No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF MUNICIPALITIES AND PUBLIC WORKS (MMPW), THE REPUBLIC OF IRAQ

THE FEASIBILITY STUDY ON IMPROVEMENT OF THE WATER SUPPLY SYSTEM IN AL-BASRAH CITY AND ITS SURROUNDINGS IN THE REPUBLIC OF IRAQ

FINAL REPORT

(SUMMARY)

JANUARY 2007

TOKYO ENGINEERING CONSULTANTS CO., LTD.

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PREFACE

In response to the request from the Government of Republic of Iraq, the Government of Japan decided to conduct "The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq" and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Akira Takechi of Tokyo Engineering Consultants Co., Ltd. and consisted of experts from Tokyo Engineering Consultants Co., Ltd. and Nippon Koei Co., Ltd. between April and December, 2006.

The team held discussions with the officials concerned of the Government of Republic of Iraq and conducted field surveys at the study area through local consultants. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Republic of Iraq for their close cooperation extended to the study.

January, 2007

Akiyuki Matsumoto
Vice President
Japan International Cooperation Agency

Mr. Akiyuki Matsumoto
Vice President
Japan International Cooperation Agency

January, 2007

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit you the final report entitled “The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq”. This report has been prepared by the Study Team in accordance with the contracts signed on 5th April 2006, between Japan International Cooperation Agency and Tokyo Engineering Consultants Co., Ltd. and Nippon Koei Co., Ltd.

The report examines the existing conditions concerning water supply system of the Central Basrah area and presents a basic plan and feasibility study on priority project selected from the basic plan.

This study aimed to improve the water supply conditions of the Central Basrah area. We are sure that the recommendations made in the report shall contribute to improving the water supply conditions of the Central Basrah Area.

All the members of the Study Team wish to acknowledge gratefully to the personnel of your Agency, Ministry of Foreign Affairs, Ministry of Health, Labour and Welfare, Iraq Unit of JICA Amman Office, Japan Bank for International Cooperation, and also to the officials and individuals of the Government of Republic of Iraq for their assistance extended to the study team.

Yours faithfully,

Akira TAKECHI
Team Leader

THE FEASIBILITY STUDY ON IMPROVEMENT OF THE WATER SUPPLY SYSTEM IN AL-BASRAH CITY AND ITS SURROUNDINGS IN THE REPUBLIC OF IRAQ

EXECUTIVE SUMMARY

1. Objectives and Planning Area of the Study

The Governorate of Al-Basrah with a population of 1.8 million is located at the farthest downstream end of the Euphrates-Tigris river system. Basrah city is the second largest city in Iraq and the capital city of the Governorate, with a population of 740,000.

To improve the water supply conditions of the Al-Basrah Governorate, the Government of Iraq requested Japanese Yen loan from the Government of Japan to implement the water supply improvement project for Governorate of Al-Basrah. This study was carried out with the objective to formulate an urgent water supply improvement plan, which will be utilized for preparation of the detailed contents of the Japanese Yen loan project.

The planning area of the study is in the area where the existing water supply conditions are most severe in the Governorate and where urgent improvement is required. This area is the central Basrah area or Basrah District, which is comprised of Basrah city and Hartha area (Figure 1).

2. Water Supply Conditions

The water supply system in the Governorate has been seriously deteriorated resulting in chronic water shortage. In the Shat Al Arab (SAA) waterway, the traditional water source of Basrah city, the salinity represented by Total Dissolved Solid (TDS) has increased a great deal. To improve the water quality of supplied water, a 240-km long canal, Sweet Water Canal (SWC), the source of which is Gheraff river, was constructed as an alternative water source to the Shat Al Arab. However, the SWC has failed to supply stable and sufficient water amount due to its structural and mechanical/electrical weaknesses.

From the socio-economic survey by the study team, the problems of water service from the customer's perspective are identified as shown in Table 1. Of these problems, the most severe problem in the opinion of customers is shortage of water quantity including low service pressure and the second is water quality of supplied water.

Table 1 Problems of Water Supply Service

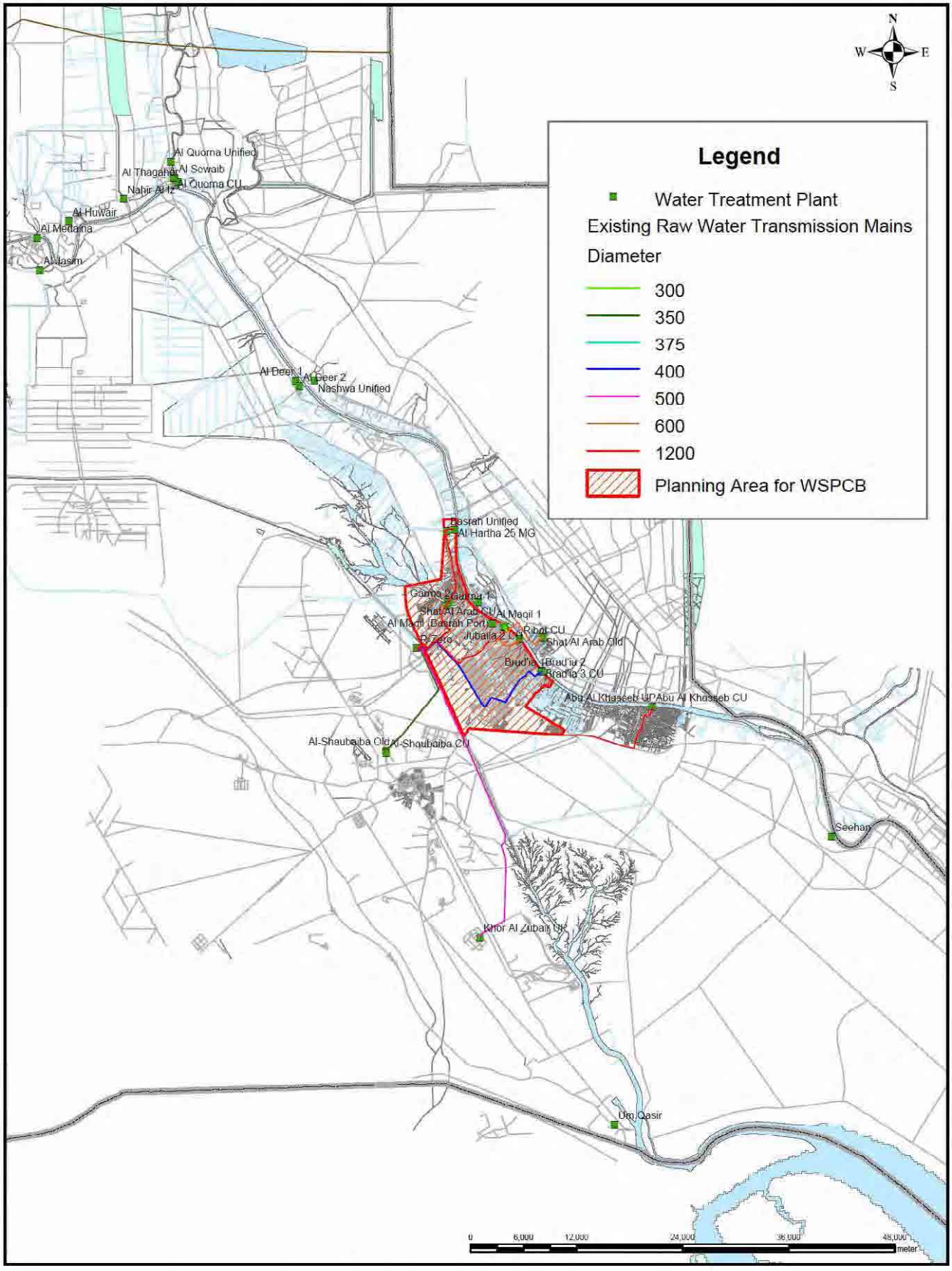
Service item		Ratio of respondents
Served water quantity / service pressure		94%
Water supply service hours		67%
Served water quality	Color /Turbidity	89%
	Taste (high salinity)	97%
	Odor (sewage odor)	85%

Note: Multiple answers

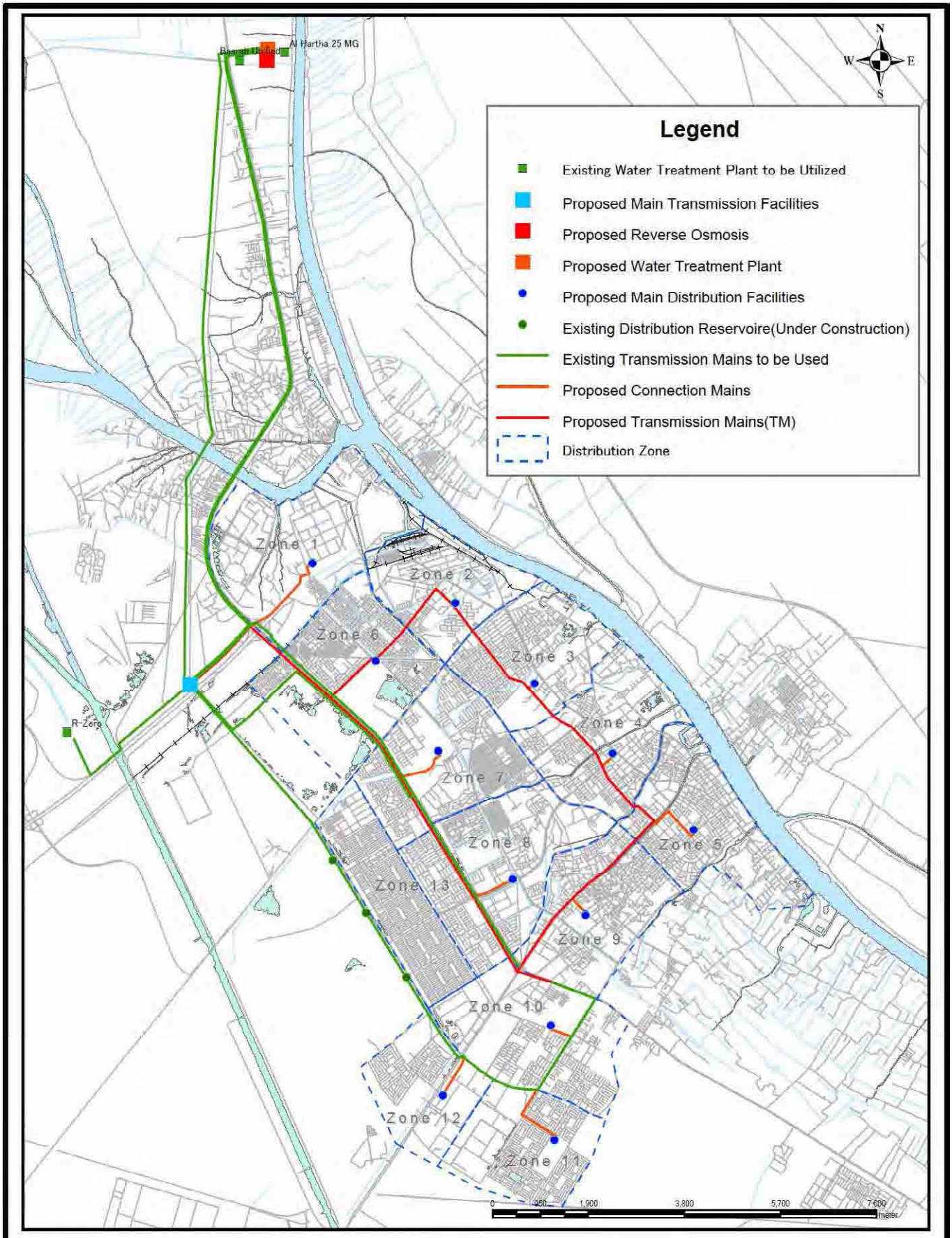
3. Water Supply Plan for Central Basrah (WSPCB)

To improve the water supply conditions, "Water Supply Plan for Central Basrah (WSPCB)" was formulated in this study targeting the year 2015. The planning area has the target population of 1,257,000 and the average day water demand of 608,000 m^3/day in 2015. The major improvement of the water supply system in the plan is as follows and the contents of the proposed facilities and their location are shown in Table 2 and Figure 2, respectively.

① Rehabilitation of existing distribution network and existing water treatment plants to recover their existing capacity
② Construction of a conventional water treatment plant, the water source of which is the Shat Al Arab, to meet the water demand in 2015
③ Construction of water transmission system in order to convey the treated water evenly from existing and proposed water treatment plants to the entire planning area
④ Creation of water distribution zones and construction of distribution main facilities in distribution zones in order to distribute the water according to the fluctuation of the water demand in the zone
⑤ Construction of a desalination plant (reverse osmosis (RO)) at the site of the proposed conventional water treatment plant in order to reduce salinity (TDS) to the appropriate level.



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	The Planning Area for Water Supply Plan for Central Basrah (WSPCB)	Fig. 1



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	**Proposed Water Supply System of WSPCB**	Fig. 2

Table 2 Proposed Facilities of WSPCB

Facilities	Capacity/Quantity
1. Rehabilitation of network	Dia.110 mm - 700 mm, 285 km
2. Rehabilitation of water treatment plant (WTP)	13 plants in Central Basrah (424,400 m^3/day) Note: Finally, only 3 plants will be utilized (264,000 m^3/day)
3. Treated water transmission system	
(1) Transmission reservoir (TR)	64,000 m^3
(2) Transmission pumping station (TPS)	710,000 m^3/day x 40 m head
(3) Ring mains and connection mains to MDF	Dia.600 mm - 2000 mm, 33,000 m
4. New water treatment plant	
(1) Treatment plant	465,000 m^3/day
(2) Treated water pumping station	369,000 m^3/day x 40 m head
5. Main distribution facilities (MDF)	13 water distribution zones (including 1 zone under construction)
(1) Strengthening of distribution mains	Dia.200 mm - 700 mm, 25,100 m
(2) Distribution reservoir (for 12 zones)	186,000 m^3 in total
(3) Transfer pumping station (for 12 zones)	945,000 m^3/day (39,800 m^3/hr) in total
(4) Elevated tank (for 12 zones)	12,300 m^3 in total
6. Reverse osmosis (RO) plant	362,000 m^3/day (output)

The total cost of the WSPCB was estimated at 1,266 million US$, comprised of 559 million US$ as direct construction cost and the rest as indirect cost.

4. Staged Development Plan for WSPCB

Considering the result of socio-economic survey and the request from the Iraqi side, the following priority was set for the development of the proposed facilities. According to this priority, the staged development plan was prepared as shown in Table 3.

The first priority: The treated water of the existing facilities is effectively and evenly distributed to the entire planning area through rehabilitation of existing distribution network and construction of transmission system.

The second priority: The capacity of the existing water treatment plants are qualitatively and quantitatively recovered through rehabilitation. In addition, the water demand is met and the water quality except salinity contents (TDS) is improved through construction of the proposed conventional water

treatment plant.

The third priority: The treated water is adequately distributed according to the fluctuation of the water demand in the distribution zones created through construction of the main water distribution facilities. In addition, TDS is reduced to the adequate level for human consumption through construction of RO plant.

Table 3 Staged Development Plan of WSPCB

Stage 1:	Rehabilitation of distribution network and construction of transmission system
Stage 2:	Stage 1 components and rehabilitation of existing water treatment plants and construction of a new conventional water treatment plant
Stage 3:	Stage 2 components and construction of main distribution facilities (13 distribution zones)
Stage 4:	Stage 3 components and construction of a new RO plant and expansion of the new water treatment plant as pretreatment of RO
Stage 5:	Stage 4 components and expansion of the RO plant and the new water treatment plant to compensate for the treatment capacity of existing water treatment plants to be abandoned (10 plants)

5. Selection of Priority Project for Feasibility Study

The study team gave a higher priority to the augmentation of water quantity and partial improvement of water quality except TDS and proposed the stage 2 as a priority project. However, the Iraqi side strongly claimed the importance of the TDS improvement and requested to include construction of RO plant in the priority project. Finally, the Iraqi side understood that the implementation of the stage 4 and stage 5, which included the construction of the full scale RO plant, was not possible considering the scale of the project and requested the stage 2-4 as follows, which applied half capacity of the RO plant in the stage 4, as the priority project.

Stage 2- 4:	Stage 2 and construction of half capacity of RO plant of the stage 4

The following shall be considered if the RO plant is included in the priority project.

- The effectiveness of water quality improvement by the stage 2-4 is not enough but the cost of RO plant is very expensive and the cost increases by 60 % from the stage 2.
- Capacity of operation and maintenance of RO plant by Basrah Water Directorate (BWD) is not adequate.
- In the current unstable power supply conditions in Basrah, the recovery of operation and maintenance cost of RO plant is not possible since the plant relies on private generators, which need expensive fuel.

- In terms of benefits, the implementation of the stage 2 improves the supplied water quantity and the water quality in terms of turbidity, color, odor and bacteriological safety except TDS.

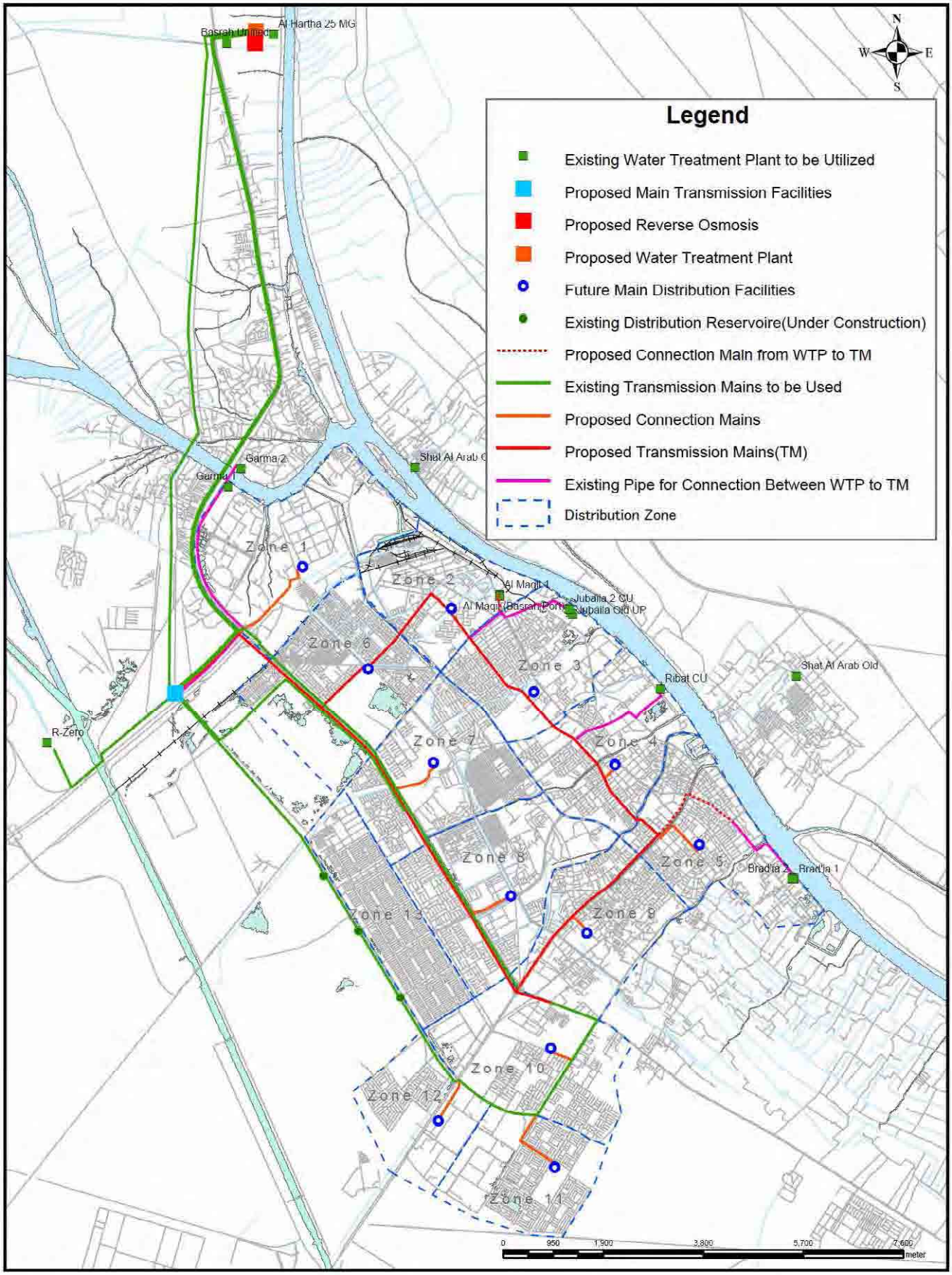
Finally, the stage 2-4 was selected as a priority project on the condition that RO plant may be removed from the project components implemented by Japanese Yen Loan.

6. Feasibility Study of the Priority Project

A feasibility study (F/S) on the priority project selected from WSPCB was conducted. The components of the proposed facilities of the priority project and their location are shown in Table 4 and Figure 3, respectively.

Table 4 Components of Priority Project for Feasibility Study

Facility Components	Capacity/Quantity
1. Rehabilitation of network	Dia. 110 mm - 700 mm, 285 km
2. Rehabilitation of existing WTPS	13 WTPs
3. Transmission system	
(1) Reservoirs	48,000 m^3
(2) Pumping station	538,000 m^3/day x 60 m head
(3) Ring mains and connection mains	Dia. 600 mm - 2000 mm, 35,200 m
4. New WTP	
(1) WTP	245,000 m^3/day
(2)Transmission pumping station	192,000 m^3/day x 40 m head
5. RO plant	145,000 m^3/day (output)
6. Distribution facility	Dia.200 mm - 700 mm, 25,100 m



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	**Proposed Water Supply System of Priority Project**	Fig. 3

The project area of the priority project is same as the area covered by WSPCB, i.e., the central Basrah consisting of Basrah city and Al-Hartha area. The estimated population and average day water demand in 2015 are 1,257,000 and 608,000 m^3/day, respectively.

An institutional capacity building program including a non-revenue water reduction program, was selected as the priority project to ensure the sustainable implementation of the project.

The total project costs of the priority project were estimated at 561.8 million US$, of which 318.9 million US$ is as direct construction cost. A breakdown of the estimated costs and costs for yearly implementation are shown in Table 5 and Table 6, respectively.

Table 5 Project Cost Estimation for the Priority Project (Million US$)

No.	Items	Local Component	Foreign Component	Total
Capital Cost				
1.	Construction Cost			
1-1	Rehabilitation of Distribution Network	9.9	11.2	21.1
1-2	Rehabilitation of Water Treatment Plant	1	6.4	7.4
1-3	Construction of Transmission system	24.3	54.9	79.2
1-4	Construction of Water Treatment Plant	23.4	34.2	57.6
1-5	Restructuring Distribution Network and Zoning	3.8	7.2	11.0
1-6	Construction of Reverse Osmosis Plant	5.1	89.9	95.0
	Sub-total (1)	67.5	203.8	271.3
2.	Administration Expenses	15.8	31.8	47.6
	Direct Construction Cost Sub-total (1+2)	**83.3**	**235.6**	**318.9**
3.	Tax and Duty	42.1	0.0	42.1
4.	Engineering Cost	13.6	29.2	42.8
5.	Price Contingency	54	24.6	78.6
6.	Physical Contingency	27.4	52	79.4
	Sub-total (3+4+5+6)	137.1	105.8	242.9
Total		**220.4**	**341.4**	**561.8**
Institutional capacity Building Program		**5.0**	**8.6**	**13.6**

Table 6 Yearly Implementation Costs of the Priority Project (Million US$)

Item	2008	2009	2010	2011	2012	2013	Total
Capital Cost							
Direct Construction Cost	0.0	0.0	16.9	111.0	94.1	96.9	318.9
Indirect Cost	0.8	8.0	18.4	73.6	67.0	75.1	242.9
Total for Capital Cost	0.8	8.0	35.3	184.6	161.1	172.0	561.8
Institutional Capacity Building Program	3.2	5.2	3.0	0.2	0.2	1.8	13.6

The cost of operation and maintenance (O&M) of BWD was 5 billion ID/annum in 2005, out of

which only 14 % was covered by the revenue collected from water charge. The priority project requires 21 billion ID for annual operation and maintenance under normal power supply conditions, and 32 billion ID assuming onsite generators are used for half a day under the existing power supply conditions.

7. Project Evaluation of Priority Project

(1) Following were identified as project benefits. All benefits other than TDS improvement could be achieved by the stage 2 project

- Fulfillment of the required day average water demand (300 l/capita/day for Basrah city).
- Improved distribution water pressure (above 15 m at tap).
- 24 hour continuous service, in principle.
- Even distribution of supplied water through the entire project area.
- Improvement of water quality except TDS and supply of hygienic water (bacteriological safety).
- Improvement of water quality of supplied water in terms of TDS from the current 1500 mg/l (the raw water quality of Shat Al Arab) to 894 mg/l for the entire project area on average.
- Strengthening of technical management capacity, and improvement of financial conditions and customer service of BWD.

