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

(MAIN)

JANUARY 2007

TOKYO ENGINEERING CONSULTANTS CO., LTD.

NIPPON KOEI 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 concerned officials of the Government of Republic of Iraq and conducted field surveys in 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 projects selected from the basic plan.

This study aims 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.

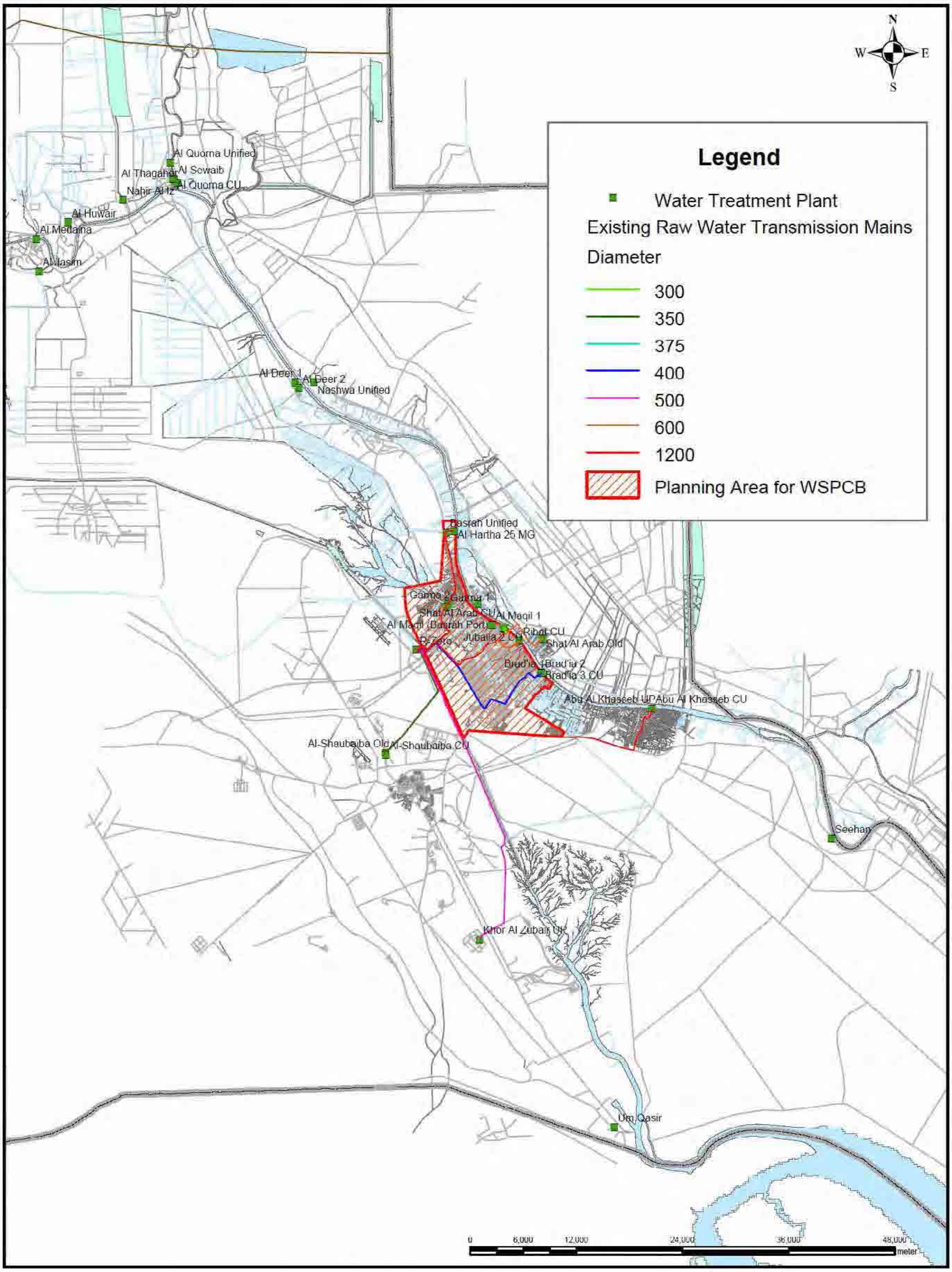
① Rehabilitation of existing distribution network and existing water treatment plants to recover their existing capacity

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

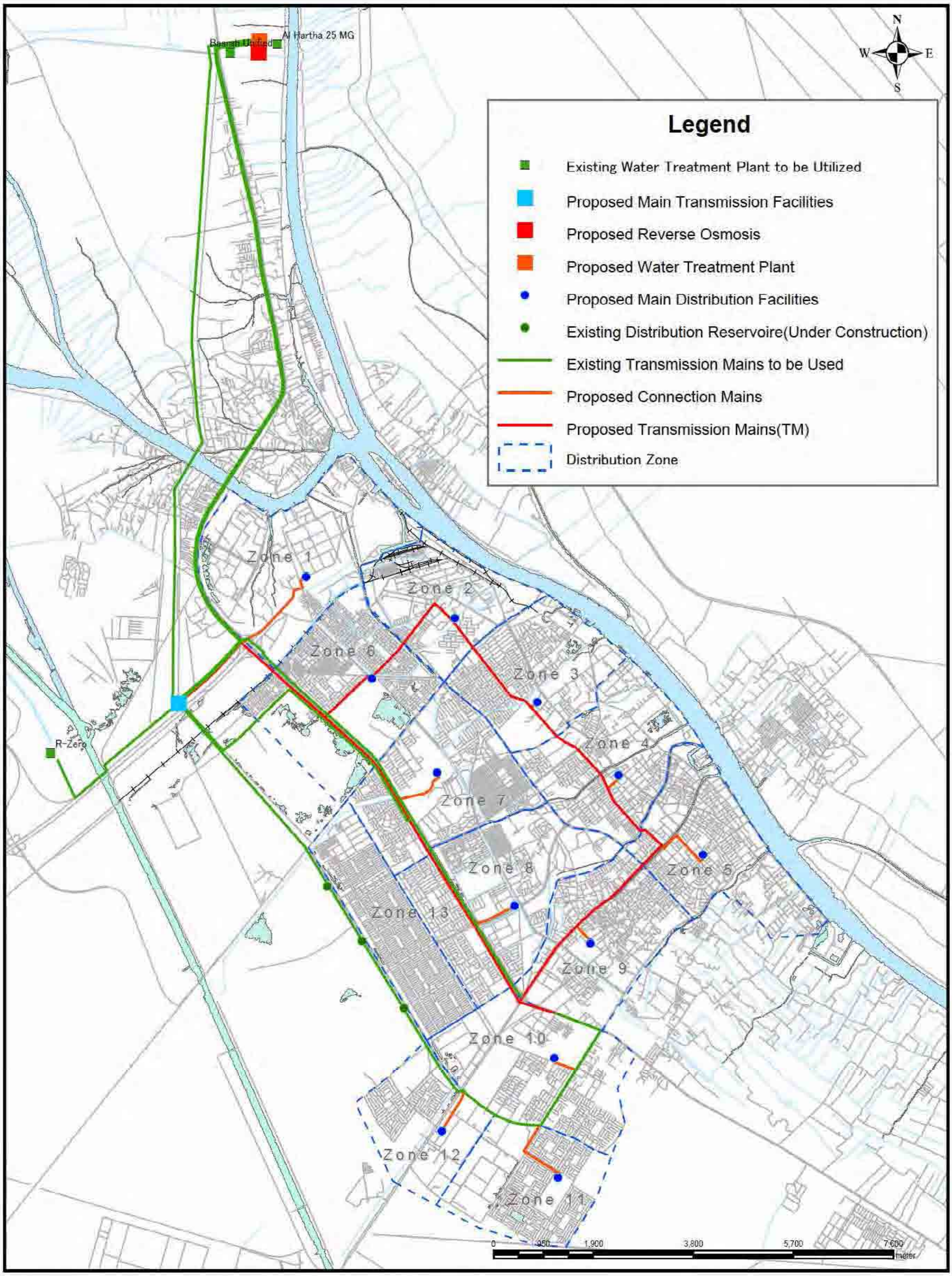
③ Construction of water transmission system in order to convey the treated water evenly from existing and proposed water treatment plants to the entire planning area

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.

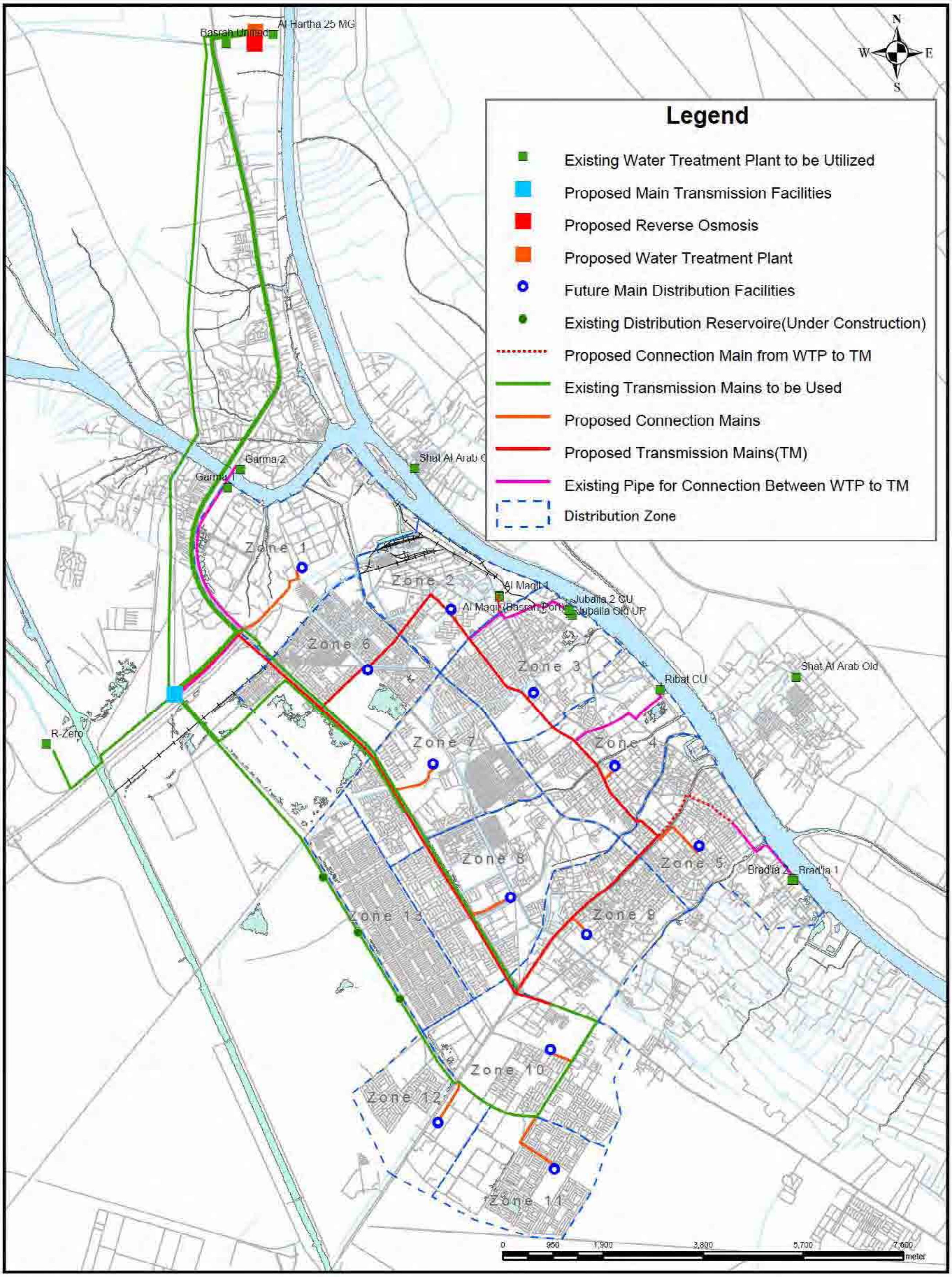
Finally, the stage 2-4 was selected as a priority project on the condition that RO plant may be removed from the project components implemented by Japanese Yen Loan.

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.

Main Report

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Acronyms and Abbreviations

AC	Asbestos cement
BG	Basrah Governorate
BWD	Basrah Water Directorate
CI	Cast iron
CUs	Compact units
DFID	Department for International Development (British)
DG	Director General
DI	Ductile iron
E. Coli.	Escherichia Coli.
EC	Electrical conductance
EIA	Environmental Impact Assessment
F.C.	Foreign Component of Cost
FS	Feasibility study
GDW	General Directorate for Water
ID	Iraqi dinar
IEE	Initial environmental examination
IRMO	Iraq Reconstruction Management Office
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
MND (SE)	Multi National Defense South East
MWR	Ministry of Water Resources
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
ODA	Official Development Assistance
PCO	Projects and Contracting Office
PIU	Project Implementation Unit
PS	Pumping station
PS1	Pumping station 1 of the SWC
PS2	Pumping station 2 of the SWC
PVC	Polyvinyl chloride
RO	Reverse osmosis
SAA	The Shat Al Arab
SMO	Strategic Management Office
SWC	Sweet Water Canal

TDS	Total dissolved solid
TP	Transmission pumping station
TR	Transmission reservoir
UFW	Unaccounted-for-water
UN	United nations
US$	United State dollars
USAID	United States Agency for International Development
WES	Water and environmental sanitation
WIBI	Washington International with Black & Veatch
WSPCB	Water Supply Plan for Central Basrah
WTP(s)	Water treatment plant(s)
d	day
hr	hour
l/c/d	liter per capita per day
y	year

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 GENERAL

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. Due to UN sanctions as well as the impact of wars, the population was once decreased but has increased after the liberation of Iraq by the return of tens of thousands of refugees and internal displacement of people. The Governorate became a battlefield in recent wars and was severely damaged. Over the last two decades the water supply system in the Governorate has seriously deteriorated resulting in a water supply deficit of no less than 30%.

Deterioration has also occurred in the quality and quantity of water sources. 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 by a factor of two due to reduced flows in the Euphrates and the Tigris and increased salinity contents. The reduced flows are due to the construction of upstream dams and expansion of irrigation systems. 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 by the Projects and Contracting Office (PCO) of the Iraq Reconstruction Management Office (IRMO) in January 2005. The Mini M/P proposed comprehensive plans to develop a water supply system to meet the demand in 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, there exists the reality that the weakening infrastructure must be urgently repaired to relieve the current severe water shortages. There are acute problems related to shortcomings with both water quantity and water quality. Furthermore, the Mini M/P did not address how the existing problems could be resolved related to 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 can be implemented under the current unstable security conditions.

1.2 OBJECTIVES AND AREA OF THE STUDY

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 same as presently covered by the water treatment plants which receive raw water from R-Zero as shown below, comprising Central Basrah 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.

Name of water treatment plants
R-Zero
Al Hartha 25 CU
Basrah UP
Garma 2 CU
Garma 1 CU
Al Maqil CU
Jubaila Old UP
Jubaila CU
Ribat CU
Barad'ia 1
Barad'ia 2
Barad'ia CU
Abu Al Khasseb UP
Abu Al Khaseeb CU
Shat Al Arab CU
Shat Al Arab UP
Al-Shauaiba Old
Al- Shauaiba CU
Khor Al Zubair UP

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 Al Hartha center and rural areas (Figure 1.2). 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)."

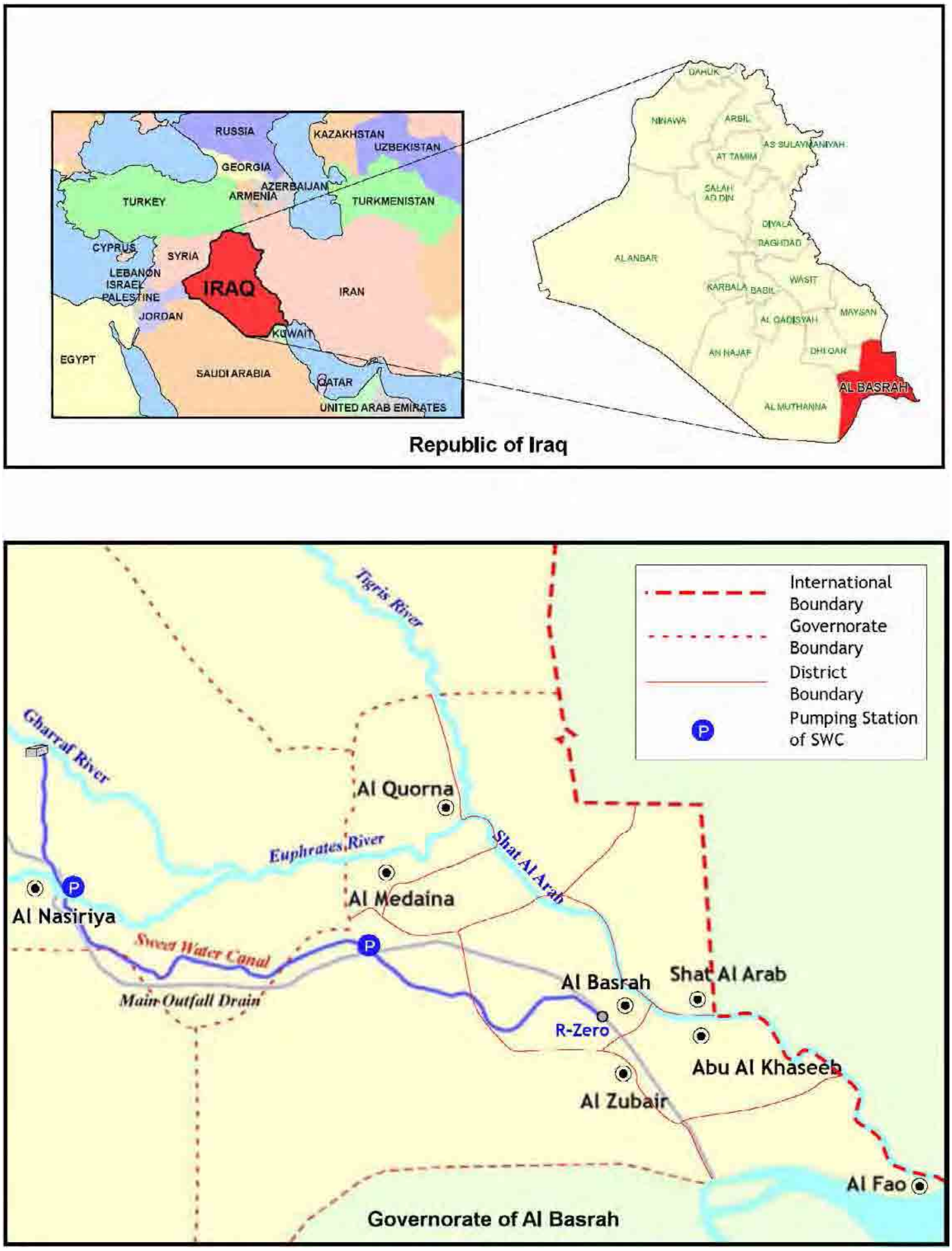
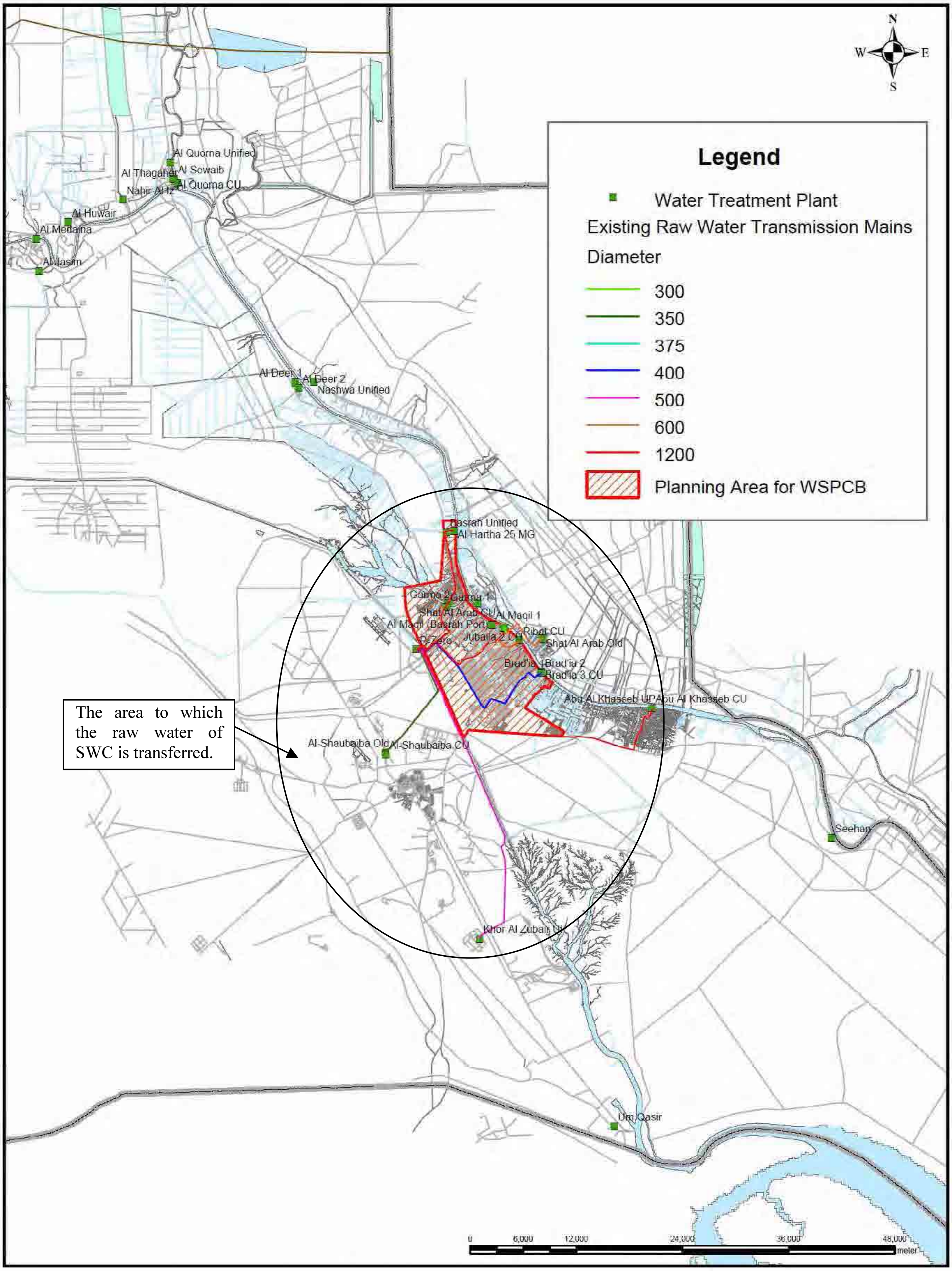


Figure 1.1 Location of the Governorate of Al-Basrah



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 No.** 1.2

1.3 OUTLINE OF THE STUDY

The field study having an office in Amman, Jordan was undertaken during a period of 8 months between April 2006 and December 2006, through the three stages as shown below.

(1) Stage I (April 2006)
   1) Conclusion of S/W of the Study
   2) Preparation of Draft Inception Report (IC/R)
   3) Finalizing of IC/R
(2) Stage II (May to October 2006)
   1) Preparation of Basic Plan, including review of master plan and rehabilitation plans for each of the facilities
   2) Submission of Interim Report (IT/R)
   3) Submission of Progress report (PR/R)
(3) Stage III (November 2006)
   1) Preliminary design of priority project(s) selected as a candidate of Japanese yen loan project, including procurement and construction plan, cost estimates, recommendation on organization strengthening and capacity building, initial environmental examination (IEE) and project evaluation.
   2) Submission of Draft Final Report (DFR)
(4) Submission of Final Report (F/R)

Interim Report presented the existing conditions of the present water supply in Al-Basrah and proposed a water supply development plan (Water Supply Plan for Central Basrah: WSPCB) that covers the central Basrah and would improve the existing severely deteriorated water supply conditions by increasing the water supply capacity to meet the demand in 2015.

It had been supposed that priority project(s) to be proposed as a candidate project to be financed by Japanese Yen Loan would be selected based on the proposed WSPCB through discussions with the Iraqi counterparts (MMPW and BWD). However, in the meetings held in August in Amman, the Iraqi side strongly requested WSPCB to be parts of the Mini Master Plan (M/P) and to include the salinity (or TDS) reduction components.

Then the technical meetings were held again in Amman in September. In the meetings, the study team established and presented clear relationship between the proposed WSPCB and Mini M/P and the Iraqi side agreed to consider WSPCB as parts of Mini MP. The Iraqi side, however, requested to include the reverse osmosis (RO) treatment in WSPCB to reduce salinity. Finally, the study team accepted the request of the Iraqi side and revised WSPCB by adding RO treatment facility.

Progress Report was prepared based on the discussions mentioned above and the priority project was selected based on the revised WSPCB in Progress Report. A feasibility study was conducted on the priority project and the results were compiled in Draft Final Report together with all the results of the Study.

After further discussion with the Iraqi side in December 2006, the contents of the Draft Final Report was in principle agreed with the Iraqi side and Final Report was prepared.

CHAPTER 2

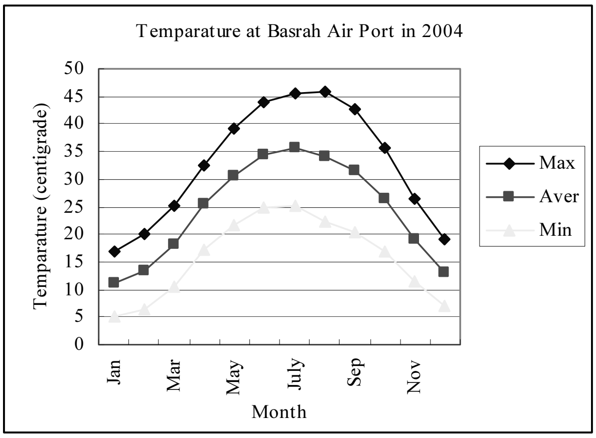
EXISTING CONDITIONS

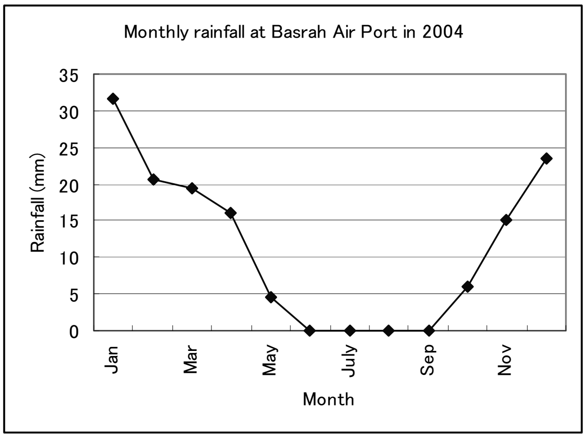
CHAPTER 2 EXISTING CONDITIONS

2.1 GENERAL CONDITIONS

2.1.1 Climate

The following figures show monthly temperature and rainfall at Basrah Airport in 2004. The average temperature in 2004 was 24.4 degree centigrade with the highest of 45.9 degree centigrade in August and the lowest of 5.1 degree centigrade in January. The total rainfall in 2004 was 136.8 mm. There was no rainfall in the months of June to September.





