CHAPTER 4

FACILITY PLAN

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4.1 REHABILITATION OF DISTRIBUTION NETWORK

Detail network data such as pipe material, age, diameter and current conditions by pipe, especially small pipeline, is not available in Basrah Water Directorate. At this stage, therefore, it is not possible to prepare a detail plan of rehabilitation needs. With lack of data enough to estimate rehabilitation works of distribution network, the following process is adopted:

1. A model area is selected from Basrah city, where network are fully developed and pipe diameter and location map of the network is available. (Al Hay sub-district)
2. In this model area, network data, pipe length by diameter were collected from map and population was estimated.
3. Using this network data and population, the total network length by diameter in Basrah District was extrapolated.
4. There is not enough data to decide how much pipe of the network should be rehabilitated. The study team assumed that half of the distribution network should be replaced.

Based on the result of analysis, the scope of (length by diameter) of the network rehabilitation is preliminarily estimated as shown in Table 4.1.

Table 4.1 Scope (Length and Diameter) of Network Rehabilitation

Pipe diameter (mm)	Length (m)
700	7,000
500	6,500
400	1,000
225	18,500
160	54,000
110 or less	198,500
Total	**285,500**

4.2 REHABILITATION OF EXISTING WATER TREATMENT PLANTS

The conditions of existing facilities were explained in CHAPTER 2 and most of the existing facilities need rehabilitation, especially mechanical and electrical equipment. In this plan, all water treatment plants should be used in the short-term and the existing plants except Al Hartha 25 MG, Basrah Unified and R-Zero plants will be demolished. Finally, in Mini M/P these 3 plants will also be demolished. In this plan, therefore, the scope of the rehabilitation works does not mean full

rehabilitation but mainly replacement of mechanical and electrical equipment.

Based on the information supplied from the sites, preliminary rehabilitation works have been identified as listed up in Table 4.2. However, these works are not fixed scope but temporal and further inspection of the facilities is required to decide the detailed scope of works at design stage.

Table 4.2 Rehabilitation Works of Existing Water Supply Plants

Facilities	Rehabilitation works
(1) R-Zero 25 C.U.	C.U. (25), Storage tank, High lift PS (8), Low lift PS (9), Chlorine system, Electrical equipment (33kv/11kv) substation & low tension equipment, Diesel generators, Plant buildings, Waste water pumps (4)
(2) R-Zero Raw Water Pumps	Al Hartha pumps (6), Basrah Unified. Pumps (6), Al Jubaila pumps (4), Bradiah pumps (3), Shuaiba pumps (4), Abu Al Khasseb pumps (6), Khor Al Zubair pumps (3), Plant buildings, Electrical equipment, Mechanical equipment
(3) Al Hartha 25 MG C.U.	C.U. (25), Storage tank, High lift PS (8), Low lift PS (7), Chlorine system, Electrical equipment, Diesel generators, Plant buildings
(4) Basrah Unified	Gravity sand filters (20), Storage tank, High lift PS (7), Low lift PS (5), Chlorine system, Electrical equipments, Diesel generators , Plant buildings, Sedimentation tanks (4), Alum dosing system, Back washing system, Pneumatic system & measuring equipment
(5) Garma 1	C.U. (8), Low lift PS (3), Chlorine system, Electrical equipment, Diesel generators, Plant buildings
(6) Garma 2	C.U. (7), Low lift PS (2), Chlorine system, Electrical equipment, Diesel generators, Plant buildings
(7) Ribat	C.U. (3), Low lift PS (3), Chlorine system, Electrical equipment, Diesel generators, Plant buildings
(8) Al Maqil 1	C.U. (3), Low lift PS (2), Chlorine system, Electrical equipment
(9) Jubaila 1	Pressure sand filters (12), High lift PS (3), Low lift PS (3), Chlorine system, Electrical equipment, Diesel generators, Plant buildings, Sedimentation tanks (2), Alum dosing system, Back washing system, Inlet piping system
(10) Jubaila 2	C.U. (4), Low lift PS (2), Chlorine system, Electrical equipment, Diesel generators, Plant buildings
(11) Bradiah 1	Pressure sand filters (14), High lift PS (4), Low lift PS (4), Chlorine system, Electrical equipment, Diesel generators, Plant buildings, Sedimentation tanks (2), Alum dosing system, Back washing system
(12) Bradiah 2	Pressure sand filters (14), High lift PS (4), Low lift PS (4), Chlorine system, Electrical equipment, Diesel generators, Plant buildings, Sedimentation tanks (2), Alum dosing system, Back washing system
(13) Bradiah C.U.	C.U. (1), Low lift PS (2), Chlorine system, Electrical equipment, Plant buildings

Note: The number in parentheses indicates the number of units of rehabilitation works.

4.3 FLOW OF WATER TREATMENT SYSTEM

In the plan, 3 existing water treatment plants should be utilized and a new conventional water treatment plant and RO plant should be constructed in the existing Al Hartha 25 MG and Basrah Unified plant site. The required volume is as follows:

- New water treatment plant: 465,000 m^3/day
- Reverse Osmosis plant: 362,000 m^3/day

- Treated water transfer pumping station: 349,000 m^3/day

Since the existing water treatment plants are used, the connections among these plants are a bit complicated. Figure 4.1 illustrates the water flow of the treatment system including R-Zero water treatment plant. Some part of the pre-treated water is transferred to RO plant and TDS is reduced; the remaining water is transferred to clear water reservoir to be mixed with RO treated water to get appropriate TDS concentration. Then, some part of the water will be directly distributed to the local area. The remaining water is transferred to transmission reservoir (TR) to distribute to Basrah city.

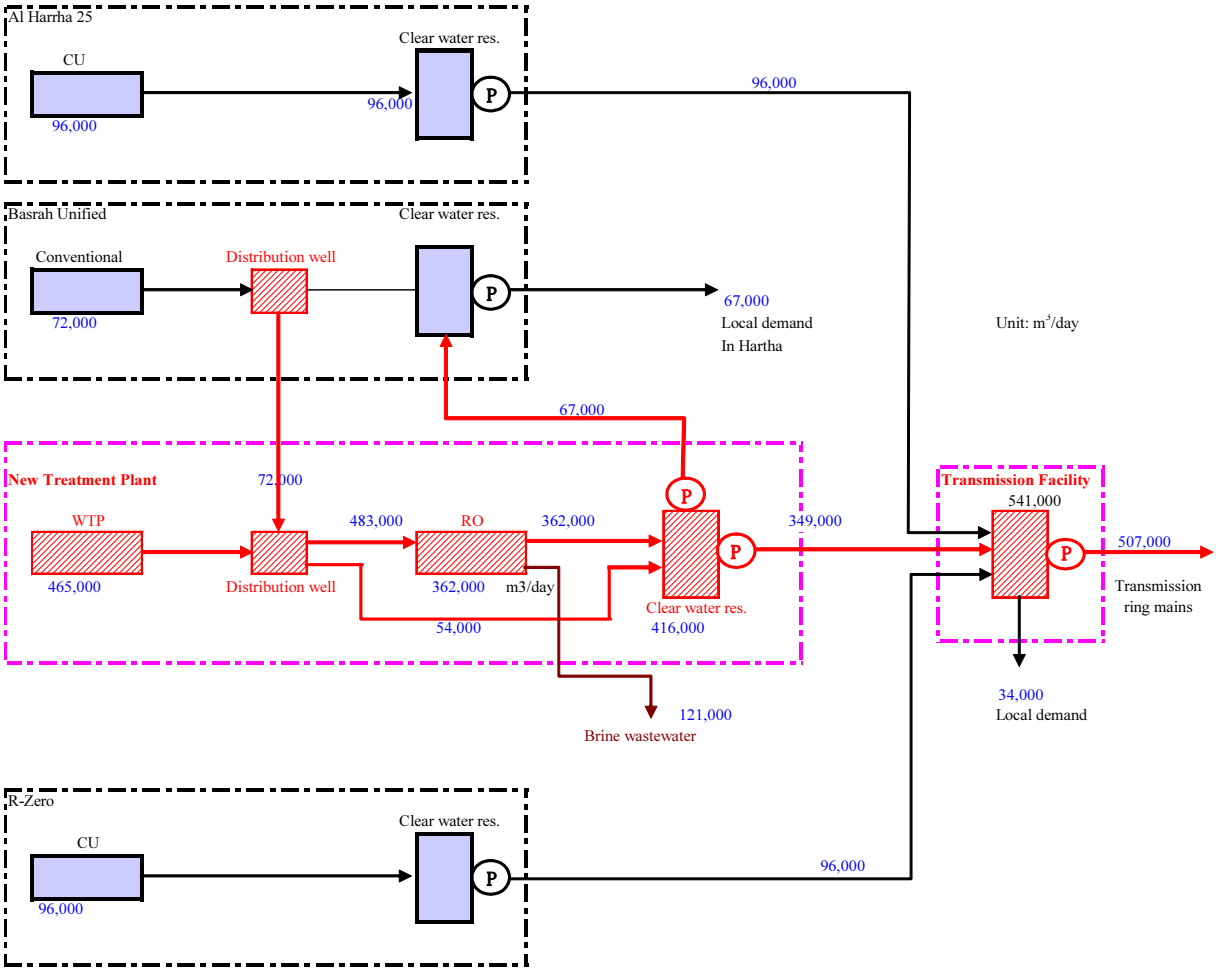


Figure 4.1 Flow of Water Treatment System

4.4 CONVENTIONAL WATER TREATMENT PLANT

Conventional rapid sand filtration method, which is most commonly used world wide and an effective method to treat river water, is adopted for treatment process as shown in Figure 4.2. As compared with compact unit, this process attains easy operation and maintenance and less trouble.

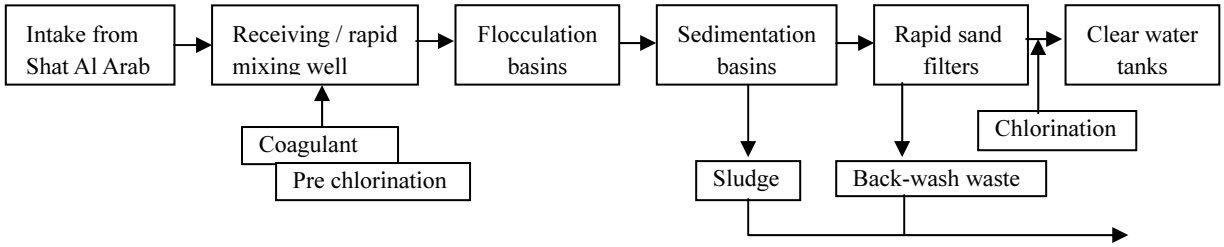


Figure 4.2 Conventional Water Treatment Process

The following methods are adopted for this process mainly from the aspects of easy operation and maintenance:

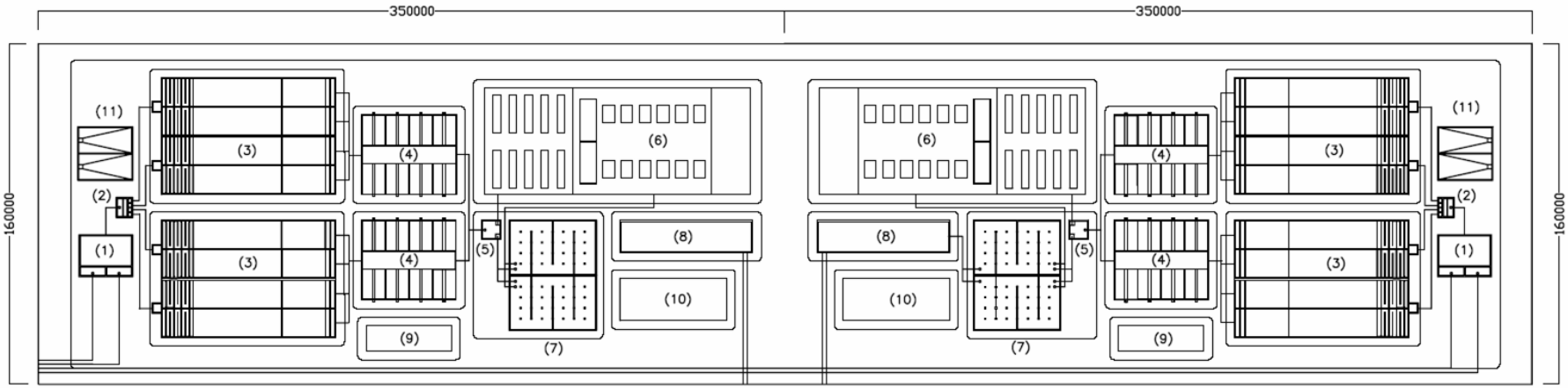
1) Rapid mixing: mechanical mixer or weir type
2) Flocculation: baffling type
3) Chemical sedimentation basin: horizontal flow type
4) Sand filter: gravity rapid sand filter
5) Chemical: chlorine gas and aluminum sulfate

The design criteria of water treatment plant are decided in Table 4.3. The details about design calculation are presented in Appendix G.

Table 4.3 Design Criteria of Water Treatment Plant

Facilities	Parameter	Adopted value
Receiving well	Detention time	1.5 min
Mixing basin	Detention time	1.0 min
Flocculation basin	Mean flow rate	25 cm/sec
	Detention time	30.0 min
Chemical sedimentation basin	Mean flow rate	0.4m/min
	Surface loading rate	25.0 mm/min
Rapid sand filter	Filtration rate	150 m/day
Receiving & distribution well	Detention time	1.5 min
Clear water reservoir	Detention time	1.0 hr

The water treatment plant consists of treatment facilities, chemical building, reservoir, pumping house, operation room, electrical room and generator room. The general layout of the water treatment plant is shown in Figure 4.3.



(1) RAW WATER PUMP

(2) RECEIVING WELL

(3) CHEMICAL SEDIMENTATION BASIN

(4) RAPID SAND FILTER

(5) RECEIVING & DISTRIBUTION WELL

(6) REVERSE OSMOSIS PLANT

(7) CLEAR WATER RESERVOIR

(8) TRANSMISSION PUMP

(9) CHEMICAL BUILDING

(10) OPERATION & ELECTRICAL & GENERATOR ROOM

(11) DRAINAGE TANK

The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq	General Layout of New Water Treatment Plant	Fig. No. 4.3

4.5 REVERSE OSMOSIS

A reverse osmosis system consists of four major components/processes: (1) pretreatment, (2) pressurization, (3) membrane separation, and (4) post-treatment stabilization.

Pretreatment: The incoming feedwater is pretreated to be compatible with the membranes by removing suspended solids, adjusting the pH, and adding a threshold inhibitor to control scaling caused by constituents such as calcium sulphate.

Pressurization: The pump raises the pressure of the pretreated feedwater to an operating pressure appropriate for the membrane and the salinity of the feedwater.

Separation: The semi-permeable membranes block the passage of dissolved salts while permitting the desalinated product water to pass through. Applying feedwater to the membrane assembly results in a freshwater product stream and a concentrated brine reject stream. Because no membrane is perfect in its rejection of dissolved salts, a small percentage of salt passes through the membrane and remains in the product water. Reverse osmosis membranes come in a variety of configurations. Two of the most popular are spiral wound and hollow fine fiber membranes. They are generally made of cellulose acetate, aromatic polyamides, or, nowadays, thin film polymer composites. Both types are used for brackish water and seawater desalination, although the specific membrane and the construction of the pressure vessel vary according to the different operating pressures used for the two types of feedwater.

Stabilization: The product water from the membrane assembly usually requires pH adjustment and degasification before being transferred to the distribution system for use as drinking water. The product passes through an aeration column in which the pH is elevated from a value of approximately 5 to a value close to 7. In many cases, this water is discharged to a storage cistern for later use.

In addition to conventional water treatment, the basic unit processes of a complete RO treatment system for Basrah would include multi-layer rapid sand filters, high pressure pumps and membrane assembly, followed by blending and post-treatment. The design parameters shall be determined through extensive pilot testing, which is required to assure that RO membranes should be operated on a sustainable basis. The experiences in surface water RO indicate that a high level of pretreatment is necessary to protect the membranes.

The product water of the RO process is generally water with less than 150- 200 mg/1 TDS, which is suitable for most domestic, industrial, and agricultural uses. A by-product of desalination is brine. Brine is a concentrated salt solution that must be disposed off. Brine can also be diluted with treated effluent. The ratio of discharged brine water or the recovery ratio of RO treated water depends on

several factors such as TDS concentration of inflow and treated outflow, pressure and the number of recycle stages of RO process.

The RO process in conjunction with blending of conventionally treated water can be designed to deliver treated water with the TDS level of approximately 600 mg/l.

Following are specifications of RO plant:

1) Recovery rate of water: 75 % (25 % brine wastewater)
2) TDS input (conventional treatment): 1,500 mg/l
3) TDS output (permeate): less than 200 mg/l
4) Capacity of input pumps: 483,000 m^3/day, 100 m head
5) Output water: 362,000 m^3/day
6) Pretreatment: Multiple layers rapid sand filter
7) The number of banks: 2 (see figure below)

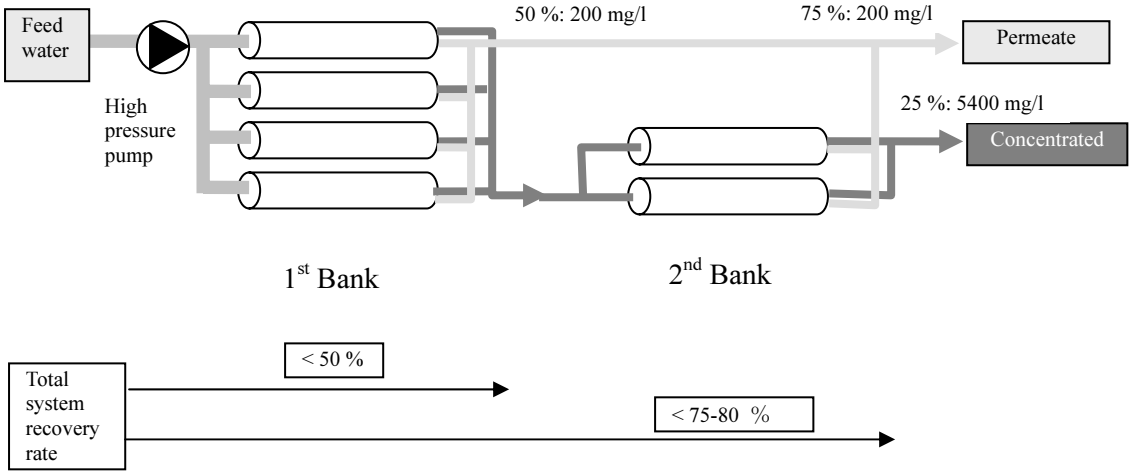


Figure 4.4 Schematic Flowchart for RO Process Treatment

As discussed in CHAPTER 12, half of the proposed total capacity of the conventional water treatment and RO plant will be constructed as the priority project. Therefore, the layout of the plant was planned assuming the plant will be constructed in two phases (phase 1 and 2). The general layout of RO plant is shown in Figure 4.3.

4.6 TREATED WATER TRANSMISSION MAIN FROM NEW WATER TREATMENT PLANT

There are two existing treated water transmission mains (1,000 mm and 900 mm) from the water treatment plants in Al Hartha. In future plan, the existing pipeline with dia. 900-mm will be utilized for

distribution of RO treated water to the local Al Hartha area. The other main will be utilized to convey RO treated water to the proposed transmission reservoir that will be constructed at the entrance of Basrah city.

In addition, the existing two raw water transmission pipelines (dia.1200 mm) installed from R-Zero to Al Hartha 25 MG plant and Basrah Unified plant shall be used for treated water transmission mains from the new water treatment plant to the transmission reservoir (Figure 3.11).

4.7 TRANSMISSION FACILITIES AND TRANSMISSION RING MAINS

In this plan, it is proposed that the total water production capacity is increased to meet the average day water demand but not maximum day water demand. Therefore, following design measures are taken in principle:

- The facilities that can be easily expandable (reservoir and pump) shall be designed to meet average day water demand
- Considering future expansion difficulty, the facilities that cannot be easily expandable (pipe) shall be designed to meet future full demand; maximum day water demand for transmission pipe and peak hour demand for distribution pipes.

In CHAPTER 9, it is proposed that the transmission facilities (reservoir, pump and pipe) and the main distribution facilities (ground reservoir, transfer pump and elevated tower) for distribution zones will be separately constructed at different construction stage. Transmission facilities will be constructed in the earlier stage and main distribution facilities shall be constructed in the later stage. This implementation results in inadequate capacity of the distribution system and without main distribution facilities, the function of transmission facilities shall include part of the distribution facilities. To solve this problem, therefore, following three measures are prepared.

Table 4.4 Capacity Options of Transmission Facilities without Main Distribution Facilities

Option	Capacity explanation	Transmission reservoir capacity	Transmission pump and pipe capacity
1	Transmission facilities to meet only transmission capacity	1 hour of average day demand	Average day demand (factor =1.0)
2	Transmission facilities to meet part of the distribution capacity	1-8 hours of average day demand	1.0 − 1.6
3	Transmission facilities to meet full distribution capacity	8 hours of average day demand	Peak hour demand (factor=1.6)

The option 1 results in inadequate distribution capacity; the option 3 requires extra large capacity in transmission facilities, which will be unnecessary after the distribution system is constructed. To compromise with the extreme cases of the option 1 and 3, the option 2 was prepared, in which

transmission reservoir and transmission pump were design to cover some of the distribution capacity. In any option, transmission pipeline should be designed to meet only transmission function to avoid large capital investment. Finally, the option 2 was selected for this plan with following design parameters.

1) Volume of transmission reservoir: 3 hour of the average day water demand
2) Discharge of transmission pumps: 1.4 x the average day water demand
3) Head of transmission pumps: to distribute water at least 15 m head at customer tap in 1.4 x average day water demand
4) Capacity of transmission pipeline: 1.4 x average day water demand

Without main distribution facilities, the transmission facilities with these parameters could cover 80 - 90 % of the peak hour water demand.

The extra large capacity of transmission pumps, which are initially installed in the transmission pumping station, could be eventually relocated in distribution pumps in main distribution facilities. The large capacity of the transmission reservoir will be used for emergency storage facility and distribution reservoir for the area nearby transmission reservoir in future.

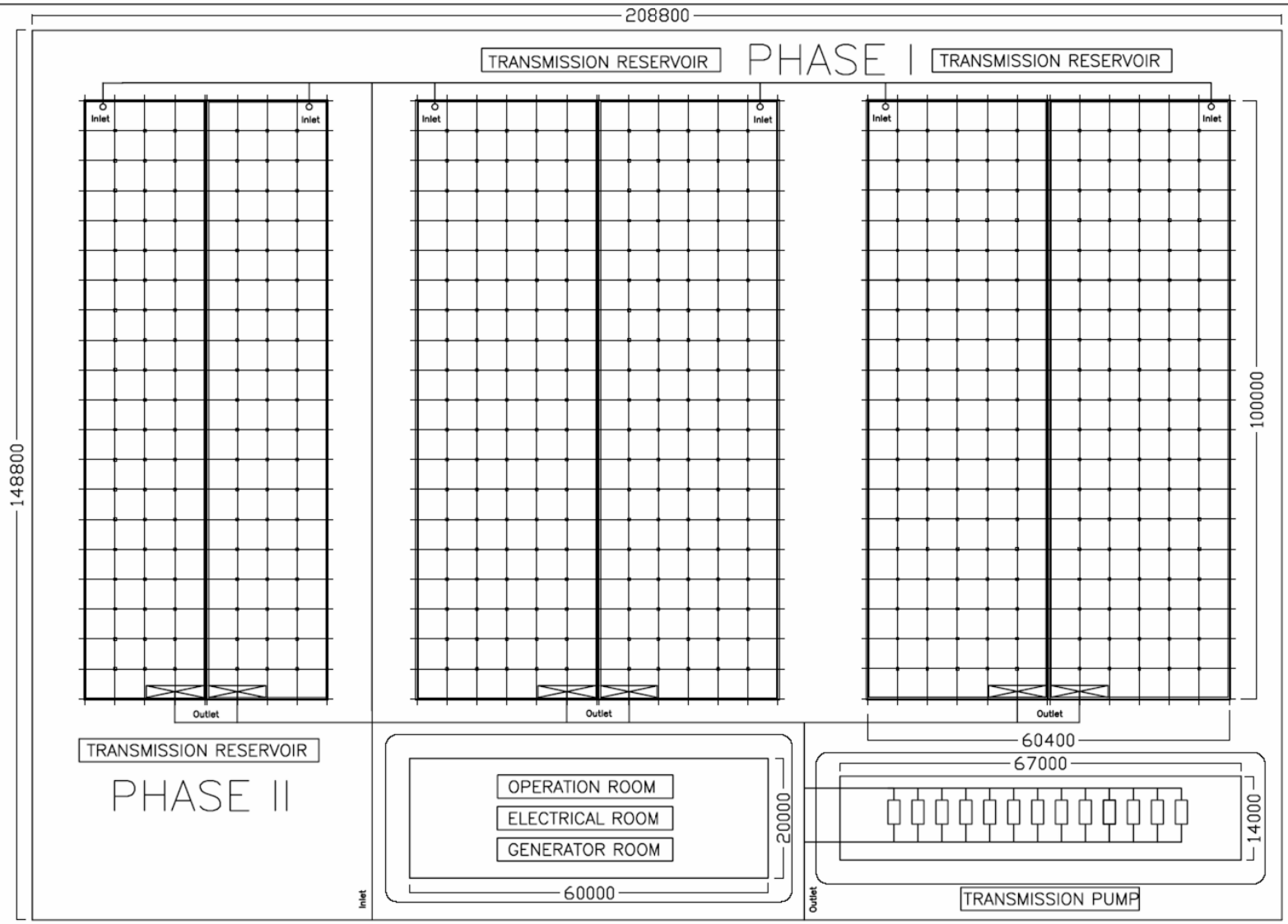
The following table shows summary of transmission facilities.

Table 4.5 Summary of Capacity of Transmission Facilities

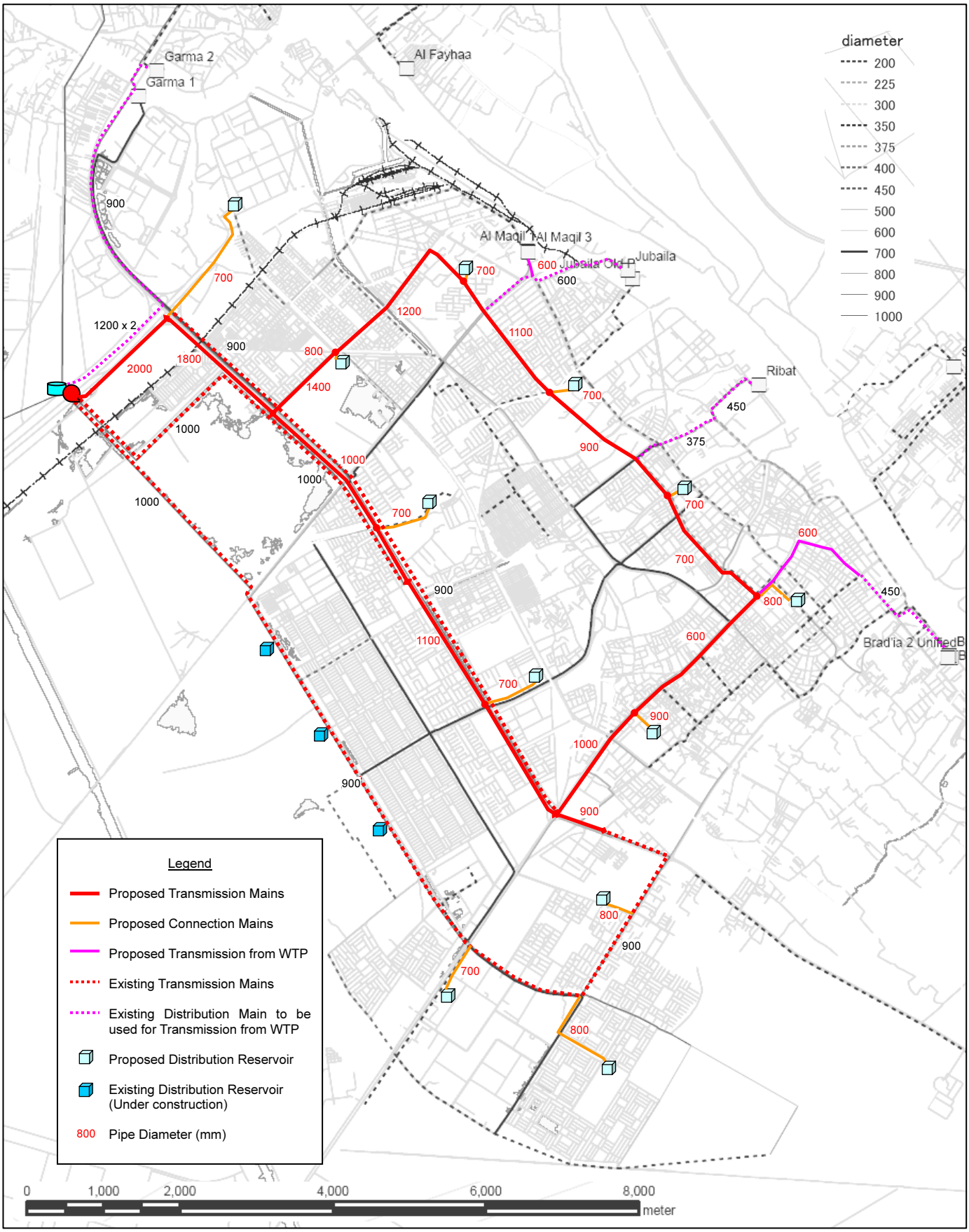
Transmission Pipeline		
Diameter (mm)	Ring main (m)	Ring main branch (m)
2,000	1,900	0
1,800	2,000	0
1,400	1,200	0
1,200	2,500	0
1,100	3,600	0
1,000	5,500	0
900	3,800	400
800	0	3,000
700	1,800	5,000
600	2,300	0
Total	24,600	8,400
600 mm - 2000 mm		33,000
Transmission Reservoir		
Volume	64,000 m^3	
Transmission Pumping Station		
Discharge	710,000 m^3/day (29,600 m^3/h) at final stage	
Head	60 m when distribution main facilities are not ready, and 40 m when distribution main facilities are ready	

Transmission facilities consist of transmission reservoir, pumping house, operation room, electrical

room and generator room. The general layout of main transmission facilities is shown in Figure 4.5, the route and diameter of transmission in Figure 4.6.