(2) As a result of the economic analysis of the project, EIRR was estimated at 5.5% when the willingness to pay for the improved water supply service was 3% of the household income. If the monetarily uncountable benefits, such as the improvement of hygienic and health conditions, were counted, viability of the project could increase more.

(3) As a result of the financial analysis of the project, it was concluded that the project implementation covering both the capital investment and O&M costs would be financially difficult. Therefore, it was recommended that at least the capital investment cost be subsidized by the central and/or local governments.

(4) As a result of the environmental impact assessment, no significant impacts by the project were identified.

8. Recommendations

(1) The study team could not carry out any site survey in Basrah due to security reasons and the scope of the priority project was prepared under such conditions. Therefore, the result of this

study contains some unconfirmed factors. At the detailed design stage, detailed investigation should be carried out to make the project components more reliable.

(2) The study team recommends that BWD adopt water demand management policy by means of the installation of water meters with establishment of proper tariff system, leakage control and encouragement of water saving. The demand control policy could give following additional benefits to the project.

- Efficient use of water by reducing wastage or in-house loss.
- Reduction of the operation and maintenance costs of water treatment and distribution by reducing the required amount of the treated water and distribution.
- Enabling of the early abandonment of the existing water treatment plants by reducing the required amount of the treated water.
- Further improvement of TDS by abandoning the operation of the water treatment plants that receives high TDS raw water from the Shat Al Arab.

(3) The study team recommends that introducing RO plant, which produces expensive water and needs high expertise for O&M, meet the following conditions.

- Appropriate operation of conventional water treatment plants to produce RO feed water.
- Acquiring of knowledge and training on required operation and maintenance method.
- Improved power supply conditions for water supply facilities.
- Improved budget level of BWD; appropriate water charge collection.
- Controlled non-revenue water; reduced leakage and illegal connection.
- Appropriate pricing of RO water.
- Reduction of water demand through installing customer meters and appropriate pricing.

(4) Based on limited water quality data, the process of RO was designed. Therefore, the study team recommends that the detailed process be decided through detailed investigation of water quality of the Shat Al Arab by implementing a pilot project.

(5) The TDS improvement by this project was estimated at 894 mg/l, while WHO recommends TDS less than 600 mg/l is preferable for human consumption. Therefore, the study team recommends BWD to confirm whether the improved TDS level can satisfy the users' requirement.

(6) Currently, the operation and maintenance of many small RO plants owned by BWD is outsourced to private companies since BWD does not have enough technical expertise on operation and maintenance of RO treatment process. Therefore, the study team recommends that outsourcing of operation and maintenance of the proposed RO plant also be considered.

(7) The southern part of Iraq, which are located downstream of the country's river system, suffers from high TDS water supply. A major cause of higher TDS in the rivers is assumed to be from discharge of high salinity contents in the upstream areas. Therefore, the southern areas receive disadvantage caused by the economic activities of the upstream areas. In this line, the study team recommends the central government of Iraq to seek for measures such as subsidy to the required cost for RO plant operation in order to compensate the geopolitical disadvantage of the project area.

(8) The current willingness to pay for the improved water supply service is 1 % of the household income. The willingness to pay would improve depending on the awareness to the water supply service. The study team recommends that BWD promote awareness campaigns to increase the people's awareness and the willingness to pay for the water supply service, which would result in enhancement of the economic and financial feasibility of the project.

SUMMARY

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Acronyms and Abbreviations

AC	Asbestos cement
BG	Basrah Governorate
BWD	Basrah Water Directorate
CI	Cast iron
C.U.	Compact unit
E. Coli.	Escherichia Coli.
EC	Electric conductivity
F.C.	Foreign Component of Cost
FS	Feasibility study
ID	Iraqi Dinar
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
L.C.	Local Component of Cost
M	million
MCU	Multiple compact units
MMPW	Ministry of Municipalities and Public Works
Mini M/P	Mini Master Plan for the Drinking Water Supply for the Governorate of Al Basra, January 2005
NRW	Non-revenue water
O&M	Operation and maintenance
PS	Pumping station
RO	Reverse osmosis
SAA	The Shat Al Arab
SWC	Sweet Water Canal
TDS	Total dissolved solid
TP	Transmission pumping station
TR	Transmission reservoir
US$	United State's dollars
WSPCB	Water Supply Plan for Central Basrah
WTP(s)	Water treatment plant(s)
d	day
hr	hour
lcd, l/ca/d, l/capita/day	liter per capita per day
y	year

CHAPTER 1 INTRODUCTION

The Governorate of Al-Basrah with a population of 1.8 million is located at the farthest downstream end of the Euphrates-Tigris river system (Figure 1.1). Basrah city (or municipality) is the second largest city in Iraq and the capital city of the Governorate, with a population of 740,000.

Over the last two decades the water supply system in the Governorate seriously deteriorated resulting in a large water supply deficit. Deterioration has also occurred in the quality and quantity of water sources for Basrah. In the Shat Al Arab (SAA) waterway, the traditional water source of Basrah, the salinity, which is represented by Total Dissolved Solid (TDS), has increased due to reduced flows in the Euphrates and Tigris rivers and increased salinity contents. The Sweet Water Canal (SWC), which was constructed as an alternative water source to the Shat Al Arab, has failed to supply stable water amount due to its structural and mechanical/electrical weaknesses.

To improve the situation and to address the future requirements for water supply, Mini Master Plan for the Drinking Water Supply for the Governorate of Al Basra (Mini M/P) was prepared in January 2005. The Mini M/P proposed comprehensive plans to develop a water supply system to meet the demand for 2025 with an investment cost of 2 billion US$, covering the entire Governorate. However, while the Mini M/P presented the ultimate goal for the system development, but explicitly showed neither the priority of project components nor the implementation schedule to reach the ultimate goal given the constraints of realistic capital funding.

This study is required to formulate projects which have immediate effect to relieve the severe water supply problems and which could be implemented under the current unstable security conditions. The objectives of the study are:

(1) to formulate a plan for the urgent improvement of the existing water supply system in the central Al-Basrah Governorate,
(2) to prepare an institutional improvement plan for the water supply service operations, and
(3) to review the “Potable Water Mini Master Plan for the Governorate of Al-Basrah”.

To improve the water supply conditions of the Al-Basrah Governorate, the Government of Iraq requested Japanese Yen loan from the Government of Japan to implement the water supply improvement project for Governorate of Al-Basrah. This study will be utilized for preparation of the detailed contents of the Japanese Yen loan, which will be evaluated by the concerned government agencies of Japan and finally decided through an appraisal of Japan Bank for International Cooperation (JBIC) in the Japanese Yen loan program for entire Iraq.

The study area is as that presently covered by the water treatment plants which receive raw water from R-Zero, which is Basrah District and its surrounding area. However, whole area of the Al-Basrah Governorate is considered to be the study area in review of the Mini M/P.

In the inception of the study, the planning area was the area covered by the water treatment plants which receive raw water from R-Zero. However, after the discussion with the Iraqi side, the planning area of the study focuses on the area where the existing water supply conditions are most severe and thus to which the highest priority is given for improvement of the water supply system. This area is central Basrah area or Basrah District, which is comprised of Basrah municipality and Hartha center and rural. As the water supply plan prepared by this study focuses on the central Basrah area, this plan is called “Water Supply Plan for Central Basrah (WSPCB).”

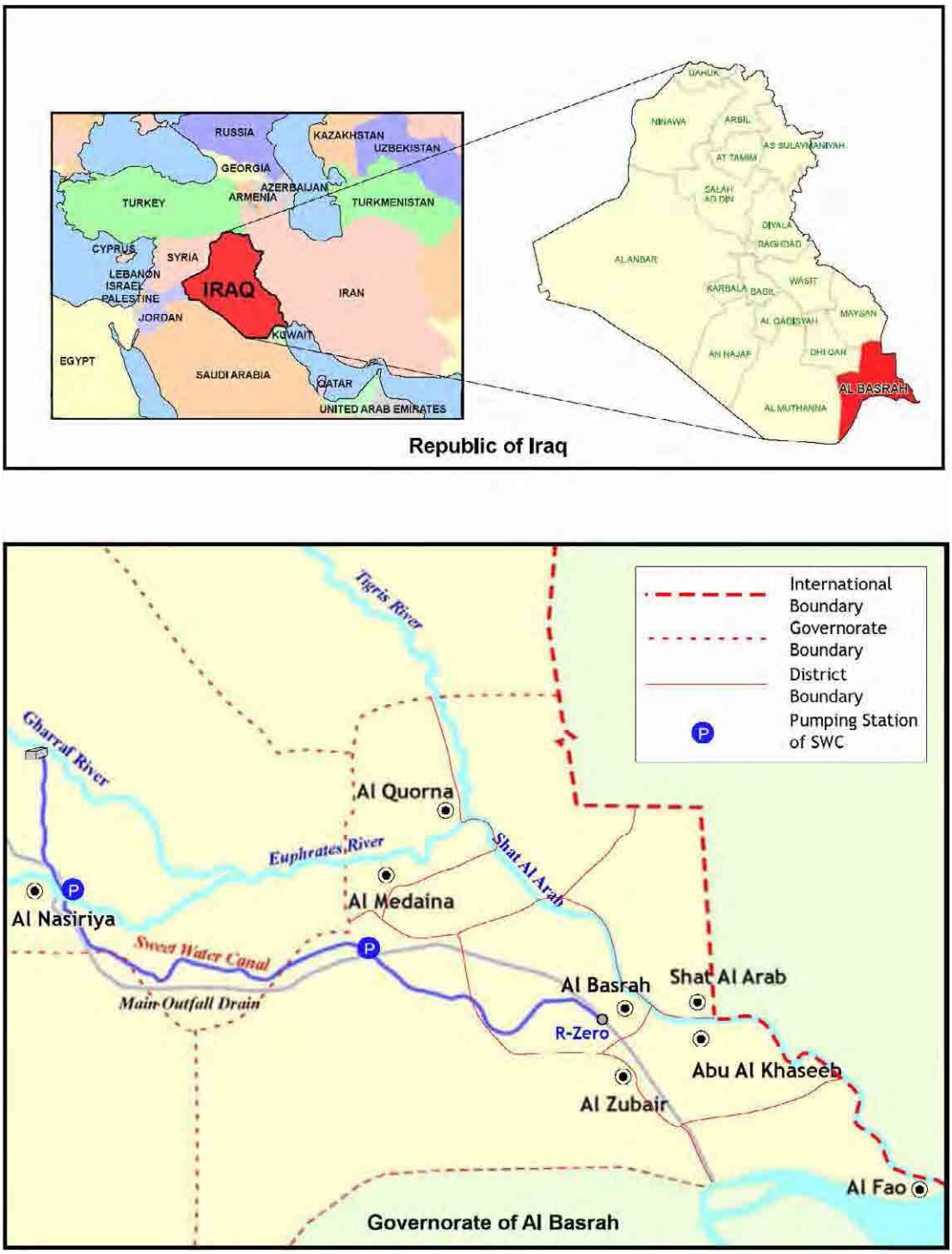


Figure 1.1 Location of the Governorate of Al-Basrah

CHAPTER 2 EXISTING CONDITIONS

2.1 Water Sources

The sources of the water supply for the study area are the Sweet Water Canal (SWC), the Tigris, Euphrates, the Shat Al Arab (SAA), the Garma Ali and ground water. The SWC is the largest water source for the existing water supply system. The following table shows outline of these water sources as potable water supply.

Table 2.1 Outline of Water Sources in the Governorate of Al-Basrah

Source	Quantity	Quality	Required treatment to comply with the water quality standards	Distribution area
The Tigris	Adequate	High TDS but lower than the Euphrates and Shat Al Arab	Conventional treatment and desalination	Al Quorna
The Euphrates	Adequate	Highest TDS in the Governorate	Conventional treatment and desalination	Al Medaina
The Shat Al Arab and Garma Ali	Adequate	High TDS and pollution in the middle and downstream stretch of the Basrah city	Conventional treatment and desalination	Al Hartha、Al Basrah、Shat Al Arab、Abu Al Khaseeb、Al Fao
The Sweet Water Canal	Limited (design max: 8.5m^3/s)	Good（moderate TDS: about 600-700 mg/L）	Conventional treatment only	Al Hartha、Al Basrah、Shat Al Arab、Abu Al Khasseb、Al Zubail
Ground water	Limited	Very high TDS, Boron content, unsuitable for RO	Conventional treatment and desalination	Um Qsir（Al Zubail）

The study team carried out the water quality survey in June and August, 2006 through a local company. The following are the findings of the survey.

- The water qualities of these five water sources have very similar characteristics except TDS (inorganic salt contents), EC (electric conductance) and turbidity. The Shat Al Arab is polluted by human activities after the middle stretch of the river in the Basrah city.
- The following figure shows the relationship of TDS and EC by river. TDS of the SWC is the lowest; the Tigris comes to the second. TDS of the Euphrates is the highest. TDS of the Shat Al Arab and Garma Ali River falls in between the SWC and the Euphrates.

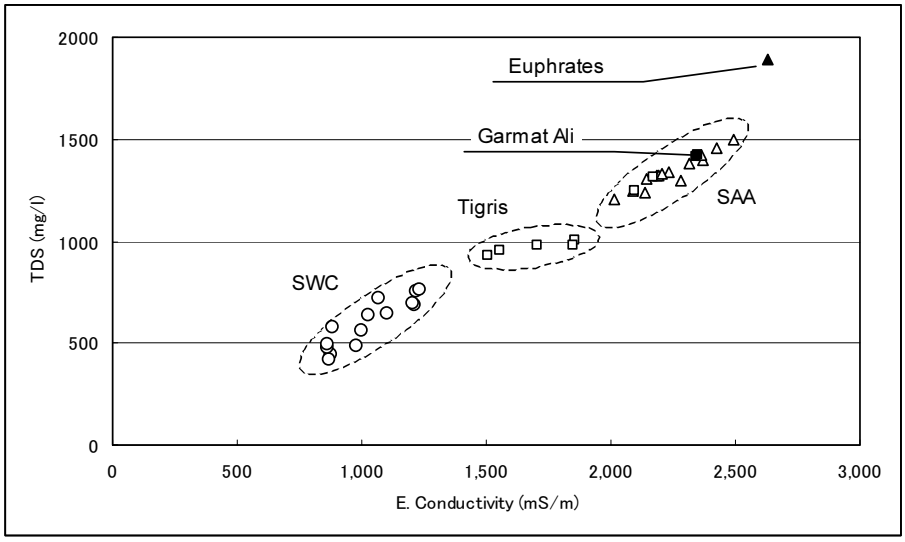


Figure 2.1 TDS and EC of Existing Water Sources

- The accepted upper limit of TDS is 1,500 mg/l in drinking water quality standards of Iraq and less than 600 mg/l is the recommendation of the WHO guidelines. However, values as high as 1,000 mg/l do not adversely impact public health, but they affect the taste. If the WHO standard is applied, only the SWC is a possible/appropriate source for drinking water with conventional water treatment process since the conventional treatment processes cannot lower TDS by any significant level. For the other sources the water should be treated by desalination process to reduce TDS for drinking purpose.
- Turbidity and color can be reduced by conventional water treatment process.
- The high concentration of n-Hexane extracts was detected in the lower reaches of the Shat Al Arab. The concentrations are higher as it goes downstream. The source of n-Hexane pollutant, which is from oil, is unidentified; however it may be from sunken ships in the Shat Al Arab or wastewater discharged from industry.

2.2 Water Supply Facilities

As a result of lack of investment and operating funds over the last two decades, the entire water supply system has deteriorated significantly and is currently constrained by inadequate water storage and treatment facilities and leaking distribution network.

(1) Water Treatment Plants

There are 37 water treatment plants in the Governorate of Al-Basrah, out of which 13 are located in the Basrah district and 7 in its surrounding area (Table 2.2 and Figure 2.2).

There are two types of water treatment plants in the study area, comprising of old conventional

treatment plants and simple treatment of multiple compact units (C.U.). Due to lack of maintenance, most of the treatment plants produce low quality water inappropriate for human consumption. Reverse osmosis (RO) treatment and distribution systems by tankers or with bottles are widely practiced in the entire Governorate to fulfill the demand of potable water.

According to the results of water quality analysis for 33 water treatment plants surveyed, the characteristics of water quality of treated water are summarized as follows.

a) The treated water of the 24 treatment plants does not satisfy turbidity criteria for drinking water. Similarly, the treated water of 19 treatment plants does not satisfy the criteria for color.
b) Residual chlorine in the treated water of 13 treatment plants was not detected and Total Coliform and Escherichia Coli. (E. Coli.) were detected.

From the above findings it can be concluded for water treatment process that coagulation, settlement and filtration processes are not working properly in most of the treatment plants and chlorination is not performed in many plants. Most of the existing water treatment plants cannot produce potable quality water. To meet the quality standards of potable water, small scale reverse osmosis (RO) treatment and distribution systems are being adopted in the Governorate in addition to supply through bottled drinking water.

Table 2.2 Water Treatment Plants in Basrah District and Its Surrounding Area

No	Name	Type	District	Water Source		Year of const.	Year of rehab.	Treatment Plant Capacity (m^3/day)		
								Nos of unit	Design	Estimated actual
	Central Basrah Area									
1	R-Zero	C.U.	Al Basrah	SWC		1996	2005	25	120,000	96,000
2	Al Hartha 25	C.U.	Al Hartha	SWC	SAA	1986	2003	25	120,000	96,000
3	Basrah Unified	Conv	Al Hartha	SWC	SAA	1978	2003	-	80,000	72,000
4	Garma 1	C.U.	Al Basrah	SWC	Garma Ali	1986	2005	8	38,400	30,700
5	Garma 2	C.U.	Al Hartha	SWC	Garma Ali	1986	2004	7	8,400	6,700
6	Al Maqil (Basrah Port)	Conv	Al Basrah		SAA	1936	-	-	13,500	12,200
7	Al Maqil 1	C.U.	Al Basrah	SWC	SAA	2004	-	3	14,400	11,500
8	Jubaila Old UP	Conv	Al Basrah	SWC	SAA	1936	2005	-	24,000	21,600
9	Jubaila 2 C.U.	C.U.	Al Basrah	SWC	SAA	1986	2005	2	24,000	19,200
10	Ribat C.U.	C.U.	Al Basrah	SWC	SAA	1985	2005	3	14,400	11,500
11	Brad'ia 1	Conv	Al Basrah	SWC	SAA	1957	-	-	24,000	21,600
12	Brad'ia 2	Conv	Al Basrah	SWC	SAA	1964	2004	-	24,000	21,600
13	Brad'ia 3 C.U.	C.U.	Al Basrah	SWC	SAA	1987	-	1	4,800	3,800
	Sub-total								509,900	424,400
	Surrounding Area									
14	Shat Al Arab Old	Conv	Shat Al Arab	SWC	SAA	1979	2004	-	24,000	21,600
15	Shat Al Arab C.U.	C.U.	Shat Al Arab	SWC	-	2002		2	9,600	7,700
16	Abu Al Khasseb UP	Conv	Abu Al Khaseeb	SWC	-	1970	2000	-	14,400	13,000
17	Abu Al Khasseb C.U.	C.U.	Abu Al Khaseeb	SWC	SAA	1986	2003	3	19,200	15,400
18	Al-Shauaiba Old	Conv	Al Zubair	SWC	-	1986	2000	-	19,200	17,300
19	Al-Shauaiba C.U.	C.U.	Al Zubair	SWC	-	1980	2000	4	16,000	12,800
20	Khor Al Zubair UP	Conv	Al Zubair	SWC	-	1983	2004	-	19,200	17,300
	Sub-total								121,600	105,100
Total Capacity									631,500	529,500
Conventional		9	plants						242,300	218,200
Compact unit		11	C.U. plants					83	389,200	311,300

Note: The actual capacity is estimated based on effective rate of 0.9 and 0.8 for conventional plants and for multiple compact units, respectively.

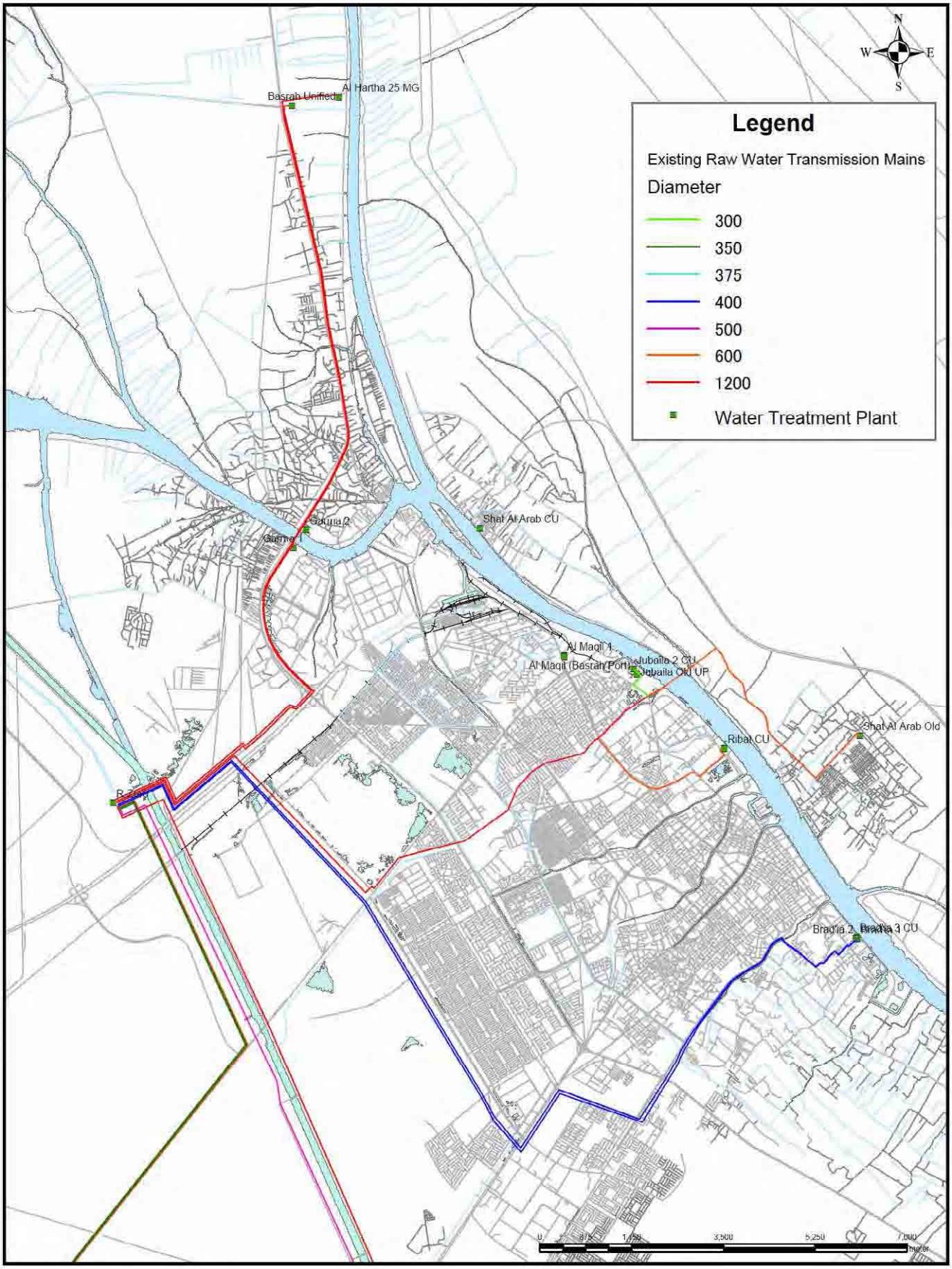
(2) Raw Water Transmission System and Treated Water Transmission and Distribution System

Most of water treatment plants in the central Basrah area use both the Shat Al Arab and the SWC as water source. The raw water of SWC is once stored in the reservoir at the R-Zero, from where the raw water is sent to existing water treatment plants through a raw water transmission system (Figure 2.2). The water source is managed in a way that the SWC is used at maximum and the rest is supplemented by the Shat Al Arab. The estimated quantity of water intake of the water treatment plants located in the central Basrah and the surrounding are as follows:

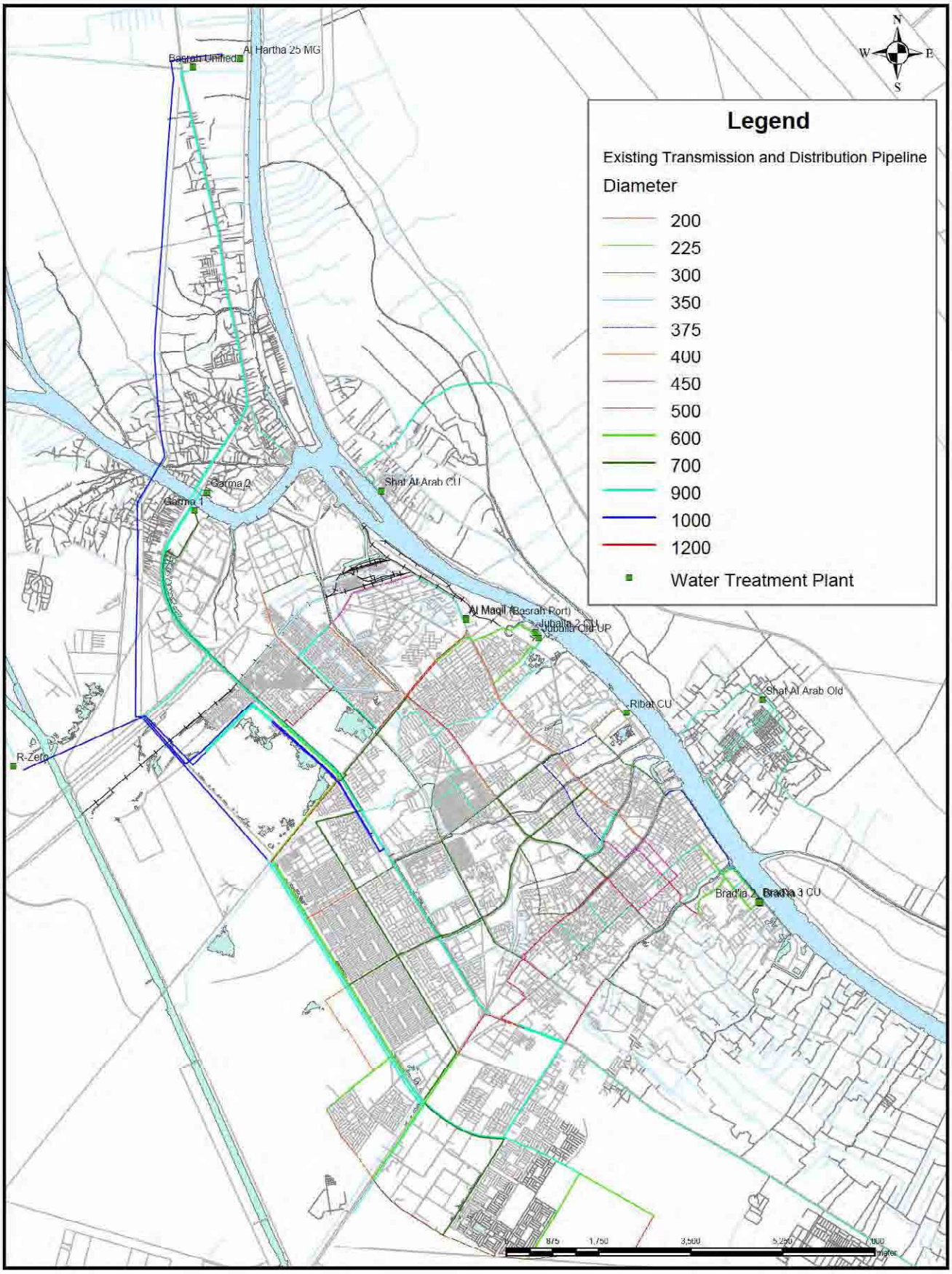
Table 2.3 Estimated Quantity of Water Intake

Item	Quantity (m^3/day)
The estimated total capacity of water treatment plants, source of which is the SWC	529,500
The estimated flow of the SWC (in July 2006)	433,500
The estimated quantity of water intake from the SAA and the Garma Ali	96,000

The treated water from water treatment plants are distributed through the existing transmission and distribution mains in the central Basrah as shown in Figure 2.3. The distribution network is very old and obsolete, the leakage ratio of which is estimated at 50 % by the study team.



