No.

THE FEASIBILITY STUDY
ON
BAGHDAD WATER SUPPLY SYSTEM
IMPROVEMENT PROJECT

FINAL REPORT
VOLUME I

EXECUTIVE SUMMARY

NOVEMBER 2006

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
GLOBAL ENVIRONMENT DEPARTMENT

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PREFACE

In response to a request from the Government of the Republic Iraq, the Government of Japan decided to conduct a feasibility study on The Feasibility Study on Baghdad Water Supply System Improvement Project and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Masasto FUJINAMI Nippon Koei CO., LTD. and consists of Nippon Koei Co., LTD. and Tokyo Engineering Consultants Co., LTD. to Amman of Jordan between February, 2006 and September, 2006.

The team held discussions with the officials concerned of the Government of the Republic Iraq at Amman, collected data and discussed with the related persons of Iraq and other international donors. 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 our two countries.

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

November 2006

Ariyuki Matsumoto,
Deputy Vice President
Japan International Cooperation Agency

November 2006

Mr. Ariyuki Matsumoto
Dupty Vice President
Japan International Cooperation Agency (JICA)
Japan

Letter of Transmittal

Dear Sir,

We have the pleasure of submitting to you the Final Report of "The Feasibility Study on Baghdad Water Supply System Improvement Project" in accordance with the Scope of Work agreed upon between the Baghdad Water Authority (BWA) and Japan International Cooperation Agency (JICA).

The study was conducted by Nippon Koei Co., LTD. and Tokyo Engineering Consultants Co., LTD. under a contract to JICA, during the period from February 2006 and November 2006, through the discussions with the officials of the BWA, aiming to formulate water supply system improvement plan for the Baghdad City in Iraq.

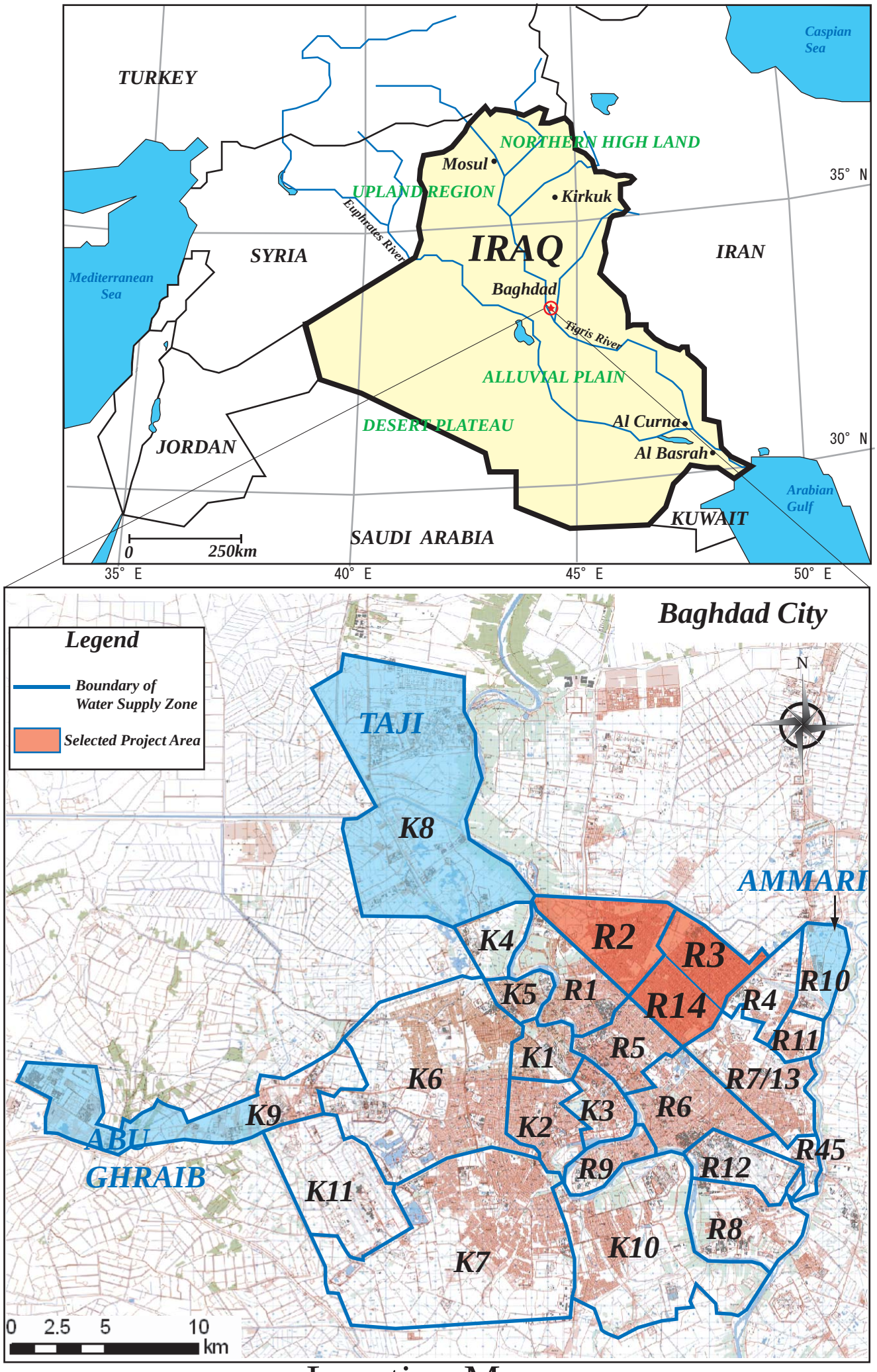
In conducting the study, which was carried out based in Amman Jordan, we have examined the present conditions of water supply system in the Baghdad City and the logistic, procurement and construction conditions, and formulated the appropriate water supply improvement plan for the Baghdad City in Iraq.

The study team sincerely hopes that the study results would contribute to the implementation of the water supply system improvement project in the Baghdad City.

Finally, we wish to express our deep appreciation and gratitude to the personnel concerned of your Agency, Ministry of Foreign Affairs and Japan Bank for International Cooperation (JBIC), as well as officials concerned of BWA.

Sincerely yours,

Masato Fujinami
Project Manger,
The Feasibility Study on Baghdad Water Supply System Improvement Project



Location Map

THE FEASIBILITY STUDY ON BAGHDAD WATER SUPPLY SYSTEM IMPROVEMENT PROJECT

Study Period: February 2006 – November 2006

Counterpart Agency: Baghdad Water Authority

OUTLINE OF THE STUDY

1 Background

Iraq is located at river basin of Tigris and Euphrates rivers which flow into Arabian Gulf. The total land area of Iraq is about 438,000km^2 and the total population of Iraq is estimated at 28.8 million as of 2005. Baghdad city is located on the alluvial plain of the Tigris River about 700 km upstream from the Arabian Gulf. The potable water supply of Baghdad is pumped from the Tigris river.

The water treatment and distribution facilities of the Baghdad water supply system are generally old due to limited investment in new facilities and a lack of maintenance of the existing facilities. This is mainly due to international economic sanctions on Iraq after the Gulf War of 1991.

The high ratio of Unaccounted for Water (UFW), which is estimated at about 50%, is extremely excessive. Records would indicate that half of the treated water does not reach water users due to leakage from the pipes, illegal connections and lack of maintenance. As a result, the current water deficit to the demand is estimated at about 1.25 million m^3/day.

2 Objectives

The objectives of the Study are summarized as follows:

1) To justify a selection of the priority area, and
2) To verify feasibility of the project for rehabilitation and replacement of distribution networks, and installation of water consumption meters in the priority area including eligibility for Japan Bank for International Cooperation (JBIC) financing.

3 Study Area

The Study area covers the water supply system of Baghdad Water Authority (BWA) in Mayoralty of Baghdad. The Feasibility Study was carried out on the selected priority area R2, R3 and R14 inside Rasafa area.

4 Outline of the Proposed Projects

(1) Basic Concepts

- To secure a safe and stable water supply for residents of the proposed Mahalahs,
- To reduce the unacceptably and unsustainably high 50% present rate of UFW
- To determine the actual water consumption of BWA customers in R2, R3 and R14 by means of equipping them with water consumption meters.

(2) Outlined

The proposed improvement plan for R3, R14, R2, which is outlined following, will be carried out starting in 2007 and be completed by the year 2011. Distribution tertiary replacement and water consumption meter installation are proposed to be implemented as priority projects. The pipe replacement project consists of a total of 294 km of pipe replacement work at selected Mahalahs in R3, R14, and R2. The water consumption meter installation project consists of a total of about 149,200 meters in all Mahalahs in R3, R14, and R2, including Mahalahs where older distribution pipes were replaced by BWA and foreign assistance activities.

Proposed Schemes are summarized as follows:

No.	Scheme	Proposed Mahalah		Distribution tertiary replacement DIP		Water consumption meter installation		Implementation period
	WSZ	Sum	Number of Mahalah	Diameter (mm)	Length (km)	Type of work	pcs	
1	R3	3	555,557, 564	150	25	Meter with service pipe	10,700	2008 - 2010
				200	-			
				250	9	Meter without service pipe	54,400	
				300	5			
				Total	39	Total	65,100	
2	R14	8	511,514, 516,518,522 (sector59), 523,535, 537	150	90	Meter with service pipe	13,300	2009 - 2010
				200	-			
				250	17	Meter without service pipe	35,800	
				300	11			
				Total	118	Total	49,100	
3	R2	7	321,331,333, 337,346,351, 353	150	73	Meter with service pipe	10,000	2010 - 2011
				200	6			
				250	34	Meter without service pipe	25,000	
				300	24			
				Total	137	Total	35,000	
Total		18		Total	294	Total	149,200	

5 Cost Estimates

The estimated costs for the proposed project are summarized as follows;

(Unit: US$ 1,000)

	Items	L.C.	F.C.	Total
1.	Direct Construction Cost (2008 to 2014)	21,402	35,354	56,756
1-1	Material Procurement and Supply	0	35,354	35,354
	1) Ductile cast iron pipes (DIP) with Fittings	0	18,588	18,588
	2) Gate Valves and Air Valves	0	3,694	3,694
	3) Fire Hydrants	0	2,967	2,967
	4) Water meters with service connection pipes	0	9,976	9,976
	5) Equipment for DMA Pilot Study	0	129	129
1-2	Civil Works	21,402	0	21,402
	1) Pipe Replacement Works	15,983	0	15,983
	2) House Connection Works	5,404	0	5,404
	3) Meter Chambers for DMA Pilot Study	15	0	15
2.	Administration Cost	6,951	6,452	13,403
3.	Tax and Duty	8,783	0	8,783
4.	Engineering Cost 11% of Direct cost	3,655	4,858	8,513
5.	Price Escalation	12,163	2,365	14,528
6.	Physical Contingency	8,103	8,834	16,937
	Total	61,057	57,863	118,920

Note:

1. L.C. means local currency portion and F.C. means foreign currency portion.

2. Physical contingency is 20% of L.C and F.C portion of sum of items 1, 2, and 5.

3. Price escalation is 9 % of L.C and 1.7% of F.C portion of items 1 and 2.

Project Cost of each scheme as follows:

Scheme	Project Cost (Million US$)
Scheme1: WSZ R3	22,069
Scheme2: WSZ R14	44,025
Scheme3: WSZ R2	52,826
Total	118,920

6 EVALUATION

(1) Environmental Impact Assessment

The Environmental Impact Assessment (EIA) report has already been approved by the Ministry of Environment (MOE), the following comments were mentioned by the MOE. The most sensitive issue mentioned was about the Asbestos Cement Pipes (ACP), they were assured that the proposal in the EIA was for the ACP to be left buried in situ after the Project implementation.

(2) Economic and Financial Evaluation

It is almost impossible to evaluate the economic benefit properly, since the Study Team cannot get enough information regarding the living condition of the Baghdad City due to the security problems. However, currently many people of Baghdad City suffered from the suspension of water supply is frequently occurred during daytime of the dry season. Consequently, many people have to secure the clean water by purchasing at markets or other methods. Breakages in the deteriorated pipes cause mixture of contaminated water into the clean water. United Nations Children's Fund (UNICEF) also mentioned that mortality rate of Iraq during the past five years was drastically increased and diarrhoea was one of the main reasons for that.

The resulting FIRR is -9.5% on the basis of the current water tariff level. The main reason of negative FIRR is based on the current low water tariff level.

Even though, the National Development Strategy (NDS) also strongly asserts that "improving access to clean water and sanitation" is the first priority for achieving the improving the quality of life. It should be recognized that the Project will bring the essential impacts for the improvement of the people's living conditions in the Project areas. It is evaluated that the Project deserves to be executed.

7 RECOMMENDATIONS

(1) It is recommended that the following projects proceed immediately to the implementation stage and that they follow the proposed schedule to minimize UFW figures and reduce chronic water shortage problems :

a) Replacement of distribution tertiary in the 18 Mahalahs in WSZs R3, R14 and R2

A program for replacement of tertiary distribution to reduce the leaking in the older damaged ACP and CIP and thus improve the existing distribution system and ensure a secure water supply.

b) Installation of water meters at the all subscribers in WSZs R3, R14 and R2

The purpose of installation of water meters is to observe the water consumption of R3, R14 and R2 for monitoring the water supply losses in the distribution systems.

(2) Recommendations for implementation schedules

- Completing the R3-Sadr WTP, by 2006 as scheduled
- Completing the new service reservoir for R14 by 2008
- Commencing the UFW action plan in 2007
- Replacing old and defective meters and installing new meters on un-metered service connections starting in 2008 providing yearly program for implementation.

- Replacing old distribution pipelines and related service connections at R3 starting in 2008.

(3) Establishing a project management team to supervise and control the project that is to be implemented with financial support from lending agencies is recommended. Coordination among stakeholders concerned is required for smooth execution of the project. The following arrangements will be necessary to achieve this goal.

- Establishing a Project Management Team (PMT) in BWA to supervise and control all relevant contracts and works to be implemented by different contractors and suppliers.
- International consultants should coordinate and manage the project from Amman.
- Detailed design and international bidding should be carried out by the international consultants in Amman
- Local consultant(s) should be stationed in Baghdad and assist the BWA and international consultant(s).
- The implementation progress in other Mahalahs should be reviewed to properly conduct the water consumption meter installation program.

(4) In the detailed design stage the following should be carried out:

- Locations of underground facilities should be confirmed based on detailed drawings prepared by related agencies such as Baghdad Sewerage Authority
- Selection of new replacement pipeline routes should be carried out by means of a detailed survey in the field based on the detailed drawings of the existing pipelines and underground facilities.
- An inventory survey of existing house connections and any illegal connections should be completed.
- A pilot study of DMA should be carried out to confirm the viability of an extended DMA program in WSZ R3.

(5) An Action plan for UFW reduction needs to be executed with the Implementation Section of BWA as the coordinator of the program with cooperation of the Planning and Follow Up Section, Computer Billing Section, Administration, Financial Affairs Section, Computer Billing Section, and the Design Section, Water section of the Municipality.

(6) It is recommended that the preliminary hydraulic analysis for the future water supply be reviewed after formulation of a Baghdad city plan since water demand was forecast based on the JICA Basic Study Report and USAID Report due to lack of a water supply master plan.

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VOLUME I
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ABBREVIATIONS

Organization

BWA	Baghdad Water Authority
CERP	Commander's Emergency Response Program
COSIT	Iraqi Central Organization for Statistics and Information Technology
CPA	Coalition Provisional Authority
CSO	Central Statistical Organization
EPID	The Environmental Protection and Improvement Directorate
GRD	Gulf Region Division of the U.S. Army Corps of Engineers
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
ILO	International Labor Organization
MOB	Mayoralty of Baghdad
MOCH	Ministry of Construction and Housing
MOE	Ministry of Environment
MOF	Ministry of Finance
MOT	Ministry of Transportation
MPDC	Ministry of Planning & Development Cooperation
MWT	Ministry of Works and Transportation
OPEC	Organization of the Petroleum Exporting Countries
PCO	Project & Contracting Office
UNICEF	United Nations Children's Fund
USACE	U.S. Army Corps of Engineers
USAID	United States Agency for International Development
WB	The World Bank

Others

ACP	Asbestos Cement Pipe
ADF	Average Daily Flow
ATP	Affordability to Pay
BS	Booster Station
CIP	Cast Iron Pipe
CSO	Central Statistical Organization
CU	Compact Unit
DIP	Ductile Iron Pipe
DMA	District Meter Area
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rete of Return

FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GIS	Geographical Information System
GSP	Galvanized Steel Pipe
IEE	Initial Environmental Examination
LDPE	Low Density Polyethylene Pipe
MDF	Maximum Daily Flow
MIS	Management Information System
NDS	National Development Strategy
ODA	Official Development Assistance
PEP	Polyethylene Pipe
PHF	Peak Hourly Flow
PMT	Project Management Team
PVC	Polyvinyl Chloride Pipe
RPS	Raw Water Pump Station
RWN	Raw Water Network
SCADA	Supervisory Control and Data Acquisition
SDMA	Sub District Meter Area
SR	Service Reservoir
STP	Steel Pipe
UFW	Unaccounted for Water
WCM	Water Consumption Meter
WSZ	Water Supply Zone
WTP	Water Treatment Plant

Units

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer

Area

cm^2	=	square centimeter
m^2	=	square meter
km^2	=	square kilometer

Volume

cm^3	=	cubic centimeter
m^3	=	cubic meter
l or lit	=	liter
MCM	=	million cubic meter

Weight

mg	=	milligram
g	=	gram
kg	=	kilogram

Time as denominator

/s or /sec	=	per second
/min	=	per minute
/hr.	=	per hour
/d	=	per day
/y	=	per year

Derived measures

lpcd	=	Liter per capita per day
m^3/s	=	Cubic meter per second
m^3/d	=	Cubic meter per day
mg/l	=	milligram per liter

Others

%	=	percent
°C	=	Celsius degrees
ppm	=	parts per million

Currency

JPY	Japanese Yen
US$	US Dollar
ID	Iraq Dinar

Transliterations of Arabic Place Names

9 Nisan	٩ نيسان
Abu Gharib	ابو غريب
Abu Nowas	ابو نواس
Adhamiyah	الاعظمية
Al Salam	السلام
Amin	الأمين
Army Canal	قناة الجيش
Boaitha	البوعيثة
Doura	الدورة
Ekhaa	الاخاء
Fahama	الفحامة
Hamediya	حميدية
Hussian Al Safi	حسن الصافي
Jomhuriya	الجمهورية
Kadhemiyah	الكاظمية
Kamaliya	الكمالية
Kanat	القناة
Karada	الكرادة
Karama	الكرامة
Karkh North	شمال الكرخ
Karkh South	جنوب الكرخ
Karkh	الكرخ
Kasra	الكسرة
Makaseb	المكاسب
Mansour	المنصور
Mendly	مندلي
Montadher	حي المنتظر
Nasser	النصر
New Akad	اكد الجديد
New Ammari	العماري الجديد
New Orfally	أورفلي الجديد
Obaidi	العبيدي
Obour	العبور
Old Akad	اكد القديم
Old Ammari	العماري القديم
Old Orfally	أورفلي القديم
Otaifiya	العطيفية
Jaderiya Bridge	جسرالجادرية
Jaderiya	الجادرية
Qadessia	القادسية
Rasafa	الرصافة
Rashad	الرشاد
Rasheed	الرشيد
Rostamia	الرستمية
Saba Kosour	سبع قصور
Sadr	الصدر
Saidiya	السيدية
Salam	السلام
Salehiya	الصالحية
Senak	السناك
Shaab	الشعب
Shark Dijla	شرق دجلة
Shola	الشعلة
Swaib	صويب
Taji	التاجي
Tal Aswad	تل أسود
Tarik	طارق
Um Al Asafier	ام العصافير
Wahda	الوحدة
Wathba	الوثبة
Zafaraniya	الزعفرانية
Zaiuna	زيونة

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CHAPTER 1 INTRODUCTION

1.1 Background to the Study

Iraq is located at river basin of Tigris and Euphrates rivers which flow into Arabian Gulf. The total land area of Iraq is about 438,000km^2 and the total population of Iraq is estimated at 28.8 million as of 2005. Baghdad city is located on the alluvial plain of the Tigris River about 700 km upstream from the Arabian Gulf. The potable water supply of Baghdad is pumped from the Tigris river.

The water treatment and distribution facilities of the Baghdad water supply system are generally old due to limited investment in new facilities and a lack of maintenance of the existing facilities. This is mainly due to international economic sanctions on Iraq after the Gulf War of 1991.

The high ratio of Unaccounted for Water (UFW), which is estimated at about 50%, is also remarkable. Records would indicate that half of the treated water does not reach water users due to leakage from the pipes, illegal connections and lack of maintenance. As a result, the current water deficit to the demand is estimated at about 1.25 million m^3/day.

The Government of Iraq settled on "Iraq's National Development Strategy (NDS)" in 2005 for national development. One of the urgent problems of Iraq is to improve the water supply and the hygiene diffusion.

On the other hand, the Japanese government declared a total US$ 150 million for the grant aid as emergency assistance at Iraq reconstruction donor’s committee meeting in Madrid on October 2003. In addition, the maximum US$ 350 million for the yen loan as a mid-term reconstruction assistance was declared basically. As a result, the total amount of assistance becomes US$ 500 million.

Under the above circumstances, JICA implemented the Preliminary Study for Iraq Reconstruction Project in Hashemite Kingdom of Jordan for the grant aid project in 2004.

Furthermore, the software assistance for the improvement of UFW has been carried out in the field of water supply plan, operation & maintenance and GIS under the Third Country Training Program of JICA in Amman from 2004.

Based on the above results, the Government of Iraq requested the Government of Japan to provide a feasibility study for the yen loan project of the UFW reduction by water supply system improvement.