2.1.2 Socio-economic Condition of Basrah Governorate

Socio-economic conditions of Iraq are compiled in Appendix A. The followings are those of Al-Basrah Governorate.

(1) Population

Although a census has not been carried out since the last census in 1997, the population of the Basrah Governorate is estimated as 1,760,000 in 2003 by the COSIT. The COSIT has set up a population growth rate of 2.25% from 2003 onwards.

The population of the Basrah Governorate is the third largest among the 18 Governorates of the country, comprising 6.6% of the total population. (Source: Iraq Living Conditions Survey 2004)

<Household size>

The average household size in the interviewed households (JICA Socio-economic Survey) is 7.9 persons/household, ranging from 2 persons to 30 persons per household. The mode of household size is 6.0 persons/household.

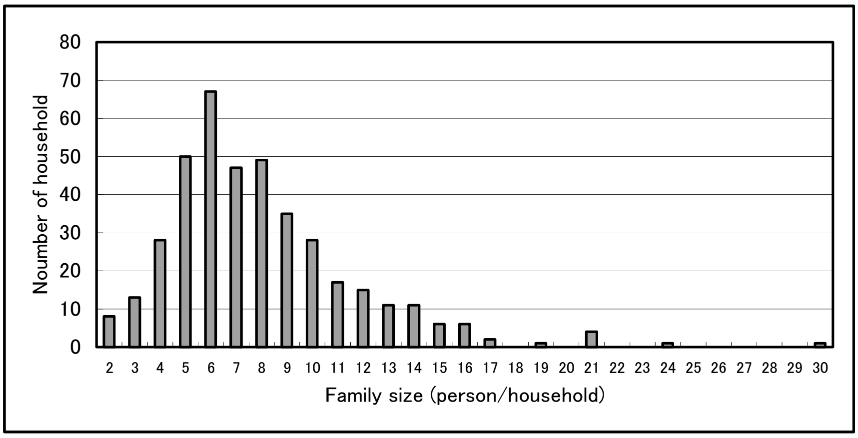


Figure 2.1 Household Size of the Interviewed Household

(2) Economy

<Working Population>

The distribution of the labor force among various economic sectors in Basrah shows that the main activities attracting large proportions of this force are as follows: service sector with its various activities, representing 72.9 percent; followed by the agriculture sector with 13.1 percent; industry with 8.3 percent, and finally, commerce with 5.7 percent. (Source: "Basrah Final Report" 2005)

<Household Income >

The average monthly income of household is 836,000 ID (approximately 560 US$ @1,500 ID=1US$), and maximum and minimum monthly incomes are 100,000 ID and 5,000,000 ID, respectively. Two thirds of all the households fall in the range of 250,000 ID/month to less than 1,000,000 ID/month (JICA Socio-economic Survey).

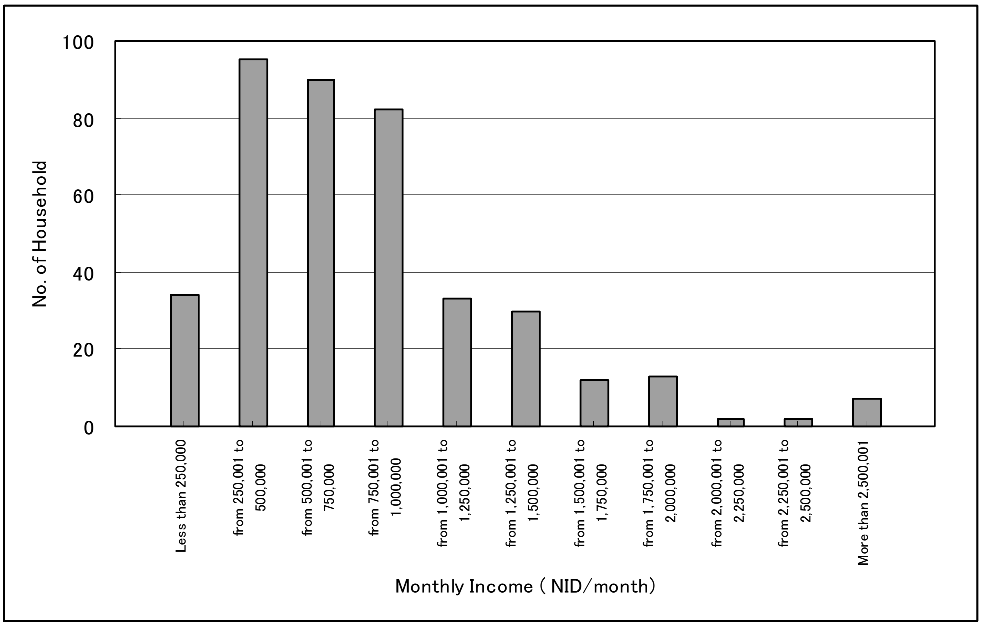


Figure 2.2 Monthly Household Income

(3) Health

According to JICA Socio-economic Survey for communities, the type of water-borne infectious diseases and their incidence in the Basrah Governorate are shown in Table 2.1. The type of diseases most communities answered as "common" or "very common" are diarrhoea, dysentery, typhoid, skin infection and eye infection.

Table 2.1 Incidence of Water Borne Infectious Diseases

Name of Disease	Number of Community (Total No.=13)			
	Very rare	Rare	Common	Very common
Diarrhea	1	1	6	5
Cholera	11	2	0	0
Dysentery	0	5	5	3
Typhoid	1	5	5	2
Skin infection	2	2	8	1
Eye infection	0	2	9	2
Hepatitis Type- A	5	4	2	0

(4) Water and Electricity supplies

<Water supply condition>

Based on the results of the Socio-economic Survey, 392 households out of 400 interviewed obtain water from public water supply service. Furthermore, purchased bottled water is used for drinking and cooking in almost all the interviewed households. The use of bottled water is firmly established in the

Study area. This means that households are not satisfied with the quality of water supplied by public water supply service.

<Sewerage service coverage in Basrah Governorate>
The sewerage coverage is 35-40% in the Basrah center, 100 % in Al Faw and Khor Al Zubair.

<Electricity supply condition>
The majority of households in Iraq are connected to an electrical network. However, the situation of electrical network does not satisfy the consumers' requirement. In evaluation of the electricity supply situation one of the important indicators is whether or not the electrical supply is stable and adequate. The questionnaire survey regarding the stability of electricity supply in Iraq and Basrah Governorate was conducted by UNDP in 2004, and the results of survey are shown in Appendix A. The electricity supply situation of Basrah Governorate is one of the best in Iraq but the percentage of satisfied households is still 60 %. All the electricity supply in Iraq is in fragile situation (Source: "Basrah Final Report" 2005).

According to the information collection survey, electricity coverage in the Basrah Governorate is 80%. The estimated average power supply hour is as follows:

- Current average power supply: 16 hrs/day (winter season), 8 hrs/day (summer season)

2.2 EXISTING WATER SUPPLY PLANS AND PROJECTS

Water quality, quantity, and pressure are the most important problems faced by the people living in the Basrah governorate due to increasing TDS concentration in Shat Al Arab River, and shortcomings in treatment facilities, conveyance, and distribution systems. For several years PCO and other organizations prepared plans and implemented projects for Basrah governorate to improve water quality and increase the quantity.

The four steps plan was prepared (in about 2004) and some of these steps have already been implemented or in the process of being implemented. The available information of this plan, which was collected by a local company sub-contracted by the study team, is outlined as follows:

The plan has been divided into 4 steps:

- Emergency plan
- Immediate action plan
- Short-term plan (one year time frame)
- Intermediate-term plan (five year time frame)

(1) Emergency Plan

This plan will be in place in the event of a total breach of the SWC and the total loss of raw water

a. Installing low lift pumps at Water Treatment Plants located on the Shat Al Arab: this will ensure that the network is pressurized with "high TDS" filtered water, and will serve most of the Basrah area and some nearby districts. Most of these pumps are being installed.
b. Other cities such as Khor Al Zubair can still get their raw water feed from R-Zero. Two reservoirs north of the R-Zero have a holding capacity of 75,000 m^3 each, if kept clean and full. They will have enough capacity for these plants for more than two weeks of operation.
c. Installation of FRP and/or bladder tanks near schools, hospitals, government buildings etc.
d. Trucking drinking water to neighborhoods, utilizing military trucks, purchasing new trucks, borrowing trucks from other cities within Iraq and leasing agreements with water suppliers.
e. Trucking drinking water from existing reverse-osmosis (RO) plants in Basrah such as:
    i. RO skids owned and operated by the local MMPW staff
    ii. State owned plants such as the Petrochemical plant, the Fertilizer Plants etc
    iii. RO plants owned and operated by private sectors
f. Purchase of water, bottled and bulk, from outside the country

(2) Immediate Action Plan

a. SWC Repair

Urgent needs to repair the SWC to improve its performance. USAID/Bechtel contracted to repair the SWC, pump stations and reservoirs which ended by December 31, 2004 and the construction work ended by early November 2004. SPOC/Washington International and Black & Veatch (WIBV) have taken over the works. Both contractors have worked directly with the Ministry of Water Resources. The work includes the following steps:

i. De-silting (cleaning) of an estimated 90,000 cubic meters of silts along the Canal and particularly at the intake, gated structures, siphons etc.
ii. Restoration of the breaches of embankments particularly beyond the PS2 for at least 20 km.
iii. Repair, or replace when necessary, the existing concrete lined sections of the Canal
iv. Rehabilitate the pump stations PS1 & PS 2
v. Continuous monitoring and assessment of the Canal's conditions
vi. Ensure reliable power supply
vii. Maximize storage capacity of the Canal's reservoir by building additional storage
viii. Complete the second conveyance canal from the reservoir to the R-Zero and provide concrete lining to minimize losses and prevent failure
ix. Rehabilitate pump stations PS1 and PS2 (this work is almost complete at the time this

report is being prepared)

x. Provide the MWR with the necessary heavy equipment as part of the capacity building, to enable the MWR to immediately take over the repair and maintenance of the remaining 220 km of the canal.

b. Existing Treatment Plants

Rehabilitation works were planned for the existing water treatment plants; this work is underway during the preparation of this report.

(3) Short-term Plan (1 year)

This plan is necessary to ensure that measures are taken to prevent another emergency condition for the 2005 summer; the plan is as follows:

a) The SWC is currently the only source of raw water and given the unreliable nature of the canal, an alternative source of raw water is required in the event of a total failure of the canal. Another source of water can be provided as follows:

   i) Installing low lift pumps in water treatment plants along the Shat Al Arab, as described above.
   ii) Installing new pumps in Al Hartha Water Treatment Plant, or nearby on the Shat Al Arab, to pump water from the Shat Al Arab to the R Zero, utilizing the existing raw water pipeline. This will ensure another source of raw water to the R-Zero, to service other treatment plants located away from the Shat Al Arab.
   iii) WIBV to work with the MWR to continue the operation and maintenance of the SWC and provide the necessary equipment as part of capacity building. MWR is to take over the operation and maintenance of the SWC upon completion of the capacity building.

b) Continuous operation and maintenance of the existing treatment plants.

c) Network leak repair to conserve water, increase pressure and hence eliminate the ingression of sewage and dirt due to low or no pressure.

(4) Intermediate-term Plan (5 year)

A long term solution (20 year plan) will be required to be realized at least within 4-5 years; hence, the need for an intermediate-term plan (5 year) was outlined as follows:

a) Operate and maintain the existing treatment plants and pump stations.
b) Reline the damaged parts of the canal with concrete, mattress, clay etc as deemed necessary.
c) Replace parts of the canal with one or more pipes, especially in troublesome areas or areas that may be flooded with the marshes.
d) Realign part of the canal especially those close to the marshes.
e) Construction of a permanent power supply to PS2 from the national grid. It is currently operated through the use of diesel driven generators, which requires trucking of the fuel through unpaved and unsecured roads.
f) Upon completion of the capacity building, MWR to take over the operation and maintenance of the SWC.
g) Operate and maintain the existing RO plants to provide low TDS drinking water.
h) Continue network repair to conserve water and maintain pressure.
i) Re-structuring of the distribution system.
j) Implement a fee collection system to encourage conservation and provide local budget.

Besides the above major plan, the Water Directorate of Basrah has announced many contracts for repairing and maintaining networks and rehabilitation of pumping station (see Appendix A).

(5) Other Projects

In addition to the national plan, the BWD has started an immediate plan implemented under supervision of the PCO which includes the following:

a) Supply, install and construct 21 units of WTP (the capacity of each unit is one million gallon of water daily (4,800 m^3/day)).
b) Install 10 RO units with capacity 50 m^3/ day (the equipment is already available at the BWD Warehouses).
c) Supply BWD with all necessary spare parts for main plants in Basrah.
d) Maintenance of the following projects
    i) Al Basrah Al Mowahad (Unified) plant
    ii) R-Zero plant
    iii) Al Ribat plant
    iv) Al Hartha 25 million gallon (MG) plant

The following are the completed and on-going water supply projects implemented by MND (SE) & DFID in Central Al Basrah.

Table 2.2 Water Supply Projects by MND (SE) & DFID

No.	Project title	Contract value (US$)	Period (year)	People employed	People to be benefited	Approx. Area
1	Leak detection & Repair BA018	125,000	3	200	20,000	Al Ma'aqal
					22,000	Hay Al Zahraa
					20,000	Al Hakemie
					15,000	Al Basrah
					25,000	Al Hainiya
					18,000	Al Qiblah
2	Abu Al Khasheeb Water Main Extension and data collection	248,700	3	150	100,000	
3	Hay Al Qaam Pump Station 218658BA01	184,000	2	200	24,000	
4	Water Tower 220105CA04	2,000,000	4	300	25,000	Al Hainiya
5	Hay Al Hussain Pump Station 219296BA01	450,800	2	150	23,000	

2.3 EXISTING WATER SUPPLY SYSTEM

2.3.1 Overview of Existing Water Supply System

The Shat Al Arab was central and southern Basrah's original source for water supply; however, due to pollution and an increase in total dissolved solids (TDS) in the Shat Al Arab the Sweet Water Canal (SWC) was constructed in the late 1990s and is now the current source of potable water, supplemented by the Shat Al Arab. The canal provides water that is relatively low in TDS. Operation of the SWC to deliver water to Al-Basrah City and its surrounding areas began in 1997. It was designed to deliver 8.5 cubic meters per second (m^3/s) to a location called R-Zero near the Basrah International Airport. The raw water of the SWC is transferred to the water treatment plants located in Basrah city, Abu Al Khaseeb, Al Zubair and Shat Al Arab districts and distributed to the local networks after treatment.

Other sources include the Tigris and the Euphrates Rivers for the northern Governorate. The Tigris is used as water source for the Al Quorna district, the Euphrates for the Al Medina district. The Shat Al Arab is also the water source for Nashwa and Deer districts in the north of Basrah city and Al Faw district in the south.

The SWC has suffered numerous failures since it was commissioned and requires continuous maintenance and monitoring, especially after the start of the war. Several long sections of the canal embankment are structurally unstable, resulting in steadily worsening performance and an increasing rate of failure. The current flow is at approximately 6.0 m^3/s (518,400 m^3/d).

As a result of the lack of investment and operating funds over the last two decades, the entire water system has deteriorated significantly and is currently constrained by inadequate storage and treatment facilities and a leaking distribution network that is prone to contamination by untreated sewage and other contaminants. Basrah's water storage facilities have a very limited capacity, far less than the normal requirements. Severe limitations also exist in the pumping and distribution system from the existing plants to water customers.

There are several treatment plants and most of these plants are old conventional treatment plants, while others comprise multiple compact units (CUs). Due to lack of maintenance, most treatment plants produce low quality water inappropriate for human consumption.

There are a number of RO plants located throughout the Governorate of Al-Basrah to produce drinking water from the high TDS water. These plants provide relatively small quantities of potable water for emergency relief and drinking water to the people, with delivery provided by trucking water to neighborhoods and selling it.

The households located outside the public water supply system obtain water by following methods:

- Private tankers
- Carrying pots filled with water from the river or lakes to their homes
- Mains and wells

Many industrial and commercial users have their own WTP drawing water from the Shat Al Arab.

2.3.2 Water Sources

(1) Outline of Water Sources

The sources of the water supply for the Study area are the SWC, the Tigris, Euphrates, the Shat Al Arab, the Garma Ali and ground water. The Sweet Water Canal was constructed in order to provide water to the system in Basrah and is the largest water source for the existing water supply system. The Tigris and the Euphrates are flowing from the north and the west, respectively, and meet at Al Quorna in the Governorate. The river becomes the Shat Al Arab after confluence and flows into the Persian Gulf. The Garma Ali is a small stream and joins the Shat Al Arab in the northern part of Basrah city. Ground water contains excessive TDS and used as water source only in Um Qasir, the south of the Governorate of Al-Basrah. The following table shows outline of these water sources as potable water supply.

Table 2.3 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 RO	Al Quorna
The Euphrates	Adequate	Highest TDS in the Governorate	Conventional treatment and RO	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 RO	Al Hartha, l Basrah、Shat Al Arab, Abu Al Khaseeb, Al Fao
The Sweet Water Canal	Limited (design max: 8.5m^3/s)	Good（moderate TDS: about 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 RO	Um Qasir（Al Zubail）

（2） Water Quality of the Sources

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

- The water qualities of these five water sources have very similar characteristics except TDS (inorganic salt contents) or EC (electrical conductivity) and turbidity, which are affected by rain and flow velocity or discharge amount of the rivers.
- The Shat Al Arab is polluted by human activities after the middle stretch of the river in Basrah city.
- 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 fall in between the SWC and the Euphrates. The following figure shows the relationship of TDS and EC by river.

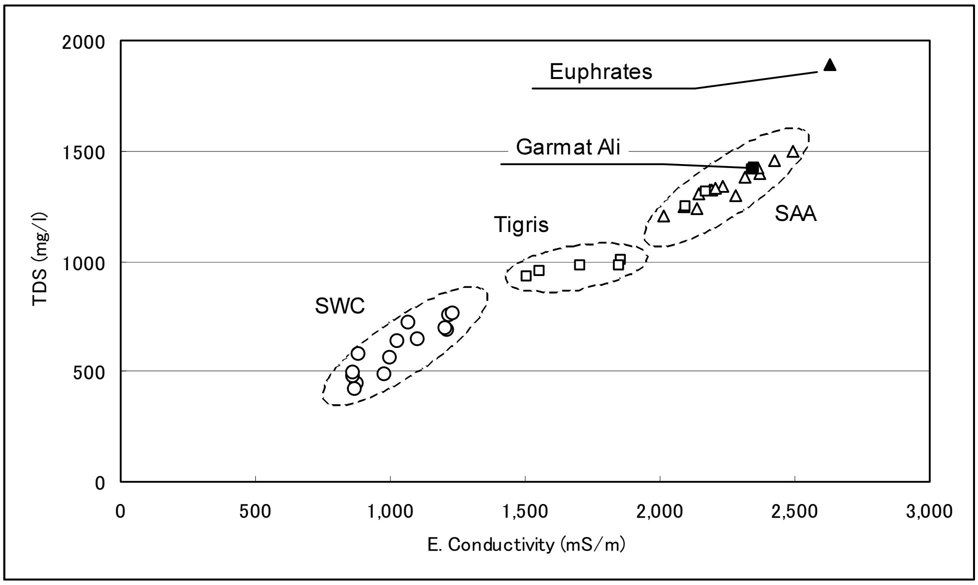


Figure 2.3　TDS and EC of Existing Water Sources

- 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, 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 conventional treatment processes cannot lower TDS significantly. 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 Basrah city.

(3) Sweet Water Canal

The SWC is the only source used for drinking water without desalination treatment in the Governorate of Al-Basrah and provides as the primary water source of Al-Basrah City and its surrounding areas. The intake of the SWC is at Bada'a near Ash Shatra on the Gharraf River, a branch of the Tigris, north of Al Nasiriya in the Governorate of Dhi Qar. The water is transferred to the canal by pumping at 2 locations; pumping station 1 (PS1) located at 60 km from the intake, where the canal crosses the Euphrates, and pumping station 2 (PS2), at 170 km, where it crosses the main outfall drain. The SWC ends near the Basrah International Airport at R-Zero. The SWC is approximately 238 km in length. The canal is operated and maintained by the Ministry of Water Resources. Table 2.4 summarizes the hydraulic characteristics of this canal and Figure 2.4 shows the layout of the SWC.

Table 2.4 Hydraulic Characteristics of Sweet Water Canal

Item	Description
Length	238 km, of which approximately 60 percent is concrete lined
Design Capacity	At source: 21 m^3/s
	As desired by MMPW: 10 m^3/s at R-Zero
	MWR projected design capacity if 100 percent lined: 13.1 m^3/s at R-Zero
	Canal constructed capacity: 10 m^3/s at reservoirs
	Conveyance canals, after reservoirs, design: 7.5 m^3/s for lined canal and 5.0 for unlined canal at R-Zero
	Conveyance canal constructed capacity: 8.5 m^3/s one canal, the second canal is unlined and not in operation.
Elevation drop	17.5 m
Headwaters	Tigris River via the Gharraf River
Transfer	Pump Stations No 1 and No 2
Storage Reservoirs	2 (Total storage capacity 750,000 m^3)
Conveyance Canal	2 canals, one lined, one operational (from the reservoirs to R-Zero)
Year Completed	1997

Source: Mini-M/P

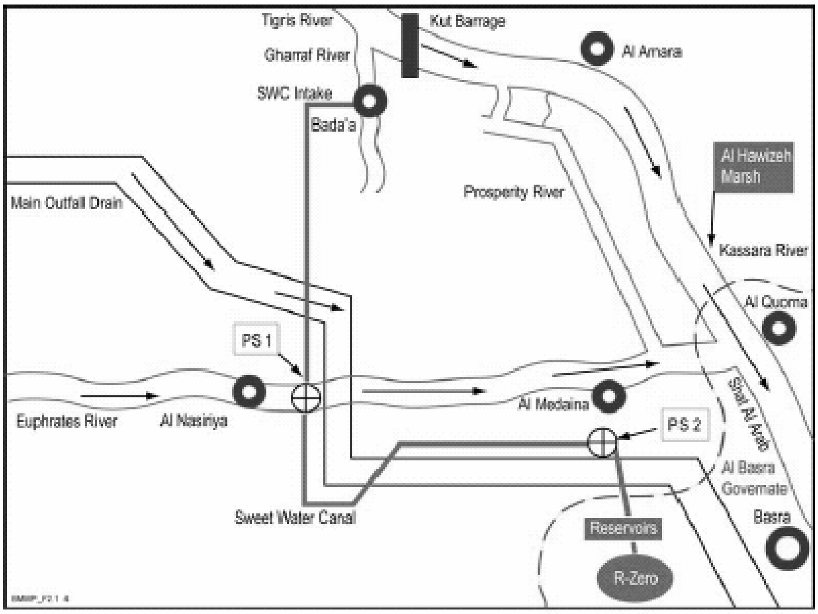


Figure 2.4 Layout of the SWC (Source: Mini Master Plan)

The following figure shows the flow rate at PS1 and R-Zero along the SWC. Before the War in February 2003 R-Zero received 6 to 8 m^3/s raw water and after the War started it reduced to 6 to 4 m^3/s. According to the latest records from January 2006, R-Zero received only 2.5 m^3/s in January but the flow records show an increased capacity to 6 m^3/s (July 2006), while the estimated discharge at PS 1 was a constant flow of around 8.5 m^3/s during this period. The flow difference may be attributable to the failures of PS2, the canal structure, illegal connection etc.