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	**Existing Water Treatment Plants in Central Basrah and Raw Water Transmission Mains from R-Zero**	**Fig No.** 2.2



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	**Existing Transmission and Distribution Network and Water Treatment Plants in Basrah District**	**Fig No.** 2.3

2.3 Water Supply Service

(1) Existing Conditions of Water Supply

To understand the existing conditions of water supply service, the study team conducted the socio-economic survey in the Basrah Governorate, in which 400 households were selected at random. The results are shown below.

According to the survey, 98 percent of interviewed households have received water from the public water supply service. Additionally bottled water is used for drinking and cooking in almost all the interviewed households. The average per capita water consumption (including bottled water) is 144 liter/capita/day (lcd), ranging from 40 lcd to 513 lcd. The average water consumption of bottled water is 4.5 lcd.

Color /turbidity, taste and odor of the supplied water were judged based on customer's observation. From the results of the survey, approximately 90 percent of interviewed households answered that the supplied water was of unsuitable quality in terms of all three parameters. Therefore, the bottled water is utilized in most of the households.

The following figure shows average composition of water consumption by use. The water use of washing /cleaning and shower /bathtub accounts for more than 60 percent. The next largest use is for toilet, gardening and cooler.

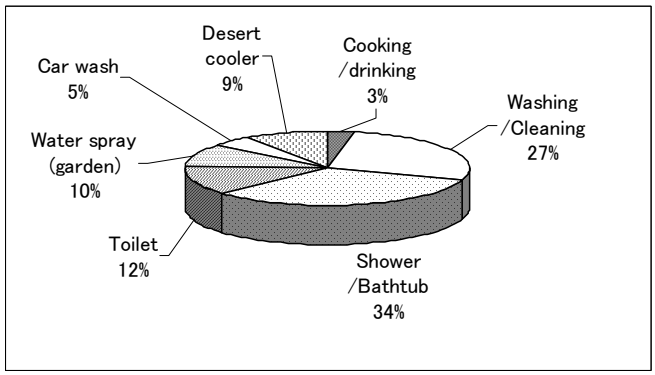


Figure 2.4 Composition of Water Consumption by Use

From results of the interview survey, 41 percent of households receive water less than 6 hours and 25 percent receive 6 - 12 hours per day through water supply.

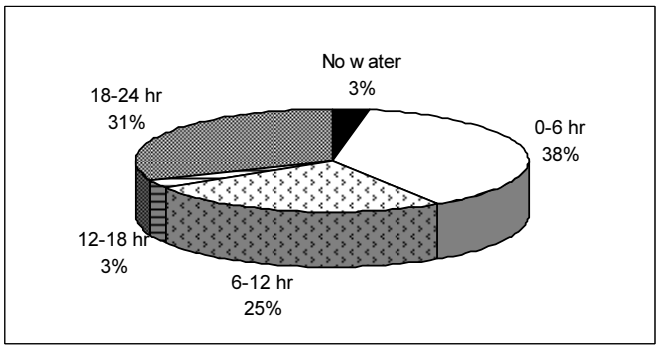


Figure 2.5 Water Supply Hours

Almost all households have storage tanks and lifting pump to store the water for use in the non-supply hours. A large number of households installed the required facilities (suction pump) to deal with the low network pressure.

The average water rate for the water supply service in interviewed households is 2,300 ID/month/household, ranging from 1,000 to 5,000 ID/month/household. While, average monthly expenditure for bottled water is 12,200 ID/month/household (1,000 - 140,000 ID/month/household). The household pay about 5 times the amount for bottled water compared to the cost they pay for public piped water. On average, the surveyed households spend 1.8 percent of the total income (836,000 ID/month/household) for water with 0.3 percent for the public water supply service and 1.5 percent for bottled water.

(2) Problems of Water Supply Service

From the socio-economic survey, the problems of water service from the customer's perspective are identified in Table 2.4. From the table, it is evident that the respondents are very dissatisfied in all the items except the cost of water. Of these problems, the most severe problem for the customers is shortage of water quantity including low service pressure and the second is the served water quality.

Table 2.4 Problems of Water Supply Service

Service item		Ratio of respondents *
Served water quantity / service pressure		94%
Water supply service hours		67%
Served water quality	Color /Turbidity	89%
	Taste (high salinity)	97%
	Odor (sewage odor)	85%
Cost of water		2%
Lack of maintenance		60%

Note: Multiple answers

(3) Willingness to Pay for the Water Supply Service

In the same survey, the willingness of household to pay for the water supply service was collected and summarized below.

1) Willingness to Pay for the Current Water Service

- Forty-three percent of the households are unwilling to pay for the current water supply service.
- Fifty-seven percent of the households are willing to pay for the current water supply service, and the average willingness to pay for the current water supply service is 2,500 ID/month/household.
- This willingness to pay is almost the same as the current actual payment for the water supply service, i.e. 2,300 ID/month/household, which is equivalent to 0.3 % of the average household income.

2) Willingness to Pay for the Satisfied Water Supply Service

- The average willingness to pay for the satisfied water supply service is 8,600 ID/month/household. The average willingness to pay amount to about 1.0 % of the average household income. Assuming the monthly water consumption per household is 30 m^3, the unit water price is 286 ID/m^3 (0.19 US$/$m^3$).
- The average willingness to pay for the satisfied water supply service is 3.4 times more than that of the current water supply service.

2.4 Existing Organizations of Water Supply Sector

MMPW (Ministry of Municipalities and Public Works) 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.

General Directorate Water (GDW) is one of the departments of MMPW, which is responsible for supplying drinking water to all of the governorates in the country except the board of Baghdad municipality and three (3) northern governorates. Under this department, Basrah Water Directorate (BWD) is directed and supervised.

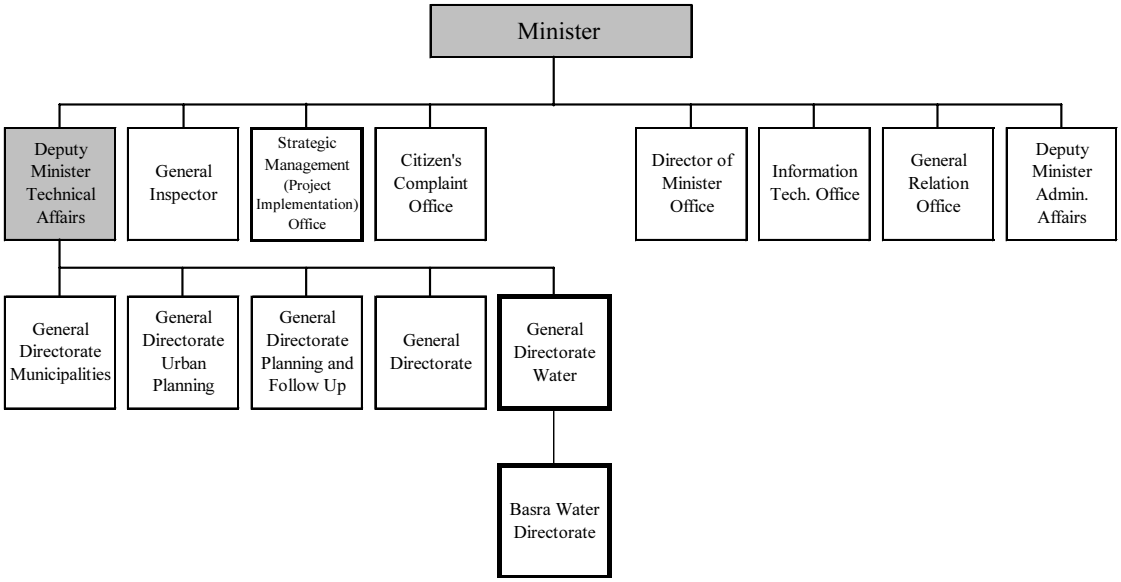


Figure 2.6 Organization of MMPW

Basrah Water Directorate (BWD) is the main entity responsible for drinking water supply in Basrah Governorate, consisting of eight departments with a total staff of 1,423 under a Director General (DG) as shown in Figure 2.7.

The largest department is Technical Department, which is responsible for mainly operation and maintenance and designing of water supply facilities.

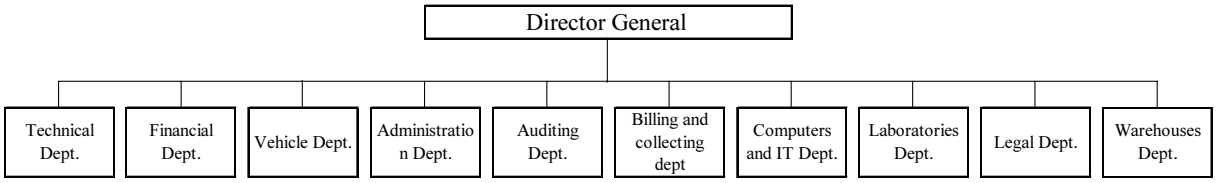


Figure 2.7 Departments of BWD

CHAPTER 3 WATER SUPPLY DEVELOPMENT PLAN

3.1 Planning Fundamentals and Policies

Based on the review of Mini M/P, the following planning policies of WSPCB are established in this study.

Table 3.1 Planning Policies

Item	Mini M/P	Planning policy of WSPCB
Planning area	The entire Governorate of Basrah	The planning area is the area where the existing water supply conditions are the most severe and thus to which the highest priority is given for improvement of the water supply system. This area is central Basrah area or Basrah District, which is comprised of Basrah municipality and Hartha center and rural.
Planning base data	-	Using only available basic data, planning base figures in the Mini M/P are re-examined. After discussion with Iraqi side, the population projection and per capita consumption in Mini M/P were used but the planning leakage ratio was modified.
Target year	2025	The target year of the study is set as 2015 since the long-term forecast of the socio-economic conditions is not possible under the current unstable conditions.
Water source	SWC is planned to be abandoned as a water source. The Tigris at Al Quorna and the Shat Al Arab at Basrah city will be utilized as water source.	In the short and mid terms the SWC is the only suitable water source for potable water supply in terms of TDS. Therefore, the SWC as well as the Shat Al Arab at Al Hartha will be utilized in this plan recognizing their problems with unreliability.
Water quality improvement	Water treatment facilities are planned mainly in terms of reduction of TDS.	Water treatment facilities are planned for improvement of the other water quality parameters as well as TDS. As for TDS, a phased water quality improvement will be considered within feasible ranges. Therefore, inadequate TDS improvement for drinking water is allowed in the middle stage of the plan.
Existing water treatment facilities	The existing facilities are all abandoned.	Although the existing facilities use inappropriate technology and/or are very old, it is not realistic to abandon these facilities. The existing facilities shall be utilized to meet the demand at least until 2015. Utilizing the existing facilities as much as possible and reducing capital investment requirements is considered in the plan.
Water treatment capacity	To fill the gap of water demand and supply in 2025, water treatment capacity is expanded.	To fill the gap of water demand and supply in 2015, water treatment capacity will be expanded. In normal planning, the capacity of new water treatment plants will be planned to meet maximum day water demand. However, as the gap is very large the capacity will be expanded to meet average day water demand in the plan.
Transmission and distribution system	No detail about transmission and distribution system is planned.	The capacity of transmission and distribution is inadequate in many areas in the planning area since planned strengthening and improvement of the facilities have not been carried out. Detail plan on the system is planned so that the water from existing and proposed new water treatment plants is adequately supplied to the entire planning area.
Implementation staging	No detail about implementation schedule is planned.	Implementation schedule of the plan up to 2015 will be studied and a feasible implementation schedule will be prepared in the plan.
Capacity improvement of BWD	No capacity improvement program is planned.	A capacity building plan is prepared to improve the management of BWD (Basrah Water Directorate).

3.2 Requirements for Improvement of Water Supply and its Measures

The evaluation of the countermeasures to meet the customers' needs that shall be taken in this plan is presented below.

Table 3.2 Evaluation of Countermeasures to meet the Customers' Needs

Customers' needs	Countermeasures to be taken in this plan
Inadequate water supply quantity (Low supply pressure) and inadequate water supply hours	・The expansion of water treatment capacity will be planned to meet the water demand. ・Leakage control measures will be planned. (technical and non-technical measures) ・Restructuring and rehabilitation of the distribution network will be planned.
Problems of water supply quality (Taste or high TDS)	・The shift of water source to the upstream (Tigris), which is planned in the Mini M/P, is not considered in this plan since it requires large scale investment for long term. ・Accepting the current low reliability of SWC, both the Shat Al Arab and SWC must be utilized in this plan. ・A large scale RO plant to cover all amount of domestic water use will be studied and its feasibility will be evaluated. ・In addition, strengthening of the existing potable water distribution system comprising of small scale RO plants, water tankers and delivery points shall also be studied as an option. ・Depending on the feasibility of the introduction of a large scale RO, a staged improvement of water quality in terms of TDS is considered.
Problems of water supply quality (Color, turbidity and odor)	・Water intake of new water treatment plants shall be located upstream of the Shat Al Arab as far as possible. ・Rehabilitation of existing water treatment plants shall be planned. ・Water quality monitoring and management shall be improved. (Soft measures) ・Adequate quantity and quality of chemicals shall be purchased. ・Leakage control measures shall be planned. (Soft and hard measures)
Inappropriate maintenance of facilities	・Operation and maintenance ability shall be improved. (Non-technical measures) ・Capacity building of BWD shall be planned.

3.3 Planning and Design Criteria

The criteria given in Table 3.3 have been followed for preparing plans and designs of required facilities.

Table 3.3 Planning and Design Criteria

<table>
<tr><th>Item</th><th>Value/Explanation</th></tr>
<tr><td>Planning area</td><td>Basrah District including Basrah Municipality and Al Hartha Center and Rural (the Central Basrah)</td></tr>
<tr><td>Target year</td><td>2015</td></tr>
<tr><td>Target water demand</td><td>Water demand in 2015</td></tr>
<tr><td>Design per capita consumption (Lpcd)</td><td>The design per capita shall follow General Water Directorate Specifications, 1985, MMPW (see Table 3.5).</td></tr>
<tr><td>Water treatment capacity</td><td>Average day water demand</td></tr>
<tr><td>Transmission pipe capacity</td><td>Maximum day water demand (1.4 x average day water demand)</td></tr>
<tr><td>Distribution pipe capacity</td><td>Peak hour water demand (1.6 x maximum day water demand)</td></tr>
<tr><td>Total dissolved solid (TDS) of water sources</td><td>SWC: 670 mg/l (average of water quality analysis in June and August 2006)
SAA: 1,500 mg/l (considering several sources of water quality analysis including JICA survey)
Tigris: 1,100 mg/l (considering several sources of water quality analysis including JICA survey)</td></tr>
<tr><td>Reverse osmosis plant</td><td>TDS of RO treated water: 200 mg/l
RO plant water recovery rate: 75 %</td></tr>
<tr><td>Water quality</td><td>The tolerable limit of TDS as per the Iraqi standards is 1,500 mg/l. Generally, it is said in Iraq that 700 mg/l is the upper limit of potable water quality. The WHO recommendation is less than 600 mg/l. The following are WHO explanation.
<table>
<tr><th>TDS (mg/l)</th><th>Organoleptic properties</th></tr>
<tr><td>Less than 300</td><td>Excellent</td></tr>
<tr><td>300-600</td><td>Good</td></tr>
<tr><td>600-900</td><td>Fair</td></tr>
<tr><td>900-1200</td><td>Poor</td></tr>
<tr><td>Greater than 1200</td><td>Unacceptable</td></tr>
</table>
In this plan, supply water shall comply with the Iraqi standards except TDS. As for TDS, the target was not decided by the Iraqi side but a value less than 600 mg/l is considered preferable and a value less than 900 mg/l is acceptable based on the above TDS properties.</td></tr>
<tr><td>Water supply pressure</td><td>The proposed distribution pressure shall be ensured, with which 4 stories buildings can receive water directly from the network, 0.15 MPa (15 m service pressure) at tap.</td></tr>
<tr><td>Water supply hours</td><td>Basically, 24 hours continuous water supply should be ensured. In case supply volume is not enough, water rationing shall be adopted to attain equitable distribution.</td></tr>
<tr><td>Water supply area</td><td>The water shall be equitably distributed in the entire planning area, either by continuous supply or rationing.</td></tr>
<tr><td>Leakage ratio</td><td>From the current 50 % (assumption) to 30 % in 2015.</td></tr>
</table>

3.4 Water Demand Estimation

The population estimate of the Mini M/P (Table 3.4) is used for planning of the future water supply system. The existing coverage of the public water supply is almost 100 % and the future coverage is set at 100 % in planning. Therefore, this population is equivalent to the service population by the water supply service.

Table 3.4 Estimated Population

District	Sub-District		2003	2005	2006	2010	2015	2020	2025
Al Basrah	Municipal	Center	737,000	782,000	807,000	907,000	1,051,000	1,218,000	1,412,000
	Al-Hartha	Center	68,000	72,000	74,400	84,000	97,000	112,000	130,000
	Al-Hartha	Rural	76,000	81,000	83,600	94,000	109,000	126,000	146,000
	Sub-total		881,000	935,000	965,000	1,085,000	1,257,000	1,456,000	1,688,000
Governorate Total			1,762,000	1,881,000	1,940,600	2,179,000	2,524,000	2,924,000	3,388,000

In the Mini MP, the per capita consumption shown in Table 3.5 was adopted. In WSPCB, the design per capita consumption of the Mini M/P is used for planning of the future water supply system.

Table 3.5 Design per Capita Consumption adopted in Mini M/P

(l/capita/day)

Category	Domestic	Commercial	Industrial	Total
Basrah	300	30	30	360
Towns with Industry	200	30	30	260
Towns without industry	200	30		230
Rural	200			200

Source: MMPW, General Water Directorate Specifications, 1985

The study team assumed that universal customer water metering will be introduced in 2015 and accordingly appropriate water price will be established to recover the costs of water supply. This measure will be a factor in reducing domestic per capita consumption. The study team expects a 10 % reduction in 2020 and a 20 % reduction in 2025 in the domestic per capita consumption.

The study team assumes that reduction measures of non-revenue water (NRW), the main part of which is composed of leakage, will be implemented by BWD. Accordingly, the future leakage ratio is planned as 30 % in 2015 and 20 % in 2025.

The average and maximum day water demands and peak hour water demand are estimated as shown in

Table 3.6. The target water demand in the average day in 2015 is 607,600 m^3/day.

Table 3.6 Estimated Water Demand

(m^3/day)

District	Sub-District		Average Day			Maximum Day			Peak Hour		
			2006	2015	2025	2006	2015	2025	2006	2015	2025
Al Basrah	Municipal	Center	581,040	540,514	529,500	813,456	756,720	741,300	1,301,530	1,210,752	1,186,080
	Al-Hartha	Center	38,688	36,029	35,750	54,163	50,440	50,050	86,661	80,704	80,080
	Al-Hartha	Rural	33,440	31,143	29,200	46,816	43,600	40,880	74,906	69,760	65,408
	Sub-total		653,168	607,686	594,450	914,435	850,760	832,230	1,463,096	1,361,216	1,331,568
Governorate Total			1,117,376	1,038,300	1,015,150	1,564,326	1,453,620	1,421,210	2,502,922	2,325,792	2,273,936

3.5 Balance between Water Demand and Supply in 2015

The water demand in 2015, the estimated actual capacity of existing water treatment plants, and water deficits in 2015 for Basrah District are summarized in Table 3.7. Using the existing water treatment capacity, the total water deficit in Basrah District in 2015 will be 183,200 m^3/day and 426,300 m^3/day for the average day and maximum day demand in 2015, respectively.

Table 3.7 Water Balance of Planning Area in 2015

Item	Water demand in 2015		Estimated actual existing capacity	Deficit in capacity	
	Ave. day	Max. day		Against ave. day demand	Against max. day demand
Water Amount (m^3/day)	607,600	850,700	424,400	183,200	426,300

3.6 Policy for Improvement of Water Supply System

(1) Improvement of water treatment system

1) Enhancement of treatment capacity

a) Use of existing water treatment plants

Without utilizing existing water treatment plants, the required capacity of new water treatment plant to meet the average day water demand in 2015 is much greater in size, 607,600 m^3/day. To reduce the capacity of new water treatment plant, the existing plants will be used as long as possible. To use existing facilities for the mid-term, rehabilitation is required but this rehabilitation shall not be comprehensive but rather temporary in nature since these facilities

shall be not used finally in the long run. The rehabilitation will be mainly for replacement of aged electrical and mechanical equipment. The following existing water treatment plants will be utilized up to 2015 but depending on the stage of the plan, all existing water treatment plants will be utilized.

- Al Hartha 25 MG (96,000 m^3/day)
- Basrah Unified (72,000 m^3/day)
- R-Zero (96,000 m^3/day)

b) Expansion of water treatment capacity

To fill the gap between the water demand in 2015 and the capacity of the existing treated water plants, the capacity of water treatment will be expanded. However, to meet the maximum day water demand in 2015, the capacity of water treatment should be enhanced by 426,300 m^3/day for the planning area even if all existing water treatment plants are utilized. To meet the urgent needs of water demand, the capacity of water treatment is enhanced to meet the average day water demand in 2015.

2) Improvement of treated water quality

a) Change of intake point

The water in the middle and downstream of the Shat Al Arab in the Basrah city is organically polluted. Therefore, the intake of proposed water treatment plant should be located at Al Hartha of the Shat Al Arab. The existing water treatment plants located in the middle and downstream of the Shat Al Arab shall be finally abandoned.

b) Rehabilitation of existing facilities

The aged existing water treatment plants will be rehabilitated to produce sanitary water, by which turbidity of treated water shall be removed to appropriate range and appropriate chlorination will be adopted.

c) Introduction of desalination facilities to reduce TDS

To arrive at an appropriate TDS level of treated water suitable for domestic use of water, Reverse Osmosis (RO) plant is planned and evaluated.