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq	General Layout of Main Transmission Facilities	Fig. No. 4.5



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	Proposed Transmission System with Existing Transmission Mains	**Fig No.** 4.6

4.8 DISTRIBUTION MAIN FACILITIES

The main distribution facilities of 13 zones were designed considering flowing criteria:

1) Total capacity of a reservoir (ground reservoir and elevated tank): 8 hours of the maximum day demand
   - Capacity of ground reservoir: 7.5 hours of maximum day water demand
   - Capacity of elevated tank: 0.5 hours of maximum day water demand
2) Transfer pump: peak hour water demand ; 40 m head
3) Capacity of distribution pipe: peak hour water demand
4) Service pressure: 15 m
5) Pipe material: HDPE (diameter less than 350 mm) and DCIP (diameter more than 400 mm)

Based on the design criteria mentioned above, the capacity of proposed distribution facilities are estimated as shown in Table 4.6 and using the prepared network model, the required strengthening of distribution network are estimated as shown in Table 4.7.

Table 4.6 Capacity of Distribution Main facilities of 13 Zones

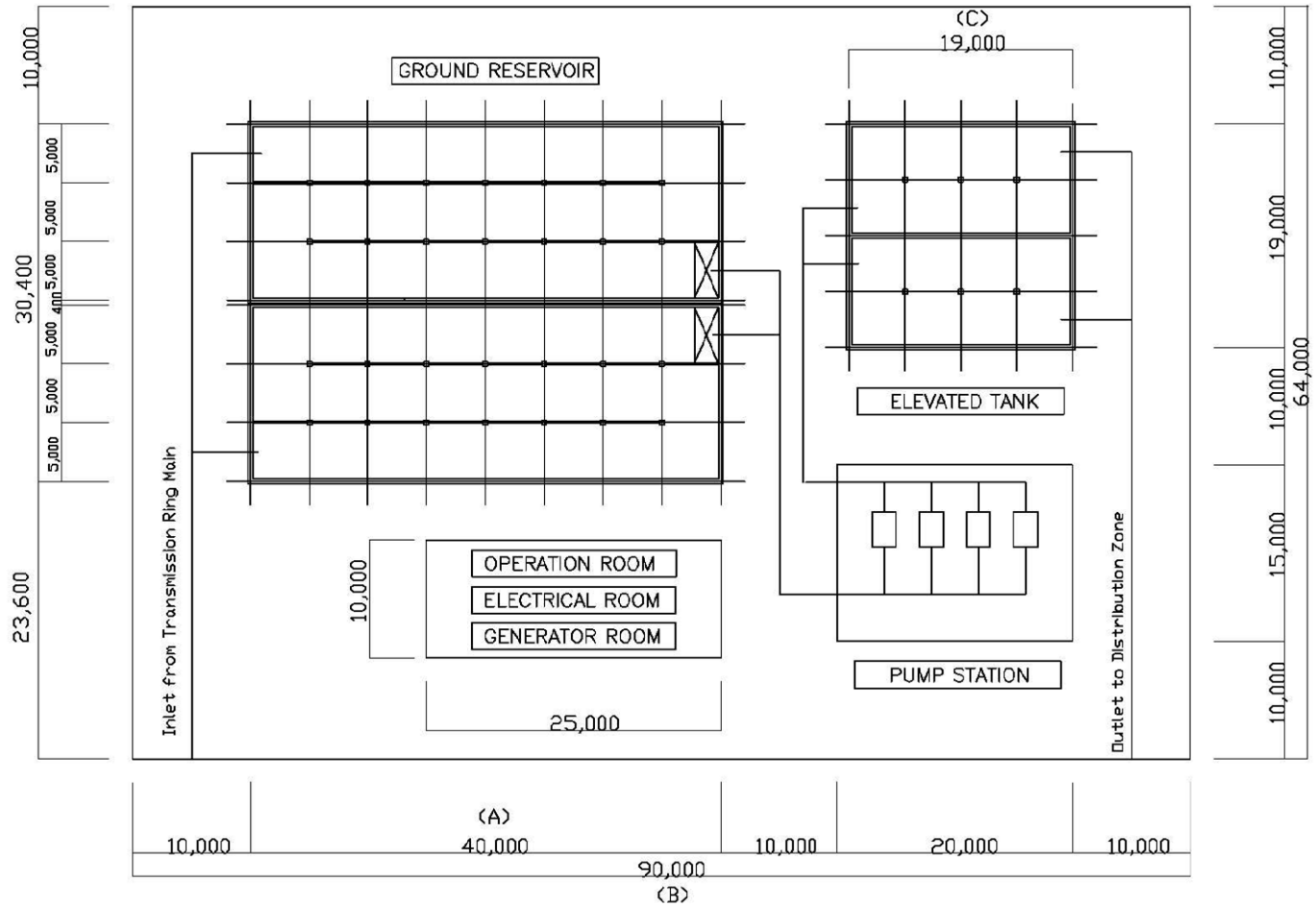
Zone No.	Water Demand			Ground Reservoir	Transfer Pumping Station		Elevated Tank
	Ave day	Max day	Peak hour				
	m^3/day	m^3/day	m^3/day	m^3	m^3/day	m^3/hr	m^3
1	27,000	37,700	60,399	12,000	60,000	2,500	800
2	26,300	36,900	59,018	12,000	59,000	2,500	800
3	29,700	41,600	66,591	13,000	67,000	2,800	900
4	35,800	50,200	80,241	16,000	80,000	3,400	1,000
5	42,500	59,600	95,285	19,000	95,000	4,000	1,200
6	43,500	60,900	97,475	19,000	97,000	4,100	1,300
7	41,400	57,900	92,713	18,000	93,000	3,900	1,200
8	46,000	64,400	103,030	20,000	103,000	4,300	1,300
9	41,700	58,400	93,376	18,000	93,000	3,900	1,200
10	38,100	53,300	85,311	17,000	85,000	3,600	1,100
11	29,600	41,400	66,225	13,000	66,000	2,800	900
12	20,800	29,200	46,644	9,000	47,000	2,000	600
13	44,200	61,900	98,988	0	0	0	0
Total	466,600	653,400	1,045,296	186,000	945,000	39,800	12,300

Note: For Zone 13, distribution main facilities are under construction.

Table 4.7 Required Strengthening of Distribution Network

Diameter (mm)	Length (m)
700	3,500
600	2,000
500	6,300
400	6,100
355	2,500
315	2,600
280	2,200
250	1,000
200	900
Total	27,100

The general layout and section plan of distribution main facilities including operation room, electrical room and generator room are shown in Figure 4.7 and Figure 4.8. The required strengthening of distribution network is calculated by network analysis software, EPA NET2, and proposed lines are presented in Figure 4.9.

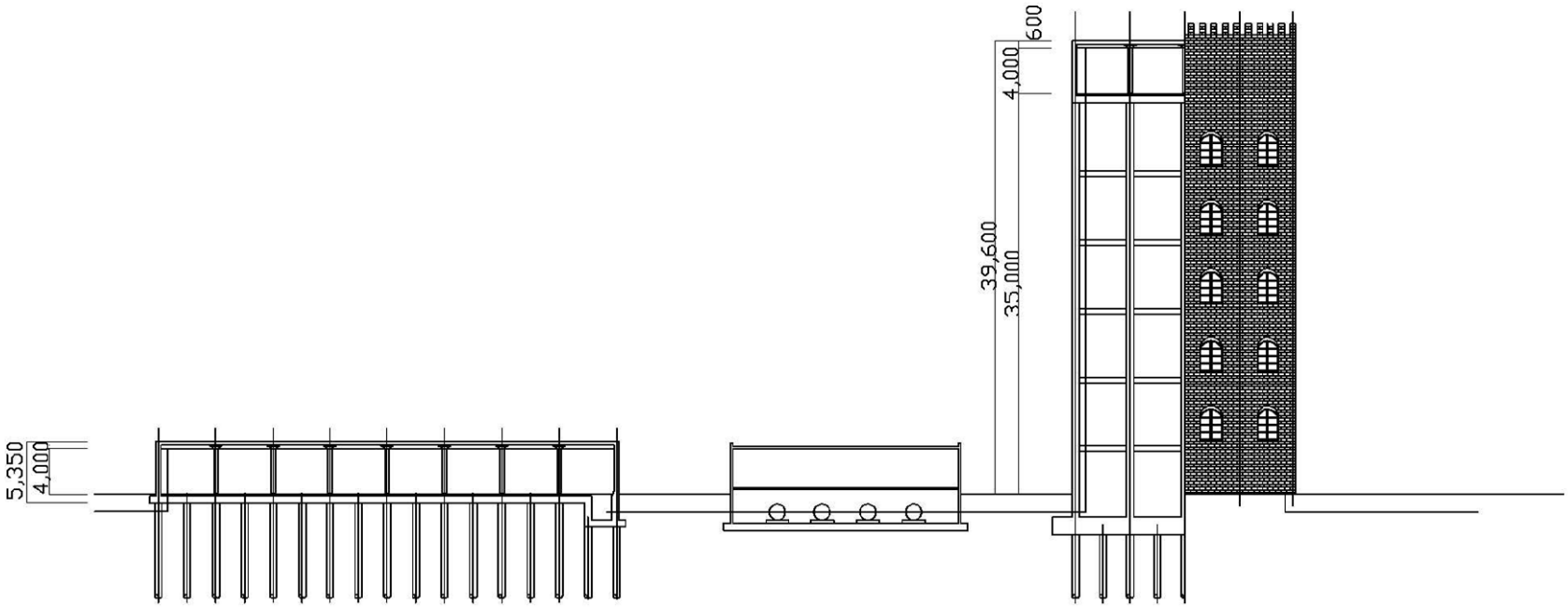


No.	(A)	(B)	(C)	(D)
1	25.0	75.0	15.0	56.0
2	25.0	75.0	14.0	55.0
3	25.0	75.0	14.0	55.0
4	30.0	80.0	15.0	56.0
5	35.0	85.0	16.0	57.0
6	35.0	85.0	16.0	57.0
7	35.0	85.0	16.0	57.0
8	40.0	90.0	19.0	60.0
9	35.0	85.0	17.0	58.0
10	35.0	85.0	16.0	57.0
11	25.0	25.0	14.0	55.0
12	20.0	20.0	13.0	54.0

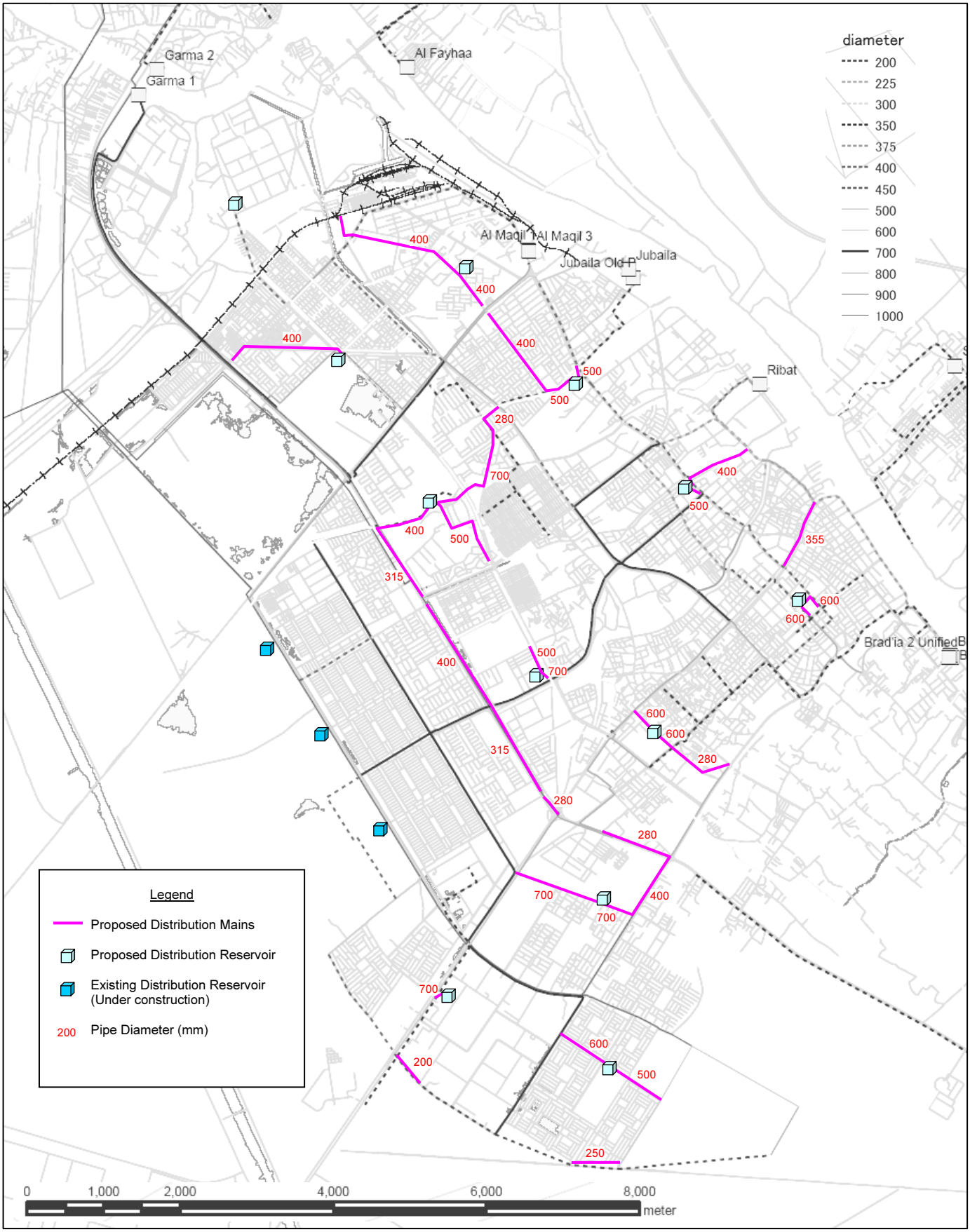
The Feasibility Study on Improvement of the Water Supply System in Al-Basrah and Its Surroundings in the Republic of Iraq

General Layout of Main Distribution Facilities

Fig. No. 4.7



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah and Its Surroundings in the Republic of Iraq	General Section Profile of Main Distribution Facilities	Fig. No. 4.8



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	Proposed Distribution Mains to Strengthen the Existing Distribution Network for Zoning	**Fig No.** 4.9

CHAPTER 5

WATER DISTRIBUTION MANAGEMENT

CHAPTER 5 WATER DISTRIBUTION MANAGEMENT

5.1 WATER DISTRIBUTION MANAGEMENT

Water distribution management is required for following purposes:

- Control of production and transmission flow
- Control of distribution flow and pressure in a water distribution zone
- Equitable water distribution
- Leakage control

(1) Production, Transmission and Distribution Management

According to implementation of the WSPCB, several existing water treatment plants, new water treatment plants and a RO plant will be operational. The produced flow of these plants and transferred flow to each distribution zone should be appropriately managed to meet the water demand, which fluctuates seasonally, weekly, daily or hourly and to attain equitable water allocation in the entire service area.

In addition, the TDS concentration of raw water differs source by source and fluctuates seasonally. Therefore, decisions are required regarding water sources that should be utilized with priority considering the seasonally fluctuating demand and the different TDS concentration of the sources. To reduce TDS, a RO plant will be introduced. The operation of RO plant is very costly and therefore, it should be appropriately minimized considering the available flow of low TDS source. To make these decisions, the flow and TDS concentration of source, water treatment plants and transmission flow should be managed.

From the transmission pumping station, the treated water is transferred to distribution reservoirs in 13 water distribution zones. Appropriate flow should be transferred to each distribution reservoir. To do so, the transferred and required flows of each zone should be managed.

To manage water flow and TDS concentration, monitoring and control systems are required. Figure 5.1 illustrates a concept of monitoring and control system. To acquire the data/information, analyze them and control or give direction, a flow management center is required, which should be located in the main transmission facilities.

Monitoring and control items by facilities are tabulated in Table 5.1. Monitoring and control could be carried by using Supervisory Control and Data Acquisition (SCADA) system in future.

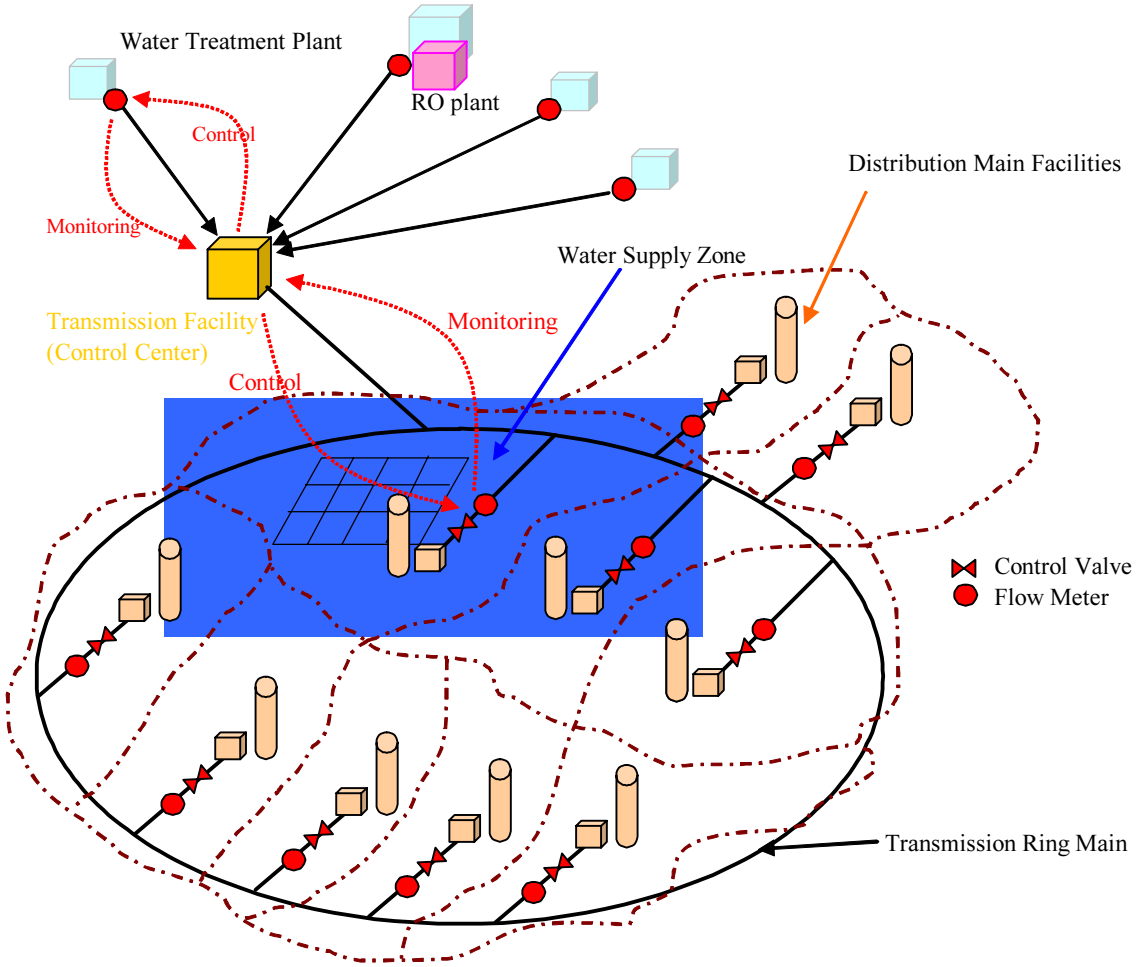


Figure 5.1 Concept of Monitoring and Control System

Table 5.1 Monitoring Items and Control Items in each Facilities

Facilities	Monitoring Item	Control Item
Source water	- Water level and flow of source	
Water treatment plant	- Inlet flow - TDS of inlet - Water level of clear water reservoir - Outlet flow - TDS of outlet	- Production flow
Main transmission facilities	- Inlet flow of transmission reservoir - Water level of reservoir - TDS of inlet - Outlet flow	- Pump operation
Main distribution facilities	- Inlet flow of distribution reservoir - Water level of reservoir - Outlet flow - Demand fluctuation in water distribution zone	- Inflow from ring main

(2) District Metered Area (DMA) Management

1) Purpose of DMA

After the Gulf Wars and the international sanctions, the distribution network seems almost ruined with high leakage ratio, probably around 50 %. The details about leakage are discussed in CHAPTER 6. To reduce leakage, the concept of District Metered Areas (DMA) management should be introduced to the Basrah distribution network.

The leakage could be controlled through direct and combined methods. The former includes leak detection, repair, and correction of illegal connections and the latter includes analysis of the balance of actual consumption and distributed volume, hydraulic analysis, proper management of pipe networks, and rationalization of the collection-of-rates system. Before the leakage control, rehabilitation of the distribution network is required. After that, DMA management should be introduced for NRW reduction programs.

2) Concept of DMA

The concept of DMA is illustrated in Figure 5.2 and the water distribution zone has the hierarchy of Water Distribution Zone, Sub-Water Distribution Zone and DMA.

After introduction of DMA, the following benefits are expected:

- Adequate hydraulic pressure is assured.
- Leakage point and amount of leakage water can be grasped easily.
- When carrying out water rationing, it becomes an independent unit.
- The area of influence can be limited when the water must be stopped in repair work etc.
- Restoration becomes easier at the time of disasters.

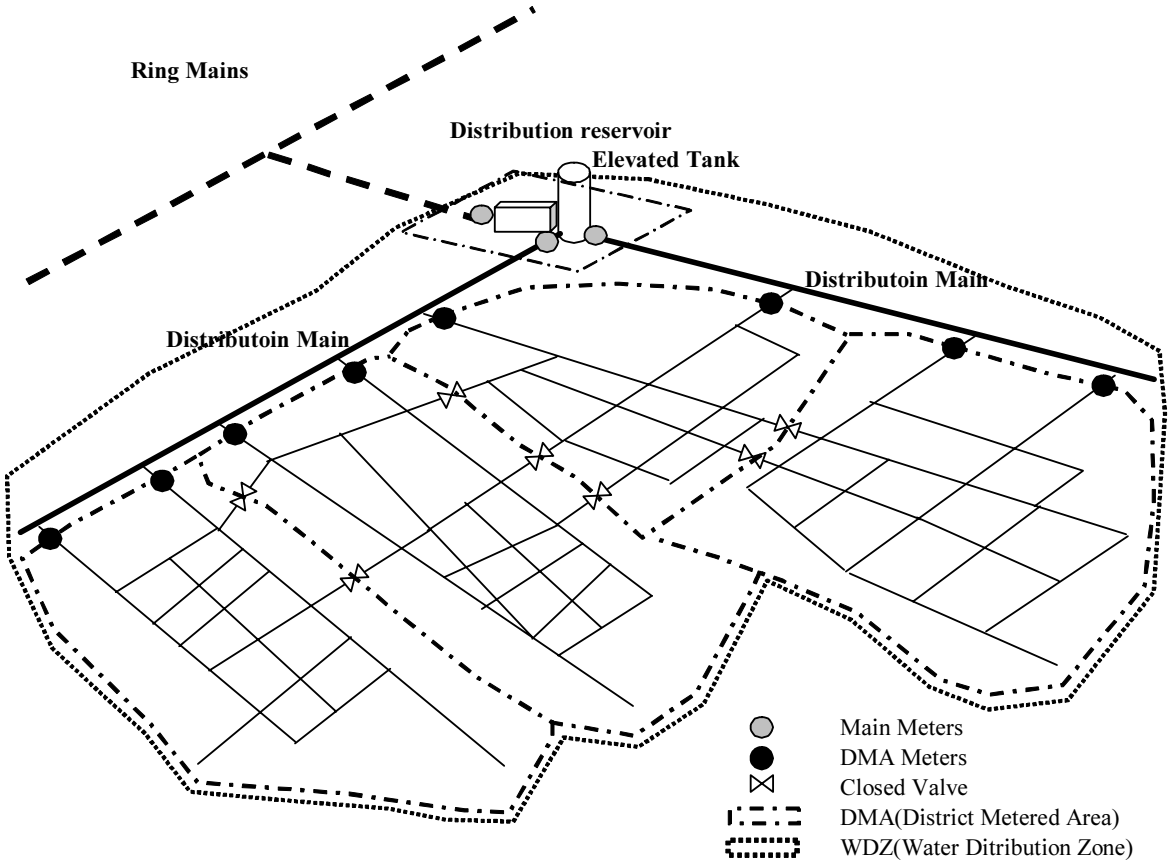


Figure 5.2 Concept of DMA

a) Water Distribution Zone

Water is transmitted to several distribution service reservoirs from transmission facilities, and distributed from each service reservoir. The area which becomes independent by some valves to which water is supplied from one or more service reservoir is defined as "Water Distribution Zone". If necessary, a control valve is installed in Distribution Main inlet just behind a service reservoir or a distribution pump, along with a flow meter, and control of flow and pressure would be carried out.

b) Sub Water Distribution Zone

It is divided from geographical feature-division, for example a hill, a river, a railroad, an arterial road, etc., and distribution of pipe network. From the other side, it will consist of aggregates of some DMA's and will be used for water supply control in a larger unit.

c) District Metered Area (DMA)

DMA is the minimum area which becomes independent from adjoining DMA by some valves, and the

consumption can be measured.

3) DMA system

DMA system is explained below and the model figure of a typical DMA is shown in Figure 5.3.

Item	Explanation.
Connection with distribution main	It is recommended that the connections with distribution mains should be minimized to reduce control and monitoring points. However, at least two distribution mains require to be connected to a DMA for emergency back up. In general, four inlets are to be installed. The diameter of each inlet would be between 400 to 250 mm based on the consumption and the number of inlet. A valve for flow control and a flow meter at each inlet should be installed.
Sub District Metered Area (SDMA)	Sub District Metered Area (SDMA) is a minimum unit, which can be separated by valves in case of pipe failure caused by accidents and repair works. One inlet of a DMA is used for inlet of a SDMA and, therefore, the number of inlets of a DMA is the same number of SDMA. Inlet valves are usually fully opened. According to the arrangement of SDMA, about 250mm – 300mm diameter pipelines are planned as secondary pipes, and 150mm diameter pipelines as tertiary pipe.
Flow meters	Permanent flow meters are preferable but not necessarily required if SCADA system is not considered. Basically, permanent flow meters are required only for the outlet of service reservoirs. Installing permanent flow meter for each DMA inlet is not feasible from financial view point. Therefore, only pits are proposed to be installed and portable flow-meter should be installed to measure the flow when required.
Valves	Generally, leakage increases according to increase in water pressure. Therefore, supplying water at a low pressure could reduce leakage to a great extent. To control water pressure within an appropriate level, hydraulic-pressure control valves, such as pressure reducing or pressure control valves, should be installed in the inlet of DMA. This approach is effective for water pressure management at water distribution zone level.

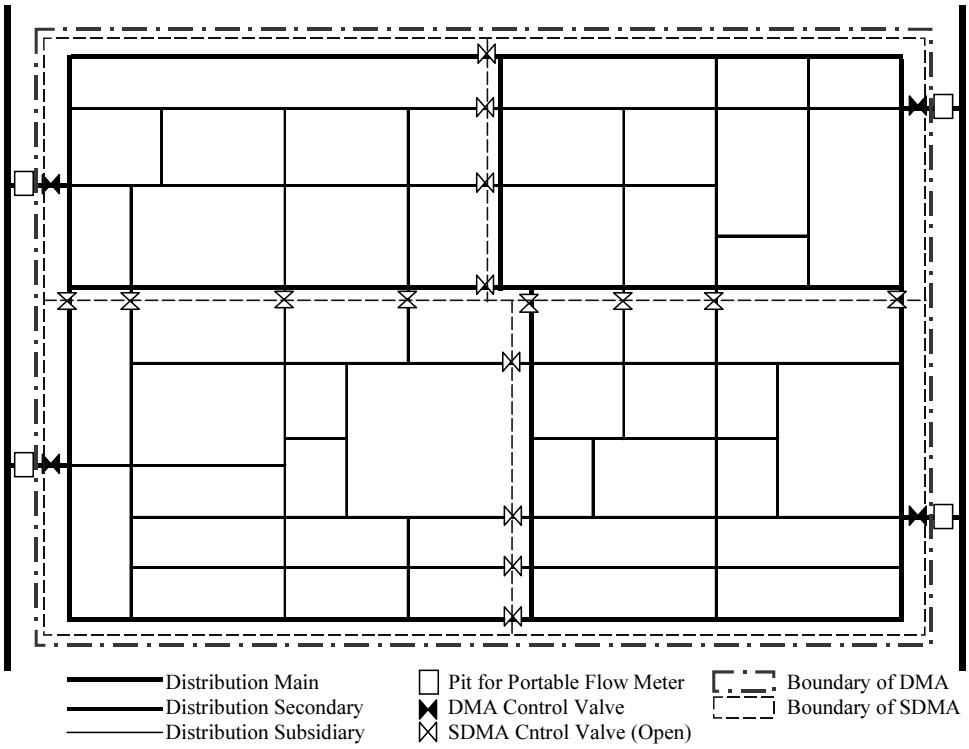


Figure 5.3 Typical DMA

4) Monitoring and Inspection of DMA

Monitoring of flow and pressure and leakage inspection is carried out considering DMA as a unit. This unit can also be used as a pilot area for NRW action plan. Water meter is installed for all consumers in principle, and it enables then to grasp the amount of water consumed. NRW figures in the DMA can be grasped by the comparison between the inlet flow measured by portable flow meter and the total consumption. Moreover, leakage can also be assumed by measuring the flow during night time and daytime. A typical 24 hour flow profile of the components of leakage and customer use is shown in Figure 5.4.

