3.5.3 Selection of Priority Measures

Priority measures for UFW reduction and the water saving is thought hereunder. All of the measures listed in the table-3.16 have high priority for implementation. However, BWA does not have enough capacity in human resources or financial sources to undertake them at one time, and so, priority for the implementation must be considered. The priority measures for UFW reduction and the water saving are selected as described below after careful consideration.

(1) Establishment or strengthening of UFW organization,

(2) Installation of meters especially consumer meters,

(3) Replacement of aged and deteriorated distribution pipes,

(4) Replacement of service connections, and

(5) Installation of GIS for recording and management of the aboves.

It is stressed that the above measures once commenced their implementation should continue toward the distant future by all means.

3.5.4 Priority Projects for UFW Reduction

Among the priority projects as selected, establishment of UFW units and installation of GIS could be materialized in a short time period although continuity of their activity or maintenance is necessary. On the contrary, it is difficult for the pipe replacement and installation of the consumer meters to be completed in a short period because they are scattered within of vast served area. Their stepwise implementation is thought necessary.

By discussion with trainees of the water supply planning course, BWA officials, the first priority areas for UFW reduction are selected as R3 and R14 zones, and for the second priority areas, R2 and R7 zones are also selected.

The present served population in each distribution zones quoted from the basic study report as attached in appendix-2 is as listed in the table-3.17. Total population in the table is almost the same as the present population as employed in the present planning.

Table-3.17 Present Zonal Population

No.	East(Rasafa)		West(Karkh)	
1	R1	270,696	K1	103,776
2	R2	360,859	K2	196,419
3	R3	680,170	K3	145,874
4	R4	35,154	K5	61,772
5	R5	233,195	K6	476,423
6	R6	241,404	K7	710,178
7	R7	288,623	K9	189,883
8	R8	133,939	K10	298,869
9	R9	121,398		
10	R10	135,662		
11	R11	103,934		
12	R13	24,356		
13	R14	495,972		
14	R45	188		
Sub-total		3,125,550		2,183,194
Total Population		5,308,744		

The total population in zones R3 and R14 is 1,176,142 and is equivalent to 22.16% of the total population. As there are no other suitable data in hand, it is assumed that numbers of meters to be for installed and length of the pipelines to be replaced are proportional to the above population rate. From this assumption, numbers of consumer meters necessary (Nm) is estimated as:

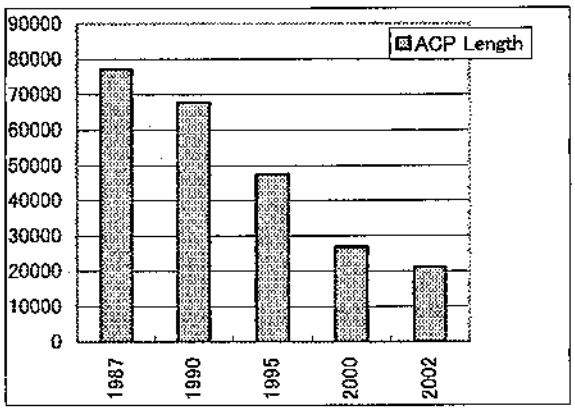
Nm = 567,551 × 1,176,142／5,308,744 = 125,700 = 130,000 units.

It is planned replacement of the existing service connections is executed together with the meter installation for UFW reduction.

As for replacement of pipelines, such aged and deteriorated pipes as the existing asbestos cement pipes and cast iron pipes are used for 225mm in diameter and below and 60% of the total pipeline length of 7,746km in length. Cast iron pipes have been in use for more than 35 years and it is considered that water leaks could occur mainly at the connection of pipes rather than from the pipe body. On the contrary, larger portion of the leaks would be from the pipe body in case of the asbestos pipes because of their fragile structure.

Fig-3.9 Replacement of ACP

Unit:km



Japan Water Supply Data Report 2004

In Japan, production of the asbestos pipes was terminated about 20 years ago, and length of the asbestos pipelines in use has lessened greatly as shown in Fig-3.9. This is accelerated by the subsidy arrangement of the ministry of labor and public welfare.