1.2 Objectives of the Study

The objectives of the Study are summarized as follows:

1) To justify the selection of the priority area, and
2) To verify feasibility of the project for rehabilitation and replacement of distribution pipes and installation of meters in the priority area including eligibility for Japan Bank for International Cooperation (JBIC) financing.

1.3 Study Area

The Study area covers the water supply system of Baghdad Water Authority (BWA) in the MOB. A Feasibility Study was carried out on the selected priority area Water Supply Zones (WSZs) R2, R3 and R14 inside Rasafa area.

CHAPTER 2 GENERAL BACKGROUND OF THE STUDY

2.1 The Past National Development Plans

The first National Development Plan of Iraq was the First 6-year-plan (1951~1956) under the administration of the monarchy, and thereafter a total of six National Development Plans were formulated until the Fourth 5-year-plan (1976~1980) by the Bakr administration. The plans had been discontinued by the change of administration. The exception was the third 5-year plan (1970-1974), which ran its full course under the Bakr regime with a budget of 6.5 billion dollars. However, after 1980, Saddam's administration (1981~2003) did not execute any long-term National Development Plans due to the Iraq -Iran war (1980~1988) and Gulf war (1991).

2.2 National Development Strategy

Iraq's National Development Strategy (NDS) 2005-2007 is a priority development program of the democratically elected government of Iraq. NDS 2005-2007 is the first strategy of the Iraqi Interim Government's (IIG) policies for national development. This consultative process has continued under the Iraqi Transitional Government (ITG). The revised NDS 2005-2007 was endorsed by the Economic High Committee and the Cabinet. The revised NDS (July 2005) is established on four major pillars that will govern strategic public actions for reconstruction and development as follows:

1) Strengthening the foundations of economic growth.

2) Revitalizing the private sector.

3) Improving the quality of life.

4) Strengthening good governance and security.

Pillar three, "Improving the quality of life", is a core pillar of the NDS. Pillar three consists of six elements for improving the quality of life. "Improving access to clean water and sanitation." is shown as the first priority of the requirements for quality of life. Taking the above into consideration, this project aims at improving the quality of life in urban areas through the improvement of water supply facilities in the Mayoralty of Baghdad (MOB).

2.3 Foreign Assistance Activities

Foreign assistance for the potable water sector of the MOB is carried out by international donors and the Commander's Emergency Response Program (CERP). The international donors' conference on the reconstruction of Iraq was held to coordinate the international donors' community at Madrid on October 24th 2003. The international donors' community

agreed to assist in the reconstruction of Iraq at the international Madrid Donors' Conference. The total pledged amounts are about US $33 billion for the period from 2004 to 2007. The United States pledged about US$18.4 billion for the Iraqi relief and Reconstruction Fund (IRRF). World Bank pledged about $3 billion to $5 billion in loans over the next five years. The Japanese government pledged about US$1.5 billion for grant aid projects and 3.5 billion for loan projects.

The main donors for the potable water sector of the Mayoralty of Baghdad consist of the World Bank, United States Agency for International Development (USAID), United Nations Children's Fund (UNICEF) and Japan. The World Bank project is the Emergency Baghdad Water Supply and Sanitation Project, which totals US$ 65 million on grant terms. The USAID project is the Iraq Infrastructure Reconstruction program Phase II Potable Water Sector. The Gulf Region Division of the U.S. Army Corps of Engineers (GRD of USACE) is also conducting pipe replacement work in several sectors in Sadr City that were designed by USAID. The GRD has completed five Sectors and has contracted to do 38 Sectors by the end of August 2006, all funded through the Commander's Emergency Response Program (CERP).

CHAPTER 3 GENERAL OUTLINE OF THE STUDY AREA

3.1 Natural Conditions

The Tigris River is 1,800 km in length. Baghdad is located on the alluvial plain of the Tigris River about 34 m above sea level and about 700 km upstream from the Arabian Gulf. The main irrigation water is taken from the Tigris River. The potable water supply of Baghdad is also pumped from the Tigris River. The water level of the Tigris River increases in April from the melting of snow in the Turkish mountainous region. The water quality of the Tigris River has deteriorated due to the salinity of the agricultural effluents, industrial waste water, and domestic waste water. Therefore, the water intake point of the Baghdad water supply system is planned to be as far upstream of Baghdad city as possible.

Annual average rainfall is 135.7 mm (50 year average). There are two seasons. The rainy season is from November to April. The dry season is from May to October. Sadr City (WSZs R3 and R14) is located on the left bank of the Tigris River and is composed of silty clay with a shallow groundwater level at 0.3~1.0 m.

3.2 Socio-economic Conditions

The total population of Iraq was estimated at 28.8 million as of 2005 and Baghdad has almost 23% of the total population of Iraq. Gross Domestic Product (GDP) per capita of 2004 and 2005 were estimated at US$ 948 and US$ 1,189 respectively. Iraq's economy historically has been characterized by a heavy dependence on oil industries. The economic activity of the oil sector is still overwhelming in Iraq's economy. This sector's share of GDP in recent years has been quite high at over 65%. The World Bank reports that the oil sector accounts for over 95% of exports and revenue for the country.

However, Iraq faces two serious issues in regard to the current socio-economic structure, which it has to cope with for achieving the above goals. One is the youthful population structure and the other is escalation of urbanization. Accordingly, maintenance and development of the socio-economic infrastructure and diversifying the monocultural economy under a transparent governance and market friendly economic policy are necessary for Iraq's sustainable development.

CHAPTER 4 PRESENT CONDITIONS OF WATER SUPPLY SYSTEM

4.1 Present Water Use

BWA supplies water to the City through two systems, a potable water supply network and a raw water supply network. The current BWA service area is estimated at 917.5 km^2 which includes not only the whole area of the City, but also suburbs of the City including Abu Gharib, Taji and Ammari as shown in Figure 4.1.1.

(1) Service area and population served

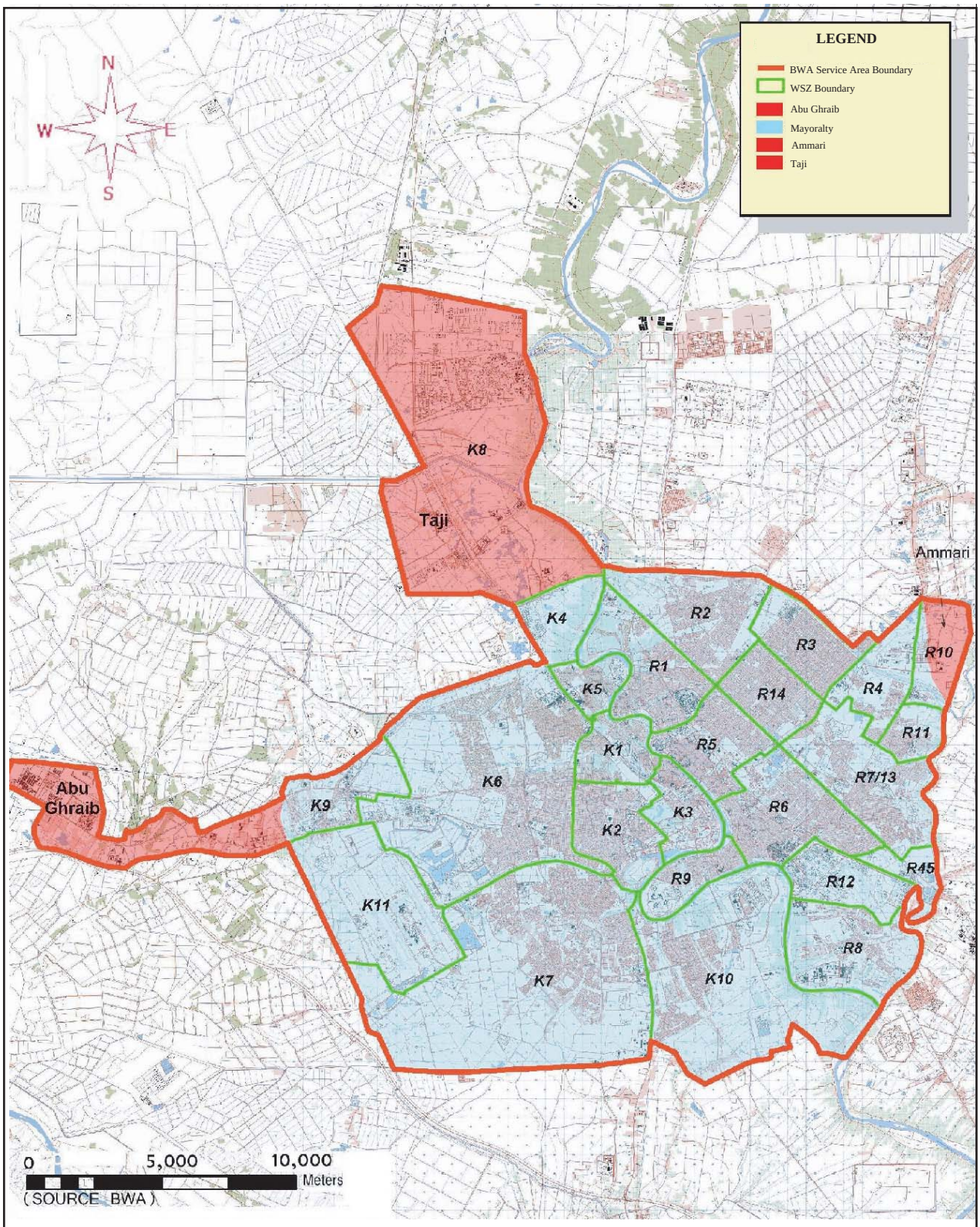
Baghdad City is divided by the Tigris River into two sides, the Karkh side (to the west of the Tigris River) and Rasafa side (to the east of the Tigris River). Total area of the City is approximately 734 km^2, while the BWA served area is about 917.5 km^2 including a suburban area of 183.5 km^2. The present BWA service ratio reaches 100% with 5.6 million of population served in 2005. About 55% of the population lives in the Rasafa side and the remaining in the Karkh side as follows.

Table 4.1.1 Service Area and Population Served

	Area	Population		Population Density
Rasafa Side	286.2km^2	3,105,000	(55%)	10,900/km^2
Karkh Side	631.3km^2	2,490,000	(45%)	3,900/ km^2
Total	917.5km^2	5,595,000	(100%)	6,100/ km^2

(Source: BWA)

The service area of BWA is divided into 25 Water Supply Zones (WSZs) for network improvement, such as pressure control systems, and system wide master metering, as shown in Figure 4.1.1. It is planned that each WSZ will include a service reservoir with a booster pump station. The service area and population served of the WSZs are estimated as shown in Table 4.1.2.



JICA Japan International Cooperation Agency	The Feasibility Study on Baghdad Water Supply System Improvement Project in the Republic of Iraq	NIPPON KOEI CO.,LTD. Tokyo Engineering Consultants Co., Ltd.	Title: BWA SERVICE AREA Figure 4.1.1

Table 4.1.2 Area and Population Served at Water Supply Zone in 2005

Water Supply Zone (WSZ)	Administrative Area (Municipality)	WSZ Area (km2)	WSZ Developed Area (km2)	Present Year: 2005*		
				Population	Population Density	Population Density at Developed Area
Rasafa Side						
R1	Adhamiyah	27.39	20.46	276,380	10,091	13,508
R2	Shaab	30.74	22.03	363,437	11,823	16,497
R3	Sadr 1 & 2/Shaab	18.48	16.54	657,803	35,595	39,770
R4	9 Nisan	16.98	10.45	112,206	6,608	10,737
R5	Rasafa	20.49	19.15	223,255	10,896	11,658
R6	Karadah	31.87	30.29	327,158	10,265	10,801
R7/R13	9 Nisan	34.55	24.65	321,266	9,299	13,033
R8	Karadah	30.09	17.13	136,750	4,545	7,983
R9	Karadah	11.96	9.72	54,764	4,579	5,634
R10 (Ammari)	9 Nisan/Suburban	14.43	11.87	41,823	2,898	3,523
R11	9 Nisan	8.06	4.77	86,335	10,712	18,100
R12	Karadah	17.09	16.79	885	52	53
R14	Sadr 1 & 2	16.40	15.49	503,083	30,676	32,478
R45	Karadah/9 Nisan	7.65	3.90	175	23	45
Sub Total		286.18	223.24	3,105,320	10,851	13,910
Karkh Side						
K1	Karkh/Shola/Kadhemiyah/Mansour	13.83	11.02	148,287	10,722	13,456
K2	Karkh/Mansour	21.64	18.78	138,467	6,399	7,373
K3	Karkh	14.64	13.44	137,548	9,395	10,234
K4	Kadhemiyah	14.17	3.81	37,644	2,657	9,880
K5	Kadhemiyah	8.92	7.19	89,064	9,985	12,387
K6	Shola/Mansour	106.46	81.49	735,845	6,912	9,030
K7	Rashid	127.21	59.41	624,716	4,911	10,515
K8: Taji Center	Suburban	134.7	75.79	133,838	994	1,766
K9: Abu Ghraib	Mansour/Suburban	56.67	36.65	139,374	2,459	3,803
K10	Doura	85.33	39.66	305,144	3,576	7,694
K11: Airport	Mansour	47.72	47.72	0	0	0
Sub Total		631.29	394.96	2,489,928	3,944	6,304
TOTAL		917.47	618.20	5,595,247	6,099	9,051

(Remark *) Population and density are estimated based on data from the following reports:

Source 1: Draft Technical Report Volume 1 Hydraulic Model Potable Water Distribution System Baghdad Water Authority Iraq Infrastructure Reconstruction Program Phase II Potable Water Sector, USAID, Jannuary 2006

Source 2: Integrated Study on Improvement of The Baghdad Water Supply System (Basic Study Report) JICA, March 2005

(2) Present water supply and water consumption

It is noted that the quantity of treated water and water consumption within the BWA service area is estimated rather than metered since most flow meters for the water treatment plant and service reservoirs are out of service and only 52% of the recorded 555,600 subscribers are equipped with water consumption meters. Daily water supply and consumption are estimated as in Table 4.1.3.

Table 4.1.3 Present Water Supply and Consumption

Item	2000*1	2004*2	2005*2
Average Water Supply (MCM/d)	1.775	1.980	2.490
Amount billed (MCM/d)	0.860	-	-
Population Served	4,769,072	5,479,862	5,595,247
Average per capita Water Supply (lpcd)	372	354	445
UFW (%)	52	47	46
Average per capita Water Consumption (lpcd)	180	190	240
Number of Households (2005 BWA Billing Data)	-	-	483,478
Average Water supply per Household including UFW (m^3/Household day)	-	-	5.150

(Source: *1UNICEF Report 2003, *2BWA)

The average family size based on the USAID Report is 12.6 persons per family. The number of households is estimated at 483,478 based on BWA billing data as shown in Table 4.1.3 on the assumption that the number of BWA domestic subscribers is equal to the number of households. In 2005, the average daily water consumption per capita was estimated at 240 lpcd. The average daily water consumption per household was estimated at 5.2 m^3/d including UFW. The net daily water consumption per household was assumed to be 2.8 m^3/d considering the UFW ratio. Daily water consumption patterns were observed by BWA. Peak water consumption occurs from 7:00 to 14:00 and again from 18:00 to 21:00 on an average day. Although BWA produced treated water to meet the present water demand, the BWA customers are unsatisfied with the BWA water supply considering the seasonal fluctuations, restricted water supply and actual UFW of more than 50%.

(3) Domestic use and non domestic use

The consumer categories in the BWA service area are summarized in Table 4.1.4. About 90% of the total number of subscribers are domestic users and the remaining are categorized as non domestic users.

Table 4.1.4 Consumer Categories

Consumer Category	Service Connections (Subscribers)	Ratio (%)	Meter Equipped	Not Meter equipped
Domestic Use	483,478	87	233,563	249,915
Non Domestic Use	72,122	13	52,936	19,186
- Governmental	6,500			
- Public, Industrial & Commercial	65,622			
Total	555,600	100	286,499	269,101

(Source: Billing Section of BWA, as of December 2005)

All households with storage reservoirs use them regardless of the season and all of those households use their reservoirs daily. The average capacity of individual household reservoirs ranges from 1 m^3 to 2 m^3.

BWA usually uses water service tankers with a capacity of 10 m^3 in order to supply potable water to residents and hospitals since water shortage and disrupted water supply are often caused by low pressure in the existing distribution system. Total average daily water supply by tankers in the BWA service area is estimated at 1,864 m^3/d consisting of 1,174 m^3/d (63%) for the Rasafa side and 690 m^3/d (37%) for the Karkh side. About 0.1% of WTPs' daily production is supplied by water service tankers. More than 50% of total water by tankers is supplied to the Municipalities of Shaab and Sadr.

4.2 Existing Water Supply System and Facilities

The Baghdad potable water supply system encompasses eight water treatment plants, eight service reservoirs with booster pump stations, over 8,000 km of trunk and distribution lines ranging in diameter from 2,300 mm to 100 mm and 34 compact unit (CUs) sites, of which 16 unit sites are directly connected with the potable water supply network. The water supply facilities of the Baghdad water supply system, such as water treatment plants (WTPs) and distribution pipe, are generally old due to limited investment in new facilities and they suffer from a lack of maintenance of the existing facilities.

(1) Water source

The only water source for the City is the Tigris River. Water is directly pumped into water treatment plants (WTP) and delivered to the water supply zones (WSZs). There are eight water treatment plants for potable water and eight raw water pump stations for irrigation and miscellaneous use along the Tigris. The average daily production of potable water and raw water in 2005 was about 2.5 million m^3/d and 0.1 million m^3/d respectively.

The Tigris River has abundant stream flow and the present average flow of the Tigris is as much as 400 m^3/s. However, the recent decrease in the river flow is rather acute. Extensive construction of dams on major tributaries of the Tigris for flood control and irrigation purposes has decreased the flow to southern Iraq. The quality of the Tigris water for drinking

use is gradually deteriorating. There are three sewage treatment plants with a total capacity of 489,000 m^3/d, more than 260 sewerage pump stations, and over 17,000 km of sewerage network in Baghdad. However the existing sewerage system is not functioning properly and about 50,000 m^3/d of untreated wastewater is thought to be discharged directly into the river. In proportion with urban population growth in Baghdad, untreated wastewater discharge and increasing agricultural runoff have a major influence upon the concentration and seasonal variations of organic pollution and salinity in the Tigris River.

(2) Raw water supply system

The City is served by an extensive raw water supply system to satisfy the following demands:

1) Irrigation use associated with farms surrounding the City

2) Gardening use for public green areas

3) Supply to CUs as source

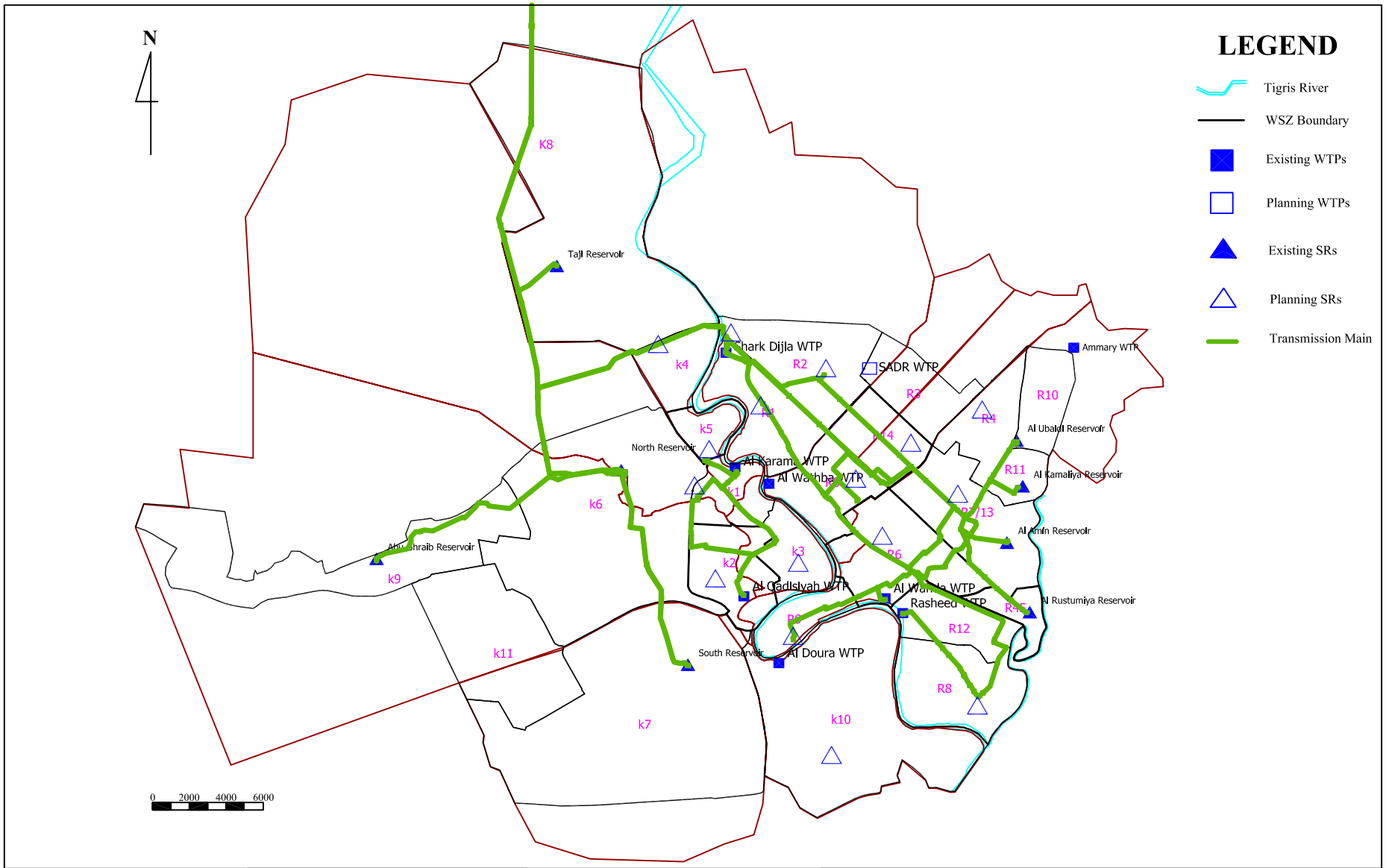
4) Non-potable use for residential, commercial and public buildings

The eight Raw Water Pump Stations (RPSs) deliver water from the Tigris River through a raw water distribution network about 4,500 km long with pipeline sizes varying from 400 mm to 1600 mm in diameter. The pumping capacity of the raw water pump stations has been severely reduced by equipment failure due to a lack of long-term maintenance and availability of spare parts. RPS No.4 in Al Zafaraniya was scheduled for abandonment by BWA since the raw water is extremely polluted. The Army canal had been used for irrigation but at present the canal is only used for drainage due to the high degree of contamination.