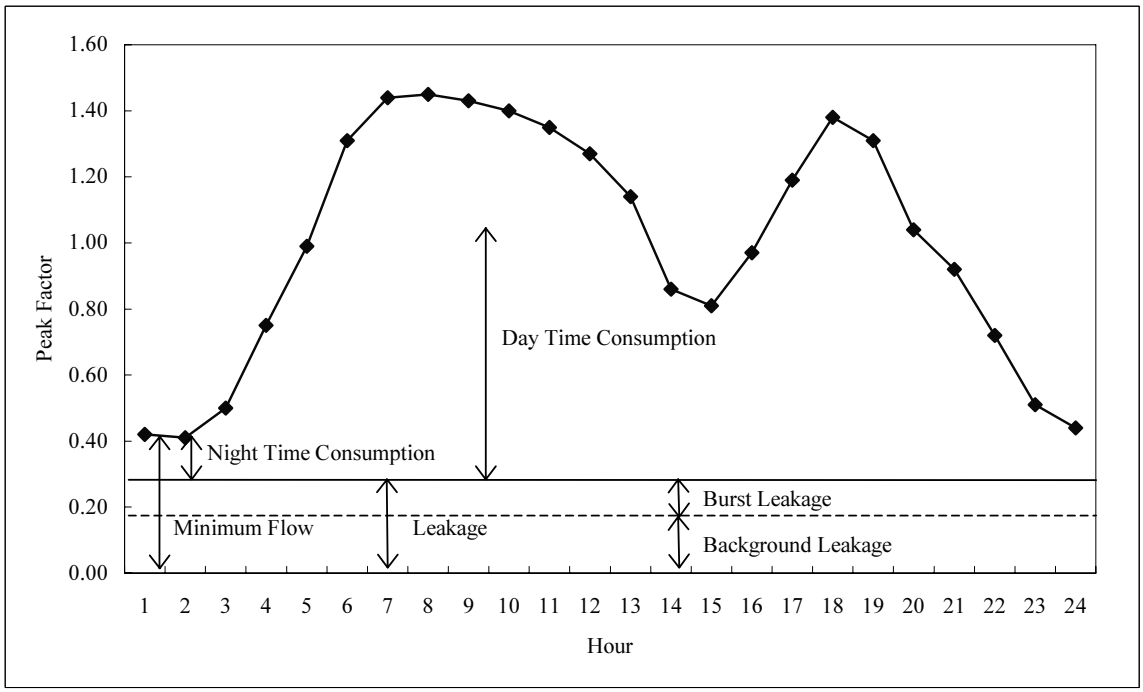


Figure 5.4 A Typical 24 hour Flow Profile showing Leakage and Actual Consumption

5.2 GIS APPLICATION FOR WATER DISTRIBUTION MANAGEMENT

GIS (Geographic Information System) is a powerful tool for management as well as planning of water supply system. The GIS for water supply system is comprised of several data/information. These data are a combination of graphical data and describes object geometry and include locations of water supply facilities and other relevant facilities, attributes of these facilities (age, diameter, materials, etc), monitoring data (flow, pressure, pipe breaks, water quality etc), and customer data/information such as individual water meters. These data are stored in specific GIS computer software for effective data/information management. Using these data/information and GIS software tools, water distribution management will be more effectively carried out. In addition, GIS is used effectively for water supply utility management.

This section describes the existing GIS in Basrah Water Directorate (BWD) and the possible application of GIS to the management of water supply system. For additional data explanation of GIS Appendix L is prepared.

5.2.1 Existing GIS

(1) GIS in BWD

At present, two departments utilize GIS tool in BWD.

- Computer Department
- Basrah Sewerage Directorate

There is no cooperation to exchange the information between these two organizations and BWD doesn't have any plan to create GIS data.

The personnel of the Computer Department have received training from 3 institutions and they produced GIS data of water supply system. However, these equipment and the created database are not effectively utilized in the water supply system management. Also GIS system now cannot be activated. The GIS projects implemented are shown in Table 5.2.

Table 5.2 Contents of GIS Project of BWD

Item	Training organization		
	Norwegian Church Aid	Private Company	UK army
Implementation Period	November.2003~March.2004	2004~2005	2006
Contents of the project	- Training of Arc GIS - Installation of computer for GIS and software	- Training of Arc GIS - Procurement of computer for GIS and software	Input of the information on pipe network, WTP and Leakage
Input data	Pipeline network	The data created at the time of the training has not been kept in BWD.	Distribution network Location of the leakage

(2) JICA GIS Maps

For planning purpose of this study, the study team created a GIS base map including the following features and specifications.

Table 5.3 GIS Features and Satellite Images for GIS Basic Map

Feature	Feature size in satellite images	Layer Type	Specification
Road	Less than 20m in width	Line	The roads with more than around 5 m in width were created. ➢ Road with asphalt: ・ 10-19m: The center of road was depicted. ・ More than 20m: The both sides of the road were depicted. ➢ Road without asphalt: ・ The road with 20m or more in width: The center of road was depicted. Three layers were created: 5 – 9 m, 10 - 19m and more than 20m.
	More than 20m in width	Poly-line	
River	Less than 20m in width	Line	The center of river was depicted.
	More than 20m in width	Polygon	The river with 20m or more in width was depicted.
Canal	Less than 20m in width	Line	The center of canal was depicted.
	More than 20m in width	Polygon	The canal with 20m or more in width was depicted.
Sweet Water Canal	All lines	Poly-line	The both sides of sweet water canal were depicted.
Rail	All lines	Line	The center of railway was depicted.
Lake, Pond	Visible images	Polygon	The visible lake and the pond were depicted.
Airport		Line Polygon	The area of airport and main roads were depicted. The landing field was depicted.

Location and some attributes of existing water supply facilities were collected through sub-contract works in Iraq. Using these data, existing facility layers shown in Figure 5.5 were created using the base map. The created data were used for planning in this study to identify location and area of proposed facilities. Samples of created layers of existing facilities are shown in Figure 5.6. In addition, the details on map and map attribute data are listed in Appendix L. These map and attribute data are not completed due to insufficient and unreliable data and BWD should improve those using actual and reliable data.

- Water treatment plant
- Pumping station
- Raw water transmission pipeline
- Main distribution pipeline of diameter more than 250 mm

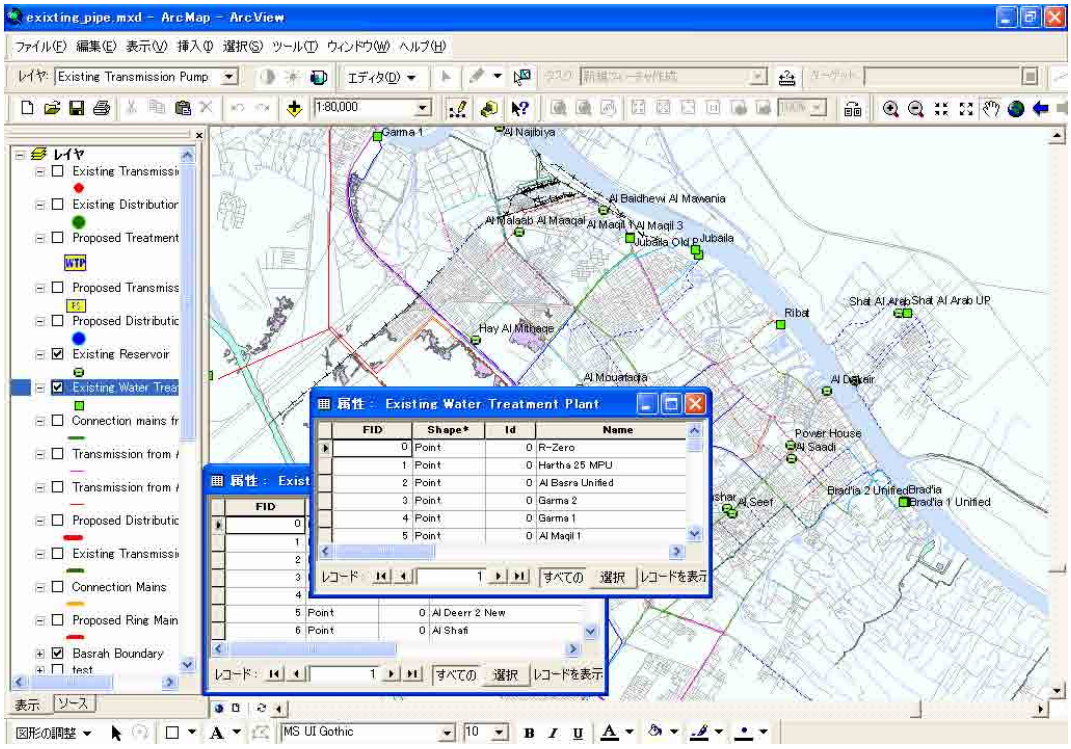


Figure 5.5 Sample Image of Layer of Existing Facilities

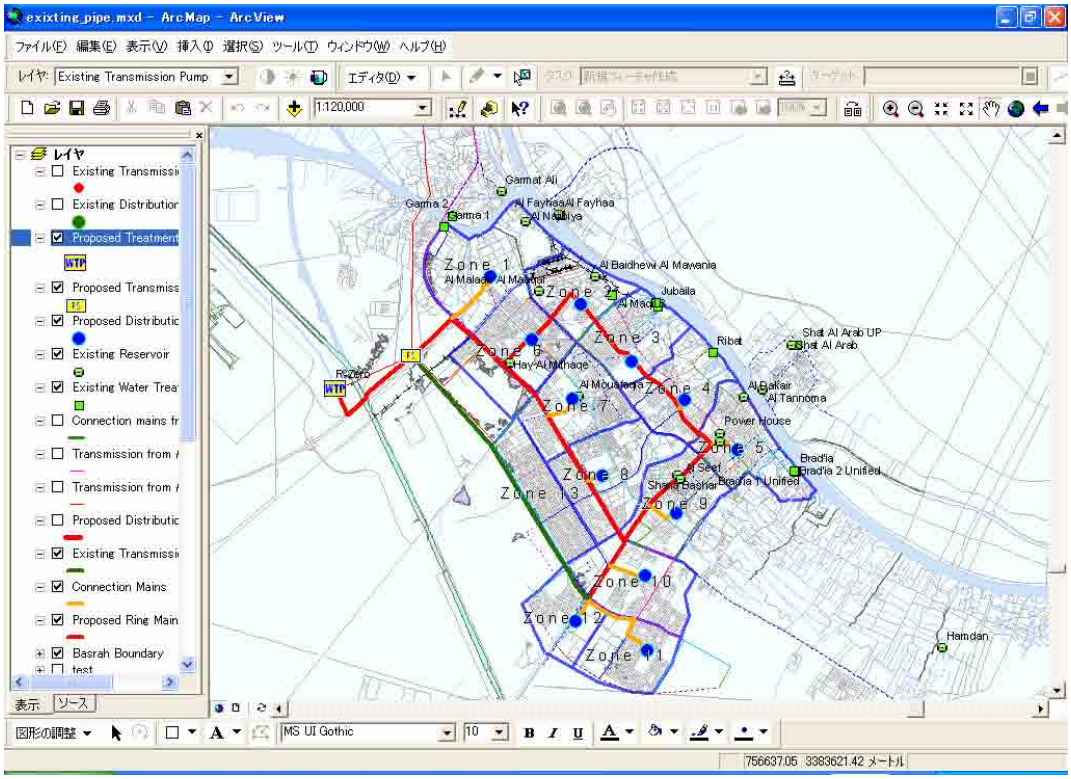


Figure 5.6 Sample Image of Proposed Water Supply Facilities (Zones and Transmission Main)

5.2.2 Possible Application of GIS for Water Supply System Management

GIS is a powerful tool to be used for management of water supply system as well as a planning tool. If GIS is used effectively for water supply utility management, the utility could save many resources and use them effectively, increase bill collection and attain an efficient modern utility. The following are possible applications of GIS for management.

- Information management of specifications of water supply facilities and the conditions of operation and maintenance
- Hydraulic network analysis of efficient water distribution management
- Reduction of unaccounted-for water
- Evaluation of distribution facilities and supplied water quality
- Efficient supervision of construction work for pipeline
- Management of water charge collection

(1) Information management of specifications of water supply facilities and the conditions of operation and maintenance

The first step to efficient management of the utility is to understand existing conditions. Without this, no utility manager could manage the utility appropriately. To do this, the information of water supply facilities and the condition of operation and maintenance should be collected and stored in GIS. GIS helps providing needed information whenever and wherever required; i.e., in case of facilities replacement due to aging and accidents, and emergency countermeasures to disaster. The information to be stored in GIS for waterworks management is shown in Table 5.4.

Table 5.4 Information to be stocked in GIS for Waterworks Management

Facilities	
Intake	➢ Intake facilities: location, quantity, quality of raw water, construction year and condition of O&M ➢ Intake pump: number, capacity, installation year and condition of O&M
Water treatment plant	➢ Location, capacity, quality of treated water, construction year and condition of O&M
Distribution	➢ Distribution reservoir and elevated tank: capacity, number of basins, construction year and condition of O&M
Pipeline and pump station	➢ Pipeline: diameter, material, length, installation year and condition of O&M ➢ Pump: number, capacity, installation year and condition of O&M
Drawings	
Drawings for water supply facilities	➢ Ground plan and structural drawing: intake facilities, pump station, water treatment plan, distribution reservoir and elevated tank ➢ Ground Plan and detailed plan: pipeline of conveyance, transmission and distribution
Operation and Maintenance	
The contents of replacement	➢ The condition of damage: damage of facilities, pipeline and equipments, leakage ➢ The contents of repair/replacement: date, period, cost and drawings
The customer information	➢ Location of customer, address, water consumption and condition of the water charge collection

(2) Efficient water distribution management

For efficient water distribution management, hydraulic analysis of network is required. To do this, the network data stocked in GIS could be used. Also the flow data recorded through the water meters of water productions and zones could be stored in GIS and used for water distribution management.

(3) Reduction of non- revenue water

Currently a large amount of water is being wasted as leakage. The rate of the present leakage was assumed as 50% due to pipeline damages and illegal connections. It is necessity to establish an appropriate water supply system that prevents pipeline damages and illegal connections. In GIS, the information of leakage and illegal connections can be input into database and the location, where repair/replacement is required for prevention of the leakage, could be decided. Therefore, GIS will help implementing necessary actions for leakage control.

(4) Evaluation of the distribution facilities

In order to solve the hydraulic problems, we need to understand clearly what is going on in that part of networks. These are clarified and solved by relating GIS to network analysis software. In GIS, the location and attribute information on distribution facilities such as pumps, reservoirs and pipes are input into database. Using these data, the parts that have hydraulic problems can be clarified in

network analysis. The main results of network analysis are service pressure, unit head loss and velocity. The parts of the network that do not comply with the stipulated criteria for distribution are required to be replaced.

(5) Residual chlorine management

Using GIS data, the behavior of residual chlorine in the network could be evaluated by using network analysis. Chemical dosing in water treatment plants and reservoirs could also be managed.

(6) Efficient construction works of pipeline

In order to conduct effective and accident-proof construction works of pipe-laying, it is necessary to confirm the location and specifications of underground facilities such as sewer, gas pipeline and electric cable at the construction site. In GIS, the location and attribute information of those objects can be input into database for this purpose. During the construction of pipelines, the required details can be obtained immediately from GIS database. After the construction, the construction records including as-built drawings should be stored in GIS database for utilization of the information by other organizations.

(7) Management of water charge collection and customer data

The water utility should store the records (location, meter condition etc.) of customers in GIS. By identifying non-payment customers geographically, the bill collection rate could be improved.

The routes of meter reading could be stocked for water charge collection. Meter readers could use this for preparing a route map for efficient water charge collection.

(8) Updating of GIS database

GIS could not be used as an effective tool unless it is updated periodically. The water utility requires cooperation with other organizations such as of sewerage, gas, electric and road for collecting and updating of information.

CHAPTER 6

NON REVENUE WATER CONTROL PLAN

CHAPTER 6 NON REVENUE WATER CONTROL PLAN

6.1 INTRODUCTION

The non- revenue water (NRW) control plan is an important element of the overall plan for improvement of any water supply system. With a high NRW ratio, neither the produced water can be effectively used for the customers nor can water supply bodies be sustainable. Leakage, a major component of the NRW, causes the reduction of distribution pressure and consumption. Furthermore, the low pressure caused by leakage degrades water quality by intrusion of pollution in pipes. In this section, the NRW control plan is prepared for BWD to achieve a sustainable water supply body and to improve current water supply conditions.

6.2 COMPONENTS OF NON-REVENUE WATER

The following are definitions and explanation of principal components of water balance and NRW of International Water Association (IWA).

<table>
<tr><td rowspan="8">System Input Volume</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Non-metered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Non-metered Consumption</td></tr>
<tr><td rowspan="4">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility’s Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to Customers’ Meters</td></tr>
</table>

Source: IWA Best Practice” Water Balance and Terminology

- Non-Revenue Water is the difference between system input volume and billed authorized consumption
- Authorized Consumption is the annual volume of metered and/or non-metered water taken by registered customers, water suppliers, and others who are implicitly or explicitly authorized to do so for residential, commercial, and industrial purposes. It includes water that is exported.
  - ✧ Unbilled Authorized Consumption can include water used for fire fighting or free water distributed at standpipes or provided to religious institutions. (usually a minor component of water balance)

- Water Losses can be identified by calculating the difference between system input volume and authorized consumption. They consist of apparent losses and real losses.
  - ✧ Apparent Losses result from unauthorized consumption (illegal consumption) and all types of inaccuracies associated with metering, such as malfunctioning water meters, estimated water consumption (when meters are not working), and misreading water meters.
  - ✧ Real Losses result from losses at mains, service reservoirs, and service connections (up to the point of customer metering). The annual volume lost through all types of leaks, bursts, and overflows depends on their individual frequencies, flow rates, and duration. Experience has shown that most leakage results from service connections, and to a large extent this is due to poor construction.

6.3 CURRENT AND TARGET WATER BALANCE IN BASRAH WATER DIRECTORATE

6.3.1 Baseline Summary

To estimate the water balance of Basrah Governorate, a baseline of the network is summarized as follows:

- Production
  - System Input: 508,000 m^3/day (BWD)
- Network Condition
  - Average age of the network is 30 years
  - About 80% of the network is asbestos cement (according to available data)
  - Joints – Most joints are leak prone, lead caulked joints (probably)
  - Substantial leakage on transmission pipes
  - Lack of capital investment for a long time
  - Lack of O & M resources
  - Substantial leakage on service pipes (probably)
  - Substantial illegal connections (30%)
- Cause of NRW
  - Old pipes
  - Corroded old tanks in treatment plants
  - Bad maintenance and operation of pumps and treatment plants
  - Illegal connections
  - Non official use
- Current measure of NRW reduction
  - Replace old pipes and asbestos cement (AC) pipes by new pipes with proper

diameter in accordance with the future demand.

- Service level
  - Most areas have very low or no pressures
  - Large areas have intermittent supplies
  - Valve operation limits supply to some areas (probably)
  - Demand exceeds supply
- Water Supply Department Operations
  - No NRW control plan & activity
  - Repair teams under –equipped
  - Passive leakage control
  - Lack of regulation and or enforcement for consumers
- Flow Measurement
  - No production or distribution zone flow metering
- Consumers
  - No metering
  - Fixed water rate
- Network Data
  - Maps incomplete and out of date
- Existing equipment for leakage detection
  - Water pipe leak detectors (3)

6.3.2 Estimation of Current Water Balance

(1) Example: Water Balance of Tokyo

Table 6.1 presents a water balance of Tokyo in 1996 as an example. The NRW in 1996 was 11.4 %, of which 8.9 % comes from real loss or leakage. Figure 6.1 shows the trend of leakage ratio in Japan. After the war, the NRW ratio was about 80 % but shortly reduced to around 30 % within 5 years. After that it took 10 to 20 years to attain 20%, 35 years to attain 15% and almost 50 years to attain 10%. To reduce leakage to some reasonable level, continuous, long term efforts are required.

Table 6.1 Example of Water Balance in Tokyo in 1996

<table>
<tr><td rowspan="6">System Input Volume (100%)</td><td rowspan="3">Authorized Consumption (90.6%)</td><td rowspan="2">Billed Authorized Consumption (88.5%)</td><td>Billed Metered Consumption (including water exported) (88.5%)</td><td rowspan="2">Revenue Water (88.6%)</td></tr>
<tr><td>Billed Non-metered Consumption (0)</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption (2.1%)</td><td>Unbilled Metered Consumption (2.1%)</td><td rowspan="5">Non-Revenue Water (11.4%)</td></tr>
<tr><td>Unbilled Non-metered Consumption (0)</td></tr>
<tr><td rowspan="3">Water Losses (9.4 %)</td><td rowspan="2">Apparent Losses (0.5%)</td><td>Unauthorized Consumption (0.3%)</td></tr>
<tr><td>Metering Inaccuracies (0.2%)</td></tr>
<tr><td>Real Losses (8.9%)</td><td>・Leakage on Transmission and/or Distribution Mains
・Leakage and Overflows at Utility's Storage Tanks
・Leakage on Service Connections up to Customers' Meters
(8.9%)</td></tr>
</table>

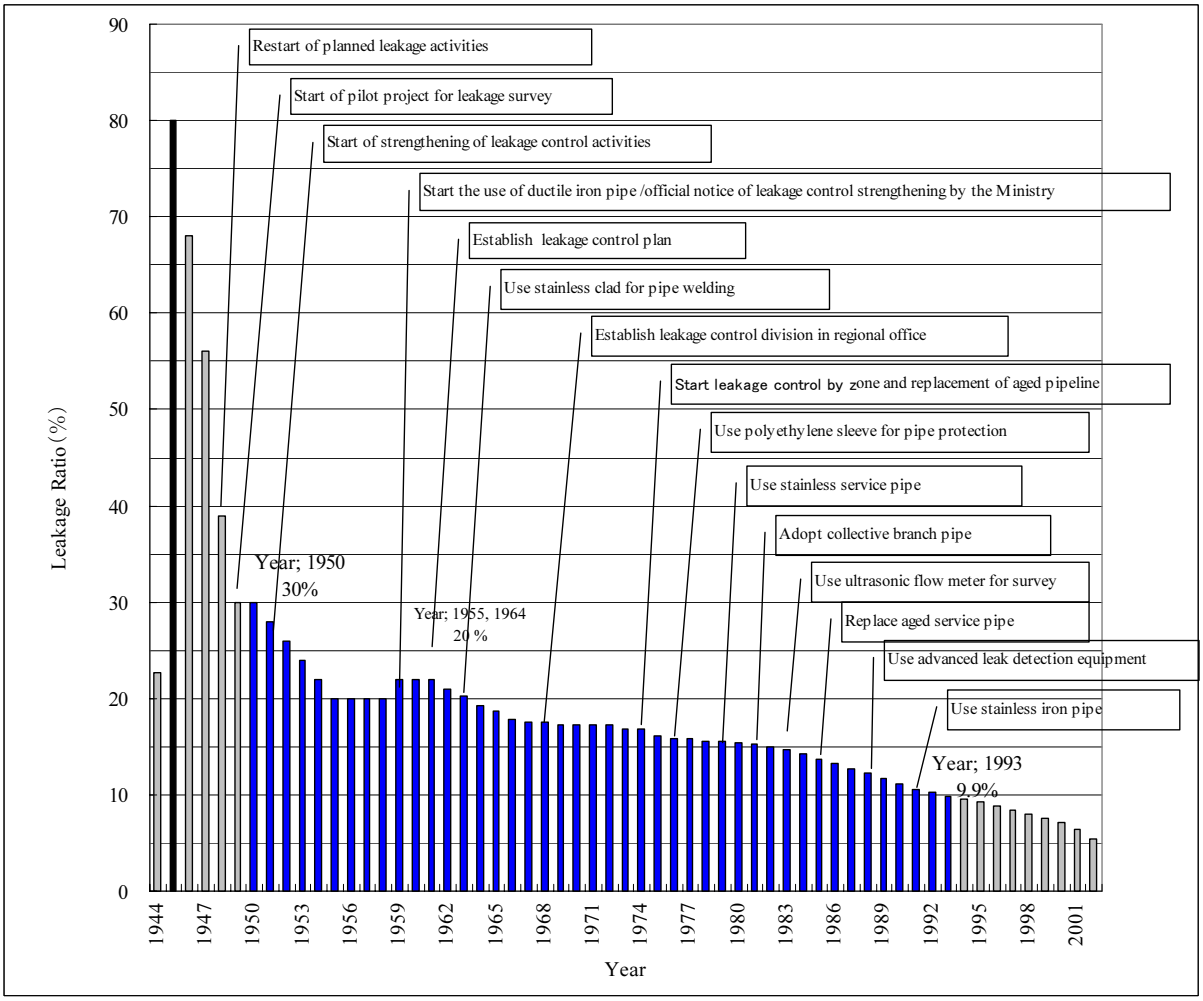


Figure 6.1 Trend of Reduction of Leakage Ratio and Leakage Control Measures in Tokyo

(2) Water Balance for the Water Supply System of BWD

Based on the current information of BWD, it is not possible to estimate water balance for the Water Supply System of BWD due to lack of reliable data as stated in baseline summary, especially of flow data. Therefore, the water balance in Table 6.2 is estimated as follows, based on the limited information, assumptions and experience and data in Japan and other countries:

- Current leakage (real loss) ratio: 50 % in transmission, distribution mains and service pipes
- Current apparent losses: 10 % mainly by illegal connections
- Current unbilled authorized consumption: 5 %, public offices and religious institutions

Table 6.2 An Estimate of Water Balance for the Water Supply System of BWD (%)

<table>
<tr><td rowspan="10">System Input Volume (100%)</td><td rowspan="4">Authorized Consumption (40%)</td><td rowspan="2">Billed Authorized Consumption (35%)</td><td>Billed Metered Consumption (0%)</td><td rowspan="2">Revenue Water (35%)</td></tr>
<tr><td>Billed Non-metered Consumption (35%)</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption (5%)</td><td>Unbilled Metered Consumption (0)</td><td rowspan="8">Non-Revenue Water (65%)</td></tr>
<tr><td>Unbilled Non-metered Consumption (5%)</td></tr>
<tr><td rowspan="6">Water Losses (60%)</td><td rowspan="2">Apparent Losses (10%)</td><td>Unauthorized Consumption (10%)</td></tr>
<tr><td>Metering Inaccuracies (0%)</td></tr>
<tr><td rowspan="3">Real Losses (50%)</td><td>Leakage on Transmission and/or Distribution Mains (20%)</td></tr>
<tr><td>Leakage and Overflows at Utility’s Storage Tanks (0%)</td></tr>
<tr><td>Leakage on Service Connections up to Customers’ Meters (30%)</td></tr>
</table>

Table 6.3 An Estimate of Water Balance for the Water Supply System of BWD (m^3/day)

<table>
<tr><td rowspan="8">508,000</td><td rowspan="4">203,000</td><td rowspan="2">178,000</td><td>0</td><td rowspan="2"></td></tr>
<tr><td>178,000</td><td>178,000</td></tr>
<tr><td rowspan="2">25,000</td><td>0</td><td rowspan="6"></td></tr>
<tr><td>25,000</td></tr>
<tr><td rowspan="4">305,000</td><td rowspan="2">51,000</td><td>51,000</td></tr>
<tr><td>0</td></tr>
<tr><td rowspan="3">254,000</td><td>102,000</td></tr>
<tr><td>0</td></tr>
<tr><td>152,000</td><td>330,000</td></tr>
</table>

Based on figures in the tables, 254,000 m^3/day or (50%) of the produced water is not used for consumption and 330,000 m^3/day (65 %) does not earn any money.

6.3.3 Target NRW Ratio

According to experiences in Japan, the NRW ratio was reduced from 70 % to 30 % within 5 years shortly after the war and then to 20 % in 10 to 15 years. Non-revenue water control should be carried out continuously by setting up the long-term targets. Therefore, the targets of the control plan is set as follows for 2015, the target year of WSPCB and 2025, the target year of Mini M/P based on the Japanese experience:

- The NRW ratio will be reduced from the current estimated 65 % to 35 % and the leakage ratio to 30 % in 2015
- The NRW ratio will be further reduced to 23% and the leakage ratio to 20 % in 2025

Table 6.4 shows the components of water balance of the current water production with following conditions:

(1) Current conditions (50% leakage)
(2) Without NRW control measure in 2015 (50%)
(3) With NRW control measure and target NRW reduction in 2015 (30%)
(4) With NRW control measure and target NRW reduction in 2025 (20%)

These targets will incur the following benefits for the customers and BWD.

- The leakage ratio will be decreased to 30 % or the water consumable volume will be increased by 121,600 m^3/day (304,000 – 182,400) in 2015 and by 184,400 m^3/day (304,000 – 119,600) in 2025. This is equivalent to the construction of new water treatment plant with a respective capacity.
- The water revenue will be increased to 2.1 times in 2015 and 2.5 times in 2025 assuming the current water tariff.