From the above discussions, replacement of the asbestos pipelines (ACP) and the cast iron pipelines (CIP) in the above two zones is selected as one of the first priority programme.

Thus, lengh of asbestos pipelines (La) to be replaced is estimated as,

La = 3,700 × 0.2216 = 820 km = 800 km.

Length of the cast iron pipes to be replaced (Lc) is estimated as,

Lc = 800 × 0.2216 = 177 km = 200 km.

UFW reduction effect by the above replacement is estimated using assumptions. For the large percentage, UFW of Baghdad water supply is assumed to be composed of 40% of leaks from pipelines of which 80% is from ACP and CIP and the remaining 20% is from the other pipes, 40% is

from service connections and 20% is from other losses including billing and collection. It is also assumed that leaks lessens from 32% (= 40% x 80%) to 4% by the replacement of ACP and CIP and also lessens from 40% to 5% by the replacement of the existing service connections

By these assumptions, it is estimated that the leak would lessen greatly from 100% to 37% as described in the table-3.18, and so, UFW would lessen from 50% to 18.5% in the said two zones. As population in the target zones is 22.16% of the total population, contribution of the said UFW reduction to the whole served area would be approximately 7% = (50%-18.5%) x 0.2216.

Table-3.18 Estimation of UFW Reduction

Pipe Loss	Present Loss	Replace
80% by ACP & CI	40x0.8=32%	4%
20% by Other Pipes	40x0.2 = 8%	8%
Connection Loss	40%	5%
Others Bill & Collection.etc	20%	20%
Total Loss	100%	37%

3.6 Preliminary Cost Estimates

Since a preparatory design of the future Baghdad water supply system is not made in this stage yet, a preliminary cost for the system development is estimated utilizing the cost by the Basic Study Report and other examples of similar water supply projects in order to grasp the scale of the long term project cost roughly. Examples to be used for the estimates are as follows.

(1) Preliminary cost in Basic Study Report by BWA engineers,

(2) Preliminary cost by the master plan of Jakarta Water Supply System, and

(3) Classification data of property of the water supply systems in Japan

3.6.1 Cost of Development Project

The Basic Study report estimates project cost for Rasafa water supply project including not only a water treatment plant but also transmission and distribution facilities are estimated as described in the table 3.19. The project cost estimated is US$ 2,370 million against the capacity of the system to be developed, and the unit cost for 1000m^3/d is calculated as 1.04 M$. The unit cost is smaller than that of Jakarta M/P.

From the table, cost for installation of the distribution centers amounts as big as US$ 1,200 million or 50% of the total cost. However, as the estimated cost breakdown of the distribution centers which is also listed in the Basic Study report is US$ 807 million, it is regarded here that rest of the cost for the distribution centers is for the cost of installation of the transmission mains. Cost for distribution network installation of US$ 400 million seems too small comparing with other examples as shown, and makes it two times. The consulting fee is also increased.

By these modification, unit cost of Rasafa project is increased to 1.378 M$/1000$m^3$/d as sown in the column "Revised" of the table and is almost same as the case in Jakarta which is 1.311. Composition of the Rasafa costs of each category also approaches to the cost of the other two examples.

However, as shown in the table, cost for the distribution networks is still smaller than the others. The reason of the smaller cost, that is bigger costs for the transmission main and the distribution centers, might be adoption of a ring trunk main system and a zoning distribution system, an image both of which is as illustrated in the Fig-3.7. Instead, by the above provision, it would not be necessary to lay big diameter distribution mains because the network capacity is limited within a zonal water distribution, and this lessens the cost for the distribution networks. Preliminary cost in this long term plan is thus estimated on the basis of the revised cost as shown in the table-3.19.