(2) Improvement of transmission and distribution system

a) Re-establishment of transmission and distribution system

Any significant capital investment for the improvement of the existing distribution network has not been made for a long time and the distribution capacity is insufficient in many areas. The existing distribution system is a single network for the entire planning area. This not only makes water distribution complicated and difficult but also makes efficient and equitable water distribution impossible. For the future, a system that manages the water distribution efficiently should be selected. For this objective, transmission and distribution pipelines shall be separated and distribution zoning will be carried out installing new transmission mains surrounding the center of the city area.

b) Rehabilitation of existing distribution network

For the following purposes, the existing distribution network will be rehabilitated.

- Pollution resulting from pipe breaks is eliminated.
- Assuming a 50 % leakage ratio for the existing network, half of the water produced is wasted without effective consumption. By reducing leakage, the effective water volume for consumption and service pressure will be increased.
- Non-revenue water (NRW) will be reduced and revenue will be increased.

(3) Improvement of institutional capacity for water supply management

The institutional capacity of BWD will be improved adequately to operate and maintain the proposed facilities and to manage the water supply sector.

3.7 Plan of Water Treatment

(1) Water Treatment Method

Conventional rapid sand filtration method is adopted for treatment process. The water treatment plant consists of treatment facilities, chemical building, reservoir, pumping house, operation room, electrical room and generator room.

Preliminarily, RO treatment process is proposed, which includes multi-layer filters and finally the high pressure pump and membrane assembly, followed by blending and post-treatment. Pretreatment method of the surface water for RO and its design parameters shall be determined through extensive pilot testing.

The treated water from the RO process is generally water with less than 150- 200 mg/1 TDS. A

by-product of desalination is brine. Brine is a concentrated salt solution that must be disposed off. The RO process in conjunction with blending of conventionally treated water can be designed to deliver treated water at 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 (see the next section)
5) Output water: 362,000 m^3/day (see the next section)
6) Pretreatment: Multiple-layer filter

(2) Expansion of Water Treatment Plant

Based on the following cases of RO construction and abandonment of existing water treatment plants, the capacity of the additional conventional water treatment plant and RO plant was planned as shown in Table 3.8.

Item	Case			
	1	2	3	4
RO Construction	No	No	Yes	Yes
Existing water treatment plants to be utilized	All existing plants (13) will be utilized			10 plants will be abandoned and only 3 plants will be used.
Construction of additional water treatment plant	No	Yes	Yes	Yes

Table 3.8 Required Capacity of Additional Water Treatment Plant and RO Plant for 2015

(m^3/day)

Item	Case 1	Case 2	Case 3	Case 4 WSPCB
Existing water treatment plants to be utilized	424,400	424,400	424,400	264,000
New conventional water treatment plant (Design capacity)	-	183,200 (184,000)	279,200 (280,000)	464,600 (465,000)
RO plant				
- Input	-	-	383,000	483,000
- Output	-	-	287,000	362,000
- Brine wastewater discharge from RO plant	-	-	96,000	121,000

The final goal of WSPCB is the case 4; RO construction and utilization of 3 existing water treatment plants. However, it is planned that all existing water treatment plants shall be utilized before reaching

to the final goal.

The proposed conventional water treatment plant should be located in the land between the existing Al Hartha 25 MG plant and Basrah Unified plant.

3.8 Transmission and Distribution Plan

The transmission and distribution system is planned based on the conditions and criteria shown in Table 3.3. Pipe is designed so as to convey the water demand in 2015. To separate transmission and distribution system, the transmission ring mains will be constructed surrounding the center of the Basrah city. The treated water from a new water treatment plant and 3 existing water treatment plants is conveyed to the new main transmission facilities (transmission reservoir and pumping station) constructed in the north of the Basrah city, from which the treated water is transmitted to 13 main distribution facilities (distribution reservoir, transfer pumping station and elevated tank) through the transmission ring mains. In this plan, 13 distribution zones and 6 sub-distribution zones were planned. Finally the treated water is distributed to each distribution zone from the elevated tower. The planned population and average and maximum day water demands are shown in Table 3.11 and the proposed water distribution zones are shown in Figure 3.1.

3.9 Proposed Future Water Supply System

The proposed improvement of water supply system focuses on the central Basrah Governorate. Therefore, this plan is called Water Supply Plan for Central Basrah (WSPCB).

In WSPCB, 13 distribution zones and 6 sub-zones are delineated and the water supply system comprising new treated water transmission ring mains, main transmission facilities and main distribution facilities was proposed. The components of the proposed water supply system are shown in Figure 3.2 and Table 3.9. The existing water supply facilities to be used at least until 2015 are shown in Table 3.10.

The general layout of the proposed water treatment plant including RO plant is shown in Figure 3.3. The general layout of the main transmission facilities and the route and diameter of transmission mains are shown in Figure 3.4 and Figure 3.5 respectively. The general layout of main distribution facilities is shown in Figure 3.6.

Table 3.9 Summary of Proposed Water Supply Facilities

Facilities	Capacity
1. Rehabilitation of network	110 mm - 700 mm, 285 km
2. Rehabilitation of water treatment plant (WTP)	13 plants in Central Basrah (424,400 m^3/day) Note: Finally only 3 plants will be utilized (264,000 m^3/day).
3. Treated water transmission system	
(1) Transmission reservoir (TR)	64,000 m^3
(2) Transmission pumping station (TPS)	710,000 m^3/day x 40 m head
(3) Ring mains and connections to MDF	600 mm - 2000 mm, 33,000 m
4. New water treatment plant	
(1) Treatment plant	465,000 m^3/day
(2) Treated water pumping station	369,000 m^3/day x 40 m head
5. Main distribution facilities (MDF)	13 water distribution zones
(1) Strengthening of distribution mains	200 mm- 700 mm, 25,100 m
(2) Distribution reservoir (for 12 zones)	186,000 m^3 in total
(3) Transfer pumping station (for 12 zones)	945,000 m^3/day (39,800 m^3/hr) in total
(4) Elevated tank (for 12 zones)	12,300 m^3 in total
6. Reverse osmosis plant	362,000 m^3/day (output)

Note: One of the 13 MDF is now under construction.

Table 3.10 Summary of Existing Water Supply Facilities to be used

Facilities	Capacity/remarks
1. Transmission pipeline	To be used after rehabilitation
2. Distribution network	To be used after rehabilitation
3. Raw water transmission system	- Pipeline and pumping station in R-Zero shall be used. - 2 lines of raw water mains (dia. 1200 mm) from R-Zero to water treatment plants in Al Hartha shall be used for treated water transmission mains
4. Water treatment plants	Al Hartha 25 MG (96,000 m^3/day) Basrah Unified (72,000 m^3/day) R-Zero (96,000 m^3/day) Note: Depending on the planning phase, all of the existing water treatment plants will be utilized.

Table 3.11 Population and Average Day and Maximum Water Demand in 2015

(m^3/day)

Distribution Zone	Population	Ave Day Demand	Max Day Demand
1	52,429	27,000	37,800
2	51,231	26,300	36,900
3	57,804	29,700	41,600
4	69,653	35,800	50,100
5	82,713	42,500	59,600
6	84,613	43,500	60,900
7	80,481	41,400	57,900
8	89,436	46,000	64,400
9	81,056	41,700	58,400
10	74,055	38,100	53,300
11	57,487	29,600	41,400
12	40,490	20,800	29,100
13	85,927	44,200	61,900
S1	31,177	16,000	22,400
S2	31,415	16,200	22,600
S3	14,483	7,500	10,400
S4	66,550	34,200	47,900
S5	97,000	36,000	50,400
S6	109,000	31,200	43,600
Total	**1,259,015**	**609,715**	**852,615**
Z-total	**907,375**	**466,600**	**653,300**
S-total	**349,624**	**141,100**	**197,300**

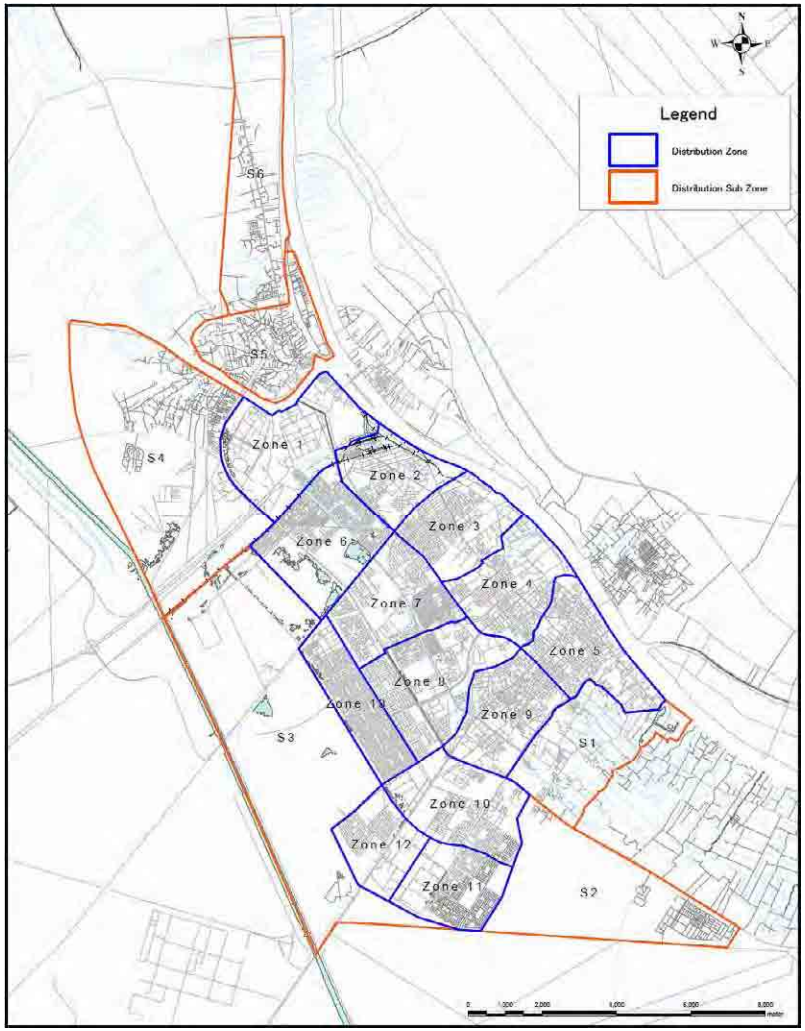
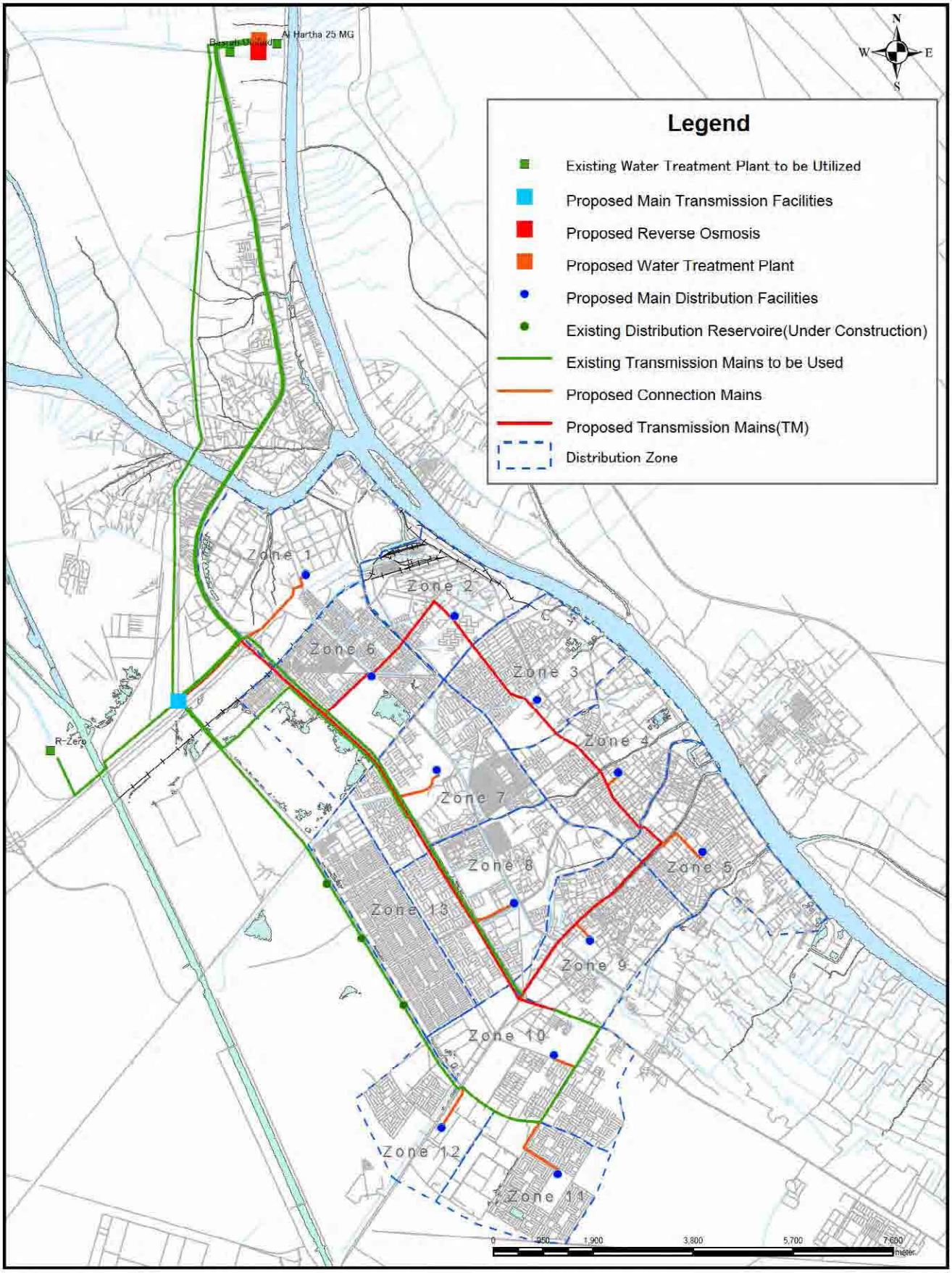
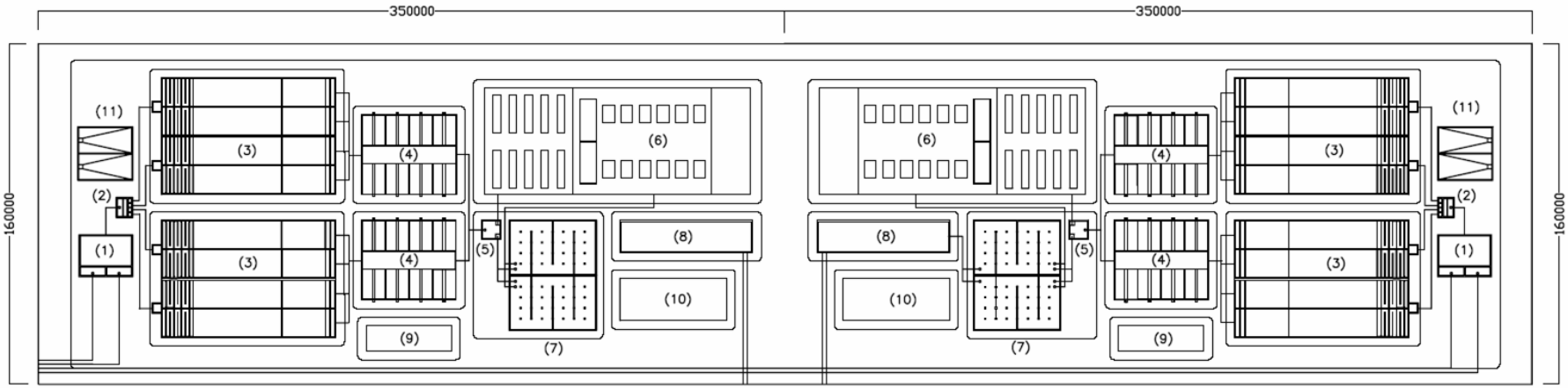


Figure 3.1 Proposed Water Distribution Zones

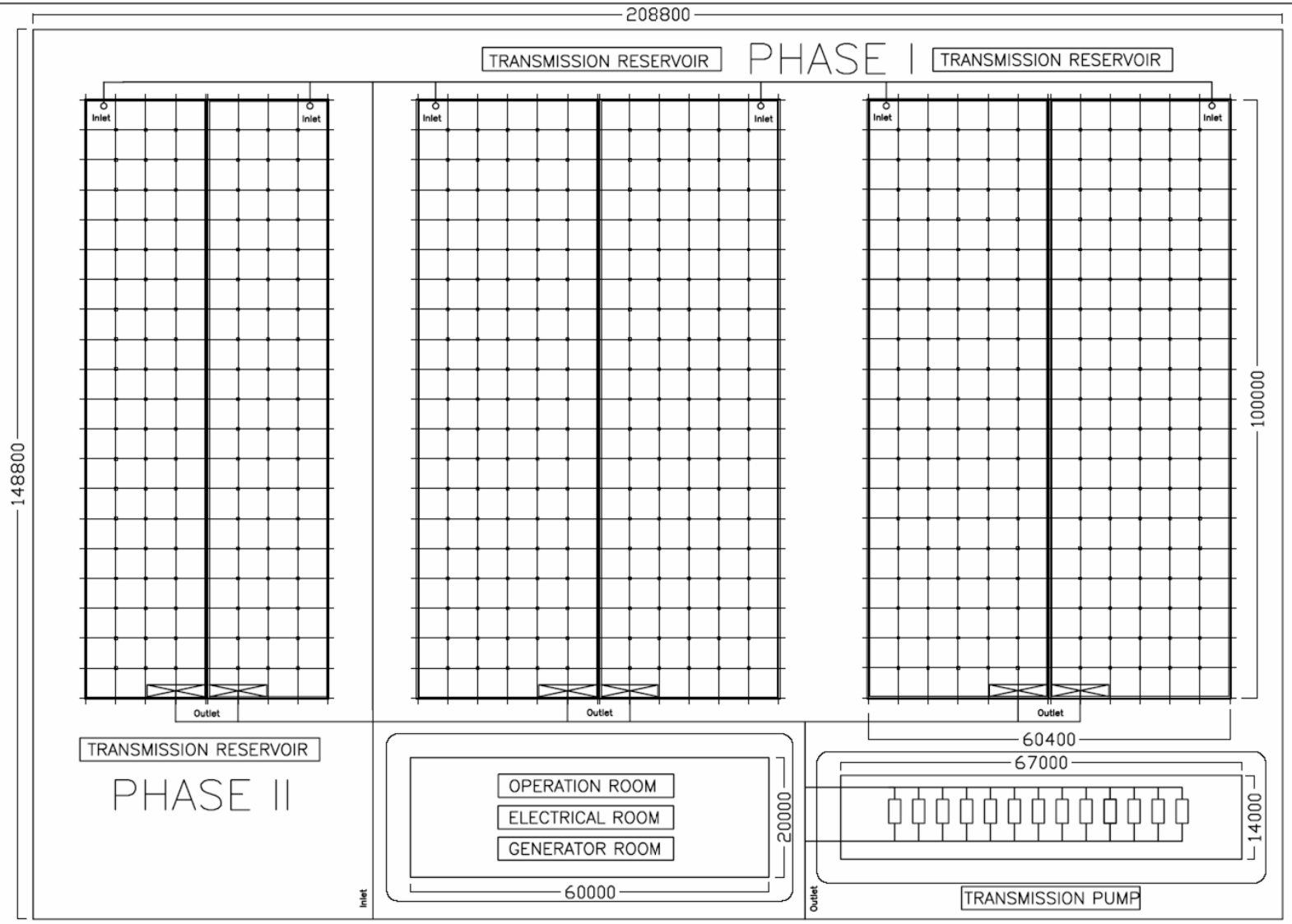


The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	Proposed Water Supply System of WSPCB	Fig No. 3.2

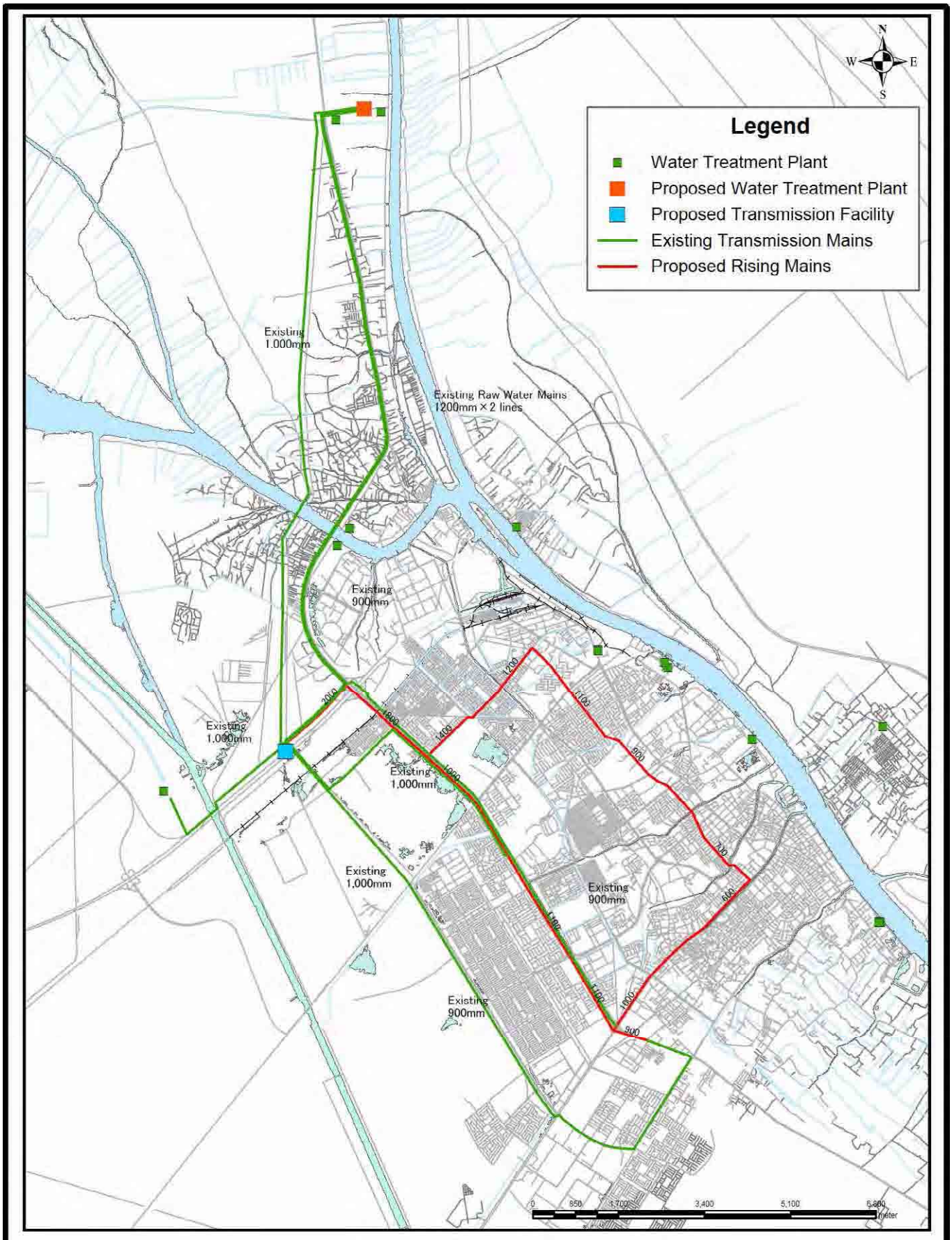


(1) RAW WATER PUMP
(2) RECEIVING WELL
(3) CHEMICAL SEDIMENTATION BASIN
(4) RAPID SAND FILTER
(5) RECEIVING & DISTRIBUTION WELL
(6) REVERSE OSMOSIS PLANT
(7) CLEAR WATER RESERVOIR
(8) TRANSMISSION PUMP
(9) CHEMICAL BUILDING
(10) OPERATION & ELECTRICAL & GENERATOR ROOM
(11) DRAINAGE TANK

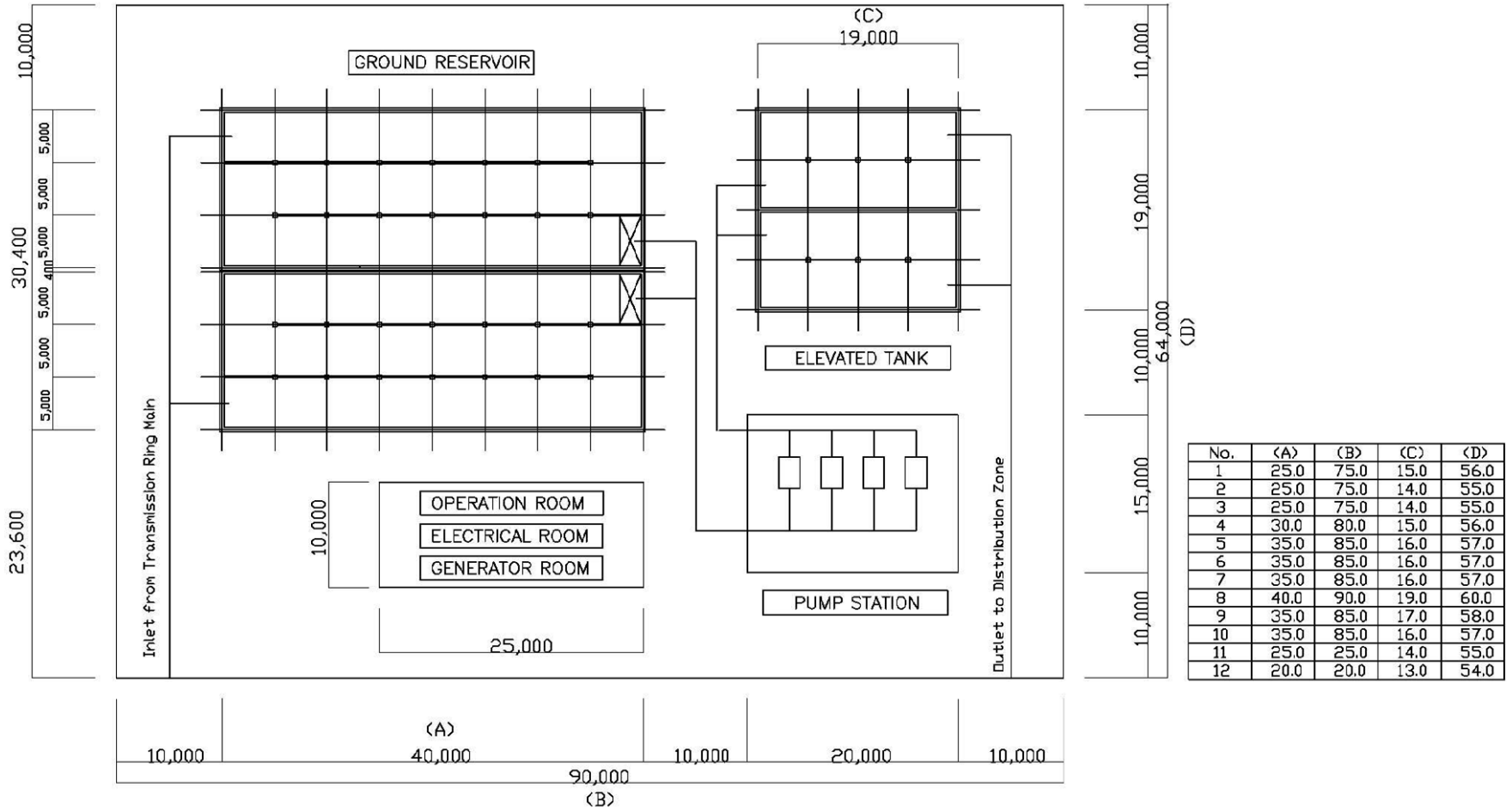
The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq	General Layout of New Water Treatment Plant	Fig No. 3.3



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. 3.4



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 of WSPCB	Fig No. 3.5



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. 3.6

3.10 Water Supply Plan for Central Basrah (WSPCB) and Mini M/P

Mini M/P is planed focusing on long-term solutions in the water supply sector but WSPCB is planned focusing on short and mid-term solutions to current problems to be urgently solved by preparing concrete solutions and implementation schedule.