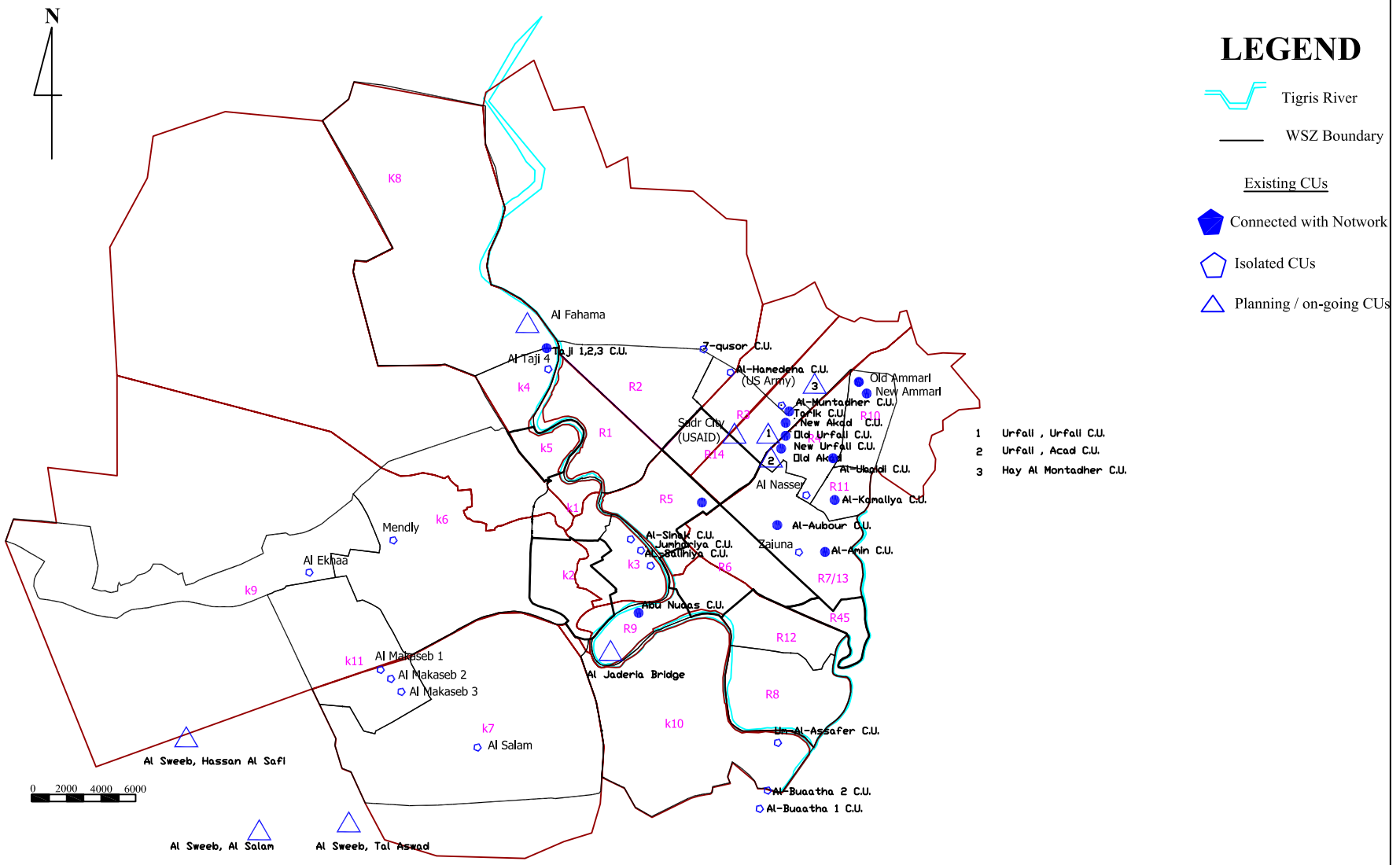
(3) Potable water supply system

1) WTPs and CUs sites

The potable water is produced through the existing eight WTPs and thirty four compact unit (CUs) sites, the package WTPs as shown in Figures 4.2.1 and 4.2.2 respectively. The existing raw water supply system supplies water to the CUs and most of the CUs deliver treated water to house connections through isolated distribution systems. In 2005, the amount of water abstracted from the Tigris River was estimated at approximately 900 MCM. The production of WTPs represents about 94% of the total water production. About 50% of the total water produced was unaccounted for. The total production of WTPs and CUs is estimated at 2.5 MCM/d and this almost met the estimated average daily water requirements of 2.6 MCM/d in 2005.



Japan International Cooperation Agency	The Feasibility Study on Baghdad Water Supply System Improvement Project in the Republic of Iraq	NIPPON KOEI CO.,LTD. / Tokyo Engineering Consultants Co.,Ltd.	Title: WATER TREATMENT PLANTS (WTPs) AND SERVICE RESERVOIRS (SRs)	
			Scale: As-Shown	Date: Figure 4.2.1



JICA Japan International Cooperation Agency	The Feasibility Study on Baghdad Water Supply System Improvement Project in the Republic of Iraq	NIPPON KOEI CO.,LTD. Tokyo Engineering Consultants Co.,Ltd.	Title: COMPACT UNITS (CUs)	
			Scale: As-Shown	Date: Figure 4.2.2

Total design capacity of the WTPs is 2,821,000 m^3/d and actual capacity is 2,343,000 m^3/d. All the existing WTPs, except for the Karkh WTP and Shark Dijla WTP, are connected to the distribution mains. The Karkh WTP, which is located about 30km north of the City, is a major treatment plant with a capacity of 1.15 MCM/d at present and this capacity represents about 50% of the current system wide capacity. Treated water from the Karkh WTP is conveyed to both sides, Karkh and Rasafa. The Karkh WTP transfers the treated water mainly to the Karkh North reservoir and the Taji reservoir on the Karkh side, and a lesser quantity to the Shark Dijla WTP equipped with a blending station (2B Blending Reservoir) on the Rasafa side.

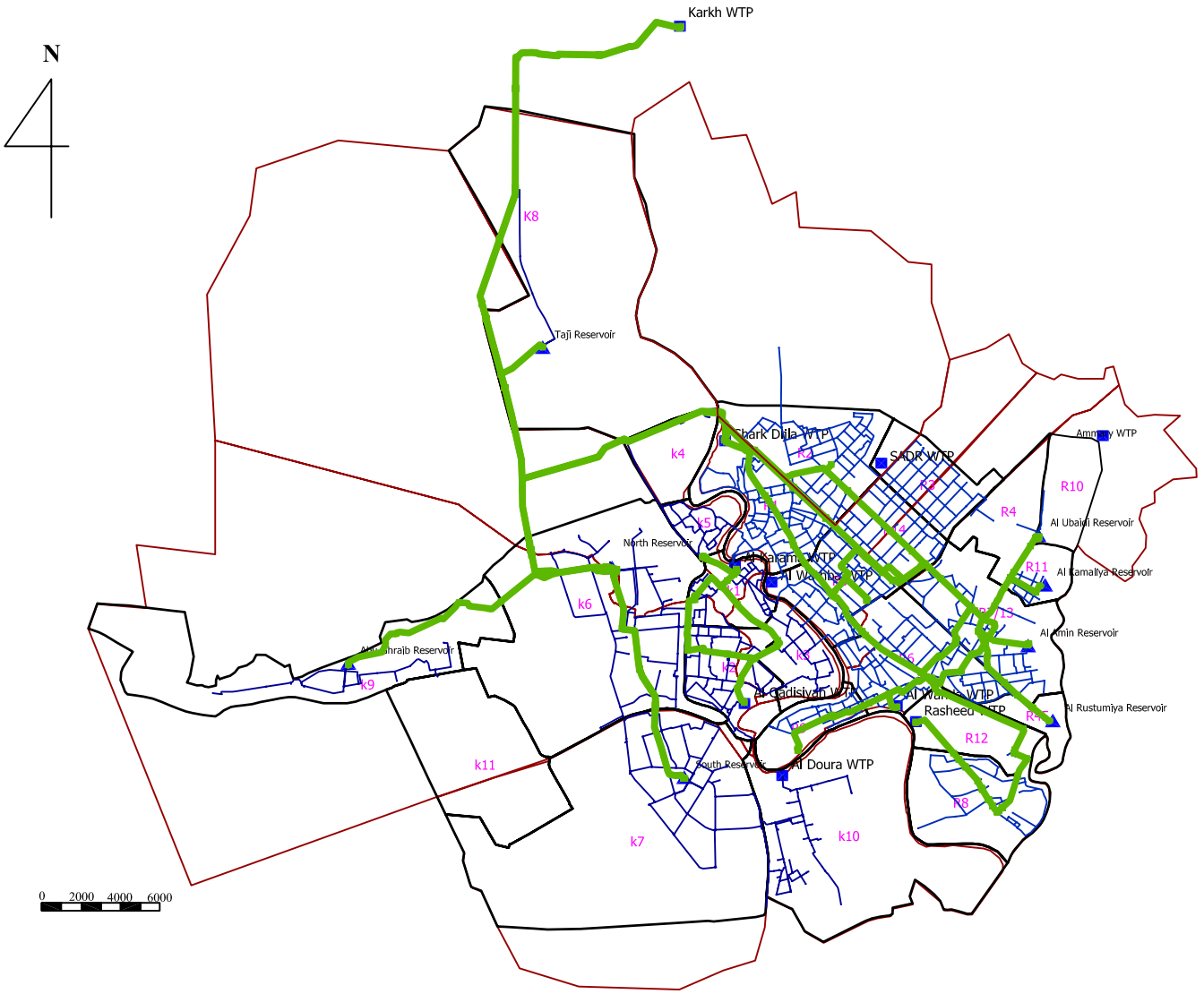
The Shark Dijla WTP supplies water to the Rasafa side and its capacity represents about 11% of the system wide capacity. The Shark Dijla WTP, which is located along the Tigris River in WSZ R1, channels about 315,000 m^3/d from the Karkh WTP through two transmission mains with diameters of 1,600mm and 1,400mm. The Shark Dijla WTP expansion-1 was conducted by the Iraq government through assistance of USAID. The Sadr WTP with a capacity of 90,000 m^3/d is under construction with the assistance of USAID. The Rasafa WTP is planned by BWA to be developed in four phases, but this plan is not moving ahead in terms of funding, budgeting or BWA institutional prospects. At the existing WTPs, except the Shark Dijla WTP, the chemical dosing and monitoring systems are not functional at all and so manual chlorination and monitoring methods are adopted at present. Almost all flow meters are out of order due to a lack of proper maintenance. It is recommended that the malfunctioning flow meters should be repaired or replaced for the sake of proper management of BWA water works.

As the 34 CUs sites were adopted for water supply in Baghdad as emergency measures, in principal, BWA plans to abandon the 16 CUs sites connected to the distribution network after properly establishing the Baghdad water supply system, such as completion of the Rasafa WTP and Shark Dijla WTP expansion, while The remaining 18 CUs sites are to continue to be used even after completion of the proposed Rasafa WTP. The CUs to be abandoned may be re-used for rural water supply.

The 564,140 m^3 total storage capacity of the service reservoirs represents 4.8 hours storage based on design capacity of the existing WTPs with 2,821,000 m^3/d and 2.4 hours storage based on the future design capacity of WTPs including the planned WTPs. About 89% of the storage capacity is located on the Karkh side of the water supply system. It is known that the number of service reservoirs is lacking and the present storage capacity is insufficient throughout the system. Especially, the water supply system on the Rasafa side is facing a problem of sever shortage. All the flow meters for the distribution network are out of order due to a lack of proper maintenance.

2) Transmission (Trunk) and distribution networks

The existing transmission (trunk) and distribution mains and submain are presented in Figure 4.2.3. The water supply system from Karkh WTP to service reservoirs plays an integral role in supplying water to the Karkh side consisting of 11 WSZs. The Shark Dijla WTP and four service reservoirs supply water to the Rasafa side consisting of 14 WSZs. Total length of transmission mains ranging from 500mm and 2,300mm in diameter is estimated at about 280 km. The future BWA transmission network is planned to be a combination of ring transmission mains and WSZs. Within each side, an inner ring main is to be installed for interconnecting service reservoirs of WSZs.



Japan International Cooperation Agency	The Feasibility Study on Baghdad Water Supply System Improvement Project in the Republic of Iraq	NIPPON KOEI CO.,LTD. / Tokyo Engineering Consultants Co.,Ltd.	Title: TRUNK AND DISTRIBUTION MAINS	
			Scale: As-Shown	Date: Figure4.2.3

The existing distribution ability of the Karkh side is better than that of the Rasafa side. The typical distribution network consists of the following three hierarchies:

Hierarchy	Range of Pipe Diameters (mm)
1) Distribution Mains	500mm to 1200mm
2) Distribution Sub-mains (Secondary)	300mm to 500mm
3) Distribution Sub-mains (Tertiary)	100mm to 250mm

Distribution pipelines with a total length of 7,746 km consist of Ductile Iron Pipes (DIP), Steel Pipes (STP), Cast Iron Pipes (CIP), Polyvinyl Chloride Pipes (PVC) and Asbestos Cement Pipes (ACP). DIP is mainly used for distribution mains and STP is used for sleeve pipe at river crossings. Distribution sub-mains are mostly composed of CIP, PVC and ACP. Degradation of the pipelines is evaluated as being directly related to age, which is given in Table 4.2.1.

Table 4.2.1 The Age of the Pipelines

Diameter	ACP	DIP	CIP	PVC	STP	Total	%
1600-1000		250				250	3.2%
900-500		375			165	540	7.0%
450-250		275			125	400	5.2%
225-200	500	200	100	47		847	10.9%
160-110	1,000	400	200	489		2,089	27.0%
100-90	2,200	900	500	20		3,620	46.7%
Total Length (km)	3,700	2,400	800	556	290	7,746	100.0%
%	47.8%	31.0%	10.3%	7.2%	3.7%	100.0%	
Very Old (>35 years)			86		11	96	
Old (>20 years)	1,835					1,835	
Medium (>10 years)		684		42		726	
Total Length > 10 yrs old (km)	1,835	684	86	42	11	2,657	
%	49.6%	28.5%	10.7%	7.5%	3.7%	34.3%	At each category

(Source: BWA, as of 2005)

The above total length of 7,746 km excludes pipes in zones K4, K8 and K11. It is assumed that the total length of the existing distribution mains is more than 10,000 km in the BWA service area.

At present, ACP, CIP and PVC are all of 225mm or less in diameter. Length of ACP, CIP and PVC represent respectively 48%, 10% and 7% of the total pipeline length. CIP, with a total length of 86 km, which is equivalent to 11% of the total length of all pipelines, has been used for more than 35 years and about 50% of the ACP has been in use for more than 20 years. Use of these aging pipes increases water leaks at a high rate. BWA has been conducting pipe replacement works throughout Baghdad with the assistance of international organizations, such as USAID, GRD-PCO, UNICEF and World Bank. Pipe replacement works mainly aim

at improvement of distribution tertiary of less than 300mm diameter which is ACP, CIP, DIP and PVC.

(4) Service Connections and Water Consumption Meters

The present service connections, based on the billing records, are summarized in Table 4.2.2.

Table 4.2.2 Number of Service Connections

Consumer Category	Meter Equipped Connections						Unmetered Connections	%	Total
	Functional	%	Malfunction/ Not accessed	%	Sub-Total	%			
Domestic Use	104,683	21	128,880	27	233,563	48	249,915	52	483,478
Non Domestic Use	23,299	32	29,637	41	52,936	73	19,186	27	72,122
Total	127,982	23	158,517	29	286,499	52	269,101	48	555,600

(Source: Billing Section of BWA, as of December 2005)

About 52% of the recorded 555,600 service connections are equipped with water consumption meters. Only 23% of the total number of service connections are metered properly and water consumption of the remaining 77% connections of which 48% are not metered and 29% have malfunctioning meters is not known by BWA. For water consumption meter reading and a proper billing system, meter installation is required urgently.

The service connection pipe from the distribution tertiary to the individual premises is generally made of polyethylene pipe (PEP). Where house of connections are inside individual premises, galvanized steel pipe (GSP) is used. The direct tapping method, which makes a tapered and threaded tap into the main pipe wall using a tapping machine, has been adopted by BWA for connections between the distribution main and the service pipe.

4.3 Unaccounted for Water (UFW)

The unaccounted for water (UFW) is a critical problem for BWA. Because the Gulf War and international sanctions on Iraq slowed the import of water system spare parts for BWA, the BWA water distribution system has been in a state of continuous deterioration for at least the past 15 years. The UFW study was carried out in Amman due to safety and security problems in Baghdad to assess the present condition of UFW of BWA based on the reports of previous water supply studies and discussions with persons in charge of water leakage. Therefore, this report was prepared without any field survey in Baghdad.

Treated water of the BWA system is supplied from several water treatment plants to the network. However, correct amounts supplied can not be estimated because flow-meters at the point of discharge to the network are malfunctioning except at expansion-1of the Shark Dijla WTP.

According to the section 4.2 (4) Service Connections and Water Consumption Meters, the actual consumption rate of 77 % the subscribers is not know.

Water leakage is common in older systems within the Baghdad water supply system. BWA and municipalities carry out pipe repair work at water leakage points based on visible leaks reported to the BWA or the water section of the municipalities by customers or the general public. But invisible leaks are not repaired due to the lack of a leak detection system in BWA and the municipalities. Accurate water system leakage can not be determined in Baghdad because none of the system is metered.

Generally, in order to estimate the UFW, the figures for billed water and un-billed water (meter malfunction, illegal use) are deducted from total water production and the balance is assumed to be UFW. However, it is difficult to assess current water losses precisely in the BWA system.

Therefore, an approach using the performance value in 2000 as given in the UNICEF report was used. However, statistics for 2000 and afterwards do not exist. Therefore, it is assumed that the present UFW is 40 - 50% from the UNICEF report.

CHAPTER 5 PLAN FORMULATION

5.1 Basic Concepts

(1) Evaluation of the Existing Water Supply System

The existing water supply system and its present conditions are described in Chapter 4. From the evaluation of the existing water supply system through review of previous studies, the following present problems were identified.

- Chronic water shortage, especially in the Rasafa Side.
- Aged water supply facilities, such as distribution mains, flow meters and WTPs.
- Abnormally high ratio of Unaccounted for Water (UFW) (50%) in the network.
- Water consumption meters in use cover only 23% of the total service connections.
- No establishment of a transmission system in the Rasafa Side.
- Poor meter reading and billing systems
- Deteriorating raw water quality and decreasing flow in the Tigris River.

Among the above problems, which BWA has been faced with, solution of chronic water shortage in the Rasafa side is considered by BWA to be the most urgent and necessary since chronic water shortage causes aggravation of the moral and social order in Baghdad. The water supply system in the Rasafa side has not been improved over the years. The JICA Basic Study Report and USAID Report concluded that improvement of the water supply system in the Rasafa side is a prime requirement.

Evaluation of the existing water supply system is summarized below and plan formulation was conducted considering the following evaluation:

Table 5.1.1 Evaluation of the Existing Water Supply System

Items	Karkh Side	Rasafa Side	Problems
1. Capacity of WTPs	A	C	Water Shortage
2. Transmission System	A	C	Insufficient Supply (Flow, Pressure, Leakage)
3. Service Reservoirs	B	C	Insufficient Supply (Capacity, Pressure)
4. Distribution Mains	B	C	Water Shortage, Low Pressure, Illegal Connections, Deterioration of Water Quality, High ratio of UFW
5. Distribution Sub-mains	C	C	
6. Water Meter Reading	C	C	High ratio of UFW

(Note) A: Sufficient, B: Moderate C: Poor

(2) Basic Concepts for the Formulations of Plans

The plan was formulated to cover to the year 2027 based on the deficiencies in the existing water supply system. The water resource development potentials for BWA were examined,

and the level of urgency of the water requirements identified through the study was considered. The target year has been set at 2014 for the mid term plan and 2027 for the long term plan.

The basic concepts for the formulation of the plans are as follows;

1) Targeting water supply system improvement for the area to be selected as the priority area in the feasibility study,
2) Reducing UFW in the existing distribution system,
3) Improving the water supply system, considering the chronic water shortage, especially in the Rasafa Side,
4) Reflecting results of the preliminary hydraulic analysis to improve the water supply system,
5) Looking for opportunities to improve the existing meter reading and billing system,
6) Considering the District Meter Areas (DMA),
7) Taking into account the Japan International Cooperation Agency (JICA) Basic Study Report and USAID Report as being the current Baghdad water supply master plan (These reports are effectively used for planning information).