Table-3.19 Examples of Unit cost for Water Supply System Development

Cost Items	Company		Revised		Remarks	Jakarta M/P		Japan	Description
	M$	%	M$	%		M$	%		
Facility Construction	2,300		2,700			3,005		%	
Treatment Plants	700	29.5	700	24.6		528	15.3	20.4	with Intake
Distribution Center	1,200	50.6	807	28.3	Breakdown	124	3.6	7.9	
Transmission Main		-	393	13.8	Rest of Above	322	9.3	11.7	
Distribution Main	400	16.9	800	28.1	2 times	2,031	58.8	50.5	
Consulting Fee	20	0.8	100	3.5		156	4.5		
Land Acquisition	20	0.8	20	0.7		294	8.5		
Others	30	1.3	30	1.1				9.5	
Sub-total Cost	2,370	100	2,850	100		3,455	100	100	
Contingency			285		10%	346			
Total Cost	2,370		3,135			3,801			US M$
Planned Capacity	2,275		2,275			2,900			1000m3/day
Unit Cost	1.042		1.378			1.311			M$/1000m3/d

Major components of the long term development project are installation both of Extension-2 of Saba Nissan system and all of Rasafa system. Total capacity for development of these two systems (Qt) is as bellow

$Qt = 225,000 + 2,400,000 = 2,625,000\ m^3/d$.

Thus, total cost (Ct) is estimated as below, though the estimated cost is of very preliminary level.

Ct = 2,625 x 1.378 = 3,617 = US $ 3,600 million

3.6.2 Cost of UFW Reduction

As for the priority program for UFW reduction, replacement of all of the existing ACP and DIP and installation of service meters to all consumers including replacement of the existing service pipelines are taken into account. It is considered that other costs for UFW reduction and the water saving are included in the system development as mentioned in the above.

1) Cost of Pipe Replacement

Amount of replacement of aged and deteriorated pipelines is assumed as follows, and it is assumed to employ ductile iron pipes (DIP) for replacement of these pipelines.

ACP: Representative diameter 100 mm Length for replacement 3,700 km, and

CIP: Representative diameter 150 mm Lengh for replacement 800 km.

2) Installation/Replacement of Consumer Meters

All of the exiting service connections either with (10%) or without (90%) meters are planned to be replaced on the consideration that they are already deteriorated under the circumstances. All of the

existing consumer meters would also be replaced from the same consideration. New consumer meters are to be installed in the service connections without meters but renewed as above. Is would be included usually in the above system development cost, but installation cost of consumer meters for the new/future customers are estimated and included in UFW reduction program. Thus, numbers of the metered service connection are calculated as below.

Replacement: 567,551 sets, and

New installation: (8,800,000 - 5,308,744)／(5,308,744/567,551) = 373,000 sets,

Cost for replacement and installation of service connections with consumer meters are estimated using the unit cost quoted mainly from the Basic Study report. And it is as shown in the table 3.20.

Table-3.20 Preliminary Cost Estimate of Pipe Replacement and Meter Installation

Unit Cost			
Replacement of ACP	Cost(ID/m)	Cost(US$/km)	
d150mm DIP Installation	93,000	63,699	Material & Pavament included
d100mm DIP Installation	73,000	50,000	Material & Pavament included
Metered Connection	Cost(ID/Nos)	US$/1000Nos	
House Connection	23,000	15,753	Install & Pave without Meter
d20mm Consumer meter	73,000	50,000	Purchase in Baghdad
Total	96,000	65,753	
Project Cost	Length(km)	Cost(US M$)	
d150mm DIP Installation	800	51	
d100mm DIP Installation	3,700	185	
	Nos.(1000)		
Metered Connection Work	493	32	Existing Connection
New Metered Connection	355	23	
Total		292	
Administaration. etc.		58	Approximately 20%
Total Cost		350	

3.6.3 Total Project Cost

Total project cost of the long term plan for the Baghdad water supply system is the sum of the system development cost and cost for UFW reduction, and it amounts as big as US$ 4,000 million. It should be noted that the cost estimated here is of very preliminary stage. The great effort should be necessary to obtain such big amount of funds for the project implementation.