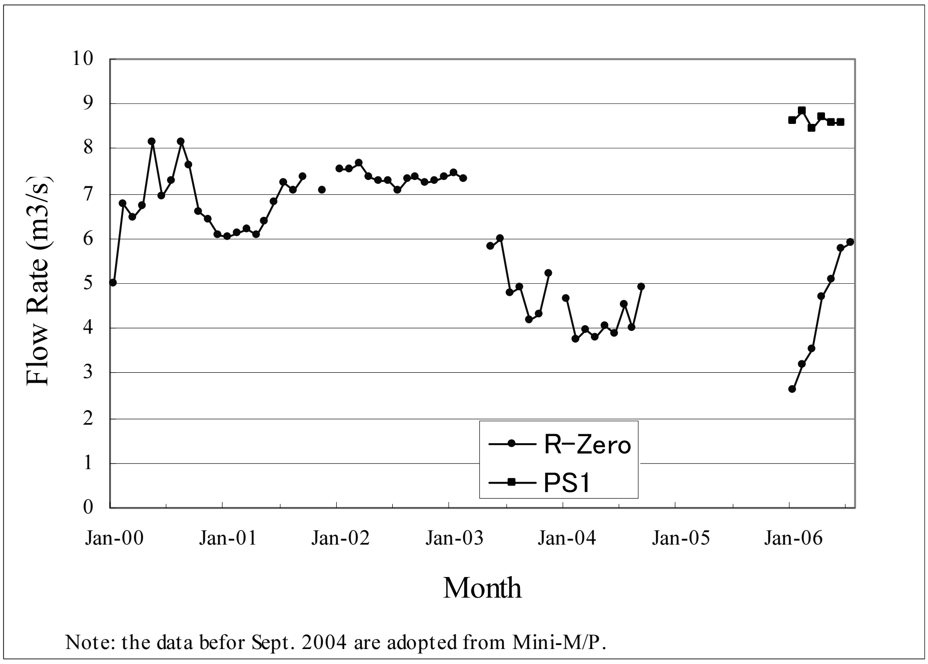


Figure 2.5 Estimated Flow at PS1 and R-Zero

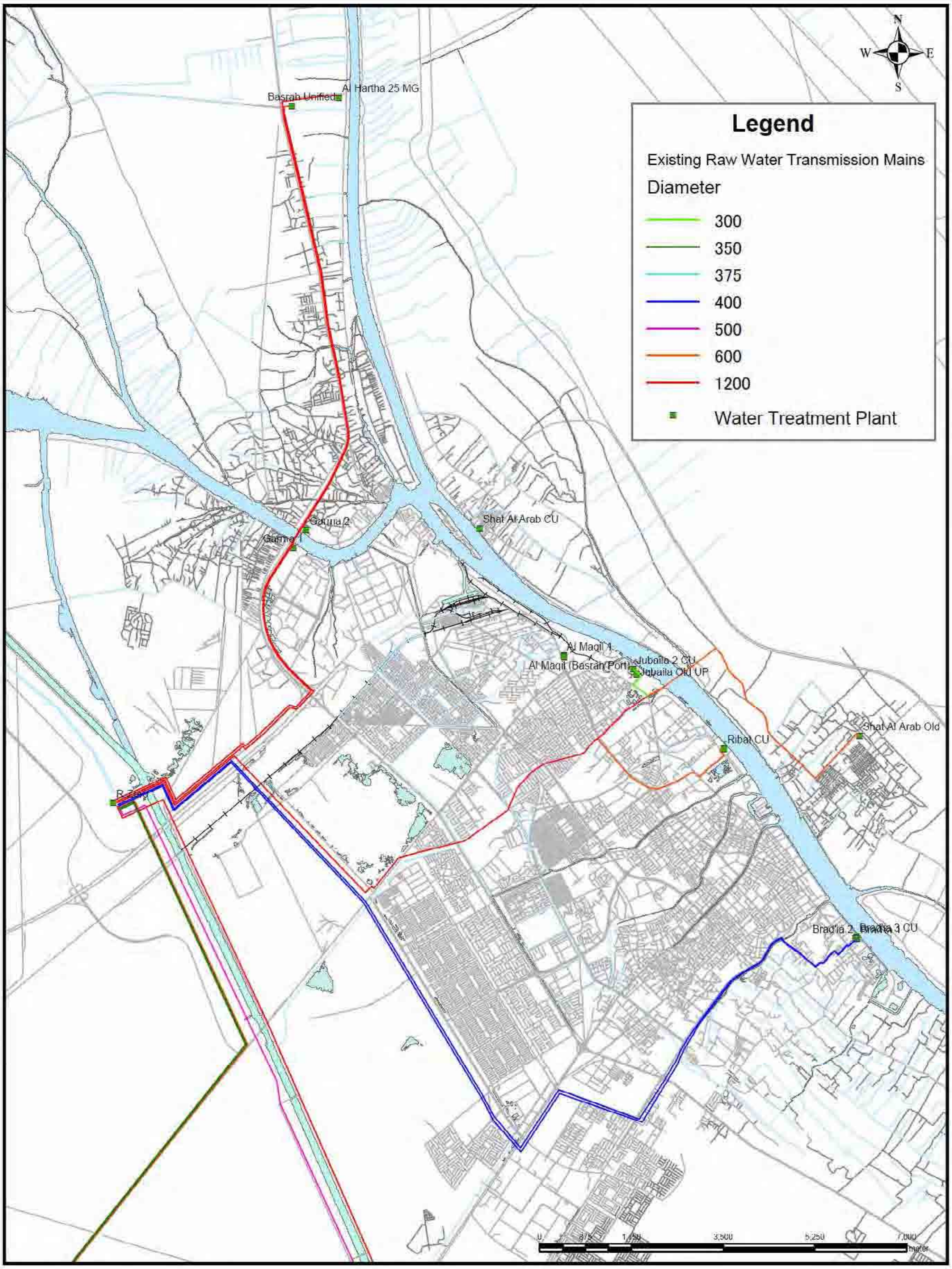
The Mini M/P concluded that the SCW was not reliable source of domestic water for Basrah and summarized the major problems of the SWC system as follows:

- Breaches of the canal at various locations between Km 165 and Km 197
- Mechanical equipment failure or inadequacy of PS1 and PS2
- High water conveyance losses especially in the unlined sections
- Lack of reliable power supply
- Lack of national grid power supply to PS2
- Lack of spare parts and proper maintenance
- Lack of heavy equipment
- Leakage, erosion, and vegetation growth in the canal
- Embankment failures and slippages
- Silting along the canal and in the reservoirs
- Potential contamination from the newly restored marshes
- Illegal extraction of water from the canal
- Lack of proper monitoring and communication systems

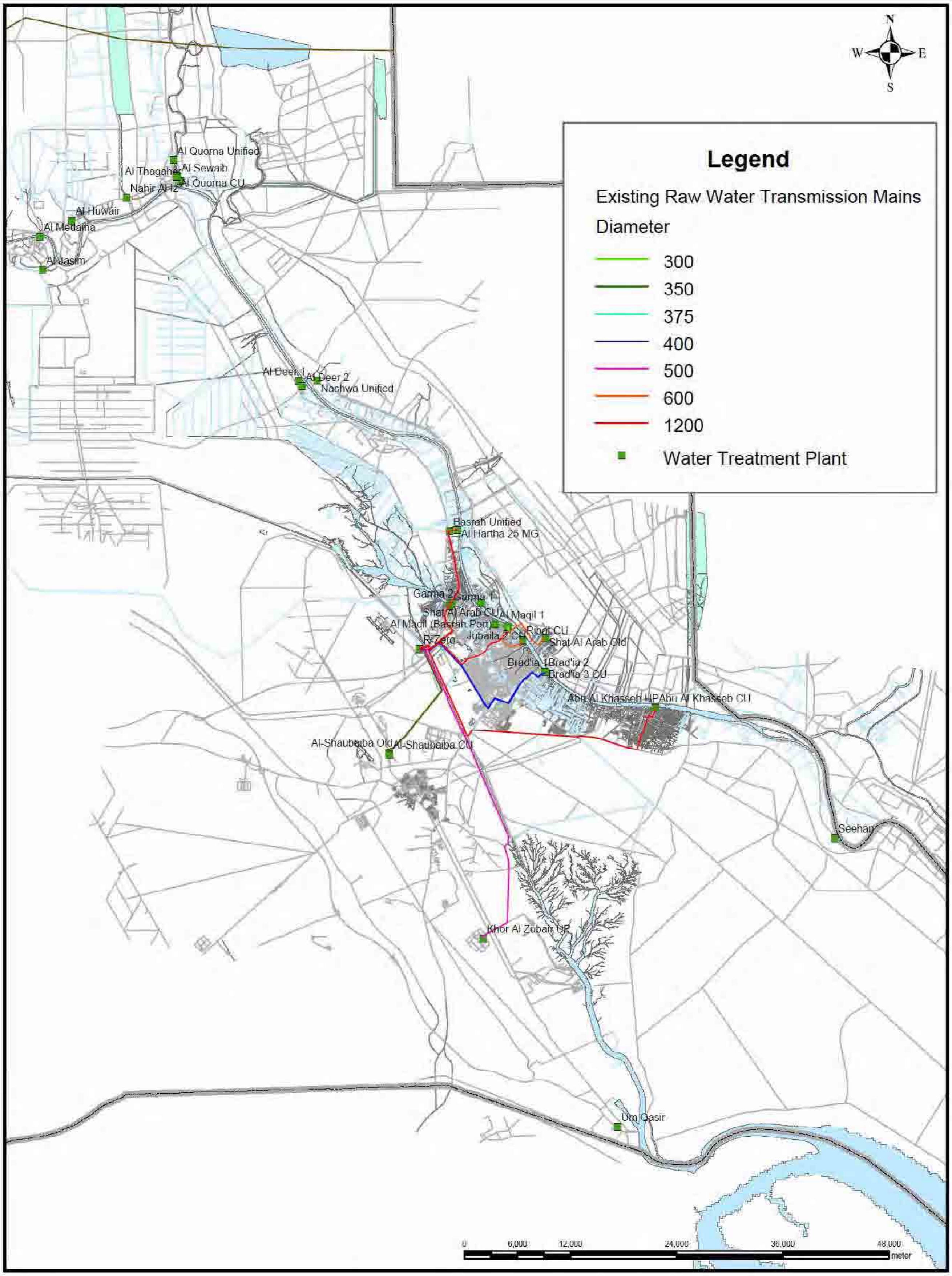
The flow of the SWC at R-Zero has been recovered as about 6 m^3/s in July 2006. However, there are several uncertainties in received flow at the R-Zero in the future and therefore the SWC is not a reliable water source. The current detailed structural conditions were not certain. The intake is located at Bada's outside of the Governorate of Al-Basrah and operated by the Ministry of Water Resources (MWR), which is not controllable by the Governorate. Also the relationship between the marsh restoration project and SWC flow is not certain. To evaluate the future reliability of the SWC, more information is required. Under these uncertain circumstances, the rehabilitation works for the pumping station 1 and 2 were prepared as shown in Appendix A.

2.3.3 Water Treatment Plant and Raw Water Transmission Pipeline

There are 37 water treatment plants in the Governorate of Al-Basrah (Figure 2.6 and Figure 2.7), out of which 20 water treatment plants are located in the Basrah City and its surrounding area, to which the raw water is fed from the SWC (Table 2.5). The rest are located out side of Basrah city (Table 2.6).



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.** 2.6



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 Basrah Governorate and Raw Water Transmission Mains from R-Zero**	**Fig No.** 2.7

Table 2.5 Water Treatment Plants in Basrah City and Surrounding Area and Connected to SWC

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.

Table 2.6 Water Treatment Plant located outside of Basrah City and Not Connected to SWC

No.	Name	District	Type	Water Source	Year of const	Year of rehab	Design Capacity (m^3/day)	Actual capacity (m^3/day)
1	Al Kaim	-	C.U.	Tigris	no data	No data	7,000	5,600
2	Al Quorna Unified	Al Quorna	Conv	Tigris	1979	2001/on-going	20,000	18,000
3	Al Quarna Old	Al Quorna	Conv	Tigris	1970	On-going	1,000	900
4	Al Quarna CU	Al Quorna	C.U.	Tigris	1984	2002	10,000	8,000
5	Al Sewaib	-	Conv	Tigris	1960	never	1,000	900
6	Al Thagaher	Al Quorna	C.U.	Tigris	1989	never	2,400	1,900
7	Nahir Al Iz	Al Medaina	C.U.	Al Eiz Iz	1995	2004	12,000	9,600
8	Al Huwair	Al Medaina	C.U.	Al Eiz Iz	1980	2004	23,000	18,400
9	Al Medaina	Al Medaina	C.U.	Euphrates	1977	2005	25,000	20,000
10	Al Sadik	Al Medaina	C.U.	Euphrates	No data	No data	10,000	8,000
11	Al Jasim	Al Medaina	-	Euphrates	2000	2006	9,600	7,700
12	Al Deer 1	Al Quorna	C.U.	SAA	1984	never	1,000	800
13	Al Deer 2	Al Quorna	C.U.	SAA	1982	never	10,000	8,000
14	Nashwa Unified	Al Quorna	Conv	SAA	1986	2001	10,000	9,000
15	Nashwa	Al Quorna	C.U.	SAA	no data	No data	1,000	800
16	Seehan	Al Fao	C.U.	SAA	1992	2004	16,000	12,800
17	Um Qasir	Al Zubail	Conv	SAA, Maqil (Basrah city)	1974	2003	unknown	
	Total capacity						159,000	130,400
	Conventional		5				32,000	28,800
	Compact Unit		11				127,000	101,600

There are two types of water treatment processes used in these water treatment plants: conventional and compact unit. Conventional plants are rather old and the latest plant was constructed in the 1980's and the oldest one in the 1930's. Compact units are comprised of simply prefabricated parts in a low cost structure. Because of the simple structure, compact units have very short life time; e.g. about 15 years.

The actual capacity of the water treatment plants is summarized as shown below and the total capacity is 660,000 m^3/day, out of which compact units provide 63 %, or 413,000 m^3/day. Currently some of the treatment plants located along the Shat Al Arab are operated at more than the design capacity, taking more water than designed from the river. This is one of the reasons for the poor treated water quality.

Table 2.7 Summary of Capacity of Existing Water Treatment Plants

(m^3/day)

Type of treatment	WTP in Basrah city and/or connected to SWC	WTP in the Other area	Total
Conventional	218,200	28,800	247,000
Compact Unit	311,300	101,600	412,900
Total	529,500	130,400	659,900

Practically, water treatment plants produce the water with the following status:

- 35% without any treatment (from river to network)
- 25% chemical added by hand without dosing equipment for alum only
- 20% chemical added by hand without dosing equipment for alum and chlorine
- 20% chemical added by dosing equipment for alum and chlorine

(Source: Local contractor)

The raw water reached at R-Zero is conveyed to the water treatment plants by pumps through transmission pipelines. The routes of the pipeline are shown in Figure 2.6. The following table presents water treatment plants by water sources in Basrah city and its surrounding area. The water treatment plants which use only raw water of SWC are located in land area far from the Shat Al Arab. The total capacity of these water treatment plants is 164,000 m^3/day. When the available raw water from the SWC is reduced, the water is conveyed to these treatment plants as a priority and other plants use water from the Shat Al Arab.

Table 2.8 Water Treatment Plant by Water Source

Water Source	Water Treatment Plant	Actual Capacity (m^3/day)
Only SWC	R-Zero, Shat Al Arab CU, Abu Al Khasseb UP, Al-Shauaiba Old, Al-Shauaiba CU, Khor Al Zubair UP	164,000
SWC and the rivers (Shat Al Arab and Garma Ali)	Al Hartha 25 MG, Basrah Unified, Garma 1, Garma 2, Jubaila Old UP, Jubaila 2 CU, Ribat CU, Brad'ia 1, Brad'ia 2, Brad'ia 3 CU, Shat Al Arab Old, Abu Al Khasseb CU	353,280
Only Shat Al Arab	Al Maqil (Basrah Port Plant)	12,150

The flow rate of raw water transmission pipelines to each treatment plant depends on the water availability at the R-Zero. The flow rate reaching to the R-Zero have increased since January 2006 and the current estimated flow is approximately 6 m^3/s in July 2006.

In late July 2006, about 5 m^3/s in total (which is equivalent to 430,000 m^3/day) was transferred from the R-Zero to treatment plants, based on the flow rate estimated from the number of operating pumps at the R-Zero. The following table shows the conveyed water flow of each treatment plant.

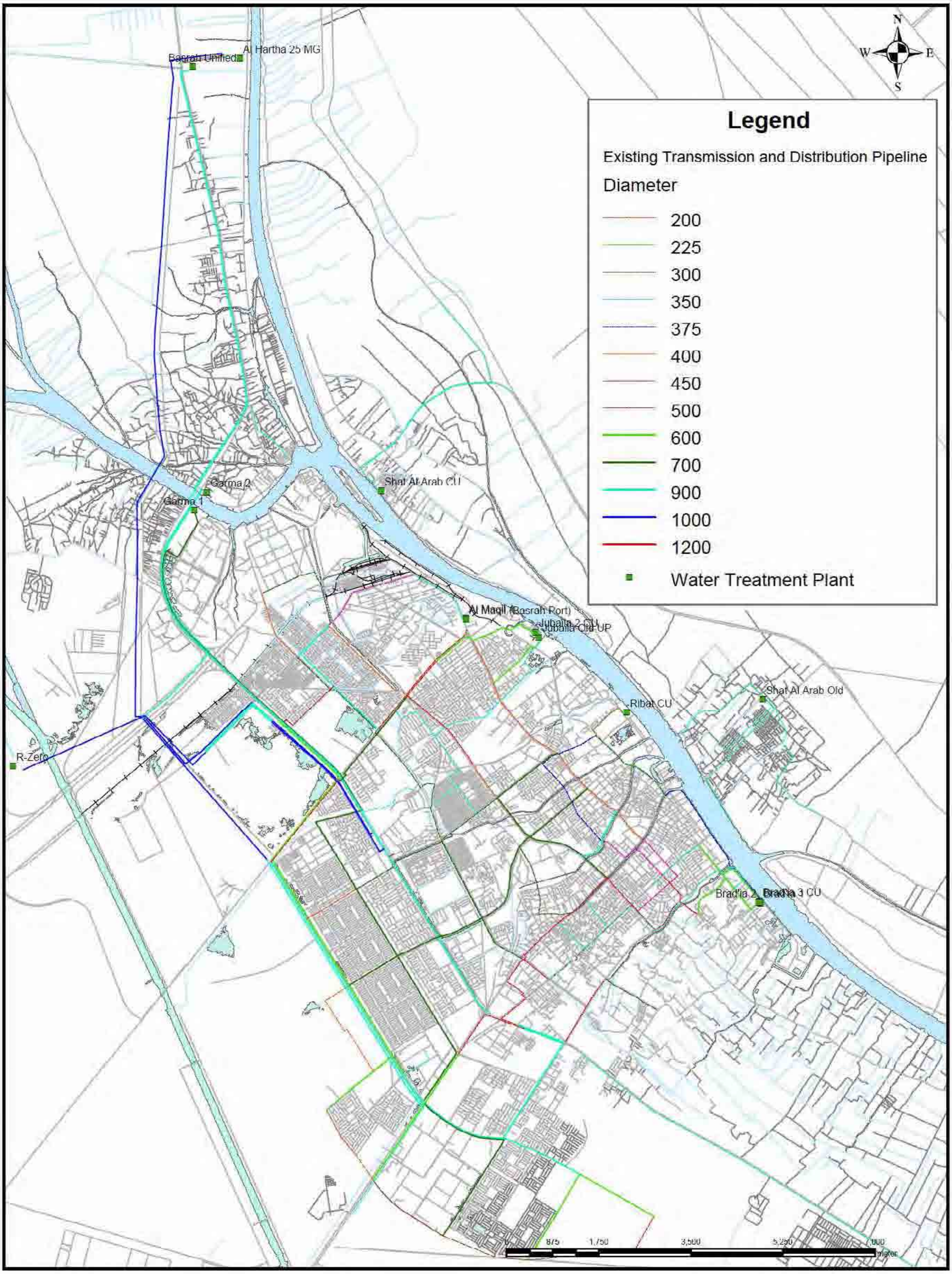
Table 2.9 Estimated Flow Conveyed from R-Zero to each Treatment Plant in late July 2006

Water treatment plant	Flow rate (m^3/day)
R-Zero Compact Unit	75,600
Al Basrah Unified	84,900
Al Hartha 25 MG	67,200
Jubaila	57,100
Bradi'ia	34,700
Abu Al Kasseb	23,700
Al Shauaiba	54,500
Khor Al Zubair	35,800
Total	433,500
(equivalent to)	5.02 (m^3/s)

Note: estimated from the number of duty pumps at R-Zero.

2.3.4 Distribution System

The existing transmission and distribution mains in Basrah city are shown in Figure 2.8. BWD has a GIS inventory but cannot activate, and the data is not available. According to available collected data from BWD, the total length of pipeline is 3,912 km (245 km for trunk main and 3,667 km for supply network). The largest pipe size in the system is 1,200 mm in diameter. The pipe materials are cast iron (CI), polyvinyl chloride (PVC), PE/HDPE, and asbestos cement (AC). Seventy-four percent of the pipes is PVC and 13 % is AC. Ninety percent of the trunk main is over 30 years old and 85 % of the supply network is between 10 to 30 years old (see Appendix A for data).



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. 2.8

The detail data of the distribution network and current conditions are not available. However, Mini M/P provides useful information on the distribution network conditions as follows:

There are no formal pressure or supply zones with boundary valves; the whole system being a single network with a few designated areas that could be isolated for maintenance and repair. Evidence from burst mains show that the distribution network operates at pressures less than 5 m of head. The low pressure causes many households to use water pumps to transfer water from the mains, indicating that water pressure in the mains is generally low and may not be operated under any normal working pressure. Mini M/P describes some of the factors affecting pressure as follows:

Basrah suffered severe bombing during the Iraq-Iran and subsequent wars, leaving many water pipes broken and punctured. Many of the repairs were made with improvised materials that may have been adequate to prevent low pressure losses but that may not able to withstand normal distribution pressures. Even at low pressures, leakage occurred in some sections of pipe.

Pumping water from the mains by private individuals further reduces the pressure in the mains and result in polluted water being drawn into the mains through fractures and other openings in the pipes.

Sediment from incomplete water treatment, infiltration of soil through fractures or during repairs, and insufficient flow and pressure to flush or even disturb deposits have caused accumulations of debris in the distribution pipes.

Many service connections from mains to houses have sub-standard fittings and are given insufficient care. In many instances low (garden hose) quality pipes were used to provide service connections, and these are not rated for normal distribution network operating pressures and often fail.

Illegal connections were made to raw water and treated water mains. The illegal connections are often indistinguishable from the legal connections. Historically, little action has been taken against the perpetrators because the illegal connections may be the only means of water availability in such cases.

Because of missing, broken, and run down equipment, Basrah's water treatment works generally produced less water than required to overcome leakage and satisfy consumers. As mentioned earlier, the existing water distribution network is very old and in poor condition.

Therefore, it requires extensive maintenance and rehabilitation especially for the pipes, fittings, and valves. Several key issues should be resolved to improve Basrah's distribution system:

- Development of network maps for the transmission and distribution networks. They apparently do not exist and no meaningful planning can be undertaken without some semblance of a network map.
- Undertake some basic modeling of the network as part of an overall plan to rehabilitate and upgrade the network.
- Addition of isolation valves is a priority to help establish operation and maintenance zones in the systems and enable isolating parts of the system when needed.
- Addition of air release valves and washouts is necessary to avoid air blockage in the pipes and to be able to drain the water and debris from the network.
- Installation of flow measurement equipment to obtain the data of the actual flows in the system is very important for the design and management of the network.
- Continued program of leak reduction. A program has been implemented over the past year, but new leaks continue to appear in spite of low pressures.

In overall, the combination of the above factors results in high levels of unaccounted-for-water (UFW), estimated at over 60 percent, and this does not allow the development of acceptable flows and pressures in the mains. The main problems in existing distribution system include the following:

- Poor or no definition of source allocation.
- No measurement of water into supply and its movement within the distribution system.
- This inhibits quantitative assessments of the relative performance of distribution areas and prevents cost effective targeting of investment for improvement.
- Inadequate head in existing storage facilities to deliver the average daily flows across the existing pipe network.
- Reliance on direct pumping into large sections of the pipe network of a widely spread area generating excessive heads in areas close to the pumping station. This wastes energy and increases leakage.
- Inadequate isolation and definition of distribution zones causing uncertainty in the demand of the area and creating the possibilities for re-circulating pumped supplies and the reduction of pumped outputs due to the unbalanced heads of one or more pump stations delivering into the same area.
- Lack of pipe network design to provide adequately sized distribution pipes within zones resulting in high head losses in the network.
- Poor matching of pump characteristics to the application because of the wide variations of flow and head when pumping directly into the distribution pipe network.
- Lack of service standards to be used for design of new infrastructure and to measure the performance of the existing system and improvements to it.
- Pipes in poor structural condition (primarily tertiary and service pipe of galvanized iron)

contribute to significant leakage ratio.

- Negative pressures causes some sections of the pipe network and pipes supplying bulk quantities of water from pump stations to fill and empty during peak demand. This phenomena causes:
  - ✧ Air locks
  - ✧ Sub-atmospheric pressures that under certain circumstances can cause the ingress of contaminated water into the distribution pipe network
  - ✧ Inaccuracy in metering devices
  - ✧ Potential damage from surge pressures on pump stopping and starting up
  - ✧ Increased potential to transport deposits laying in pipes, resulting in blocked meters (subscriber meters are particularly vulnerable) and dirty water complaints
  - ✧ Conditions encouraging more rapid corrosion of ferrous pipe and pipe fittings
  - ✧ Inequitable distribution of available water due to the significant differences in subscriber storage

After the preparation of Mini M/P, several network improvement projects were conducted mainly by DFID so the condition of network is expected to improve. Therefore, before the preparation of a detail plan for the distribution network, detail network studies including mapping was planned to acquire necessary data.

2.3.5 Problems of Operation and Maintenance of Facilities

(1) General Operation and Maintenance Problems

Several major problems in operation and maintenance of the facilities are identified from various sources and listed as follows:

- Workers' knowledge of water treatment plants is very poor
- Technical education level of operators & technicians is very low
- Number of operators and maintenance staff are less than the required
- Severe shortage of tools, spare parts and measuring equipment
- All warehouses in water treatment plants are empty or disorganized except 4 plants (R-Zero, Jubaila 1, Jubaila 2 & Garma 1) which are under the private company contracts for operation and maintenance
- Low salaries except the persons working in the plants which are under private company contracts
- Transportation means for the workers is inadequate
- Most of operators and maintenance staff need training
- Some of the water treatment plants are lacking staff because of security issues. Local people use and operate the plant's equipment without authority

- There is no protective maintenance schedule except for those which are under private company contract
- Chemicals (aluminum sulphate and chlorine gas) available in the local market is of poor quality and in insufficient quantity. Private contractors import the chemicals from United Arab Emirates (UAE) or Iran
- Inadequate budget for maintenance and operation
- There is no budget for purchase of chemicals

Many problems of operation and maintenance of compact units are identified by the local engineers. (see Appendix A). The life time of compact units is usually 15 years or less and construction of compact units is a temporal solution to increase water production capacity. As a sustainable solution, conventional water treatment plant is required to increase water production capacity for Basrah.

(2) Main Drawbacks of Basrah Water Distribution Networks

The difficulties of the network are summarized below in terms of the age of the network, type of the network, and the current situation of the network.

1) Age of network

There still exist many old main pipelines in Basrah, most of which were implemented before 1950. Most of these pipelines are asbestos and the other are cast iron. The total length of these pipes is more than 50 km which is connected to the old water treatment plants like Jubaila and Brad'ia. These pipelines mostly pass throw the old sectors of Basrah city. The main difficulties to use this type of pipes are:

a) The accessories of this network are not functioning and result into difficulties in the control of water flow.
b) Unavailability of the spare parts for repair and maintenance.
c) Losing the experienced persons who once worked on this type of pipes because of retirement.
d) The asbestos pipe is not allowed to be used as water pipelines.

2) Type of network

In Basrah there is a complete design prepared in 1982 for the whole area of Basrah city which contains the main pipelines, the reservoirs and elevated tanks with a complete model showing the flow directions and the pressure in each branch. This design has not been implemented because of the change in the water source from Al Quorna to Al Badaa in Nasyriah, because of the Iraq – Iran war and the increase in the salinity in the Shat Al Arab and the southern part of Tigris.

Because of the delay in the implementation of the new treatment plant and seeking to the urgent solutions, many groups of compact units have been installed with new pipelines and distribution lines without taking into account of the previous complete network design. So still the previous distribution pipelines take the water from the old plants and the new distribution pipelines take the water from the new ones without any logical calculations to put a new distribution model to the whole network and canceling the use of the elevated tanks.

All the other new main pipe lines and distribution pipelines have been implemented not to complete the previous design but to solve the urgent need of the water in Basrah.