Based on careful scrutiny of the problems in the existing water supply facilities extracted by the previous studies, the following basic strategies for improvement are recommended for the present and future water supply systems.

1) Aged Asbestos Cement Pipe (ACP), Cast Iron Pipe (CIP) and Polyvinyl Chloride Pipes (PVC), which have been causing water leakage in the distribution network, shall be replaced for leakage prevention and water saving as early as possible.
2) The currently extremely large amount of unaccounted for water (UFW) shall be reduced in stages, not only for supporting economic development and financial strengthening of BWA, but also for conservation of water resources.
3) Considering effectiveness in UFW reduction, replacement of tertiary pipes consisting of aged ACP, CIP and PVC is regarded as a top priority scheme for the distribution networks and in the future the replacement of distribution mains, including secondary pipes should follow.
4) According to the hydraulic analysis, all the tertiary pipes should be replaced simultaneously to best augment the existing capacity.
5) Improvement of transmission and distribution mains shall be recommended based on the preliminary network analysis and its implementation will be conducted after replacement of tertiary pipes taking account of the order of priority of the schemes and the BWA budget.

6) Phased construction of Water Treatment Plants (WTPs) shall be adopted to meet the present and future water requirements.

7) New Service Reservoirs (SRs) shall be constructed at each WSZ, especially in the Rasafa Side. These are urgently required since the present storage capacity is equivalent to only 1.0 hour based on the water requirements.

8) The existing flow meters at WTPs and SRs shall be repaired or replaced for proper management of BWA water works.

9) Water consumption meters shall be replaced or new ones installed as early as possible in order to improve the meter reading and billing system and to determine the exact water consumption rates.

10) The construction plan for pipe replacement works shall be made in consideration of the existing underground structures and application procedures for permission for construction work in roads due to the existence of utility lines, such as water mains, sewers, electric cables and telephone lines (refer to DATA BOOK 2 Drawings of Water Supply Facilities).

5.2 Population Projection and Water Demand

(1) Prediction of Population Served

Through discussions with BWA, the 2004 population projected by the USAID Report was chosen to be applied for the prediction of BWA population served. For the Feasibility Study, the 1997 population was estimated based on the 2004 projection of the USAID Report and, as will be mentioned later, the annual population growth of the JICA Basic Study Report and estimated population is allocated for each WSZ. For the future population projections, the following annual population growth rates were applied

Table 5.2.1 Annual Growth Rates

Time Period	Baghdad City	Suburban
1997 to 2010	2.10%	2.20%
2010 to 2020	2.25%	2.20%
2020 to 2027	2.25%	2.25%

(Source: JICA Basic Study Report)

The estimates of BWA population served in the present and in the future are based on the population in Baghdad city and its suburban estimated from the 1997 BWA customer base. The population served in the future is presented in Table 5.2.2 and the population for the target years is summarized below:

Table 5.2.2 Summary of Population Projection at Water Supply Zones for Target Years

Water Supply Zone (WSZ)	WSZ Area (km2)	WSZ Developed Area in 2005 (km2)	Present Year: 2005*							Middle-term Target Year: 2014			Long-term Target Year: 2027		
			WSZ			Maharh		Sector at Sadr City		WSZ			WSZ		
			Population	Population Density	Population Density at Developed Area	Number	Population Density at Mharh	Number	Population Density at Sector	Population	Population Density	Population Density at Developed Area	Population	Population Density	Population Density at Developed Area
Rasafa Side															
R1	27.39	20.46	276,380	10,091	13,508	28	9,871			362,382	13,230	13,230	483,938	17,668	17,668
R2	30.74	22.03	363,437	11,823	16,497	21	17,307			440,769	14,339	20,008	648,713	21,103	21,103
R3	18.48	16.54	657,803	35,595	39,770	31	21,219	47	11,738	820,240	44,385	44,385	1,095,379	59,274	59,274
R4	16.98	10.45	112,206	6,608	10,737	17	6,600			136,081	8,014	13,022	208,667	12,289	12,289
R5	20.49	19.15	223,255	10,896	11,658	42	5,316			277,910	13,563	13,563	371,132	18,113	18,113
R6	31.87	30.29	327,158	10,265	10,801	31	10,553			400,471	12,566	12,566	534,803	16,781	16,781
R7/13	34.55	24.65	321,266	9,299	13,033	28	11,474			389,625	11,277	15,806	576,010	16,672	16,672
R8	30.09	17.13	136,750	4,545	7,983	19	7,197			165,847	5,512	9,682	257,169	8,547	8,547
R9	11.96	9.72	54,764	4,579	5,634	12	4,564			70,555	5,899	5,899	94,222	7,878	7,878
R10 (including Ammar	14.43	11.87	41,823	2,898	3,523	6	6,971			53,105	3,680	3,680	70,711	4,900	4,900
R11	8.06	4.77	86,335	10,712	18,100	7	12,334			104,705	12,991	21,951	159,696	19,813	19,813
R12	17.09	16.79	885	52	53	3	295			1,074	63	64	1,434	84	85
R14	16.40	15.49	503,083	30,676	32,478	30	16,769	37	8,611	619,674	37,785	37,785	827,534	50,459	50,459
R45	7.65	3.90	175	23	45	4	44			212	28	54	335	44	44
Sub Total	286.18	223.24	3,105,320	10,851	13,910	279	11,130	84	10,175	3,842,650	13,427	15,942	5,329,742	18,624	18,643
Karkh Side															
K1	13.83	11.02	148,287	10,722	13,456	17	8,723			190,566	13,779	13,779	254,488	18,401	18,401
K2	21.64	18.78	138,467	6,399	7,373	22	6,294			174,406	8,059	8,059	232,908	10,763	10,763
K3	14.64	13.44	137,548	9,395	10,234	15	9,170			170,727	11,662	11,662	227,994	15,573	15,573
K4	14.17	3.81	37,644	2,657	9,880					45,654	3,222	11,983	60,968	4,303	4,303
K5	8.92	7.19	89,064	9,985	12,387	11	8,097			115,692	12,970	12,970	154,499	17,320	17,320
K6	106.46	81.49	735,845	6,912	9,030	56	13,140			962,733	9,043	9,043	1,285,669	12,077	12,077
K7	127.21	59.41	624,716	4,911	10,515	47	13,292			757,643	5,956	12,753	1,011,784	7,954	17,031
K8: Taji Center	134.7	75.79	133,838	994	1,766					162,794	1,209	2,148	248,814	1,847	1,847
K9: Abu Ghraib	56.67	36.65	139,374	2,459	3,803					169,528	2,991	4,626	251,829	4,444	4,444
K10	85.33	39.66	305,144	3,576	7,694	28	10,898			370,073	4,337	9,331	494,209	5,792	12,461
K11: Airport	47.72	47.72	0	0	0					0	0	0	0	0	0
Sub Total	631.29	394.96	2,489,928	3,944	6,304	196	12,704			3,119,815	4,942	7,280	4,223,161	6,690	8,156
TOTAL	917.47	618.20	5,595,247	6,099	9,051	475	11,779			6,962,464	7,589	10,403	9,552,903	10,412	11,886

(Source: BWA & JICA Study Team)

Table 5.2.3 Population Projections at Target Years

Target Year	Rasafa Side	Karkh Side	Total
2005	3,105,320	2,489,928	5,595,247
2014	3,842,650	3,119,815	6,962,464
2027	5,329,742	4,223,161	9,552,903

(Source: BWA & JICA Study Team)

As shown in Table 5.2.3, about 56% of the population served is distributed on the Rasafa side and 44% on the Karkh side. The population and population density of the total area, developed areas and Mahalahs in 2005 are estimated as shown in Table 5.2.4:

Table 5.2.4 Population and Density in 2005

Service Area	Total Area (km^2) **(A)**	Developed Area: DA (km^2) **(B)**	Population **(C)**	Population Density in Total Area **(C)/(A)**	Population Density in Developed Area **(C)/(B)**	Mahalahs	
						Number	Average Population in Mahalah
Rasafa Side	286.18	223.24	3,105,320	10,851	13,910	272	11,417
Karkh Side	631.29	394.96	2,489,928	3,944	6,304	205	12,146
Total	917.47	618.20	5,595,247	6,099	9,051	477	11,730

(Source: BWA & JICA Study Team)

(2) Water Demand Projection

The service area is estimated at 917 km^2 including undeveloped areas of 299 km^2. The existing population served in 2005 is estimated at 5,595,000 by multiplying the total number of billed domestic connections by the average number of persons per domestic connection (12.6 persons per family from the USAID Report). Targeted population to be served in 2027 is estimated at 9,553,000. As discussed with BWA, the following water use conditions and factors were applied for the water demand projection and hydraulic analysis of the water supply system in Baghdad:

Table 5.2.5 Water Use Conditions and Factors

Year	2000	2005	2014	2027
Unit Water Consumption (lpcd)	230	244	280	360
UFW Ratio (%)	50.0	46.4	38.0	25.0
Annual UFW Reduction Rate (%)	0.925			
Peak Daily Factor	1.40	1.365	1.292	1.25
Peak Hourly Factor	2.25			
Persons per Service Connection	12.6			

(Source: BWA & JICA Study Team)

The classified water demand projection at each target year is shown in Table 5.2.6 and summarized below:

Table 5.2.6 Projected Water Demand and Water Requirement at Water Supply Zone (Target Years of 2005, 2014 and 2027)

Water Supply Zone (WSZ)	2005						2014						2027					
	Served Population	Water Demand (m^3/d) (Unit Water Demand) 244 lpcd	UFW (m^3/d) 46.4%	Average Day Supply (m^3/d)	Maximum Day Supply (m^3/d) (Peak Day Factor) 1.365	Peak Hourly Flow (m^3/h) 2.25	Served Population	Water Demand (m^3/d) (Unit Water Demand) 280 lpcd	UFW (m^3/d) 38.0%	Average Day Supply (m^3/d)	Maximum Day Supply (m^3/d) (Peak Day Factor) 1.292	Peak Hourly Flow (m^3/h) 2.25	Served Population	Water Demand (m^3/d) (Unit Water Demand) 360 lpcd	UFW (m^3/d) 25.0%	Average Day Supply (m^3/d)	Maximum Day Supply (m^3/d) (Peak Day Factor) 1.250	Peak Hourly Flow (m^3/h) 2.25
Rasafa Side																		
R1	276,380	67,516	58,514	126,029	172,030	11,815	362,382	101,467	62,189	163,656	211,444	15,343	483,938	174,218	58,073	232,290	290,363	21,777
R2	363,437	1.9 88,783	76,945	165,727	2.6 226,218	15,537	440,769	2.3 123,415	75,642	199,057	3.0 257,182	18,662	648,713	3.6 233,537	77,846	311,382	4.5 389,228	29,192
R3	657,803	3.5 160,692	139,266	299,958	4.7 409,443	28,121	820,240	4.3 229,667	140,764	370,431	5.5 478,597	34,728	1,095,379	6.1 394,336	131,445	525,782	7.6 657,227	49,292
R4	112,206	27,410	23,756	51,166	69,841	4,797	136,081	38,103	23,353	61,456	79,401	5,761	208,667	75,120	25,040	100,160	125,200	9,390
R5	223,255	54,538	47,266	101,804	138,963	9,544	277,910	77,815	47,693	125,508	162,156	11,766	371,132	133,607	44,536	178,143	222,679	16,701
R6	327,158	79,920	69,264	149,184	203,636	13,986	400,471	112,132	68,726	180,858	233,668	16,955	534,803	192,529	64,176	256,706	320,882	24,066
R7/R13	321,266	78,481	68,017	146,497	199,969	13,734	389,625	109,095	66,865	175,960	227,340	16,496	576,010	207,363	69,121	276,485	345,606	25,920
R8	136,750	33,406	28,952	62,358	85,118	5,846	165,847	46,437	28,462	74,899	96,769	7,022	257,169	92,581	30,860	123,441	154,301	11,573
R9	54,764	13,378	11,594	24,973	34,088	2,341	70,555	19,755	12,108	31,864	41,168	2,987	94,222	33,920	11,307	45,226	56,533	4,240
R10*	41,823	10,217	8,855	19,071	26,032	1,788	53,105	14,869	9,114	23,983	30,986	2,248	70,711	25,456	8,485	33,941	42,426	3,182
R11	86,335	21,090	18,278	39,369	53,738	3,691	104,705	29,317	17,969	47,286	61,094	4,433	159,696	57,490	19,163	76,654	95,817	7,186
R12	885	216	187	404	551	38	1,074	301	184	485	626	45	1,434	516	172	688	860	65
R14	503,083	2.7 122,896	106,510	229,406	3.6 313,139	21,507	619,674	3.2 173,509	106,344	279,853	4.2 361,570	26,236	827,534	4.6 297,912	99,304	397,217	5.7 496,521	37,239
R45	175	8.0 43	37	80	11.0 109	7	212	9.8 59	36	96	12.7 124	9	335	14.3 121	40	161	17.9 201	15
Sub-total	3,105,320	758,585	657,441	1,416,026	1,932,900	132,752	3,842,650	1,075,942	659,448	1,735,390	2,242,200	162,693	5,329,742	1,918,707	639,569	2,558,276	3,197,900	239,838
Karkh Side																		
K1	148,287	36,224	31,394	67,619	92,300	6,339	190,566	53,358	32,704	86,062	111,192	8,068	254,488	91,616	30,539	122,154	152,693	11,452
K2	138,467	33,826	29,315	63,141	86,187	5,919	174,406	48,834	29,930	78,764	101,763	7,384	232,908	83,847	27,949	111,796	139,745	10,481
K3	137,548	33,601	29,121	62,722	85,615	5,880	170,727	47,803	29,299	77,102	99,616	7,228	227,994	82,078	27,359	109,437	136,797	10,260
K4	37,644	9,196	7,970	17,166	23,431	1,609	45,654	12,783	7,835	20,618	26,638	1,933	60,968	21,949	7,316	29,265	36,581	2,744
K5	89,064	21,757	18,856	40,613	55,437	3,807	115,692	32,394	19,854	52,248	67,504	4,898	154,499	55,620	18,540	74,159	92,699	6,952
K6	735,845	179,756	155,789	335,545	458,019	31,457	962,733	269,565	165,217	434,783	561,739	40,761	1,285,669	462,841	154,280	617,121	771,401	57,855
K7	624,716	152,609	132,261	284,871	388,848	26,707	757,643	212,140	130,021	342,161	442,073	32,078	1,011,784	364,242	121,414	485,656	607,070	45,530
K8 (Taji Center)*	133,838	32,695	28,335	61,030	83,306	5,722	162,794	45,582	27,938	73,520	94,988	6,892	248,814	89,573	29,858	119,431	149,288	11,197
K9 (Abu Ghraib)*	139,374	34,047	29,508	63,555	86,752	5,958	169,528	47,468	29,093	76,561	98,917	7,178	251,829	90,658	30,219	120,878	151,097	11,332
K10	305,144	74,542	64,603	139,146	189,934	13,045	370,073	103,620	63,509	167,130	215,931	15,668	494,209	177,915	59,305	237,220	296,525	22,239
K11 (Airport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total	2,489,928	608,254	527,153	1,135,407	1,549,831	106,444	3,119,815	873,548	535,400	1,408,949	1,820,362	132,089	4,223,161	1,520,338	506,779	2,027,117	2,533,897	190,042
Total	5,595,247	1,366,839	1,184,594	2,551,433	3,482,731	239,197	6,962,464	1,949,490	1,194,849	3,144,339	4,062,562	294,782	9,552,903	3,439,045	1,146,348	4,585,394	5,731,797	429,881
Annual Water Requirement (MCM/year)		499		931	1,271			712		1,148	1,483			1,255		1,674	2,092	

(Source : BWA & JICA Study Team)

Table 5.2.7 Water Demand Projection at Each Target Year

Classification	2000	2005	2014	2027
1. Water Use Condition				
1.1 Unit Water Consumption (lpcd)	230	244	280	360
1.2 Planned UFW Ratio (%)	50.0	46.4	38.0	25.0
1.3 Peak Day Factor	1.400	1.365	1.292	1.250
2. Average Water Requirements				
2.1 Average Water Requirements (MCM/d)	2.320	2.551	3.144	4.585
2.2 UFW Amount (MCM/d)	1.185	1.185	1.195	1.146
2.3 Unit Average Water Demand per capita (lpcd)	460	456	452	480
3. Maximum Water Requirements				
3.1 Max. Daily Water Requirements (MCM/d)	3.247	3.483	4.063	5.732
3.2 Unit Max. Water Demand per capita (lpcd)	644	622	583	600
4. Reference Index				
4.1 UFW Reduction Rate at Target Year (%)	-	3.6	8.4	13.0
4.2 Effective Ratio of Water Requirements (%)	50.0	53.6	62.0	75.0

(Source: BWA & JICA Study Team)

5.3 Water Requirements and Production

(1) Water requirement

Based on the projected water demand, water requirements are estimated as shown in Table 5.2.6 the year 2005, 2014 and 2027 for the future Baghdad water supply system. The estimated water requirements assume that the land use pattern in the existing service areas will not change significantly. Water requirements in the service area are summarized as shown in Table 5.3.1. Annual water requirements at each target year are estimated based on average daily water supply of 931 MCM/y in 2005, 1,148 MCM/y in 2014 and 1,674 MCM/y in 2027.

Table 5.3.1 Summary of Water Requirements in the Service Area

Description	2000	2005	2014	2027
1. Rasafa Side				
1.1 Population (10^3)	2,799	3,105	3,843	5,330
1.2 Water Demand ($10^3m^3/d$)	644	759	1,076	1,919
1.3 Average Daily Supply ($10^3m^3/d$)	1,287	1,416	1,735	2,558
1.4 Max. Daily Supply ($10^3m^3/d$)	1,802	1,933	2,242	3,198
2. Karkh Side				
2.1 Population (10^3)	2,243	2,490	3,120	4,223
2.2 Water Demand ($10^3m^3/d$)	516	608	874	1,520
2.3 Average Daily Supply ($10^3m^3/d$)	1,032	1,135	1,409	2,027
2.4 Max. Daily Supply ($10^3m^3/d$)	1,444	1,550	1,820	2,534
3. Total of Baghdad				
3.1Population (10^3)	5,042	5,595	6,962	9,553
3.2 Water Demand ($10^3m^3/d$)	1,160	1,367	1,949	3,439
3.3 Average Daily Supply ($10^3m^3/d$)	2,319	2,551	3,144	4,585
3.4 Max. Daily Supply ($10^3m^3/d$)	3,247	3,383	4,063	5,732

(Source: BWA & JICA Study Team)

(2) Proposed Water Production

As described in Section 4.2, the water production is estimated at around 2.3 MCM/d in 2004 and 2.5 MCM/d in 2005. Production of the WTPs is more than 93% of total production. Based on the above-mentioned water demand projections, BWA required 2.5 MCM/d in 2004 and 2.6 MCM/d in 2005 on an average daily supply basis. It is supposed that a deficit exists in the present water supply system, not only in terms of the maximum daily supply but also the average daily supply. It is, therefore, necessary that BWA improve the existing WTPs and develop new treatment plants.

Water treatment capacity projections were provided by BWA as shown in Table 5.3.2. As for the proposed WTPs implementation schedule, the JICA Basic Study Report was referred to. Capacity of the existing plants, including Shark Dijla WTP Expansion-1, is estimated at the present actual capacity base and capacity of on-going/proposed plants is presented with the design capacity base.

Table 5.3.2 Water Treatment Capacity Projection

Name of Treatment Plant		First Year of Operation	Capacity (m^3/d)			Remarks
			Total	Rasafa Side	Karkh Side	
1	Existing Plants					
	8 WTPs		2,208,000	678,000	1,530,000	Actual Capacity
	16 CU Sites Connected with Network		125,280	118,000	7,280	
	18 CU Sites Isolated from Network		55,465	39,905	15,560	Actual Capacity
2	On-going/Currently Constructed Plants					
	Shark Dijla WTP Expansion-1	2005	135,000	135,000		USAID, Actual Capacity
	Sadr City WTP	2006	90,000	90,000		USAID, Design Capacity
	Sadr City 27 CU Sites (Isolated)	2006	405	405		USAID, Design Capacity
	19 CU Sites (Isolated)	2007	85,500	76,500	9,000	JICA, Design Capacity
3	Proposed Plants					
	Shark Dijla Expansion-2	2009	315,000	315,000		Design Capacity
	Rasafa WTP Stage-1	2011	600,000	600,000		Design Capacity
	Rasafa WTP Stage-2	2015	600,000	600,000		Design Capacity
	Rasheed WTP Abandon	2015	-50,000	-50,000		to be abandoned
	Rasafa WTP Stage-3	2019	600,000	600,000		Design Capacity
	Half of Existing 16 CU Sites Removal	2019	-62,640	-59,000	-3,640	to be removed
	Rasafa WTP Stage-4	2023	600,000	600,000		Design Capacity
	Half of Existing 16 CU Sites Removal	2023	-62,640	-59,000	-3,640	to be removed
Total			5,239,370	3,684,810	1,554,560	

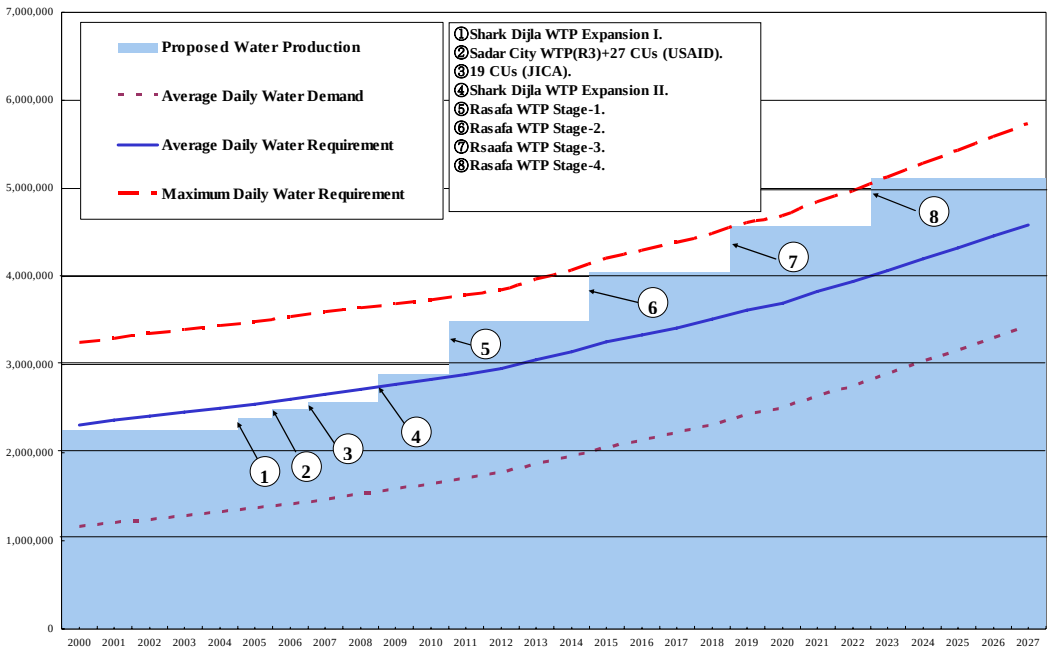
(Source: BWA & JICA Study Team)

As shown in Table 5.3.2, the existing deteriorated Rasheed WTP will be demolished after completion of Rasafa WTP stage-3. A half of the existing 16 CU sites connected with the distribution network are to be removed in the year 2019, and the remaining half in 2023.

