table 6.7. It is evaluated that the impact level for biota is not as serious.

Table 6.7 Vegetation and Habitats in Proposed Facilities

Facility	Required area (ha)	Topographic feature	Vegetation in planning area	Major habitat	Present land-use
1. Existing WTP expansion	-	Open land along the Bahr el-Jebel	No vegetation	No major habitat	Old treatment plant, parking and office space
2. North Low SR	1.66	Open land Elevation: 510 - 515m	No Vegetation	No major habitat	Memorial ground belonging to the government
3. North High SR	0.72	Open land at the foot of rocky mountain Elevation: 530 - 540m	Seasonal short grass and young acacia trees	No major habitat	Grazing land for livestock
4. West WTP	4.0	Open land along Bahr el-Jebel and seasonal swampy area Elevation: 460m	Seasonal short grass and young acacia trees	A few small mammals and birds in grassy areas	Unused land

Existing WTP

North Low SR

North High SR

West WTP

(7) Air Pollution

The operation of construction machines and other equipments will generate dust during construction activities and diffuse to the surrounding area of the project sites.

The impact on dust or air pollution is not significant in the sites of West WTP and North High SR as these sites are located in no or low density residential area. Exiting WTP and North Low SR are

located in the residential area and the operation of construction machines and trucks will generate dust to rise from unpaved roads and construction sites. Although the generation of dust is a usual phenomenon in Juba, most of which are unpaved, generation of dust may cause minor impact.

(8) Water Pollution

The water supply project provides positive impacts. On the other hand, an increase of water supply quantity indicates an increase of discharged wastewater in the service area. In addition, sludge discharged from water treatment plant may affect the environment.

a) Water Balance of Intake and Discharge

The water volume of intake on average daily consumption basis is estimated as 52,125 m^3/d at West WTP and 6,120 m^3/d at expansion WTP, respectively. Approximately 95 % of this volume is supplied to the service area after treatment and the remaining 5% is discharged as backwash water and sludge from water treatment plants, eventually to the Bahr el-Jebel.

The increased volume of discharged water between the year of 2009 and 2015 is estimated at 37,300 m^3/d based on the following assumptions and as indicated in Figure 6.3.

- Calculation is made based on total water treatment capacity but not water demand in 2015
- Calculation is made on average daily water treatment capacity base but not on maximum daily capacity base
- 1.05 times of the water production is abstracted from the river
- 20 % of the supplied water goes to leakage
- 80 % of the consumed water by the users is discharged to the environment.