3) The current situation of the network

The existing water network in Basrah has been constructed based on the bad design and the hasty works to solve the urgent need of the water, and has added the following difficulties:

a) The shelling in the three wars caused a lot of unseen leakages in the networks which causes high leakage and makes the current water production ineffective and not enough to cover the water demand of the city. This difficulty needs an accurate investigation by using a modern technology and then a planned work with enough funds to solve it.
b) The cancellation of the elevated tanks makes the pressure uneven in the network.
c) Because there are no reservoirs inside the city, the water in the network will be stopped if the water plants are stopped for any reasons. Therefore, to solve this problem, reservoirs with a capacity of at least covering the need of eight hours are required.
d) The illegal and bad connections in the network make it lose high percent of the produced water.
e) The unavailability of a good quality of controlling and monitoring devices in the network makes the control of the water distribution in the network very difficult especially when the need to repair damaged pipes or to make a rationing schedule arises.
f) Bad house connections lead to the loss of a lot of treated water and results into poor pressure.
g) The wide use of house boosting pumps directly connected to the network leads to a poor pressure or negative pressure in the network and causes ingress of dangerous pollution sources from sewage.

4) Conclusions

From the drawbacks discussed above, we can conclude that the proper way to improve the water networks depends on:

a) Preparing a hydraulic computer model of the existing network to discover all the problems in the distribution and any improvement needs like installation of new control valves or implementation of new distribution pipes or change of the existing pipes, etc.

b) Implementing construction of trunk transmission mains such as ring mains to transfer water from the existing and future water treatment plants.

c) Dividing the network to zones and constructing new water reservoirs, pump stations and elevated tanks inside the city with respect to the zones.

d) Making a comprehensive investigation of the network, examining its situation with respect to the pressure, the leakages, illegal connections, house connection, etc.

e) Changing all the old pipes like the asbestos pipes with new ones.

f) Installing telemetry system to help BWD and the maintenance teams in monitoring the network and discovering the faults immediately.

g) Development of the qualification/capabilities of the maintenance teams by continuing training courses utilizing Basrah Water Training Center and other training institutions inside and outside Iraq.

h) Supporting the maintenance teams by providing important equipment and tools along with the needed spare parts.

2.3.6 Drinking Water Supply by Reverse Osmosis

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. The long-term development plan of water supply envisioned in the Mini M/P is still ongoing. For the immediate future, RO water will continue to be the main source of potable water for a large percentage of the population.

Currently there are 34 RO plants in operation and under construction in the Governorate of Al-Basrah with their combined design capacity of 900 m^3/hr (see Appendix A). Each plant usually operates 10 hours per day. There are no storage tanks at the RO plants for treated water so that the plants can only operate in working hours directly filling road tankers. The RO plants are owned and operated by the BWD, the city of Basrah, state owned industrial enterprises, or the private sector. In October 2006, the state owned Petro Chemical Plant in Basrah was to commence RO production at the rate of 1000 m^3/hour. The plant has been refurbished with funds from DFID and UNICEF.

Table 2.10 Design Capacity of RO Plants in Basrah

District	Number of Plants	Current design capacity (m^3/hr)
Al Basrah and Al Hartha	4	212
Abu Al-Khasseb	3	87
Al Zubair	5	105
Al Quorna	5	173
Al Fao	3	75
Shat Al Arab	3	68
Al Medaina	11	210
Calculated Total	34	930

Table 2.11 shows the treated water quality of RO units in Basrah. TDS is reduced to the potable water quality level ranging from 50 to 200 mg/l.

Table 2.11 TDS (mg/l) of RO Plants in Basrah

NO.	RO Plant	May (2006)	June (2006)
1	Bradia	-	172
2	Ribat	-	168
3	Mouafaqia	-	48
4	Jubaila	-	57
5	Garma	69	-
6	Abu Al Khaseeb (Mhailla)	97	-
7	Al Medaina	100	-

Source: BWD Center Lab

The RO treated water is transferred by tankers to the distribution points and distributed through a network of distribution centers. Each of the distribution centers has the capacity for several hours of storage and is located across the city with the basic premise that no person in an urban area should have to walk more than 500 m for potable water (Mini M/P).

To determine a fair cost to sell the water to the public, only the operating and maintenance cost was considered and not the initial capital cost. The costs also should include replacement of membranes, chemicals, occasional plant breakage, wages, etc. The resulting cost for RO water was determined to be 1 US\$/m^3. Allowing for a reasonable profit margin for the contractor, this gave a target figure of 100 ID per 20 liters, or 5,000 ID /m^3 (about 6 US\$/m^3). This could be comparable with 250 ID per 20 liters for most privately sourced RO water (Mini-M/P).

2.4 WATER QUALITY

(1) Survey Methodology

The study team carried out water quality survey in June and August 2006 through a local contractor. The objectives of the water quality survey is to confirm the existing conditions and to assess problems in the water supply sources, raw and treated water at the treatment plant and distributed water at the service connections.

A total of 104 samples were collected and analysed. The details of the sampling points and their locations are shown in Appendix C.

Table 2.12 Number of Samples Collected for Water Quality Analysis

Location	Number of samples collected		Total number of samples
	Dry season (end of June)	Rainy season (end of August)	
Water sources (rivers, canal and well)	9	9	18
Raw and treated water in water treatment plants	33 WTPs	-	66
Distributed water at water hydrants	20	-	20
Total			104

To assess the results of water quality analysis the Iraqi standards for drinking water were applied for most of the parameters. However, for the water quality items related to the protection of human health and undecided items by the Iraq standards, the WHO Guidelines were applied (see Appendix C for standards).

(2) Results of Water Sources

According to the results of water quality analysis for water sources, the characteristics of water quality of river, canal and groundwater in the Study area are summarized as follows.

Ground water

Salinity of the well water in Khor Al Zubair is abnormally high (TDS=5,635 mg/l, EC=8,133 mS/m) and the water quality is far from the necessary criteria for drinking water or the criteria for water supply. The water quality of this source was the worst of all sources investigated.

River water

The Tigris, the Euphrates, and the Shat Al Arab rivers were surveyed. The characteristics of the river water qualities are described as follows:

a) The river waters satisfy the water quality items related to the protection of human health in the water quality standards of Iraqi and WHO guideline for drinking water.

b) Similarly, water quality of these rivers satisfy water quality items related to the abstraction of water utilization for drinking and domestic water except some parameters but these can be achieved by conventional water treatment.

c) Some items representing inorganic substances namely, TDS, Total Hardness, Chlorides, Sulphates and n-Hexane Extracts do not satisfy the criteria for drinking water.

d) Inorganic substances can be reduced below the criteria for drinking water by RO treatment only.

e) n-Hexane extracts are detected in the lower reaches of the Shat Al Arab in the Basrah city. These contents cause problems in water treatment process and deteriorate water quality for drinking.

The characteristics of water quality by river are described below.

Tigris River

TDS of this river was the lowest (863 mg/l in June and 1,286 mg/l in August) among the surveyed rivers, while turbidity was the highest (115 NTU).

Euphrates River

In comparison to the Tigris River, the Euphrates is not as good a water source for water supply. The concentration of inorganic substances (TDS is 1,895 mg/l in June and 1876 mg/l in August) is high. For the other parameters however, the water quality of the Euphrates satisfies the requirements for water sources.

Shat Al Arab

There in no significant difference in TDS values of the Shat Al Arab water from the upper reaches to the lower reaches, which is ranging from 1,364 mg/l to 1,448 mg/l in June and 1,729 mg/l to 1,809 mg/l in August. N-Hexane extracts were detected in the lower reaches of this river. N-Hexane values in Abu Al Khaseeb and in Seehan are 72 mg/l and 672 mg/l, respectively. The pollution source of n-Hexane extracts is uncertain; it may be from sunken ships or wastewater from the Basrah urban waste. Consequently, the Shat Al Arab upstream of Basrah City should be used as a water supply source to avoid contamination by n-Hexane extracts.

In addition, the following data were collected from BWD for Shat Al Arab. In deciding the capacity of proposed RO plant and conventional water treatment plant, a TDS value of 1,500 mg/l is used for Shat Al Arab after confirmation with MMPW in the second technical meeting.

Date	Shat Al Arab
June 2006	1620
May 2006	1327
Oct 2005	1300
Dec 2005	1325
Nov 1997	1450
Average	1404

Sweet Water Canal

Inorganic substances of the SWC were the lowest with TDS of 542 mg/l in June and 789 mg/l in August (670 mg/l on average), Conductivity of 849 mS/m and Total hardness of 238 mg/l in June. The SWC is the most suitable water supply source in the Study area in terms of TDS.

The findings of the water quality survey for water sources are summarized as follows:

- In terms of TDS, the SWC is most suitable water source in the Study area. The ground water in Khor Al Zubair is not a suitable water source.
- Relatively, the Tigris and the upstream of the Shat Al Arab are better water supply sources.

(3) Results of Water Treatment Plant

According to the results of water quality analysis for 33 water treatment plants in the Study area, treatment efficiency and 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 colour.

b) Residual chlorine in the treated water of 13 treatment plants was not detected and Total Coliform and Escherichia Coli (E. Coli.) were detected.

c) Iron, Manganese and Ammonia Nitrogen satisfy the criteria for drinking and domestic water.

The following 3 figures explain the existing water treatment conditions. Only 6 plants meet the water quality standards in terms of turbidity. Six plants produce water having turbidity value more than 80 (NTU). Similarly, the 19 plants do not meet the standards for color. E. Coli was found in the treated water of 13 plants.

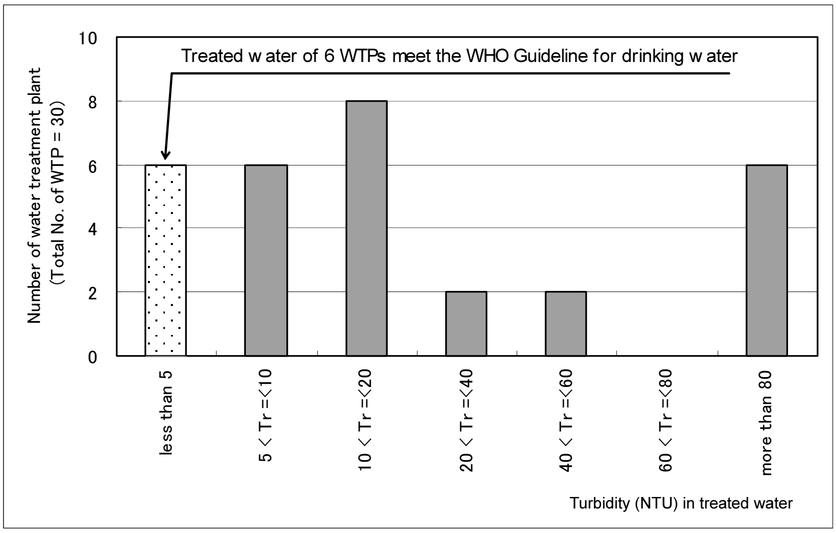


Figure 2.9 Turbidity of Treated Water of Existing 30 WTPs

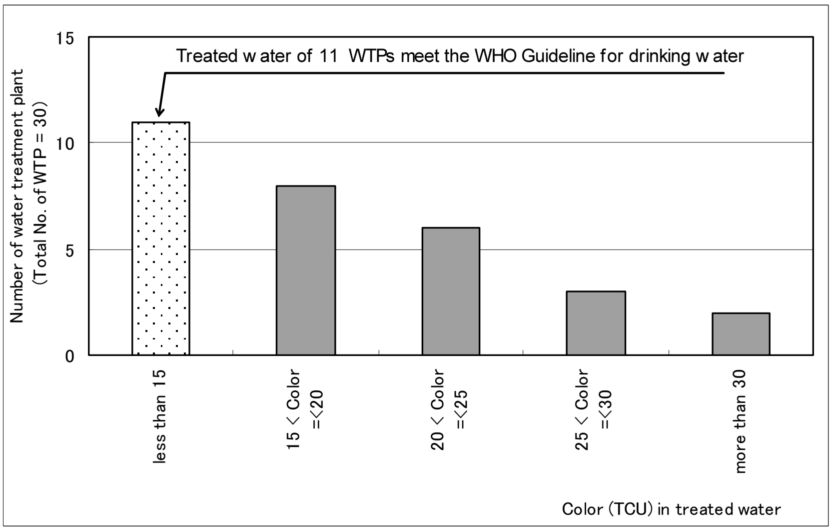


Figure 2.10 Color of Treated Water in Existing 30 WTPs

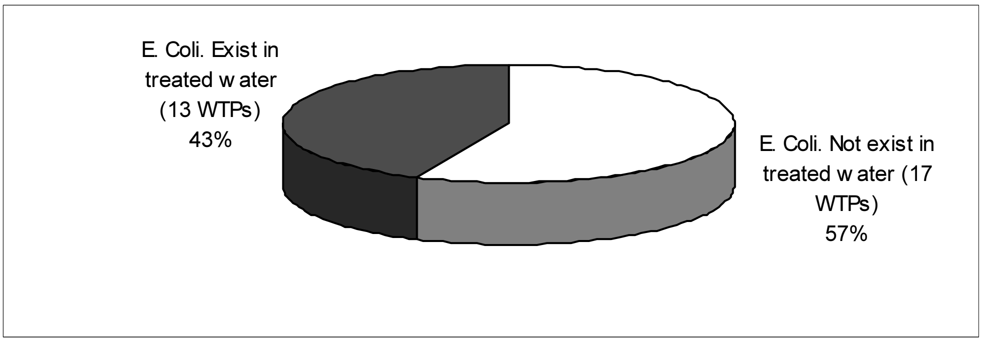


Figure 2.11 E. Coli of Treated Water in 30 WTPs

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.

(4) Results of Water Hydrants

Based on the results of water quality analysis for 20 water hydrants in the Study area, the characteristics of water quality of distributed water are summarized as follows.

- Residual chlorine was not detected in the distributed water in 12 hydrants out of 20 surveyed and Total Coliform and E. Coli. were detected.
- It is implied that the presence of Total Coliform and E. Coli. in the distributed water was caused by intrusion of sewage into the distribution pipe or insufficient chlorination of water at treatment plants.
- Distributed water in 60 percent of the investigated hydrants is not suitable for drinking.

From the results of water quality survey for water treatment plants the distributed water quality is not suitable in terms of turbidity and color in many places where water treatment conducted is inadequate or inappropriate.

2.5 BASIC DATA OF BASRAH WATER DIRECTORATE

(1) Basic Indicators of BWD

The following table presents the basic indicators of BWD.

Table 2.13 Basic Indicators of BWD

No.	Items	Contents (source)	Remarks
1	Total population in Basrah Governorate	1,881,000	BWD
2	The total number of subscribers (customers) at the end of 2005	114,366	BWD
3	Population served by public water supply	1,354,600	BWD
		903,491	114,366 x 7.9 persons per household by the study team
4	Service population ratio	71.65%	BWD
		48 %	by the study team
4	Average water production	508,590 m^3/day	BWD
5	Maximum water production m^3/day	685,520 m^3/day	BWD
6	The months of peak demand	July, August & September	BWD
7-1	Average per capita water production	270 l/ca/day	For total population
7-2	Average per capita water production	375 l/ca/day	For service population
8-1	Average per capita consumption	185 l/ca/day	Assuming 50 % leakage by JICA
8	Amount of billed (sold) water for subscribers during the year	710,628.505 ID	BWD
9	Average annual water tariff per subscriber	6,250 ID (US$4)	BWD
10	Number of customer water meters	0	BWD

Source: Basrah Water Directorate and the study team estimate.

The following table presents the number of subscribers (connections) for the past 3 years. The growth rate of connections is about 1 % during the year 2005. Assuming 7.9 persons per household (derived from the Social Survey by the study team), the total service population is 887 thousand. This is equivalent to 47 % of the total Governorate population. This may imply that about 30 % of the total population is not authorized customers of BWD.

Table 2.14 Number of Subscriber (Connections) at the End of Year of 2003, 2004 and 2005

Fiscal year	2003	2004	2005
Residential	111,058	111,558	112,258
Industrial & Commercial	1,326	1,326	1,326
Public (institutional)	382	382	782
Others	-	-	-
Total	112,766	113,266	114,366

The following table shows the average day water production of water treatment plants of BWD. Of the total 560,000 m^3/day produced, 58 % was produced from compact units and 39 % from conventional plants. The remaining 3 % was supplied without any treatment.

Table 2.15 Average Day Water Production of Water Treatment Plants of BWD

No.	Water treatment plant (Compact units)	Water production (m^3/day)	No.	Water treatment plant (Conventional)	Water production (m^3/day)
1	R-Zero	72,000	1	Bradaia 1	25,200
2	Al Hartha 25 MG	72,000	2	Jubaila 1	24,000
3	Garma 1	42,262	3	Basrah Unified	22,800
4	Al Ribat	39,240	4	Shat Al Arab	20,000
5	Jubaila	19,200	5	Maqal 2	19,200
6	Sihan	19,000	6	Al lbani	19,000
7	Mhila	13,000	7	Al Shaiba old	17,500
8	Garma 2	8,000	8	Bradaia 2	16,000
9	Shaiba com	8,000	9	Al Quorna Unified	15,600
10	Al Fyhaa (Shat Al Arab)	5,600	10	Khor Al Zubair	15,000
11	Maqal 1	4,800	11	Al Nashwa	10,000
12	Bradaia	4,000	12	Al Swabe	5,800
13	Talha	4,000	13	Al Quorna old	3,600
14	Al Izz river	3,200	14	Um Qasir	2,700
15	Medaina	3,000		Sub-total	216,400
16	Garma com	2,000		Transmission pumping station	
17	Al Hwair	1,500	15	Maqal 3	18,000
18	Al Deer 1	600	16	Shaiba Al Askari	3,000
19	Al Thager	350		Sub-total	21,000
20	Deer 2	400			
	Sub-total	322,152		Total	559,551

Source: BWD

(2) Water and Sewerage Charge

The following table presents monthly water charge by type of customer. The tariff rate of sewerage is the same as water tariff rate. For the household with 4-5 rooms, monthly water and sewage charge is 2070 ID. This charge level is considered to be low.

Table 2.16 Monthly Water and sewerage Charge by Type of Customer

1. Charge for water and sewerage for low commercial locations

Type	Water charge for one month (ID/month)	Sewerage charge for one month (ID/month)
Food/ spare parts/ stock	900	900
Carpenter shop/ work shop/ barber shop	1,800	1,800
Al Tarsh Shop	2,700	2,700
Coffee shop	3,600	3,600
Bakery furnace	4,500	4,500

2. Charge for water and sewerage for registered directorate

Pipe diameter	Water charge for one month (ID/month)	Sewerage charge for one month (ID/month)
1/2"	7,800	7,800
3/4"	18,000	18,000
1"	30,000	30,000
2"	126,000	126,000

3. Houses

Number of rooms	Water charge (ID/month)	Sewerage charge (ID/month)
(1) 2-3 rooms	435	435
(2) 4-5 rooms	1,035	1,035
(3) 6-9 rooms	1,635	1,635
(4) 10 rooms	2,235	2,235

2.6 EXISTING WATER SUPPLY SERVICE AND CUSTOMERS' NEEDS

Based on the results of the socio-economic survey, the existing condition of water supply service and people's needs are summarized as follow.

The socio-economic survey was carried out to investigate social condition as living condition and awareness of population about water supply service through questionnaire. The target area of the socio-economic survey was Al-Basrah and its neighboring cities within 20 to 30 km radius. The number of properties for the questionnaire was 400 households in 13 communities. The details of the socio-economic survey are given in Appendix B.

2.6.1 Existing Condition of Water Supply Service

(1) Conditions of Water Supply Service

Ninety-eight 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 (398 households out of 400 households); this implies that the use of bottled water supply system is firmly established in the Study area. Some households have a combination of supplied water and river water or others (carried water or water tanker) for domestic use.

(2) Estimated Water Consumption by Use

The average per capita water consumption (including bottled water) is 144 litre/capita/day (lcd), ranging from 40 lcd to 513 lcd. Approximately 86 percent of households fall in the range of 50 lcd to 150 lcd. Average unit water consumption of bottled water is 4.5 lcd (median= 4.0 lcd), and 25 percentile and 75 percentile are 2.9 lcd and 5.0 lcd, respectively.

These volumes are not measured consumption because all interviewed households have no water meter. Therefore, consumption has been estimated by volume of bucket/tank or consumer's imagination.

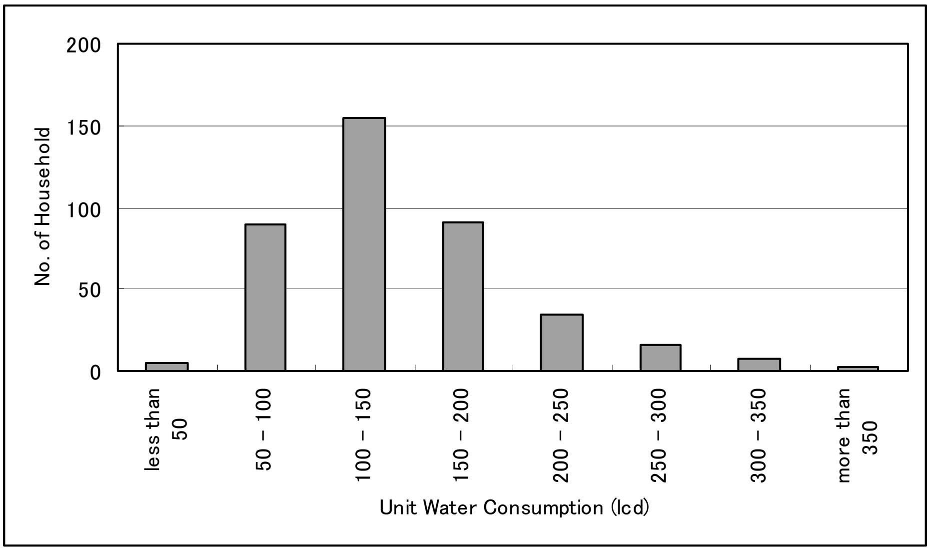


Figure 2.12 Per Capita Water Consumption

The following figure shows the per capita water consumption by monthly income group. It shows higher income groups use more water than lower income groups.

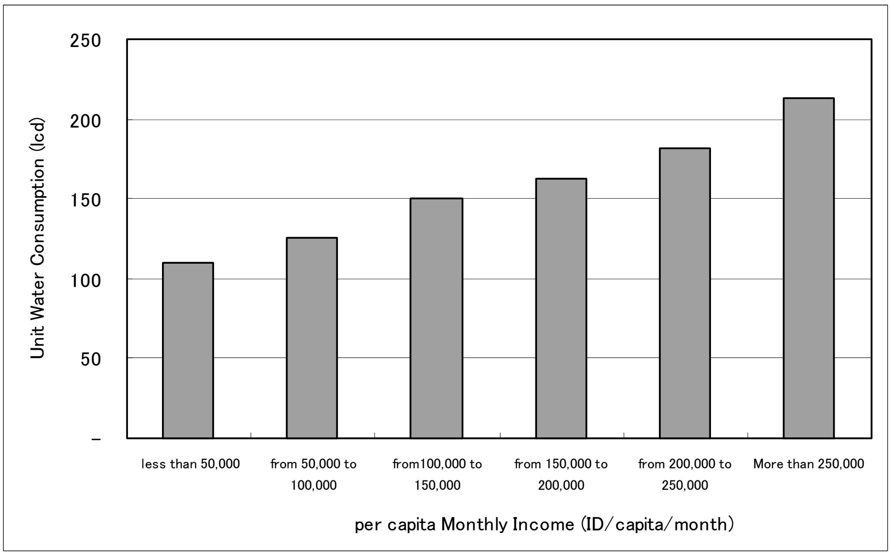


Figure 2.13 Per Capita Water Consumption by Per Capita Monthly Income

The following figure shows the 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 car washing.

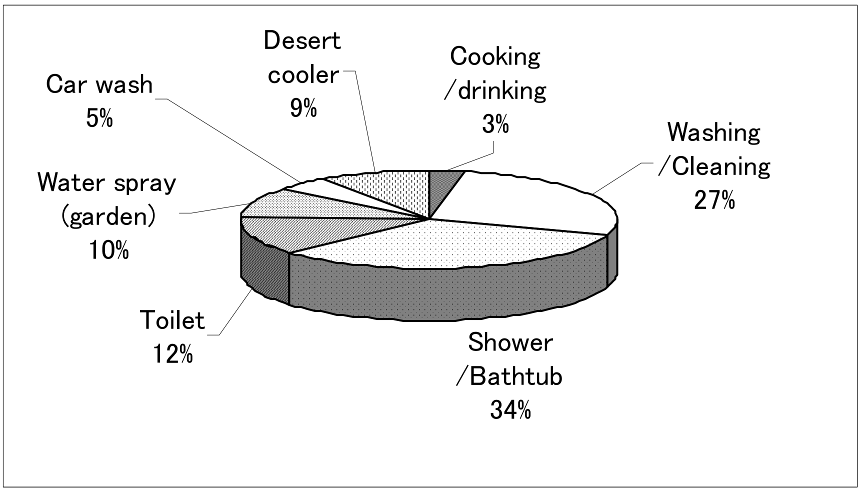


Figure 2.14 Composition of Water Consumption by Use

(3) Water Supply Service Hours

The target water supply service hours are 24 hours/day basically. However, the actual water supply service hours is limited by power failure, the shortage of capacity and poor maintenance of water supply facilities. From results of the interview survey, 41 percent of the households receive water for less than 6 hours and 66 percent, for less than 12 hours per day.

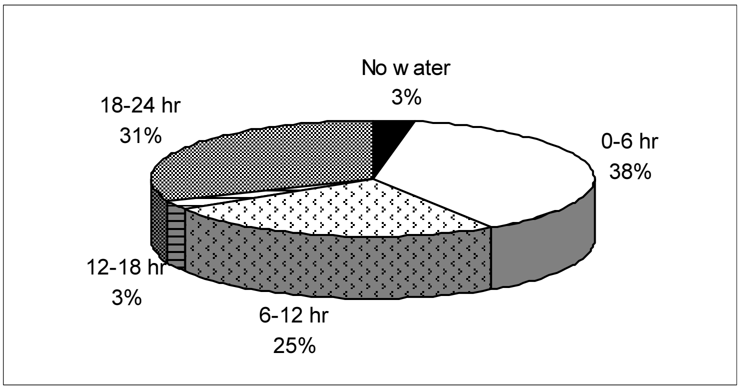


Figure 2.15 Water Supply Hours

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 compensate the low network pressure. Average capacity of storage tank is 1.1 m^3 (0.1 – 3.0 m^3), the average height of tank top is 4.5 m (0.5 m – 12 m).

(4) Cost of Water

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 people 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 expenditure for water with 0.3 percent for the public water supply service and 1.5 percent for bottled water.