The relationship between the facility components of WSPCB and an alternative system selected in Mini M/P is explained in the following figure. As shown in this figure, all the facilities constructed in WSPCB could be integrated with and utilized as the components of the selected alternative. WSPCB comprises of the most urgent and higher priority components in Mini M/P.

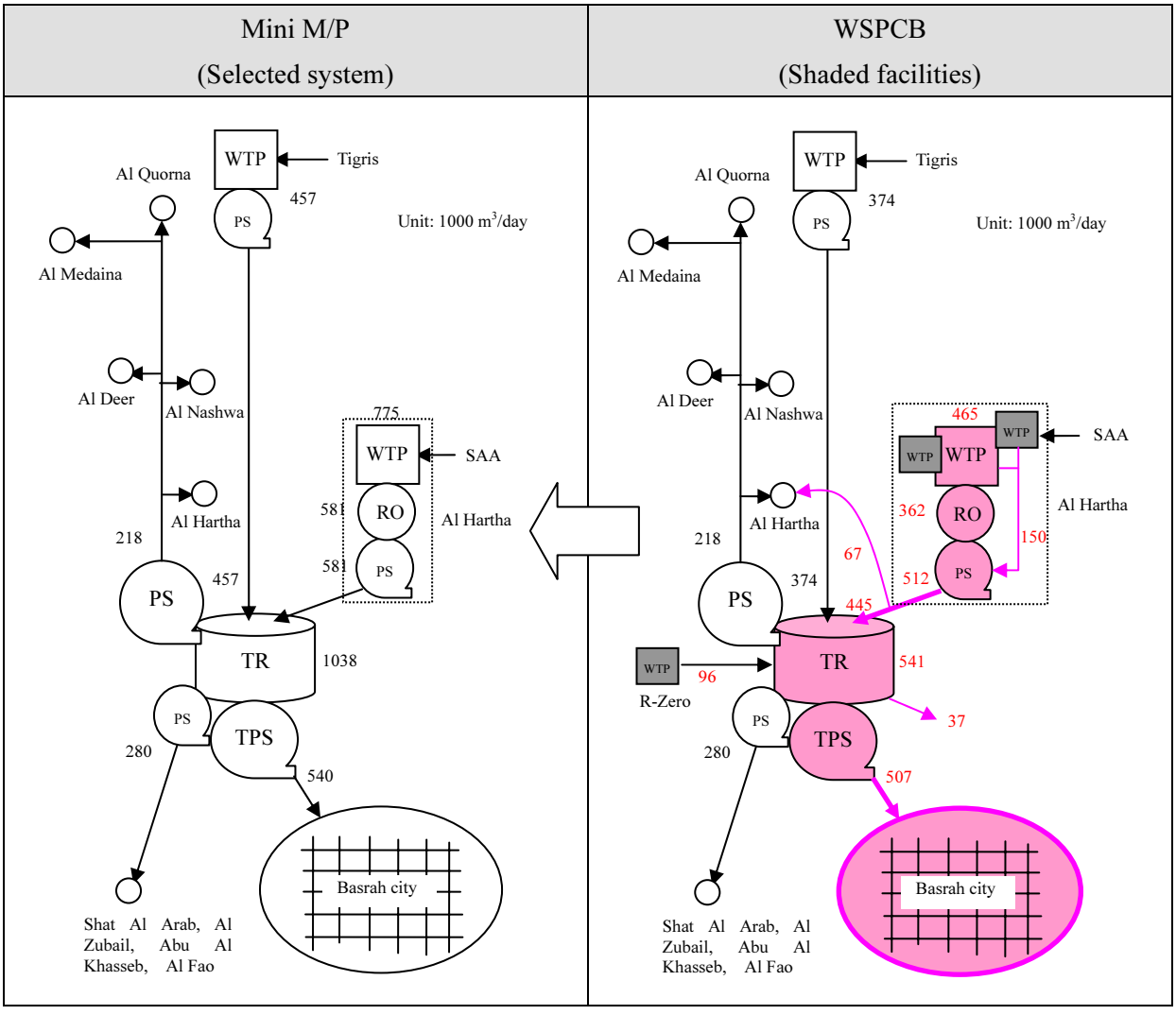


Figure 3.7 Schematic Layout of Water Supply Facilities of Mini M/P and WSPCB

CHAPTER 4 WATER DISTRIBUTION MANAGEMENT

4.1 Introduction of Water Distribution Management System

Water distribution management is required for following purposes:

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

In WSPCB, 3 existing water treatment plants, a new water treatment plant, main transmission facilities, transmission ring mains and main distribution facilities will be operational and the treated water will be distributed into 13 distribution zones. For equitable water distribution to the entire planning area according to the water demand fluctuating seasonally, weekly, daily or hourly, the water distribution management to observe and control the flows between these facilities was proposed in WSPCB.

The distribution network seems to be in a bad shape with high leakage ratio, probably around 50%. To reduce leakage efficiently, the concept of District Metered Areas (DMA) management should be introduced to the Basrah distribution network.

4.2 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 in several data/information complied in tables and layers of water supply facilities such as 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. This data/information is stored in specific GIS computer software for effective data/information management. Using these data/information and GIS software tools, water distribution management will be carried out more effectively. In addition, GIS is used effectively for water supply utility management. The following are possible applications of GIS for management.

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

CHAPTER 5 NON REVENUE WATER CONTROL PLAN

5.1 CURRENT WATER BALANCE IN BASRAH WATER DIRECTORATE

It is not possible to the estimate water balance for the water supply system of BWD due to lack of reliable data. Therefore, the water balance is estimated as follows, based on the limited information, assumptions and experience and data in Japan and other countries.

- Real loss (Leakage): 50%
- Apparent loss (mainly illegal connections): 10%
- Authorized non-revenue water (public institutions and religious facilities): 5%

Based on these figures, it is estimated that 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.

5.2 TARGET OF NON-REVENUE WATER CONTROL

Non-revenue water control should be carried out continuously by setting up the long-term targets. Therefore, the targets of the control plan are set as follows for 2015 and 2025 based on the Japanese experience.

(1) The NRW ratio will be reduced from the current estimated 60 % to 35 % and the leakage ratio to 30 % in 2015
(2) The NRW ratio will be reduced to 23% and the leakage ratio to 20 % in 2025

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 in 2015 and by 184,400 m^3/day in 2025.
- The water revenue will be increased to 2.1 times in 2015 and 2.5 times in 2025 assuming the current water tariff.

5.3 NON-REVENUE WATER CONTROL PLAN

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 meter reading and tariff collection system

The following 3 stages are proposed for the implementation of the NRW control plan for BWD.

Stage 1: Preliminary

- 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 by outsourcing - Intensive effort for detailed planning, implementation and technology transfer

Stage 2: Medium term up to 2015 (WSPCB)

- 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 (Mini M/P)-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)

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 to start NRW control:

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

CHAPTER 6 INSTITUTIONAL CAPACITY BUILDING

6.1 GOALS AND VISIONS OF BASRAH WATER DIRECTORATE

In line with the introduction of democracy system in Iraq, the introduction of decentralization and de-concentration has been discussed for efficient and effective administration of the government organizations. The national trends of decentralization and de-concentration, which was started by the government authorities concerned and assisted by World Bank (WB), will affect the water sector policy. Considering the trends of decentralization and de-concentration, the current issues and current characteristics of BWD management, the goal for BWD is set as follows:

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

To achieve the goal, the visions of BWD management in WSPCB are set as follows:

(a) Establishment of proper water supply management system using recent technology

(b) Establishment of water supply service with transparency and accountability under democracy system

Under the current turmoil in Iraq, since it is not possible to achieve decentralization system in the short term, the current BWD management has to be continued under current centralized management system of governments until realization of decentralization reform. This may be achieved around in 2015, the target year of this study. Accordingly, until 2015, the following actions should be taken as transitional measures for 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, billing and collection, and accounting system)
- Implementation of human resources development

6.2 STRATEGIES FOR INSTITUTIONAL STRENGTHENING OF MMPW AND BWD

To achieve the goal and the visions of BWD, the following five strategies are set:

Strategy-A: Smooth project implementation of facilities development

Strategy-B: Formation of legal framework for water supply policy

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

6.3 RECOMMENDATIONS FOR 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 assumed Yen loan of JBIC (Japan Bank for International Cooperation). As a similar unit existing within the Strategic Management Office (SMO) of MMPW has managed the projects funded by international donors, it is recommended that MMPW add the PIU to the existing SMO. The proposed PIU together with MMPW shall be responsible for the following functions:

- Dealing with the JBIC Missions (for Fact Finding and Appraisal)
- Conclusion of Exchange of Note (E/N) and Loan Agreement (L/A)
- Preparation of TOR for Consultants and cost estimate of Engineering Services (ES), Employment of Consultant, Checking and approval of tender documents
- Procurement of Contractor (Implementation of Tender, Tender Evaluation)
- Execution of preparation for the Project Implementation such as land clearance and EIA
- Construction Supervision, Transfer of water 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. The capacity building for the purpose is indispensable.

- 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)

(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.

6.4 RECOMMENDATIONS ON THE ORGANIZATION OF BWD

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

BWD will be the organization 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)

The following issues on organization of BWD were identified through the subcontract survey by the study team and the results of the participatory PCM workshop.

- Inadequate management of the command lines
- Complicated and disunities command lines
- Lack of function of customer service
- Shortage of audit system

Considering these issues, a new simplified and unified organization of BWD is proposed as shown in Figure 6.1 and Customer Department and Audit Committee should be established for customer-oriented, transparent and accountable management.

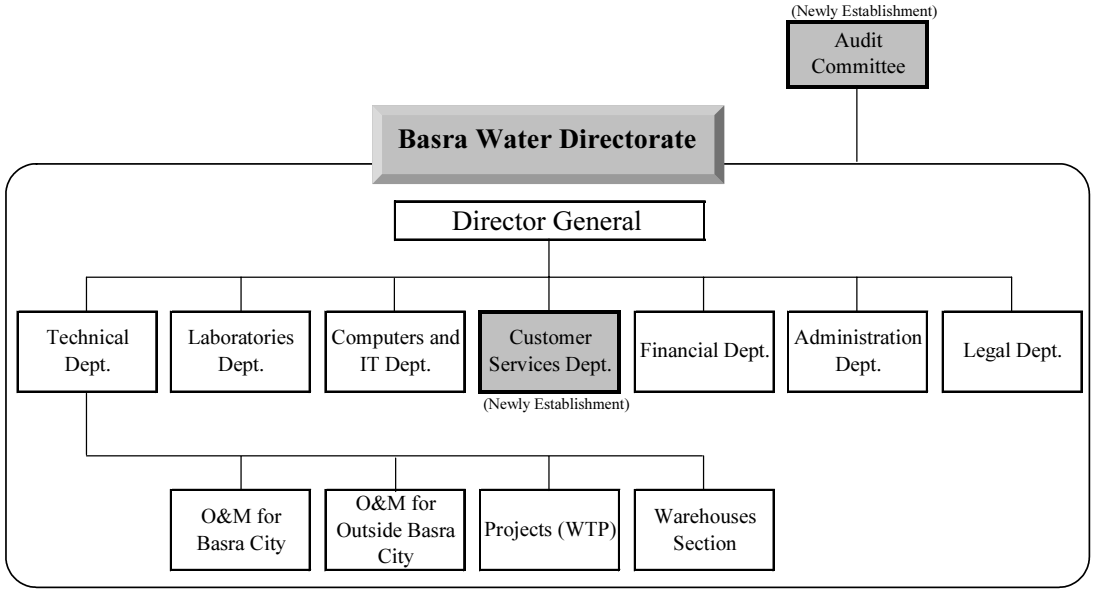


Figure 6.1 Proposed Organization of BWD

(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:

1) Efficient O&M for water supply facilities

The BWD staff shall operate and maintain efficiently and effectively the constructed facilities by improved capacity and prepared guidelines and manuals.

2) GIS application for water supply management

GIS system can be utilized for efficient operation and maintenance of the water supply system management. It is proposed to develop GIS system for the water supply management.

3) Establishment of registration system of customers

The following customer database shall be prepared for efficient management of water supply service.

- Customer basic information
- Type of water use (domestic use/ commercial use/ industrial use / public use)
- Estimated / metered water consumption volume
- Payment conditions of tariff (record of payment, payment amount, etc.)

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

1) Improvement of recruitment system

The cases of favoritism and nepotism for employment exist in system. It is recommended that the examination system including the paper test and job interview after screening of CVs of candidates, be applied to recruit the required educated level of human resources and to discourage favoritism and nepotism.

2) Enhancement of motivation for work

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

- Adopt a promotion system based on their ability
- Adopt an appropriate staff appraisal system
- Adopt a merit system for salaries based on the appropriate staff appraisal system
- Adopt a bonus system such as incentive bonus for bill collectors if they achieve the target collection ratio

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

1) Improvement of tariff collection system

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

- Introduction of metering system
- Introduction of incentives system (bonus system) for collectors
- Introduction of strict penalty for illegal use
- Implementation of awareness campaign

2) Establishment of Audit Committee

The audit system for financial statement of BWD shall be established to ensure transparency and accountability of the management. The auditing for financial statements shall be carried out periodically by the committee.

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

To strengthen institutional capacity of BWD and develop required human resources to solve the issues mentioned above, the following capacity building programs are proposed.

1) Technical Career Development Menu	2) Organizational Career Development Menu
(1) Practical Technical Development	(18) Pre-contract training
(2)Practical Professional Training	(19) Newly recruited staff training
(3) Operation and maintenance for production and distribution of water	(20) Computer training
(4) NRW control (technical)	(21) Post promotion training (Ranking)
(5) NRW control (non technical)	(22) Manager training
(6) Customer service relations	(23) Personnel evaluator training
(7) Awareness campaign for tariff collection	(24) Director training
(8) Sales promotion	
(9) Site management	
(10) BWD management	
(11) Financial management	
(12) Human resources management	
(13) New staff OJT	
(14) Technical OJT	
(15) Site inspection abroad	
(16) Seminar and workshop	
(17) Formal training	

CHAPTER 7 IMPLEMENTATION SCHEDULE AND COST ESTIMATION OF WSPCB

7.1 Capital Cost Estimation

The capital cost was estimated based on the conditions and assumptions as explained in Table 7.1.

Table 7.1 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 = ID 1,475 = JPY 112 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. ・ Security and insurance costs are included.
5) Price contingency	・ 9.0 percent per annum of price contingency was applied for the local currency portion. ・ 1.7 percent per annum of price contingency was applied for the foreign currency portion.
6) Physical contingency	・ 20 percent of the direct construction cost, administration expenses, and engineering cost was applied for both the local currency and foreign currency.
7) Tax and Duty	・ Custom Duty: 5 percent of CIF Basrah prices of foreign procurements 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.

The project proposed in WSPCB is planned to start with selection of consultant in 2007 and complete in 2015. The preliminary implementation schedule was prepared as shown in Table 7.2.

Table 7.2 Proposed Implementation Schedule

Item	2007		2008		2009		2010		2011		2012		2013		2014		2015	
Loan Arrangement																		
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																		

The estimated costs for the proposed project are summarized in Table 7.3. The total project cost is 1,266 million US$, of which 653 million US$ is the construction cost. Forty percent of the direct cost is occupied by RO plant and 18 % by water treatment plant.

Table 7.3 Capital Cost Estimation

(million US$)

No.	Items	L.C.	F.C.	Total
1.	Direct Construction Cost			
1-1	Rehabilitation of Distribution Network	9.9	11.2	21.1
1-2	Rehabilitation of Water Treatment Plant	1	6.4	7.4
1-3	Construction of Transmission system	29	49.6	78.6
1-4	Construction of Water Treatment Plant	45.4	56.8	102.2
1-5	Construction of Distribution Facilities	79.7	49.8	129.5
1-6	Construction of Reverse Osmosis Plant	14.5	206.3	220.8
	Sub-total (1)	179.5	380.1	559.6
2.	Administration Expenses	36.3	57.8	94.1
	Construction Cost - Sub-total (1) + (2)	**215.8**	**437.9**	**653.7**
3.	Tax and Duty	84.4	0	84.4
4.	Engineering Cost	41.5	56.2	97.7
5.	Price Contingency	189.8	60.1	249.9
6.	Physical Contingency	81.1	99.6	180.7
	Indirect Cost Total	**396.8**	**215.9**	**612.7**
	Total	**612.6**	**653.8**	**1,266.4**

Note: 1. L.C. indicates local currency portion and F.C. indicates foreign currency portion.

7.2 Institutional Capacity Building Programs Cost

Based on the proposed programs and equipment, the capacity development cost is estimated as shown in Table 7.4. The total required cost is 18.3 million US$.

Table 7.4 Capacity Building Cost Estimation

Item	Cost (Million US$)		
	L/C	F/C	Total
Program	9.1	8.2	17.3
Equipment	0	1.0	1.0
Total	9.1	9.2	18.3

Note: Equipment includes computers and leakage detection equipment

7.3 Implementation Cost Schedule

The yearly implementation cost of the construction project and the institutional capacity building programs is estimated as shown in Table 7.5.

Table 7.5 Implementation Cost Schedule

Item	2008	2009	2010	2011	2012	2013	2014	2015	Total
Capital Cost of Construction Project	0.8	6.4	33.3	150.9	139.9	151.0	383.8	400.3	1266.4
Institutional Capacity Building Program	0.0	3.9	2.9	2.9	5.4	3.2	0.0	0.0	18.3

7.4 Operation and Maintenance Cost of the Project

The operation and maintenance (O&M) cost of WSPCB were estimated as shown in Table 7.6 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 the 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 reference, 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

The cost of operation and maintenance for the Basrah water supply system in 2005 is 5 billion ID/annum, out of which only 14 % or 0.7 billion ID was recovered from the water charge. The 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 with operation of on-site generators, BWD requires 54.3 billion ID/year for operation and maintenance and without RO operation and with normal power supply condition, 13.6 billion ID/year.

Table 7.6 Operation and Maintenance Cost of WSPCB by Case in 2015

(Million ID/year)

Item	2005 (Actual)	Normal	Case 1	Case 2	Case 3
Salary	4,419	7,838	7,838	7,704	7,704
Operating budget	350	543	543	543	543
Consumable (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 (equivalent to Million UD$/year)	3.3	20.0	36.2	15.8	9.0

CHAPTER 8 STAGED DEVELOPMENT OF WSPCB

8.1 Development Priority

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. Therefore, a development priority for the WSPCB is prepared with several alternative project packages.

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

Table 8.1 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 water treatment plants (WTP) is not constrained by 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 and quantity of supplied water is not improved. 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 a new WTP should be constructed 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 8.2, which was agreed by 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 they requested that the construction of RO should be given higher priority. Finally, it was given as the third priority.

Table 8.2 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

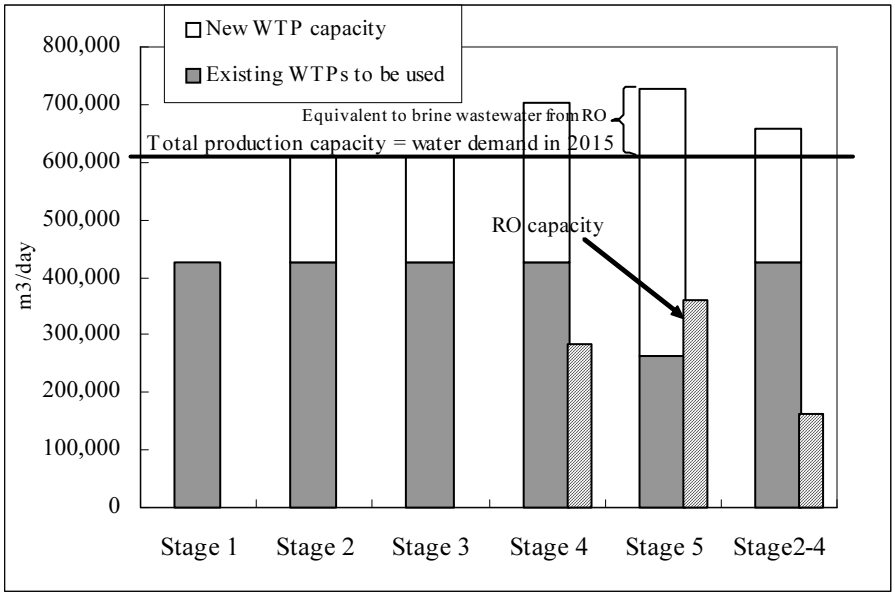
8.2 Staged Development

Based on the priority given, a staged development plan for the proposed water supply system of WSPCB comprising of stage 1 to stage 5 is prepared as shown in Table 8.3 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 relationship among the average day water demand in 2015, the capacity of existing water treatment plants to be used, the capacity of proposed water treatment plant and the capacity of RO plant is illustrated in Figure 8.1.

The stage 2-4 are 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 8.3 Staged Development of WSPCB 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 develop.	Full develop.	Full develop.	Full develop.	Full develop.
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 develop	Full develop	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	Meet the standards	Meet the standards	Meet the standards	Meet the standards	Meet the standards
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: 25% of the treated water injected to RO from conventional water treatment plant is wasted as brine water.

Figure 8.1 Capacity of Existing and Proposed Water Treatment Plants and RO Plant by Stage

The capital cost by stage was estimated at 1,266 Million US$ for the stage 5 and 184 Million US$ for the stage 1 as shown in Table 8.4. If RO with half of the capacity of the stage 4 is introduced, the cost of the stage 2-4 will be 529 Million US$.