Table 6.4 Current and Target Water Balance of BWD

Estimated Water Balance of BWD Water Supply System in 2006
In 2006

System Input Volume 100%	Authorized Consumption 40%	Billed Authorized Consumption 35%	Billed Metered Consumption (0%)	Revenue Water 35%
			Billed Non-metered Consumption (35%)	
		Unbilled Authorized Consumption 5%	Unbilled Metered Consumption (0%)	Non-Revenue Water 65%
			Unbilled Non-metered Consumption (5%)	
	Water Losses 60%	Apparent Losses 10%	Unauthorized Consumption (10%)	
			Metering Inaccuracies (0%)	
		Real Losses 50%	Leakage on Transmission and/or Distribution Mains (20%)	
			Leakage and Overflows at Utility's Storage Tanks (0%)	
			Leakage on Service Connections up to Customers' Meters (30%)	

(Water Balance with the Current Water Production)

(unit: m3/day)

508,000	203,200	177,800	0	177,800
			177,800	
		25,400	0	330,200
			25,400	
	304,800	50,800	50,800	
			0	
		254,000	101,600	
			0	
			152,400	

508,000 m3/day : Current Average Water Production

Estimated Water Balance of BWD Water Supply System
In 2015 without NRW control

System Input Volume 100%	Authorized Consumption 40%	Billed Authorized Consumption 35%	Billed Metered Consumption (0%)	Revenue Water 35%
			Billed Non-metered Consumption (35%)	
		Unbilled Authorized Consumption 5%	Unbilled Metered Consumption (0%)	Non-Revenue Water 65%
			Unbilled Non-metered Consumption (5%)	
	Water Losses 60%	Apparent Losses 10%	Unauthorized Consumption (10%)	
			Metering Inaccuracies (0%)	
		Real Losses 50%	Leakage on Transmission and/or Distribution Mains (20%)	
			Leakage and Overflows at Utility's Storage Tanks (0%)	
			Leakage on Service Connections up to Customers' Meters (30%)	

(Water Balance Considering Water Demand in 2015)

(unit: m3/day)

608,000	243,200	212,800	0	212,800
			212,800	
		30,400	0	395,200
			30,400	
	364,800	60,800	60,800	
			0	
		304,000	121,600	
			0	
			182,400	

608,000 m3/day : Average Water Production

Target Water Balance of BWD Water Supply System
In 2015 with NRW control

System Input Volume 100%	Authorized Consumption 65%	Billed Authorized Consumption 60%	Billed Metered Consumption (60%)	Revenue Water (60%)
			Billed Non-metered Consumption (0%)	
		Unbilled Authorized Consumption 5%	Unbilled Metered Consumption (5%)	Non-Revenue Water (40%)
			Unbilled Non-metered Consumption (0%)	
	Water Losses 35%	Apparent Losses 5%	Unauthorized Consumption (5%)	
			Metering Inaccuracies (0%)	
		Real Losses 30%	Leakage on Transmission and/or Distribution Mains (5%)	
			Leakage and Overflows at Utility's Storage Tanks (0%)	
			Leakage on Service Connections up to Customers' Meters (25%)	

(Water Balance Considering Water Demand in 2015)

608,000	395,200	364,800	0	364,800
			364,800	
		30,400	0	243,200
			30,400	
	212,800	30,400	30,400	
			0	
		182,400	30,400	
			0	
			152,000	

608,000 m3/day : Average Water Production

Target Water Balance of BWD Water Supply System
In 2025

System Input Volume	Authorized Consumption 77%	Billed Authorized Consumption 75%	Billed Metered Consumption (75%)	Revenue Water (75%)
			Billed Non-metered Consumption (0%)	
		Unbilled Authorized Consumption 2%	Unbilled Metered Consumption (2%)	Non-Revenue Water (25%)
			Unbilled Non-metered Consumption (0%)	
	Water Losses 23%	Apparent Losses 3%	Unauthorized Consumption (3%)	
			Metering Inaccuracies (0%)	
		Real Losses 20%	Leakage on Transmission and/or Distribution Mains (3%)	
			Leakage and Overflows at Utility's Storage Tanks (0%)	
			Leakage on Service Connections up to Customers' Meters (17%)	

Note: After 2015, universal customer water metering will be implemented.

(Water Balance Considering Water Demand in 2025)

595,000	458,150	446,250	446,250	446,250
			0	
		11,900	11,900	148,750
			0	
	136,850	17,850	17,850	
			0	
		119,000	17,850	
			0	
			101,150	

595,000 m3/day : Average Water Production

6.4 TYPICAL NRW CONTROL ACTIVITIES

It is essential to measure and assess various elements of water use. A lot of this information will come from flow measurement around the network and therefore requires installation and maintenance of flow metering equipment. A schematic of the inter-relation between these components is shown in Figure 6.2 for typical NRW control activities.

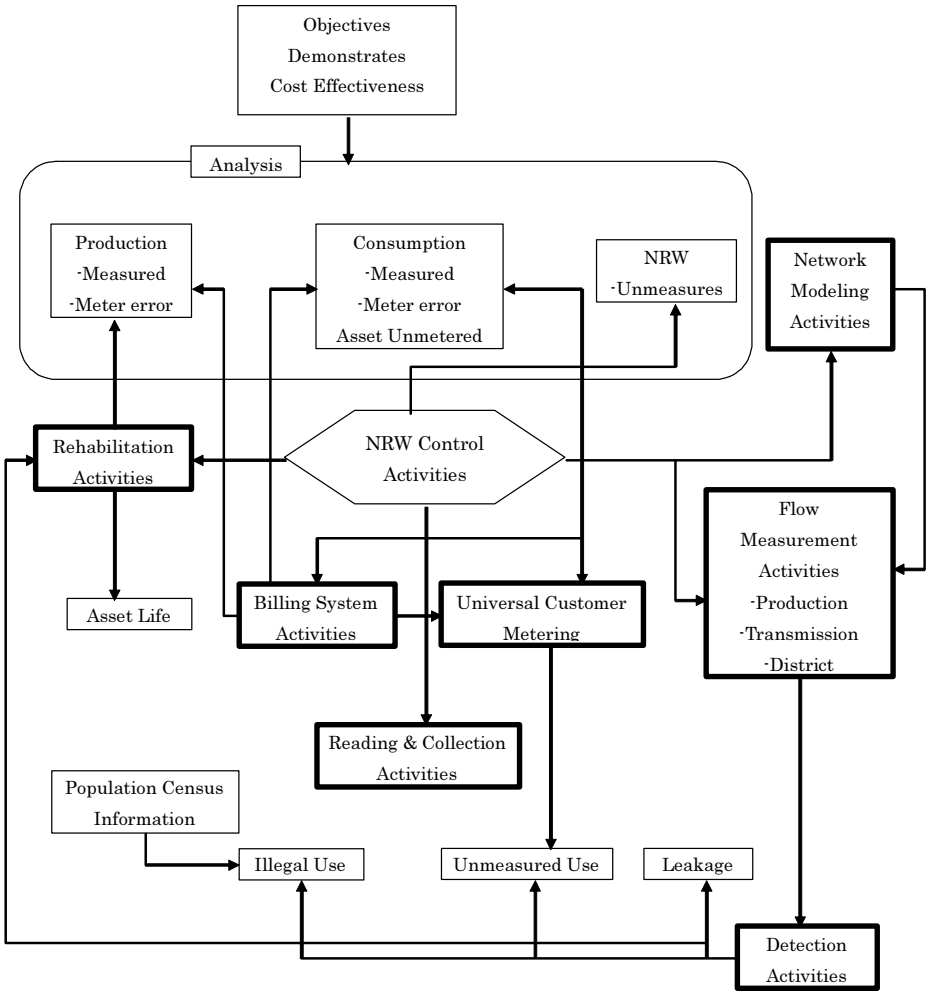


Figure 6.2 Typical NRW Control Activities

NRW reduction plans are categorized into technical and non-technical measures as follows. In WSPCB, mainly technical measures are planned.

（Technical measures）

- Rehabilitation of distribution and service pipe
- Leakage control
- Universal customer metering and replacement of water meter

・ Eradication of illegal connection

（Non-technical measures）

・ Improvement of billing system

・ Improvement of reading and collection system

As a first step to introduce NRW control in Basrah, following framework plan must be prepared:

- Present context (Baseline)
- Justification for NRW plan
- Outline & general approach
- Proposed sequencing
- Specific activities checklist & timeline
- Identification of priority projects and preliminary cost estimates.

Activities and initial target figures and progress rates have been cited as a basis for preliminary planning. Once implementation is under way and detailed data becomes available,, the targets and planning should be reviewed and modified according to cost benefit criteria.

6.5 NRW CONTROL PLAN

As an overview, the three phases can be characterized as follows:

Stage 1: Preliminary

- Initiation and start up of all activities across the board
- Training and practice of basic techniques and methods
- Installation of equipment, especially production and zone flow meters
- Surveying
- Mapping of Network
- Establishment of NRW Control Unit and Team
- Work on Trial “pilot” areas
- Technical Assistance – Intensive effort for detailed planning, implementation and technology transfer

NRW control work will start in the good service areas. One or several “pilot” areas will be set up (possibly based on sub-district) and subject to the gamut of activities, including but not limited to:

- Mapping and consumer survey
- Large user identification & monitoring
- Meter repair and replacement
- Leakage survey & detection (applying different techniques as appropriate)

- Timely repair of leaks

When the pilot area has been completed, a lower level of activity will be continued to maintain the NRW control in the area.

A new set of pilot areas will be set up and the intensive efforts directed in these new areas. This sequence continues building up the area of coverage until a complete district or zone has been completed. Then the next district is started.

Stage 2: Medium term up to 2015

- Establish routine procedures
- With increasing time-based data, review NRW levels and adapt control efforts
- Progressively repeat and expand task to cover more and more of the network
- Continue and complete surveying
- Reduce and phase out technical assistance as NRW unit becomes self-sufficient
- Prioritize and direct NRW control activities

Phase 3: Long term up to 2025

On a 5 year cycle:

- Review NRW levels and control measures strategically
- Modify and prepare a plan and revise objectives
- Continue and repeat NRW control, prevention and monitoring
- Continue expansion of area covered until completion
- Continue to increase level of detail, specificity of data by progressive sub-division of the network into smaller areas (to the extent justified)

6.6 RESOURCES AND ORGANIZATION

It is now relevant to outline the resources needed to begin implementation of the NRW Control Plan. In order to be effective over a sustained period, it is essential that adequate budgets are available for this. There are five main aspects to be considered:

1. Organization for NRW control
2. Personnel to staff the team
3. Training and skills acquisition for the staff
4. Technical assistance to the organization
5. Material and equipment resources

(1) Organization - NRW Task Force Approach

1) NRW Control Team

To implement the structures and measures needed to begin the process of reducing NRW to economic levels, a separate, dedicated section will be essential. This section and its manager need to have sufficient authority and the requisite autonomy to be able to make progress once the plan has been agreed.

The NRW control section must be set up immediately on starting the program. It should be considered as a permanent unit, not a time limited, temporary one; though ultimately many or all of its functions may be absorbed within the operations of mainstream departments, such as distribution or customer service.

The applied methodologies should in most cases be introduced at pilot level and then applied progressively to other areas, once the method has been tested and the problems resolved.

Phase 1

During the first twelve months of operation, the NRW control unit will be set up, trained, developed and become firmly established. Within this period, it is expected that the first half will be principally occupied with setting up, preparing and training and the latter half will be practice and trial implementation.

For phase 1, the team will be kept relatively small and exclusive, so that it remains manageable and all its members can be properly trained. This is a relatively long lead-in time, because the BWD is starting from almost zero and a change in approach is needed.

Phase 2

At the end of phase 1, a review will be carried out to determine the future direction of efforts and reinforcement of the team that is needed, along with the additional resources required. The role of the original core team will then be modified to include training and supervising additional staff brought in to cope with the expanded work program.

2) Repair Teams

A properly resourced repair section should also be set up and equipped at the same time as the NRW control section. Though probably part of the distribution department, the repair section will have close ties with the NRW team, mainly physical loss group, and work co-operatively.

The same principles apply to this repair section as to the NRW control team. That is to develop a small, strong competent core then review the full scale of the requirements to reduce NRW levels according

to a timetable and finally provide the resources and staffing accordingly.

The size of these first stage teams should be limited to around 12 to 15 persons, though later many more staff will be involved in one way or another. The suggested composition of the NRW control team is given in the following section. The size of the repair teams does not include unskilled labor.

(2) Personnel to Staff the Team

1) NRW control Staffing

NRW Project Manager

To ensure that effective action is taken, a well-qualified project manager responsible for NRW should be appointed. The project manager must be allocated sufficiently experienced staff to develop a separate NRW team and should be given suitable assistance to undertake special studies. Additionally, the task force manager may be assisted by one or more consultants or other technical assistance.

NRW Team

The typical titles of each of the members of the team are described below: The proposed NRW team structure is shown in Figure 6.3.

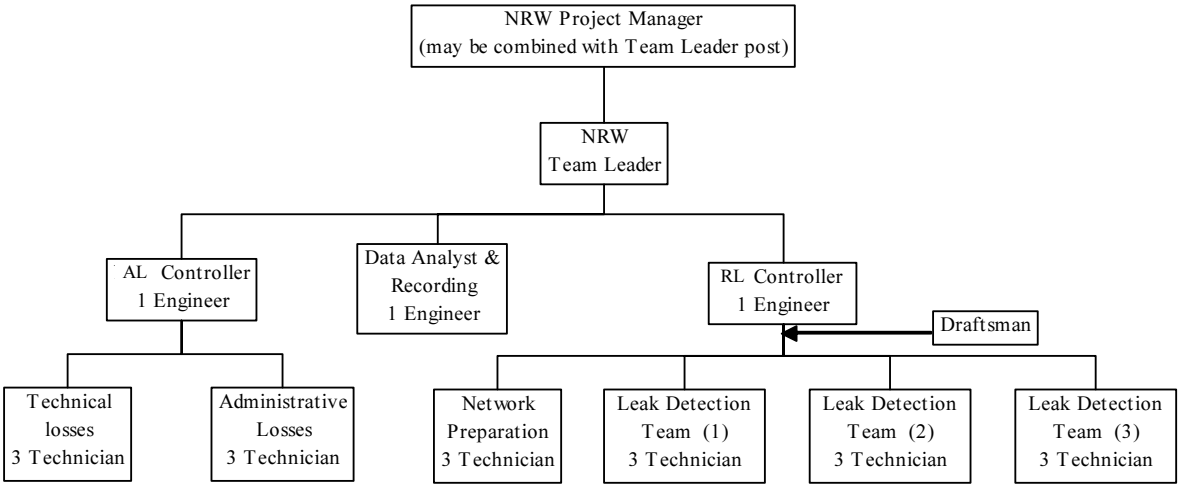


Figure 6.3 NRW Team Structure

Team Leader : maybe combined function with the project manager

Data Control Engineer: Co-ordinates with team for data collection and analysis

Apparent Loss (AL) Team

AL Controller: 1 Engineer: Manages the AL team

Technical Controller:	3 Technician: Specialized in Water Meters
Administrative Controller:	3 Technician: Specialized in consumer issues

Real Loss (RL) Team:

RL Controller:	1 Engineer: Manages the RL team
Draftsman:	1 draftsman prepares network drawings for work and updates
Network Preparation Team:	3 Technicians: Specialized in pipe work
Leak Detection Teams:	3 Technicians Specialized in Leak Detection x 3 teams

All other manpower needed for the field surveys, and all field operation and works are to be taken from other relevant departments. Passive leakage control (repair of visible leaks and operations upon request of consumers) remains the "maintenance and repair" tasks of the BWD staff.

2) Co-operation and Co-ordination

It must be emphasized that Water Loss Control is the duty of all water supply department staff and not only NRW team. Equally, all sections or departments are involved in the work and should co-operate with the NRW team.

(3) Training

To start with, about three employees should go for a period of up to three months to a developed country where they will be given special training using modern equipment and will work with trained inspectors employed by another water authority. If two or more employees working in the area of repairs could under go similar training, it will be advantageous as they can learn the standards of workmanship required to ensure the best possible repair under difficult conditions.

One of those selected should be an engineer or technician with an aptitude for teaching. This person could provide training to additional employees required to build up the team later on. This initial training of a few selected staff should be part of an ongoing scheme. An incentive for new recruits should be the potential to be selected for training abroad.

Overseas training should provide short, formal courses at specialized training centers that include:

(a) theory of leakage control;
(b) practical experience in the use of a wide variety of equipment
(c) maintenance of and simple repairs to all equipment.

This is followed by a hands-on operational work during the daytime and at night, covering all forms of active control. The technical assistance consultants should also provide on-the-job training and experience, including activities on pipelines & cable location, flow measurements, tapping mains under pressure, use of insertion flow meters, repairs to pipes and service, flushing mains and sterilization, testing valves to ensure tight shut-off, the use of portable test equipment and data loggers for flow and pressure, and setting up a district metering system and a water meter district.

Arranging for such training is one of the first steps to be taken in implementing a program for improved leak control. The recommended optimum solution is that overseas training is supplemented by on-the-job training as part of the terms of reference for technical assistance.

(4) Technical Assistance

It must be stressed that leak control is not a short-term activity, which once begun can then come to an end. Experience shows that unless the control program is perpetuated indefinitely, soon after cessation the NRW figure is as high as ever. The need for appointing a competent, long-term consultant to assist the BWD should be seriously considered.

A key part of any contract with a consultant is the establishment of an effective permanent organization in the BWD and a commitment to continue advising the BWD on the detailed solutions of problems encountered during the first year or longer. Of equal importance is provision by the BWD of a sufficient number of suitably motivated, intelligent, and qualified "counterpart" employees to gain the necessary training and experience to take over the operation at the end of the consultant's contract.

Areas to be considered for some form of technical assistance include:
- General NRW Technical Management Assistance (e.g. Technical Assistance Unit)
- Mapping survey and capture
- Information systems
- DMA design & Implementation
- Meter sizing & selection
- Meter Testing & Calibration
- Metering Policy
- Byelaws & Technical standards Policy & Implementation

(5) Material and Equipment Resources

Having identified and trained the staff needed for the NRW control plan, it is important that due consideration is also given to ensuring that adequate materials and equipment are provided to do the job effectively.

Much equipment and material will be needed, but in three main categories:

1. Office-based drawing and data records and functional equipment for staff
2. Equipment and transport for fieldwork including specialist leak detection equipment
3. Repair materials, tools and equipment of the type and quantity necessary to get repairs implemented in a timely and effective manner.

These elements need to be considered and defined in preparing detailed budgets for the project and a first tranche will be needed at a very early stage. Sufficient allowance within these categories, especially 2 & 3 must be made for training and practice materials, to allow staff to gain the necessary skills.

The following table summarizes required equipment and machine for leakage detection team. These equipment shall be procured in the implementation stage.

Table 6.5 Leakage Detection Equipment

1	Basic network kits
2	Sound loggers (15 x loggers + Patroller)
3	Electric Listening Stick
4	Mechanical Listening stick
5	Pressure logger with display
7	GSM pressure Logger
10	Correlator
11	Ultrasonic flow meter for pipe diameters 50 mm and above
12	Insertion flow meter with logger
13	Pipe locator - for metallic or plastic pipes
14	Boring bar
15	Accessories
16	Miscellaneous (Battery, Computer etc)
17	Vehicle (pickup truck and van)

6.7 PLANNED NRW CONTROL ACTIVITIES

It has been explained that action will be required on all aspects of NRW control, as well as some related activities. The general approach to implementing and phasing this policy has been outlined. In this section, the particular elements of this approach are summarized.

To provide an overview of the range of activities and to provide a form of ready reference, a checklist of the tasks with the key action for phase 1 and for phase 2 identified has been compiled. This is shown in Table 6.6.

It is to be noted that not all of these categories will necessarily be carried out by nor be the sole responsibility of the NRW control Unit.

Table 6.6 Checklist of NRW Control Tasks

Item No.	Activity Description	Key Action Phase 1	Key Action Phase 2
1	GENERAL MANAGEMENT & NRW CONTROL PLANNING		
1.a	NRW Control Program	Plan & Establish	Review & Modify
1.b	NRW Control Project Team	Set up & Train	Continue
1.c	Reporting & Information Systems	Develop & Establish	Keep up to date
1.d	NRW Ratio	Analysis & Review	Repeat periodically
1.e	Cost-benefit Analysis for NRW Activities	Analysis & Review	Repeat periodically
2	REAL LOSS ACTIVITIES		
2.a	Trunk Mains Leakage Investigation	Visual Inspection	Repeat annually
2.b	Service Reservoir Leak Investigation	Drop test for leaks	Repeat every 4 year
2.c	Network Leak Detection Program	Prepare requirements	Reinforce & Expand
	ALC Leak Detection Team	Set up, train & Practice	Implement progressively
2.d	Pressure Management	N/A	Review when pressures improved
2.e	Leak Repair Program		
	Network Repair Team	Set up repair team(s)	Scale to suit needs
	Network Repair Materials	Review repair items required and set up	Supply & maintain stock of repair items
	Repair Reporting	Monitor repair teams	Continue
2.f	Service Pipe Repair Program	Combine with rehabilitation program	
3	APPRENT LOSS ACTIVITIES		
3.a	Large Users (Consumers)	Define, identify & install meters	Monitor closely & check meters often
3.b	Domestic Metering Policy	Define & plan	Implement plan
3.c	Domestic Meter Testing		
	Meter Test & Repair Facilities	Set up & install test & calibration equipment	Maintain
	Meter Testing Program	Establish routine	Continue
3.d	Un-metered Use by Category		
3.e	Assessment of Un-metered Use by Sampling of Groups	Identify sample groups and monitor	Continue as required
4	MEASURING & PRIORITISING of NRW ACTIVITIES		
4.a	Production Metering		
	Surface Water	Review & Install	Monitor
	Ground Water	Review requirements	Install & Monitor
4.b	Bulk Metering in Network	Review & Install	Monitor
4.c	District or Zone Metering in Network		Begin to Install & monitor
4.d	Waste Metering Program	Set up pilot areas	Repeat & Expand
4.e	DMA Management		
4.f	Analysis of Night Flows		Use nightlines
4.g	Prioritization of Areas for ALC & Rehab.	Use results to prioritize high leak areas	Develop and continue
5	ASSOCIATED ACTIVITIES		
5.a	Mapping of Network and Recording of Network Data	Mobilize: start in "good service" areas	Continue and finish then keep up-to-date
	Data Capture & Presentation	Set up and apply	
	Field Survey Work	Establish Methods	
5.b	Establishment and Updating of Customer Database	Combine with network mapping	
	Data Capture & Presentation	Set up and apply	Continue and finish then keep up-to-date
	Field Consumer Audit Survey	Establish Methods	
5.c	New Works and Network Rehabilitation	Maintain good co-ordination for plans & ensure NRW control included in design	
5.d	O&M Departments - co-ordination	Maintain good co-ordination for works	
5.e	Public Education & Information	Set Policy & Practice	Begin to implement

Item	Activity	Key Action	
No.	Description	Phase 1	Phase 2
5.f	Byelaws & Technical Standards	Set Policy & Practice	Begin to implement
6	TECHNICAL ASSISTANCE PROGRAMME		
	NRW Control Management	Full-time support	Reduce level
	Including special inputs on:		
	Mapping survey and capture		
	Information systems		
	DMA design & Implementation		
	Meter sizing & selection		
	Meter Testing & Calibration		
	Metering Policy		
	Byelaws & Technical standards Policy & Implementation		

CHAPTER 7

INSTITUTIONAL CAPACITY BUILDING

CHAPTER 7 INSTITUTIONAL CAPACITY BUILDING

7.1 EXISTING CONDITIONS OF ORGANIZATIONS CONCERNED

(1) Basrah Water Directorate (BWD)

1) Organization of BWD

The Basrah Water Directorate (BWD) which is under management of Ministry of Municipalities and Public Works (MMPW) is the main entity responsible for water production and distribution in Basrah both for the Basrah Municipality (the capital of the Governorate) and other municipalities throughout the governorate. It is noted that water supply in some communities in the Governorate is the responsibility of the Ports Authority and these are mainly areas close to the port districts of southern Basrah.

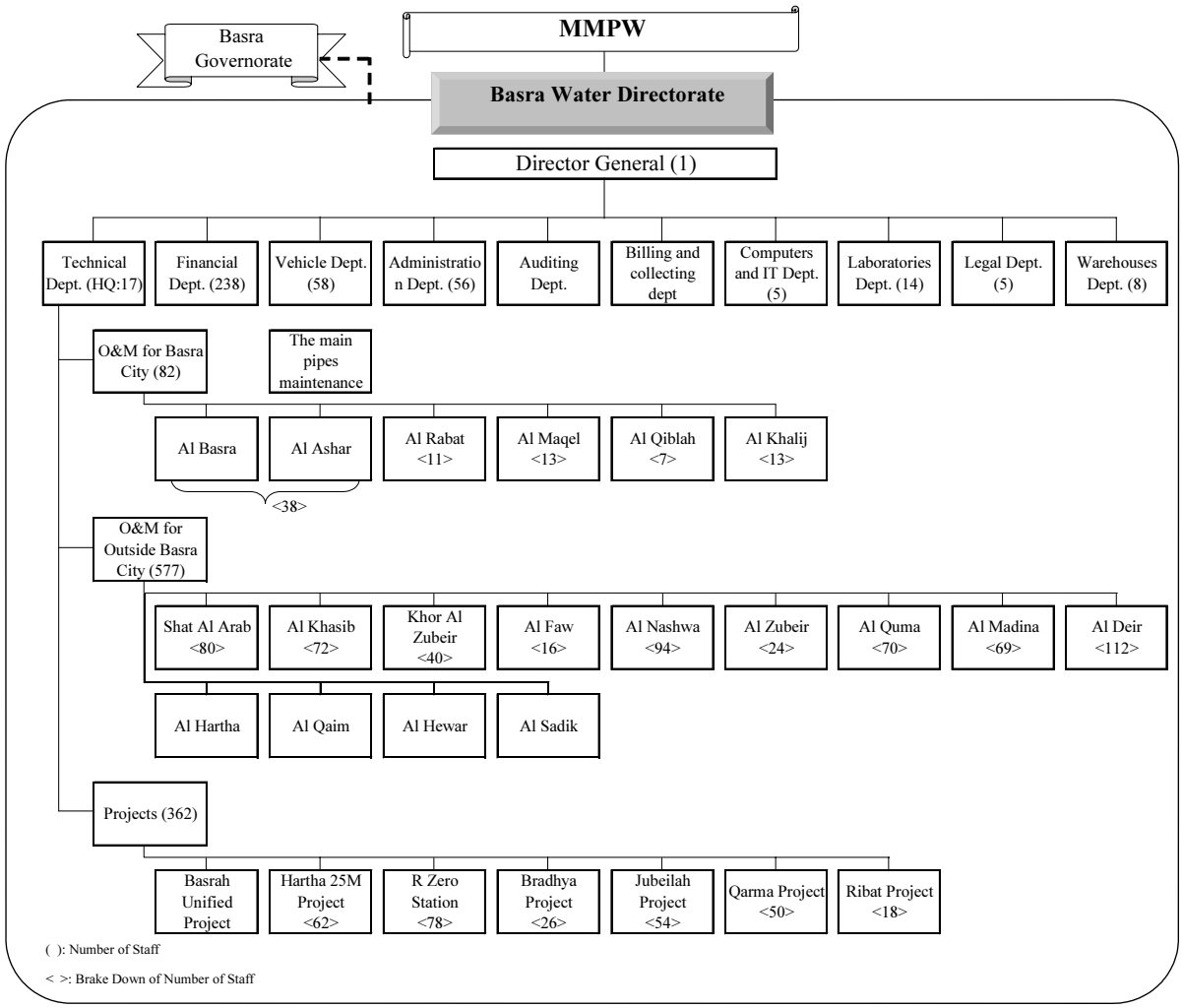
The number of staff in each department and section is shown in Table 7.1. The majority of staff belongs to the technical department (1,021), followed by the financial department (238).

Table 7.1 Existing Numbers of Staff of BWD

Name of Department	Name of Section	Numbers of Staff
Director General		
1. Technical Dept.	(1) Head Quarter	17
	(2) O&M Section for Basrah City	82
	(3) O&M Section for Outside Basrah City	577
	(4) Projects Section	362
2. Financial Dept.	(include auditing dept and billing and collection dept)	238
3. Vehicle Dept.		58
4. Administration Dept.		56
5. Computers and IT Dept.		5
6. Laboratories Dept.		14
7. Legal Dept.		5
8. Warehouses Dept.		8
Total		1423

Note: See Appendix H for detail numbers

Figure 7.1 shows the existing organizational structure of the BWD as of June 2006. The organization structure of BWD consists of a Director General (DG) and eight (8) departments with a total staff of 1,423.



Source: BWD

Figure 7.1 Existing Organization of BWD

The responsibilities of BWD by department are summarized as shown in the following table. Although the department structure seems to have no serious issues, there seems to be the lack of customer service function such as dealing with commercial promotion, customer's complaints and customer service promotion.

Table 7.2 Responsibilities of BWD by Department

Department	Responsibilities
Technical Dept.	• Prepare maintenance schedules for distribution networks and projects, • Perform the necessary maintenance for leakage pipes and expansion of distribution pipes, • Design the new distribution networks, • Produce drinking water, • Supervision of the construction of a new water plants and networks, and • Supervision of the construction of a new buildings.
Financial Dept.	• Organize daily accounting records, • Organize the yearly audit review for revenues and expenditures and general ledger, • Organize the book records for the different activities including allowances, • Pay salaries, and • Prepare an estimated budget for each year.
Vehicles Dept.	• Check on fuel, oil quantities assigned for vehicles and generators, • Oversee the operation of the Dept. vehicles, • Provide the vehicles and equipment to transport needed materials from the General Warehouse in Baghdad, and • Maintain the vehicles.
Administration	• Supervise the Human Resource affairs within the Dept. including vacation and sick leave, • Organize the yearly salary raise, • Issue the orders for hiring, firing, retirement, and transfer, and • Prepare external communications in addition to preparing the reports related to Water Dept. employees.
Computer Dept.	• Prepare special programs for the Directorates work (salaries, employees, vehicles, etc), • Operate and maintain the existing computers, • Operate software such as GIS, GPS, and • Follow up on the external communications through the internet.
Billing and Collection	• Collect billed amounts of drinking water sold to citizens and Governmental agencies, and • Transfer collected amounts to the financial dept. to be deposited in a special account.
Central laboratory	• Monitor the produced water quality in WTPs, and • Coordinate with the Environment. Dept. and the Health Dept. of Basrah Governorate.
Audit Dept.	• Monitor all withdrawal activities, • Organize the yearly audit and inventory for the fixed assets, • Check on the items available in the warehouses and the process of entering and withdrawing of the items, and • Follow on the works of inventory committees and participate in the tendering committees for evaluation and awarding.
Legal Dept.	• Organize special contracts for all activities of the Directorate, • Follow on legal cases against the directorate, • Follow on the process of acquisition of lands used for the Directorate projects, and • Check and verify on the legal problems that can occur from and against the Directorate employees.
Warehouse	• Dispense items based on withdrawal documents, • Receive and organize the inventories, and • Prepare the yearly audit for inventories and follow on the unused material.