(5) Served Water Quality

In the survey, color /turbidity, taste and odor were judged from a customer's own senses. From the results of the survey, approximately 90 percent of the 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.

2.6.2 The Public Requirement for a Water Supply Service

The problems of water service from the customer’s perspective are shown in Table 2.17. From the table, it is evident that the respondents are very dissatisfied in all the items except the cost of water. Based on the dissatisfaction ratio, the highest concern is taste of water, followed by water quantity/pressure, color/turbidity, odor and then service hours. These represent the requirements of the customers.

Table 2.17 Problems of Water Supply Service

Items		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

2.6.3 Willingness to Pay for the Water Supply Service

From the Socio-economic Survey, the information of willingness of household to pay for the water supply service was obtained and is summarized below.

(1) Willingness to Pay for the Current Water Service

- 170 households (43%) are unwilling to pay for the current water supply service.
- 230 households (57%) 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

- 16 households are unwilling to pay for the water supply service even if the service is improved or they cannot pay because of insufficient income.
- From results of 384 interviewed households, the average willingness to pay for the satisfied water supply service is 8,600 ID/month/household and the median value is 10,000 ID/month/household (see Figure 2.16). 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.

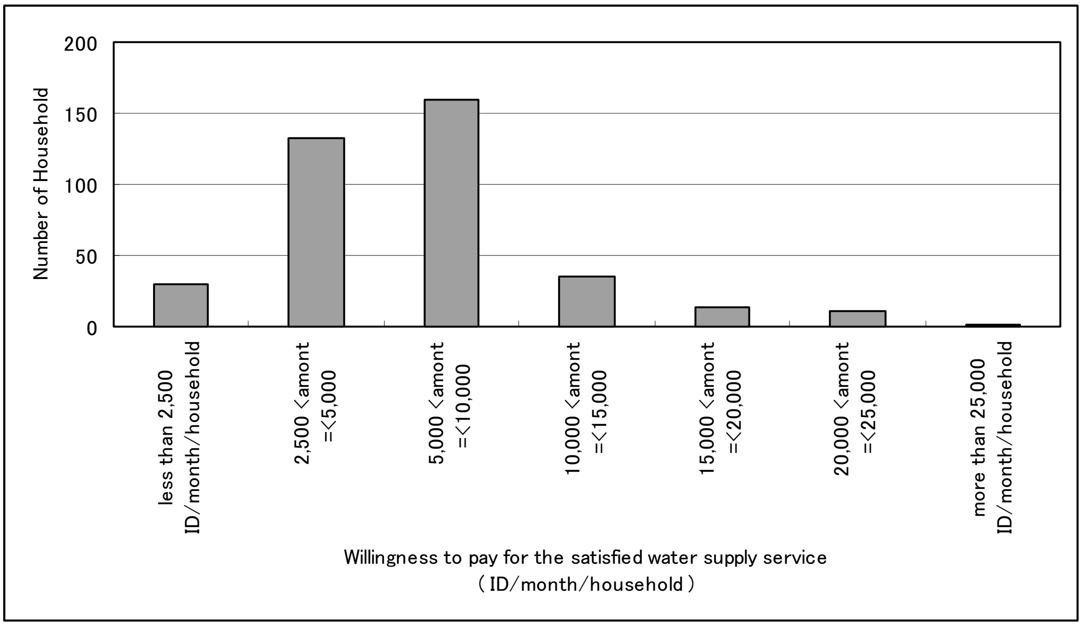


Figure 2.16 Distribution of Willingness to Pay for the Satisfied Water Supply Service

All of the interviewed households have no operable water meters; 97 % of them expressed willingness to install new meters at their premises. Also 95 % of the interviewed households agree to pay for the water bill according to the actual water consumption by water meter. Sixty-five percent of them agree to pay for installation fee.

CHAPTER 3

WATER SUPPLY DEVELOPMENT PLAN

CHAPTER 3 WATER SUPPLY DEVELOPMENT PLAN

3.1 REVIEW OF MINI MASTER PLAN

The target year of Mini M/P is 2025 with an estimated water demand of 1,167 thousand m^3/day. It was planned assuming that all the existing water treatment plants will be abandoned by then and several new treatment plants with a total capacity of 1,167 thousand m^3/day would be constructed. To meet the gap between demand and supply, the following 7 alternatives were selected and evaluated in Mini M/P.

Table 3.1 Alternative Projects in Mini M/P

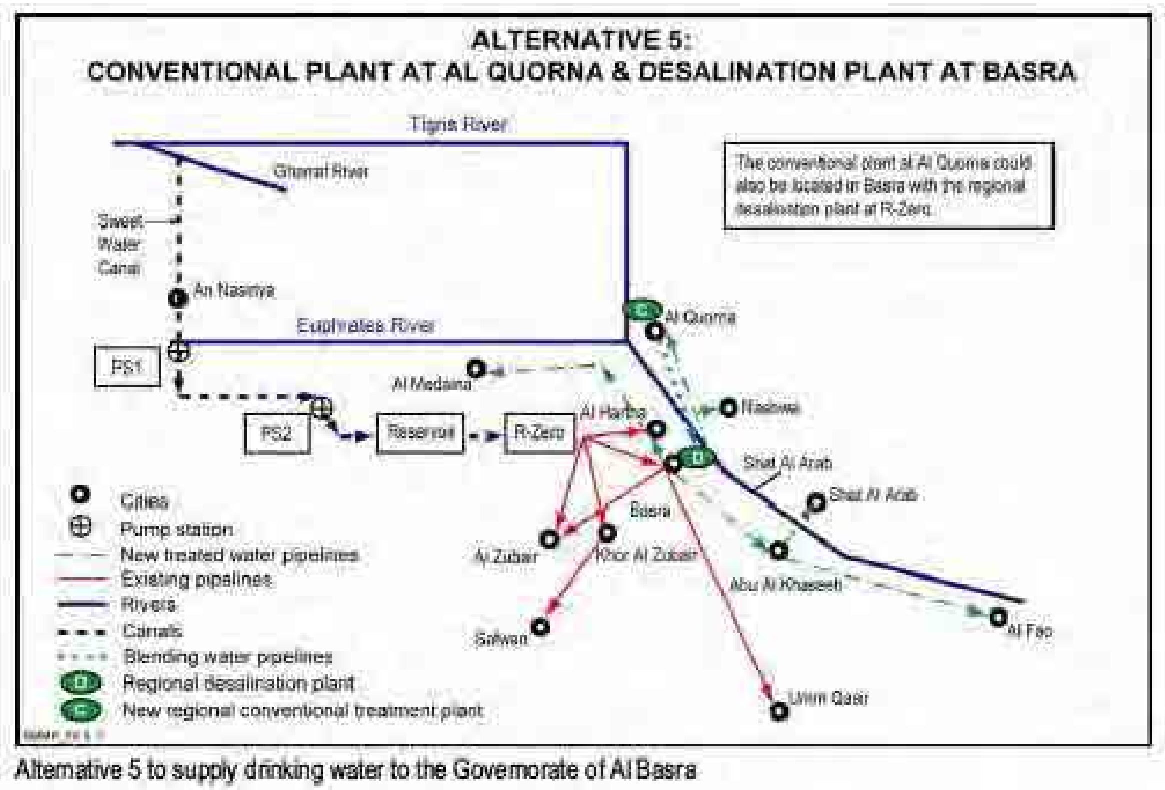
Alternative Projects	Expected TDS mg/l	Est. Capital Cost US$M[2]	Est. Annual O&M US$M
Alternative 1—Use the existing treatment plants, install additional capacity where and when required, treat raw water from the Gharraf River delivered by the SWC to R-Zero. Provide this raw water to all treatment plants within the governorate.	700[1]	2,135	81
Alternative 2—Construct a regional conventional water treatment plant at R-Zero to treat raw water from the Gharraf River delivered by the SWC. Supply this treated water to all areas in the governorate from this regional plant.	700[1]	1,971	66
Alternative 3—Construct a regional conventional water treatment plant at Al Quorna to treat raw water from the Tigris River and supply treated water to all areas from this regional plant.	1200[1]	2,135	68
Alternative 4—Construct a regional desalination water treatment plant at Basrah to treat raw water from the Shat Al Arab and supply treated water to all areas from this regional plant.	<700	2,244	109
Alternative 5—Construct a regional conventional water treatment plant at Al Quorna to treat raw water from the Tigris River and construct a desalination plant at Basrah to treat raw water from the Shat Al Arab. Pipe treated water from the Al Quorna plant to Basrah City and blend with treated water from the Basrah desalination plant. Supply blended treated water to all areas from the Basrah regional desalination plant.	<700	2,104	94
Alternative 6—Construct a regional conventional water treatment plant at R-Zero or Al Quorna to treat raw water from the SWC or Tigris River, respectively, and a desalination water treatment plant at Basrah to treat raw water from the Shat Al Arab. Construct a second distribution network in each city. Distribute the higher TDS water from the conventional plant for hygiene, laundry, and irrigation. Distribute the low TDS desalted water in the second network for drinking and cooking purposes.	700 [1]	-	-
Alternative 7—Replace the SWC with a pipeline and construct a regional conventional water treatment plant at R-Zero to treat raw water from the Gharraf River. Supply treated water to all areas from this regional plant.	700*	2,214	66

1 TDS level may increase depending on water management upstream of the Tigris and Euphrates in Turkey, Syria, and Iraq and the restoration of the marshes.
2 Includes cost of distribution system rehabilitation.
Source: Taken from Mini Master Plan

In Mini M/P, all the alternatives except the Alternative 1 adopt the water supply system in which one or two centralized water treatment plants and a centralized water transmission system in the Governorate shall be constructed. Alternative 1 adopts that the existing water treatment plants shall be utilized, rehabilitating them and enhancing their capacity and the transmission systems and thus will not be centralized.

Alternative 6 was immediately eliminated as the cost of two parallel distribution systems was too high. Alternatives 1, 2 and 7 rely on SWC as the water source of the Governorate the intake of which is from the Gharraf River and located outside of the Governorate. This gives the control of water source to persons from outside the Governorate, which reduces the reliability of water source for the Governorate. The TDS of treated water in alternative 3 would be 1,200 mg/l which is unsuitable for drinking. The construction as well as operation and maintenance costs are the highest in alternative 4.

Finally, alternative 5 is selected for the future drinking water supply for the Governorate of Al Basrah in Mini M/P. Alternative 5 purposes to take raw water from within the governorate (water independence) and desalination process provides the ability to adjust the treatment to maintain the desired level of TDS. A schematic of this alternative is shown in Figure 3.1.



(Source: Mini M/P)

Figure 3.1 Schematic Layout of Alternative 5

As far as the assumption that SWC will be abandoned in near future is adopted, Alternative 5 may be the best option. This assumption seems reasonable under the present unreliability of the operations and structures of SWC and requirements of MMPW and BWD to the water source fully under their control. However, considering that no full study for the physical rehabilitation of SWC has been conducted under current security conditions and there is an indication for the nation-wide comprehensive water resource management, decision of abandonment of SWC should be postponed. Therefore, there is still possibility that an option other than Alternative 5 becomes the best option as a result of the future review.

At the same time, the study team recognizes that the Mini M/P is very meaningful and that it is the latest available main planning reference. However, the study team found several difficulties with implementing the Mini M/P, especially achieving the final 2025 water supply goal in one step. The difficulties are listed below:

- The Mini M/P forecasted the water demand in 2025 with a fixed population growth rate. However, it is not realistic to forecast such a long term trend under the current politically and socially unstable conditions without reliable and sufficient data. A plan with such a long target year may have a large discrepancy from the actual conditions in the future. Therefore, a plan should have a shorter target year and be reviewed after a certain interval.
- All the alternatives in the Mini M/P unify water treatment plants into one or two in the long term. In the short and medium term, however, it will be necessary to utilize the existing facilities before new facilities become available. Therefore, alternatives which have multiple water treatment plants should be studied in order to rehabilitate existing water treatment plants and to utilize them in future.
- The estimated project costs were very large and the realization of the projects is questionable. Therefore a phased implementation of the projects will be prepared.
- Area-wise prioritization should be introduced to enable the phased development.
- Rehabilitation and capacity enhancement needs of the distribution system were less emphasized. In all alternatives in the Mini M/P, existing distribution networks are utilized. Therefore the planning of distribution system shall be focused more.

3.2 PLANNING FUNDAMENTALS AND POLICIES

3.2.1 Planning Policies

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

Table 3.2 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 Al 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 of unreliability.
Water quality improvement	Water treatment facilities are planned mainly for improvement 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 improvement of 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 plan is planned.	A capacity building plan is prepared to improve the management of BWD (Basrah Water Directorate).

3.2.2 Requirements for Improvement of Water Supply Service and its Measures

To understand the customers' needs for water supply service, a socio-economic survey was conducted by the study team and the results have been explained in Chapter 2 earlier, and in Appendix B. As a result of the survey, the customers' first priority for water service is additional water with longer hours of service and the second priority is improvement of water quality.

Based on the survey results, the possible countermeasures by the water supply side are listed in Table 3.3 to meet the customers' needs and compared to the existing water supply service level. The evaluation of the countermeasures that shall be taken in this plan is presented in Table 3.4.

Table 3.3 Customers Needs, Existing Water Supply service and Countermeasures to meet the Customers' Needs

Customers' Priority		Customers' Needs	Existing Water Supply Service	Various Countermeasures by Water Supply Side
1st	1	Water quantity (Insufficient quantity and low pressure)	It is reported that water service pressure is very low or negative. More than 90 % of the surveyed houses answered that water quantity and pressure is insufficient.	・Expansion of the treatment capacity (Construction of water treatment plant) ・Reduction of leakage (Implementation of leakage control measures) ・Restructuring of distribution network
	2	Service hour (Insufficient service hour)	The survey shows that 39 % and 65 % of the surveyed households were supplied water less than 6 hours and 12 hours per day, respectively.	・Expansion of the treatment capacity (Construction of water treatment plant) ・Reduction of leakage (Implementation of leakage control measures) ・Restructuring of distribution network and improved Distribution Management.
2nd	1	Water quality (Taste; TDS)	The existing treatment plants cannot treat or reduce TDS, which impart taste. The concentration of TDS of the supplied water is decided by the raw water quality and the treatment method used. (Drinking water is produced by small scale RO plants and distributed by tankers.)	・Reduction of TDS in water source (Construction of RO facilities) ・Shift of the water source to low TDS water source (Shift to the upstream of Tigris in the Governorate) ・Improvement of reliability of SWC (Comprehensive rehabilitation of SWC) ・Enhancement of a potable RO treatment and delivery system (Increase of RO facilities, water tanker and delivery points)
	2	Water quality (Color and turbidity)	The results of the JICA water quality survey shows that supplied water quality in color and turbidity is bad and does not satisfy the standards. It is also reported that appropriate treatment is not done in the existing treatment plants due to insufficient budget and skills of O&M staff.	・Appropriate water quality management in water treatment plants (Rehabilitation of existing facilities) ・Appropriate operation and maintenance of water treatment plants (Training) ・Use of chemicals (Preparation of budget) ・Purchase of high quality chemicals ・Establishment of water quality monitoring system
	3	Water quality (Smell)	The surveyed households answered that the water smelled like sewage This implies that the smell is caused by the raw water pollution by sewage, inappropriate treatment or sewage intrusion through pipe breaks when the service pressure is negative.	・Shift of water intake to the upstream of the Shat Al Arab ・Appropriate water quality management (Rehabilitation of existing water treatment plant) ・Checking of contamination into the network (repairs of pipes, appropriate distribution pressure control, reduction of leakage) ・Adoption of pollution control regulations such as wastewater discharge regulation to water sources ・Water Distribution Management − keep positive pressures in the distribution pipes.
3rd	-	Maintenance of facilities (Low)	The survey found that the people have the opinion that water supply facilities are not maintained properly, especially on leakage.	・Establishment of operation and maintenance team including experts and training the staff (Implementation of capacity building program)

Note: Prepared based on the results of socio-economic survey by the study team.

Table 3.4 Selection of Countermeasures to meet the Customers' Needs

Customers' needs		Countermeasures to be taken in this plan
Inadequate water supply quantity (Low 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)		・Introduction of full scale RO plant requires adequate water quality management in the existing water treatment plants, which supply feed water to RO, and the reduction of leakage in the distribution network to supply expensive RO treated water. ・Considering the current conditions, the introduction of full scale RO plant will be at the time when these conditions are established and BWD capability is improved both technically and financially. ・The shift of water source to the upstream of the Tigris in the Governorate requires large scale investment as proposed by the Mini M/P. ・Improvement of SWC requires large scale investment such as replacement of open channel to pipeline.
	Conclusions	・The shift of water source to the upstream (Tigris) is not considered in this plan. ・Accepting the current 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 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 will be recommended.
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. (non-technical measures) ・Adequate quantity and quality of chemicals shall be purchased. ・Leakage control measures shall be planned. (Technical and non-technical measures)
Inappropriate maintenance of facilities		・Operation and maintenance ability shall be improved. (Non-technical measures) ・Capacity building of BWD shall be planned.

3.2.3 Design Criteria

The facility planning is conducted adopting following design criteria.

<table>
<tr><th>Item</th><th>Value/Explanation</th></tr>
<tr><td>Maximum day demand factor:</td><td>1.4</td></tr>
<tr><td>Peak hour demand factor:</td><td>1.6</td></tr>
<tr><td>Capacity of service reservoir</td><td></td></tr>
<tr><td>- Single ground reservoir:</td><td>8 hours of the maximum day water demand</td></tr>
<tr><td>- Both uses of ground reservoir and elevated tank:</td><td>8 hours (7.5 hours for ground reservoir and 0.5 hours for elevated tank)</td></tr>
<tr><td>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>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 tolerable limit as per WHO standards is 1,000 mg/l and the WHO recommendation is less than 600 mg/l. The following are WHO explanation.
<table>
<tr><td>TDS (mg/l)</td><td>Organoleptic properties</td></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 Iraq standards except TDS, for which 600 mg/l is adopted.</td></tr>
<tr><td>Water supply pressure:</td><td>The proposed distribution pressure shall be ensured by which 4 stories buildings can receive water directly from the network.</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>
</table>

3.3 WATER DEMAND AND SUPPLY PLAN

3.3.1 Population Projection

The census has been conducted every 10 years and the last census was in 1997. The following table shows the census population in 1977, 1987 and 1997.

Table 3.5 Past Census Population

Year	Iraq		The Governorate of Basrah	
	Population	Growth rate from the previous census (%)	Population	Growth rate from the previous census (%)
1977	12,000,497	3.2	1,008,626	3.47
1987	16,335,199	3.15	872,176	-1.4
1997	22,046,244	3.1	1,556,445	6.0

Since 1997 no census has been conducted. The total population of Iraq and that of Basrah Governorate in 2003 was estimated as 26,340,227 and 1,762,000 by the Ministry of Planning assuming an annual average growth rate of 3.0 %.

The Ministry of Planning has estimated the future population assuming an annual growth rate of 2.25 % from 2003 to 2010 and 2.0 % after 2010. While the Mini M/P adopted an annual growth rate of 3.0 % to estimate population of Basrah Governorate until 2025 assuming the population growth rate in Basrah is higher than the country's average.

The population of the past census, the Ministry of Planning estimate and Mini M/P estimate are shown in Figure 3.2. The census population in 1987 has drastically dropped in comparison with the previous census. This may be due to the effect of the Iraq -Iran war. Since then until now several incidents have occurred and these may have affected the population growth or population migration in Basrah and resulted in an unstable population growth trend. Therefore, it is very difficult to estimate the current population based on the past trend and for the reliable population projection one has to wait until the next census survey.

Under such conditions, the Ministry of Planning has estimated the future population. Compared with the Ministry of Planning estimate for 2025 and the extrapolated population of the past census, the Mini M/P estimate is 20 % to 50 % more. The Mini M/P estimated a larger population compared with the trend of the past census and the Ministry of Planning but nobody can validate its accuracy without actual data.

Depending on population estimate, the capacity of water supply system or the size of a project is changed. The long term facility plan of water supply system shall rely on a reliable population estimate when the results of the next census survey are available. Tentatively, the Mini M/P estimate is used for planning of the future water supply system considering the opinion of Basrah Water Directorate. However, this plan shall be reviewed and revised according to the results of the next census survey. 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 public water supply service.

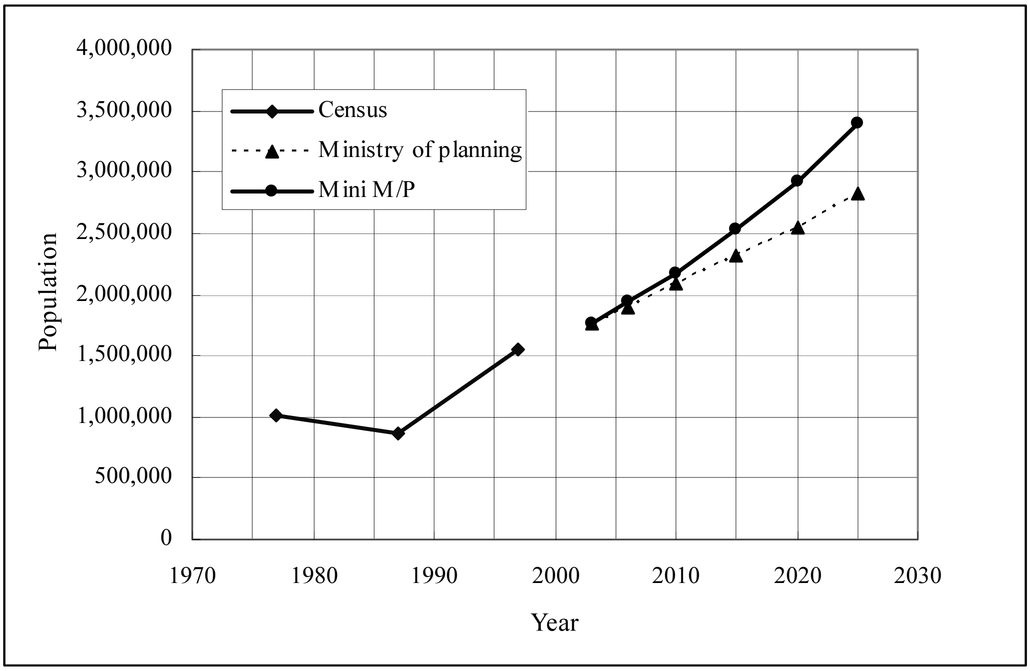


Figure 3.2 Census Population and Future Population Estimate by Mini M/P and Ministry of Planning for the Governorate of Basrah

The following table shows estimated district population of the Mini M/P.

Table 3.6 Estimated Population by the Mini Master Plan

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
Abu Al-Khaseeb	Municipal	Center	140,000	148,000	152,800	172,000	199,000	231,000	268,000
	Municipal	Rural	11,000	12,000	12,400	14,000	16,000	19,000	22,000
	Sub-total		151,000	160,000	165,200	186,000	215,000	250,000	290,000
Al Zubair	Municipal	Center	155,000	165,000	170,200	191,000	222,000	257,000	298,000
	Municipal	Rural	65,000	70,000	72,200	81,000	94,000	108,000	126,000
	Safwan,	Center	10,000	11,000	11,400	13,000	15,000	17,000	20,000
	Safwan,	Rural	21,000	23,000	23,600	26,000	30,000	35,000	40,000
	Um Qasir	Center	32,000	34,000	35,200	40,000	46,000	53,000	62,000
	Um Qasir	Rural	11,000	12,000	12,400	14,000	16,000	18,000	21,000
	Sub-total		294,000	315,000	325,000	365,000	423,000	488,000	567,000
Al Qurna	Municipal	Center	60,000	64,000	66,000	74,000	86,000	99,000	115,000
	Municipal	Rural	48,000	52,000	53,600	60,000	70,000	81,000	93,000
	Al-Deer,	Center	23,000	25,000	25,800	29,000	34,000	39,000	45,000
	Al-Deer,	Rural	45,000	48,000	49,600	56,000	65,000	75,000	87,000
	Sub-total		176,000	189,000	195,000	219,000	255,000	294,000	340,000
Al Fao	Municipal	Center	15,000	17,000	17,400	19,000	22,000	26,000	30,000
	Municipal	Rural	2,000	3,000	3,000	3,000	4,000	4,000	5,000
	Sub-total		17,000	20,000	20,400	22,000	26,000	30,000	35,000
Shat Al Arab	Municipal	Center	71,000	76,000	78,400	88,000	101,000	117,000	136,000
	Municipal	Rural	3,000	4,000	4,200	5,000	5,000	6,000	7,000
	Al Nashwa,	Center	2,000	2,000	2,000	2,000	2,000	3,000	3,000
	Al Nashwa,	Rural	20,000	22,000	22,600	25,000	29,000	34,000	39,000
	Sub-total		96,000	104,000	107,200	120,000	137,000	160,000	185,000
Al Medaina	Municipal	Center	28,000	30,000	31,000	35,000	40,000	47,000	54,000
	Municipal	Rural	20,000	22,000	22,600	25,000	29,000	34,000	39,000
	Al Huwair	Center	18,000	19,000	19,600	22,000	26,000	30,000	34,000
	Al Huwair	Rural	26,000	28,000	28,800	32,000	37,000	43,000	50,000
	Talha,	Center	32,000	35,000	36,000	40,000	46,000	54,000	62,000
	Talha	Rural	23,000	24,000	24,800	28,000	33,000	38,000	44,000
	Sub-total		147,000	158,000	162,800	182,000	211,000	246,000	283,000
Calculated Total	(adopted)		1,762,000	1,881,000	1,940,600	2,179,000	2,524,000	2,924,000	3,388,000
Total shown in table of Mini MP			1,761,000	1,869,000	1,928,400	2,166,000	2,511,000	2,911,000	3,375,000

3.3.2 Water Demand Estimates

(1) Per Capita Consumption

In the Mini M/P the per capita consumptions, shown in Table 3.7, were adopted which are same as the General Water Directorate Specifications, 1985, MMPW. This consumption level is very high and more than that of the large cities in Japan, Tokyo and Osaka (Table 3.8). Although not appropriate to compare because of the limitation of water resources in Jordan, the overall design per capita consumption in Jordan is just 150 l/c/d. However, compared to the per capita consumption of domestic use of 200 l/c/d in Lebanon, where water resources are not limited as in Jordan and the living standards are high, the per capita consumption of Basrah is still higher. The high consumption may be explained by very hot summer and the large consumption of water for gardening. In addition, it may be explained by affluent water resources of the Tigris and the Euphrates, due to which the people could use plenty of water. Also the water charge has been set at a very low level (about 0.015 US$/$m^3$) and the people have not considered the conservation of water in terms of reducing expenditure because they have had no incentive to reduce consumption.