Cost of Development Project	US$ 3,600 million
Cost of UFW Reduction	US$ 350 million
Total Long term Project Cost	US$ 3,950 million = 4,000 million

4. Priority Project

4.1 Project Frame

1) Purpose

Purpose of the priority project is firstly to recover capacity of Baghdad water supply system from the present insufficient conditions to the level of the average water demand. And secondary, the aim is to create basis for a future appropriate level of water supply. For the purpose, a large scale development of water supply system is planned to approach the capacity of Baghdad system to the day maximum water demand.

2) Target Year

The target year of the priority project is set in 2014 approximately ten years from now on.

3) Future Population and Planned Water Supply

(1) Planned served population	6,710,000 Person
(2) Planned day maximum water supply	Q_{max} = 3,750,000 m3/d
(3) Planned average supply	Q^{ave} = 2,900,000 m3/d
(4) Planned water production capacity	Q_{cap} = 3,520,000 m3/d

4.2 Project component and cost

4.2.1 Project Component

Priority project is classified into two steps, namely the first priority and the second priority. First priority project includes construction of the extension-2 of Saba Nissan water treatment plant and aged pipe replacement and installation of consumer meters in the zone R3 and R14. By the first priority project, Baghdad water supply system will cover the average water demand up to the year 2012. Major item for the second priority project includes implementation of Rasafa stage-1 system of which capacity is 600,000m3/d. By the implementation of the large scale installation, capacity of Baghdad water supply system approaches for the day maximum water demand.

Construction period of Saba Nissan system is scheduled to be completed until 2008, and is short, only for three years. Therefore, it is considered to limit project components of the system to installation of a water intake station and a treatment plant. Considering that premises for those facilities are said already in hand of BWA and design thereof is underway by the assistance of USAID. It could be completed until 2008. Water produced by the plant will be supplied to consumers through the existing transmission and distribution facilities.

As for UFW reduction, the first priority programme will be as follows which is as studied in the section 3.5.

(1) Replacement of ACP and CIP in zones R3 and R14, and

(2) Installation of consumer meters including replacement of the existing service connections in zones R3 and R14.

As for the second priority project, implementation of Rasafa satage-1 water supply project includes not only intake and treatment facilities but also transmission and distribution facilities of a large scale. Installation of distribution centers in zones R3 and R14 has high priority and those in zones R2 and R7 shall be followed. Implementation of transmission mains connecting the new treatment plants with distribution centers in the above zones has also high priority. Replacement of the deteriorated pipelines and installation of the consumer meters will proceed to zones R2 and R7.

4.2.2 Cost of Priority Project

Cost of the priority project is estimated classifying it into two projects, namely the first priority project and the second priority one. However, as same reason as described in the subsection 3.6.3, the cost estimated hereunder is of very preliminary stage too.

As shown in the table-4.1, cost of the first priority project is approximately US$ 180 million. However, cost of the second priority project is of very huge amount over US$ 1,300 million. This is because of a big capacity of facility installation and installation of the delayed or suspended facilities so far because of the countries circumstances. Great effort and cooperation of organizations related are essential for realization. It is noted that the project cost estimated does not include and security expense and the like.

4.3 Implementation Program

Implementation programme of the priority project is as shown in the Fig-4.1. Considering from the figure, it is judged possible to execute the priority project in accordance with the implementation schedule as shown though rather tight. It is because to increase capacity of the present water supply system, which is under an average demand level at present, up to the level to approach day maximum demand in about ten years. It is necessary to put together power of all the related organization for the successful implementation of the project as the same as acquisition of its funds.