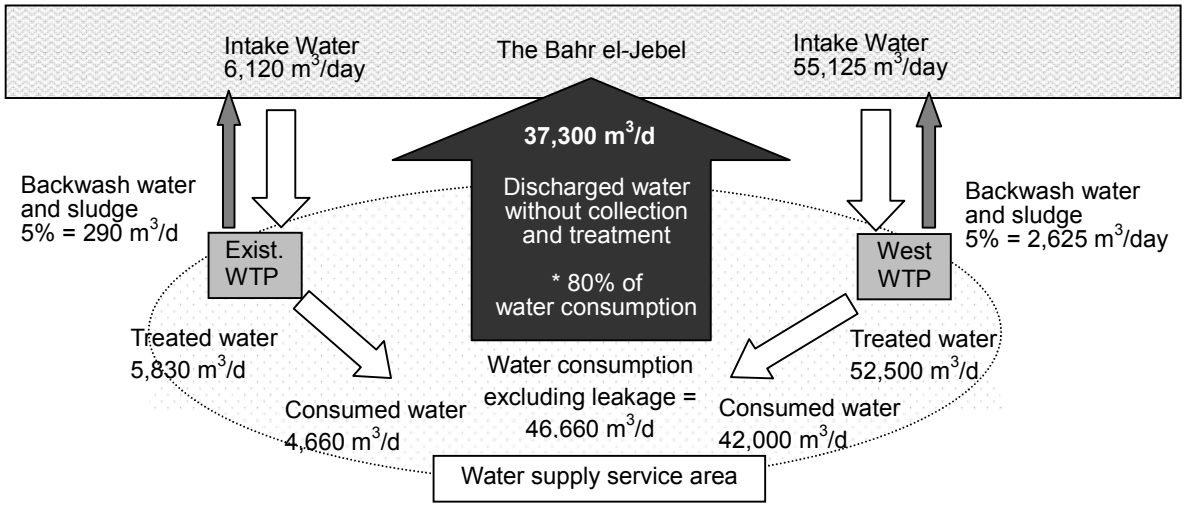


Figure 6.3 Water Intake and Wastewater Balance

The intake amount of 61,245 m^3/d is equivalent to 0.06 % of the design minimum flow of the Bahr el-Jebel of 97.2 million m^3/d. Therefore, the intake amount does not give any impact to the river.

b) Impact on the Bahr el-Jebel

Without a collection and treatment system, discharged sewage finally reaches to the Bahr el-Jebel and pollutes the river. With following assumptions, it is estimated that the BOD level of the Bahr el-Jebel would increase to 2.08 mg/l in 2015 from assumed present level of 2.0 mg/l. Therefore, the increase of BOD is just 4 % and this level of increase of BOD in the river is not significant.

- Existing BOD level of river water is 2 mg/l
- Raw wastewater has BOD level of 200 mg/l
- Discharged sewage to the river is instantly mixed perfectly.

In addition, increase of suspended solid in the river by discharge of backwash water and sludge is estimated. The test result of turbidity of the river in 2008 was 16.9 NTU, which is equivalent to about 19.01 mg/l as suspended solid. After the implementation of project in 2015, suspended solid is estimated to increase to 19.13 mg/l, which is only 0.6 % increase from the existing level of suspended solid in the river.

As analyzed above, discharged water will not cause a significant change in the water quality of the Bahr el-Jebel. In addition, the sludge discharged from the water treatment plants contains mainly original constituents of the river and small quantity of Aluminum but does not include any hazardous contents such as heavy metals and chemicals.

c) Impact on Stream Water Quality

The Bahr el-Jebel flows from the south to the north in the service area and five seasonal streams called Luri, Khorbou, Lobulyet, Wallan and Khor Ramla flowing from the west to the east and join the Bahr el-Jebel in sequence from north towards south. In the dry season, no water flows in these streams and even in the rainy season the flow is very small compared to that of the Bahr el-Jebel.

Without a sewerage system, increased wastewater will be stagnant on roads and in empty areas, and eventually discharged to the Bahr el-Jebel through these seasonal streams. This will result in unfavorable living environment, especially nearby these streams.

(9) Noise

The operation of the water supply facilities such as generator and pump cause noise and vibration at the post construction stage and construction machines and trucks during the construction also increase

noise and vibration in the surrounding areas. In addition, the increased number of water tankers shall increase noise and vibration.

a) Present Sound Level

The main sources of noise are generator and pump in water supply facilities. The present level of noise of these equipments was measured in the existing water treatment plant and the result is shown in Table 6.8. The noise near these sources is very high.

Table 6.8 Power Level of the Sound Source in Existing WTP

Sound Source	Specification	Noise level (dB(A))	Conditions
Generator	300 KV	103.5	10 minutes/ 1 m from source
	1250 KV	100.9	Exhaust 1 minute / 1 m from source
		91.3	Intake 1 minute / 1 m from source
Pump	28.1 KW	91.0	1 m from source

The present sound level was measured at the proposed facility sites and the results are shown in Table 6.9 and the specifications including locations and times for measurement are given in Appendix-K. The existing noise level ranges from 37 to 78 dB(A). The main sources of the present noise are traffic noise and operation of equipment in the water treatment plant.