Table 8.4 Cost Estimation of Staged Development

(Million US$)

Item	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5 Target of 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 cost is estimated under normal power supply.

CHAPTER 9 PROJECT EVALUATION

9.1 Benefits of the Project

The following table summarizes the existing water supply conditions, the countermeasures to be taken in WSPCB and the project benefits.

Table 9.1 Existing Water Supply Conditions, Countermeasures and Benefits

Problems	Existing Conditions	Countermeasures in WSPCB	Project Benefits
Inadequate water supply quantity (Low pressure)	・The current actual water consumption is very low due to leakage and lack of water treatment capacity ・The average service pressure is negative to about 5 m, depending on the area.	・Expansion of water treatment capacity ・Leakage control ・Restructuring of the transmission and distribution network	・Average water demand will be met but in peak demand period, shortage will occur. ・Water pressure will be at least 15 m in the entire service area.
Inadequate water supply hours	・Less than 6 hr/day of supply hours for 41 % of the surveyed households and more than 6 hours and less than 12hr/day for 25 %	・Restructuring of the transmission and distribution network	・24 hours basically, but at peak hour in peak demand period, shortage will occur. ・Equitable water transmission for the entire project area by efficient water transmission management.
Problems of water supply quality (Taste or high TDS)	・SWC: 670 mg/l ・SAA: 1,500 mg/l	・Construction of RO plant	・Blended water: 600 mg/l SWC: 670 mg/l SAA: 1,500 mg/l RO water: less than 200 mg/l
Problems of water supply quality (Color, turbidity and odor)	・The treated water of most of the treatment plants exceeds the water quality standards in turbidity and color. The treated water of 43 % of the water treatment plants contains E. Coli and it is inappropriate for domestic use.	・Rehabilitation of existing water treatment plants ・Use of adequate chemicals for treatment ・Leakage control measures ・Restructuring of the transmission and distribution network ・Water intake in the upstream of the Shat Al Arab	・The water treatment plants produce the treated water that meets the standards. ・The service pressure will be positive and leakage will be repaired so that contamination in pipes is eliminated.
Inappropriate maintenance of facilities	・The capability of O&M is not sufficient in treatment and leakage control.	・Capacity building program of operation and maintenance	・The capability of O&M will be improved.
Insufficient income	・The current level of revenue water ratio is low, resulting in low level of income	・Non revenue water (NRW) control measures (include leakage control) ・Financial management improvement program	・NRW will be reduced and income will be increased.

9.2 Financial Evaluation

(1) Purpose and Analysis Conditions

Financial evaluation is curried out to judge whether the proposed project is feasible [or profitable] or not or can be run from the financial view point of implementation entities, in this case, MMPW and BWD. Financial evaluation is carried out by calculating financial internal rate of returns (FIRR) based on the estimated project costs and revenue.

Item	Contents
Project life	40 years from 2007
Tariff collection rate	The tariff collection rate will improve from the current 35 % to 60 % in 2015 and 75 % in 2025 and after.
Water tariff level	In addition to the current water tariff level, 50 times and 100 times of the current tariff are used for analysis since the current level is very low to realize the project. Note: As commonly understood, the maximum tariff level for sanitation service including water supply and wastewater disposal should be less than 2 -3 % of the household income.
Project revenue	Water tariff x revenue water volume (revenued-m^3) by the project
Project costs	Capital cost: Direct construction cost, construction administration expenses, engineering cost and tax & duty are included in analysis.
	O&M cost: Normal power supply conditions are adopted for O&M cost
Evaluation criteria	In general, it is recognized by international financial institutions that the project is judged feasible if the FIRR of the project is more than about 10 %. The following are estimation conditions.

Financial analysis was carried out for the projects of the stage 5, stage 3, stage 2, and stage 2-4. In addition, a required water tariff level by which all operation and maintenance cost is covered from water charge is estimated.

(2) Results of Financial Analysis

The results of calculation of financial indicators are summarized in Table 9.2. With the existing tariff level, FIRRs of all stages become negative and the all projects are judged as unfeasible. To make the stage 5 financially feasible, or to obtain more than 10 % of FIRR, the water tariff should be 100 times of the current tariff level, which is equivalent to 11 % of the average household income. The water tariff should be more than 5.5 % of the household income for the stage 3 and the stage 2-4, and 3.9 % for the stage 2. Since the estimated tariff levels are higher than the feasible water tariff level (2 – 3 % of the household income), all stages are judged unfeasible. However, the stage 2 has the highest FIRR and a most preferable stage.

Table 9.2 Calculation Results of Financial Indicators

Case		Water price (US$/ m^3)	FIRR	Proposed price level (Existing price level (EPL))	
				Times of EPL	% of house income
Stage 5	(1)	0.0074	Negative	1	0.11%
	(2)	0.372	Negative	50	5.5%
	(3)	0.743	10.4%	100	11.0%
Stage 3	(1)	0.0074	Negative	1	0.11%
	(2)	0.372	9.8%	50	5.5%
	(3)	0.743	20.7%	100	11.0%
Stage 2	(1)	0.0074	Negative	1	0.11%
	(2)	0.372	15.1%	50	5.5%
	(3)	0.743	27.1%	100	11.0%
	(4)	0.260	10.3%	35	3.9%
Stage 2-4	(1)	0.0074	Negative	1	0.11%
	(2)	0.372	9.5%	50	5.5%
	(3)	0.743	21.0%	100	11.0%

(3) Financial Analysis for Recovery of Operation and Maintenance Cost

In the financial analysis to recover all the costs (capital and operation and maintenance costs) from water tariff collection, all projects are judged unfeasible. In this section, therefore, financial analysis is carried out to estimate a water tariff level, from which operation and maintenance cost is recovered. The following 2 options of generator use are used in the analysis considering the current power supply conditions.

Option 1: 12 hours of generator use (current conditions)
Option 2: No generator use assuming the power supply condition will improve in future

Table 9.3 Required Water Tariff level for O&M Cost Recovery

Case		Water price (US$/Revenue water-$m^3$)	Required tariff level	
			Times of EPL	Percentage of house income
O&M cost recovery with generator option	Stage-5	0.223	30	3.3%
	Stage-3	0.104	14	1.5%
	Stage-2	0.082	11	1.2%
	Stage 2-4	0.126	17	1.9%
O&M cost recovery without generator option	Stage-5	0.149	20	2.2%
	Stage-3	0.052	7	0.8%
	Stage-2	0.052	7	0.8%
	Stage 2-4	0.104	14	1.5%

The estimated tariff level for the stage 5 project is more than 2 - 3 % of the average household income and requires a tariff hike of 20- 30 times of the current tariff. Therefore, the project is evaluated unfeasible. The projects of the stage 2, stage 3 and stage 2-4 are evaluated feasible irrespective of generator use. However, the tariff level of these projects requires an increase of at least 7 times of the

current tariff and therefore a gradual tariff increase may be required considering political stability.

9.3 Economic Evaluation

(1) Purpose and Analysis Conditions

Economic evaluation is carried out to judge whether the proposed projects [or the effect of improved service] is viable or not from the view point of national economy or Iraqi citizen. Economic evaluation is carried out by calculating economic internal rate of returns (EIRR) of the project based on the economic project costs and economic benefits [or willingness to pay/willingness to accept the compensation]. The economic benefits and costs are used in economic evaluation and EIRR is calculated using the net economic benefits and costs with the project minus those without the project. The following are estimation conditions.

<table>
<tr><th>Item</th><th>Contents</th></tr>
<tr><td>Economic Costs</td><td>The following prices of the major construction commodities are converted from financial cost to economic cost.
<table>
<tr><th>Item</th><th>Value</th><th>Contents</th></tr>
<tr><td>Imported materials</td><td>0.97</td><td>Standard conversion factor</td></tr>
<tr><td>Electricity tariff</td><td>0.0093 US$/kWh</td><td>The estimated electricity price without price distortion in Iraq.
・ 0.002 US$/kWh : Existing electricity tariff in Basrah for water supply facilities</td></tr>
<tr><td>Tax and duties</td><td>Deducted</td><td>This item is deducted.</td></tr>
</table></td></tr>
<tr><td>Economic Benefits</td><td>The following table summarizes the adopted economic benefits or willingness to pay and willingness to accept the compensation.
<table>
<tr><th>Item</th><th>Value (US$/capita/month)</th><th>Source</th></tr>
<tr><td>1. Willingness to pay for the current water supply service</td><td>0.21</td><td>JICA socio-economic survey</td></tr>
<tr><td>2. Willingness to pay for the improved service</td><td>0.73</td><td>JICA socio-economic survey</td></tr>
<tr><td>3. Willingness to accept the compensation (2 -3 % of the household income)</td><td>1.41～2.11 US$/capita/month</td><td>Commonly indicated by international institutions</td></tr>
</table></td></tr>
<tr><td>Beneficial Population</td><td>The projected population of WSPCB</td></tr>
<tr><td>Criteria</td><td>In general, it is recognized by international financial institutions that the project is judged viable and most preferable if EIRR of the project is more than about 10 %. But commonly understood, if it is more than 5 % the project could be economically viable.</td></tr>
</table>

(2) Results of Economic Analysis

The results of economic evaluation are shown in Table 9.4. Assuming 3 cases of the economic benefits, The EIRRs of the stage 5 in all cases become negative and the stage 5 is judged economically not viable. The EIRR of the stage 2 is more than 10 % assuming 3 % of the household income. Therefore, the stage 2 is judged economically most viable.

The current willingness to pay for the improved water supply service is 1 % of the household income. The willingness to pay would probably improve depending on the awareness or understanding of customers on the water supply service. To make the project more viable, therefore, the willingness to pay should be enhanced by campaigns such as information, education and communication (IEC) activities by BWD.

Table 9.4 Results of Economic Evaluation

Stage	Economic Costs		Economic Benefits		EIRR
	Without project	With project	Without project	With project	
5	・ Replacement of existing facilities/ equipment after life time use ・ Operation & maintenance of existing water supply system	Construction and O&M of total project components	0.21 US$/ca/month	0.73 US$/ca/month	Negative
				1.41 US$/ca/month	Negative
				2.11US$/ca/month	Negative
3		Construction and O&M of total project components without RO plant		0.73 USD/ca/month	Negative
				1.41 US$/ca/month	Negative
				2.11US$/ca/month	6.3 %
2		Construction and O&M of total project components without RO plant and distribution main facilities		0.73 USD/ca/month	Negative
				1.41 US$/ca/month	5.8 %
				2.11US$/ca/month	11.2 %
2-4		Stage 2 components and half capacity of RO plant		0.73 USD/ca/month	Negative
				1.41 US$/ca/month	Negative
				2.11US$/ca/month	5.9 %

Note: The economic costs with and without project include replacement cost of the existing facilities.

9.4 Evaluation from Customers' Satisfaction

From the JICA socio-economic survey, the problems of water supply service from the customer's perspective by service item were surveyed and dissatisfaction percentage of the respondents was calculated by service item. Using this percentage and assuming 100 % as full improvement of all services, the ratio of improvement of each service is estimated (Table 9.5). This ratio is called improvement contribution factor. Assuming the degree of improvement of service in each stage as shown in the table, total improvement point of each stage was calculated by multiplying the improvement contribution factors by the degree of improvement. For the stage 5, the total improvement point is 100 as all services are improved at 100%. In the stage 1, total improvement point is about 19 % and in the stage 2 it is about 70 %. The capital investment cost per improvement point was calculated to evaluate improvement efficiency as for investment. The unit improvement cost of the stage 2 is the lowest and thus it is judged as the most efficient investment project.

Table 9.5 Calculation of Improvement Points and Capital Cost per Improvement Point by Stage

Service Item	The percentage of respondents who dissatisfy*	Satisfaction contribution factor	Assumed improvement ratio (%)					
			Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 2-4
Amount /pressure	94 %	21.8%	50	80	100	100	100	80
Service hours	67 %	15.5%	50	80	100	100	100	80
Turbidity	89 %	20.6%	0	100	100	100	100	100
Taste (salinity)	97 %	22.5%	0	0	0	100	100	50
Odor	85 %	19.7%	0	100	100	100	100	100
Total	-	100.0%						
Item			Satisfaction points					
Amount/pressure			10.9	17.4	21.8	21.8	21.8	17.4
Service hours			7.8	12.4	15.5	15.5	15.5	12.4
Turbidity, color			0	20.6	20.6	20.6	20.6	20.6
Taste (salinity)			0	0	0	22.4	22.4	11.2
Smell			0	19.7	19.7	19.7	19.7	19.7
Total (Improvement points)			18.7	70.1	77.6	100	100	81.3
Cost for improvement			Capital cost (Million US$)					
			184	329	687	1,118	1,266	529
Cost to gain 1 point			Cost to gain improvement 1 point (Million US$/point)					
			9.8	4.7	8.9	11.2	12.7	6.5

* The study team socio-economic survey

9.5 Environmental and Social Considerations for WSPCB

Potential environmental impacts by the implementation of WSPCB have been identified based on the field surveys and data collection by the local subcontractor. As a result of the evaluation, no significant impact of the proposed plan was identified. However, the following some possible minor impacts are identified.

Project Component	Possible Impact
1. Rehabilitation of distribution networks	・ When the existing pipe is replaced, it may cause health hazard of workers in cutting, transporting and disposing of asbestos cement pipe (ACP). The impact is avoidable with appropriate measures.
2. Rehabilitation of existing water treatment plants	・ No impact
3. Construction of transmission system	・ No impact
4. Construction of new water treatment plant	・ Impact of sludge disposal is considered but judged minor.
5. Construction of RO	・ The wastewater discharged from RO plant may cause pollution of the river environment but it is judged minor.
6. Construction of main distribution facilities (13 zones)	・ According to selection of the land for the proposed facilities, resettlement of residents can be avoided but land acquisition may be required.

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS OF WSPCB

10.1 Conclusions and Recommendations

The Water Supply Plan for the Central Basrah (WSPCB) targeting the year 2015 with a staged development plan was formulated in this report. The results of the study were summarizes as follows:

1. The planning area includes the central Basrah comprising Al Basrah district center and Al Hartha center and rural area, with a population of 1,257,000 and the average day water demand of 608,000 m^3/day in 2015.

2. The major components of the WSPCB are as follows:

Facilities	Capacity/Quantity
1. Rehabilitation of network	Dia.110 mm - 700 mm, 285 km
2. Rehabilitation of water treatment plant (WTP)	13 plants in Central Basrah (424,400 m^3/day) Note: Finally, only 3 plants will be utilized (264,000 m^3/day)
3. Treated water transmission system	
(1) Transmission reservoir (TR)	64,000 m^3
(2) Transmission pumping station (TPS)	710,000 m^3/day x 40 m head
(3) Ring mains and connections to MDF	Dia.600 mm - 2000 mm, 33,000 m
4. New water treatment plant	
(1) Treatment plant	465,000 m^3/day
(2) Treated water pumping station	369,000 m^3/day x 40 m head
5. Main distribution facilities (MDF)	13 water distribution zones
(1) Strengthening of distribution mains	Dia.200 mm - 700 mm, 25,100 m
(2) Distribution reservoir (for 12 zones)	186,000 m^3 in total
(3) Transfer pumping station (for 12 zones)	945,000 m^3/day (39,800 m^3/hr) in total
(4) Elevated tank (for 12 zones)	12,300 m^3 in total
6. Reverse osmosis plant	362,000 m^3/day (output)

Note: one of the 13 main distribution facilities is now under construction.

In addition, the execution of following programs was proposed to strengthen the capacity of the Basrah Water Directorate (BWD) and thus to establish the sound and sustainable water supply operations.

(1) Non-revenue water reduction program

(2) Organization and institutional capacity building program

3. It was confirmed that the WSPCB could be considered as part of the Mini M/P, which is targeted for the year 2025. The WSPCB comprises of the most urgent and higher priority components in the Mini M/P and all the facilities proposed in WSPCB will be integrated with the water supply system proposed in the Mini M/P.

4. The total cost of the WSPCB was estimated at 1,266 million US$, comprised of 559 million US$ as direct construction cost and the rest as indirect cost.

5. It is proposed that the WSPCB be developed in several stages as the total project of WSPCB is considerably large in capital cost and the number of components and it is possible to implement by component.

6. Considering the problems of water supply service from the customers' perspective identified in the socio-economic survey and a required sequence for construction, the following 5 stages are proposed.

Stage 1:	Rehabilitation of distribution network and construction of transmission system
Stage 2:	Stage 1 components and rehabilitation of existing water treatment plants and construction of a new water treatment plant
Stage 3:	Stage 2 components and construction of main distribution facilities (13 distribution zones)
Stage 4:	Stage 3 components and construction of a new RO plant and expansion of the new water treatment plant as pretreatment of RO
Stage 5:	Stage 4 components and expansion of the RO plant and the water treatment plant to compensate the treatment capacity of existing water treatment plants (10 plants) to be abandoned

7. Upon discussion with the Iraqi side, following stage 2-4 including requirement of TDS improvement was added as a strong request of the Iraqi side.

Stage 2-4:	Stage 2 components and construction of half capacity of RO plant of the stage 4

After further discussions and considering an adequate project scale, stage 1, stage 2 and stage 2-4 were selected as candidates of the priority project.

8. The current cost of annual operation and maintenance for the Basrah water supply system is 5 billion ID, out of which only 14 % or 0.7 billion ID was recovered from the water charge. The total project requires 30.0 billion ID for annual operation and maintenance with normal power

supply conditions, and 54.3 billion ID by half day power supply using on-site generators and half day normal power supply reflecting the existing power supply conditions.

9. As a result of financial evaluation, with the existing tariff level, FIRRs of all stages become negative and all projects are judged as unfeasible. To make the stage 5 financially feasible, or to obtain more than 10 % of FIRR, the water tariff should be 100 times of the current tariff level, which is equivalent to 11 % of the average household income. The water tariff should be more than 5.5 % of the household income for the stage 3 and the stage 2-4, and 3.9 % for the stage 2. Since the estimated tariff levels are higher than the feasible water tariff level (2-3 % of the household income), all stages are judged unfeasible. However, the stage 2 has the highest FIRR and a most preferable stage.

10. Judged from the tariff levels, by which the only operation and maintenance cost is recovered, the stage 5 project is evaluated unfeasible and the projects of the stage 2, stage 3 and stage 2-4 are evaluated feasible. However, the tariff level of these projects requires a increase of at least 7 times of the current tariff and therefore a gradual tariff increase may be required considering political stability.

11. As a result of economic evaluation, the implementation of the stage 5 is not economically viable. However, the projects of the stage 3, stage 2-4 and stage 2 are economically viable assuming 3 % of the household income for the willingness to accept the compensation for the improved service. The project of the stage 2 gives the highest economic internal rate of return (EIRR) of 11.2 %.

10.2 Selection of Priority Project

Three candidates of the priority projects are the stage 1, stage 2 and stage 2-4, which were agreed between the study team and the Iraqi side.

As a result of comparison of construction and operation & maintenance costs and benefits of the project stages, the following were found:

- The benefit of the stage 1, which mainly improves water transmission and distribution system, is not enough since the supply quantity meets only 70 % of the water demand.
- The stage 2 includes improvement of water transmission and distribution system, rehabilitation of the existing water treatment plants and expansion of water treatment capacity. The project meets the water demand although a complete stable distribution through service reservoirs and elevated towers is not achieved, and it improves the water quality in terms of turbidity, color, odor and bacterial pollution except TDS.
- The stage 2-4, which includes RO plant in addition to the stage 2 components, improves the water quality in terms of TDS to some extend.

The stage 2-4 would be selected as the priority project if the estimated TDS improvement is considered to count for additional project cost of 200 million US$, the burden for the operational and maintenance costs and challenges for the difficult RO operations.

It is true that the customers are expecting the improvement of water supply service including TDS reduction but their first priority for improvement is the water quantity and the water quality comes later.

The study team wished to conclude that the estimated TDS improvement would be not enough and thus does not overcome other disadvantages, and to select the stage 2 as the priority project.

However, as the Iraqi side strongly claimed residents' desires for the TDS improvement, it was agreed that the stage 2-4 be selected as the priority project for feasibility study on the condition that RO component would be possibly excluded from the Japanese Yen loan component when the project will be appraised by Japanese government for application of Japanese Yen loan.

CHAPTER 11 FEASIBILITY STUDY FOR PRIORITY PROJECT

11.1 Priority Project Components

The stage 2-4 of the Water Supply Plan for Central Basrah (WSPCB) was selected as the priority project for feasibility study (F/S). The project components of the stage 2 are explained in the following table comparing to those of WSPCB.

Priority Project Component	Relationship between priority project and WSPCB
(1) Rehabilitation of distribution network	・ Same as WSPCB (stage 5).
(2) Rehabilitation of existing water treatment plants	・ Same as WSPCB (stage 5).
(3) Construction of a water treatment plant (WTP)	・ Construction of the part of the water treatment plant proposed in WSPCB (stage 5).
(4) Construction of a reverse osmosis (RO)	・ Construction of half capacity of RO facilities of the stage 2-4.
(5) Construction of water transmission system	・ Main transmission facilities: Construction of part of the WSPCB (stage 5) ・ Transmission mains: Same as WSPCB (stage 5) ・ Connection mains will be constructed to connect between the existing WTP and transmission mains
(6) Strengthening of distribution mains and creation of 13 distribution zones	・ Distribution zones: Delineation of 13 zones ・ Distribution mains: Same as WSPCB (stage 5) ・ Main Distribution Facilities: Not construction.
(7) Institutional capacity building program	・ Higher priority programs shall be implemented to increase the capacity of Basrah Water Directorate (BWD) for operation and maintenance of the facilities constructed.

11.2 Design Conditions

Item	Contents
(1) Design criteria	・ The same design conditions as in WSPCB are used for the priority project as shown in Table 3.3.
(2) Estimated water demand	・ The same water demand projection in WSPCB was used. ・ 13 distribution zones and 6 sub-zones were set in WSPCB. The water demand by zone is shown in Table 3.11 and Figure 3.1.
(3) Existing water supply facilities utilized	・ 3 existing water treatment plants will be utilized in WSPCB but all 13 existing WTP will be utilized in the priority project.
(4) Water demand and supply balance	・ The same water demand as in WSPCB is adopted. In WSPCB, 3 existing WTPs are planned to be utilized but all 13 existing WTPs are planed to be utilized in the priority project. Therefore, the water supply regarding this part is different from that of WSPCB. The water flow balance of the priority project is shown in Figure 11.1.

11.3 Proposed Facilities

The proposed water supply system of the priority project is shown in Figure 11.2 and the summary of proposed water supply facilities of the priority project is shown in Table 11.1. The proposed layout of the water treatment facilities was decided as illustrated in Figure 11.3 and Figure 11.4. The transmission mains and distribution mains were designed to ensure appropriate distribution pressure in the network using network analysis. The layout of the proposed main transmission facilities (reservoir, pumping station and control room) is shown in Figure 11.5. The proposed transmission system and required strengthening of distribution mains are shown in Figure 11.6 and Figure 11.7, respectively.

Table 11.1 Summary of Proposed Water Supply Facilities

Project component	WSPCB (Stage 5)	Priority project (Stage 2-4)
1. Rehabilitation of network	Dia.110 mm - 700 mm, 285 km	Dia.110 mm - 700 mm, 285 km
2. Rehabilitation of water treatment plant (WTP)	13 plants (424,400m^3/day) Note: finally only 3 WTPs (264,000 m^3/day) will be utilized.	13 plants (424, 400m^3/day)
3. Transmission system		
(1) Transmission reservoir (TR)	64,000 m^3	48,000 m^3
(2) Transmission pumping station (TPS)	710,000 m^3/day x 40 m head Note: The water is supplied to customers through the main distribution facilities.	538,000 m^3/day x 60 m head Note: The water is supplied directly from TPS to customers without the main distribution facilities.
(3) Ring mains and connections	Dia.600 mm - 2000 mm, 33,000 m	Dia.600 mm - 2000 mm, 35,200 m Note: Connection mains from the existing WTPs to transmission mains are included.
4. New water treatment plant		
(1) Treatment plant	465,000 m^3/day	245,000 m^3/day
(2) Treated water pumping station	369,000 m^3/day x 40 m head	192,000 m^3/day x 40 m head
5. RO plant	362,000 m^3/day (output)	145,000 m^3/day (output)
6. Distribution Facilities *	13 water distribution zones	13 water distribution zones
(1) Strengthening of distribution mains	Dia.200 mm-700 mm, 25,100 m	Dia.200 mm-700 mm, 25,100 m
(2) Distribution reservoir (for 12 zones)	186,000 m^3 in total	-
(3) Transfer pumping station (for 12 zones)	945,000 m^3/day (39,800 m^3/hr) in total	-
(4) Elevated tank (for 12 zones)	12,300 m^3 in total	-

Note: * One zone is under construction.