Source: BWD

As seen in Figure 7.1 and Table 7.1, the biggest department is the Technical Department, which is mainly responsible for operating the water projects (treatment plants and compact units) within Basrah Governorate, monitoring maintenance divisions within the Governorate, preparing maintenance schedules for distribution networks and projects, and designing new distribution networks. Under this department, there are three main sections as follows:

① Operations and Maintenance (O&M) Section for Basrah City: responsible for O&M of distribution networks (pipes less than 8 inches in diameter) within the Basrah City borders,
② O&M Section for areas outside Basrah City: responsible for O&M of distribution networks in all diameters outside the borders of the Basrah City as well as O&M of distribution networks (pipes larger than 10 inches in diameter) within the Basrah City borders, and
③ Projects Section (it is noted that projects mean water treatment plants).

The areas covered by the O&M Section for Basrah City are Al Basrah, Al Ashar, Al Rabat, Al Maqel, Al Qiblah, and Al Khalij. Besides the areas served by the O&M Section for areas outside Basrah City are Shat Al Arab, Al Khasseb, Khor Al Zubeir, Al Faw, Al Nashwa, Al Quorna, Al Madina, Al Hartha, Al Sadik, Al Kaim, Al Hewar and Al Deir. The main responsibilities of those divisions are to perform the necessary maintenance for leakage pipes and expansion of distribution pipes, in order to ensure the stable water supply to the citizens.

The Projects (or WTPs) Section is mainly responsible for producing drinking water according to high standards and pumping it through a special network for the various WTPs. The WTPs managed by this section are Basrah Unified, Al Hartha 25 MG, R Zero, Bradhya, Jubaila, Garma 1 and Garma 2 and Ribat.

2) Financial Management of BWD

Table 7.3 and Table 7.4 below show the main revenue and expenditure statements of BWD during the past 3 years, respectively. Unfortunately, most of the pre-war records were lost or destroyed and the revenue data for 2003 is not available for the post-war period.

As seen in the Table 7.3, the main revenues to BWD are ministerial funding and revenues. Those cover salaries, operating budget and the following year's planned projects budget. It should be mentioned, however, that the salaries and operating budget were transferred from the Basrah governorate budget in 2003, but it came from MMPW in 2004 and 2005.

There is a significant increase in the total revenue between 2003 and 2004. The total revenues in 2004 and 2005 reach more than 4 million US$.

Regarding revenue of tariff collection, the amount is quite limited, that is 11.5% of the total revenue in 2005. The current ratio of tariff collection is estimated to be only 30-35% due mainly to lack of billing system and inadequate tariff collection system. Those systems are not properly functioned because staff can not identify the water consumption volume of each household caused by no metering system so far. Since the water consumption volume is estimated based on the location and diameter of the

second main pipes by staff of the Department of Billing and Collection, the inaccurate tariff is imposed at present. The tariff collection system is adversely affected by these issues. The low ratio of tariff collection is assumed to be caused by no incentives system for collectors, illegal connection and lack of awareness campaign on duties for payment.

Table 7.3 Revenue Statements of BWD

Category	2003			2004			2005		
	Million ID	Thousand USD	Total Thousand USD*	Million ID	Thousand USD	Total Thousand USD*	Million ID	Thousand USD	Total Thousand USD*
1. Salaries	760.4	639.5	1,146.4	3,227.0	0.0	2,151.3	3,723.0	0.0	2,482.0
2. Operating Budget	243.7	174.5	337.0	708.0	0.0	472.0	1,049.0	0.0	699.3
3. Planning Budget	N/A	N/A	N/A	2,492.3	0.0	1,661.5	807.4	0.0	538.3
4. Revenue of Tariff Collection	N/A	N/A	N/A	364.5	0.0	243.0	724.3	0.0	482.9
Total	1,004.1	814.0	1,483.4	6,791.8	0.0	4,527.9	6,303.7	0.0	4,202.5

Note: The exchange rate : 1 US$=1,500 ID

Source: BWD

As seen in Table 7.4, the main expenditure items reported by the BWD are (i) salaries inclusive of remuneration, incentives, and overtime, (ii) operating budget which includes maintenance of buildings and machinery and vehicles, furniture, delegations outside Iraq, and rental of equipment, and training, (iii) consumables such as fuel, electricity, spare parts and stationary, and (iv) others which includes acquisition of machinery, vehicles, furniture and spare parts.

There is a significant increase in the expenditures between the years of 2003 and 2004 as well. As the total expenditure in each year is below the total revenue, it seems that the surplus operation has been done since 2004. However, it is not surplus operation managed by the water supply projects but depending on the funding of MMPW such as subsidy. Therefore, it is necessary to improve the financial management system, in order to meet the minimum requirement of a concept of O&M cost recovery.

Table 7.4 Expenditure Statements of BWD

Category	2003			2004			2005		
	Million ID	Thousand USD	Total Thousand USD*	Million ID	Thousand USD	Total Thousand USD*	Million ID	Thousand USD	Total Thousand USD*
1. Salaries	769.4	642.4	1,155.3	3,508.8	0.0	2,339.2	4,419.3	0.0	2,946.2
2. Operating Budget	0.0	19.2	19.2	918.1	0.0	612.1	350.4	0.0	233.6
3. Consumables (fuel, electricity, spare parts and stationary)	0.0	7.7	7.7	83.1	0.0	55.4	230.7	0.0	153.8
4. Others (purchase of machinery, vehicles, furniture)	0.0	41.0	41.0	65.6	0.0	43.7	4.4	0.0	2.9
Total	769.4	710.3	1,223.2	4,575.6	0.0	3,050.4	5,004.8	0.0	3,336.5

Note: The exchange rate : 1 US$=1,500 ID

Source: BWD

3) Capacity of BWD Staff

Regarding employee qualifications, only 79 of 1,423 staff have above the bachelor degree. The majority of the staff such as laborers, operators, plumbers, welders, etc. has education level lower than that of high school.

There are four categories of specialty backgrounds of staff; sciences, technology and engineering, humanities and economics/ finance. It is noted that none of the BWD staff have been educated outside Iraq. It is assumed that the sanctions had been imposed on Iraq which had prohibited the possibility of sending Iraqi students abroad for their educations and due mainly to financial reasons and political reasons as well.

Based on the interviews with the DG and other relevant departmental heads, the general levels of managerial skills among responsible staff seem to be less than needed. According to the interviews, only 20% of responsible staff may have “good managerial skills” and 40% seems to have “fair managerial skills”, while the remainder may have “poor and very poor managerial skills”. The justification of the BWD for such low levels of management skills includes the following:

- Insufficient managing system
- Lack of equipment
- Lack of guidelines and manuals
- Lack of training
- Lack of staff qualification (technical managing skills)
- Poor line of command within the organization
- Lack of communication with related organization (such as other governmental organization)
- Lack of communication with donors
- Lack of financial management

(2) Ministry of Municipalities and Public Works (MMPW)

1) MMPW

After the war, when the Ministry of the Interior was subdivided during the establishment of the CPA, the security aspects were retained in a streamlined Ministry of the Interior, and the municipalities and public works elements were hived off into a reformed Ministry of Public Works itself renamed as the Ministry of Municipalities and Public Works (MMPW) by CPA Order Number 33 of 9 September 2003.

The MMPW is the chief national policymaker for the provision of all municipal services outside the Baghdad city, except for electricity and telecommunications. It is responsible for delivery of safe drinking water, environmental sanitation involving wastewater and solid waste service, urban development, municipal road works, and public land management. Such service within the Baghdad city, on the other hand, are the responsibility of the Mayoralty of Baghdad.

The aim of the Ministry is to decentralize service delivery and administrative organization. The duties of the MMPW are:

- Act as the center of excellence for national strategic planning and setting standards for municipal level planning, development and service delivery,
- Provide the basis for preparation of urban development plans for every governorate and each municipality,
- Foster local ownership of service delivery processes,
- Assist in the development of short-term and long-term plans for ensuring that every governorate and municipality is capable of achieving national standards for water supply and distribution, sewerage, and environmental health,
- Coordinate with donor agencies, government and non-government organizations, and private sector organizations towards achieving the goals.

The main challenges that the MMPW faces in achieving those objectives includes security (staff, facilities and assets), sound management of water treatment facilities, increasing revenues and restructuring.

The MMPW generally consists of several general directorates; Administration and Finance, Planning and Follow-up, Inspector General, Municipalities, Water, Sewerage, Urban Planning, and Human Resources as shown in Figure 7.2. The Ministry has offices at 266 municipalities in fifteen (15) of the eighteen (18) governorates in Iraq. The three Governorates of the Iraqi Kurdistan Region, Dohuk,

Erbil and Sulaimaniya are affiliated but administered separately. More than 40,000 employees serve in MMPW working at over 600 locations. The national general directorates provide administrative, financial and technical support to each governorate and municipality. They are responsible for overseeing distribution systems for water, sewerage, and other municipal services. They oversee installation and maintenance of water and sewerage treatment facilities. They also set and oversee the standards for design and operations for all municipal services, such as refuse collection, municipal roads, cemeteries, abattoirs, and public parks.

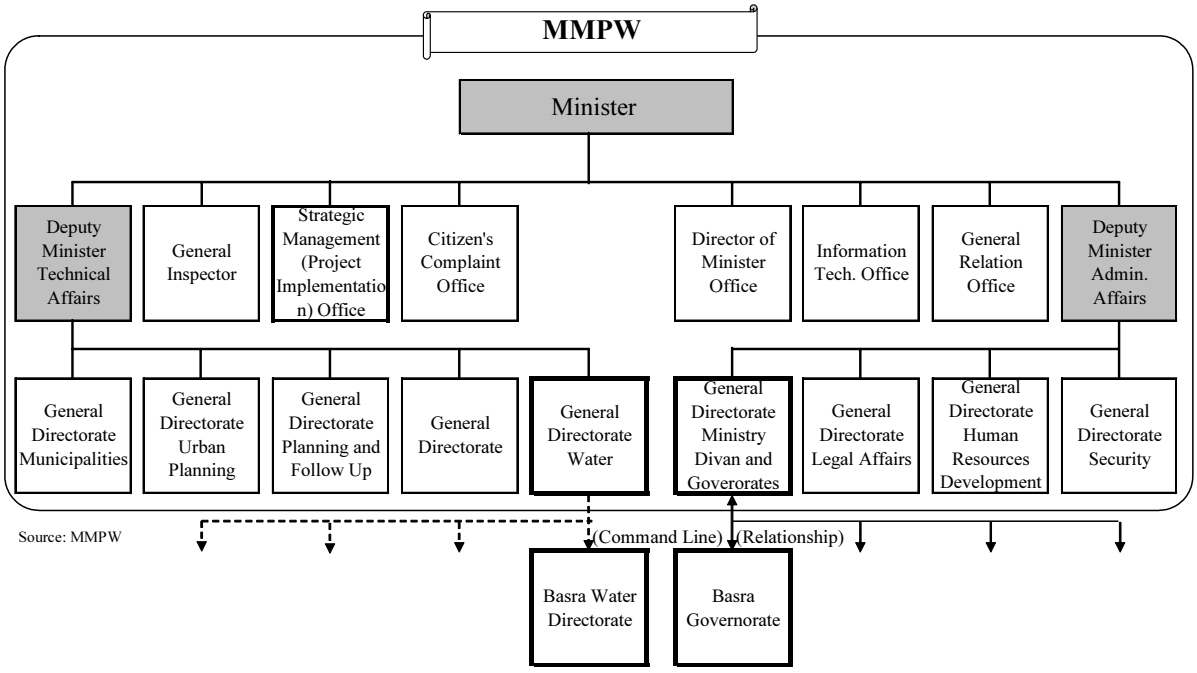


Figure 7.2 Current Organization of Ministry of Municipalities and Public Works

As for legal framework on the water and environmental sanitation (WES) sector in Iraq, the operation of WES sector concerned with Basrah water supply system has been governed by the following laws and regulations:

1. Classifying water resources management criteria (Act No. 25 of 1967),
2. Establishing the national and provincial centers for environmental protection and development (Act No. 2 of 1997),
3. Transforming the General Establishment of Water and Sewerage into a state-owned corporation (Act No. 148 of 1999), and
4. Drinking water quality standards issued by Ministry of Health (MOH) in 1974.

There, however, are no water sector policies and regulations in Iraq after the war. The preparation of 'National Water and Wastewater Sector Policy' is about to start by assistance of World Bank (WB).

2) General Directorate for Water (GDW) of MMPW

The GDW is one of the departments of MMPW, which is responsible for supplying potable water to all of the governorates in the country except the board of Baghdad municipality and three (3) north governorates. The duties of GDW are to supply the potable water for all people through water treatment plants, compact unit water networks, planning, new water plants, new water networks, site surveying for project location, engineering studies, technical design for water projects and networks, implementation of water projects, rehabilitation of existing water projects and pipe replacement, operation and maintenance of water projects, and laboratories for testing water quality. The MMPW Law No. 154 specifies the various duties and responsibilities of all the directorates under MMPW including GDW entrusting it with the responsibility of managing and operating water services nationwide except in the Mayoralty of Baghdad. The duties and responsibilities are still under review by the parliament.

Its main targets and service can be summarized as shown in Table 7.5, and its organizational structure is shown in Appendix H.

Table 7.5 Target and Services of GDW

Target	• Potable water for all people through water treatment plant, compact unit water network. • Planning, new water plant, new water network according to the requirement in budget. • Site surveying for project location and network. • Engineering studies, technical design for water project and network. • Implementation water project, network. • Rehabilitation of existing water treatment plants and replacement of pipes in network. • Operation and maintainance of water treatment plants. • Test laboratory for water and quality.
Services	• Supply potable water for all people according to Iraqi standard specification. • Operate engineering staff and technical staff, operators in administrative, operation water project and network. • Operate engineering staff and co-operate with consultant bureau in universities for scientific design for water project and network.

Unfortunately, further data and specific details on the GDW could not be obtained. The survey team's counterpart at the MMPW was out of reach due to security conditions and the detailed information could not be obtained.

Besides it is said that the communication between GDW and BWD has been not made properly. It is necessary to improve the communication system, in order to execute the water supply service for the residents of Basrah efficiently and effectively.

(3) Basrah Governorate (BG)

1) Organization of BG

The Basrah Governorate (BG) which is under management of MMPW is responsible for the entire local administration of Basrah.

The existing organizational structure of the BG is shown in Appendix H. The functions are divided into two; one is executive function of public services and another is implementation of registration and monitoring for those services. It is noted that the Basrah Governorate is headed by the chairman of the Governorate and the Executive Department is headed by the Governor. The total number of employees in BG is 305, with 130 employees in administration, 103 in planning, and 72 in finance.

The water unit headed by the Director General of BWD is responsible for the water supply service under the executive department. Besides the committee is assigned as the monitoring function under the department of registration and monitoring.

2) Financial Management Conditions of BG

The project funded by the Governorate either resourced from the Ministry of Finance or from donor grants is directly allocated to the project itself. The procedure of budget approval for Governorate is shown in the following figure.

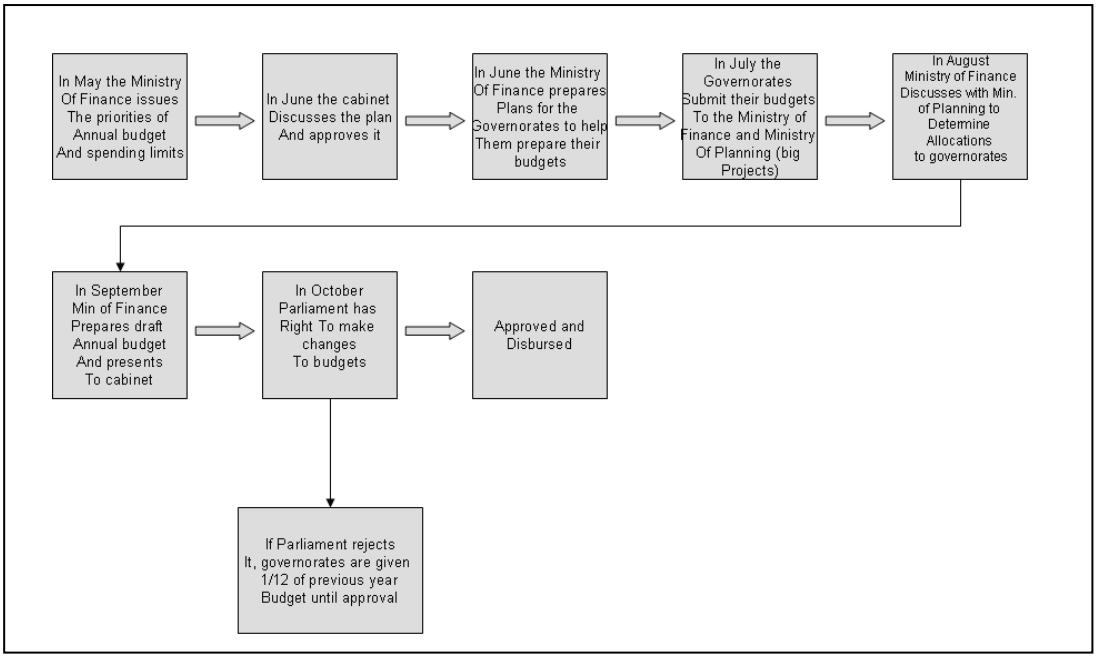


Figure 7.3 Procedure of Budget approval for BG

The governorate declined to provide any financial data. However, the following information was obtained through the discussions between the sublet survey team and a member of the development committee:

- BG has received 11.6 million US$ for new water networks.
- The BG has just started to prepare a plan to utilize the finance allocated to the Governorate from the Ministry of Finance for the execution of water projects and in coordination with BWD. The budget amount for the year 2006 is 20 billion ID, which is expected to be completely spent before the end of 2006.
- There is additional revenue of 15 billion ID from custom returns.

3) Relation between of BG and BWD

The relation between the Governorate and other governmental agencies is typical and is mainly made through interaction and coordination between the various committees under the legislative department and their corresponding governmental agencies such as local reconstruction unit under the Executive Department. The following figures describe the relation between the Basrah Governorate and the MMPW/BWD as an example for two different scenarios; the first in case the project is funded by the Governorate as shown in Figure 7.4, and the second in case the project is funded by the MMPW as shown in Figure 7.5.

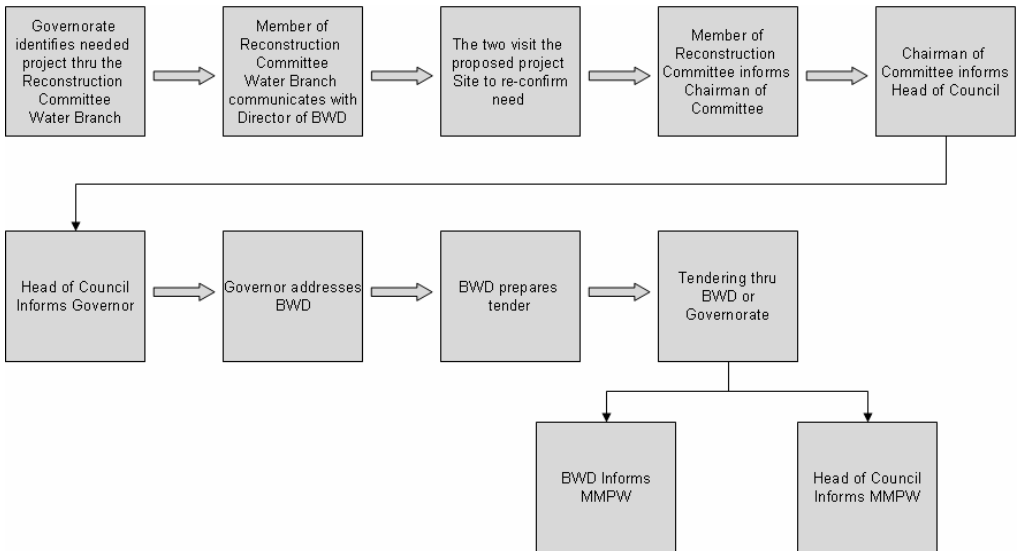


Figure 7.4 Method of Coordination between Governorate and BWD for Governorate Financed Projects

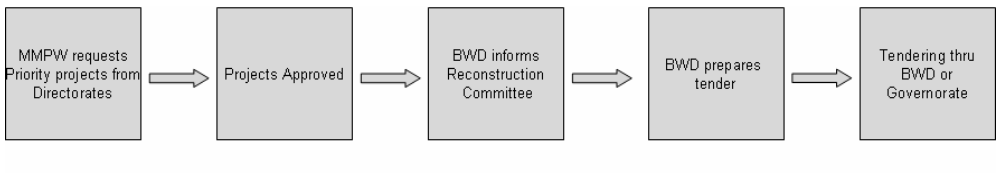


Figure 7.5 Method of Coordination between Governorate and BWD for MMPW Financed Projects

(4) Ministry of Water Resources (MWR)

1) Organization of MWR

In 1969, the Ministry of Water Resources (formerly Ministry of Irrigation) was formed and was responsible for water matters and improving surface and ground water resources in Iraq. At present the MWR has the responsibility to develop and manage the water resources within the Tigris and Euphrates River Basins, from the borders with Turkey, Syria and Iran to the outlet of the Shat Al Arab into the Arabian Gulf.

The Ministry manages and operates a total of 7 dams and 18 barrages along the course of the Tigris and Euphrates rivers, and also has the responsibility for the management of groundwater resources within the country. The primary water supply for the major cities in Iraq is from surface water, supplied from river pumping stations or canal systems. The Ministry is also responsible for managing and supplying water for irrigation through canal and lateral systems and managing drains and pumping stations.

The specific duties of the Ministry include the following:

- Construction of small and large dams for the purpose of water storage, flood control, and the supply of water for agriculture, municipal use, electrical power generation and industrial use
- Construction of new irrigation projects and the utilization of irrigation machinery systems (such as sprinkler and drip irrigation) as well as land reclamation through the construction of such networks
- Creation of ground water supply system in regions with limited water resources, especially in the western desert region by drilling
- Carrying out specialized studies and designs for irrigation projects
- Operation and Maintenance of irrigation and drainage networks, nationwide including small and large pump stations, in addition to improvement and maintenance of river flow lines and protecting their blanks

In Ministry's organizational structure (Appendix H), there are four main streams under the Minister; construction and maintenance, companies, planning and engineering design, financial and administrative affairs.

2) MWR Responsibility concerned with Sweet Water Canal

In terms of the Basrah governorate water system, the MWR is responsible for the operation, maintenance, and dredging of the Sweet Water Canal, which is the main source of water supply to Basrah feeding into the R-Zero water treatment plant. This responsibility is shared between the General Directorate for Operating and Maintenance of Irrigation Projects and the General Directorate for River Dredging.

Some of the canal's water treatment stations date back to 1932 and its upkeep was minimal. The canal and its reservoirs were filled in places with up to two meters of sediment, and vegetation was growing on the surface. A lack of dredging reduced the effectiveness of the reservoirs, and the high solids content of the water increased wear on the pumps. At a cost of almost 38 million US$, the entire system was being rehabilitated by USAID including the 240 km canal, its two pump stations, two reservoirs, and fourteen water treatment stations. Work has included dredging and cleaning the canal and reservoirs, refurbishing pump stations, providing backup power sources, repairing canal embankments, and replacing worn and broken parts.

7.2 ON-GOING PROJECTS CONCERNED WITH CAPACITY BUILDING

(1) Activities of Capacity Building for BWD

There are two training facilities; one is under preparation and another has been completed. The completed one is located in the R zero station and was implemented by Fluor Amec. One of the rooms of the station was converted into a training facilities equipped with eight (8) PCs, one (1) Xerox machine, and one (1) printer. Trainees are nominated by BWD and are mainly trained by the IT Department manager in the areas of IT. Trainees are paid 10 US$ per training day. A typical training course includes 16 trainees (i.e., 2 staff per PC).

The second training center is a comprehensive training center including three (3) training rooms also located in R-Zero station, which is being constructed by MoTT McDonald funded by DFID. It has not yet been furnished or equipped and still to be handed over to BWD.

Fluor Amec Training Center
(Existing as of July 2006)

DFID Training Center
(Under Construction)

In terms of staff capacity building, there are some ongoing capacity building activities such as training on leak detection, procurement, management, and internal training activities in the areas of labs, accounting and IT. However, they are not enough to meet the requirement for effective and efficient management. Also the capacity building activities are not systematic and do not follow any certain guideline.

As for future needs, there is a need for extensive training in various areas and for the different types of employees. The main areas of training are:

- Train the computer skills
- Train the trainers for operation and maintenance
- Train the maintenance method of the distribution network of Basrah
- Send engineers and technicians for training outside Iraq
- Train the Laboratory team for the latest water quality tests outside Iraq
- Train on GIS and remote sensing outside Iraq
- Train on the financial software programs outside Iraq
- Train the manager class on the managerial skills outside Iraq
- Prepare a training program for maintaining the water network of Basrah

(2) Operational Training of WTPs by SNAFEE

As a part of the Water Sector Institutional Strengthening (WSIS), SNAFEE together with BECTEL conducted the operational training of WTPs in Basrah (R-Zero, Garma 1 and Jubaila) for the target gropes of MMPW staff and BWD staff for the period between December 2005 and January 2006. The following training programs were included:

① How to operate and maintain the water treatment plant safely
② How to test water quality and adjust the plant operation based on the results

③ How to control materials

The trainings consisted of (i) initial classroom training, (ii) refresher course, (iii) on-the-job training (OJT), and (iv) training evaluation.

Since the effectiveness of training shall be increased by repetition of the same activities periodically, it is expected to continue similar trainings.

(3) Building Recovery and Reform through Democratic Governance (BRDG) : National Capacity Development (NCD) Program

The Building Recovery and Reform through Democratic Governance (BRDG): National Capacity Development (NCD) Program has just started funded by USAID.

The purpose of the activity is to design and implement the National Capacity Development (NCD) Program. The NCD Program is a two plus one option year. The Program will assist the Government of Iraq (GOI) to strengthen the management capability of executive branch institutions and key training centers and could assist approximately ten (10) key national ministries.

The NCD Program will focus on core public administration functions: fiscal management, personnel management and administration, leadership/communications, strategic planning, information technology, and technical skills.

It is designated that civil service reform will be an important theme that may be supported as a national policy and Ethics and anti-corruption will be cross-cutting themes across the entire NCD Program.

The objective of the NCD Program is to assist the GOI improve its operations, management, and policy formulation, thereby improving the effectiveness and legitimacy of its national-level institutions.

The NCD Program will strengthen the following illustrative core functions:

1) Leadership/communications
2) Strategic planning/policy development
3) Fiscal management
4) Personnel management and administration
5) Information technology -- IT knowledge (basic skills and advanced for IT departments) and IT equipment

6) Technical skills (generally ministry-specific skills, e.g., operations and maintenance, standard investigative practices, project management, ISO 9001 quality management, etc.)

Regarding the NCD Program, it is expected that the capacity building of MMPW has been accelerated, because MMPW is one of targets for key ministries.

7.3 RESULTS OF PCM WORKSHOP

In order to study and analyze the current situation and issues of the water supply system from a viewpoint of organization and institution, a Participatory Project Cycle Management (PCM) workshop was conducted from 11 to 13 September 2006. About 20 participants mainly from BWD were required to attend the workshop, but only eight (8) staff in total (6 from BWD and 2 from BG) attended the workshop. In the PCM workshop, the stakeholder analysis, the problem analysis, the objective analysis and the alternative analysis were carried out through the discussion among participants.

The following discussion themes were prepared for the workshop:

a) Organization and Institution Aspect
b) Facility Management and Technical Aspect
c) Human Resources Development (HRD) Aspect
d) Financial Management Aspect

The results of the PCM workshop are summarized as below and detail results are presented in Appendix H.