Water requirements and water production are projected in chronological order as shown in Figure 5.3.1 (as for calculation of the balance between forecast demand and treatment capacity,

refer to DATA BOOK 1). Figure 5.3.1 shows the balance of forecast demand and treatment capacity. The JICA Basic Study Report recommended that a balancing quantity of about 520,000 m^3/d might be transmitted from the Rasafa side to the Karkh side in the target year of 2027. For this water transmission, the existing river crossing trunk mains of 1600 mm and 1400 mm in diameter will be used as they have sufficient conveying capacity and pressure.

Although the water treatment capacity projection is to improve the water supply condition in Baghdad, it is noteworthy that the maximum daily supply has never been met as shown in Figure 5.3.1. Shark Dijla expansion-2 allows the average daily supply to be met in the year 2009. Based on the BWA standard design, the WTPs are typically to be designed to fulfil the maximum daily supply with on-line distribution storage providing peak hourly supply. From a practical standpoint regarding the existing facilities, the actual treated water through the WTPs, as mentioned in Section 4.2, is well below the design capacity so that average daily supply is not being met.



(Source: BWA & JICA Study Team)

Figure 5.3.1 Water Requirements and Proposed Water Production

5.4 Priority Areas and Projects

(1) Results of the preliminary hydraulic analysis

The preliminary hydraulic analysis was carried out using a simplified computer model as described in Appendix A. The results of the preliminary analysis are summarized below:

- For present and future average daily flow, distribution mains on the Karkh side are sufficient. They are not sufficient on the Rasafa side, especially in R3 and R14.
- For future peak hourly flow, almost all distribution mains are in a critical condition with more than 7 m/km of head loss gradient.
- For the present peak hourly flow, in the Karkh side zones K1, K5, K6, K10 and in the Rasafa side zones R1, R2, R3, R14, R7/13, R4, R5, R6, R11 are in a critical condition with more than 7 m/km of head loss.
- Several pipes of the existing trunk and distribution main capacity in R3 and R14 need to be improved since some networks in the zones are showing low pressure problems due to insufficient pipe capacity.
- Minimum water pressures in R3, analyzed at sub mains consisting of secondary and tertiary lines, are between 0 m and 10 m. These figures do not meet BWA's minimum criteria of 10 m.
- Results suggest that WSZs on the Rasafa side should be improved urgently by means of improvement of the distribution network to provide proper pipe capacity and a service reservoir at each WSZ.

(2) Priority area ranking and selection

From the above-mentioned examination and analyses of the Baghdad water supply system, distribution network improvement, UFW reduction and augmentation of water production are ascertained to be required as the most urgent and fundamental measures for the present and future water supply system improvement. The BWA service area shall be improved in order of priority based on evaluation of the water supply condition in each WSZ. Twenty five WSZs rated as priority improvement projects were ranked to determine implementation priority by applying four factors; number of beneficiaries, population density, urbanization rate of the area in 2005 and necessity of network improvement. The following table shows the relative priority among the WSZs to improve water supply conditions in Baghdad.

Table 5.4.1Priority Area Ranking

WSZs	Population		Population Density		Urbanization		Necessity of Network Improvement	Priority Ranking
Rasafa	3,105,320		10,851		78.00%			
R1	276,380	B	10,091	B	74.70%	B	A	6
R2	363,437	A	11,823	A	71.70%	B	A	3
R3	657,803	A	35,595	A	89.50%	A	A	1
R4	112,206	B	6,608	B	61.50%	B	B	12
R5	223,255	B	10,896	A	93.50%	A	B	7
R6	327,158	A	10,265	B	95.00%	A	B	4
R7/13	321,266	A	9,299	B	71.30%	B	A	5
R8	136,750	B	4,545	C	56.90%	C	C	15
R9	54,764	C	4,579	C	81.30%	A	C	17
R10	41,823	C	2,898	C	82.30%	A	C	18
R11	86,335	C	10,712	A	59.20%	C	B	16
R12	885	C	52	C	98.20%	A	C	23
R14	503,083	A	30,676	A	94.50%	A	A	2
R45	175	C	23	C	51.00%	C	C	24
Karkh	2,489,928		3,944		62.60%			
K1	148,287	B	10,722	A	79.70%	A	B	9
K2	138,467	B	6,399	B	86.80%	A	C	10
K3	137,548	B	9,395	B	91.80%	A	C	11
K4	37,644	C	2,657	C	26.90%	C	C	22
K5	89,064	C	9,985	B	80.60%	A	B	14
K6	735,845	A	6,912	B	76.50%	A	A	8
K7	624,716	A	4,911	C	46.70%	C	C	13
K8	133,838	B	994	C	56.30%	C	C	21
K9	139,374	B	2,459	C	64.70%	B	C	20
K10	305,144	B	3,576	C	46.50%	C	A	19
K11	Airport						-	-
Baghdad	5,595,247		6,099		67.40%			

(Remark) A: High, B: Midium, C: Low

Zones R3, R14 and R2 are ranked as the highest priority followed by zones R6, R7 and R5. There are large populations living in these WSZs, which are located in the heart of the Rasafa side. Water consumption and UFW ratio are high and the projects for water supply system improvement are urgently required to meet basic human needs and to generate a large saving in unaccounted for water. As discussed with BWA, Zones R2, R3 and R14 within Shaab and Sadr 1 and Sadr 2 administrative municipalities on the Rasafa side were selected as the most urgent zones for improving the water supply system. The water supply system improvement plan for Zones R2, R3 and R14 is to be formulated as a proposed project.

(3) Outline of Priority Areas and Projects

The present population and population density for the priority areas in 2005 are summarized below:

Table 5.4.2 Population and Density of Priority Areas in 2005

WSZ	Area (km^2)	Developed Area (km^2)	Population	Population Density:	Population density in Developed Area
R2	30.74	22.03	363,437	11,823	16,497
R3	18.48	16.54	657,803	35,595	39,770
R14	16.40	15.49	503,083	30,676	32,478
Total of Priority Areas	65.62	54.06	1,524,323	23,230	28,197
Baghdad	917.47	618.20	5,595,247	6,304	9,051
Proportion (%)	7%	9%	27%	-	-

(Source: BWA & JICA Study Team)

Zones R2, R3 and R14 are divided into 21, 31 and 30 administrative districts or Mahalahs respectively and zones R3 and R14 are further divided by BWA into 47 sectors and 37 sectors respectively as given in Table 5.4.3

Table 5.4.3 Population and Density Classified by Mahalah and Sector in 2005

Project Area (WSZ)	Administrative District: Mahalah				BWA Sector	
	Number	Population per Mahalah	Mahalah without Sectors	Mahalah with Sectors	Number	Population Density per Sector
R2	21	17,307	21	-		
R3	31	21,219	4	27	46	11,738
R14	30	16,769	12	18	37	8,611
Total/Average	82	18,589	37	45	83	10,175

(Source: BWA & JICA Study Team)

The future populations are projected considering the above mentioned future land use developments and land use patterns. The forecast population served in the priority areas for each target year are summarized below:

Table 5.4.4 Population Projection for Priority Areas

Year	R2	R3	R14	Total
2005	363,437	657,803	503,083	1,524,323
2014	440,769	820,240	619,674	1,880,683
2027	648,713	1,095,379	827,534	2,571,626

(Source: BWA & JICA Study Team)

(4) Water requirements of the priority areas

The projected water demands and water requirements of the priority areas are summarized for each WSZ as follows:

Table 5.4.5 Water Demand and Requirement Projections for Priority Areas

WSZ	2005			2014			2027		
	Water Demand (m^3/d)	Average Daily Supply (m^3/d)	Maximum Daily Supply (m^3/d)	Water Demand (m^3/d)	Average Daily Supply (m^3/d)	Maximum Daily Supply (m^3/d)	Water Demand (m^3/d)	Average Daily Supply (m^3/d)	Maximum Daily Supply (m^3/d)
R2	88,783	165,727	226,218	123,415	199,057	257,182	233,537	311,382	389,228
R3	160,692	299,958	409,443	229,667	370,431	478,597	394,336	525,782	657,227
R14	122,896	229,406	313,139	173,509	279,853	361,570	297,912	397,217	496,521
Total	372,370	695,091	948,800	526,591	849,341	1,097,348	925,785	1,234,381	1,542,976

(Source: BWA and JICA Study Team)

In the priority areas, the projected average daily water supply in 2005 is classified by Mahalahs and sectors as presented in Table 5.4.6.

Table 5.4.6 Water Requirement of Priority Areas in 2005

WSZ	Average Daily Supply (m^3/d)	Mahalah		Sector	
		Number	Average Daily Supply at Each Mahalah	Number	Average Daily Supply at Each Sector
R2	165,727	21	7,892	-	-
R3	299,958	31	9,676	46	6,976
R14	229,406	30	7,647	37	9,176
Total	695,091	82	8,477	83	8,275

(Source: BWA and JICA Study Team)

(5) Water supply system improvement plan

A water supply system improvement plan for the zones R2, R3 and R14 is to be formulated as a proposed project. The following improvements in the priority areas are required to proceed immediately for the implementation of the water supply system improvement project in the present and for the future water supply system.

- Replacement of aged ACP, CIP and PVC.
- Replacement of distribution tertiary to meet the present and future water flow.
- Installation of water consumption meters.
- Introduction of DMAs for UFW reduction from the existing extremely large amount of 50%.

The overall implementation schedule for the proposed projects is shown in Figure 5.4.1.

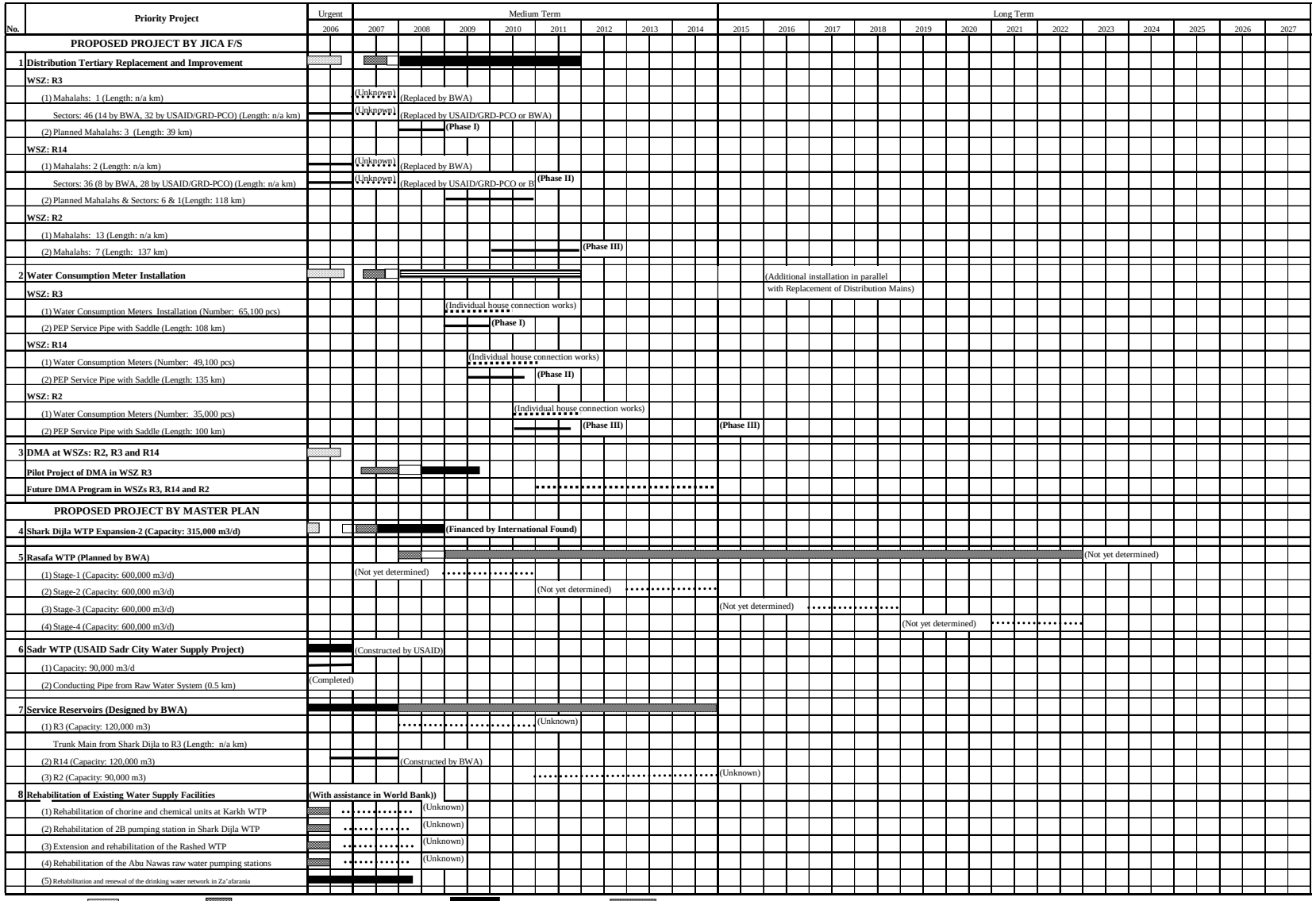


Figure 5.4.1 Overall Implementation Schedule

1) Distribution tertiary replacement

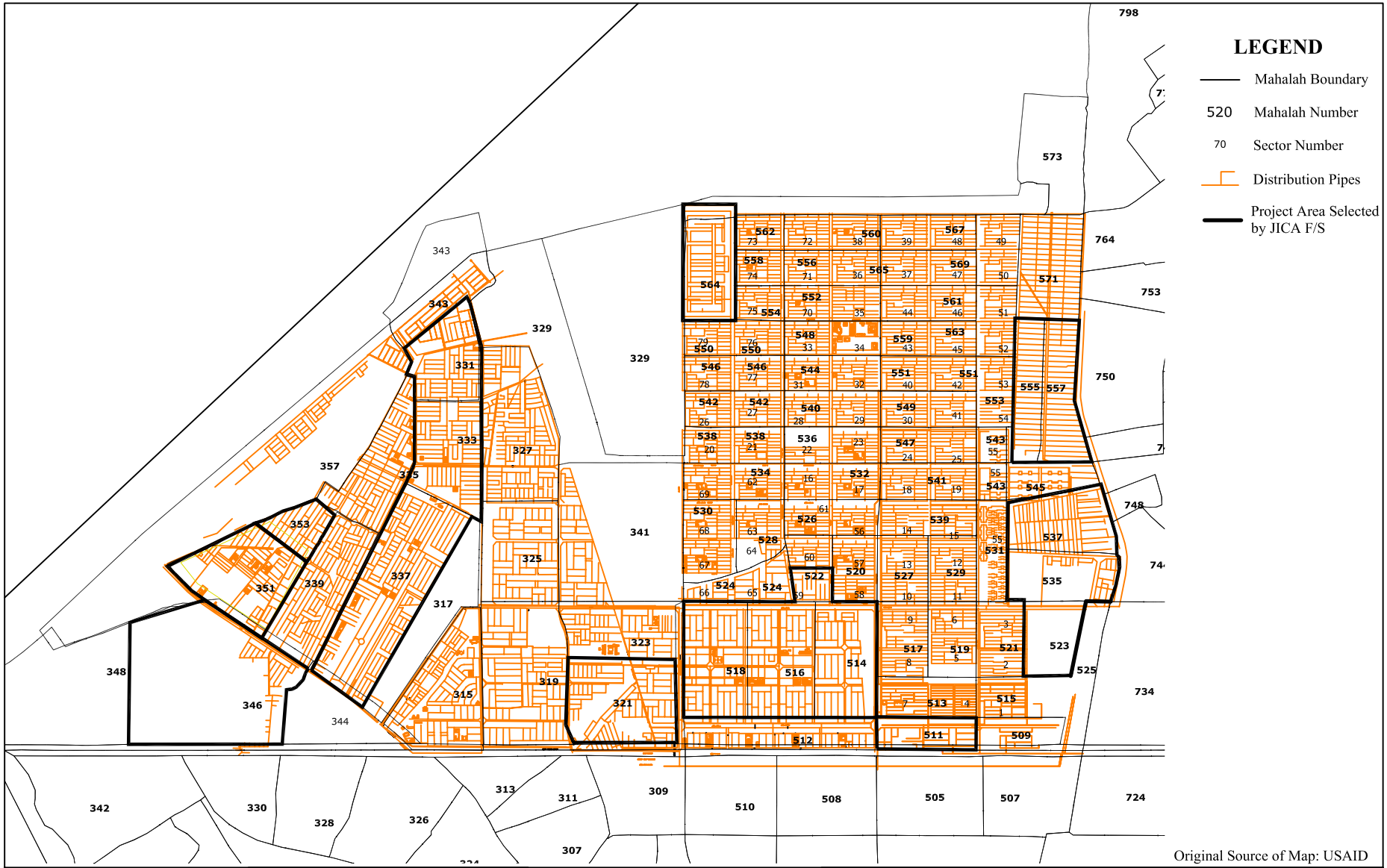
At present, the total length of distribution pipelines ranging from 75mm to 250mm in diameter in the priority area is estimated at about 1,166 km. A variety of materials have been used over the years. In general the older mains are ACP and CIP and the newer mains are ductile iron pipes. Replacement works in the priority area are summarized in Table 5.4.7 and as shown in Figure 5.4.2

Table 5.4.7 Required Distribution Tertiary Replacement

(Unit: km)

Pipe Length	R2	R3	R14	Total
1. Length of Existing Distribution Tertiary: D ≦250mm	420	372	374	1,166
a) ACP	237	210	211	658
b) CIP	51	45	46	142
c) Others (DIP/PVC)	132	117	117	366
2. Pipe Length Covered by Projects of BWA, USAID & GRD-PCO	283	333	256	842
3. Pipe Length Required by F/S	137	39	118	294

(Source: BWA and JICA Study Team)



JICA Japan International Cooperation Agency	The Feasibility Study on Baghdad Water Supply System Improvement Project in the Republic of Iraq	NIPPON KOEI CO.,LTD. Tokyo Engineering Consultants Co.,Ltd.	Title: PROJECT AREA (MAHALAHS AND SECTORS)
			Scale: As-Shown / Date: / Figure 5.4.2

2) Water consumption meter Installation

About 48% of the 483,478 house connections are equipped with water consumption meters. However, there is a huge backlog of defective or unreadable water consumption meters waiting to be repaired or replaced (more than 129,000 or 55% of house connections) and a substantial amount of revenue is being lost due to malfunctioning meters. For water meter reading and a proper billing system, meter installation is urgently required as follows:

Table 5.4.8 Water Consumption Meter Installation

Description	R2	R3	R14	Total
Number of Water Consumption Meters	35,000	65,100	49,100	149,200
a) 12 mm (1/2') Meters (set)	28,700	53,400	40,300	122,400
b) 18 mm (3/4') Meters (set)	3,200	5,800	4,400	13,400
c) 25 mm (1') Meters (set)	3,100	5,900	4,400	13,400

(Source: BWA and JICA Study Team)

3) Introduction of a District Meter Area (DMA) System

The implementation of a District Meter Area (DMA) is an essential requirement for an effective leakage control strategy. The proposed DMA system is summarized below:

Table 5.4.9 Proposed DMA System

Classification of Block	R3	R14	R2	Number of Blocks
i) Large Block System without medium blocks	1	1	1	3
ii) Small Block System	67	68	47	182
iii) Total Number of Proposed Blocks	68	69	48	185

(Source: BWA & JICA Study Team)

4) Projects related to the priority project proposed by the JICA Study Team

The following projects are planned by BWA with assistance from international agencies.

- Water Production Improvement: Shark Dijla WTP expansion 2 and Rasafa WTP: design has been completed but not yet funded.
- Service Reservoir Development for R2, R3 and R14: R14 is to be constructed by BWA in 2008 while R2 and R3 are only designed by BWA.
- Rehabilitation of water supply facilities under financed by World Bank: consisting of i) Rehabilitation of chorine and chemical units at Karkh WTP, ii) Rehabilitation of 2B pumping station in Shark Dijla WTP, iii) Extension and rehabilitation of the Al Rasheed WTP, iv) Rehabilitation of the Abu Nawas raw water pumping stations and v) Rehabilitation and renewal of the drinking water network in Al-Zufraniya.