Table 3.7 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

Table 3.8 Example of Per Capita Water Consumption in the Other Countries

Country	City/Classification	Per Capita Day (l/c/d)	Remarks
Japan	Tokyo	356	Data for 2000, Net domestic 246, Urban facilities 110
	Yokohama	322	Data for 2000, Net domestic 244, Urban facilities 78
Jordan	All	150	Standards/Criteria
Lebanon	Beirut	200	
	Other Urban Area	190	
	Rural Area	185	
Egypt	City	165 - 180	
	Village population less than 50,000	135 - 150	
France		137	Data for 1997, Domestic only
German		117	Data for 1997, Domestic only
Greek	Athens	200	Data for 1997, Domestic only
Italy		213	Data for 1997
Spain		185	Data for 1985

Source: Several sources

(2) Water Demand Estimation

The water demand up to 2025 is estimated using the population estimate of the Mini M/P and the per capita consumption stipulated by MMPW as shown in Table 3.7. In the estimation, the following case studies were conducted:

1) Reduction of per capita consumption

Considering the increasing scarcity of good water quality of water resources in Basrah and lower per capita consumption in other countries, the cases of reduction of the per capita water consumption were studied. The study team assumed that universal customer water metering will be introduced in Basrah after 2015 and accordingly appropriate water charge will be collected from the customers to cover the costs of water supply. This measure will be a factor to lead to reduction of 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 believes it is not feasible to introduce water metering before 2015 until the water supply quantity will be enhanced to meet the demand and the quality of supplied water will be improved through implementation of several projects. Until that time the water consumption will be continuously suppressed by the limited water supply capacity even if the customers want to use as much as they like.

2) Different leakage ratio

In water demand estimation, leakage quantity shall be considered. Currently, there is only limited information to estimate leakage. The Mini M/P inferred that about 60 % was unaccounted-for water (UFW), which is composed of leakage, unauthorized consumption etc. Based on existing network data and experience in other countries, the study team estimated that current leakage ratio is about 50 %. In the water demand estimation up to 2025, leakage ratios of 0 %, 50 %, 40%, 30 % and 20 % were adopted. The results of the water demand estimation are shown in Table 3.9.

The future leakage level depend on what measures will be taken to reduce leakage. The study team assumes that reduction measures of non-revenue water (NRW), the main part of which is composed of leakage control, will be implemented by BWD. Accordingly, the future leakage ratio is planned as 30 % in 2015 and 20 % in 2025. The details on the NRW control plan are presented in CHAPTER 6.

Note: Currently, the terminology of non-revenue water (NRW) is internationally used instead of unaccounted-for water (UFW). (International Water Association)

Table 3.9 Results of Average Day Water Demand Estimation by Leakage Ratio

(Base: Population projection based on the Mini M/P Growth Rate, 10 % reduction of domestic use after 2015 to 2020 and 20 % to 2025, and leakage ratio of 60 - 20%)

District	Sub-District		2006					2015					2025				
			0	50	40	30	20	0	50	40	30	20	0	50	40	32	20
Al Basrah	Municipal	Center	290,520	581,040	484,200	415,029	363,150	378,360	756,720	630,600	540,514	472,950	423,600	847,200	706,000	622,941	529,500
	Al-Hartha	Center	19,344	38,688	32,240	27,634	24,180	25,220	50,440	42,033	36,029	31,525	28,600	57,200	47,667	42,059	35,750
	Al-Hartha	Rural	16,720	33,440	27,867	23,886	20,900	21,800	43,600	36,333	31,143	27,250	23,360	46,720	38,933	34,353	29,200
	Sub-total		326,584	653,168	544,307	466,549	408,230	425,380	850,760	708,967	607,686	531,725	475,560	951,120	792,600	699,353	594,450
Abu Al-Khaseeb	Municipal	Center	39,728	79,456	66,213	56,754	49,660	51,740	103,480	86,233	73,914	64,675	58,960	117,920	98,267	86,706	73,700
	Municipal	Rural	2,480	4,960	4,133	3,543	3,100	3,200	6,400	5,333	4,571	4,000	3,520	7,040	5,867	5,176	4,400
	Sub-total		42,208	84,416	70,347	60,297	52,760	54,940	109,880	91,567	78,486	68,675	62,480	124,960	104,133	91,882	78,100
Al Zubair	Municipal	Center	44,252	88,504	73,753	63,217	55,315	57,720	115,440	96,200	82,457	72,150	65,560	131,120	109,267	96,412	81,950
	Municipal	Rural	14,440	28,880	24,067	20,629	18,050	18,800	37,600	31,333	26,857	23,500	20,160	40,320	33,600	29,647	25,200
	Safwan,	Center	2,622	5,244	4,370	3,746	3,278	3,450	6,900	5,750	4,929	4,313	3,800	7,600	6,333	5,588	4,750
	Safwan,	Rural	4,720	9,440	7,867	6,743	5,900	6,000	12,000	10,000	8,571	7,500	6,400	12,800	10,667	9,412	8,000
	Um Qasir	Center	9,152	18,304	15,253	13,074	11,440	11,960	23,920	19,933	17,086	14,950	13,640	27,280	22,733	20,059	17,050
	Um Qasir	Rural	2,480	4,960	4,133	3,543	3,100	3,200	6,400	5,333	4,571	4,000	3,360	6,720	5,600	4,941	4,200
	Sub-total		77,666	155,332	129,443	110,951	97,083	101,130	202,260	168,550	144,471	126,413	112,920	225,840	188,200	166,059	141,150
Al Qurna	Municipal	Center	17,160	34,320	28,600	24,514	21,450	22,360	44,720	37,267	31,943	27,950	25,300	50,600	42,167	37,206	31,625
	Municipal	Rural	10,720	21,440	17,867	15,314	13,400	14,000	28,000	23,333	20,000	17,500	14,880	29,760	24,800	21,882	18,600
	Al-Deer,	Center	5,934	11,868	9,890	8,477	7,418	7,820	15,640	13,033	11,171	9,775	8,550	17,100	14,250	12,574	10,688
	Al-Deer,	Rural	9,920	19,840	16,533	14,171	12,400	13,000	26,000	21,667	18,571	16,250	13,920	27,840	23,200	20,471	17,400
	Sub-total		43,734	87,468	72,890	62,477	54,668	57,180	114,360	95,300	81,686	71,475	62,650	125,300	104,417	92,132	78,313
Al Fao	Municipal	Center	4,524	9,048	7,540	6,463	5,655	5,720	11,440	9,533	8,171	7,150	6,600	13,200	11,000	9,706	8,250
	Municipal	Rural	600	1,200	1,000	857	750	800	1,600	1,333	1,143	1,000	800	1,600	1,333	1,176	1,000
	Sub-total		5,124	10,248	8,540	7,320	6,405	6,520	13,040	10,867	9,314	8,150	7,400	14,800	12,333	10,882	9,250
Shat Al Arab	Municipal	Center	20,384	40,768	33,973	29,120	25,480	26,260	52,520	43,767	37,514	32,825	29,920	59,840	49,867	44,000	37,400
	Municipal	Rural	840	1,680	1,400	1,200	1,050	1,000	2,000	1,667	1,429	1,250	1,120	2,240	1,867	1,647	1,400
	Al Nashwa,	Center	460	920	767	657	575	460	920	767	657	575	570	1,140	950	838	713
	Al Nashwa,	Rural	4,520	9,040	7,533	6,457	5,650	5,800	11,600	9,667	8,286	7,250	6,240	12,480	10,400	9,176	7,800
	Sub-total		26,204	52,408	43,673	37,434	32,755	33,520	67,040	55,867	47,886	41,900	37,850	75,700	63,083	55,662	47,313
Al Medaina	Municipal	Center	8,060	16,120	13,433	11,514	10,075	10,400	20,800	17,333	14,857	13,000	11,880	23,760	19,800	17,471	14,850
	Municipal	Rural	4,520	9,040	7,533	6,457	5,650	5,800	11,600	9,667	8,286	7,250	6,240	12,480	10,400	9,176	7,800
	Al Huwair	Center	4,508	9,016	7,513	6,440	5,635	5,980	11,960	9,967	8,543	7,475	6,460	12,920	10,767	9,500	8,075
	Al Huwair	Rural	5,760	11,520	9,600	8,229	7,200	7,400	14,800	12,333	10,571	9,250	8,000	16,000	13,333	11,765	10,000
	Talha,	Center	9,360	18,720	15,600	13,371	11,700	11,960	23,920	19,933	17,086	14,950	13,640	27,280	22,733	20,059	17,050
	Talha	Rural	4,960	9,920	8,267	7,086	6,200	6,600	13,200	11,000	9,429	8,250	7,040	14,080	11,733	10,353	8,800
	Sub-total		37,168	74,336	61,947	53,097	46,460	48,140	96,280	80,233	68,771	60,175	53,260	106,520	88,767	78,324	66,575
Total			558,688	1,117,376	931,147	798,126	698,360	726,810	1,453,620	1,211,350	1,038,300	908,513	812,120	1,624,240	1,353,533	1,194,294	1,015,150

(3) Demand Variance

General annual fluctuations in water demand are shown in Figure A (Figure 3.3). The water demand generally reaches its peak in the summer and bottoms out in winter. Figure B shows the general daily fluctuations in water demand. The hourly water demand increases in the morning and evening when water consumption activities increase. Since water consumption activities fall drastically at night, the only demand at night is basically attributable to leakage under normal water service conditions. At the project site, however, due to the implementation of water supply rationing, households store water in their water tanks overnight on water supply days for their use on non-supply days. Consequently, current water demand is expected to remain high even during the night time.

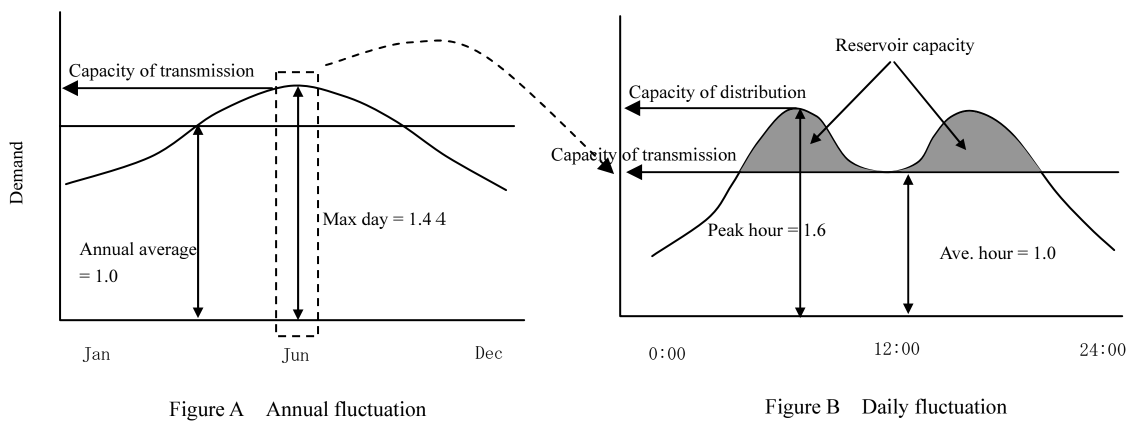


Figure 3.3 Typical Water Demand Fluctuation

In consideration of the above water demand patterns, the following water demand which is generally used in designing water supply facilities will be adopted:

Facilities	Required capacity	Water demand adopted
Water treatment plant	Capacity to meet the maximum day water demand	Maximum day water demand = 1.4 times of the average day water demand
Transmission mains and transmission pumping stations:	Capacity to supply the maximum day water demand	Maximum day water demand = 1.4 times of the average day demand
Distribution pipes and distribution pumping stations:	Capacity to distribute the peak hour demand on the day of the maximum day water demand	Peak hour water demand = 1.4 x 1.6 (=2.24) times of the average day water demand
Service reservoirs:	Capacity to absorb the difference in flow between the constant inlet water amount from the transmission mains and the diurnal demand fluctuation on a day when the yearly water demand peaks	8 hours of the maximum day water demand

The variation of water demand is estimated as shown in Table 3.10.

The target year of the facilities will be 2015. However, only pipes shall be planned considering a long term demand forecast, i.e., in 2025 since the enhancement of pipe capacity in the short term is uneconomical. In this case, the estimated water demand for 2015 is more than for 2025. Therefore, the water demand for 2015 shall be used for all the proposed facilities.

Table 3.10 Water Demand Variation for Facility Design

(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
Abu Al-Khaseeb	Municipal	Center	79,456	73,914	73,700	111,238	103,480	103,180	177,981	165,568	165,088
	Municipal	Rural	4,960	4,571	4,400	6,944	6,400	6,160	11,110	10,240	9,856
	Sub-total		84,416	78,486	78,100	118,182	109,880	109,340	189,092	175,808	174,944
Al Zubair	Municipal	Center	88,504	82,457	81,950	123,906	115,440	114,730	198,249	184,704	183,568
	Municipal	Rural	28,880	26,857	25,200	40,432	37,600	35,280	64,691	60,160	56,448
	Safwan,	Center	5,244	4,929	4,750	7,342	6,900	6,650	11,747	11,040	10,640
	Safwan,	Rural	9,440	8,571	8,000	13,216	12,000	11,200	21,146	19,200	17,920
	Um Qasir	Center	18,304	17,086	17,050	25,626	23,920	23,870	41,001	38,272	38,192
	Um Qasir	Rural	4,960	4,571	4,200	6,944	6,400	5,880	11,110	10,240	9,408
	Sub-total		155,332	144,471	141,150	217,465	202,260	197,610	347,944	323,616	316,176
Al Qurna	Municipal	Center	34,320	31,943	31,625	48,048	44,720	44,275	76,877	71,552	70,840
	Municipal	Rural	21,440	20,000	18,600	30,016	28,000	26,040	48,026	44,800	41,664
	Al-Deer,	Center	11,868	11,171	10,688	16,615	15,640	14,963	26,584	25,024	23,940
	Al-Deer,	Rural	19,840	18,571	17,400	27,776	26,000	24,360	44,442	41,600	38,976
	Sub-total		87,468	81,686	78,313	122,455	114,360	109,638	195,928	182,976	175,420
Al Fao	Municipal	Center	9,048	8,171	8,250	12,667	11,440	11,550	20,268	18,304	18,480
	Municipal	Rural	1,200	1,143	1,000	1,680	1,600	1,400	2,688	2,560	2,240
	Sub-total		10,248	9,314	9,250	14,347	13,040	12,950	22,956	20,864	20,720
Shat Al Arab	Municipal	Center	40,768	37,514	37,400	57,075	52,520	52,360	91,320	84,032	83,776
	Municipal	Rural	1,680	1,429	1,400	2,352	2,000	1,960	3,763	3,200	3,136
	Al Nashwa,	Center	920	657	713	1,288	920	998	2,061	1,472	1,596
	Al Nashwa,	Rural	9,040	8,286	7,800	12,656	11,600	10,920	20,250	18,560	17,472
	Sub-total		52,408	47,886	47,313	73,371	67,040	66,238	117,394	107,264	105,980
Al Medaina	Municipal	Center	16,120	14,857	14,850	22,568	20,800	20,790	36,109	33,280	33,264
	Municipal	Rural	9,040	8,286	7,800	12,656	11,600	10,920	20,250	18,560	17,472
	Al Huwair	Center	9,016	8,543	8,075	12,622	11,960	11,305	20,196	19,136	18,088
	Al Huwair	Rural	11,520	10,571	10,000	16,128	14,800	14,000	25,805	23,680	22,400
	Talha,	Center	18,720	17,086	17,050	26,208	23,920	23,870	41,933	38,272	38,192
	Talha	Rural	9,920	9,429	8,800	13,888	13,200	12,320	22,221	21,120	19,712
	Sub-total		74,336	68,771	66,575	104,070	96,280	93,205	166,513	154,048	149,128
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

3.3.3 Balance between Water Demand and Treated Water Supply in 2015

The water demand in 2015, the estimated actual capacity of exiting water treatment plants and water deficits in 2015 for Central Basrah are summarized in Table 3.11. Using full capacity of the existing water treatments, the total water deficit in 2015 will be 183,200 m^3/day and 426,300 m^3/day for the average day and maximum day demand, respectively.

Table 3.11 Water Balance for Central Basrah in 2015

(m^3/day)

District	Water demand		Estimated actual existing capacity	Deficit in capacity	
	Ave. day	Max. day		Against ave. day demand	Against max. day demand
Al Basrah (Central Basrah)	607,600	850,700	424,400	183,200	426,300

3.4 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 plants should be located at Al Hartha of the Shat Al Arab and used for new water treatment plant. 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 achieve 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 to 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 efficiently manages the water distribution should be selected. For this objective, transmission and distribution pipelines shall be separated and distribution zoning will be done 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 intruding 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) Development 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 more efficiently.

3.5 ALTERNATIVES FOR FUTURE WATER SUPPLY SYSTEM

(1) Selection of Bulk Water Transmission System Upstream of the City

The future water sources for the Basrah city and its surrounding areas will be the SWC or the Shat Al Arab. Considering further degradation of future water quality in the middle and downstream of the Shat Al Arab in Basrah city, the water intake of the proposed new treatment plant should be located upstream of the city.

Most of the intakes of existing and proposed water treatment plants will be located at upstream of Basrah city. Considering this, alternatives for water transmission system are prepared as shown in Figure 3.4

In the alternative 1, a proposed water treatment plant will be simply added to the existing decentralized transmission system. In addition, there may be an additional pumping station if required before entering the city to supplement the existing pump capacity of the water treatment plants located in Al Hartha. This system will further complicate the distribution management.

In the alternative 2, a transmission reservoir and pumping station will be constructed and all the water from existing and proposed water treatment plants will be conveyed to this pumping station and transmitted to the city network. This enables centralized management of the transmission system. For the future system, this centralized bulk transmission system is proposed.

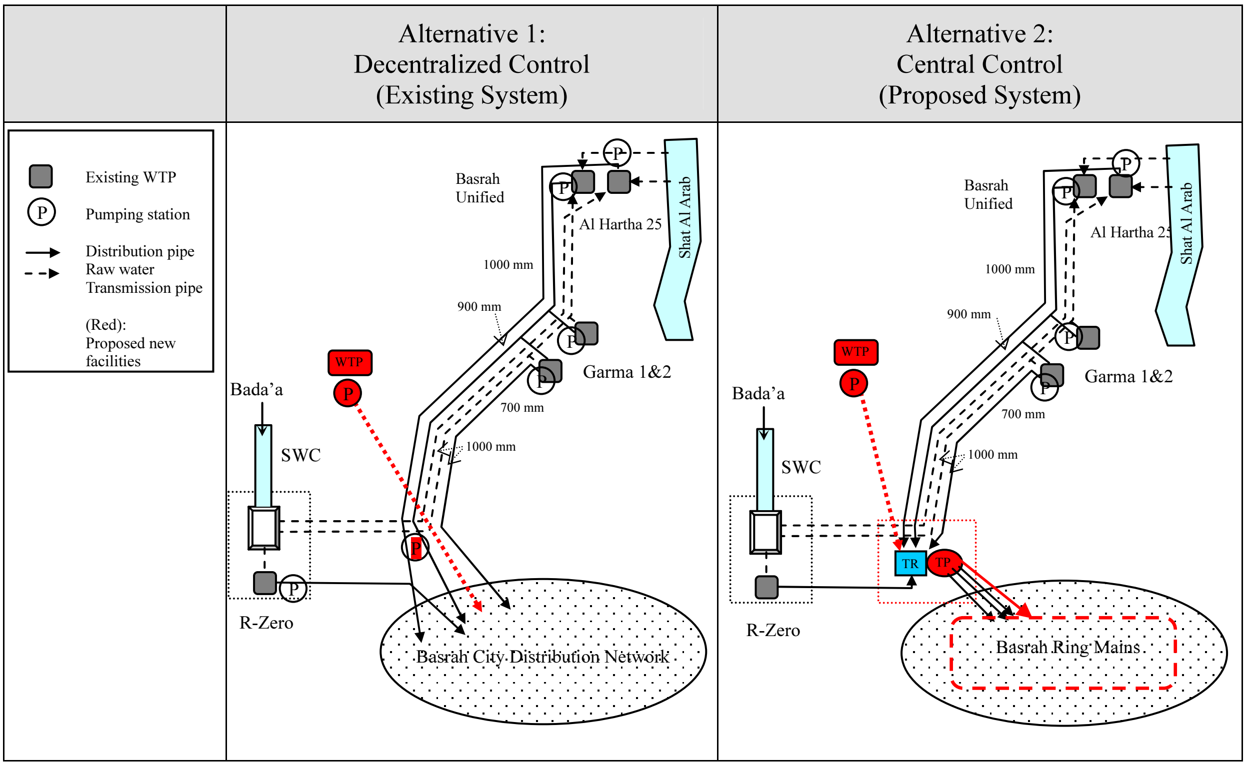


Figure 3.4 Alternatives for Bulk Water Transmission Systems Upstream of Basrah City

(2) Location of Proposed Water Treatment Plant

The three alternatives are shown in Figure 3.5 for the location of proposed water treatment plants.

- Alternative 1: At the same site of the proposed transmission reservoir and pumping station
- Alternative 2: At the nearby location of existing R-Zero water treatment plant
- Alternative 3: At the Al Hartha and Basrah Unified plant

As a result of evaluation together with Basrah Water Directorate, the alternative 3 was selected for the location of proposed water treatment plant for following reasons:

- The reliable raw water of the Shat Al Arab is easily available
- The raw water of SWC is also utilized using existing raw water transmission pipeline if the water is available
- The existing operation and maintenance staff and equipment in Al Hartha 25 MG and Basrah Unified plants are utilized. The total capacity of both plants is largest in Basrah and the effect of scale of economy is expected
- The existing power supply facilities are utilized
- Vacant public land is available for the facilities and there seems to be no problem in land acquisition

(3) Concept of Transmission and Distribution Systems (Separation of distribution network from transmission line and zoning of distribution network)

In the existing distribution network the transmission mains and distribution mains are not separated but mutually connected. This makes the functions of the transmission and distribution mains unclear and the operation and maintenance complicated. Also it is difficult to monitor the water supply conditions (flow and pressure) and control water distribution in the system.

The following are advantages of the system where distribution system is separated from transmission system.

- It is easy to monitor water supply conditions in transmission and distribution system
- It is easy to manage the water allocation to each distribution zone
- The size of transmission system is smaller

With the separated system, the transmission and distribution systems shall be planned to meet maximum day and peak hour water demand, respectively. While without the separated system, both systems shall be planned to meet peak hour water demand, which results in larger capacity of water supply facilities.

For efficient water distribution management, the separation of distribution system from transmission system is proposed.

The larger the water supply system, the more complicated the operation and maintenance becomes. The current Basrah water supply system seems unmanageable due to a single large water network.

Even in the large water supply system, the introduction of distribution zoning makes operation and maintenance efficient and less complicated. Also this system makes leakage control measures easy. In a large water supply system such as Basrah, distribution zoning should be introduced to manage the system efficiently. The distribution zoning is proposed for the future water distribution system.

The conceptual layout of separation of distribution from transmission system and zoning system is shown in Figure 3.6.

(4) Alternatives for Transmission and Distribution Systems (Link mains and Distribution Zoning)

Alternatives for the transmission and distribution system for the Basrah city network are shown in Figure 3.6.

・ Alternative 1: The existing distribution system will be used. Pipelines and pumping stations to enhance flow capacity are added on ad-hoc basis where the capacity is insufficient

(Existing transmission and distribution system)

- Alternative 2: New transmission ring mains and a large distribution pumping station will be constructed and water is supplied from the distribution pumping station directly to the distribution network. (A single distribution system)
- Alternative 3: New transmission ring main, a transmission pumping station and main distribution facilities comprised of distribution reservoir, distribution pumping station and elevated tank will be constructed and at first water is conveyed to main distribution facilities and then to the distribution network. (Separated transmission and distribution system)

The alternative 3 is proposed for the Basrah transmission and distribution system, which is the most ideal system to manage the water supply system.

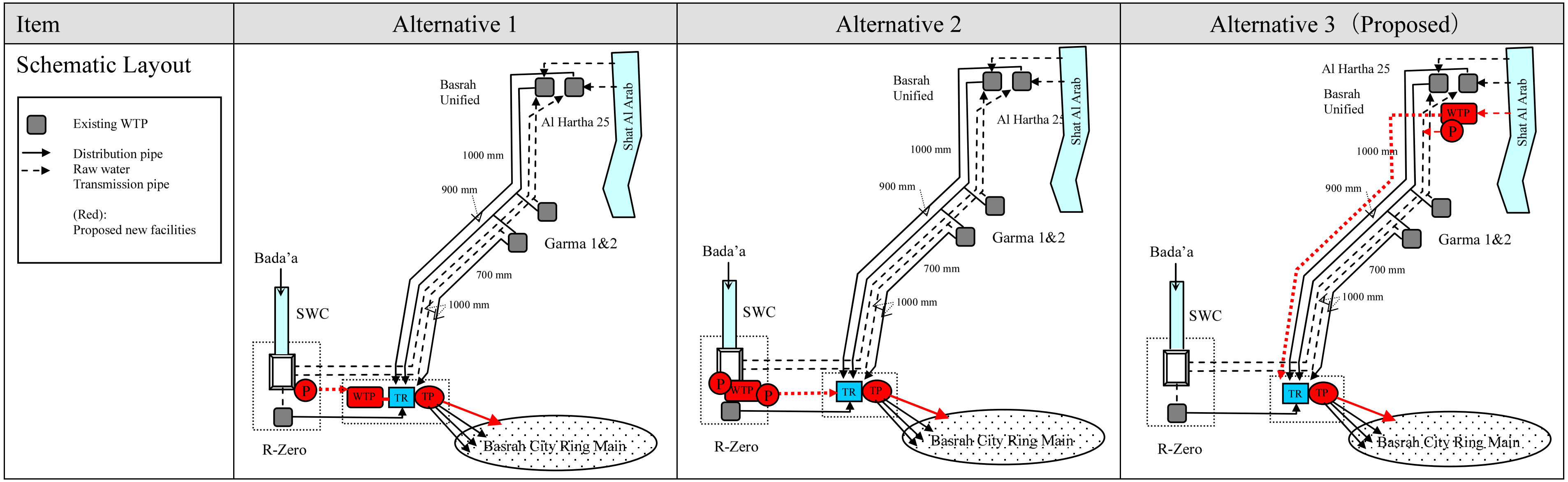


Figure 3.5 Alternative Locations for Proposed Water treatment Plant

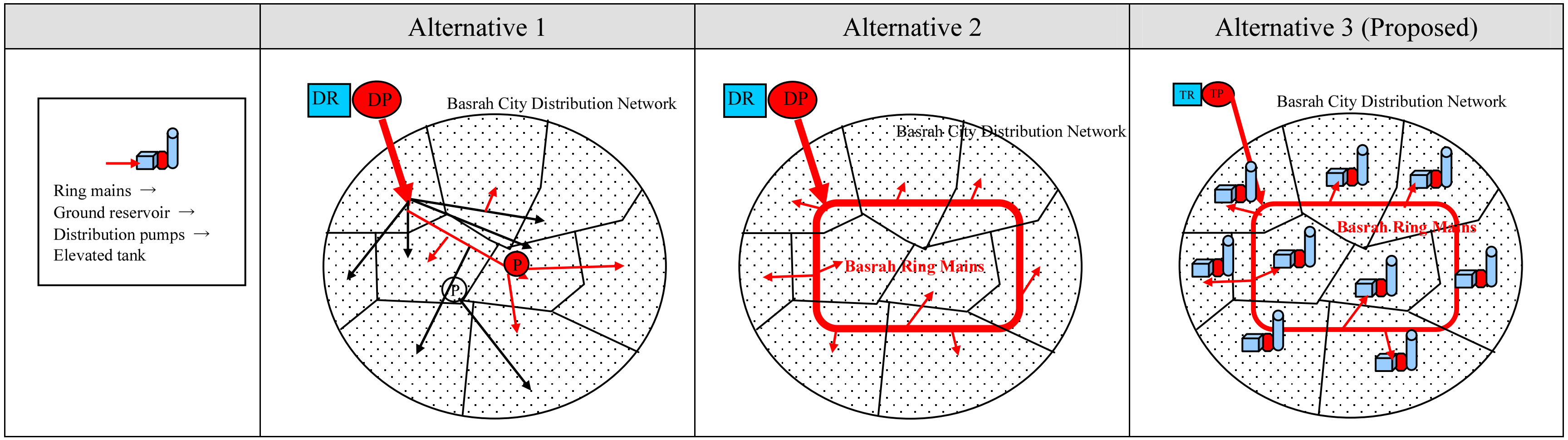


Figure 3.6 Alternatives of Transmission and Distribution System (Link mains and Distribution Zoning)

(5)　Configuration Options for Distribution Zone

The following 3 options are proposed to distribute water in a distribution zone. Basically, option 1 is recommended as the control of water distribution is easiest, only switching on and off pumps according to the water level of the elevated tank. In option 3, the control of water distribution (flow and pressure) is rather difficult and sophisticated pumping equipment is required for effective management of water distribution. If there are land acquisition problems or construction of an elevated tank is not possible then option 2 or 3 should be adopted.