Table 7.6 Summary of Result of PCM Workshop

Discussion Themes	Causes	Core Problem	Measures (Approaches)
1) Organizational and Institutional Aspect	• BWD organization is a centralized structure • Little coordination between BWD and MWR/MMPW • Little coordination between Local Gov., and Gov. Council • Organization is not good for its wide geographical area • Unclear legislation for water supply service	• Undefined organization and responsibilities	• Communication and coordination improvement approaches • Administration and organization reform approaches • Legal framework development approaches
2) Facilities Management and Technical Aspect	• Unorganized distribution network • High non-revenue water • Old water treatment plants (WTPs) • Low quality of water • Shortage of power supply (fuels and electricity)	• Not enough water (quality and quantity)	• Network management project approaches • Non-revenue water (NRW) management approaches • Water quality improvement approaches • Water treatment plants (WTPs) project approaches • Energy management approaches
3) Human Resources Development (HRD) Aspect	• Required human resources (HR) are not developed • Staff has negative attitude and motivation of staff is insufficient	• HR efficiency and effectiveness are not enough	• HRD approaches • Motivation improvement approaches • Personnel administration approaches
4) Financial Management Aspect	• Inefficient financial administration • Accounting system and staff are not enough • Weak capacity of tariff collection system	• Financial management is not efficient	• Financial system improvement approaches • Accounting staff HRD approaches • Collection system improvement approaches

7.4 ISSUES TO BE ADDRESSED

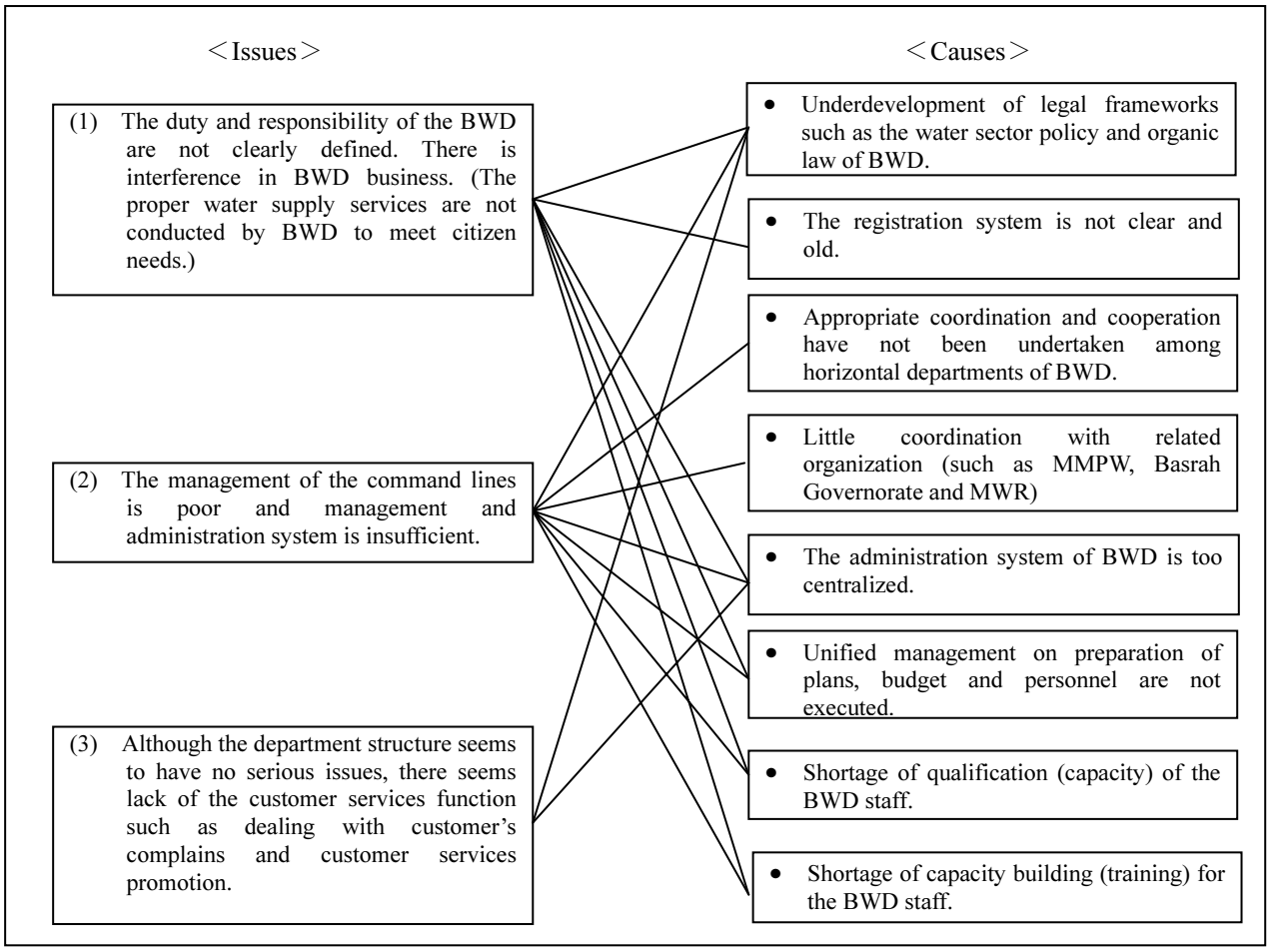
(1) Issues to be addressed for the water supply system of BWD

The most serious problem and issue for the water supply system of BWD is not to be able to supply adequate and safe drinking water to customers due to the wide range and various causes at present. Those causes can be divided from following aspects:

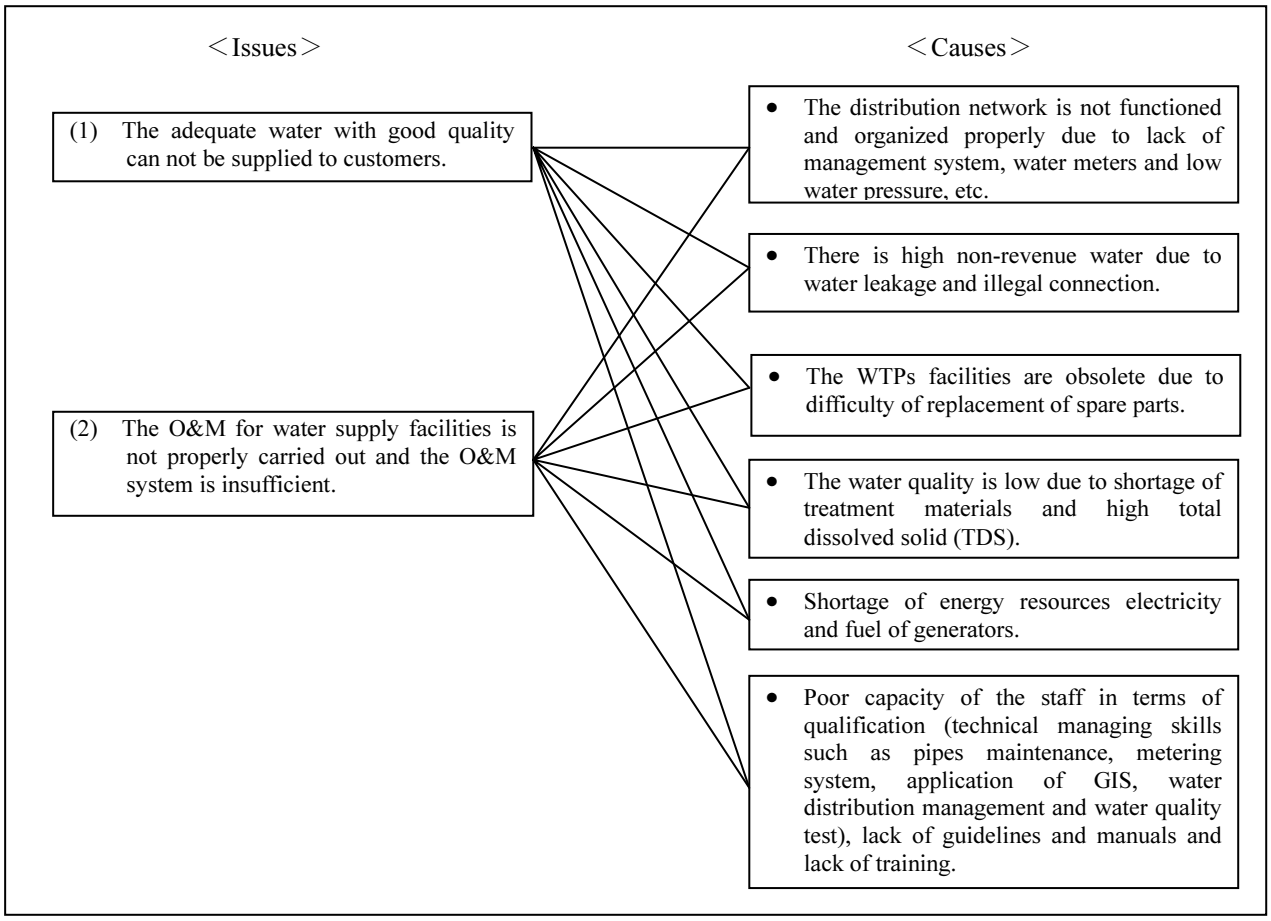
1) Organization and Institution Aspect
2) Facility Management and Technical Aspect
3) Human Resources Development (HRD) Aspect
4) Financial Management Aspect

In the Study, the issues on organization and administration of BWD are analyzed by each aspect as follows:

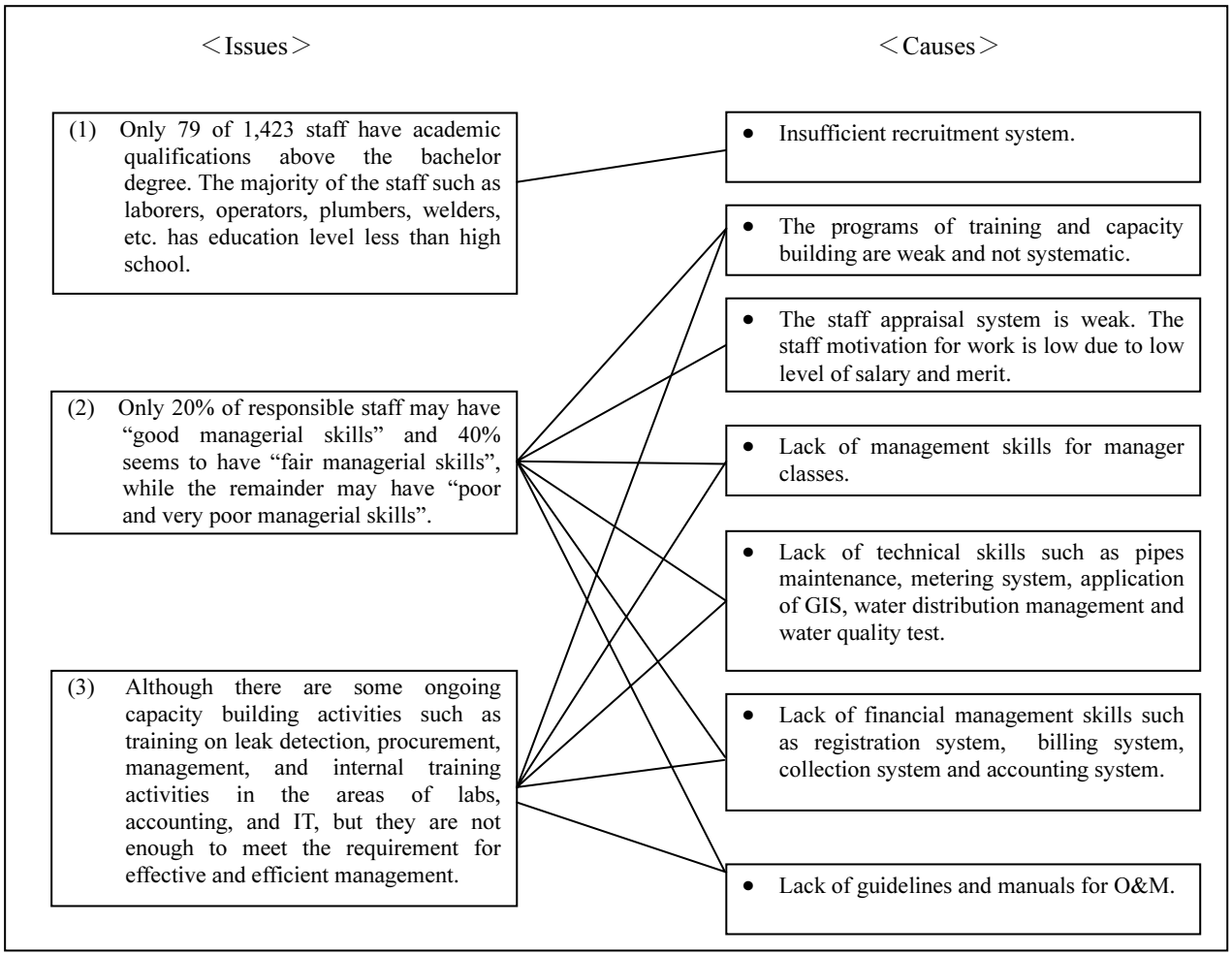
(a) Issues and causes on organization and institutional aspect of BWD



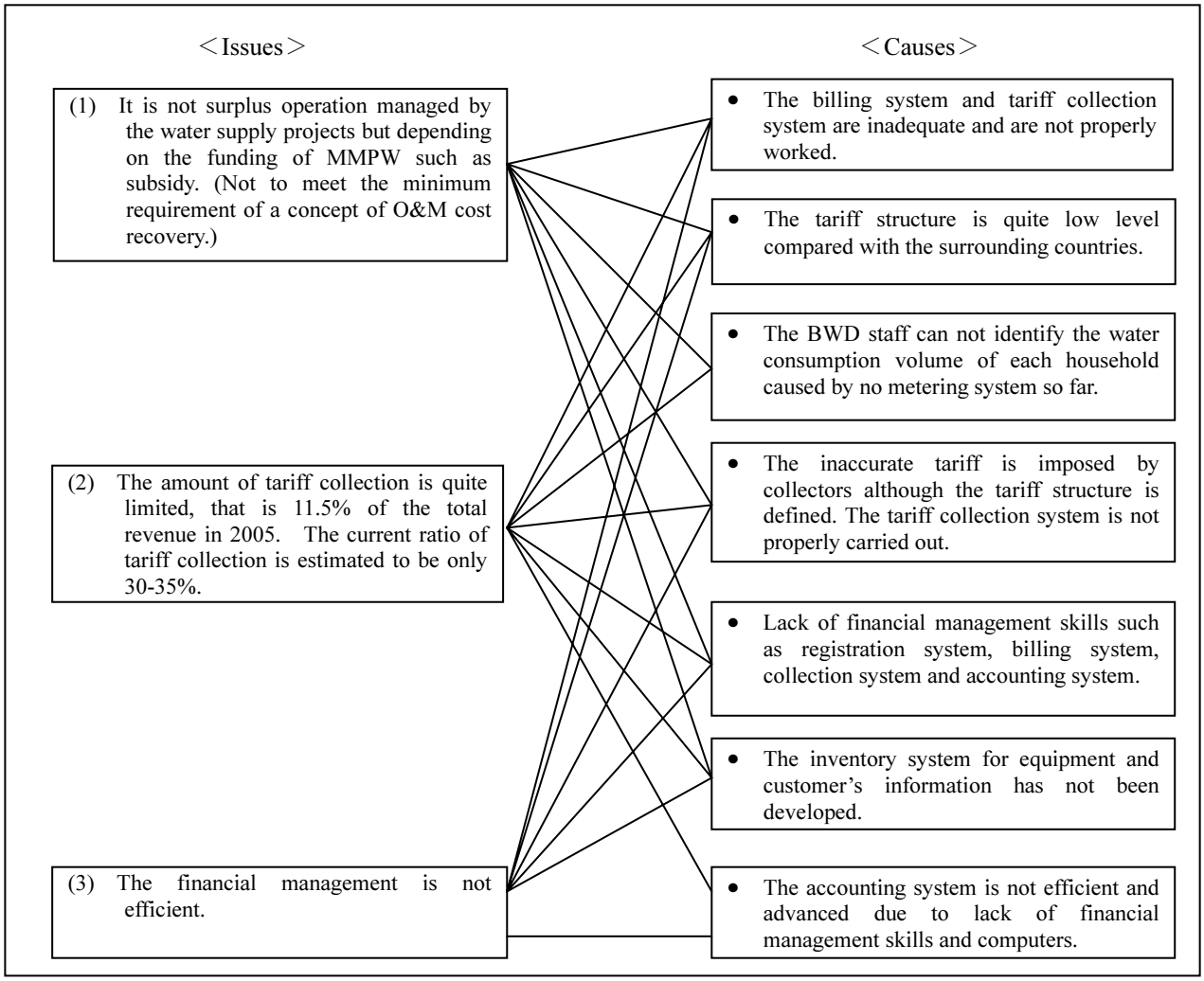
(b) Issues and causes on facility management and technical aspect of BWD



(c) Issues and causes on human resources development (HRD) aspect of BWD



(d) Issues and causes on financial management of BWD



(2) Issues to be addressed for MMPW

Project Implementation Unit (PIU) to manage and handle the Project to be funded by JBIC loan has not yet been formed and therefore PIU shall be established by MMPW at the appropriate timing after conclusion of the Exchange of Note (E/N) between the Government of Japan (GOJ) and the Government of Iraq (GOI).

It is expected that the capacity building for MMPW has been conducted by the National Capacity Development (NCD) Program funded by USAID. In addition, it is necessary for PIU staff to obtain the required knowledge and know-how for JBIC loan procedure.

7.5 GOAL AND VISION FOR WATER SUPPLY SYSTEM OF BASRAH WATER DIRECTORATE

In line with the introduction of democracy system, the introduction of decentralization and de-concentration have been discussed for efficient and effective administration of the government organizations. The national trends of decentralization and de-concentration, which started by the concerned government authorities assisted by World Bank (WB), will affect the water sector policy.

Possibly, the realization of decentralization and de-concentration will be expected by the year 2015, the target year of this Study.

Considering the trends of decentralization and de-concentration, the issues and characteristics of BWD, the goal for BWD is set as follows:

- **Goal : Autonomous and Unified Organization of BWD**

The vision of BWD administration system is set along the aims of the policy of the Government of Iraq as follows:

(a) Establishment of proper water supply management system using recent technology
(b) Execution of water supply service under council democracy system in order to ensure transparency and accountability

Based on the visions mentioned above, the capacity building steps to be taken by BWD are presented in the following figure.

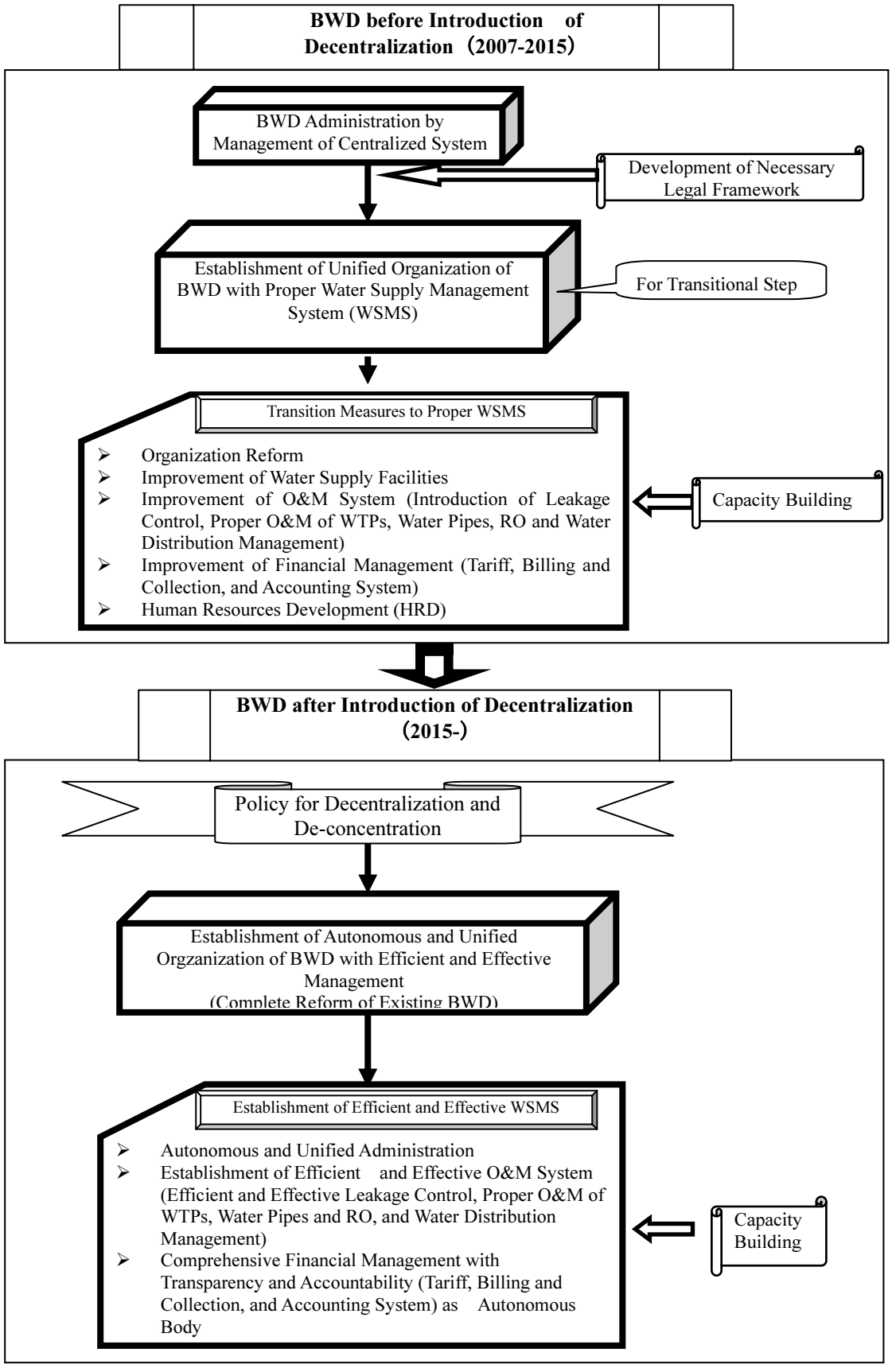


Figure 7.6 Ideal Feature of BWD

The current BWD administration has to be continued under current centralized management system until realization of decentralization. During the periods between 2007 and 2015, the following actions should be taken as transitional measures in the implementation of capacity building program.

- Development of necessary legal framework
- Organization reform
- Improvement of water supply facilities
- Improvement of O&M system (leakage control, proper O&M of WTPs and RO and water distribution management)
- Improvement of financial management (tariff system, billing and collection, and accounting system)
- Implementation of human resources development (HRD) activities

After realization of decentralization in 2015, the BWD shall be reformed toward autonomous and unified administration. The following actions should be taken after 2015:

- Autonomous and unified administration,
- Establishment of efficient and effective O&M system (efficient and effective leakage control, efficient and effective O&M of WTPs, water pipes and RO, and water distribution management), and
- Comprehensive financial management to secure transparency and accountability (tariff, billing and collection, and accounting system) as an autonomous body.

7.6 STRATEGY FOR STRENGTHENING MMPW AND THE ORGANIZATION OF BWD

Considering the goal, the vision and functions of the organization of BWD, the following five strategies are set:

Strategy-A: Smooth project implementation of this plan
Strategy-B: Formation of legal framework for water supply policy and direction
Strategy-C: Execution of autonomous and unified administration of BWD after the national decentralization and de-concentration reform
Strategy-D: Establishment of efficient and effective O&M system
Strategy-E: Ensuring adequate budget for operation and maintenance as an autonomous and unified administration body

(1) Strategy-A: Smooth Project Implementation of the Plan

The Project Implementation Unit (PIU) to manage the JBIC loan project shall be established by MMPW at the appropriate timing after conclusion of the Exchange of Note (E/N) between the Government of Japan (GOJ) and the Government of Iraq (GOI). PIU staff is required to obtain the required knowledge and know-how for JBIC loan procedure for smooth implementation of the project.

(2) Strategy-B: Development of Legal Framework for Water Supply Policy and Direction

In Iraq, the water supply service has been regarded as the public service with almost free of cost to the citizen and has been heavily subsidized by the government during the past several decades. In principle, the water supply service shall be managed based on a concept of 'cost recovery' through the efficient and effective operation and management of the water supply system to satisfy the requirement of the customers. As abrupt introduction of the concept of the full cost recovery for both capital and operation and maintenance cost may not be possible both from the BDW and customers' side, al least a concept of cost recovery for operation and maintenance should be advocated as the principle for water supply policy and the direction to the autonomous administration body without subsidy from the central government. Based on the concept of cost recovery for operation and maintenance, the legal frameworks such as registration of customers, tariff structure and tariff collection to sustain a healthy autonomous administration body should be developed.

(3) Strategy-C: Execution of Autonomous and Unified Administration of BWD after Decentralization and De-concentration Reform

The current centralized management has impeded not only communication and coordination between MMPW/MWR and BWD but also the motivation of the BWD staff as well as a customer oriented water supply service. The progress of national decentralization and de-concentration policy will affect the development of the water sector policy, which is expected to involve the water directorate of each area in the development of autonomous and unified administration body. To achieve efficient and effective management for the water supply service, an autonomous and unified body should be introduced in the water supply sector. To do so, strengthening of the functions of BWD as an autonomous body is required in terms of administration system and capacity of BWD staff.

(4) Strategy-D: Establishment of Efficient and Effective O&M System

The existing water supply facilities and equipment in Basrah are so obsolete and inadequate at present and the operation and maintenance system is not properly functioning due to insufficient technical capacity of staff of BWD, education/trainings and regulation and planning for operation and maintenance. In the project, the water supply facilities will be refurbished or newly constructed. These facilities should be operated and maintenance appropriately by experts and skilled workers. To do so, the development of the technical capacities of staff is required and efficient and effective O&M system

should be established.

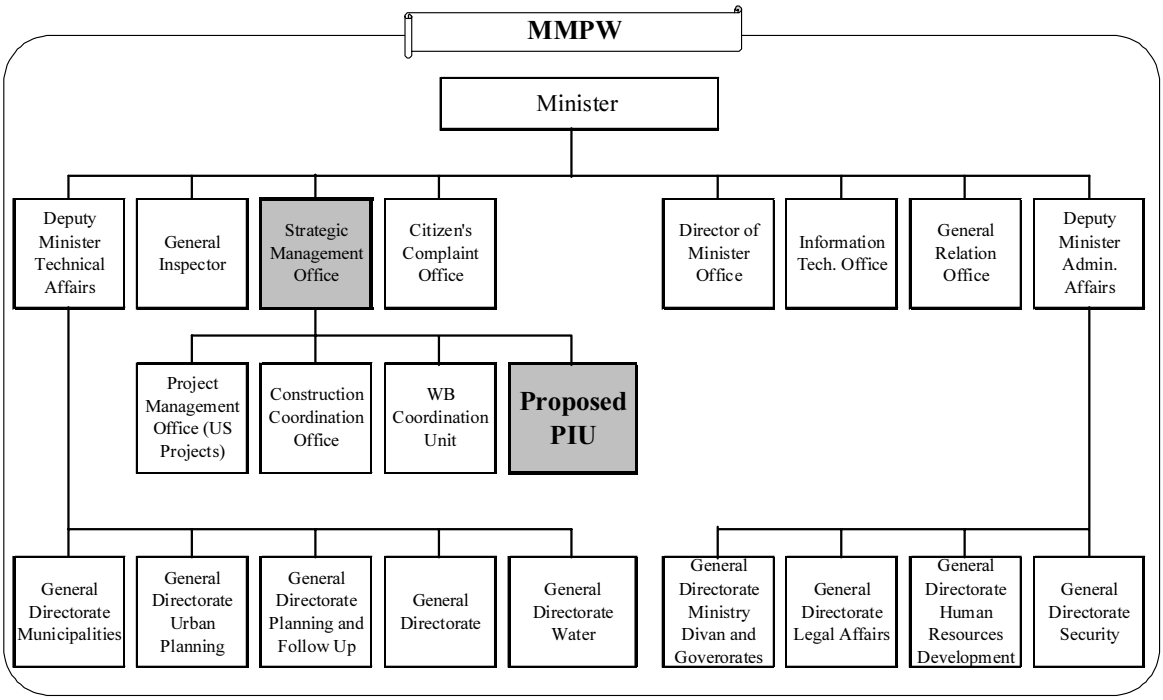
(5) Strategy-E: Ensuring Adequate Budget for O&M as an Autonomous and Unified Administration Body

The ensuring of adequate budget for O&M of the water facilities is required for a healthy autonomous and unified administration body without relying on government subsidy. To do so, the bill collection system of BWD should be upgraded, for which intensive awareness campaigns to customers to promote payment of proper tariff which covers at least operation and maintenance cost should be carried out.

7.7 RECOMMENDATIONS ON MMPW

(1) Establishment of Implementation Organization for the Project in MMPW (for Strategy-A)

It is proposed that the Project Implementation Unit (PIU) should be newly established within MMPW, in order to manage and handle the Project to be funded by the JBIC loan. The existing Strategic Management Office (SMO) of MMPW have managed similar projects funded by international donors, and has been carrying out similar functions. Therefore, it is recommended that MMPW add a PIU to the existing SMO as shown in Figure 7.7.



Source: the study team

Figure 7.7 Proposed PIU within SMO of MMPW

SMO shall act as the Program Central Implementation Unit, especially for program that requires special skills. In addition SMO is responsible for coordination with technical consultants and providing the Minister with technical advice on issues related to the investment program, priorities and the nomination of staff to work in different programs. Currently the functions of SMO are as follows:

- Coordinator of the Project Management Office (Coordination of American Aid Projects)
- Construction Coordination Office
- World Bank (WB) Coordination Unit in charge of the Projects funded by WB

The proposed PIU together with MMPW shall be responsible for the following functions:

① Dealing with the JBIC Missions (for Fact Finding and Appraisal)
② Conclusion of Exchange of Notes (E/N)
③ Loan Agreement (L/A)
④ Preparation of TOR for Consultants and cost estimate of Engineering Service (ES)
⑤ Employment of Consultant
⑥ Checking and approval of tender documents
⑦ Procurement of Contractor (Implementation of Tender, Tender Evaluation)
⑧ Execution of preparation for the Project Implementation such as land clearance and EIA
⑨ Construction Supervision
⑩ Transfer of water supply facilities to O&M organization (BWD) after completion of construction works

(2) Implementation of Capacity Building for PIU Staff (for Strategy-A)

For smooth and efficient implementation/coordination for the Project, it is necessary for PIU staff to obtain the following knowledge and know-how.