4.3.1 Study

Generally, implementation of water supply system improvement is commenced with a study. A reconnaissance survey, a master plan and a feasibility study are usually performed in the order, and

Table-4.1 Preliminary Cost Estimates of Priority Projects

Work Items	Nos.	Unit	Unit Cost	Cost in M$	Remarks
First Priority Project					
Facility Cinstruction					
East Tigris Extention-2	225,000	m3/d	400	90.0	Including Intake Station
UFW Reduction					
Replacement of ACP	800	km	50,000	40.0	R3 & R14 Zones
Replacement of CIP	200	km	63,699	12.7	R3 & R14 Zones
Installation of Meters	130,000	Nos.	67.1	8.7	Including replace of Service Pipe
Administration, etc				28.5	Approximately 20%
Project Cost				180.0	
Second Priority Project					
Facility Construction					
Rasafa-1 Plant	600,000	m3/d	400	240.0	Including Intake Station
Distribution Center	R3,R14,R2&R7			275.4	From BWA Cost Estimates
Trnsmission Pipelines	Ratio of Population			135.1	393 x 1825624 / 5308744
Distribution Mains	Ratio of Population			275.1	800 x 1825624 / 5308744
Sub-total				925.6	
UFW Reduction					
Replacement of ACP	453	km	50,000	22.7	R2,R7:3700x649482/5308744
Replacement of CIP	98	km	63,699	6.2	R2,R7: 800x649482/5308744
Installation of Meters	69,463	Nos.	67.1	4.7	=649482/9.35 Existing Area
Installation of Meters	149,867	Nos.	67.1	10.1	=(6710000-5308744)/9.35 New
				43.6	
Administration, etc				191.0	Approximately 20%
Project Cost				1,160	
Total Project Cost				1,340	

after that, implementation including designing, tendering and construction is undertaken. However, in case of Baghdad water supply system, there has been insufficient development of the system and poor operation and maintenance of the system during these 10 to 15 years due to the countries condition, and consumers of the Baghdad water supply could not wait no more for improvement of the service level. Actually, the extension-1 programme of Saba Nissan by the assistance of USAID and the compact treatment units by Japan are under implementation without a study confirming necessity or feasibility of the implementation.

It is obvious that even with the above implementation, the supply capacity is still far beyond the satisfactory level of Baghdad citizen, and immediate addition of new water supply facilities is needed. They are the extension-2 of Saba Nissan plant and Rasafa stage-1 project and should be put into implementation as soon as possible. In case these facilities are put in the implementation stage, it is proposed to prepare a master plan for the future water supply system of Baghdad city together with a feasibility study for Rasafa stage-2 project. The master plan should include not only technical matters including facilities installation and UFW reduction but should include institutional, organizational, water rates and financial studies for sound management of Baghdad water supply system..

4.3.2 First Priority Project

As described in the section 4.2, extention-2 of Saba Nissan is said underway of implementation. This must be confirmed and if deemed necessary measures to complete the plant within 2008 should be taken. As for it implementation, firstly, design and tender documents should be checked in a short period, and tender and award follow to the checking. Then construction of the plant will start and should be completed within 2.5 years and the plant will commence it production of 225,000 m^3/d water from the year 2009.

Replacement of the deteriorate pipes is scheduled to be completed within three years. The Basic Study report shows that replacement of 450 km of the existing pipelines and installation of 600 km new pipelines is scheduled by BWA in the year 2005. It is considered that BWA has enough implementation capacity for pipe laying works. So, it is thought possible to replace 1,000 km pipelines within three years. As for installation of the consumer meters and replacement of the service connections, it is also considered possible.

4.3.3 Second Priority Project

Rasafa stage-1 project should be completed until 2014. Especially, other facilities than distribution networks should keep the pace. As for implementation period of the satage-1 treatment plant, 4.5 to 5 years are considered necessary as mentioned below. Therefore, it is necessary to acquire the land area for necessary facilities including the intake station and treatment plant and to make a loan agreement with the international lending agencies until early next year.