Table 6.9 Result of Present Sound Level Survey

No.	Proposed facility/activity	Location / payam	Category of noise measured	Sound level dB(A)
St.1	North High SR	Jebel Körök / Northern Bari	Ambient	60.9
St.2	North Low SR	Memorial ground	Ambient	59.9
St.3		Nearest residential area	Ambient	52.1
St.4	Water tanker route	Hainyahama / along the Parliament road	Traffic	71.3
St.5	Water tanker route	Juba Hospital compound	Ambient	57.7
St.6		Along the Hospital road	Traffic	71.9
St.7	West WTP	Nearest residential area	Ambient	43.0
St.8		Tokiman primary school	Ambient	62.3
St.9		JICA study team test well No.3	Ambient	37.4
St.10	Expansion WTP	Office area	Operation	58.4
St.11		Reservoir	Operation	77.1
St.12		On the top of sedimentation tank	Operation	78.4
St.13		Boundary nearest generator (south)	Operation	64.3

Note: Sound level was measured by sound level meter (Lion NL27)

b) Results of Noise Estimation for Proposed Facilities

Proposed facilities that include noise generation sources of pump and generator are expansion water

treatment plant, North Low Service Reservoir and West Water Treatment Plant. The noise level was estimated for these facilities and results are shown in Table 6.10 and the detailed calculation is given in Appendix-K. The evaluation criteria was set at 65 dB(A) as the maximum allowable noise level. The result shows that the noise level of the expansion water treatment plant does not comply with this criteria and it requires mitigation measures.

Table 6.10 Results of Noise Level Estimation in the nearest Residential Area of Proposed Facilities

Facility name	Facility of sound source	Sound source	Power level dB(A)	Combined sound level dB(A)	Evaluation of estimated noise level
Expansion WTP	Generator	Generator B / 300 KVA	103.5	67.1	The estimated value does not comply with the target value. Mitigation measures against generator should be made.
	Raw water pump house	Pump A / 18.5 KW	91.0		
		Pump B / 18.5 KW	91.0		
	Transmission and distribution pump house	Pump A / 90 KW	91.0		
		Pump B / 90 KW	91.0		
		Pump C / 90 KW	91.0		
North Low SR	Generator	Generator A / 300 KVA	103.5	60.0	The estimated value complies with the target value.
	Transmission pump house	Pump A / 90 KW	91.0		
		Pump B / 90 KW	91.0		
West WTP	Generator	Generator 1,500 KVA	100.9	40.7	The estimated value complies with the target value.
	Raw water pump house	Pump A / 18.5 KW	91.0		
	Transmission pump house	Pump A / 90 KW	91.0		
		Pump B / 90 KW	91.0		
		Pump C / 90 KW	91.0		

Note: Estimation of sound level is given by the following formulation:
Lr = Lw - 8 - 20 log(r), Lr: Estimated value, Lw: Power level of sound source, r: distance
The maximum allowable level in residential and industrial area is set at 65 dB(A) in day time.

c) Noise Level Estimation by Increase of Water Tanker

The operation of water tanker is estimated at 2,675 round trips per day in 2015. The current operation is about 600 round trips per day, and the operation in 2015 will increase to about 2,075 round trips (4,150 single trips) per day, which will increase noise level of the roads traffic. The noise level of the increase of trips is estimated as given in Appendix-N. The increase of 4,150 trips per 12 hours is equivalent to 346 single trips per hour and rise the noise level by 0.5 dB (A) on an hourly average. Therefore, the increase of water tanker trips does not give any significant impacts to the surrounding area.

(10) Bottom Sediment

Sludge will be discharged at the rate of 3,500 m^3 per day from the water treatment plants into the Bahr el-Jebel. The sludge does not contain any hazardous matter as the raw water is abstracted from the Bahr el-Jebel and only Aluminum will be added to water for treatment. However, the discharge of

sludge may affect river water users or the aesthetics locally or in a short period, if the sludge is discharged into the river along the river bed and for a short period of a day. Mitigation measures are required to minimize the impact.

6.4 Mitigation Measures and Monitoring Plans

Proposed mitigation measures by stage and by impact item are described in Table 6.11.