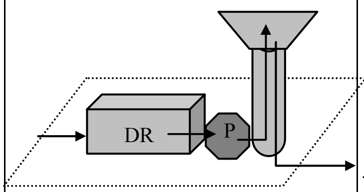
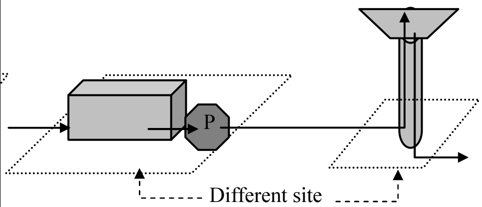
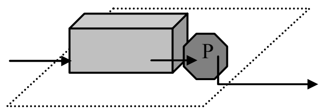
Option 1	Option 2	Option 3
		

Figure 3.7　Configuration Options for a Distribution Zone

(6)　Distribution Zone Area and Proposed Water Transmission System

To delineate distribution zones and select the location of elevated tanks in Basrah city, the following points were considered:

- The height and location of elevated tank should be selected to distribute water directly to 4 stories buildings (apartments) (Figure 3.8)
- The maximum distance between the edge of the distribution zone and site of the elevated tank should be within 2 km
- Roads, drains, rivers and routes of existing distribution pipelines should be considered in delineating distribution zones.

Considering the above, the distribution zoning for the Basrah network is proposed as shown in Figure 3.9 and the water demand in 2015 is estimated by zone in Table 3.12 and Figure 3.10. In zoning, sub-zone indicates the area of low population density, where detailed zoning and restructuring of network was not planned in this study. Based on the distribution zones, the location and route of water transmission system were selected as shown in Figure 3.11.

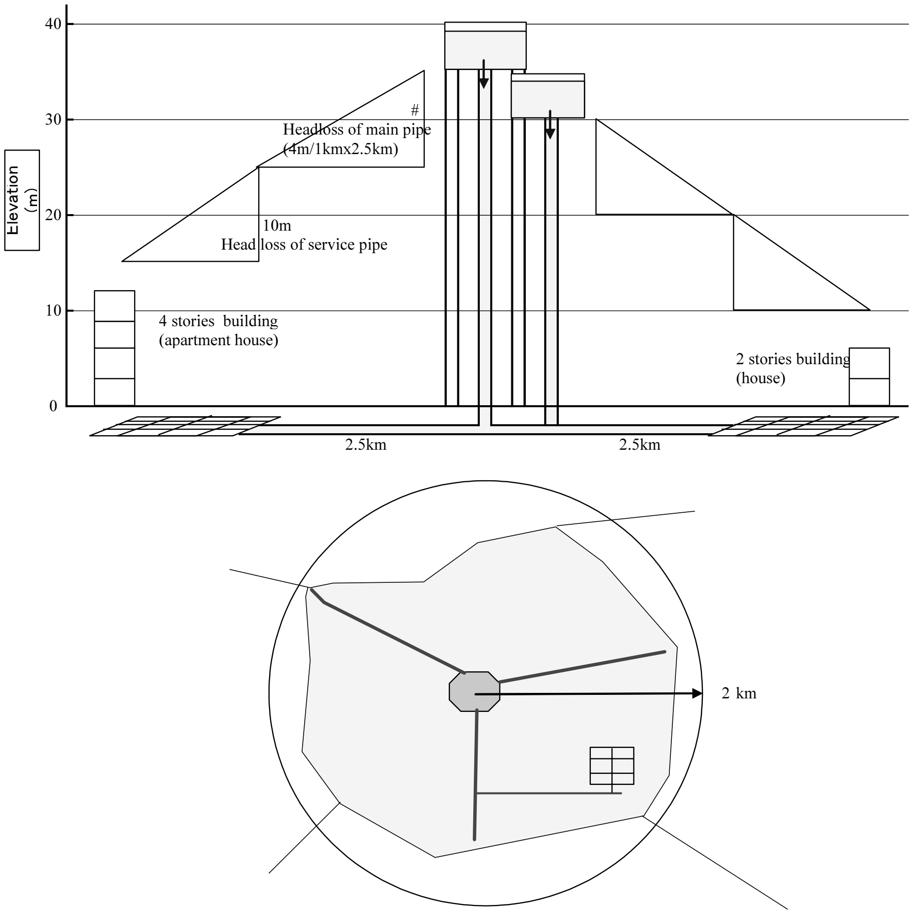
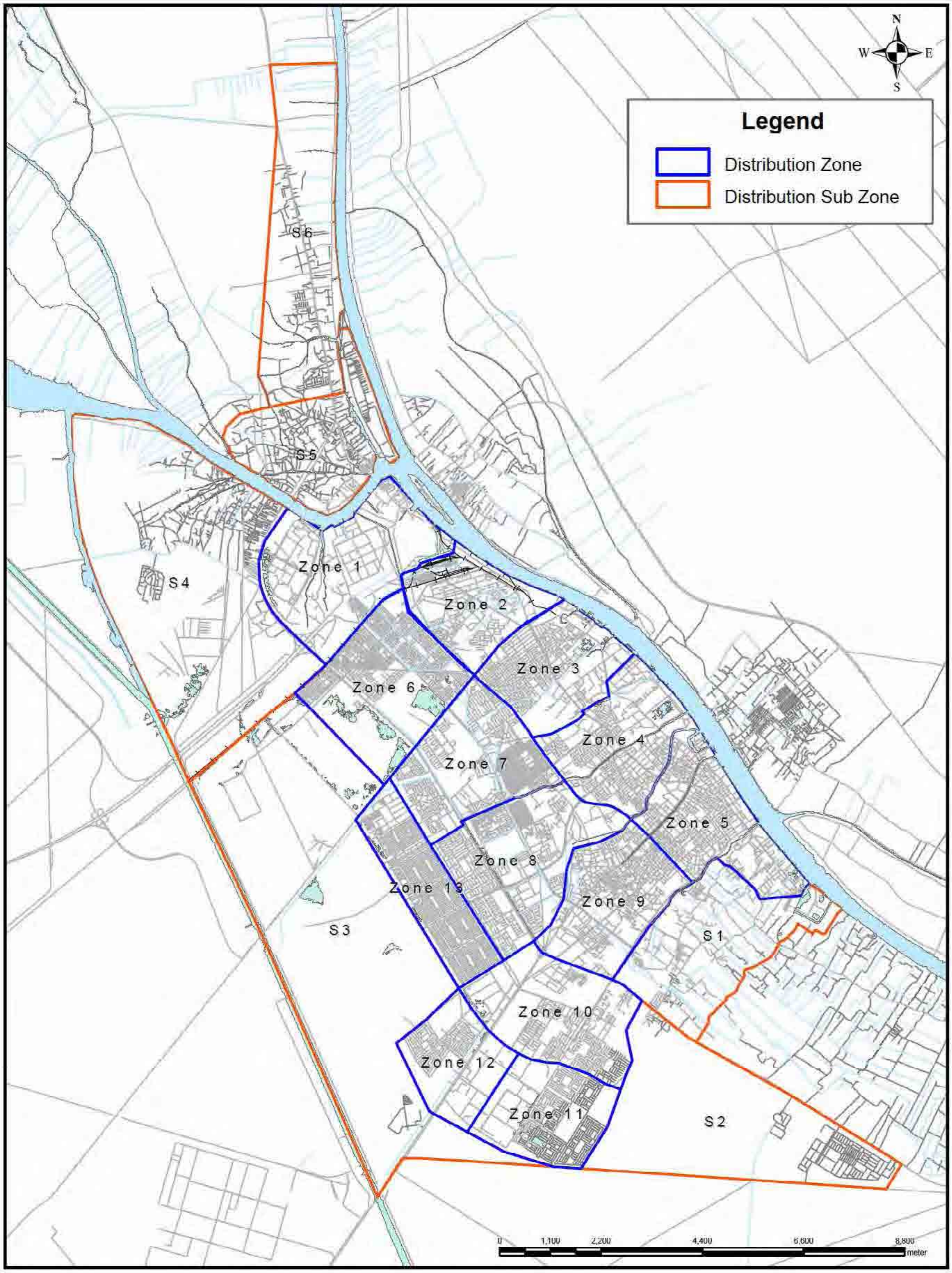


Figure 3.8 Concept of Water Supply Pressure and Location of Elevated Tank



The Feasibility Study on Improvement of the Water Supply System in Al-Basrah City and Its Sorroundings in the Republic of Iraq	Proposed Distribution Zone in Basrah District	Fig No. 3.9

Table 3.12 Estimated Zone Population, Average and Maximum Day Water Demand for Basrah District

Zone	Population			Average Day Water Demand (m^3/day)			Maximum Day Water Demand (m^3/day)		
	2006	2015	2025	2006	2015	2025	2006	2015	2025
1	38,913	52,429	70,461	28,000	27,000	26,400	39,300	37,800	37,000
2	40,442	51,231	66,893	29,100	26,300	25,100	40,800	36,900	35,100
3	48,194	57,804	66,355	34,700	29,700	24,900	48,600	41,600	34,800
4	55,669	69,653	81,835	40,100	35,800	30,700	56,100	50,100	42,900
5	69,118	82,713	90,455	49,800	42,500	33,900	69,700	59,600	47,500
6	69,674	84,613	90,246	50,200	43,500	33,800	70,300	60,900	47,400
7	68,611	80,481	93,142	49,400	41,400	34,900	69,200	57,900	48,900
8	70,603	89,436	114,856	50,800	46,000	43,100	71,200	64,400	60,300
9	66,790	81,056	98,047	48,100	41,700	36,800	67,300	58,400	51,500
10	44,176	74,055	90,585	31,800	38,100	34,000	44,500	53,300	47,600
11	37,938	57,487	62,076	27,300	29,600	23,300	38,300	41,400	32,600
12	22,237	40,490	52,755	16,000	20,800	19,800	22,400	29,100	27,700
13	71,061	85,927	85,927	51,200	44,200	32,200	71,600	61,900	45,100
Z-total	**703,426**	**907,375**	**1,063,633**	**506,500**	**466,600**	**398,900**	**709,300**	**653,300**	**558,400**
S1	24,610	31,177	41,901	17,700	16,000	15,700	24,800	22,400	22,000
S2	24,799	31,415	123,503	17,900	16,200	24,600	25,000	22,600	34,400
S3	4,647	14,483	38,908	3,300	7,500	36,300	4,700	10,400	50,800
S4	49,518	66,550	144,055	35,700	34,200	54,000	49,900	47,900	75,600
S5	74,401	97,000	130,000	38,700	36,000	35,800	54,200	50,400	50,100
S6	83,600	109,000	146,000	33,400	31,200	29,200	46,800	43,600	40,900
S-total	**261,575**	**349,625**	**624,367**	**146,700**	**141,100**	**195,600**	**205,400**	**197,300**	**273,800**
Total	**965,001**	**1,257,000**	**1,688,000**	**653,200**	**607,700**	**594,500**	**914,700**	**850,600**	**832,200**

“S” indicates sub-zone.

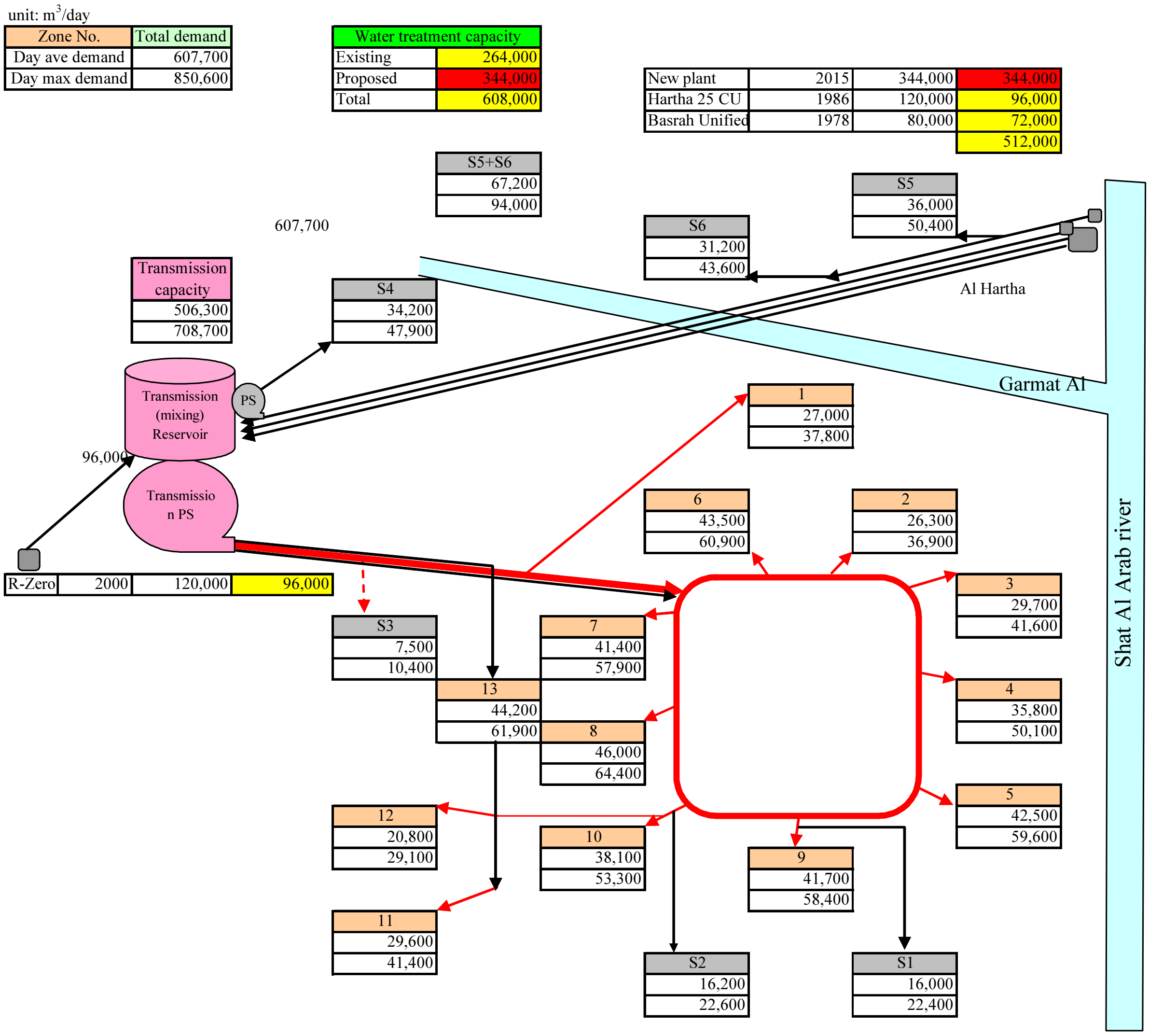
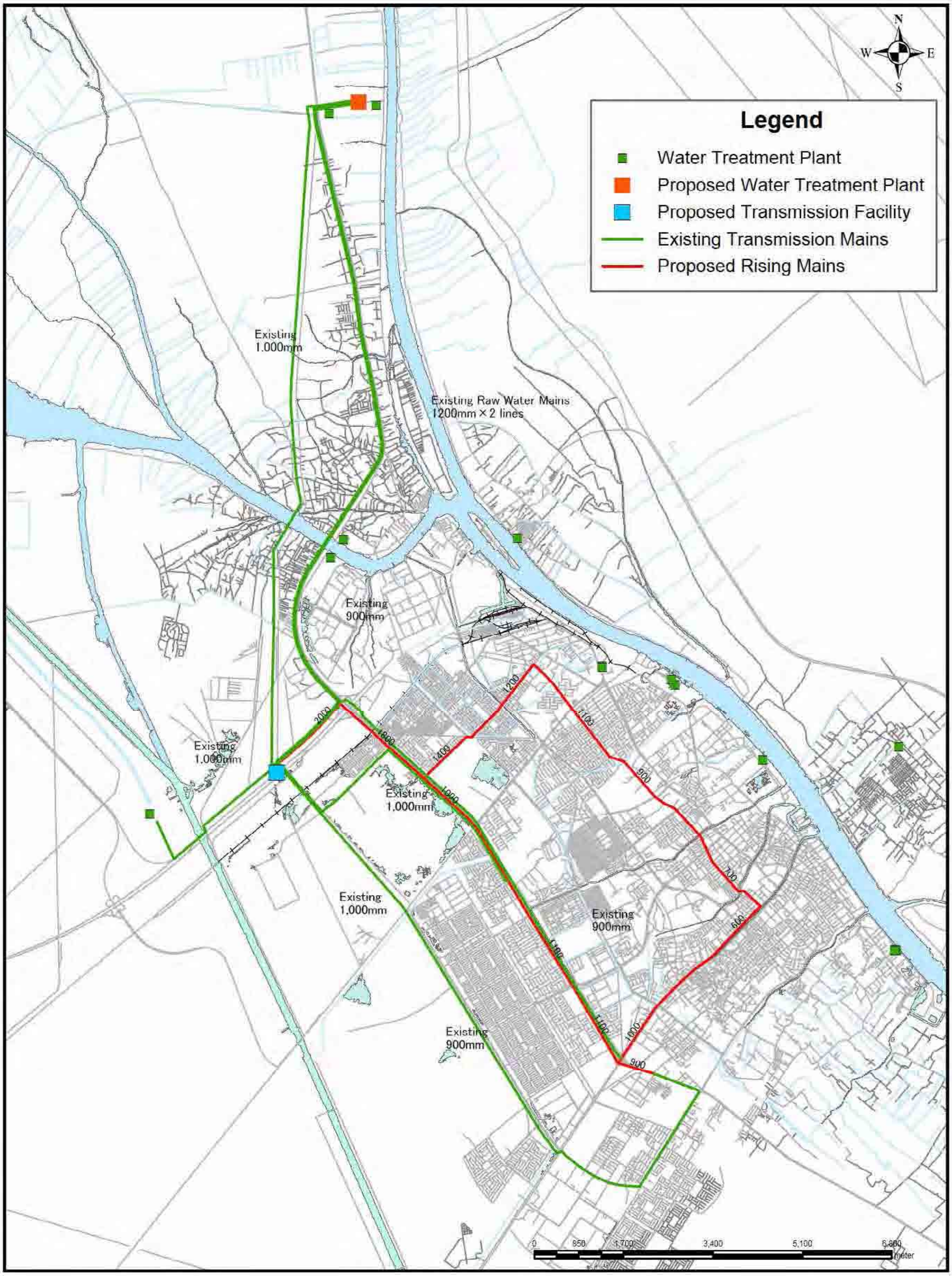


Figure 3.10 Average and Maximum Day Water Demand by Distribution Zone in 2015



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. 3.11

3.6 REHABILITATION OF EXISTING FACILITIES

The following existing facilities should be rehabilitated to recover the treatment capacity with appropriate water quality. The contents of rehabilitation are described in Appendix D. These rehabilitations are uncertain and require more detail surveys and inspections before the start of the project. Also rehabilitation of some of the facilities has just been completed or is now under way. The latest data on existing facilities should be collected for more detail planning.

Table 3.13 Rehabilitation of Existing Facilities

No.	Water Treatment Plant and Pumping Station
1	R-Zero C.U.
2	R-Zero raw water pumps
3	Al Hartha 25 MG C.U.
4	Basrah Unified
5	Garma 1 and Garma 2
6	Ribat
7	Al Maqil 1
8	Jubaila 1 and Jubaila 2
9	Bradiah 1, Bradiah 2, and Bradiah C.U.

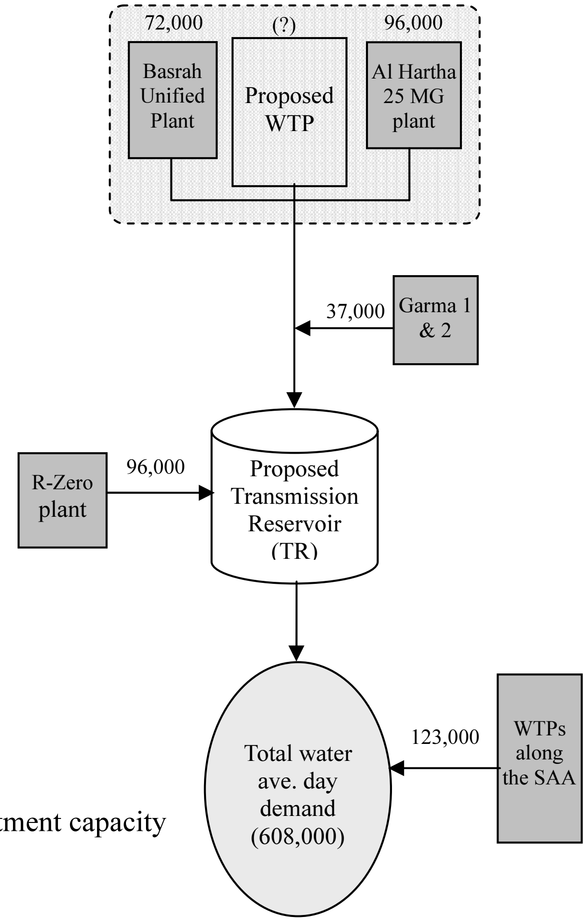
3.7 PROPOSED WATER TREATMENT PLANT

The proposed water treatment plant should be located near the existing Al Hartha 25 MG plant and Basrah Unified plant. A schematic layout of existing water treatment plants and a proposed water treatment plant is shown in Figure 3.12. Based on the existing capacity, the capacity of the proposed water treatment plant was estimated to meet average water demand for 2015 by following 3 cases, as shown in Table 3.14.

Case 1: All existing water treatment capacity should be utilized
Case 2: Only major water treatment plants located upstream of the Shat Al Arab should be utilized
Case 3: No existing water treatment plant should be utilized.

The estimated capacities for Case 1, 2 and 3 are 184,000 m^3/day, 344,000 m^3/day and 608,000 m^3/day, respectively. In this mid-term plan, it is proposed that 184,000 m^3/day or 344,000 m^3/day should be considered for proposed capacity of the new water treatment plant for expansion.

However, if a desalination system such as reverse osmosis should be introduced into the existing water supply system to reduce TDS to an appropriate level, more treated capacity is needed. This option is discussed in the next section.



Note:

The values are actual treatment capacity

Figure 3.12 Schematic Layout and Actual Treatment Capacity of Existing Water Treatment Plant

Table 3.14 Existing Water Treatment Capacity to be Used and Proposed Capacity

(m^3/day)

Case	Existing WTP to be used	Total actual capacity of existing WTPs	Proposed WTP capacity
1	All existing WTPs	424,000	184,000
2	Major WTPs located upstream SAA (R-Zero, Al Hartha 25 MG and Basrah Unified)	264,000	344,000
3	No existing WTP	0	608,000 (= average day water demand)

3.8 OPTION OF INTRODUCTION OF FULL SCALE REVERSE OSMOSIS WATER SUPPLY SYSTEM

(1) Required capacity

For those waters exceeding an acceptable TDS level, desalination will be required. Desalination of brackish water such as Shat Al Arab near Basrah City can be achieved by membrane processes. In this case, the RO process is the most suitable. However, it requires some form of pretreatment in addition to conventional treatment prior to the desalination treatment process.

In this plan, the Shat Al Arab as well as SWC should be used as the water sources for Basrah to meet the demand. The required capacity of RO plant and conventional water treatment plant as pretreatment are estimated below with the conditions shown in Table 3.15.

Table 3.15 Capacity Estimation Conditions of RO and Conventional Water Plant

No.	Items	Conditions
1.	Covered area	Basrah District (Basrah city and Al Hartha)
2.	Total water demand	608,000 m^3/day (Average day demand in 2015)
3.	Water source of RO	The Shat Al Arab
4.	TDS of water source	The Shat Al Arab:1,500 mg/l SWC: 670 mg/l
5.	Expected TDS of RO output	200 mg/l
6.	Expected recovery ratio of RO	75 % of input volume (25 % of highly brine water and wasted)
7.	Location of RO plant	Al Hartha (Same location as proposed water treatment plant)
8.	Existing WTPs to be used	Case 1: Al Hartha 25 MG, Basrah Unified and R-Zero Case 2: All existing WTPs

The schematic layout of the water supply system including full proposed scale RO plant is shown in Figure 3.13.