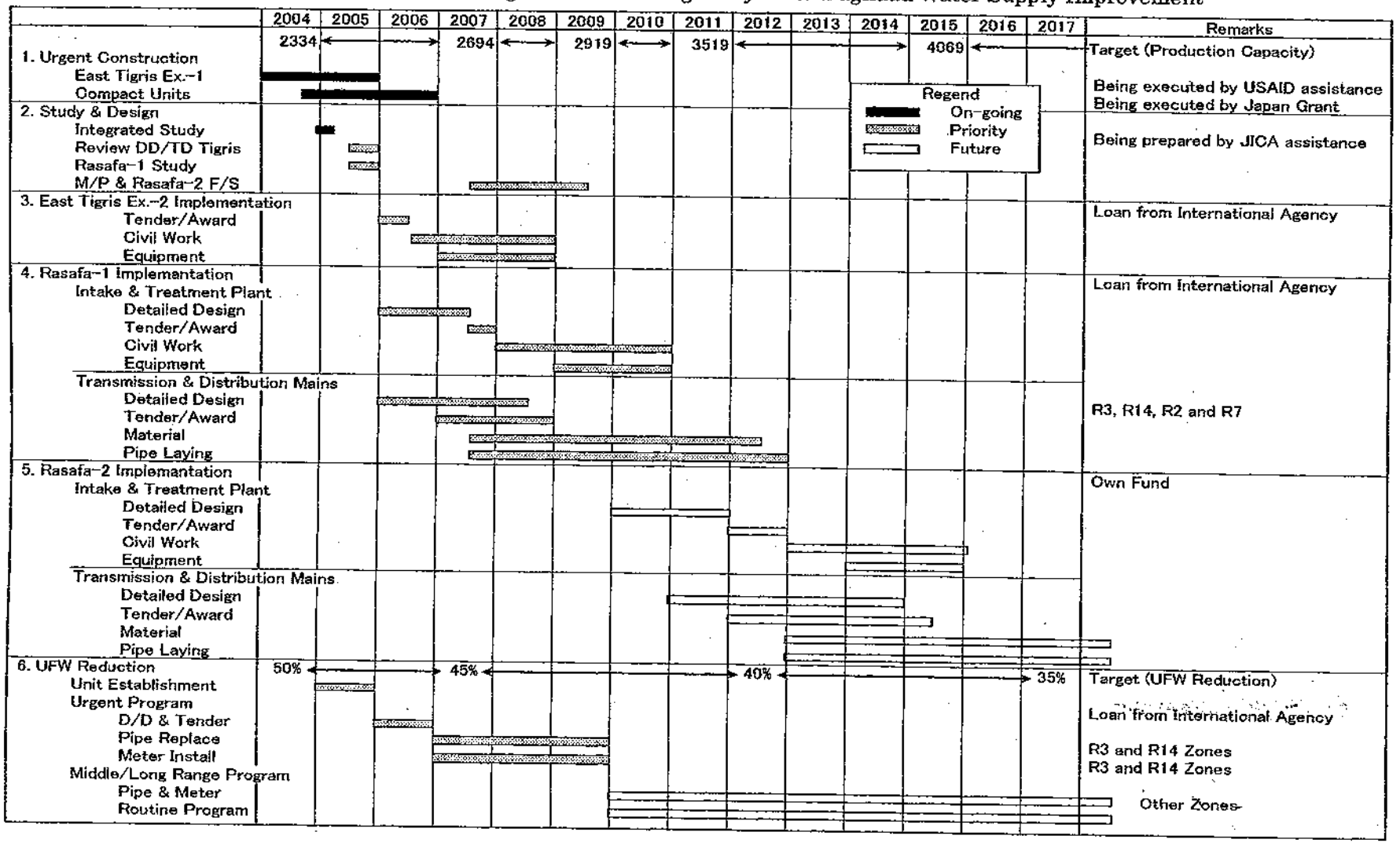
(1) In case of a normal implementation, two years for designing, tendering and award and three years for construction are deemed necessary, and
(2) In case of design-built contract, one and half years for basic design, tendering and award and three to three and half years for detailed design and construction would be needed.

Component of facilities to be constructed in the Rasafa stage-2 project includes the followings.

(1) An intake station and a treatment plant with the capacity of 600,000m3/d,
(2) Distribution centers in zones R3,R14,R2 and R7,
(3) Transmission mains connecting the plant and the distribution centers, and
(4) Distribution networks in zones R3,R14,R2 and R7.

Replacement of ACP and CIP in zones R2 and R14 and installation of consumer meters including replacement of the existing service connections in the same zones are to be implemented under the second priority project.