Table 6.11 Proposed Mitigation Measures and Monitoring Items for the Priority Project

	Items	Mitigation Measures	Monitoring Items
Social Environment	1. Resettlement (or loss of properties/ land acquisition)	[**This Study**] • Stakeholder meetings were held for information disclosure and confirmation of the agreement with stakeholders of the project. [**Basic design**] • The holding of stakeholder meetings for information disclosure and confirmation of the agreement with stakeholders. • The establishment of a community coordination committee for smooth land acquisition and required compensation. • Proponent shall take a law-based process for land acquisition and compensation. [**Detailed design and construction**] • Detailed measurement survey shall be done. • Proponent shall complete land acquisition and compensation.	[**Detailed design and construction**] ✧ Observation of adequate land acquisition process and compensation
	2. Land use and local resources utilization	[**Basic Design**] 2.1 All agricultural fields, fruit trees and wells shall be recorded in a topographical survey 2.2 All properties should be avoided in the design [**Detailed Design and Construction**] 2.3 Detailed Measurement Survey shall be done 2.4 Proponent shall complete land acquisition and compensation 2.5 Replant trees instead of cutting trees for clearance during construction	[**Detailed Design and Construction**] - Observation of ~~a~~dequate land acquisition process and compensation during construction
	3. Sanitation	[**Post construction**] 3.1 Installation of a drainage and sewerage system	- Not required
	4. Infectious diseases such as HIV/AIDS	[**Detailed Design and Construction**] 4.1 Healthcare education for workers and inhabitants before construction in association with the Ministry of Health and NGOs 4.2 Implementation of periodical prevention campaigns [**Post construction**] 4.3 Installation of a drainage system for the prevention of malaria	[**Detailed Design and Construction**]& [**Post Construction**] - Number of HIV, Malaria and other infectious disease cases during and post construction
	5. Traffic accidents	[**Detailed Design and Construction**] 5.1 Education on traffic rules for construction workers, drivers of water tankers and inhabitants 5.2 Staffing of traffic control during construction	[**Detailed Design and Construction**] - Number of traffic accidents during construction

	Items	Mitigation Measures	Monitoring Items
Natural Environment	6. Biota and ecosystems	[**Basic Design**] 6.1 Affected trees shall be confirmed based on a basic design [**Detailed Design and Construction**] 6.2 The contractor must set up the markings of the boundaries of construction areas. 6.3 Replant trees instead of cutting trees in the construction yard	[**Detailed Design and Construction**] - Visual observation of the condition of vegetation
Pollution	7. Air pollution	[**Detailed Design and Construction**] 7.1 Sprinkling of water near residential areas to reduce suspended particle matter during construction	[**Detailed Design and Construction**] - Visual observation of the condition of dust distribution during construction
	8. Water pollution	[**Basic design**] • Backwashed drainage and sludge should be discharged at the center of the river shall be adopted in design • Formulation of wastewater management plan. [**Detailed design, construction and post construction**] • Construction of drainage and sewerage system. • Establishment and enforcement of regulations of effluent standards from industries and commercial.	[**Post construction**] • Water quality survey and monitoring
	9. Noise and Vibration	[**Basic Design**] 9.1 Sound sources such as generators and pumps should be set up in the room with soundproof walls in design [**Detailed Design and Construction**] 9.2 Adjustment of work time (limited work time during the daytime)	[**Detailed Design and Construction**]& [**Post Construction**] - Equivalent sound levels at the boundary and nearest residence before, during and post construction
	10. Bottom sediment in the sea and rivers	[**Basic Design**] 10.1 Backwashed drainage and sludge should be discharged in the center of river in design	- Not required

6.5 Recommended Implementation Framework of Mitigation Measures and Monitoring

Environmental and social consideration activities or process to be carried out after the feasibility study are explained in Figure 6.4. The process is prepared on the assumption of Japanese grant aid and ODA loan.

In case of Japanese grant aid project, the proponent have to submit an environmental permission approved by the Government of Southern Sudan to the Government of Japan in a basic design study. In case of Japanese loan project, an environmental permission shall be submitted in 120 days before loan agreement.

In principal, the proponent should prepare detailed environmental management and monitoring plan (EMMP) during a detailed design based on the approved IEE and /or EIA and carry out all activities of the proposed EMMP at constriction and post construction stages. Implementation of EMMP shall be recorded and reported to the Department of Environment Affairs in MHPP&E and relevant authorities periodically.