- JBIC loan procedures
- Procedure for employment of Consultant
- Procedure for procurement of Contractor
- Procedure and method for land acquisition and clearance (if any)
- Procedure and method for EIA (if required)

① JBIC loan procedures

The JBIC loan procedures shall be understood and recognized by MMPW and PIU staff (see Appendix H).

② Procedures for Employment of Consultant

The procedures for employment of Consultant shall be understood and recognized by MMPW and PIU

staff (see Appendix H).

③ Procedures for procurement of Contractor

The procedures for procurement of Contractor shall be understood and recognized by MMPW and PIU staff (see Appendix H).

(3) Formation of Legal Framework for Water Supply Policy and Direction (for Strategy-B)

A concept of operation and maintenance cost recovery should be advocated as the principle for water supply policy and direction to enable the autonomous administration without subsidy from the central government. The legal frameworks such as tariff structure should be reformed based on the operation and maintenance cost recovery concept.

The current tariff rate is set at quite low level. To ensure an adequate budget for proper operation and maintenance, the tariff level should be gradually raised and the structure should be also reformed for the customers to accept it. After the water supply service in terms of both quantity and quality is improved, 2 – 3 % of the household income may be affordable to pay for the service.

7.8 RECOMMENDATIONS ON THE ORGANIZATION OF BWD

(1) O&M Organization for the JBIC Loan Project (for Strategy-D)

BWD will be the organization responsible for O&M of the facilities constructed under JBIC loan project. Their institutional capacities should be strengthened through proposed institutional capacity building programs.

(2) Organization Reform of BWD (for Strategy-C and D)

To deal with the following issues identified through a subcontracted interview survey of the study team and the results of the participatory PCM workshop, an organization reform to operate and maintain the water supply facilities more efficiently is required.

- Inadequate management of the command lines
- Complicated and not unified command lines
- Lack of function of customer service
- Absence of appropriate audit system.

Considering these issues, a new organization of BWD is proposed as shown in Figure 7.8 and it is recommended that ‘Audit Committee’ be established to carry out financial audit.

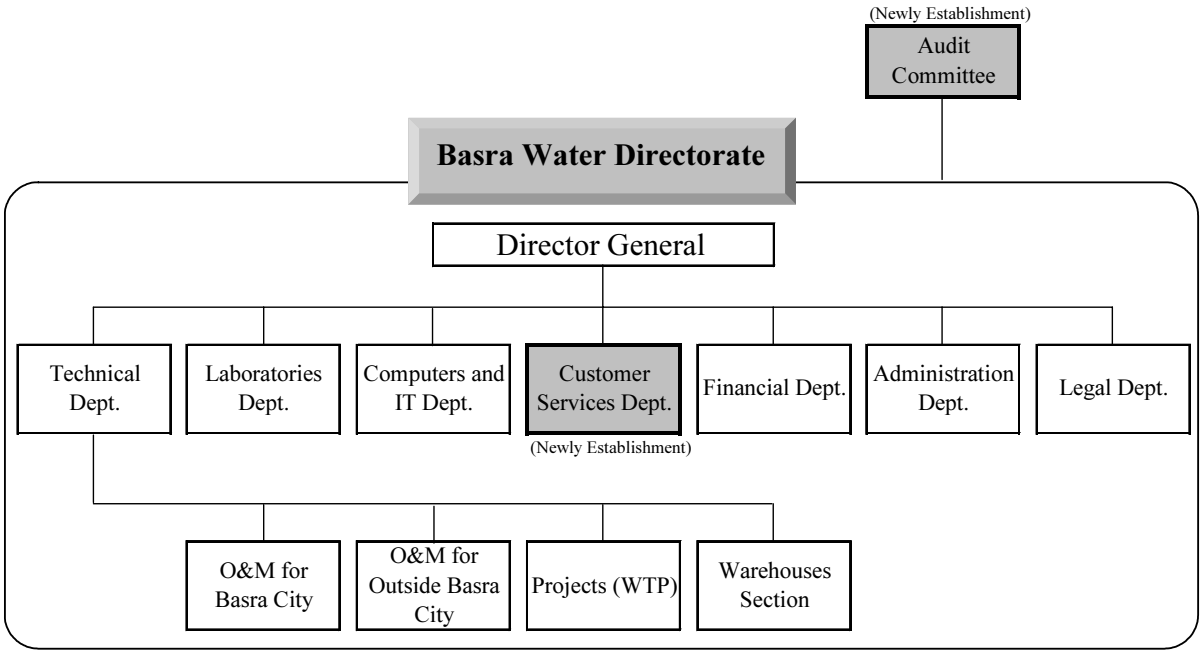


Figure 7.8 Proposed Organization of BWD

The responsibilities of a new organization of BWD are proposed as shown in Table 7.7.

Table 7.7 Proposed Responsibilities of BWD by Department

Department	Responsibilities
Technical Dept.	• Prepare maintenance schedules for distribution networks and projects, • Perform the necessary maintenance for leakage in pipes and expansion of distribution pipes, • Design the new distribution networks, • Operate and maintain the WTPs, the new reservoir and ROs, • Operate and maintain the pumping stations, • Produce drinking water, • Supervision of the construction of a new water treatment plants and networks, and • Supervision of the construction of new facilities.
Laboratory Dept.	• Monitor the produced water quality in WTPs, and • Coordinate with the Environment Dept. and the Health Dept. of Basrah Governorate.
Computer and IT Dept.	• Prepare the programs for the Directorates work (salaries, employees, vehicles, etc), • Operate and maintain the existing computers, • Operate software such as GIS, GPS, and • Develop the programs for the database for registration, maintenance method of pipes and the water distribution management.
Customer Service Dept.	• Registration of customers, • Awareness campaign on payment, • Sales promotion, • Take prompt action on claim, • Customer service relation works, and • Billing and Tariff collection.
Financial Dept.	• Organize daily accounting records, • Organize the yearly audit review for revenues and expenditures and general ledger, • Organize the book records for the different activities including allowances, • Pay salaries for staff, and • Prepare an estimated budget for each year.
Administration Dept.	• Carry out human resources development (capacity building), • Organize the yearly salary raise and incentives, • Issue the orders for hiring, firing, retirement, and transfer, and • Prepare external communications in addition to preparing the reports related to Water Dept. employees.
Legal Dept.	• Organize special contracts for all activities of the Directorate, • Follow on legal cases against the directorate, • Follow on the process of acquisition of lands used for the Directorate projects, and • Check and verify on the legal problems that can occur from and against the Directorate employees.

(3) Improvement of Operation and Maintenance System (for Strategy-D)

The operation and maintenance system should be modernized to achieve efficient and effective O&M as follows:

(a) Efficient O&M for water supply facilities

After completion of construction works of the JBIC loan project, the water supply facilities will be transferred from MMPW to BWD. The BWD staff shall efficiently and effectively operate

and maintain those facilities by improved capacity and the guidelines/manuals which will be prepared by the project consultant and the contractor.

(b) GIS application for water supply management

The GIS system can be utilized for efficient operation and maintenance of the water supply system. It is proposed to develop GIS system for the water supply management. The GIS system will contribute to implementation of the following tasks:

① Maintenance of the network pipes
② Leakage control
③ Estimation of water consumption
④ Water distribution (water flow) management
⑤ Customer registration data storage

(c) Registration system of customers

The database shall be prepared for management of registration system of customers. The following information shall be included in the database.

① Customer information
② Type of water use (domestic use/ commercial use/ industrial use / public use)
③ Estimated / metered water consumption volume
④ Payment conditions of tariff (performance of payment, payment amount, etc.)

(4) Improvement of Personnel Administration System (for Strategy- C and D)

It is recommended that the personnel administration system be improved as follows:

(a) Improvement of recruitment system

The current education background of the staff does not meet the requirement of qualification, because only 79 out of 1400 staff have the degree above bachelor and the majority of the staff has educational qualification less than the level of high school. In addition, there also exist problems of favoritism and nepotism.

It is recommended that examinations including the paper test and job interview after the screening by CVs for candidates be applied to recruit the required human resources with appropriate educational level and to discourage favoritism and nepotism.

(b) Encouragement to work

One of the serious problems is discouragement of the staff to work due to insufficient staff motivation system, no merits and incentives irrespective of staff's effort. It is recommended that a merit system be introduced as follows:

① Resort to a promotion system based on ability
② Adopt an appropriate staff appraisal system
③ Adopt a merit system for salaries based on the appropriate staff appraisal system
④ Adopt a bonus system such as incentive bonus for bill collectors if he achieves the target collection ratio

The objectives of the personnel evaluation system are to establish clear personnel evaluation systems and establish linkage among the personnel affairs. The example of staff appraisal criteria is presented in Appendix H.

(5) Improvement of Financial Management (for Strategy-E)

It is recommended that the improvement of the financial management be carried out for ensuring adequate budget of O&M. The following measures should be taken by BWD.

(a) Improvement of tariff collection system

The current ratio of tariff collection is estimated to be only 30-35% due mainly to an insufficient billing system and inadequate tariff collection system. The following measures are recommended to increase tariff collection:

Table 7.8 Recommended Measures for Tariff Collection System

Causes of Low Tariff Collection	Recommended Measures	Target
・ Unfair tariff charge	・ Introduction of metering system	BWD
・ No incentives system for collectors	・ Introduction of incentives system (bonus system) for collectors	Collectors
・ Illegal connections	・ Introduction of strict penalty	Customers
・ Lack of awareness campaigns on importance of duties for payment	・ Implementation of awareness campaign	BWD staff

(b) Establishment of Audit Committee (AC)

The audit system for financial statement of BWD shall be established to ensure transparency and accountability. The Audit Committee (AC) is proposed as an auditing unit as shown in Figure 7.8. The members of the committee are preliminarily proposed as follows:

① Director General of BWD
② Director of Technical Department of BWD
③ Director of Financial Department of BWD
④ Chairman of Governorate Council of Basrah Governorate (BG)
⑤ Governor of Basrah Governorate (BG)
⑥ Representative of Committee Member of Anti-Corruption Unit of Basrah Governorate (BG)

The auditing for financial statements including annual revenue and expenditure shall be carried out by the committee periodically.

(6) Implementation of Capacity Building for BWD Staff (for Strategy- D and E)

It is necessary to strengthen the staff capacity and develop human resources by means of various capacity building programs to increase motivation of the staff, to establish efficient and effective O&M system and to ensure adequate budget for O&M through proper financial management.

The following capacity building programs are recommended to be necessary for the BWD staff.

(a) Career development programs

The career development program is designed to develop individual potential or skills in the long term that reflects the life plan or life target. An individual's capability tends to decrease as they get aged, but BWD should maximize utilization of the staff regardless of age. At the same time, the staff has a desire to gain a position at management level or improve their skills. The career development program aims to satisfy the objectives of BWD and individual objectives, and this contributes to sustainable development for both parties. Basic procedures of the career development program are summarized below.

- The staff and managers based on the career (target) proposed by the staff and personnel record shall be coordinated.
- Establishment of career development targets based on both the BWD operational targets and the human resources development plan. Job rotation and promotion shall be decided based on individual and the BWD targets.
- Skill development shall be continuously monitored and revised based on discussions with the staff.
- BWD shall support skill development by providing OJT or financial support.

The most important points for the career development program are the improvement of initiative

of the individual staff members and coordination with the BWD plan. The BWD staff needs to be aware of the BWD plan when they consider their career path.

The components of career development scheme can be classified into three aspects (i) BWD management, (ii) individual development, and (iii) training and education.

(i) BWD organizational management

The BWD management segment includes an operational plan as well as a human resources development plan that will be a guide for individual career development planning. In order for the staff member to plan his career so that it follows the BWD objectives for water supply service, the BWD's objectives have to be clarified. In addition a human resources development plan based on the BWD plan has to be prepared so that the staff can receive training that follows BWD's objectives. Followings are the plans or policies that need to be prepared and disseminated to staff.

- BWD's short term, midterm and long term objectives
- Efficient utilization of staff
- Recruitment
- Training and education
- Setting goals for career development and personnel policy (job rotation, promotion based on eligibility)
- Work experience/skill development plan

(ii) Individual development

For individual development, career targets, career objectives and skill improvements should be included which have been initiated by the staff member himself. Even though career development has to be initiated by the staff member, BWD shall provide support for career development by guiding them in the right direction. Following are the items to be considered at the individual level.

- Setting individual targets (life plan, life stage)
- Staff's direction on career (appropriate place, personality, training)
- Individual improvement
- Career guidance based on individual interview
- Personnel record
- Personnel evaluation

(iii) Training and education

Career development has to be supported by continuous training and education. Individual needs and BWD needs change as the operating environment changes. The training and education programs need to be reviewed constantly and revised if necessary.

The training menu is provided based on career paths and training needs. The structure of training and the training menu are summarized below.

(b) Technical Career Development Menu

The objective of the menu is to develop and improve individual technical and management skills and knowledge for specialized fields for water supply service. This menu shall also include managerial skills such as customer service relations, financial management and human resources management.

(i) Compulsory technical development menu

Training aims for improvement of career paths for technical and management staff through development of basic skills and knowledge necessary for all staff, and sets the direction of the career path of the staff.

Programs	Objectives	Candidates	Priority
(1) Practical Technical Development	Improvement of knowledge of general water supply system operation.	Min. 20 years of age	B
(2) Practical Professional Training	Improvement of knowledge of general water supply management.	Min. 30 years of age	B

* A: Highest, B: High, and C: Fair

(ii) Technical career development menu for strengthening staff duties

Training aims for the development of requisite skills and knowledge for tasks required by the departments and/or staff.

Programs	Objectives	Candidates	Priority
(3) Operation and maintenance (O&M) for production and distribution of water	Improve the skills needed for O&M of water supply facilities as follows: ● Training on the guidelines and manuals for efficient O&M of the water supply facilities (WTPs, pumping stations, reservoir and network pipes) and its proper operation. ● Training on GIS application for water supply management. ● Training on water distribution management. ● Training on metering system.	Technical staff	A
(4) NRW control (technical)	Improve skills needed to minimize technical NRW as follows: ● Training on leakage control method. ● Training on method to reduce the illegal connection.	Technical staff	A
(5) NRW control (non technical)	Improve skills needed to minimize non technical NRW as follows: ● Training on awareness method to reduce the illegal connection.	Staff in customer service department	B
(6) Customer service relations	Improve the handling of all requests from customers and promote PR.	Staff in customer service department	B
(7) Awareness campaign for tariff collection	Improve the condition of tariff collection. ● Training on how to carry out the awareness campaign on significance of payment	Staff in customer service department	A
(8) Sales promotion	Improve the condition of tariff collection. ● Training on how to carry out the sales promotion for water.	Staff in customer service department	B
(9) Site management	Improve supervision of operations.	Staff with some experience and in a management position	C
(10) BWD management	Improve BWD management skills. ● BWD planning and implementation ● Communication ● Support the organizational reform ● Decentralization of organization ● Internal auditing	Staff in administration department	B
(11) Financial management	Improve the financial management system. ● Financial accounting ● Managerial accounting ● Budget management	Staff in financial department	B
(12) Human resources management	Improve the staff capacity. ● Career development plan ● Training plan	Staff in administrative section and management	B
(13) New staff OJT	Learn the activities and culture of BWD.	All new staff	C
(14) Technical OJT	Improve technical skills by adapting new technology or new methods of operation as well as behavior and attitude of staff.	Technical staff	C

* A: High, B: Medium, and C: Low

(iii) Optional technical development menu

Training aims to develop business managers, technical leaders and management leaders strategically by selecting specific staff with potential. This involves high-level education and training.

Programs	Objectives	Candidates	Priority
(15) Site inspection abroad	Learning stete-of-the-art technology for water supply systems and water supply management.	Staff recommended by technical department	C
(16) Seminar and workshop	Learning technology that is not available in BWD.	Staff recommended by technical department	B
(17) Formal training	Learning advanced technology for water supply.	Staff recommended by technical department and administration department	C

* A: High, B: Medium, and C: Low

(c) Organizational Career Development Menu

The objective of this menu is to utilize individual skills and knowledge in the organization of BWD and to maximize the performance of BWD through improving management skills. This type of training shall be provided mainly by the Administration Department.

(i) Compulsory career development training menu

Programs	Objectives	Candidates	Priority
(18) Pre-contract training	• Learning basic rules for working for BWD • Learning basic writing skills	Candidate staff	C
(19) Newly recruited staff training	• Introduction to BWD activities • Introduction to expectations from BWD	Newly recruited staff	C
(20) Computer training	• Learning basic computer skills for daily work	Staff required to use computer	A
(21) Post promotion training (Ranking)	• Feedback of the experiences and plan for the future • BWD management • Responsibility and function of management position	Newly promoted staff	C

* A: High, B: Medium, and C: Low

(ii) Career development training menu for strengthening staff duties

Programs	Objectives	Candidates	Priority
(22) Manager training	• Basic responsibility as a manager • Problem solving at work place • Financial management • Staff appraisal training	Department head	B
(23) Personnel evaluator training	• Acquire knowledge of personnel evaluation system and how to execute evaluation	Staff responsible for personnel evaluation	A
(24) Director training	• Management skills required for each section • Planning of BWD business management	Directors	B

* A: High, B: Medium, and C: Low

(d) Implementation procedure of career development programs

Training programs shall be implemented as following procedure. Trainings shall always be monitored and recorded.

Step 1: Preparation of annual training programs by each department (individual requests and department policy)
Step 2: Implementation
Step 3: Routine follow up (monthly) by recording the training results (participated in training or not, certificate) by means of the education and training plan/ monitoring sheet for Department
Step 4: Report of trainee to manager and Administration Department
Step 5: Review of the performance

(e) Necessary training periods and input of consultant for training programs

It is recommended that the training programs be carried out by engineering services and advisory services of consultants. The necessary training durations and input of the foreign and local consultant is estimated as shown in the following table.

Table 7.9 Necessary Training Periods and Input of Foreign and Local Consultant

Programs	Necessary Training Periods	Foreign Consultant (MM)	Local Consultant (MM)	Priority A: High B: Med C: Low
I. Technical Career Development Menu				
① Technical development menu for mandatory type				
(1) Practical Technical Development	6 months	2	6	B
(2) Practical Professional Training	1 year	3	12	B
② Technical development menu for strengthening staff duties				
(3) Operation and maintenance (O&M) for production and distribution of water	4 years	96	240	A
(4) NRW control (technical)	3 years	48	144	A
(5) NRW control (non technical)	1 year	6	12	B
(6) Customer service relations	2 years	12	24	B
(7) Awareness campaign	4 years	24	144	A
(8) Sales promotion	2 years	12	72	B
(9) Site management	1 year	3	12	C
(10) BWD management	3 years	12	72	B
(11) Financial management	3 years	12	36	B
(12) Human resources management	6 months	3	6	B
(13) New staff OJT	3 months	1	3	C
(14) Technical OJT	1 year	2	12	C
③ Technical development menu for selection type				
(15) Site inspection abroad	1 month	1	1	C
(16) Seminar and workshop	Subject to seminar and workshop	-	-	B
(17) Formal training	Subject to formal training	-	-	C
II. Organizational Career Development Menu				
① Career development training menu for mandatory type				
(18) Pre-contract training	4 months	2	4	C
(19) Newly recruited staff training	1 month	1	1	C
(20) Computer training	2 years	12	72	A
(21) Post promotion training (Ranking)	3 months	2	6	C
② Career development training menu for strengthening staff duties				
(22) Manager training	1 year	6	12	B
(23) Personnel evaluator training	1 year	6	12	A
(24) Director training	1 year	6	12	B
A programs		**186**	**612**	
B programs		**74**	**264**	
C programs		**12**	**39**	
Total		**272**	**915**	

* A: High, B: Medium, and C: Low

(f) Proposed implementation schedule of training programs

It is proposed that training programs be carried out on the basis of the following schedule.

Table 7.10 Proposed Implementation Schedule of Training Programs

	2008	2009	2010	2011	2012	2013	2014	2015
I. Technical Career Development Menu								
①Technical development menu for mandatory type								
(1) Practical Technical Development					■			
(2) Practical Professional Training					■■			
②Technical development menu for strengthening staff duties								
(3) O&M for production and distribution of water	■■	■■	■■	■■				
(4) NRW control (technical)	■■	■■	■■					
(5) NRW control (non technical)				■■				
(6) Customer service relations				■■	■■			
(7) Awareness campaign	■■	■■	■■	■■				
(8) Sales promotion				■■	■■			
(9) Site management						■■		
(10) BWD authority management			■■	■■	■■			
(11) Financial management			■■	■■	■■			
(12) Human resources management			■■					
(13) New staff OJT								■
(14) Technical OJT							■■	
③Technical development menu for selection type								
(15) Site inspection abroad							■	
(16) Seminar and workshop			■	■■■	■■■			
(17) Formal training							■■■	■■■
II. Authority Career Development Menu								
①Career development training menu for mandatory type								
(18) Pre-contract training								■
(19) Newly recruited staff training								■
(20) Computer training	■■	■■						
(21) Post promotion training (Ranking)								■
②Career development training menu for strengthening staff duties								
(22) Manager training				■■				
(23) Personnel evaluator training	■■							
(24) Director training				■■				

CHAPTER 8

COST ESTIMATION AND IMPLEMENTATION SCHEDULE

CHAPTER 8 COST ESTIMATION AND IMPLEMENTATION SCHEDULE

8.1 CONDITIONS OF CAPITAL COST ESTIMATION

(1) Composition of Capital Costs

The project capital cost comprises the following cost items.

1) Direct construction cost
2) Administration expenses
3) Taxes and duties
4) Engineering cost
5) Price contingency
6) Physical contingency

The project costs are divided into the foreign currency portion (F.C.) and local currency portion (L.C). The unit construction costs are also divided into F.C. and L.C. as presented in Appendix I1 considering the following major factors and utilizing the cost estimation of other water supply projects which were being implemented recently.

- ✓ Availability of skilled and common labors
- ✓ Productivity and availability of construction materials in Iraq
- ✓ Productivity and availability of construction equipment and construction material plant

Mainly the foreign currency portion includes the cost as CIF price of equipment and materials to be imported and the local currency portion includes the costs of labors, equipment and materials procured locally and custom clearance.

(2) Conditions and Assumptions for Cost Estimation

The capital cost was estimated based on the conditions and assumptions as explained in Table 8.1.

Table 8.1 Conditions and Assumptions for Cost Estimation

Item	Conditions and Assumptions
1) Price Level	・ The price level is as of June 2006.
2) Foreign Exchange	・ The exchange rate was set as follows. US$ 1.0 = ID1475 = JPY112 as of June 2006.
3) Implementation Schedule	・ 2007-2013 Tender Design, Pre-qualification and Tender ・ 2010-2015 Construction
4) Administration expenses	・ Administration expenses were assumed in proportion to the amount of 10 percent of the direct construction cost. ・ Administration expenses were applied and incorporated into local and foreign currency potions. ・ Security cost for transportation was applied and incorporated into foreign currency portion. ・ Security cost for construction site was applied and incorporated into local currency portion. ・ Insurance for transportation of imported equipment and materials was applied and incorporated into foreign currency portion. Insurance for construction was applied and incorporated into local currency portion.
5) Price contingency	・ Price contingency was provided to cover price escalation in Iraq and foreign countries, where imported equipment and materials are manufactured. ・ 9.0 percent per annum of price contingency was applied for the local currency portion (L.C.). ・ 1.7 percent per annum of price contingency was applied for the foreign currency portion (F.C.).
6) Physical contingency	・ Physical contingency was provided to cover minor differences in actual and estimated quantities, omissions of minor items of work incidental, difficulties unforeseeable at the site, possible changes in plan, and other uncertainties. ・ 20 percent of the direct construction cost, administration expenses, and engineering cost was applied for both of the local currency and foreign currency.
7) Tax and Duty	・ Custom Duty 5 percent of CIF Basrah prices of foreign procurements (Pipes, Fittings equipment, electric panel and etc) was incorporated ・ Tax 10 percent of the direct construction cost and administration expenses was applied.
8) Engineering Cost	・ 11 percent of the direct construction cost was applied.

(3) Implementation Schedule of the Project

The proposed project will require a large amount of capital investment. Therefore, it will be implemented through several construction phases. The implementation schedule of the project is prepared based on the priority decided in CHAPTER 9.

The project is planned to start at selection of consultant in 2007 and complete in 2015. The implementation of the project is planned in a manner to ensure the proper execution of the work considering the construction conditions including contractors and suppliers, procurement of materials and labor force, the manner of procurement of materials, and the manner of construction. As a result, the implementation schedule was prepared as shown in Table 8.2.

Table 8.2 Proposed Implementation Schedule

Item	2007		2008		2009		2010		2011		2012		2013		2014		2015	
Selection of Consultant																		
Detailed Design																		
Tendering																		
Rehabilitation of Distribution Network																		
Rehabilitation of WTP																		
Construction of Transmission System																		
Construction of Water Treatment Plant																		
Construction of Distribution System																		
Construction of RO Plant																		

(4) Direct Construction Cost

1) Method of Direct Construction Cost Estimation

a) Pipeline

Unit direct construction cost of pipe for each diameter ranging from 110 mm to 2,000 mm was estimated (Appendix I1). High Density Polyethylene (HDPE) pipes from 110 mm to 355 mm and Ductile Iron pipes (DCIP) above 400mm were applied considering material prices and past results.

Cost of pipe materials was based on quotations of manufacturers and suppliers from countries such as Japan, European Counties, Turkey, etc. Construction cost of civil works, pipe lying, pavement, etc. were estimated based on standard section planning, which was applied for roads and side walk. Temporary works are applied for relatively large diameter pipes, which require deep digging, based on assumptions stated in 4) Conditions of Civil Works.

b) Rehabilitation of Water Treatment Plants

Cost of rehabilitation was estimated based on existing conditions of water treatments plants. The conditions of facilities and equipment of each existing water treatment plants are examined through Information Collection Survey. The contents of cost estimation are listed in Appendix I2. Rehabilitation of existing water treatment plants was planed not to achieve complete replacement but life extension of facilities and equipment.

c) Pumping Station

A cost versus capacity curve for construction of pumping station was formulated based on cost estimation for various capacities (Appendix I1). The capacities of pumping station for estimation were chosen based on the suction diameters of pumps. The cost components include pump equipment, electrical facilities, generator, building and accessories such as monitoring instruments and pipes. The capacity of each component was decided in basic facility planning.

d) Water Treatment Plant

A cost versus capacity curve for construction of water treatment plant was formulated based on cost estimation for various capacities (Appendix I1 Estimated Unit Direct Cost). The cost includes intake pump facilities, receiving and flush mixing facilities, flocculation facilities, sedimentation facilities, filtering facilities, chemical facilities, treated water reservoir, management facilities, electrical and generator facilities, piping works and temporary works. The capacity of each component was decided in basic facility planning. Foundation works of civil structures and temporary works were estimated based on assumptions stated in 4) Conditions of Civil Works.

e) Ground Reservoirs and Elevated Tank

A cost versus capacity curve for construction of ground reservoir and elevated tank was formulated based on cost estimation for various capacities (Appendix I1). Basic values such as number of pilings and volume of concrete work, which mainly influence the cost, were calculated based on basic facility planning and assumptions. Foundation works of ground reservoirs and elevated tanks were estimated based on assumptions stated in 4) Conditions of Civil Works.

f) Reverse Osmosis Plant

Cost estimation of reverse osmosis plant was preliminarily made using the cost estimation of similar projects and based on experience in Japan and hearing from membrane manufactures. Most of the construction cost of the plant was estimated as foreign portion.

2) Availability of Materials

a) Local Materials

In the local market, materials for civil works such as aggregate, concrete blocks, bricks, asphalt, cement, reinforcing steel, and wood are available. Cement is produced in Iraq, but the available quantity is insufficient compared to demand. Therefore, the shortfall is covered by importing cement from neighboring countries such as Turkey, Jordan, and Egypt. The market price has stabilized at present. Reinforcing steel

bars and other industrial products for construction are also planned to be imported to cover shortage. The market price of light oil and gasoline is as much as 10-20 times the official price. The market price of fuel is fluctuating day to day.

b) Imported Materials

Water pipes and fittings of Ductile Iron pipe and High Density Polyethylene pipes are not available in the local market. Mechanical and electrical equipment, which are required to be installed at water treatment plants and pumping stations, are also not available. Consequently, these materials and equipment should be imported from foreign countries.

3) Transportation Route to the Project Site

The materials and equipment to be transported from abroad consist of huge amounts of pipes and machinery such as pumps, electric panels, etc. Those materials and equipment are planned to be transported to Kuwaiti Port by ocean freight from origin countries and to project site through inland transportation from Kuwaiti Port.

There is Um Qasir Port close to Basrah City. Currently, number of tankers is limited due to security reasons and hence not reliable. Therefore, Um Qasir route is not appropriate for this project, which is required to transport huge amounts of materials such as pipes, at least in current condition. Therefore, Kuwaiti route is assumed for cost estimation. But, it is required to reexamine transportation route during implementation stage considering the latest security conditions.

4) Conditions of Civil Works

Basrah city is situated on the accumulation layer formed by Tigris and Euphrates river flood. Therefore, it is expected that some leakage problems during excavation might occur and shortage of bearing capacity could be caused in the accumulation layer of project sites. However, most of them do not rule out the possibility of implementation of the schemes. To secure the safety of works, the measures that shall be undertaken during excavation and to meet shortage of bearing capacity for the foundation, are outlined below.

1) Leakage

The groundwater level varies in the range of -2.5m and/or -0.5m. In order to keep the dynamic stability of excavated slope in the pit, Steel Sheet Pile method and dewatering with sufficient capacity drainage pump is recommended.

2) Bearing capacity

According to the existing data of ground borehole analysis in the project site, which was obtained through Information Collection Survey, the allowable bearing capacity of ground surface layer lies in the range of 2-7 t/m^2, the depth of bearing layer ranges between -23m and -25m from the ground level. Therefore, pile foundations are recommended for civil structures of water treatment plants, ground reservoirs and elevated tanks.