Fig-4.1 Implementation Program of First Stage Project for Baghdad Water Supply Improvement



Appendix-1
The Existing Water Supply System

1. Socioeconomic Condition

1. Present States of BAGHDAD Water Supply System

1.1 Framework of Present Water Supply

1.1.1 Area

Area of Baghdad Governorate: 734 km² (including Mayoralty of Baghdad)

Served Area: Mayoralty of Baghdad + Two Suburban Areas of the Governorate as shown in the figure at the top of the report.

1.1.2 Population

(1) Population of Baghdad

Census Population of Baghdad City

Year	1947	1957	1965	1977	1987	1997
Population	500	1000	1657	2664	3841	4402

Recent Population

	1977	1987	1997	2000
Mayoralty			4,399,516	4,769,072
Others			1,009,143	
Governorate	3,189,700	3,841,268	5,408,659	
Country	12,000,497	16,335,199	22,200,791	24,329,958

Population by Area (Population Served is same.)

District	Sub-district	Urban Population	Rural Population	East/West of Tigris
Al-Adhamiyah	Al-Adhamiyah Center	241,135		East
	Al-Fahama	363,100		
Al-Kadhimiyah	Al-Kadhimiyah Center	520,782		West
	That Al-Salasil		15,694	
Al-Karkh	Al-Karkh Center	112,557		West
	Al-Ma'moon	849,400		
	Al-Mansour	422,813		
Al-Risafa	Al-Karrada Al-Sharqiyah	228,689		East
	Al-Risafa Center	141,472		
	Baghdad Al-Jedeeda	744,459		
Saddam(Sadir City)	Saddam Center	1,128,971		East
Total	4,769,072	4,753,378	15,694	
Distribution	East Side of Tigris River		West Side of Tigris	
Population	2,847,826		1,921,246	
Ratio	59.7 %		40.3 %	

(2) Served Population

Service Coverage: 100% both urban and rural

Served Population: 4,769,072 Person

Urban Population; 4,753,378, 99.7%

Rural Population; 15,694, 0.3%

1.1.3 Water Production and Use

Data in 1999

Production Capacity: 2,429,855 m^3/day

Average Production: 648 mil m^3/year = 1.775 mil m^3/day

Supply Billed: 314 mil m^3/year = 0.860 mil m^3/day, 48%

Per Capita Water Use: $0.860 \times 10^6 / 4,769,072 = 0.180 m^3/cd$ = 180 lcd

Urban; 181 lcd, Rural; 86 lcd

Average Per Capita Supply: Total; 372 lcd

Max Per Capita Production: Total; 504 lcd, Urban; 505 lcd, Rural; 118 lcd

Ratio of Water Shortage: Urban; 47%, Rural; 0%

Data in 1993

Average Per Capita Production: 425 lcd	Average Production: 1.774 mil m^3/d
Max Daily Production : 574 lcd	Peak Day Production: 2.348 mil m^3/d
	Served Population: 4,093,200