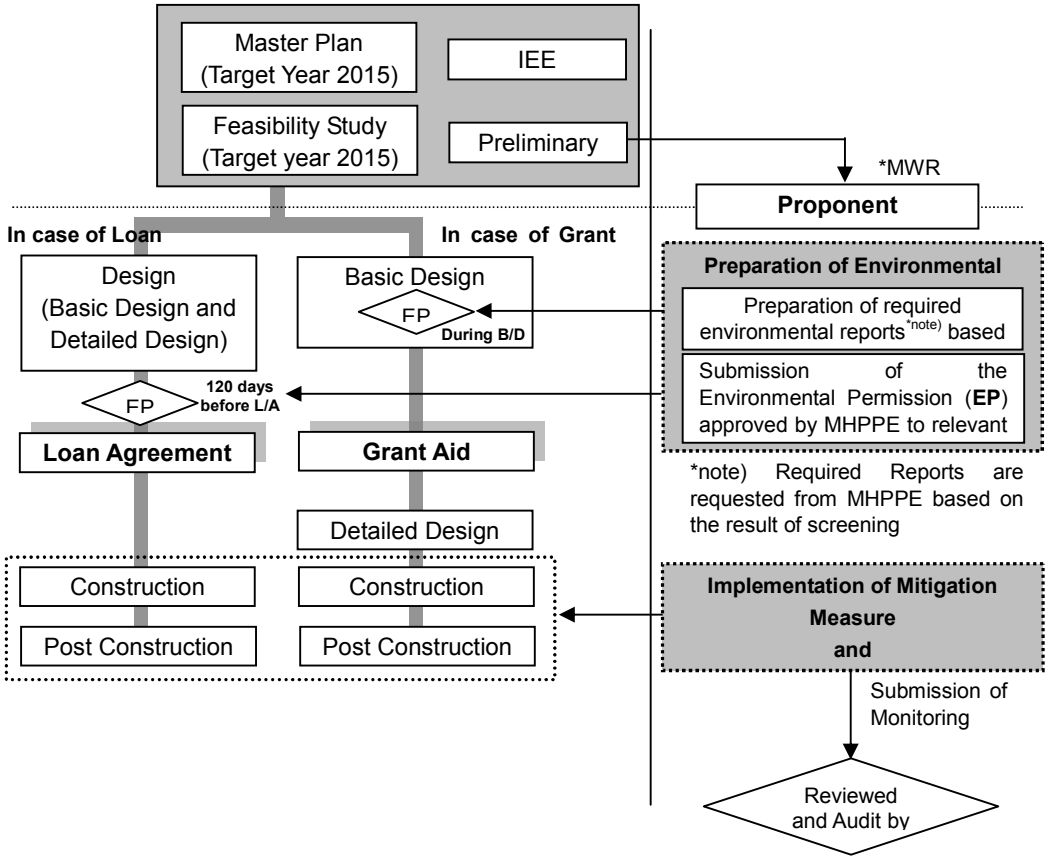


Figure 6.4 Implementation Framework for Environmental Activities

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

1. A part of the components proposed in the Master Plan is selected as "priority project," which will be required to be implemented by 2015 with a higher priority. The components included in the first and second phases of the Master Plan were selected as priority project. A feasibility study was carried out for the priority project in the Study.

2. The target service area of the priority project is the same as the Master Plan. The target service coverage is set as 80 % of the population in the service area, who can access safe and clean water supply by means of house connection, public taps/kiosk or water tanker by 2015. The total population in 2015 is projected at 680,000 and the service population is set at 544,000.

3. The projected total water demand and proposed treatment capacity in 2015 are 69,000 m^3/d and 77,000 m^3/d, respectively.

4. The major components of the priority project are as follows:
   - Expansion of existing water treatment plant (7,000 m^3/d)
   - Construction of a water treatment plant in the west bank (63,000 m^3/d)
   - 2 service reservoirs (North Low SR (10,000 m^3) and North High SR (10,000 m^3))
   - Transmission pipelines (17.5 km)
   - A transmission pump station (30,000 m^3/d x 40 m head)
   - Replacement and expansion of distribution network (409.7 km)

5. Financial strengthening is identified as a primary management policy for UWC to be a self-sustaining organization. Under this perspective, following management targets are proposed.
   - Establishment of new increasing block water tariff to cover operating expenses and depreciation
   - Upgrading of billing and revenue collection system based on metering system.
   - Enhancement of customer service and authorization to disconnect
   - Strengthening of debt management

6. The workforce of UWC in 2015 is estimated to be 378 persons on assuming the staff efficiency of 15 staff-members per 1,000 connections. Given this, organization reform is proposed by redefining internal profit units of production and customer service departments. Involvement of the private sectors is also recommended for water supply management, as public taps (including water kiosk) and water tankers will take important roles in supplying treated water of UWC. In

this case, license will be granted by UWC to communities and private vendors to ensure water quality and retail price of the supplied water.