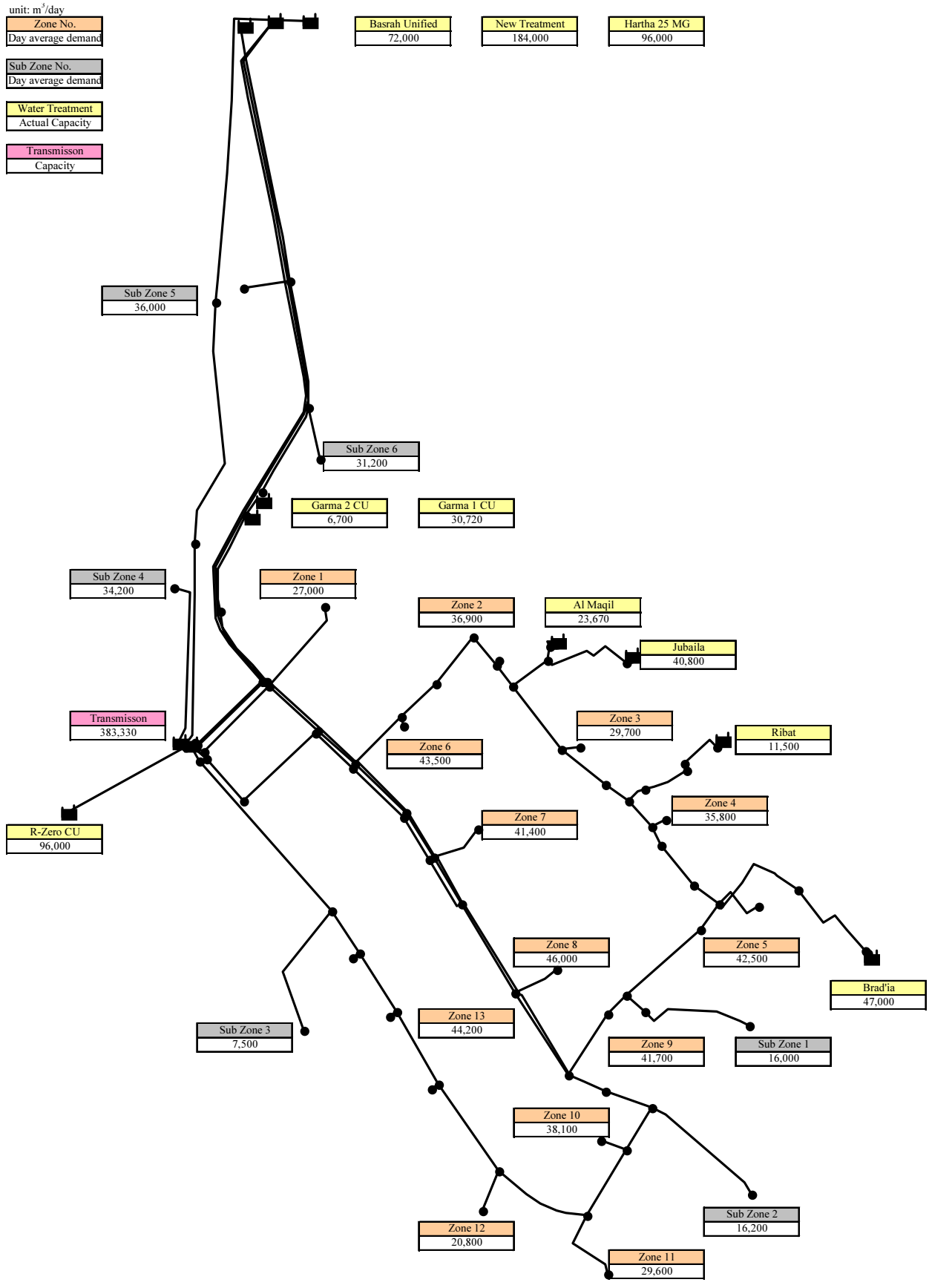
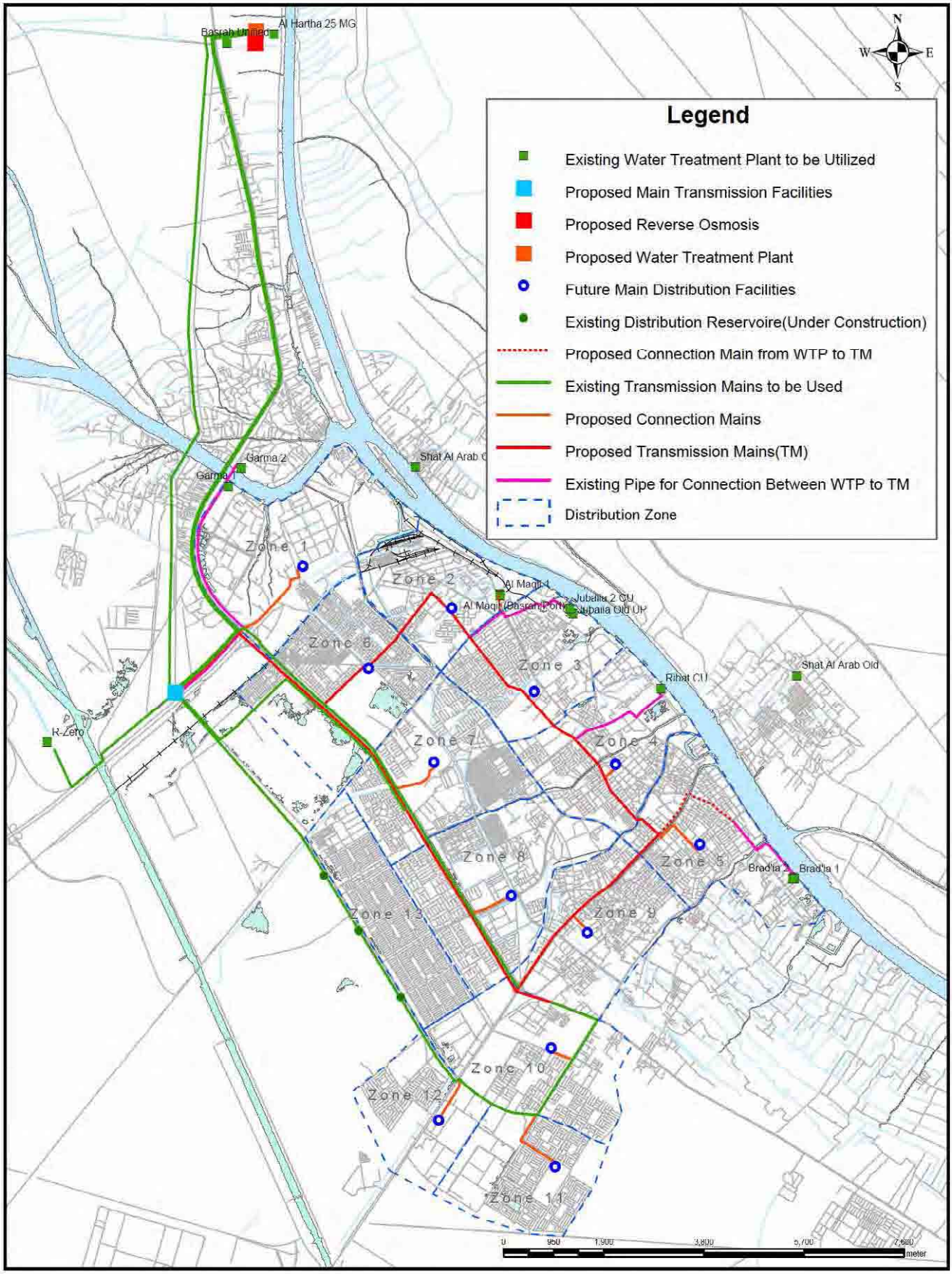


Figure 11.1 Design Flow Balance of Priority Project



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	**Proposed Water Supply System of Priority Project**	**Fig No.** 11.2

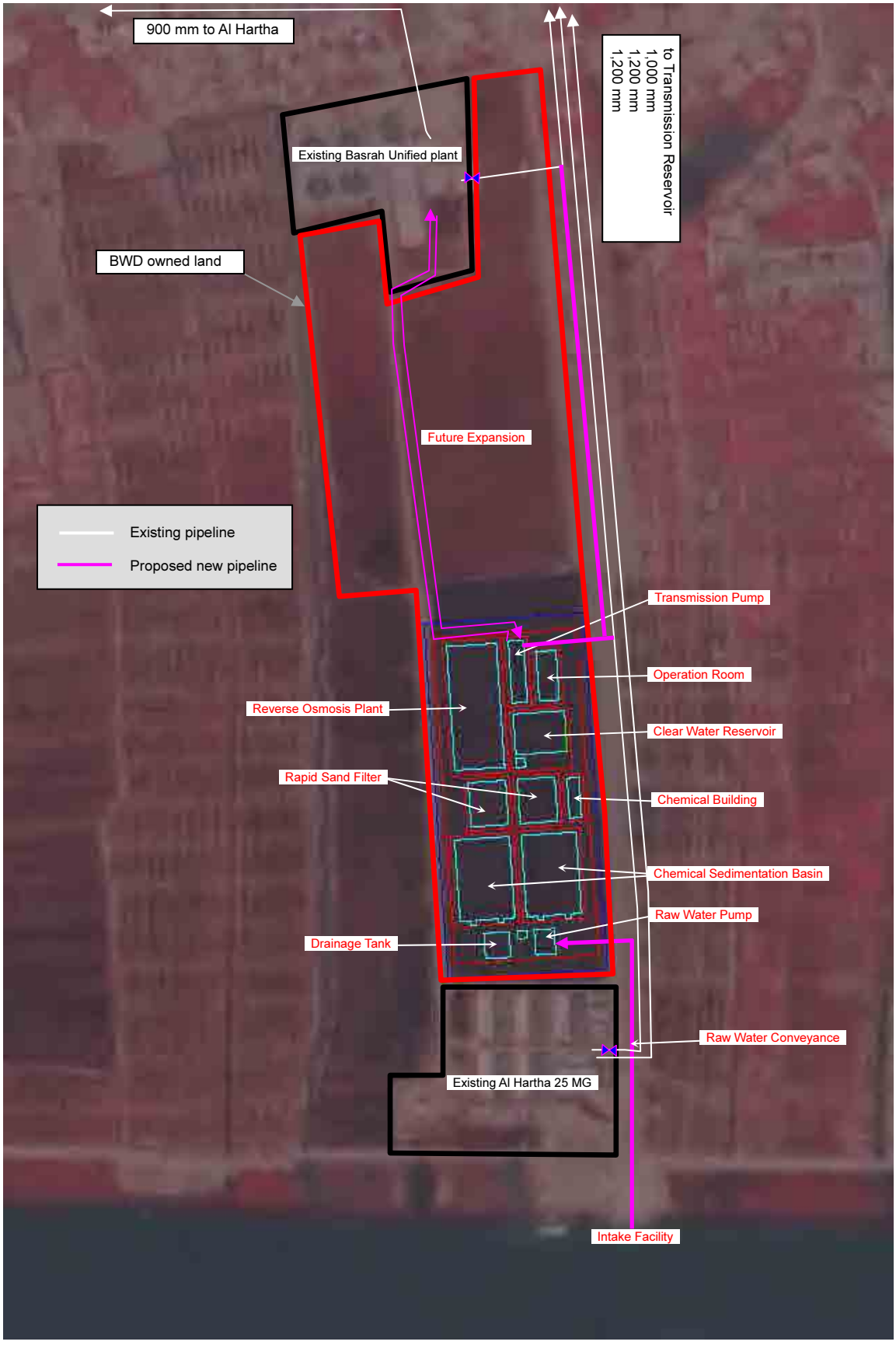
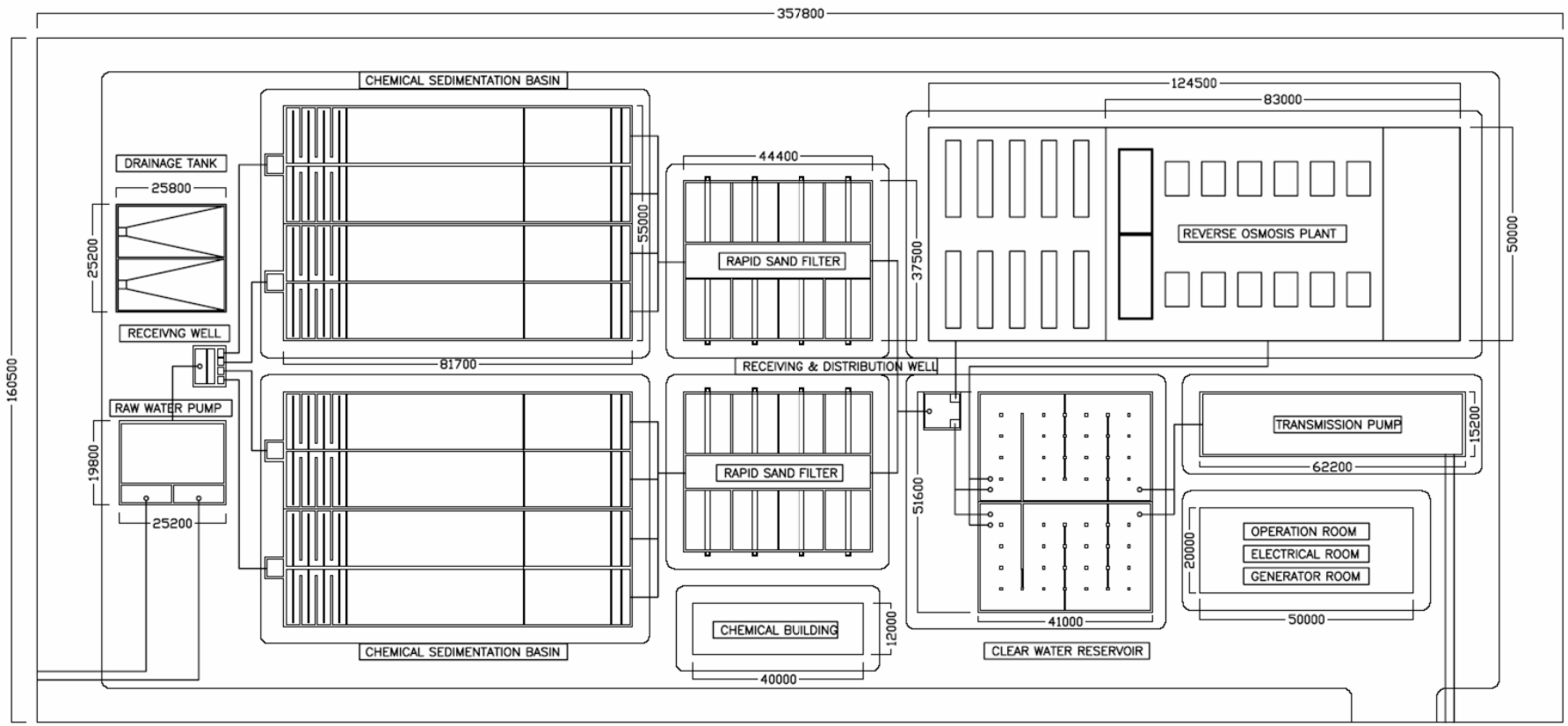
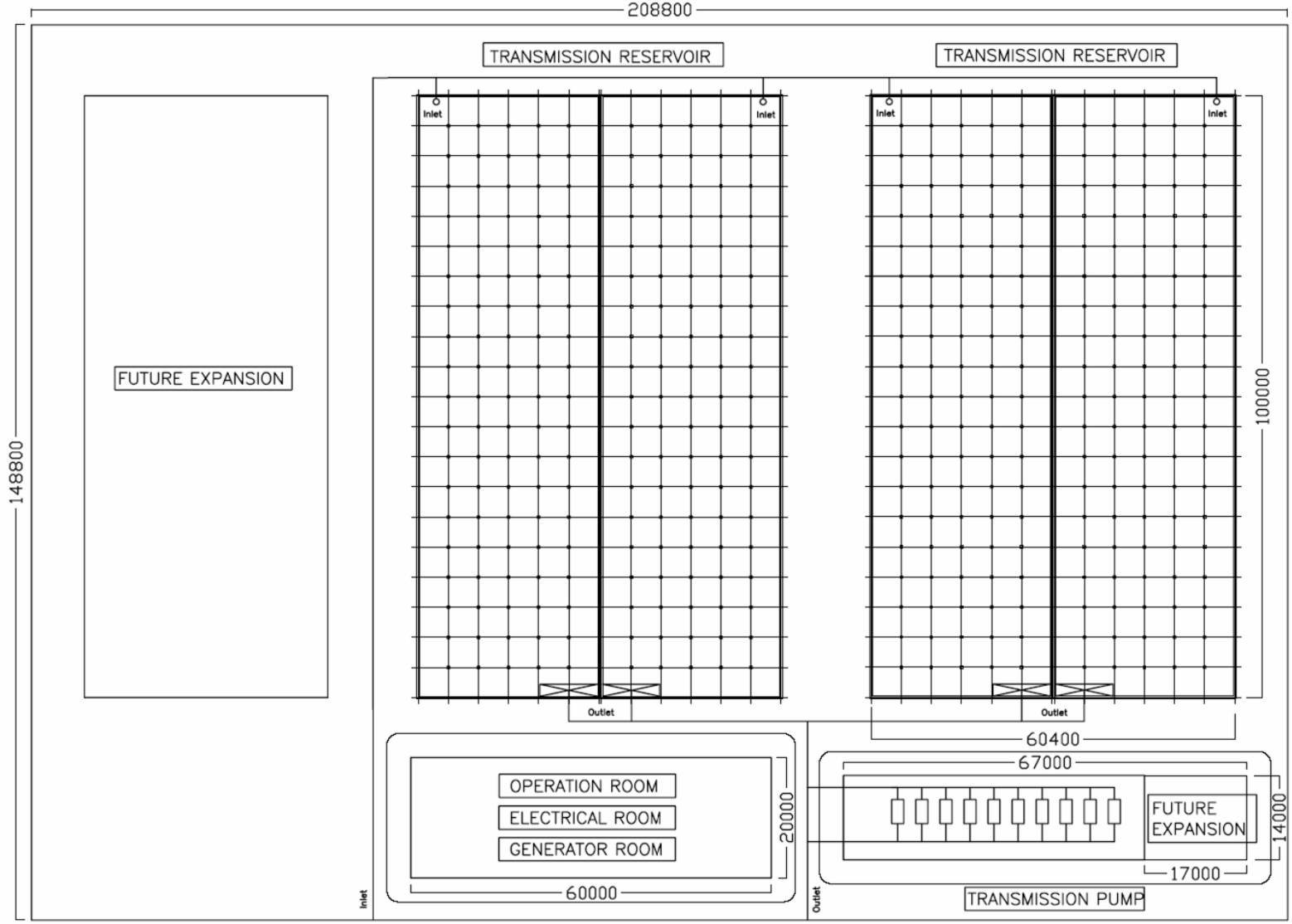


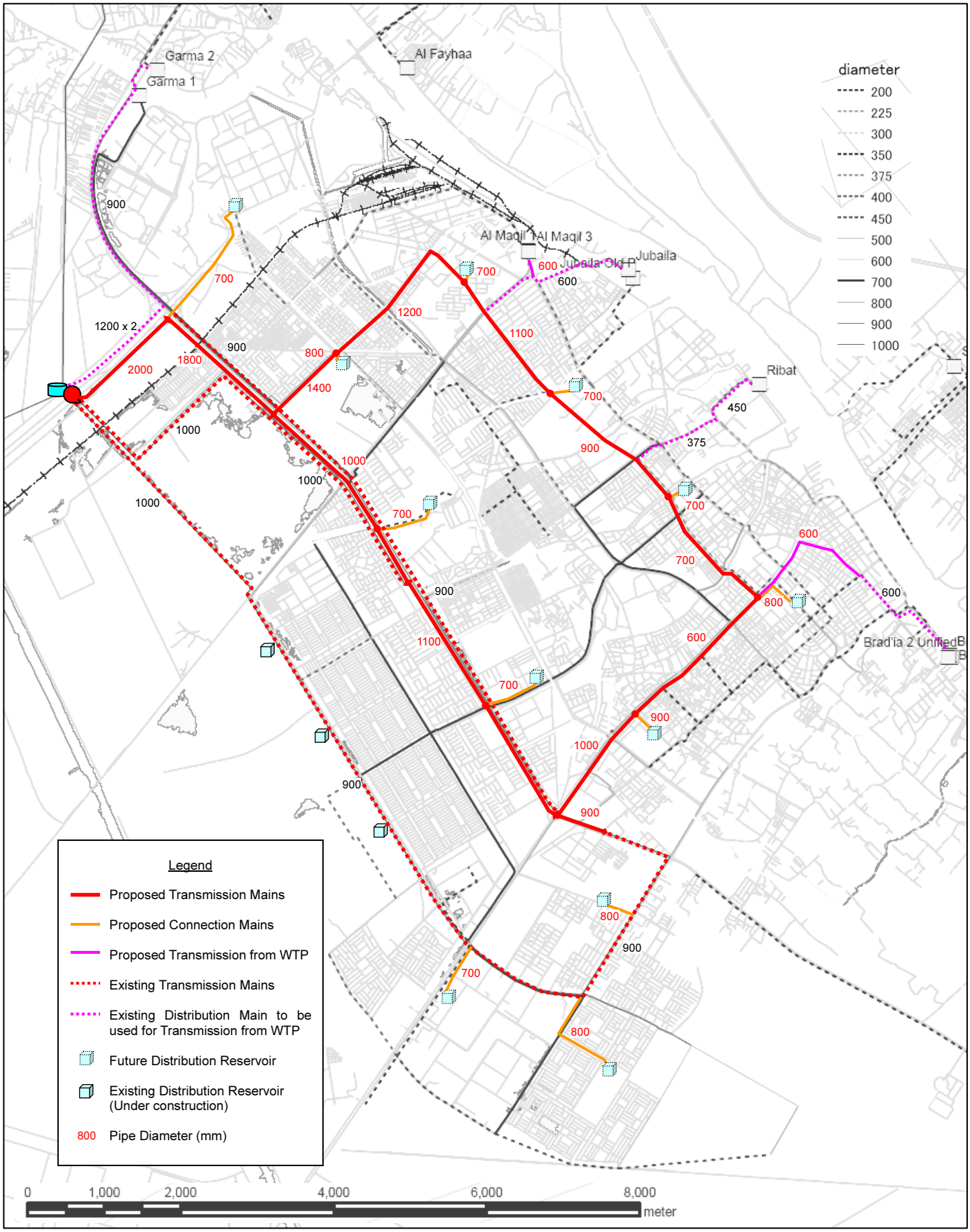
Figure 11.3 Layout of New Treatment Plant (Priority Project)



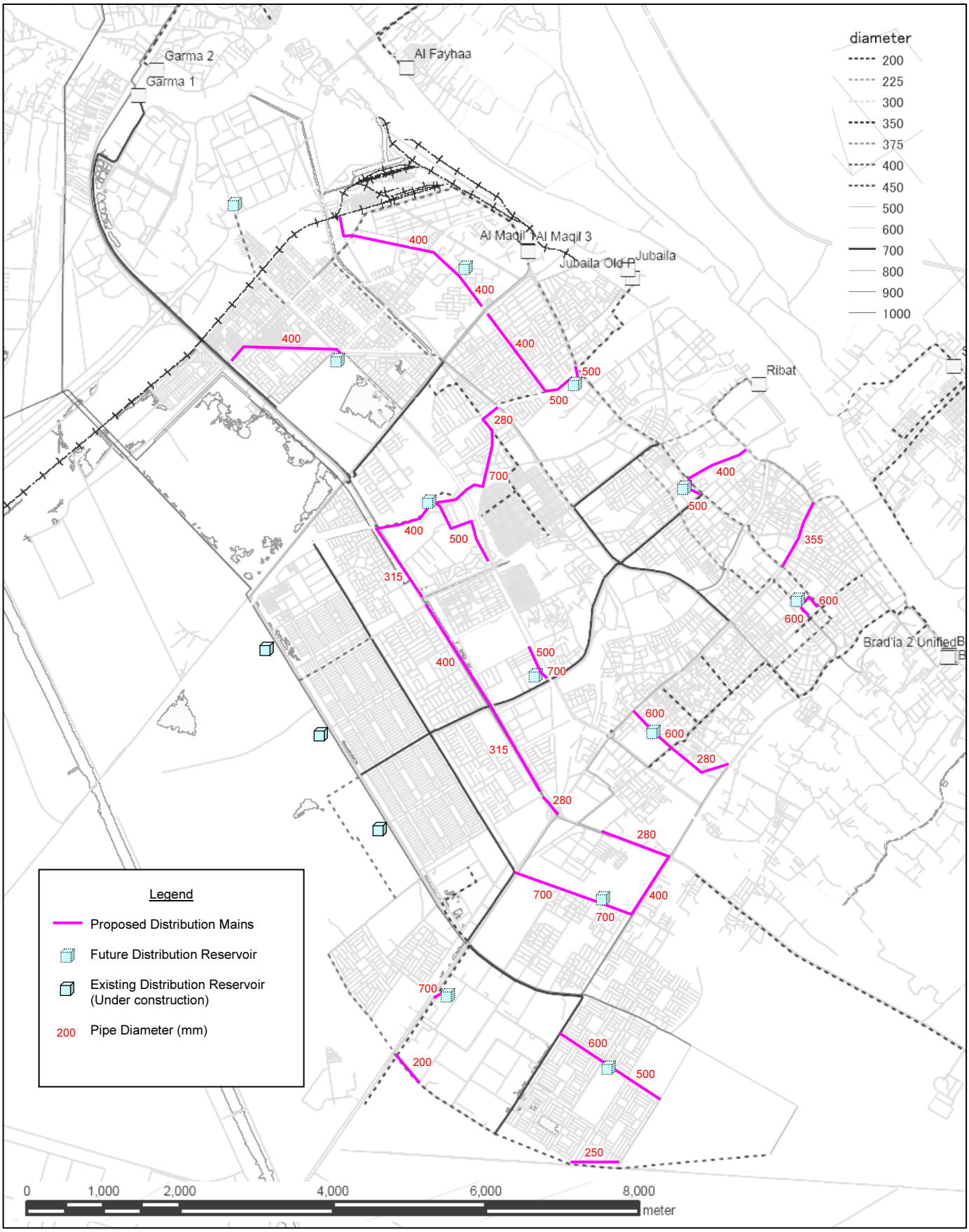
The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq	General Layout of New Water Treatment Plant	Fig No. 11.4



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. 11.5



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq	Proposed Transmission System for Priority Project with Existing Transmission Mains (Priority Project)	Fig No. 11.6



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Surroundings in the Republic of Iraq	Proposed Distribution Mains for Strengthening of Existing Distribution Network (Priority Project)	Fig No. 11.7

11.4 Institutional Capacity Building for Priority Project

In the 5 strategies proposed in WSPCB, implementation of the strategies D and E are of most importance for appropriate operation & maintenance for the facilities proposed in the priority project and thus these strategies were focused as the priority capacity building target.