(5) Security issues

Transportation of equipment and materials to the construction sites and each construction site itself are assumed to be at high risk due to terrorism, riots, and disorder that can not be predicted at present. Security measures, that can respond quickly when some threat or attack occurs, will be required to successfully implement the project.

1) Transportation Security

Security measures are required for the drivers and trucks transporting imported equipment and materials into Iraq. The cost for security measures shall be included in the project cost. Transportation in Iraq is no safer than it was before. Transported cargo is moved in convoys and is continuously escorted by private security companies. However, the level of security in Iraq changes with the place and time. Therefore, security measures such as level of guard and transportation route shall be reconsidered during implementation stage based on the latest security information.

2) Site Security

The local contractors shall engage a local security company that is very familiar with the circumstances in the project area. Security measures for the main construction site and pipe lying site, including materials stockyard, warehouses and temporary site offices should be carried out 24 hours a day, seven days a week. This cost was estimated based on security cost of a local company.

(6) Capability of Local Contractors and Labor Force

1) Capability of Local Contractors

Contractors and suppliers who intend to undertake the construction works and/or the supply of construction equipment and materials shall be registered with the government agencies concerned. The Iraqi Contractors Association is responsible for contractor classification and registration.

Iraqi contractors are divided into state owned national construction companies and private companies. The technical levels of the state owned national construction companies are currently in a period of transition from being nationally owned companies to becoming private companies due to a change in government policy. The staff of these national construction companies ranges from 600 to 1000 employees.

The private contractors generally employ from 30 to 200 persons with the average size of a private construction company being around 50 employees. In addition, there are some foreign private contractors from neighboring countries, contracting some projects in Iraq, but they have security problems.

2) Labor Force

The skilled workers, which are necessary for the pipe works, are available in the project area because there were numerous workers who have experience in relation to manual excavation and backfilling pipe projects carried out by DFID, Iraq fund and USA funded Project in the Basrah City. The new projects will promote employment of the local people, thus reducing the present unemployment rate, which will also contribute to increasing the value of the project to the people of Basrah and surrounding area.

8.2 ESTIMATION OF CAPITAL COST

The estimated costs for the proposed project are summarized in Table 8.3 and the breakdowns are given in Appendix I2.

Table 8.3 Capital Cost Estimation

(1,000 US$)

No.	Items	L.C.	F.C.	Total
1.	Direct Construction Cost			
1-1	Rehabilitation of Distribution Network	9,895	11,192	21,087
1-2	Rehabilitation of Water Treatment Plant	995	6,359	7,354
1-3	Construction of Transmission system	28,981	49,619	78,600
1-4	Construction of Water Treatment Plant	45,396	56,775	102,171
1-5	Construction of Distribution Facilities	79,739	49,752	129,491
1-6	Construction of Reverse Osmosis Plant	14,480	206,340	220,820
	Sub-total (1)	179,486	380,037	559,523
2.	Administration Expenses	36,266	57,832	94,098
	Construction Cost - Sub-total (1) + (2)	**215,752**	**437,869**	**653,621**
3.	Tax and Duty	84,364	0	84,364
4.	Engineering Cost	41,470	56,248	97,718
5.	Price Contingency	189,828	60,147	249,975
6.	Physical Contingency	81,116	99,603	180,719
	Indirect Cost Total	**396,778**	**215,998**	**612,776**
	Total	**612,530**	**653,867**	**1,266,397**

Note: L.C. means local currency portion and F.C. means foreign currency portion.

The yearly implementation cost of the project is estimated as shown in Table 8.4.

Table 8.4 Yearly Implementation Cost of the Project

(Million US$)

Item	2008	2009	2010	2011	2012	2013	2014	2015	Total
1.+2. Direct Cost + Administration	0.0	0.0	16.7	86.6	70.0	72.1	204.2	204.2	653.8
3. Tax and Duty	0.0	0.0	2.1	10.9	8.8	9.0	26.8	26.8	84.4
4. Engineering	0.8	6.4	7.1	7.4	18.0	19.0	19.0	19.9	97.6
5. Price Contingency	0.0	0.0	3.4	23.9	24.3	30.4	77.5	90.5	250.0
6. Physical Contingency	0.0	0.0	4.0	22.1	18.8	20.5	56.3	58.9	180.6
Total	0.8	6.4	33.3	150.9	139.9	151.0	383.8	400.3	1266.4

The percentage of components of the estimated capital cost were analyzed as shown in Figure 8.1 and that of the estimated direct cost in Figure 8.2. The direct construction cost and administration expenses occupy 51 % of the total cost. Forty percent (45 %) of the direct cost is occupied by RO plant and 18 % by water treatment plant.

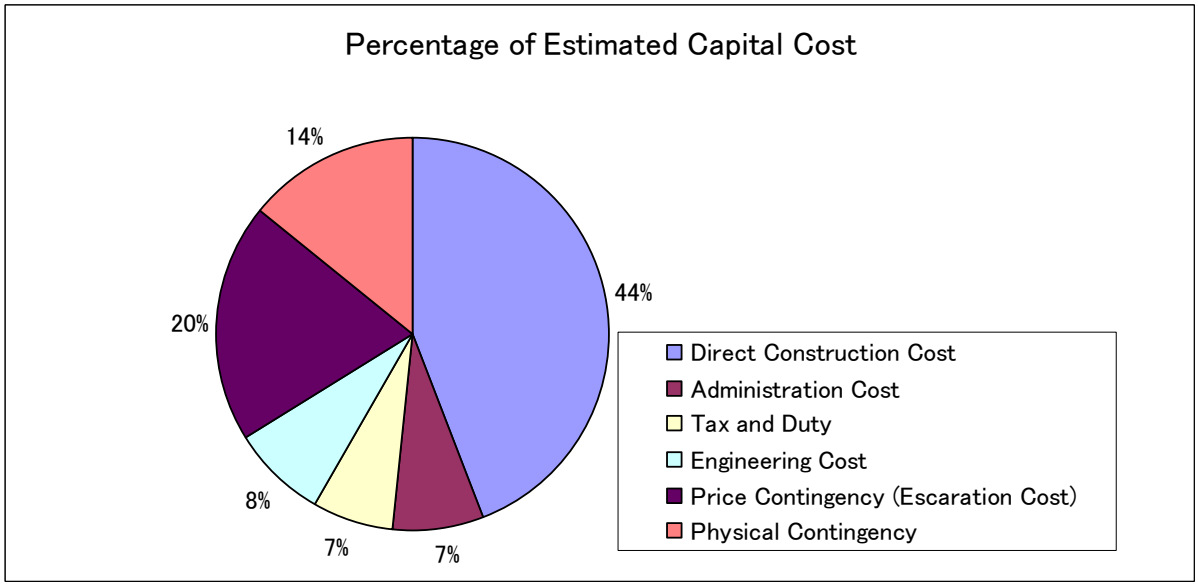


Figure 8.1 Percentage of Components of Capital Cost

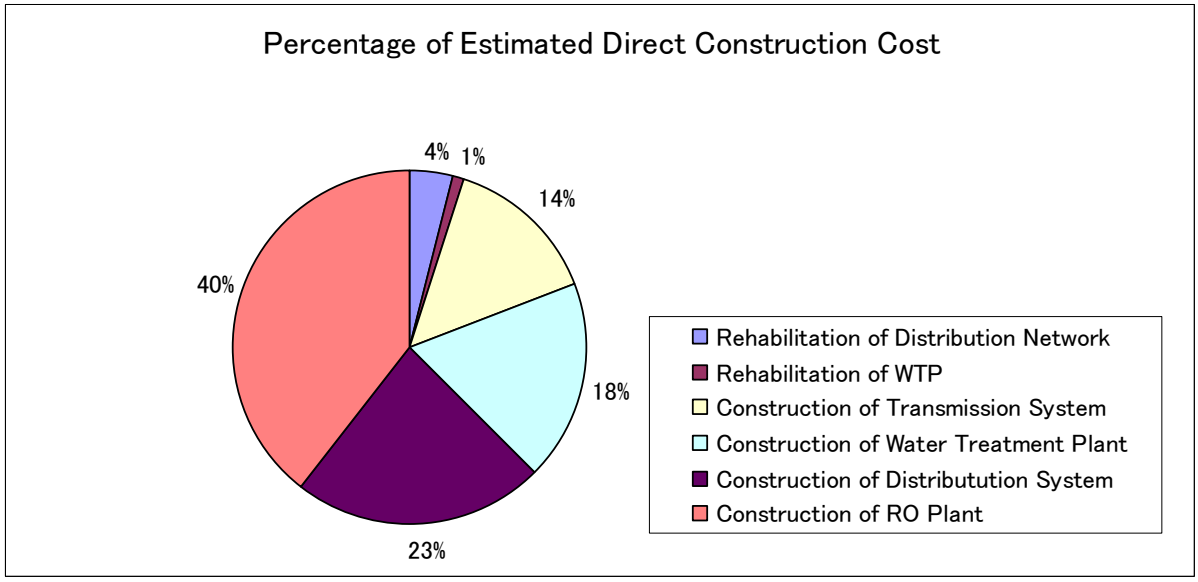


Figure 8.2 Percentage of Components of Direct Construction Cost

8.3 OPERATION AND MAINTENANCE COST OF WSPCB

Based on the assumptions and conditions given in Table 8.6, the operation and maintenance (O&M) cost of WSPCB for 2015 were estimated as shown in Table 8.5 together with the existing actual expenditure in 2005. The current average hours of power supply is about 12 hours for water supply facilities due to shortage of power supply in Basrah Governorate and during the rest of the day, on-site generators are used for operation or the facilities are stopped when expensive fuel for generators is not available. For reference or evaluation purpose of the project, the operation and maintenance costs are estimated assuming 12 hours generator operation if the power supply conditions are not improved. For the same reason, the operation and maintenance costs with and without operation (or introduction of RO) are estimated as RO operation gives considerable impact on the operation and maintenance cost of BWD. The following table shows these cases.

Item		Operation or introduction of RO	
		With	Without
Operation of on-site generator	Without	Normal	Case 3
	With	Case 1	Case 2

Table 8.5 Operation and Maintenance Cost of WSPCB in 2015

(Million ID/year)

Item	2005 (Actual)	Normal Conditions	Case 1	Case 2	Case 3
Salary	4,419	7,838	7,838	7,704	7,704
Operating budget	350	543	543	543	543
Electricity	231	1,007	25,295	10,849	750
Consumable (Chemicals for WTP)		1,505	1,505	1,032	1,032
Consumable (Chemicals for RO)		5,309	5,309	0	0
Consumable (Membrane)		10,233	10,233	0	0
Other consumables (Maintenance)		3,449	3,449	3,449	3,449
Others	4	78	78	77	77
Total (Million ID/year)	5,004	29,962	54,250	23,654	13,555
Total (Million UD$/year)	3.3	20.0	36.2	15.8	9.0

Table 8.6 Assumptions and Conditions of O&M Cost Estimation

<table>
<tr><th>Item</th><th>Explanation</th></tr>
<tr><td>(1) Salaries</td><td>• The current average salary is 259 thousand ID/month (172 US$). With the project, this will be increased to 400 thousand ID/month (267 US$) to the current median salary for the surveyed household owner's income (JICA socio-economic survey). This increase is not the result of price escalation but due to skill and capacity improvement.
• The total number of the current staff is 1,423 and this will be increased to 1,619 with the project for constructed new facilities and non-revenue water control team and GIS.</td></tr>
<tr><td>(2) Operating Budget</td><td>This will be increased by 5 % every year.</td></tr>
<tr><td>(3) Consumables (Electricity)</td><td>Estimated power consumption of WTP, Pump Station and RO Plant
• for existing facilities: 131.8 million kW/year
• for the proposed facilities: 242.1 million kW/year
Power supply is assumed that half of consumption is supplied by power distribution and the rest is supplied by generators according to the condition of current power supply.
Unit generation cost
• 331 ID/kWh (Diesel 0.75 US$/L)
Unit electricity tariff
• 3 ID/kWh for 11 kv
• 8.5 ID/kWh for 380 V
Note: it is very low cost compared to other countries.</td></tr>
<tr><td>(4) Consumables (Chemicals for WTP)</td><td>Dosing rate
• Alum: 23 mg/l
• Chlorine gas: 2 mg/l
Cost of chemicals:<table><tr><th colspan="2">Aluminum US$/ton</th><th colspan="2">Chlorine US$/ton</th></tr><tr><td>Domestic</td><td>Imported</td><td>Domestic</td><td>Imported</td></tr><tr><td>60</td><td>550</td><td>400</td><td>1400</td></tr></table>The quality of chemicals of domestic origin is not appropriate and imported ones are high quality. Assuming the quality of domestic chemicals will be improved, domestic chemicals will be used for estimating.
In Iraq, the quality of chemicals shall be improved in the domestic market. It is recommended that MMPW prepare guidelines for the quality of the chemicals for producers.</td></tr>
<tr><td>(5) Consumables (Chemicals for RO Plant)</td><td>In order to avoid the decrease of permeate flow rate, deterioration of the quality and the pressure loss increase of membrane due to accretion of scale and iron, washout with acid is required. Washout with acid and disposal of Waste solution is estimated.</td></tr>
<tr><td>(6) Consumables (Membrane)</td><td>Reverse Osmosis membrane life is assumed to be three years according to recommendation of manufactures. Replacement of membrane is estimated.</td></tr>
<tr><td>(7) Other Consumables (Maintenance)</td><td>This cost may be for repairs. The average ratio of the large water works in Japan is used. Forty-four percent (44%) of the salaries is assumed.</td></tr>
<tr><td>(8) Others</td><td>One percent (1%) of the salaries is assumed.</td></tr>
</table>

The current cost of annual operation and maintenance for the Basrah water supply system is 5 billion ID/year, out of which only 14 % or 0.7 billion ID was covered by the revenue collected from water charge. The annual operation and maintenance cost of WSPCB is estimated at 30 billion ID/year under normal conditions, which is 6 time more than the current operation and maintenance cost. With operation of RO and operation of on-site generators, BWD requires 54.3 billion ID/year for annual operation and maintenance and without RO operation and with normal power supply condition, 13.6 billion ID/year. For sustainable project implementation, BWD apparently requires considerable

increase in its revenue.

8.4 INSTITUTIONAL CAPACITY BUILDING PROGRAM COST

The institutional capacity building programs are essential components to ensure the sustainability of the water supply bodies and the sustainable implementation of the proposed projects. The program components were identified in the previous chapter and are summarized in Table 8.7 with priority.

Table 8.7 Institutional Capacity Building Programs with Priority

Programs	Necessary Training Periods	Input of Foreign Consultant (MM)	Input of Local Consultant (MM)	Priority A: High B: Med C: Low
I. Technical Career Development Menu				
① Technical development menu for mandatory type				
(1) Practical Technical Development	6 months	2	6	B
(2) Practical Professional Training	1 year	3	12	B
② Technical development menu for strengthening staff duties				
(3) Operation and maintenance (O&M) for production and distribution of water	4 years	96	240	A
(4) NRW control (technical)	3 years	48	144	A
(5) NRW control (non technical)	1 year	6	12	B
(6) Customer service relations	2 years	12	24	B
(7) Awareness campaign	4 years	24	144	A
(8) Sales promotion	2 years	12	72	B
(9) Site management	1 year	3	12	C
(10) BWD management	3 years	12	72	B
(11) Financial management	3 years	12	36	B
(12) Human resources management	6 months	3	6	B
(13) New staff OJT	3 months	1	3	C
(14) Technical OJT	1 year	2	12	C
③ Technical development menu for selection type				
(15) Site inspection abroad	1 month	1	1	C
(16) Seminar and workshop	Subject to seminar and workshop	-	-	B
(17) Formal training	Subject to formal training	-	-	C
II. Organizational Career Development Menu				
① Career development training menu for mandatory type				
(18) Pre-contract training	4 months	2	4	C
(19) Newly recruited staff training	1 month	1	1	C
(20) Computer training	2 years	12	72	A
(21) Post promotion training (Ranking)	3 months	2	6	C
② Career development training menu for strengthening staff duties				
(22) Manager training	1 year	6	12	B
(23) Personnel evaluator training	1 year	6	12	A
(24) Director training	1 year	6	12	B
A programs		**186**	**612**	
B programs		**74**	**264**	
C programs		**12**	**39**	
Total		**272**	**915**	

In order to implement institutional capacity building programs, the following equipment is required.

- Computer: 100 sets
- Leakage equipment: 3 sets (The details are explained in Chapter 6)

Based on these programs and equipment, the institutional capacity building program cost is estimated with priority in Table 8.8. The required total man-months are 272 MM for the foreign component and 915 MM for the local component. The total required cost is 18.3 million US$. Further, the yearly costs according to implementation schedule are prepared as given in Table 8.9.

Table 8.8 Capacity Development Costs by Priority

Program Priority	Input (MM)			Cost (Million US$)		
	Total	L.C.	F.C.	Total	L.C.	F.C.
A	798	612	186	11.7	6.1	5.6
B	338	264	74	4.8	2.6	2.2
C	51	39	12	0.8	0.4	0.4
Sub-total	1,187	915	272	17.3	9.1	8.2
Equipment	Sets			Cost (Million US$)		
	Total	L.C.	F.C.	Total	L.C.	F.C.
Computer	100	0	100	0.3	0	0.3
Leakage detection	3	0	3	0.7	0	0.7
Sub-total	-	-	-	1.0	0	1.0
Total	**-**	**-**	**-**	**18.3**	**9.1**	**9.2**

Note:
Estimation conditions:
Foreign component: 30,000 US$ per man-month
Local component: 10,000 US$ per man-month
Computer: 3,000 US$/set
Leakage detection equipment: 220,000 US$/set

Table 8.9 Implementation Schedule of Capacity Building Programs

Priority	2009		2010		2011		2012		2013	
	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
Program A	1.4	1.5	1.4	1.5	1.4	1.5	1.4	1.6		
Program B							1.1	1.3	1.1	1.3
Program C									0.4	0.4
Equipment		1.0								
Total	**1.4**	**2.5**	**1.4**	**1.5**	**1.4**	**1.5**	**2.5**	**2.9**	**1.5**	**1.7**

CHAPTER 9

STAGED DEVELOPMENT OF WATER SUPPLY PLAN

CHAPTER 9 STAGED DEVELOPMENT OF WATER SUPPLY PLAN

9.1 DEVELOPMENT PRIORITY

(1) Necessity of Priority and Staged Development

The proposed WSPCB will require a large amount of capital investment and many years to complete. In general, such large projects become feasible for implementation if they are implemented through several construction stages with appropriate development steps or prioritized implementation. The development priority is also utilized in selecting a priority project in the later chapter. Further, the priority is needed for investment decision by financial or investment institutions. Projects are typically composed of several components and usually higher priority components or the components that create higher profit are implemented first.

For the above reasons a development priority for the WSPCB is considered by preparing a number of alternative project packages.

(2) Proposed Project Components

Many project components have been proposed in the previous chapter; some need relatively large capital investment while the others need small. These components are summed up to the following 6 major project components by function:

1) Rehabilitation of distribution network
2) Rehabilitation of existing water treatment plant
3) Construction of transmission system (Ring mains and transmission facilities)
4) Construction of water treatment plant
5) Construction of distribution system and zoning
6) Construction of reverse osmosis (RO) plant

(3) Effects and Benefits of Project Components

The effects and benefits of the project components are summarized in the following table.

Table 9.1 Effects and Benefits of Project Components

Components	Effects and benefits
1) Rehabilitation of distribution network	・ This component reduces leakage, increases consumable quantity of the supplied water and would increase revenue of BWD. ・ With this component, the treated water of existing and proposed WTPs is effectively and sanitarily consumed. ・ Due to pipe breaks and negative pressure, the piped water is contaminated by wastewater through pipelines. This component improves pipe breaks and thus contributes to improvement of water quality except TDS and sanitary water will be provided.
2) Rehabilitation of existing WTP	・ One of the most important concerns of the customers is high turbidity and color in the supplied water. This component improves water quality except TDS of the treated water in the existing water treatment plant and sanitary water is supplied. In addition, it restores production capacity after rehabilitation.
3) Construction of transmission system (Ring mains and main transmission facilities)	・ With this component, the management of the water transfer all over the Central Basrah area will be improved and equitable water transfer all over the project area will be achieved. However, the distribution management in each zone will not be complete without main distribution facilities. Note: To increase the service pressure in each distribution zone without main distribution facilities, the head of the proposed transmission pumps shall be increased from 40 m with main distribution facility to 60 m without main distribution facilities.
4) Construction of distribution system and zoning	・ With this component along with transmission system, water can be equitably distributed with appropriate pressure for entire supply duration in each distribution zone. ・ Distribution facilities will accommodate peak hour demand with enough pressure. ・ It enables higher distribution management and leakage control.
5) Construction of water treatment plant	・ Increased treated water produced in this plant will increase consumable amount of water for the customers and mitigate the current severe water shortage. ・ Water quality except TDS of the treated water will be improved and sanitized water will be supplied.
6) Construction of RO plant	・ This component reduces salinity (or TDS) to an adequate level.

(4) Development Sequence

The physically required sequence among the components and its explanation are shown in the table below.

Table 9.2 Development Sequence by Physical Requirements

1st order	2nd order	3rd order	4th order
Rehab. of network ⇨	Transmission facilities ⇨	Water treatment plant ⇨	RO plant
Rehab. of existing WTP		⇨ Distribution system	

・ Rehabilitation of existing network and WTPs does not give constrains to and is not constrained by the other components in construction. However, without rehabilitation of the network, leakage remains large and treated water is not effectively used. Also without rehabilitation of existing WTP, the quality of supplied water is not improved in the area covered by the plants. Therefore, the rehabilitation should be implemented at the early stage.

・ Without transmission facilities, the other proposed components are not effectively utilized; the treated water of new WTP and RO plant cannot be appropriately distributed and the distribution system is not functioned.

・ Water treatment plant is required as RO pretreatment so that the construction of WTP should be earlier than RO plant or together.

Considering the required development sequence above and requests by the Iraqi side, the study team proposed the development priority as shown in Table 9.3, which was agreed with the Iraqi side. Originally, the construction of RO is set as the fourth priority but the Iraqi side explained that the TDS improvement is higher priority under the national water supply policy and therefore requested that the construction of RO should be put higher priority. Finally, it was included as the third priority.

(5) Development Priority

The following are the priority of the project components decided through discussion between the study team and Iraqi side based on the results of socio-economic survey and considering the required sequence for development.

Table 9.3 Development Priority

Priority	Components	Major effects	Benefits to customers		
			Equitable distribution of water	Increase of water quantity	Improvement of water quality
1	Construction of Transmission Facilities	- Enable bulk distribution management - Stable and equitable water input to distribution network	O		
	Rehab. of Network	- Leakage reduction and increase of effective water use		O	△ (partial)
2	Construction of Water Treatment Plant	Increase of water production and supplied water		O	O
	Rehab. of Existing WTP	Recovery of existing water production capacity and water quality improvement except TDS			O
3	Zoning and Main Distribution Facilities	Enable higher distribution management and stable water distribution	O	△ (partial)	
	Desalination	TDS improvement			O

9.2 STAGED DEVELOPMENT

(1) Facilities Required for Staged Development and Benefits

Based on the priority given, a staged development plan for the proposed water supply system of WSPCB comprising the stage 1 to stage 5 is prepared as shown in Table 9.4 with the capacity of major facilities. The stage 5 is the target system of WSPCB. In the same table, the benefits in terms of water quality, quantity and pressure and leakage improvement by stage are summarized.

The stage 2-4 is composed of construction of the half capacity of RO plant of the stage 4 in addition to the components of the stage 2. This stage was requested by the Iraqi side as a candidate of the priority project as a result of the discussion on the Interim Report.

Table 9.4 Staged Development of Water Supply System and Benefits

Item	unit	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5 (Target)	Stage 2-4
Work Components							
1. Rehabilitation of network		Yes	Yes	Yes	Yes	Yes	Yes
2. Rehabilitation of existing WTP		No	Yes	Yes	Yes	Yes	Yes
3. Transmission system							
(1) Transmission reservoir (TR)	m^3	25,000	48,000	48,000	48,000	64,000	48,000
(2) Transmission pumping station (TPS)	m^3/day	280,000	538,000	538,000	538,000	710,000	538,000
(3) Ring mains		Full develop.	Full	Full	Full	Full	Full
4. New water treatment plant							
(1) Treatment plant	m^3/day	0	184,000	184,000	280,000	465,000	231,500
(2) Treated water PS	m^3/day	0	188,900	188,900	273,900	348,900	188,900
5. Main distribution facilities (13 zones)		No	No	Full develop	Full	Full	No
6. RO plant	m^3/day	0	0	0	287,000	362,000	143,500
Benefits							
1. Water quality							
Estimated average TDS in Basrah District	mg/l	1,087	1,289	1,289	588	595	894
Estimated TDS in transmission reservoir	mg/l	1,172	1,437	1,437	567	602	964
Oil, turbidity, color & bacteria	-	No improvement	Improved	Improved	Improved	OK	Improved
2. Water quantity (Satisfaction of ave demand)		70%	100%	100%	100%	100%	100%
3. Water pressure		Not enough	Improved	Adequate	Adequate	Adequate	Improved
4. Leakage		Improved	Improved	Improved	Improved	Improved	Improved

Note:
1) 360 l/ca/day for urban and 200 l/ca/day for rural
2) The estimation of the capacity and TDS improvement by stage is calculated in Appendix F.

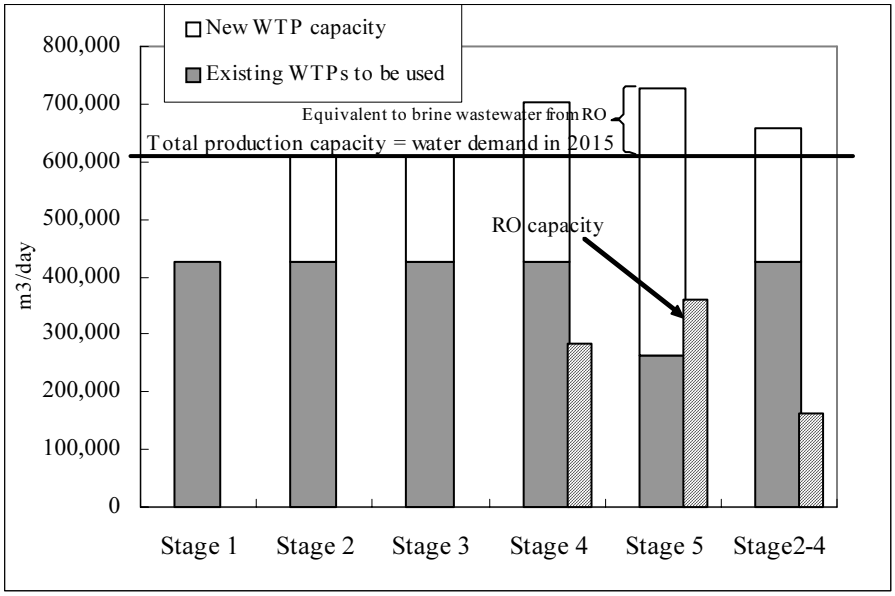
The estimation conditions of development of water treatment plant (RO plant, proposed new and existing water treatment plant) are shown in Table 9.5 and Table 9.6. The relationship among the average day water demand in 2015, the capacity of existing water treatment plants to be used, the capacity of a proposed water treatment plant and the capacity of RO plant are illustrated in Figure 9.1.

Table 9.5 Estimation Conditions of Water Treatment Plant Development

Stage	RO plant	New water treatment plant	Existing water treatment plant
5	Full capacity	Full capacity	Use major WTPs (Al Hartha 25 MG, Basrah Unified and R-Zero WTPs)
4	Full capacity	Full capacity	Use all existing WTPs
3	Zero	Full capacity	Use all existing WTPs
2-4	Half capacity of stage 4	Full capacity	Use all existing WTPs
2	Zero	Full capacity	Use all existing WTPs
1	Zero	Zero	Use all existing WTPs

Table 9.6 Estimation Conditions of TDS Concentration and RO Design Parameters

Parameter	Value
Total average water demand	608,000 m^3/day
TDS of SWC	670 mg/l
TDS of SAA	1,500 mg/l
TDS of RO treated water output	200 mg/l
RO recovery rate	75 %



Note: 25% of the treated water injected to RO from conventional water treatment plant is wasted as brine water.

Figure 9.1 Capacity of Existing and Proposed Water Treatment Plants and RO Plant by Stage

(2) Cost Estimation by Stage

The cost by stage is estimated as shown in Table 9.7. The capital cost is estimated as 1,266 Million US$ for the stage 5 and 184 Million US$ for the stage 1. If RO with half of the capacity of stage 4 is introduced, the capital cost of the stage 2-4 will be 529 Million US$.

Table 9.7 Cost Estimation of Staged Development

(Million US$)

Item	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5 Target for WSPCB	Stage 2-4
Direct Construction Cost						
1. Rehabilitation of network	21	21	21	21	21	21
2. Rehabilitation of existing WTP	0	7	7	7	7	7
3. Transmission system	62	74	71	71	79	74
(1) Transmission reservoir (TR)	9	17	17	17	23	17
(2) Transmission PS (TPS)	8	12	9	9	11	12
(3) Ring mains	45	45	45	45	45	45
4. New water treatment plant	0	46	46	66	102	58
(1) Treatment plant	0	41	41	60	96	53
(2) Treated water PS	0	5	5	6	6	5
5. Main distribution facilities (13 zones)	0	0	129	129	129	0
6. RO plant	0	0	0	175	221	88
Total of Direct Construction Cost	83	148	274	469	559	248
Indirect Construction Cost	101	181	413	649	707	281
Total	184	329	687	1,118	1,266	529
Operation & maintenance cost (Million US$/year)	-	7.1	8.9	-	20.0	12.7

Note: The O&M costs are estimated in the case of normal power supply.