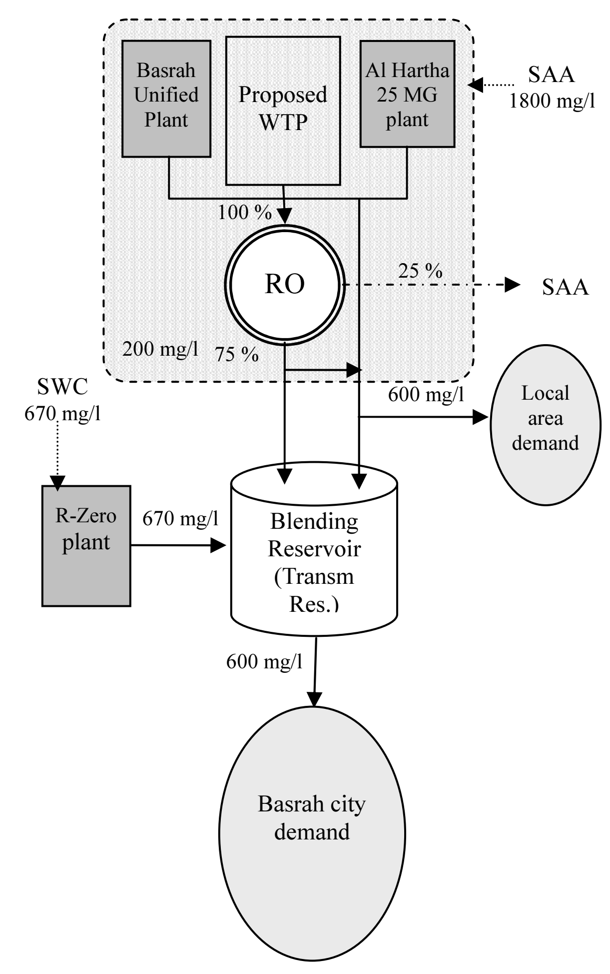
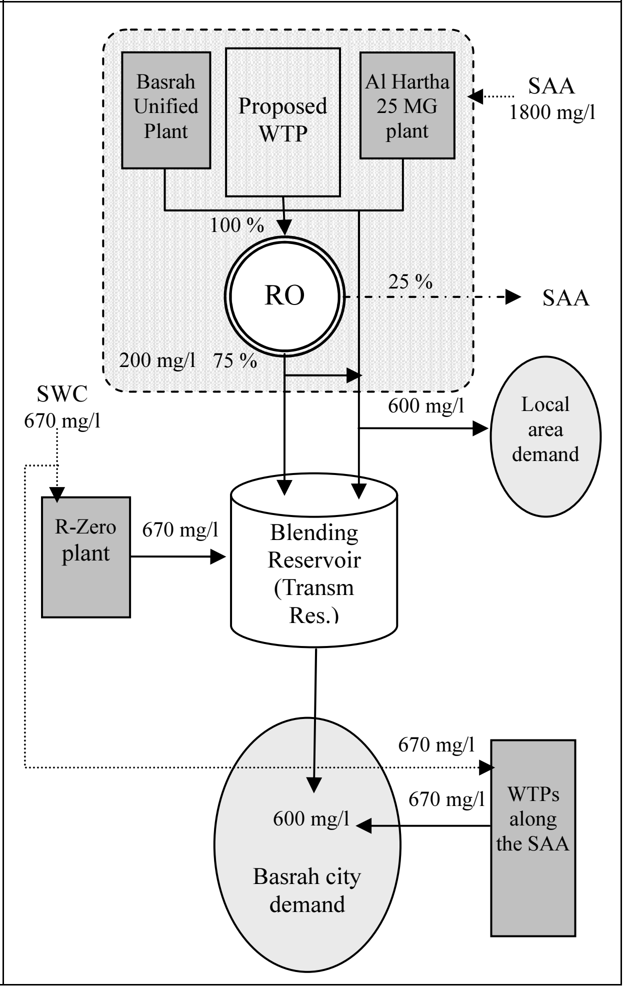
Case 1	Case 2
Use of Existing Al Hartha 25 MG, Basrah Unified and R-Zero Plants	Use of All Existing WTPs
	

Figure 3.13   Schematic Layout of Full Scale RO Water Supply System

The proposed conventional water treatment plant should be located in the land between the existing Al Hartha 25 MG plant and Basrah Unified plant. Based on the following cases of RO construction schedule 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 3.16 and Appendix F for detail.

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 3.16 Required Capacity of Additional Water Treatment Plant and RO Plant for 2015

(m^3/day)

Item	Case 1	Case 2	Case 3	Case 4
Existing water treatment plants to be utilized	424,400	424,400	424,400	264,000
Conventional water treatment plant (Rounding up for design capacity)	-	183,200 (184,000)	279,200 (280,000)	464,600 (465,000)
RO plant - Input - Output	 - -	 - -	 383,000 287,000	 483,000 362,000
Brine wastewater discharged from RO plant	-	-	96,000	121,000

Note: The capacity of RO plant is planned using a recovery rate of 75 %.

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

(2) Time of Introduction of full scale RO System

The introduction of full scale RO plant requires adequate pretreatment and water quality management in existing water treatment plant, and the reduction of leakage in the distribution system to supply expensive RO treated water effectively. Considering the current conditions of the water supply system in Basrah, the introduction of full scale RO plant will be at the time when these conditions are established and BWD becomes sustainable both technically and financially to operate such expensive plant. The feasibility of the introduction of RO system is discussed in the later chapters.

3.9 DRINKING WATER SUPPLY PLAN BY SMALL SCALE REVERSE OSMOSIS

(1) Required Capacity of Small Scale RO System in 2015

Before the introduction of full scale RO system, the drinking and cooking water would be supplied by the prevailing small scale RO system in Basrah Governorate.

The following table summarizes the existing capacity of RO plants by district; the estimated future potable water demand and RO plant requirements in 2015 for potable water. The required potable water is calculated assuming 10 l/ca/day for drinking and cooking.

With the existing capacity and the current operation mode of RO plants, 10 hours per day, an additional capacity is required for Basrah, Abu Al Khaseeb, Al Zubair and Shat Al Arab districts to meet the demand. Currently, all RO plants are operated during the working time of distribution tankers for 10 hours per day because there is no storage tank for RO treated water. If an appropriate capacity of storage tank is installed, the existing RO plants can produce more water and store it while the tankers are not working at night.

Assuming 10 hours operation of the existing RO plants, 9,442 m^3/day of RO water is short for Central Basrah in 2015 and 13,825 m^3/day for Basrah Governorate.

Table 3.17 Estimated Required Additional Small Scale RO Capacity for Drinking and Cooking

District	Required RO water in 2006 (m^3/day)	Required RO water in 2015 (m^3/day)	Existing RO capacity (m^3/hr)	Existing supply quantity (m^3/day) in 10 hours working	Supply and demand Balance in 2015 10 hour working of existing RO (m^3/day)
Al Basrah	9,499	11,562	212	2,120	-9,442
Abu Al-Khaseeb	1,628	1,982	87	870	-1,112
Al Zubair	3,170	3,858	105	1,050	-2,808
Al Qurna	1,898	2,310	173	1,730	-580
Al Fao	183	223	75	750	527
Shat Al Arab	1,035	1,260	68	680	-580
Al Medaina	1,585	1,929	210	2,100	171
Calculated Total	18,999	23,125	930	9,300	-13,825

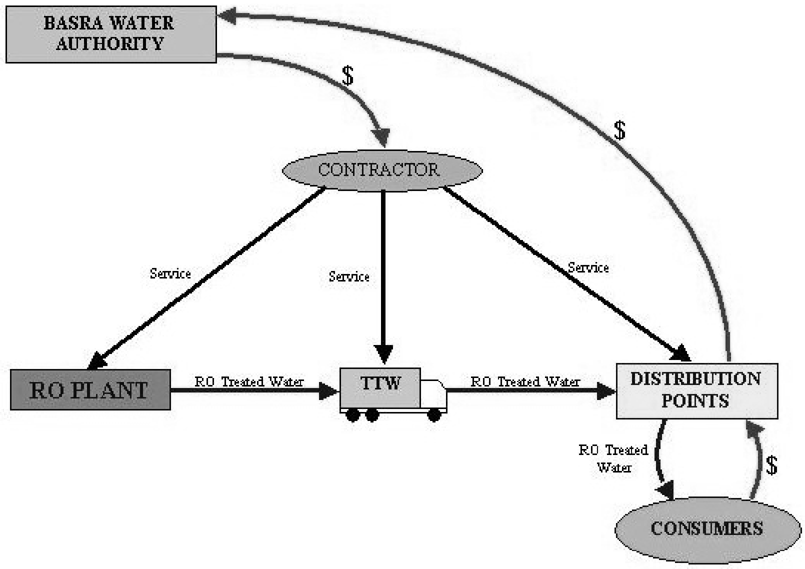
Note: Required RO water is calculated as 10 l/ca/day for drinking and cooking

(2) Operation of Small Scale RO Distribution System

The study team does not have enough information on distribution of RO water. The following is information from the Technical Advisory Team, DFID on the operation and management of RO distribution systems in Basrah. The DIFD team analyzed the way forward for the operation and maintenance of the RO system and reached the following conclusions and gave recommendations. The study team agrees with their conclusions and recommendations as outlined below:

> The BWD has neither the assets nor the knowledge to run RO water on a successful and sustainable basis. The Directorate and Governorate team members agreed that the only way

forward was a form of contracting out for the entire operation, with BWD keeping ownership of the fixed assets and having a regulatory role. This relationship between the BWD and the contractor is set out graphically as follows:



With the basic parameters for the operation set down, a contract was drawn up to allow a tender to be advertised for the service.

Even with the continual refurbishments and upgrades to the raw water and treated water aspects of the piped water supply in Basrah, the water delivered to household will not be of an acceptable potable standard for many years. In the ensuing period, which could be 5-10 years, large portions of the population will continue to rely on private and publicly owned commercial RO water sources. This should not be seen as a failure of the system and indeed may be an acceptable method of provision of water for the population in the South.

Formal adoption of the principal of a 2-tier water quality system for Basrah may be the step forward that is needed to give direction and a more realistic aim for each water system. Without splitting of the system, there will come a time in the future where grand-scale desalination may be required to lower the TDS of the general piped water supply to drinkable quality. With the split system, only 5-10 liters/person/day is required, initially delivered via distribution centers, which could eventually grow, funds permitting, into a piped network. The quality of the 'general' piped water system would then be acceptable at a much higher TDS and hence the useable life of the current source, along with raw water augmentation, would be increased.

It should be stressed that splitting the system into 2 formally recognized tiers of quality and delivery systems should not have a direct effect on the viability of the SWC as the delivery system for water for Basrah. Its effect would be to lengthen the viable life of the asset, whilst lowering the strategic aim for quality of treatment at the ‘general’ water treatment works. The present BWD could effectively manage the refurbished piped network with the minimal re-structuring and training which is already planned. The new expanded system for delivery of RO water would be a new arm of the BWD, with specific retraining for the responsibility for delivery of RO and monitoring the regulation (joint with Ministry of Health) of the private RO segment.

It is proposed that a 2-tier quality water system should be considered as an option for the long-term water needs of Basrah. Essentially this would be the recognition of the current system as an appropriate long term option worthy of further expansion.

Adoption of this in principle should lead to a more realistic goal for the refurbishment and the water quality expected from the general water treatment works. Whilst a 2-tier quality system is proposed, further analysis would be required before even suggesting the formal adoption of a 2 pipe system as the long term aim of the pipe network rehabilitation.

Current policy aim for the Greater Basrah and its satellites is for the treatment and distribution, to food grade potable standard, of some 8.5 m^3/second or 750,000 m^3/day of ‘drinking water’. This is a colossal undertaking and even planning for years in the future within a ‘new and stable Iraq’, this may turn out to be an unachievable goal. Adoption of the 2-tier system splits this into approximately 740,000 m^3/day of general water and 10,000 m^3/day of potable water, a percentage of which will be delivered by the private sector.

3.10 SOFT COMPONENTS OF THE PROJECT

(1) Reduction of Non- Revenue Water (NRW)

To reduce NRW including leakage the following measures should be implemented. The contents are described in detail in CHAPTER 6.

- Replacement of old pipes and asbestos pipes
- Change leak detection and control approach
- Implement leak detection and repair activities
- Distribution management - installing boundary valves, zone metering and customer metering
- Improvement of service pipe materials and construction methods
- Reduction of illegal connections
- Introduction of advanced billing and collection system

（2） Organization, Institution and Capacity Building

A training plan should be prepared for organization, institution and capacity building for BWD. The contents are described in CHAPTER 7.

3.11 PROPOSED FUTURE WATER SUPPLY SYSTEM

The proposed improvement of water supply system focuses on the central Basrah Governorate so that this plan should be 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, a transmission pumping station and main distribution facilities (distribution reservoir, transfer pumping station and elevated tank) was proposed. The components of the proposed water supply system are shown in Figure 3.14 and Table 3.18. The existing water supply facilities to be used at least until 2015 are shown in Table 3.19. The design of the proposed facilities is discussed in CHAPTER 4.

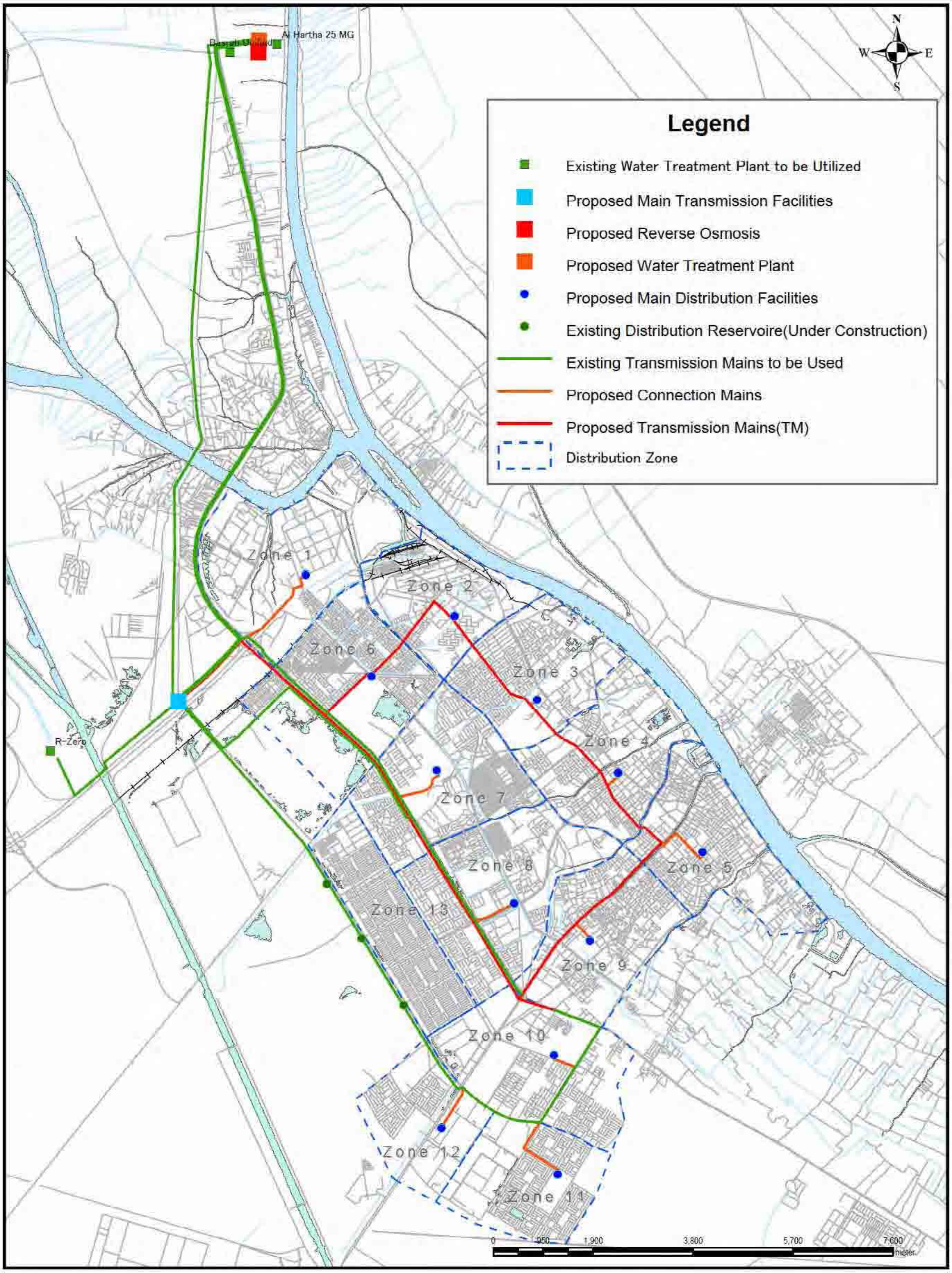
Table 3.18 Summary of Proposed Water Supply Facilities (WSPCB)

Facilities	Capacity
1. Rehabilitation of network	110 mm - 700 mm, 285 km
2. Rehabilitation of water treatment plant (WTP)	13 plants in Central Basrah
3. 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) Ground reservoir	186,000 m^3 in total
(3) Transfer pumping station	945,000 m^3/day (39,800 m^3/hr) in total
(4) Elevated tank	12,300 m^3
6. RO plant	362,000 m^3/day (output)

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

Table 3.19 Summary of Existing Water Supply Facilities to be used

Facilities	Capacity/remarks
1. Transmission pipeline	Used after rehabilitation
2. Distribution network	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 Al Hartha shall be used for treated water transmission mains from the new water treatment plant to the transmission reservoir.
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.



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.** 3.14

3.12 WATER SUPPLY PLAN FOR CENTRAL BASRAH (WSPCB) AND MINI M/P

Alternative 5 was selected as the best alternative for the future water supply for Al-Basrah Governorate in Mini M/P for the year 2025, but it has not been clearly decided as an approved legitimate plan. Therefore, for the purpose of comparison of facility components of Mini M/P and WSPCB, the study team takes Alternative 5 as reference.

Mini M/P also did not clearly mention the capacity and exact location of the proposed water supply facilities for all alternatives. Therefore, the location of water supply facilities for Alternative 5 and the capacity of these water supply facilities were estimated by the study team as shown in Figure 3.15, assuming following conditions and assumptions. In the Alternative 5, the required capacity is estimated as 1,231,000 m^3/day for conventional water treatment plant and 581,000 m^3/day for RO plant.

Estimation conditions:

- Total water demand: 1,038,000 m^3/day
- TDS of Tigris (1,100 mg/l), TDS of Shat Al Arab (1,500 mg/l)
- Expected TDS of RO treated water output: 200 mg/l
- Recovery rate of RO: 75 % of input

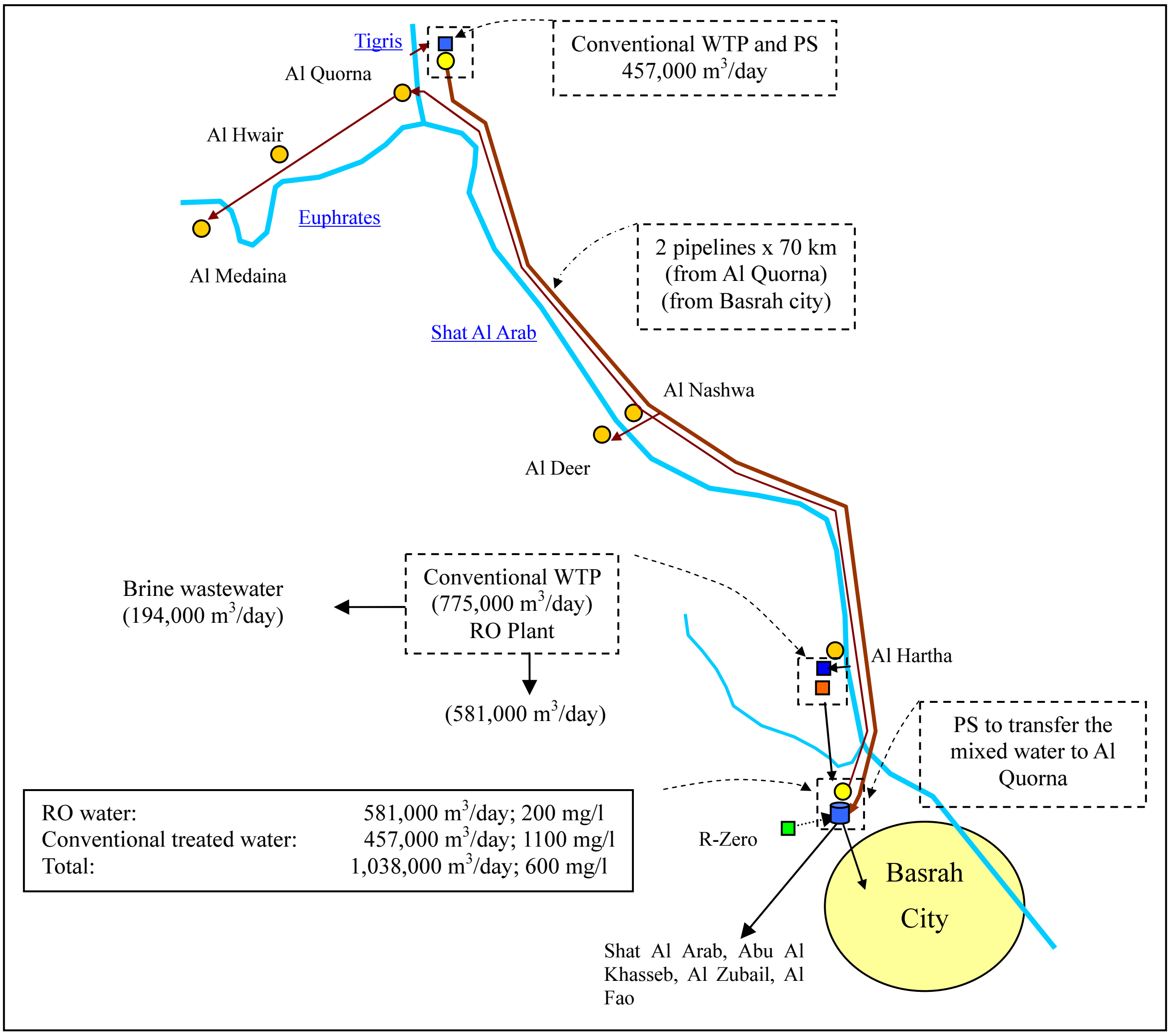


Figure 3.15 Estimated Component of Water Supply Facilities in Mini M/P

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 a selected alternative system of Mini M/P is explained in the following figure. As shown in this figure, all the facilities constructed in the WSPCB could be utilized as the components of the selected alternative.

WSPCB comprises the most urgent and higher priority components in Mini M/P and all facilities proposed in WSPCB will be integrated into the water supply system proposed in Mini M/P.

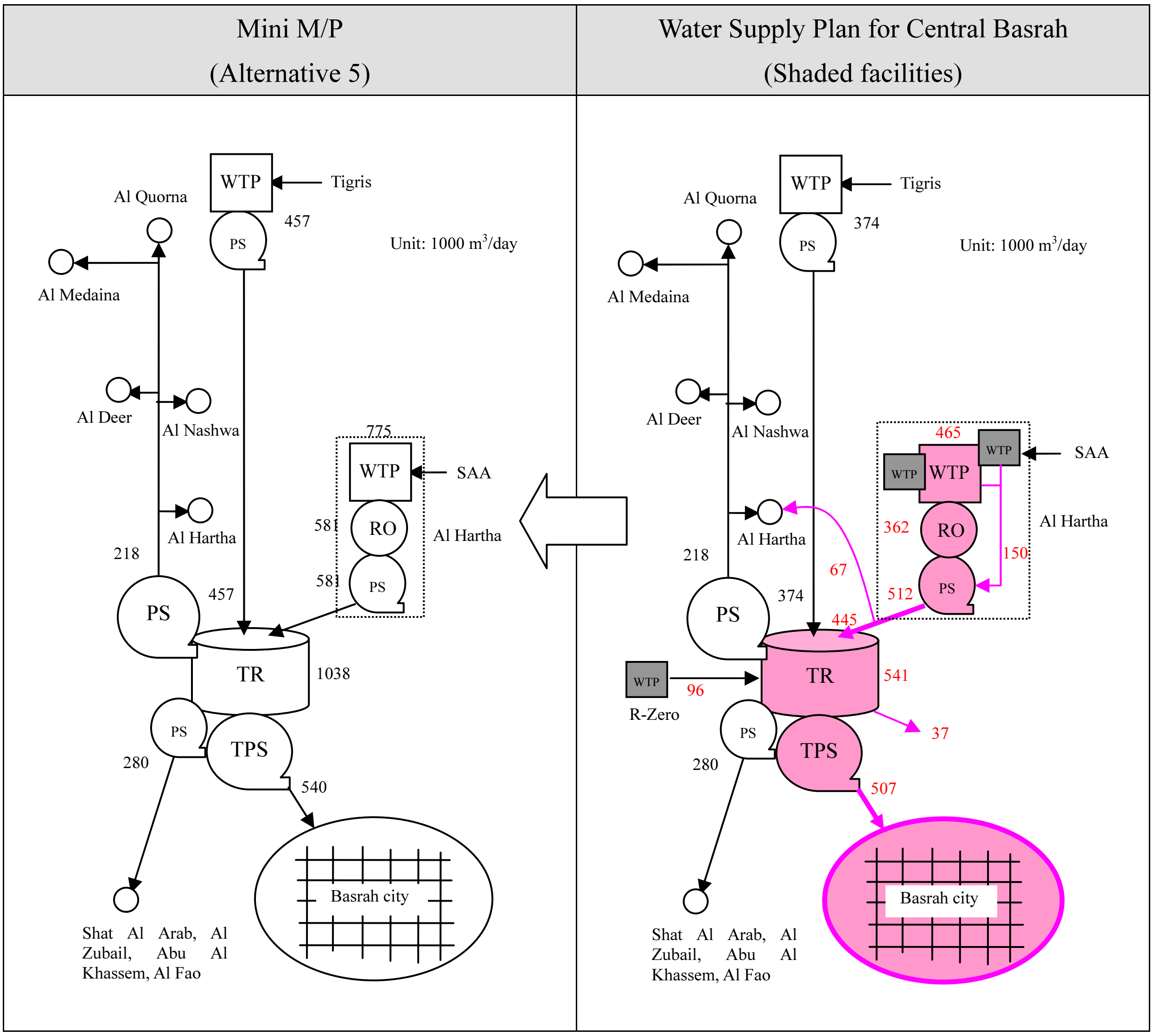


Figure 3.16 Schematic Layout of Water Supply Facilities of Mini M/P and WSPCB