CHAPTER 6 THE PROPOSED PROJECT

6.1 Countermeasures for Reduction of UFW

(1) Alternative Plan for Reduction of UFW

In order to reduce the unaccounted for water in the Project Areas (WSZs R2, R3 and R14), various countermeasures have been proposed and are listed below:

1) Replacement of distribution tertiary

Since the Gulf War and the international sanctions on Iraq, malfunctioning of the aging pipe network has been common place in the Mayoralty of Baghdad. Many of the pipes are old cast iron and asbestos cement pipes which frequently leak and by replacing these pipes the leakage will be reduced. The replacement of the distribution network in R2, R3, and R14 areas was selected as a priority project in response to the request of BWA. Replacement of distribution tertiary has been conducted in R3 and R14 by USAID, GRD and BWA since 2004. Therefore, the JICA Feasibility Study was carried out for the Mahalas which were nominated by BWA for the JICA Study to avoid duplication. The program for replacement of distribution tertiary is explained in chapter 6.2, the Rehabilitation and Improvement Program.

2) District Meter Area

The second countermeasure is to measure the leakage of the system. The measurement of the system would be executed through a policy and plan to establish District Meter Areas (DMAs), which is explained in the following Section (2), “The DAM System”. However, there will be a need to carry out a pilot study, including a field survey, to confirm the viability of execution of the DMA program in the future. A DMA system will be introduced after the completion of the distribution replacement program, installation of water consumption meter and implementation of the pilot study at the selected Sector.

3) Leak Detection Activity

At present, there are no leakage survey teams for any of BWA’s distribution system. This makes it impossible to detect invisible leaks. The reducing of UFW will not be attained without organically combining and carrying out continuous inspections. The proposed leak detection activity is explained in the following Section (3), “Leakage Detection and Control”.

(2) DMA System

1) Proposed DMA Plan

The project area covers three Water Supply Zones, R2, R3, and R14, and has the following topographic features:

- Ground surface is almost flat and ground level is at about 35m±2m above MSL.
- There are no geographical boundaries such as rivers or hills that divide the area.
- The road networks are designed as a grid pattern

From the above it can be seen that it is not necessary to set up Water Supply Sub Zones in the project area. In addition, in a part of R3 and R14, USAID and GRD have already performed rehabilitation of the distribution pipelines in a sector that is, in principle, half the size of a Mahalah. The each sector area is divided arterial roads with distribution secondary buried beneath them.

Therefore, the size of each DMA area would be determined by the boundary of arterial roads of the sector. In addition, the size of each area is considered to be manageable.

A summary of proposed DMAs is shown in Table 6.1.1.

Table 6.1.1 Summary of Proposed DMAs

WSZ	Number of Maharhs	Number of DMAs
R2	21	47
R3	31	67
R14	30	68
Total	82	182

2) Monitoring and Inspection of DMAs

Monitoring and leakage inspection are to be carried out considering the DMA as a unit. This unit can also be used for carrying out a pilot plan, especially an action plan for UFW reduction. Water supply meters should be installed for all consumers, in principle, and this would enable the supplier to grasp the amount of water consumed. UFW figures in the DMA can be grasped by a comparison between the inlet flow measured by the portable flow meter and the total metered consumption. Moreover, leakage can also be quantified by measuring the flow during the night time and daytime. A typical 24 hour flow profile of the components of leakage and customer use is shown in Figure 6.1.1.

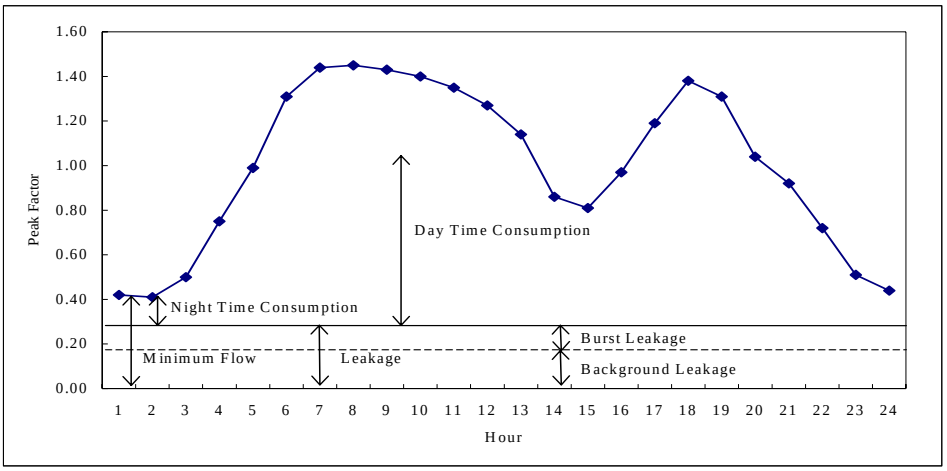


Figure 6.1.1 Typical 24 Hour Flow Profile of the Components of Leakage and Consumption

This system has the advantage that it can detect leakage more efficiently and its technique provides increased productivity of the leakage detection field work.

(3) Leakage Detection and Control

At the present, there are no leakage detection teams for any of BWA service areas. Pipe repair works are only carried out based on the reports of visible leaks. There is an immediate need for programs to organize a leakage detection team to detect unknown invisible leaks. In addition to leakage, illegal connections are a huge problem in the BWA systems, but the current situation can not be accurately observed by BWA. Leakage detection and control will be realized through organically combining related sections within BWA. However, a policy of leakage detection and control has not yet been established, and neither trained people nor materials to conduct the above tasks are available in sufficient quantities in BWA, at present. Therefore, a UFW reduction action plan for the effectiveness of the rehabilitation and improvement program shall be required in the future.

(4) Necessity of an Action Plan

The UNICEF report proposed a UFW reduction action plan for Iraq in January 2003 to reduce the water system losses. BWA will select the pilot area and conduct the UFW reduction action plan based on the suggestion of the UNICEF report. However, BWA has no experience or equipment for water leakage surveys. JICA has been performing mass training of BWA staff in a water leakage survey course, GIS course, and operation & management course in Jordan to support the BWA UFW reduction program since the beginning of 2005. The JICA training program will provide the required various leakage detection equipment for BWA after the leakage survey training. Consequently, BWA has an opportunity to conduct the action plan by themselves with the fruits of the JICA training program.

The concept of the functional units for the action plan in the UNICEF report can be applied to the BWA organization as follows:

- UFW Unit: Monitor UFW and other actions in coordination with
  - Leak Detection Unit (To be set up in the Implementation Section, Water Section of the Municipality)
  - Pipe Repair Unit (Implementation Section, Water Section of the Municipality)
  - Consumer Survey Unit (To be set up in the Computer Billing Section)
- GIS Unit: Produce maps from data furnished by field surveys. Building of hydraulic models and analysis. (Design Section)
- MIS Unit: Collect operational and billing data to be incorporated in the MIS database. (To be set up to cooperate with the Planning and Follow Up Section, Administration and Financial Affair Section, and Computer Billing Section)

But UFW reduction will not be attained without organically combining each unit and carrying out the work continuously. Therefore, the action plan needs to be executed by the Implementation Section of BWA as coordinator of the program with cooperation of the Water Section of the Municipality, Planning and Follow Up Section, Computer Billing Section, Administration and Financial Affairs Section, Computer Billing Section, and the Design Section.

(5) Pilot Study of DMA

It will be a requirement to carry out a pilot study to confirm the viability of an extended DMA program in WSZ R3. In order to effectively manage and operation of pilot study, the following program should carry out at detailed design stage and construction stage by a consultant of the implementation project with cooperation of BWA:

Step1 (Preparation/ Detailed Design Stage)

- Preparations of plans & drawings of pilot DMAs
- Arrangement of DMA data on distribution system
- Selection of meter chamber sites for portable flow meter
- Identification of large demand subscribers and industrial night use

Step2 (Preparation/ Construction Stage)

Construction of meter chambers for portable flow meter

Water meters inspection

Service reservoir and master meter inspection (overflow and leakage)

Step3 (Monitoring)

- Carry out flow and pressure measurements of pilot DMA
- Carry out analysis of water meter reading records of pilot DMA
- Analysis of fire hydrants operational use in pilot DMA

Step4 (Evaluation)

- Prepare flow and pressure profiles of pilot DMA
- Calculation of water balance of pilot DMA
- Prepare recommendations for detailed leakage survey
- Carry out leakage survey at recommendation area
- Calculation of cost savings
- Prepare detailed recommendations for DMA plan of whole of R3

6.2 Rehabilitation and Improvement Program

(1) Objectives of the Program

Objectives of the Program are:

- To secure safe and stable water supply to residents of the three WSZs,
- To reduce the present high 50% rate of UFW at present
- To avoid chronic water shortage and disrupted water supply,
- To prevent illegal connections which are estimated at about 10% of total subscribers at present, and
- To grasp the actual water consumption of BWA customers by means of equipping them all with water consumption meters.

(2) Planning concepts

For planning the rehabilitation and improvement program, the following concepts are adopted and the BWA design criteria and standards are also employed.

Table 6.2.1 Planning Concepts

WSZ	Area (km^2)	Medium Term Target Year: 2014			Long Term Target Year: 2027		
		Population	Average Day Supply (m^3/d)	Maximum Day Supply (m^3/d)	Population	Average Day Supply (m^3/d)	Maximum Day Supply (m^3/d)
R2	30.74	440,769	199,057	257,182	648,713	311,382	389,228
R3	18.48	820,240	370,431	478,597	1,095,379	525,782	657,227
R14	16.40	619,674	279,853	361,570	827,534	397,217	496,521
Total	65.62	1,880,683	849,341	1,097,348	2,571,626	1,234,381	1,542,976
UFW Ratio		38%			25%		
Water Saved		12% of Average Day Supply			25% of Average Day Supply		
Family Size		12.60 persons per family					
Load Factor		Peak Hourly Factor : 2.25					

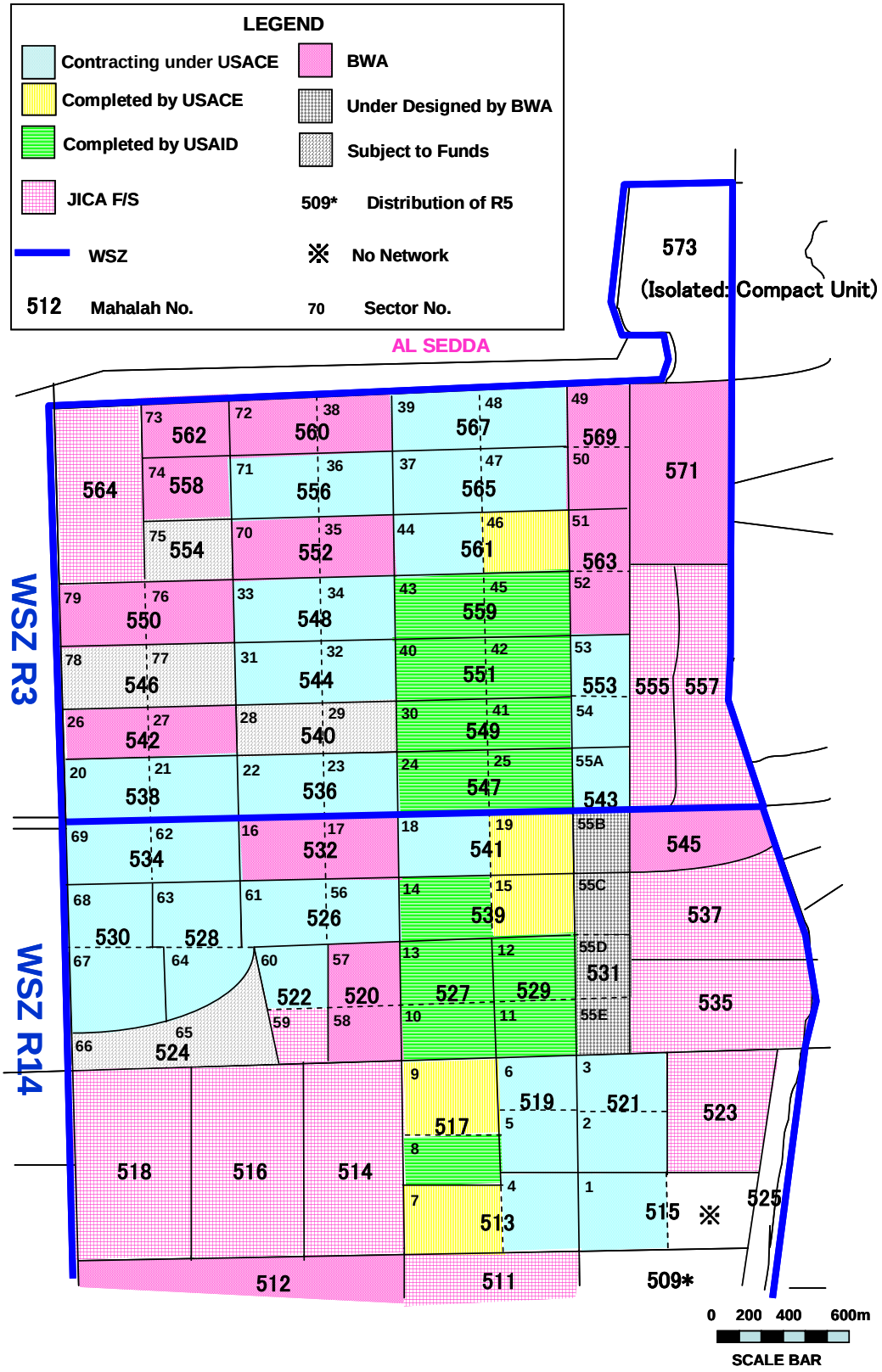
(Source: BWA and JICA Study Team)

Distribution pipe replacement works have been conducted by BWA, GRD-PCO and USAID in the priority areas. The numbers of Mahalahs for distribution pipe replacement works are to be apportioned as Table 6.2.2 and Figure 6.2.1.

Table 6.2.2 Apportionment of Mahalahs for Pipe Replacement Works

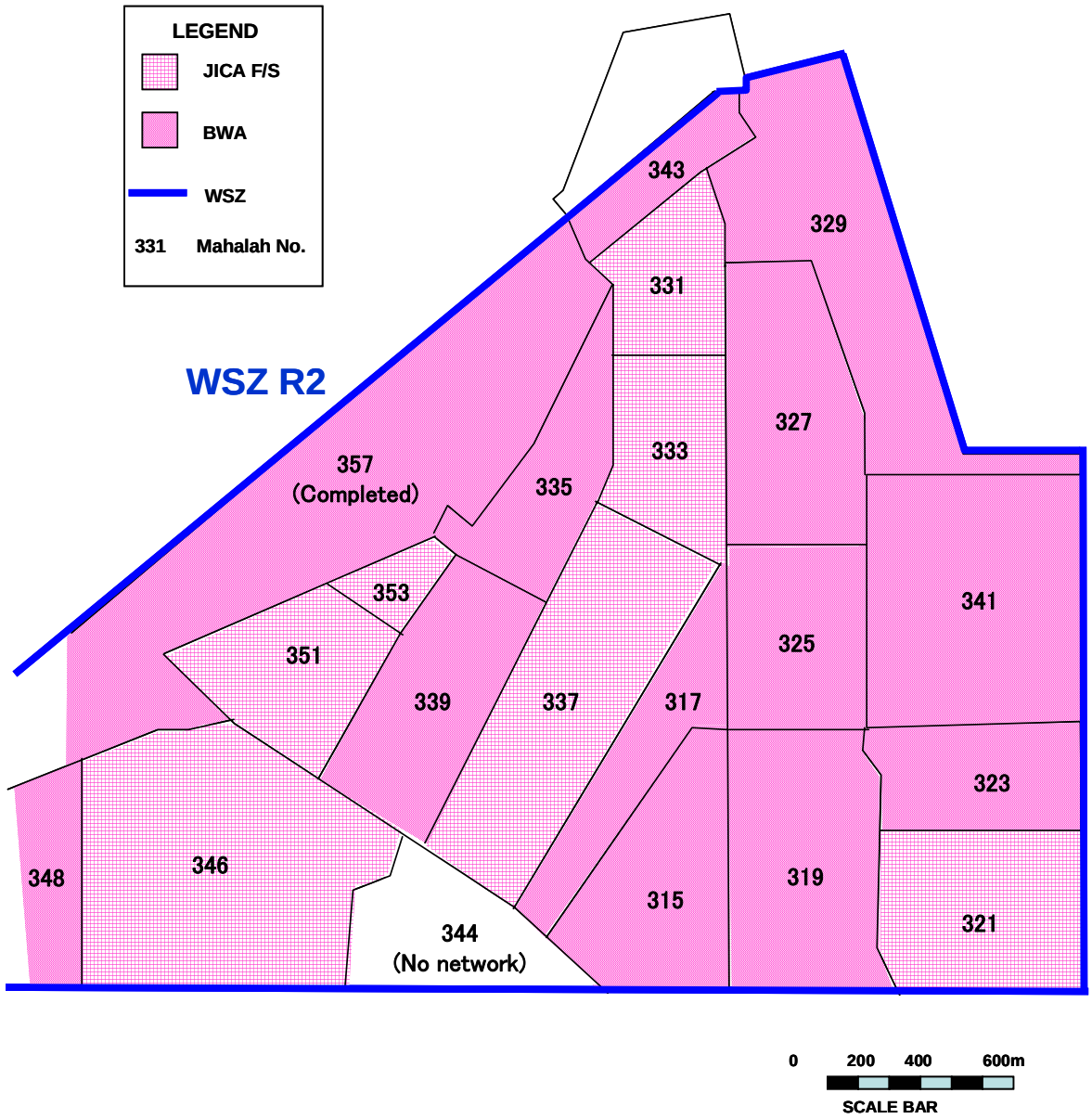
WSZ	BWA	USAID	GRD-PCO	JICA F/S	Others*	Total
R2	13	-	-	7	1	21
R3	9	4	13	3	2	31
R14	7	3	11	8	1	30
Total of Mahalahs	29	7	24	18	4	82

(Source: BWA & GRD-PCO) *: No need for replacement work due to no network or CU areas



(Original Source: BWA and GRD-PCO)

Figure 6.2.1 On-going Pipe Replacement Works (1/2)



(Original Source: BWA and GRD-PCO)

Figure 6.2.1 On-going Pipe Replacement Works (2/2)

Pipe replacement works are divided into the following schemes for the project implementation:

1) Scheme 1 : WSZ R3 in Sadr City 1 and 2 Municipalities
(Mahalah Nos. 555, 557 and 564)
2) Scheme 2 : WSZ R14 in Sadr City 1 and 2 Municipalities
(Mahalah Nos. 511, 514, 516, 518, 535, 537, 523 and 522: Sector 59)
3) Scheme 3 : WSZ R2 in Shaab Municipality
(Mahalah Nos. 321, 331, 333, 337, 346, 351 and 353)

(3) Distribution tertiary replacement

The objective of the Project is to provide the necessary materials and fittings and to replace the old leaking distribution tertiary in order to urgently reduce the water losses in the distribution system. Total pipe length required for replacement in each WSZ is summarized below:

Table 6.2.3 Summary of Pipe Replacement

Priority Area		Range of Pipe Diameters (mm)	Total(km)	Implementation Period
Detailed Design Stage				2007
Scheme 1	R3	150mm to 300mm	39	2008 to 2010
Scheme 2	R14	150mm to 300mm	118	2009 to 2010
Scheme 3	R2	150mm to 300mm	137	2010 to 2011
Total		150mm to 300mm	294	2007 to 2011

(Source: BWA and JICA Study Team)

Ductile iron pipe with cement mortar lining was selected on account of its excellent durability and corrosion resistance. In addition to pipe replacement, fittings and accessories (air valves and shut-off valves) are also to be replaced since leakage from them is considerable. Water supply facilities related to the water supply system are to be rehabilitated in scheme with the distribution tertiary replacement. The following water supply facilities, which are to be replaced or newly constructed, and their quantities to be improved are summarized in Table 6.2.4.

Table 6.2.4 Number of Water Supply Facilities

Priority Area		Gate Valves (pcs)	Fire Hydrants (pcs)	Air Valves (pcs)
Scheme 1	R3	180	196	8
Scheme 2	R14	500	589	23
Scheme 3	R2	260	685	28
Total		940	1,470	59

(Source: BWA and JICA Study Team)

(4) Water consumption meter installation

Phasing of water consumption meters will be conducted by the same implementation schedule as the distribution replacement project. Installation of water consumption meters is summarized below:

Table 6.2.5 Outline of Water Consumption Meters Installation

Water Consumption Meter Installation	R2	R3	R14	Total
Water Consumption Meters (pcs.)				
a) 12 mm (1/2") Meters	28,700	53,400	40,300	122,400
b) 18 mm (3/4") Meters	3,200	5,800	4,400	13,400
c) 25 mm (1") Meters	3,100	5,900	4,400	13,400
Total (pcs.)	35,000	65,100	49,100	149,200
PEP Service Pipe (km)				
a) DN 20mm (3/4") PEP	82	88	110	280
b) DN 25mm (1") PEP	18	20	25	63
Total (km)	100	108	135	343
Snap Tap with Saddle (set)				
a) 20mm (3/4") x DN150 – DN300	8,200	8,800	10,900	27,900
b) 25mm (1") x DN150 – DN300	1,800	1,900	2,400	6,100
Total (set)	10,000	10,700	13,300	34,000

(Source: BWA and JICA Study Team)

Diameters of PEP service pipes in the above Table 6.2.5 are recommended in consideration of practical difficulties in the field since the actual number of house connections per service point was not identified exactly. PEP service pipes of DN 20mm and DN 25mm are selected for 12 mm meters and 18 mm meters respectively. For installation work, reducers shall be used at each site. Snap taps with saddles are recommended for the connection between the distribution tertiary and the service pipe for leakage protection and the required numbers of snap taps with saddles are estimated at 34,000 pieces (pcs). For the program, water consumption meters, PEP service pipes and snap taps with saddles are to be provided. Stop cocks and GIP for house connections shall be provided by each subscriber.