Strategy-D: Establishment of efficient and effective operation & maintenance system
Strategy-E: Ensuring adequate budget for O&M toward an autonomous and unified administration body

The components of the required training for the capacity building programs identified preliminarily in this study are summarized in Table 11.2.

Table 11.2 List of Required Training Programs

No.	Programs	Objectives	Strategy
1.	Operation and maintenance (O&M) for water production and distribution	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 their proper operation • Training on water distribution management • Training on metering system	D
2.	NRW control (technical)	Improve skills needed to minimize NRW as follows: • Training on leakage control method • Training on method to reduce the illegal connection	D&E
3.	NRW control (non technical)	Improve skills needed to minimize NRW as follows: • Training on awareness method to reduce the illegal connection	E
4.	Customer service relations	Improve the handling of all requests from customers and promote PR	E
5.	Awareness campaign for tariff collection	Improve the condition of tariff collection. • Training on how to carry out the awareness campaign on significance of payment	E
6.	Sales promotion	Improve the condition of tariff collection. • Training on how to carry out the sales promotion for water	E
7.	Financial management	Improve the financial management system. • Financial accounting • Managerial accounting • Budget management	E
8.	Computer and GIS training	• Learning basic computer skills for daily work	D&E

11.5 Implementation Plan and Cost Estimation for Priority Project

The implementation schedule for the priority project and capacity building programs was rearranged from the schedule established in WSPCB, considering the reduced scope of the priority project. The

implementation schedules are prepared as shown in Table 11.3 for the priority project and Table 11.4 for the capacity building programs.

Table 11.3 Proposed Implementation Schedule for Priority Project

Item	2007		2008		2009		2010		2011		2012		2013	
Loan Negotiation														
Selection of Consultant														
Detailed Design														
Tendering														
Rehabilitation of Distribution Network														
Rehabilitation of WTP														
Construction of Transmission System														
Construction of Water Treatment Plant														
Restructuring of Distribution Network and Zoning														
Construction of RO Plant														

Table 11.4 Proposed Implementation Schedule for Capacity Building Training Programs

No.	Program	2008	2009	2010	2011	2012	2013
1	O&M for water production and distribution						
2	NRW control (technical)						
3	NRW control (non technical)						
4	Customer service relations						
5	Awareness campaign						
6	Sales promotion						
7	Financial management						
8	Computer and GIS training						

Based on the same cost estimation conditions as in WSPCB, the costs for the priority project and capacity building programs has been estimated and summarized in Table 11.5 and the yearly implementation cost was estimated as shown in Table 11.6.

The direct construction cost and administration expenses constitute 57 % of the total cost. Of the direct construction costs, 35 % is occupied by construction of RO plant, 29 % by construction of water treatment plant and 21% by construction of transmission system.

Table 11.5 Capital Cost Estimation

(Million US$)

No.	Items	L.C.	F.C.	Total
Capital Cost				
1.	Direct Construction Cost			
1-1	Rehabilitation of Distribution Network	9.9	11.2	21.1
1-2	Rehabilitation of Water Treatment Plant	1	6.4	7.4
1-3	Construction of Transmission system	24.3	54.9	79.2
1-4	Construction of Water Treatment Plant	23.4	34.2	57.6
1-5	Restructuring Distribution Network and Zoning	3.8	7.2	11.0
1-6	Construction of Reverse Osmosis Plant	5.1	89.9	95.0
	Sub-total (1)	67.5	203.8	271.3
2.	Administration Expenses	15.8	31.8	47.6
	Sub-total (1+2)	**83.3**	**235.6**	**318.9**
3.	Tax and Duty	42.1	0.0	42.1
4.	Engineering Cost	13.6	29.2	42.8
5.	Price Contingency	54	24.6	78.6
6.	Physical Contingency	27.4	52	79.4
	Sub-total (3+4+5+6)	137.1	105.8	242.9
Total		**220.4**	**341.4**	**561.8**
Institutional capacity Building Program		5.0	8.6	13.6

Table 11.6 Yearly Implementation Costs of the Priority Project

Item	2008	2009	2010	2011	2012	2013	Total
Direct construction works	0.0	0.0	16.9	111.0	94.1	96.9	318.9
Indirect Construction works	0.8	8.0	18.4	73.6	67.0	75.1	242.9
Total capital cost	0.8	8.0	35.3	184.6	161.1	172.0	561.8
Capacity building program	3.2	5.2	3.0	0.2	0.2	1.8	13.6

11.6 Operation and Maintenance Cost of the Project

Based on the same cost estimation conditions as the WSPCB, the annual operation and maintenance cost of BWD for 2015 was estimated as shown in Table 11.7. The current average hours of power supply is 12 hours for water supply facilities in Basrah due to shortage of power supply. Considering the current condition, two cases were considered for estimation of operation and maintenance cost. It is assumed that this condition will continue in future in the case 1 and the power supply conditions will improve in future in the case 2.

Table 11.7 Annual Operation and Maintenance Cost of the Priority Project in 2015

(Million ID/year)

Item	Case 1 Generator : 12 hrs use	Case 2 Generator : No use
Salary	7,430	7,430
Operating budget	543	543
Electricity	11,801	505
Consumable (Chemicals for WTP)	1,505	1,505
Consumable (Chemicals for RO)	2,105	2,105
Consumable (Membrane)	5,541	5,541
Other consumables(Maintenance)	3,269	3,269
Others	74	74
Total (Million ID/year)	32,268	20,972
Total (equivalent to Million UD$/year)	21.5	14.0

11.7 Project Evaluation

(1) Project Benefits

The following table summarizes the existing issues of water supply, the existing conditions of the water supply and the benefits of the priority project.

Table 11.8 Benefits of the Proposed Projects

Issue	Existing Conditions (Without Project)	Benefits (With Project)
Inadequate water supply quantity (Low pressure)	・The current actual water consumption is very low due to leakage and insufficient water treatment capacity ・The average service pressure is negative to about 5 m, depending on the area.	・Per capita water consumption of 300 l/ca/day for Basrah municipality, 260 l/ca/day for Hartha center and, 200 l/ca/day for Hartha rural is assured. ・Average water demand will be met but in peak demand period minor shortage may occur. ・Service pressure will be at least 15 m in the entire project area.
Inadequate water supply hours	・Less than 6 hr/day for 41 % of the surveyed households and 6 - 12 hr/day for 25 %	・24 hours continuous sully basically, but at peak hour in peak demand period some shortage may occur ・Equitable water transmission for the entire project area by efficient water transmission management.
Problems of water supply quality (Taste or high TDS)	・SWC: 670 mg/l ・SAA: 1,500 mg/l	・Average: 894 mg/l (after mixing) SWC: 670 mg/l SAA: 1,500 mg/l RO water: below 200 mg/l
Problems of water supply quality (Color, turbidity and odor)	・The treated water of most of the treatment plants exceeds the water quality standards in turbidity and color. The treated water of 43 % of the water treatment plants contains E. Coli and is inappropriate for domestic use.	・The water treatment plants will produce the treated water that meets the standards. ・The service pressure will be positive and leakage will be repaired so that contamination in pipes will be eliminated.
Inappropriate maintenance of facilities	・The capability of O&M is low in treatment and leakage control.	・The capability of O&M will be improved.
Insufficient income	・The current level of revenue water ratio is low, resulting in low level of income	・NRW will be reduced and income will be increased.

(2) Customer's Satisfaction

Based on the results of socio-economic survey and the concept pf satisfaction contribution factors that was introduced in evaluating WSPCB, customer's satisfaction by the priority project are evaluated as shown in Table 11.9. Assuming the improvement degree of this project as shown in the table, total improvement ratio or total customer satisfaction ratio is calculated as 81.3 % for the priority project. It means that if the current satisfaction is zero, this project contributes to increasing customer's satisfaction to 81 %. The customer's satisfaction will reach to 100 % if the stage 5 of the WSPCB is implemented.

Table 11.9 Calculation of Customers' Satisfaction by Priority Project

Service Item	The ratio of respondents who complained *	Satisfaction contribution factor	Assumed improvement degree by service item (%)	Total improvement (Customer satisfaction) (%)
Amount /pressure	94 %	21.8%	80	17.4
Service hours	67 %	15.5%	80	12.4
Turbidity	89 %	20.6%	100	20.6
Taste (salinity)	97 %	22.5%	50	11.2
Smell	85 %	19.7%	100	19.7
Total	-	100.0%	-	**81.3**

* JICA study team socio-economic survey

(3) Financial Evaluation

1) Evaluation Conditions

The same evaluation conditions as the WSPCB were adopted for financial evaluation for the priority project. In the analysis following options regarding input of subsidy to the project in addition to the generator use option are considered with following grounds.

Input of Subsidy	・ The northern and central parts of Iraq do not suffer from high TDS. ・ Only the southern part of Iraq suffers from high TDS water supply. ・ The TDS increase in the rivers is caused by discharge of high salinity contents at the upstream area, i.e., northern and central part of Iraq. ・ Considering this fact, the measures to decrease TDS to the equitable level in the country should be undertaken by the central government as national policy concerns. ・ The study team recommends that the costs relating reverse osmosis (RO) as a TDS reduction measure be covered by the central government subsidy in line with national policy. ・ Therefore, following 2 options are considered in analysis. Option 1: Without government subsidy for the costs related to RO Option 2: With government subsidy for the costs related to RO
Generator Use	・ Currently, the normal power supply is available only for half a day. Therefore, following two options are considered in the analysis. Option 1: 12 hours of generator use (requires expensive fuel) Option 2: No generator use assuming the power supply condition will be improved in near future
Estimated Subsidy Amount	(billion ID/year (million US$/year))

Item	Total O&M cost	RO O&M cost for subsidy	Other O&M cost
With using generator	28.7 (19.1)	14.0 (9.3)	14.7 (9.8)
Without using generator	17.4 (11.6)	7.8 (5.2)	9.6 (6.4)

2) Result of Financial Analysis

Financial indicators were calculated assuming the total project costs, comprising capital and operation & maintenance costs should be recovered from water charge collection only. The results of calculation

of financial indicators are summarized in Table 11.10.

The estimated water tariffs which return more than 10 % of FIRR vary from 4.0 % to 6.9 % of the average household income, which are more than 2 % to 3 % of the average income or the assumed upper limit of water and sewerage tariff for a household. Therefore, the project in all cases is evaluated not financially feasible.

Table 11.10 Calculation Results of Financial Indicators (Full cost recovery)

Case	Water tariff (US$/ revenue-$m^3$)	Net Present value (M US$)	FIRR	B/C ratio	Required tariff level	
					multiple of the current tariff level	% of the household income
Case 1 Without subsidy and with generator	0.0074	-369	-	0.016	1	0.11 %
	0.372	-76	6.9%	0.798	50	5.5%
	0.468	2	**10.1%**	1.005	63	6.9%
	0.743	223	17.3%	1.596	100	11.0 %
Case 2 Without subsidy and without gen.	0.0074	-328	-	0.018	1	0.11 %
	0.372	-35	8.6%	0.895	50	5.5%
	0.416	1	**10.0%**	1.002	56	6.2%
	0.743	215	16.1%	1.560	100	11.0 %
Case 3 With subsidy and with gen.	0.0074	-227	-	0.026	1	0.11 %
	0.290	0	**10.0%**	0.999	39	4.3%
	0.372	66	13.4%	1.281	50	5.5%
	0.743	365	25.4%	2.561	100	11.0 %
Case 4 With subsidy and without gen.	0.0074	-209	-	0.028	1	0.11 %
	0.267	0	**10.0%**	1.001	36	4.0%
	0.372	84	14.3%	1.390	50	5.5%
	0.743	383	26.1%	2.780	100	11.0 %

3) Financial analysis for Recovery of Operation and Maintenance Cost

In Iraq, as the water supply bodies are heavily subsidized from the central and local governments and the water tariff is set at a very low level, the water supply bodies cannot cover their operation and maintenance cost by the revenue collected from water charge.

As shown in the results of the calculation above, the projects were judged unfeasible in case if both of the capital and operation & maintenance costs shall be covered by the revenue collected from water charge. In this section, therefore, an analysis is made to estimate a water tariff level at which only operation and maintenance cost shall be covered. In this case, FIRR is not calculated since there is no capital investment. Table 11.11 shows the results of the analysis.

Table 11.11 Estimated Water Tariff for Recovery of Operation and Maintenance Cost

Case	Description	Water tariff (US$/ revenue-$m^3$)	Required tariff level	
			multiple of the current tariff level	% of the household income
Case 1	Without subsidy and with generator	0.126	17	1.9%
Case 2	Without subsidy and without gen.	0.104	14	1.5%
Case 3	With subsidy and with gen.	0.067	9	1.0%
Case 4	With subsidy and without gen.	0.059	8	0.9%

As commonly understood, a feasible tariff level for sanitation service including water supply and wastewater disposal is less than 2 -3 % of the household income. This priority project deals with only improvement of water supply service. The case 3 and case 4, in which the operation & maintenance costs of reverse osmosis are covered by subsidy, are preferable condition for the implementation of the project considering the current low tariff level. These tariff levels are equivalent to 8 - 9 times of the current tariff and are almost same as the willingness to pay for the improved service, which was observed in the socio-economic survey by the study team.

(4) Economic Evaluation

Based on the same analysis condition as in WSPCB, an economic analysis is carried out. As a result, EIRR of the priority project was calculated as 5.5 % if the willingness to pay for the improved water supply service is 3 % of the average household income. As the EIRR is more than 5 %, the priority project is judged to be economically viable although the EIRR is not at preferable level (more than 10 %).

The current willingness to pay for improved water supply service is 1 % of the household income. The willingness to pay would probably improve depending on the awareness or understanding of customers on the water supply service. To make the project more viable, therefore, the awareness and the willingness to pay should be enhanced by as information, education and communication (IEC) activities by BWD.

11.8 Initial Environmental Evaluation on Priority Project

As a result of the field surveys conducted by the local subcontractor and evaluation carried out by the study team, no significant impact of the priority project was identified but some minor impacts were identified, which is summarized in following table with their mitigation measures.

Table 11.12 Summary of Minor Impacts and Mitigation Measures

Facility	Possible Impact	Mitigation Measures
1. Rehabilitation of network	・ About 15 % of the distribution pipes are asbestos cement pipe in the project area and the replacement works of ACP will be required in the rehabilitation of the distribution network. It is possible that the scattering of asbestoses causes health hazard to the workers.	・ The scattering in the air and exposures to the workers should be minimized as much as possible during the rehabilitation works. ・ The aged ACP should not be touched but left buried, and new pipelines should be installed.
2. Rehabilitation of water treatment plant	・ No significant impact	-
3. Construction of transmission system	・ No significant impact	
4. Construction of new water treatment plant	・ The sludge removed from sedimentation basins are discharged to the Shat Al Arab once in a half year so that the flux of the sludge at a time is large. The contents of the sludge discharged do not affect river environment but the large flux of the discharge may affect the human activities along the river bank downstream.	・ To reduce the impact to the human activities along the river bank as much as possible, the discharge point should be located at the center of the river. ・ The drainage should be carried out in many days.
5. Construction of RO plant	・ The increased TDS concentration by discharge of high concentrated brine water from RO is less than 2 % in the Shat Al Arab and does not affect the river environment.	-
6. Strengthening of distribution mains and zoning	・ No significant impact	-

For smooth implementation of the projects, public and all stakeholders should be involved in the project through stakeholder meetings and public hearings, where the information on the proposed project should be disclosed, stakeholders' opinions should be collected, and consultation for the stakeholders should be carried out.

11.9 Technical Evaluation of Priority Project

In the components of the priority project, reverse osmosis (RO) requires advanced and special technology for operation and maintenance and the other components use ordinary technology of water supply. Therefore, a technical evaluation is made focusing on RO technology. The following table describes the results of the technical evaluation and recommendations made to follow up the results.

Table 11.13 Results of Technical Evaluation

Item	Evaluation result	Recommendations
Selection of RO treatment process	RO plant requires pre-treatment such as multi-layer filters, activated carbon process or ultra-filtration. Furthermore, appropriate membrane type and the number of banks of RO should be decided according to the raw water quality.	The detailed process and capacity of RO should be decided through detailed investigation of water quality of the Shat Al Arab and a pilot project for 1 year is recommended.
RO operation and maintenance	RO plant needs high expertise in O&M. BWD does not have enough expertise on RO treatment process. Therefore, currently, the operation and maintenance of many small RO plants in Basrah is contracted out to private companies.	Introducing of RO should meet the following conditions: ・Appropriate operation of conventional water treatment plants to produce RO feed water. ・Acquiring of required operation and maintenance technology of RO. ・Securing of operation and maintenance budget for RO plant. These shall be brought about through the institutional capacity building programs.
		Contracting out of operation and maintenance of a large scale RO plant should also be considered as an option.
Cost of RO water	RO plant produces expensive water and cannot be operated at the current level of budget including subsidy and revenue from water charge.	・The budget level of BWD shall be improved through appropriate water charge collection, etc. ・Non-revenue water shall be reduced through reduction of leakage and illegal connection, etc. ・RO water shall be priced appropriately. ・Water demand shall be reduced through installing customer meters and appropriate pricing.
TDS concentration of supplied water	There is a concern about the improved TDS level, or 894 mg/l on average in the project area, whether or not the customers will be satisfied with this level of TDS for drinking and cooking.	To start the project, customer's satisfaction in terms of TDS concentration should be explained.

CHAPTER 12 CONCLUSIONS AND RECOMMENDATIONS OF FEASIBILITY STUDY

12.1 Conclusions

1. The stage 2-4 of the Water Supply Plan for Central Basrah (WSPCB) was selected as the priority project for feasibility study and the proposed facilities were designed with the following estimated capacity:

Facilities	Capacity/Quantity
1. Rehabilitation of network	Dia.110 mm - 700 mm, 285 km
2. Rehabilitation of water treatment plant (WTP)	13 plants in Basrah District
3. Transmission system	
(1) Transmission reservoir (TR)	48,000 m^3
(2) Transmission pumping station (TPS)	538,000 m^3/day x 60 m head
(3) Ring mains and connections	Dia. 600 mm - 2000 mm, 35,200 m
4. New water treatment plant	
(1) Treatment plant	245,000 m^3/day
(2) Treated water pumping station	192,000 m^3/day x 40 m head
5. RO plant	145,000 m^3/day (output)
6. Strengthening of distribution mains and 13 zoning	Dia. 200 mm- 700 mm, 25,100 m

2. In addition, institutional capacity building programs including non-revenue water control programs were selected for priority project to build the required capacity of Basrah Water Directorate (BWD) to ensure the project sustainability.

3. The target area of the priority project is the same area as in WSPCB and includes the central Basrah comprising Al Basrah district center, Al Hartha center and rural area with the population of 1,257,000 and the average day water demand of 608,000 m^3/day in 2015.

4. The total project cost of the priority project was estimated at 561.7 million US$, and comprised of 318.9 million US$ as direct construction cost and the rest as indirect cost.

5. The current cost of operation and maintenance for the Basrah water supply system is 5 billion ID/annum, out of which only 14 % or 0.7 billion ID was recovered from the water charge. The total project requires 21 billion ID for annual operation and maintenance with normal power supply conditions, and 32 billion ID using onsite generators in the existing power supply

conditions.

6. The following project benefits are identified:
   - Satisfaction of the day average water demand (300 l/ca/day for Basra city)
   - Improved service water pressure (15 m at tap)
   - In principle, 24 hours water supply
   - Even water distribution through the entire project area
   - Improvement of water quality except TDS and supply of hygienic water
   - Improvement of total dissolved solid (TDS) concentration of supplied water (on average 894 mg/l from the current 1,500 mg/l of Shat Al Arab river)
   - Improved technical management capacity, financial conditions and customer service of Basrah Water Directorate

7. As a result of financial evaluation of the project, the implementation of the project is financially not feasible in condition of the full cost recovery including the capital and operation & maintenance cost. Therefore, it is recommended that the central and local governments subsidize capital costs until the water supply service of BWD is well developed.

8. As a result of economic evaluation, the implementation of the priority project gives 5.5 % of EIRR in case that the willingness to pay for improved service is equivalent to 3 % of the household income. This value indicates that the project may be economically viable. The project would be more viable if other unmeasured economic benefits or indirect benefits such as improvement of health conditions are also included in these benefits.

9. According to initial environmental examination, no significant impact of the proposed project was identified.

12.2 Recommendations

Based on the conclusions made in the feasibility study, the followings are recommended to increase feasibility of the priority project.

1. The study team could not carry out any site survey in Basrah due to security reasons and the scope of the priority project was prepared under such conditions. Therefore, the result of this study contains some unconfirmed factors. At the detailed design stage, detailed investigation should be carried out to make the project components more reliable.

2. The study team recommends that BWD adopt water demand management policy by means of the installation of water meters with establishment of proper tariff system, leakage control and

encouragement of water saving. The demand control policy could give the following additional benefits to the project.

- Efficient use of water by reducing wastage or in-house loss.
- Reduction of the operation and maintenance costs of water treatment and distribution by reducing the required amount of the treated water and distribution.
- Enabling of the early abandonment of the existing water treatment plants by reducing the required amount of the treated water.
- Further improvement of TDS by abandoning the operation of the water treatment plants that receives high TDS raw water from the Shat Al Arab.

3. The study team recommends that introducing RO plant, which produces expensive water and needs high expertise for O&M, meet the following conditions.
    - Appropriate operation of conventional water treatment plants to produce RO feed water.
    - Acquiring of required operation and maintenance method.
    - Improved power supply conditions for water supply facilities.
    - Improved budget level of BWD; appropriate water charge collection.
    - Controlled non-revenue water; reduced leakage and illegal connection.
    - Appropriate pricing of RO water.
    - Reduction of water demand through installing customer meters and appropriate pricing.

4. Based on limited water quality data, the process of RO was designed. Therefore, the study team recommends that the detailed process be decided through detailed investigation of water quality of the Shat Al Arab by implementing a pilot project.

5. The TDS improvement by this project was estimated at 894 mg/l, while WHO recommends TDS less than 600 mg/l is preferable for human consumption. Therefore, the study team recommends BWD confirm whether the improved TDS level can satisfy the users' requirement.

6. Currently, the operation and maintenance of many small RO plants owned by BWD is outsourced by private companies since BWD does not have enough technical expertise on RO treatment process. Therefore, the study team recommends that outsourcing of operation and maintenance of the proposed RO plant also be considered.

7. The southern part of Iraq, which are located downstream of the country's river system, suffers from high TDS water supply. A major cause of higher TDS in the rivers is assumed to be from discharge of salinity contents in the upstream areas. Therefore, the southern areas receive disadvantage caused by the economic activities of the upstream areas. In this line, the study team recommends the central government of Iraq seek for measures such as subsidy to the required cost for RO plant operation in order to compensate the geopolitical disadvantage of the project area.

8. The current willingness to pay for the improved water supply service is 1 % of the household income. The willingness to pay would improve depending on the increased awareness to the water supply service. The study team recommends that BWD promote awareness campaigns to increase the people's awareness and the willingness to pay for water supply service, which would result in enhancement of the economic and financial feasibility of the project.