7. Water quality management and distribution management should be focused in operation and maintenance of the water supply system as the core value of water supply services. In addition, the importance of customer services is primarily emphasized as the number of customers will increase drastically by 2015.

8. Implementation of a capacity development plan by 2015 is proposed to strengthen management capacity of the urban water sector through foreign technical assistance programs. The proposed outputs of the plan are as follows:
   - Improvement of management practices of UWC related to basic waterworks management skills and revenue collection
   - Construction and management of public taps stands /water kiosks and tanker stations as pilot project
   - Reduction of non-revenue water in the pilot area

9. The strategy of implementation of the priority project is developed. To facilitate the development of water supply system at the initial stage, the phase-1 project is formulated to give larger benefit with relatively small scale of investment. Furthermore, phase-1 project is divided into 3 small packages for further facilitation of the project implementation.

10. In implementation of the priority project, non-facility (management) measures as well as facility measures should be implemented for UWC to become a capable organization. Small or medium scale grant aid project for rehabilitation of the existing water supply system along with technical cooperation to strengthen the management capability shall be invited at the initial stage of the priority project. Through the implementation of rehabilitation project along with technical cooperation project, UWC should establish sound management fundamentals and become a capable organization to attract large investment irrespective of public or private fund to materialize the new water supply system proposed in the phase-2. Based on the established sound management fundamentals, UWC could manage a large project, expand the service area, and improve their services.

11. The construction cost up to 2015 is estimated at 124.5 million USD and total fund requirement including indirect costs consisting of administration and engineering costs and contingencies is estimated at 184.8 million USD.

12. The annual operation and maintenance cost for the water supply system in 2015 is estimated at 6,768,000 USD with the estimated unit cost per revenue water at 0.52 USD/m^3.

13. New water tariff structure is proposed in the Master Plan should be adopted for the priority project in consideration of affordability of customers, sustainability for waterworks and fairness among customers.

14. The priority project returns reasonable FIRR of 8.8 %. The repayment of the loan principal and interest can be covered by the anticipated free cash flows. The proposed water tariff would be acceptable from the viewpoint of affordability. Consequently, it is judged that the priority project is financially viable.

15. The EIRR of the priority project resulted in 24.7%, thanks to considerably high willingness to pay for improved water supply services. Therefore, the priority project is quite viable from the national economic perspective.

16. As a result of preliminary environmental impact assessment (pre-EIA), land acquisition and increased wastewater due to increase of water supply are identified as main impacts of the priority project.

7.2 Recommendations

1. The Government of Southern Sudan and UWC should address financial issues of water works management, such as enacting water tariff reform based on metering policy and debt management which can be done within their current capability. In this regard, water meters procured under the project of the multi donor trust fund (MDTF) should be installed as early as possible.

2. In addition to house connections, public taps, water kiosks and water tanker venders play a key role to supply the treated water to the residents, especially at the initial stage of the priority project, and they are important sources of revenue of UWC. UWC should establish a system to manage these customers. While selecting public taps or water kiosks, UWC should decide the appropriate management organization, by a careful assessment on the involvement of community or private business based management.

3. As the necessity of technical assistance for capacity development is quite high to ensure the sustainability of the priority project, it should be implemented in parallel with infrastructure investment.

4. Small package projects were prepared in the feasibility study. These projects shall be requested as grant aid project along with a foreign technical cooperation project to improve water supply services and management fundamentals of the waterworks.

5. The acquisition process of the land for following proposed facilities should be followed immediately after the Study.
   - West Water treatment Plant in Tokiman, Rejaf
   - North Low Service Reservoir and Pump Station in the John Garang Memorial Site
   - North High Service Reservoir at the foot of Mt. Jebel Körök