(5) Project Effective

The effects to be expected from the implementation of the Project are summarized below:

- Reduction of leakage volume and leakage accidents in distribution mains: 28,000 m^3/d and 3% of the incidents of leakage problems
- Water saved to be used for water supply: enough to supply 114,000 persons at unit water demand
- Reducing secondary contamination
- Cutting repair cost
- Increasing revenues: approximately US$52,000 in additional revenue per year at current tariff levels (assuming an average water tariff: 7.5 ID/m^3)
- Cutting operation cost of water service tankers

(6) System Operation and Maintenance

The large diameter distribution mains of 300mm or more are managed by the Implementation Section of BWA and small diameter of less than 300mm are maintained by the Water Section

of each Municipality. The Computer/Billing Section executes works for meter reading and billing.

6.3 Cost Estimates

(1) Cost Estimates for the Project

1) Composition of the project costs

The project costs are composed of direct construction costs, administration costs, taxes and duties, engineering costs, physical contingency and price escalation. The foreign currency portion (F.C.) includes the cost in CIF price of materials to be imported. The local currency portion (L.C.) includes the costs of labour, equipment and materials procured locally, custom clearance costs and mobilization and remobilisation.

2) Conditions and assumptions for cost estimates

- Price level: June 2006
- Exchange rates used in the cost estimates are as follow;
  US$ 1.0 = ID1475.262 = JPY112.264 as 1st of June 2006.
- Unit costs: The unit construction costs used in the local currency portion (L.C.) are taken as the unit costs recently used in BWA contracts.
  The unit costs used in the foreign currency portion (F.C.) are taken as the CIF prices of imports from foreign countries, in Baghdad.
- Land acquisition and compensation: executed by BWA
- Administration expenses: 10 % of the direct construction cost
- Tax and Duty is 10 % of the direct construction cost and administration cost and 5 % of CIF Baghdad price of the costs of foreign procurements for Import duty
- Security issue cost is 43 % of and included sum of administration cost
- Insurance of transportation and construction is 15 % of and included in administration cost
- Engineering service expenses: 11 % of the direct construction cost. Price escalation and physical contingency of the consulting service shall be included in the cost of the consulting services.

The estimated costs for the proposed project are summarized as follows;

(Unit: US$ 1,000)

	Items	L.C.	F.C.	Total
1.	Direct Construction Cost			
1-1	Material Procurement and Supply			
	1) Ductile cast iron pipes (DIP) with Fittings	0	18,588	18,588
	2) Gate Valves and Air Valves	0	3,694	3,694
	3) Fire Hydrants	0	2,967	2,967
	4) Water consumption meters with service pipes	0	9,976	9,976
	5) Equipment for DMA Pilot Study	0	129	129
	Sub-Total (1)	0	35,354	35,354
1-2	Civil Works			
	1) Pipe Replacement Works	15,983	0	15,983
	2) House Connection Works	5,404	0	5,404
	3) Meter Chambers for DMA Pilot Study	15	0	15
	Sub-Total (2)	21,402	0	21,402
	Sub-Total (1) + (2)	21,402	35,354	56,756
2.	Administration Cost 10% of Direct cost	6,951	6,452	13,403
3.	Tax and Duty	8,783	0	8,783
4.	Engineering Cost 11% of Direct cost	3,655	4,858	8,513
5.	Price Escalation	12,163	2,365	14,528
6.	Physical Contingency	8,103	8,834	16,937
	Total	61,057	57,863	118,920

Note:

1. Price escalation is 9 % of L.C. and 1.7 % of F.C. portion of items 1 and 2.
2. Physical contingency is 20% of L.C. and F.C. portion of the sum of items 1, 2 and 5.

The estimated cost for each WSZ, R3, R14 and R2 in the proposed project is summarized in Table 6.3.1.

Table 6.3.1 Project Cost for each WSZ

(Unit: US$ 1,000)

Cost Item	Total			Scheme: R3			Scheme: R14			Scheme: R2		
	L.C.	F.C	Total	L.C.	F.C	Total	L.C.	F.C	Total	L.C.	F.C	Total
1 Direct Construction Cost	21,402	35,354	56,756	3,964	7,643	11,607	8,303	13,371	21,674	9,135	14,340	23,475
1.1 Material Procurement and Supply	0	35,354	35,354	0	7,643	7,643	0	13,371	13,371	0	14,340	14,340
1) Ductile Cast Iron Pipes (DIP) with Fittings	0	18,588	18,588	0	2,481	2,481	0	6,814	6,814	0	9,293	9,293
2) Gate Valves, Air Valve and Others	0	3,694	3,694	0	721	721	0	1,890	1,890	0	1,083	1,083
3) Fire Hydrants	0	2,967	2,967	0	396	396	0	1,182	1,182	0	1,389	1,389
4) Water Comsumption Meters with Service Connection Pipes	0	9,976	9,976	0	3,916	3,916	0	3,485	3,485	0	2,575	2,575
5) Equipment for DMA Pilot Study in WSZ R3	0	129	129	0	129	129						
1.2 Civil Works	21,402	0	21,402	3,964	0	3,964	8,303	0	8,303	9,135	0	9,135
1) Pipe Replacement Works	15,983	0	15,983	2,156	0	2,156	6,237	0	6,237	7,590	0	7,590
2) House Connection Works	5,404	0	5,404	1,793	0	1,793	2,066	0	2,066	1,545	0	1,545
3) Meter Chambers for DMA Pilot Study in WSZ R3	15	0	15	15	0	15						
2 Administration Cost	6,951	6,452	13,403	974	1,255	2,229	2,350	2,393	4,743	3,627	2,804	6,431
3 Tax and Duty	8,783	0	8,783	1,766	0	1,766	3,310	0	3,310	3,707	0	3,707
4 Engineering Cost	3,655	4,858	8,513	630	1,037	1,667	1,385	1,834	3,219	1,640	1,987	3,627
1)Engineering Cost 11% of Direct cost	2,354	3,888	6,242	436	840	1,276	913	1,471	2,384	1,005	1,577	2,582
2)Price Contingency (Escaration) (9.0% of LC, 1.7% of FC)	692	160	852	89	24	113	241	57	298	362	79	441
3)Physical Contingency (20.0% of LC and FC of 1) & 2) of Item 4)	609	810	1,419	105	173	278	231	306	537	273	331	604
5 Price Escalation (9.0% of LC, 1.7% of FC of Item 1and 2)	12,163	2,365	14,528	1,378	316	1,694	3,996	834	4,830	6,789	1,215	8,004
6 Physical Contingency (20.0% of LC and FC of Item 1, 2 & 5)	8,103	8,834	16,937	1,263	1,843	3,106	2,930	3,319	6,249	3,910	3,672	7,582
Total	61,057	57,863	118,920	9,975	12,094	22,069	22,274	21,751	44,025	28,808	24,018	52,826

6.4 Implementation of Program

The Baghdad Water Supply System Improvement Project is planned to be completed by 2011. The implementation of the Project is planned in a manner to ensure proper execution of the work by taking into consideration the conditions for the Project including the contractors and suppliers, procurement of materials and labour force, the manner of procurement of water supply materials, and the manner of construction.

Comprehensive implementation schedules, mainly for such items as material procurement and supply, pipe replacement works and house connection works are presented in Figure 6.4.1.

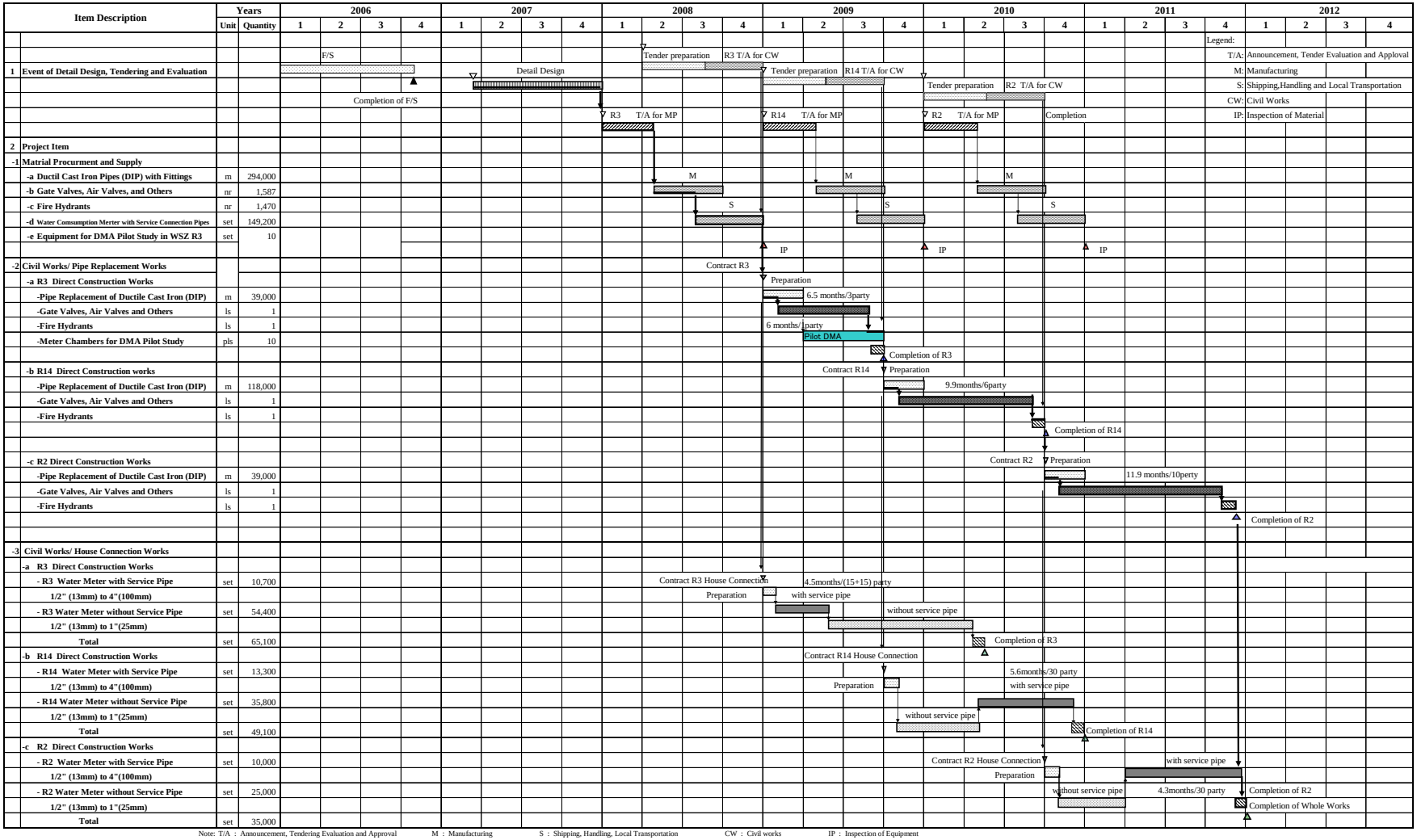


Figure 6.4.1 Implementation Schedule

(1) Availability of Materials

1) Local materials

In the local market, aggregate, concrete blocks, bricks, asphalt, cement, and lumber are available. The reinforcing steel bars, which were previously imported from neighbouring countries, can be procured from the local market. The cost estimate in the study is based on the local market price.

2) Imported materials for construction

Water pipes, fittings, water consumption meters, construction equipment, submersible water pumps and the spare parts for the construction and engineering tools are not available in the local market. Consequently, those materials and equipment should be imported from foreign countries.

3) Transportation Route to the Project Site

There are various transportation routes into Baghdad for materials imported from neighbouring countries. Therefore, alternative transportation routes from neighbouring countries to Baghdad city are nominated as follows:

- Turkish route (Mersin Port or Iskanderun Port)
- Kuwaiti route (Shuwaikh Port or Shuaiba Port)
- Jordanian route (Aqubah port)
- Syrian route (Ladhiqiyah Port or Tartous Port)

The materials to be transported consist of huge amounts of pipes, fittings and water consumption meters. The criteria for selection of the routes are as follows:

- To provide adequate security for transportation
- To ensure the freight schedule

The Turkish route was selected as the first priority route based on the above criteria of the study. Actual transportation routes to the project sites shall be selected by the contractor and/or suppliers as his sole responsibility in consideration of the origin of procurement and the security situation in Iraq.

(2) Capability of Local Contractors and Labour Force

1) Capability of Local Contractors

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

Iraqi contractors are divided into state owned national construction companies and private companies. The technical levels of the state owned national construction companies are

comparatively high. The number of staffs in the national construction companies range from 600 to 1000 employees. However, their work efficiency is not very satisfactory.

The local registered contractors have the capability and experience required to construct the proposed projects without the use of international contractors. Local contractors have sufficient construction machinery and equipment, including heavy construction machines for the water supply project.

2) Labor Force

The skilled workers, which are necessary for the pipe work projects, are available in the project area because there are numerous workers who have experience in relation to manual excavation and backfilling pipe projects implemented by BWA, USAID and PCO in Sadr City.

(3) Construction and Procurement Plans

Construction and procurement of equipment and materials will be executed in Iraq as follows. Projects with foreign components are to be procured through international competitive bidding, and civil works are to be procured by local competitive bidding procedures in accordance with the guidelines of BWA through study of the following alternatives.

1) The manner of procuring the materials and civil works are proposed as follows;

a) International bidding for material procurement and supply including:

- Pipe materials and fittings for pipelines (DIP)
- Water consumption meters with service pipes

b) Local bidding for civil works[1] for pipe replacement and house connections

- Civil works are grouped into multiple packages by area or contract period for local bidding by the contractors registered with the BWA.
- Pipe replacement works for distribution pipes
- House connections works with water consumption meters

2) Construction method for pipe installation

a) Where the existing pipes are under vehicular traffic roads

The method of construction to be adopted as the simplest is the open cut method as shown in DATA BOOK 2 in Volume IV.

For excavation depths deeper than 1.5m adequate shoring and dewatering must be employed.

[1] Reference: Bidding procedure for BWA projects is to be implemented in compliance with "*The Conditions of Contractors for Civil Engineering Works 1987*" which were prepared by the Ministry of Planning and Development Cooperation.

The new pipeline should be installed in parallel with the existing pipe without removal of the existing pipe to maintain water supply service to the sector. All house connections shall be carried out after installation of all other pipes is completed. One lane of the traffic road will be closed during the construction period.

b) Where the existing pipes are under a side walk

The new pipeline should be installed in parallel with the existing pipe without removal of the existing pipe to maintain water supply service to the sector. The excavation and back filling should be done manually and on a schedule that ensures the completion of the works within the contract period. Manual trench excavation is adopted for pipe diameters less than DN300mm. The adjacent road is to be closed during the construction period and a by-pass road is to be used around the construction area until the completion of the work.

c) House connections with water consumption meters

Steps to follow in the installation of a house connection

1. Completion of installation of new distribution pipe line
2. Pavement removal around new and old house connection points as necessary
3. Excavation of new and old connection points
4. Saddle installation on new DIP
5. Install ferrule service connection with stop valve
6. Lay LDPE pipe to house, length =10m
7. Install new water meter
8. Remove old house connection material
9. Connect line from house to new water meter
10. Back fill and re-pave road
11. Hand over to house owner

3) Security issues

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

a) Transportation Security

Security measures are required for the drivers and trucks transporting imported equipment and materials into Iraq. The cost for security measures shall be included in the

transportation cost of equipment and materials. The level of security in Iraq changes with the place and time. Therefore, security companies must look for the best transportation route to promote the safety of the transported materials based on the most current security information.

b) Site Security

The local contractors who will carry out pipe installation and/or house connection works shall engage a local security company that is very familiar with the circumstances in the Project area. Security measures for the main temporary yard and each temporary stock yard, including materials stockyards, warehouses and temporary site offices should be carried out 24 hours a day, seven days a week.

(4) Implementation Schedule

In preparing a realistic schedule for the implementation of the Project, BWA will organize the construction activities. Most of the construction works will be conducted by contractors and will be supervised by BWA and/or designated consultants.

The implementation schedule is presented in Figure 6.4.1. The project is expected to start in 2008 and be completed in 2011 with a loan agreement to be signed in March of 2007, detailed design shall be started in April of 2007 and material procurement shall be started in January of 2008. Civil works for pipe replacement and house connections will be commenced in parallel from January 2009 and completed by 2011. The implementation schedules for each WSZ, R3, R14 and R2 are as follows:

	Scheme1: R3	Scheme2: R14	Scheme3: R2
Detail Design	April 2007 – December 2007		
Material Procurement and Supply	January 2008 – December 2008	January 2009 – December 2009	January 2010 – December 2010
Pipe Replacement Works	January 2009 – September 2009	October 2009 – September 2010	October 2010 – December 2011
House Connection Works	January 2009 – May 2010	October 2009 – December 2010	October 2010 – December 2011

1) Detail Design / Bidding Process

The selected consultants will carry out the detailed design for distribution tertiary replacement in 18 Mahalahs and water consumption meters in WSZ R3, R14 and R2.

Material procurement and supply will be, in principle, through international competitive bidding, and civil works will be carried out by local competitive bidding.

Evaluation of the bids shall be made mainly on three aspects, namely, compliance with administrative requirements, technical standards and bid prices.

2) Material procurement and supply

The selected supplier of the international competitive bidding will supply the material required for construction. After conclusion of the Loan Agreement, the schedule will proceed as shown in Figure 6.4.1.

3) Civil works for pipe replacement and house connections with water consumption meters

The project for pipe replacement, including the above mentioned material procurement and supply, is scheduled in all three schemes, and it is expected that the terms of the loan agreement will be concluded circa December 2011. The local contractors selected by the local competitive bidding will do the installation work.

4) Pilot study of DMA

Study for pilot DMA and requirement equipment of the study will be carried out at detail design stage and construction stage on pilot study of DMA in WSZ R3 as mentioned in Section 6.1(5). Total number of 10 meter chambers shall be constructed in WSZ R3 for after the pipe replacement. The implementation schedule shall be completed in civil works of WSZ R3 as shown in Figure6.4.1.

5) Project management

The management of various portions of the Official Development Assistance (ODA) loan project will be carried out by the borrower (BWA), the funding agency, international consultants along with local consultants, and contractors/suppliers. The management organizational structure for the project implementation is presented in Figure 6.4.2. In this case BWA should establish a Project Management Team (PMT) to supervise and control all relevant stakeholders. The PMT should be headed by a Team Leader/ Project Manager who is to be nominated by the mayor of the MOB.

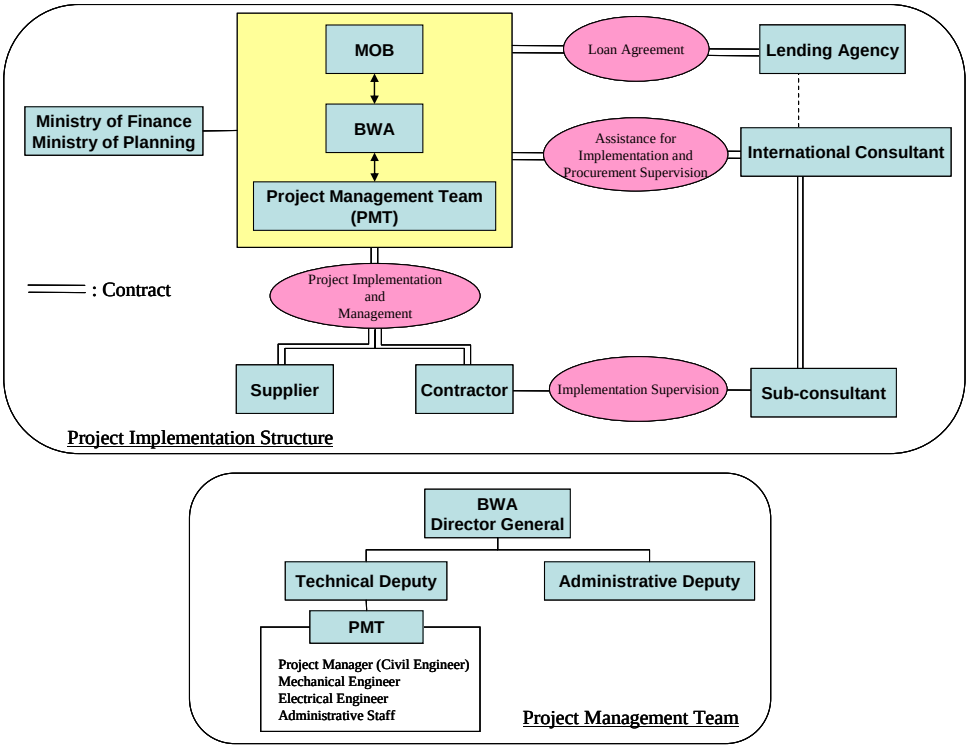


Figure 6.4.2 Management Organizational Structure for the Project Implementation

Implementation of the Project is to be executed through the different stages as follows:

a) Detailed design / preparation of tender documents and evaluation

Detailed design works are to be carried out by the international consultant at Amman in association with the local consultant. The field survey in Baghdad is to be carried out by a local consultant with cooperation of BWA staff and PMT. The main field survey is to be composed of survey work, and investigation of existing pipes and related structures. The international consultant will carry out the water pipe design works, construction plan, cost estimates, preparation of bid documents, and P/Q work in Amman based on the field survey. The bid evaluation, and negotiation of tendering will be carried out in Amman with the cooperation of BWA staff.

b) Materials procurement and supply

The supplier selected in the international competitive bidding will supply the material required for construction. It will be necessary to check the quality, quantity and condition of the material and verify that it meets all relevant specifications. It will be impossible for the international consultant to do this directly. Therefore, the materials must be made available for inspection by the international consultant before they are transported into Iraq. Additionally, the local consultant will inspect the materials at the site in Baghdad in preparation for handover to the BWA.

c) Civil works for pipe replacement and house connections with water consumption meters

The local contractors selected in the local competitive bidding will do the onsite installations. It is impossible for the international consultant to supervise the work at the site in Baghdad. Therefore, the civil works will be supervised by BWA with the local consultant's assistance. The international consultant will provide support for technical requirements, meeting claims, quality control, construction management, evaluation of monthly progress, design changes and so on, out of their Amman office.

(5) Consultant Service

The Consultant will not be able to work in Iraq due to the ongoing security problems. Therefore, it is recommended that a consulting office be established in Amman Jordan in order to carry out the necessary consulting services for the Project. It may be proposed that a BWA officer be stationed full time at the consultants' Amman office in order to coordinate the consulting service with the BWA office in Baghdad for smoothing and confirming tasks related to the Project.

In addition, a local consultant in Baghdad could conduct on site investigations, surveys, and data collection at the detailed design period under the instructions of the Consultants' Amman office.

1) Supervision of procurement of equipment and materials

The Consultants' Amman office will carry out the supervision of procurement of equipment and materials for the Project. The local consultant will supervise and follow up on the transportation process in Iraq and deliveries to BWA and report on progress to the Consultants' Amman office.

2) Construction Supervision

The Consultants' Amman office will assist the construction supervision of the Project for BWA. The Consultants' Amman office will assist with the review and approval of the construction plans and consultation with the resident representative of BWA to ensure proper progress of the construction schedule. The construction supervision shall be carried out by BWA. BWA shall report the progress of the construction work to the Consultants' Amman office through weekly progress reports. A monthly task meeting is to be held with BWA and local contractors in Amman. Quarterly progress meetings will be held with the participation of JBIC and MOB.

CHAPTER 7 INSTITUTIONAL ISSUES AND FINANCIAL AFFAIRS

7.1 Legislation

The water supply service for Baghdad has historically been managed by two entities under the following 2 Laws.

- Law number 50 of the Year 1924: A committee appointed by the Ministry of Works and Transportation rendered water service works for Baghdad from 1924 till 1994.
- Law number 16 of the Year 1995: BWA has rendered water supply services for Baghdad City based on this law since 1995.

7.2 Institutional Issues

BWA, one of the main administrations under the responsibility of the Technical Affairs Deputy of the Mayoralty of Baghdad (MOB) is responsible for operation and maintenance of main water intakes, treatment plants, transmission lines, storage reservoirs, and water distribution network pipes of diameters 300 mm and above in Baghdad. On the other hand, Operation and maintenance of water distribution network pipes of diameters less than 300 mm were transferred to the responsibility of the respective 13 Municipalities.

BWA has six technical implementation sections and two administrative sections under the two Deputies of the Director General (DG) in addition to 4 sections directly under the control of the DG. Currently, almost 1,900 staff are working for the entity and about 17% of them seem to be skilled engineers.

7.3 Water Tariffs

Present water tariffs were set in 2000 and have never been revised since. Tariffs of domestic subscribers are set at ID 2, 5, 7.5 and 20 per m^3 according to the monthly consumption amounts of respectively 1 to 30 m^3, 31 to 60 m^3, 61 to 90 m^3 and more than 91 m^3. Non-domestic subscribers are divided into the categories of governmental use, which is charged ID 20 per m^3 and commercial use, which is charged ID 30 per m^3. However, only 23 % of total connections are metered. Therefore, BWA also charges subscribers that are not metered by the flat rate system likewise most of the developing countries. However, the current water tariff system of BWA is extremely low even comparing with the other Gulf countries'. Although revision of the current water tariff system is an emergent issue for BWA to provide sustainable and qualified water supply services, BWA has no authority to set water tariffs.

7.4 Billing and Collection

The Computer section and some units of the Administration section have responsibility for from water meter reading till billing and collecting water charges. The billing and collection has been carried out every 4 months in principle. However, bill collection ratio remains at about 50% due to the lack of efficient management and monitoring system and security issues. The collection achievement of Sadr City seems worst among the MOB.

7.5 Financial Management and Cost Accounting

Realistically, there is no concept of financial "Management" in BWA. This is because the financial structure of BWA is entirely dependant upon the annual budget from the Mayoralty of Baghdad. Therefore, having concept of recovering its operating expenditures by revenues is very difficult. BWA's recent profit and loss statements have indicated huge net deficits. BWA employs a unified governmental accounting system as same as the other governmental entities. In order to establish a sustainable financial management system on the basis of cost-recovery principle, BWA is expected to have a certain level of autonomy to operate and manage the water supply services.

CHAPTER 8 PROJECT EVALUATION

8.1 Economic Evaluation

The economic evaluation of projects generally requires Economic Internal Rate of Return (EIRR) calculation, Net Present Value (NPV) and Cost-benefit analysis. However, since the Study Team cannot get enough information regarding the living condition of the Baghdad City due to the security problems, it is almost impossible to evaluate the economic feasibility properly, since it is difficult to quantify all the economic benefits.

It should be recognized that the Project will bring a huge economic impacts on the socio-economic situations which have been worsened by the limitation for the use of water. For instance, people can save the costs and time for securing clean water, since the suspension of water supply has been frequently occurred. Improvement of public health will also be expected. UNICEF cautioned that diarrhoea was one of the main causes that increased the recent mortality rate of Iraq. Breakages in the deteriorated pipes cause mixture of contaminated water into the clean water, and that brings about diarrhoea. The Project also creates large number of employments of local people, since BWA plans to employ the large numbers of local people of the Project area for civil works, due to the security reason.

In addition, improving the quality of life is mentioned as a core pillar in the NDS (National Development Strategy). The NDS also strongly asserts that "improving access to clean water and sanitation" is the first priority for achieving the improving the quality of life.

Finally, it is concluded that the Project will bring the essential impacts for the improvement of the people's living conditions in the Project areas. According to the overall discussion, it is evaluated that the Project deserves to be executed.

8.2 Financial Evaluation

(1) General

A financial evaluation has been conducted by Financial Internal Rate of Return (FIRR) calculation. However, since the current water tariff level is too low to recover even the current operating costs, calculating a positive level of FIRR is almost impossible. The current water tariff level is much lower than the average water tariff level of the neighbour countries. The figure is also much lower than the water tariff level which the World Bank and other donor agencies recommended[2]. In addition the ultimate goal of the Project is to reduce the UFW. Therefore, the Project itself does not generate a huge amount of water revenues by increasing water supply.

[2] Appendix C.2 of Supporting Report (Vol. III) explains about the current water tariff problems in detail.

The financial evaluation period for calculating FIRR is set at 40 years.

(2) Financial Benefits and Costs

1) Financial Benefits

a) An increase in water revenues by pipe replacement

The increase in water revenues is firstly generated by selling the quantity of water equal to the demand level due to the Project implementation. The total incremental water brought about by the Project will be about 1,200 $x10^6$ m^3 during the financial evaluation period. The incremental water sales by the Project implementation will be calculated about US$10.8 million on the basis of the current average water tariff per m^3.

b) An increase in water revenues by the water consumption meter installation

Installation of about 150 thousand water consumption meters for domestic subscribers will also increase the water revenues. It is because the payments for the water consumption of these newly metered subscribers will be shifted from the flat rate system into the quantitative system. It is projected that the current average flat rate water charge for domestic subscribers is 108 ID[3] per month. At present, the average monthly water consumption per household is estimated at 84.6m^3. This volume of water is sold at 394.5 ID according to the current quantitative tariff system. Therefore, the total incremental water sales by the installation of water consumption meter will be calculated at 512.9 million ID[4] per year.

However, it is informed that currently BWA only could bill the 26.6% of the total metered subscribers in Sadr City. As long as the security problem is not settled and the additional NRW (Non Revenue Water) improvement activities are not conducted by BWA, the bill collection ratio will be consistent. Since the scope of the Project does not include any NRW improvement program so far[5], the financial benefit by the water meter installation is accordingly limited at 26.6% of the above figure. Finally, the incremental water sales by the water meter installation during the financial evaluation period are calculated at about US$6.1 million.

c) Cost reduction of O&M for leakage loss

Cost reduction of operation and maintenance for leakage loss includes the O&M cost for the water tankers. The annual O&M costs are currently estimated at about US$535,000.

[3] The average monthly flat rate, 108 ID per month, is calculated based on the weighted average as following; 60 ID (Housing size less than 100m^2) x 80%, 225 ID (from 100m^2 less than 200m^2) x 10%, 300 ID (from 100m^2 less than 200m^2) x 5%, and 450 ID (from 100m^2 less than 200m^2) x 5%

[4] The figure is calculated by the following formula;
286.5 ID (monthly incremental revenue per HH) x 12 month x 149,200 (Numbers of newly metered subscribers).

[5] The improvement of billing and collection is essential for BWA to achieve the sustainable management. The Study Team strongly recommends that an additional assistance for the institutional strengthening should be conducted in parallel with project implementation. (See Chapter 9 and Appendix C)

The price of single water tanker, which will be replaced every 10 years, is assumed at US$87,000. The O&M costs of the water tankers are assumed to be increased by 2% till the year 2027, due to the decrepit distribution pipes. The total financial benefits by cutting the O&M costs of the water tankers during the financial evaluation period will be estimated at about US$31.4 million. The financial benefit by cutting repair costs for the leaks[6] is excluded from the calculation due to the lack of information.

2) Financial Costs

a) Investment costs including pipe replacement and water consumption meter installation

The investment costs for pipe replacement and water consumption meter installation are estimated at US$99 million. This figure is calculated based on the Project Costs which is already explained in the Chapter 6. The price contingency is excluded for the FIRR calculation.

b) Replacement costs for the water consumption meters

The water consumption meters are assumed to be replaced every 10 years after the installation. The replacement costs for the water consumption meters are estimated at US$15.4 million. The replacement work will be occurred three times during the financial evaluation period.

c) O&M costs

The annual O&M cost for pipe replacement is expected not so high. Although any referential information was not available, the Study Team assumed that 0.5% of the civil work component of the construction costs would be enough, which is estimated at about US$80 thousand.

Finally, the total financial costs of the Project are estimated at US$147.9 million.

(3) FIRR

The resulting FIRR is -9.5% on the basis of the current water tariff level. Since the Project does not aim to generate the increase of the water sales but to rehabilitate the decrepit distribution pipes, the fiscal benefits are basically not expected as much by the Project implementation. Of course, the current water tariff level is also the main factor to diminish the financial benefit greatly.

For the future reference, if the bill collection ratio is improved gradually up to 80% by 2027, because of the efforts by BWA, the FIRR is slightly improved at -7.1%. The figure indicates that even the efforts for improving NRW does not generate so much financial benefit if the revision of water tariff is not conducted.

[6] UNICEP Report mentioned that the average number of leaks repaired was about 1,000 per month on the distribution network and about 200 per month on the trunk mains in 2003. However, JBIC water sector study report mentioned actual number of leaks repaired would be higher.

As a criterion for judging the execution of a loan project, more than 10% of FIRR is generally recommended by International donor agencies[7]. Therefore, the Study Team finally calculated the necessary water tariff level in order to achieve 10% of FIRR. The simulation of FIRR calculation indicates that the unit water revenue per m^3 must be US$0.493. This figure is almost 55 times higher than the current level. Even though the bill collection ratio is improved same as above 80% by 2027, US$0.485 for the unit water revenue per m^3, 53.9 times higher than the current level, is required to achieve 10% of FIRR.

Above figures are provisional and calculated based on the cost-recovery principle. However, it is impossible to revise into such the high levelled figures in practice. Therefore, subsidiary scheme from MOB should be considered to implement the water supply project. In this regard, it is necessary for BWA to conduct willingness to pay (WTP) survey for the actual water tariff setting in the future. (See Appendix C)

8.3 Technical Evaluation

The scope of the Project is technically viable for both the BWA and Municipalities engineers. BWA and related Municipalities has already carried out rehabilitation of the distribution pipelines in parts of R3 and R14 under the assistance of USAID. A same scope of project is also now on the Detailed Design stage financed by the World Bank.

A DMA system will be introduced after the completion of replacement of water distribution pipes and installation of water consumption meters to measure the leakage of the system for reduction of UFW. JICA has been performing mass training of BWA staff on UFW reduction program since 2005. BWA needs to set up functional units for an action plan for UFW reduction and conduct of pilot study of DMA based on the JICA training.

8.4 Institutional Evaluation

As an indicator to evaluate the operating efficiency, number of staff per ‘000 connections is frequently employed. In the case of BWA, number of staff per 1,000 connections is currently 3.4, whereas the World Bank mentions that 5 staff per ‘000 connections is desirable case for the developing countries. Furthermore, organization structure of BWA is well classified according to the roles of each section.

However, as long as BWA keeps the current financial operation system depending on the budget from MOB, it is not available to secure the enough O&M cost. In order to establish self-management system, additional assistance on the financial improvements and legislative strengthening is expected.

[7] This figure is NOT a condition for the decision of a loan project.

8.5 Environmental Impact of Proposed Projects

Screening and scoping for the planning of the project were conducted for possible environmental impacts that could be caused by implementation of the proposed projects in accordance with the environmental law in Iraq and the JICA environmental guidelines. These examinations were conducted by the Iraqi side through the Environmental Department of the Mayoralty of Baghdad (MOB) in cooperation with the JICA study team through discussions in the technical meeting in Amman. Important environmental factors which were nominated on the IEE and EIA report are shown in the SUPPORTING REPORT in Volume III. The most sensitive environmental impact that could be caused by implementation of the proposed projects as brought to light through the IEE and EIA processes are the elimination of old Asbestos Cement Pipes (ACPs). The results of the environmental examination through the IEE and EIA are summarized mainly for elimination of old ACP as follows:

(1) Effect on Health by Disposal of old Asbestos Cement Pipes

The replacement of old ACP will be done without cutting as much as possible. Old ACP will be left buried in situ after replacement with the new Ductile Iron Pipes (DIP). When cutting old ACP, workers will use masks to protect themselves against fine fibres of ACP and spray water on the construction site in order to keep it wet during construction.

USAID published a Weekly update dated July 28, 2005, in which disposal of old ACP was mentioned. The article concluded that the form of disposal currently being proposed would be suitable. It was supposed that the old ACP was also to be left buried in that project.

(2) Conclusion

IEE and EIA were conducted by the Iraqi side through the Environment Department of the MOB in cooperation with the JICA study team through discussions in the technical meeting in Amman. The EIA report (see attached in DATA BOOK 3 in Volume IV) was approved by the Ministry of Environment (MOE). Through the discussions among the MOB, BWA and the MOE, it was confirmed that no Environmental Law and/or Guideline in Iraq prescribes the elimination of ACP as shown in the attached letter in DATA BOOK 3 in Volume IV. The MOE approved the proposal that the ACP will be left buried in situ after the Project implementation.

CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions and Recommendations

(Proposed Project)

1. It is recommended that the following projects proceed immediately to the implementation stage and that they follow the proposed schedule to minimize UFW figures and reduce chronic water shortage problems :

    a) Replacement of distribution tertiary in the 18 Mahalahs in WSZs R3, R14 and R2

    A program for replacement of tertiary distribution to reduce the leaking in the older damaged ACP and CIP and thus improve the existing distribution system and ensure a secure water supply.

    b) Installation of water consumption meters for all subscribers in WSZs R3, R14 and R2

    The purpose of installation of water consumption meters is to observe the water consumption of R3, R14 and R2 for monitoring the water supply losses in the distribution systems.

2. The proposed improvement plan for R3, R14, R2, which is outlined following, will be carried out starting in 2007 and be completed by the year 2011. The total length of distribution pipeline is 294 km with diameters varying from DN 150 mm to DN 300 mm. Distribution tertiary replacement and water consumption meter installation are proposed to be implemented as priority projects. The pipe replacement project consists of a total of 294 km of pipe replacement work at selected Mahalahs in R3, R14, and R2. The water consumption meter installation project consists of a total of about 149,200 meters in all Mahalahs in R3, R14, and R2, including Mahalahs where older distribution pipes were replaced by BWA and foreign assistance activities.
3. Recommendations for implementation schedules
    - Completing the R3-Sadr WTP, by 2006 as scheduled
    - Completing the new service reservoir for R14 by 2008
    - Commencing the UFW action plan in 2007
    - Replacing old and defective meters and installing new meters on un-metered service connections starting in 2008 and providing a yearly program for implementation.

- Replacing old distribution pipelines and related service connections at R3 starting in 2008.

4. Comprehensive city development plan for Baghdad city (master plan) which will be carried out by the World Bank shall be considered the Study for the proposed project.

(Project management)

5. Establishing a project management team to supervise and control the Project that is to be implemented with financial support from lending agencies is recommended. Coordination among stakeholders concerned is required for smooth execution of the projects. The following arrangements will be necessary to achieve this goal.
   - Establishing a project management team in BWA to supervise and control all relevant contracts and works to be implemented by different contractors and suppliers.
   - International consultants should coordinate and manage the project from Amman.
   - Detailed Design and International Bidding should be carried out by the international consultants in Amman
   - Local consultants should be stationed in Baghdad and assist the BWA and international consultants.
   - The implementation progress in other Mahalahs should be reviewed to properly conduct the water consumption meter installation program.

(Consulting Service)

6. It is recommended to set up an international consulting office in Amman Jordan during the detailed design stage in order to carry out the necessary consulting service for the Project due to security problems in Iraq. It may be proposed that a BWA officer be stationed full time at the consultants' Amman office to coordinate the consulting service with the BWA head office in Baghdad for smoothing and confirming tasks related to the Project.
7. In the detailed design stage the following should be carried out:
   - Locations of underground facilities should be confirmed based on detailed drawings prepared by related agencies such as Baghdad Sewerage Authority
   - Selection of new replacement pipeline routes should be carried out by means of a detailed survey in the field based on the detailed drawings of the existing pipelines and underground facilities.
   - An inventory survey of existing house connections and any illegal connections should be completed.

- A pilot study of DMA should be carried out to confirm the viability of an extended DMA program in WSZ R3.

(Action plan for UFW reduction)

8. An action plan for reduction of the UFW that will enable BWA to monitor the distribution system by establishing DMAs and identifying areas of high leakage should be implemented. But reduction of the UFW will not be attained without organically combining all units and carrying out inspection and repair continuously. Therefore, the action plan needs to be executed with the Implementation Section of BWA as the coordinator of the program with cooperation of the Water Section of the Municipality, the Planning and Follow Up Section, Computer Billing Section, Administration and Financial Affairs Section, and the Design Section.

(Environment)

9. It was confirmed through the EIA that the old ACPs shall be left buried in situ. The potential for asbestos pollution should be monitored during pipe replacement work since ACPs have been used widely in Baghdad. The following work procedure will be needed. Sadr City is one of the highest population density areas in Baghdad and protection of public health is going to be an important issue in the efforts to carry out the proposed leakage control projects. A set of laws and guidelines for construction works for replacing the older ACP was reviewed to assess and minimize any potential environmental impacts to resident's health from the proposed projects.

(Evaluation)

10. Financial analysis resulted in negative figures due to very low water tariff. It is hardly to justify the project from financial viewpoint. However, the project will contribute to the improvement of the public health and cutting the costs and time for securing clean for households, since access to the safe and stable water is one of the Basic Human Needs (BHN). It has been concluded that the proposed project is viable from the economic viewpoint. Accordingly, it is concluded to implement the Project.
11. It is highly recommended that the Consultants should review and carry out the financial and institutional survey in the early stage of implementation of the Project. If a soft component was not included in the scopes of the Project, additional assistance or an intensive capacity development program should be carried out. In this case, it is highly recommended that an ODA loan donor assist the Consultant to ensure that the proper staffs of both BWA and the MOB are involved in the project during the proper period.

9.2 Issues and Risks

The implementation of the proposed project must be undertaken in a manner that will minimize the issues and risks that could arise due to the fact that the Study was carried out in Amman Jordan without any onsite investigations because of the security and safety problems in Iraq. These issues and risks are listed below:

1. In general, collection of data and information required for the study was a most formidable task because it was supposed that the data and information in BWA and related authorities were missing or damaged during the political unrest of the recent years.
2. Water demand was forecast based on the JICA Basic Study Report and USAID Report due to lack of a water supply master plan and water demand is allocated evenly to each Mahalah in the WSZs since there is no detailed information about land use patterns, type of subscribers or type of buildings.
3. It is recommended that the preliminary hydraulic analysis for the future water supply be reviewed after formulation of a Baghdad city plan since the water supply network was analyzed in this study on the above mentioned assumptions such as population and water demand projections.
4. As for pipe replacement schemes, length and size of pipes consisting of aged ACP and CIP are assumed to be the same in each Mahalah in the WSZs due to lack of detailed information about the existing distribution system.
5. The number of water consumption meters that will be required had to be estimated by assuming that the average family size was 12.6 persons per subscriber as proposed by the 2006 USAID Report owing to lack of an updated census.
6. The Turkish route was selected as the first route for project implementation based on the current security information and experience of past projects. Actual transportation routes to the project sites shall be selected by the contractor and/or suppliers as their sole responsibility in consideration of the origin of procurement and the security situation in Iraq.