Standard Water Demand by Planning Board Decision No.1

Domestic User: 330, Industrial and Commercial: 40, Government: 50

UFW: 75, Total 500 lcd

Adequacy line defined by GOI

Urban (except capital); 150 lpcd, Rural; 80 lpcd

Monthly Production Data of Baghdad Water Supply System

2004

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily
Karkh	30,480	30,000	32,310	31,800	32,700	32,610	33,400	32,600	31,400	33,160	29,000	31,320	1,043
East Dijlah	15,000	14,900	14,500	15,000	14,700	14,850	14,100	15,100	14,500	14,500	16,200	15,000	486
Al-Doura	1,700	1,700	1,700	2,410	2,410	3,220	3,215	3,200	3,210	3,200	2,410	1,700	82
Al-Karama	3,100	3,400	3,500	3,500	4,470	3,500	4,460	4,900	4,140	4,460	4,430	3,400	129
Al-Kadiseea	2,800	2,000	2,500	2,300	3,000	3,000	3,500	3,500	3,500	3,500	2,500	2,800	96
Al-Wathba	2,100	2,100	2,100	2,100	2,100	2,100	2,170	2,100	1,950	1,860	2,100	2,100	68
Al-Rasheed	1,000	1,000	1,000	1,300	1,488	1,520	1,670	1,700	1,620	1,620	1,050	1,100	44
Al-Wihda	1,100	1,400	1,100	1,500	1,500	1,600	1,150	1,150	1,600	1,150	980	1,100	42
Total	57,280	55,600	58,710	59,910	62,368	62,400	63,665	64,250	61,920	63,450	58,670	58,520	1,991
Average	1,848	1,986	1,894	1,997	2,012	2,080	2,054	2,073	2,064	2,047	1,956	1,888	P=1.06
Mon.Temp.	9.4	11.8	16.2	21.7	27.7	32.3	34.6	34.2	30.8	24.9	17.2	11.1	

2003

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily
Karkh	32,150	29,880	34,250	25,000	31,000	32,700	34,000	34,670	32,700	32,700	30,650	31,320	1,044
East Dijlah	14,100	10,900	11,780	15,000	15,000	16,000	18,250	16,200	16,200	16,200	15,500	15,000	494
Al-Kadiseea	1,500	1,400	1,500	750	2,250	2,250	3,250	4,000	4,000	3,600	2,800	2,800	82
Al-Wathba	1,800	1,400	2,100	2,100	2,100	2,100	2,100	2,170	2,100	2,100	2,100	2,100	66
Al-Doura	1,610	1,610	1,600	1,600	2,000	2,250	3,250	3,250	3,220	3,220	2,410	1,700	76
Al-Karama	6,810	4,800	5,250	3,500	3,500	4,250	4,250	4,730	3,460	3,960	3,460	3,400	141
Al-Rasheed	1,400	1,120	930	930	1,260	1,260	1,260	1,260	1,370	1,100	1,100	1,100	39
Al-Wihda	1,340	1,340	920	630	1,120	1,300	1,400	1,470	1,420	1,000	1,100	1,100	39
Total	60,710	52,450	58,330	49,510	58,230	62,110	67,760	67,750	64,470	63,880	59,120	58,520	1,980
Daily	1,958	1,873	1,882	1,650	1,878	2,070	2,186	2,185	2,149	2,061	1,971	1,888	p=1.10

2001

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily
Karkh	34,500	31,160	35,000	34,000	35,500	35,400	37,000	40,200	40,500	39,000	36,000	36,000	1,190
7Nissan	14,000	14,000	15,350	16,000	16,000	16,000	16,200	16,200	16,200	16,200	15,500	15,500	513
Al-Doura	1,600	1,600	1,600	2,400	3,000	3,000	3,210	3,210	3,210	2,410	2,400	2,000	81
Al-Karama	3,570	3,500	3,700	3,500	4,800	4,800	5,400	5,300	5,180	5,350	3,900	3,500	144
Al-Kadiseea	3,000	3,000	3,000	3,500	3,500	3,400	3,450	3,450	3,100	2,500	2,500	2,250	100
Al-Wathba	2,100	2,100	1,300	1,300	2,000	2,100	2,170	2,170	2,100	2,100	2,100	2,100	65
Al-Rasheed	1,000	1,000	1,300	1,000	1,300	1,300	1,550	1,550	1,550	1,500	1,400	1,000	42
Al-Wihda	1,570	1,570	2,000	2,000	2,000	2,000	2,000	2,000	2,000	1,800	1,600	1,600	61
Total	61,340	57,930	63,250	63,700	68,100	68,000	70,980	74,080	73,840	70,860	65,400	63,950	2,196
Daily	1,979	1,869	2,040	2,055	2,197	2,194	2,290	2,390	2,382	2,286	2,110	2,063	p=1.09

1999

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily
Karkh	35,700	33,930	36,360	34,340	35,950	36,000	37,000	37,389	35,700	37,000	34,700	31,500	1,166
7Nissan	10,900	10,000	10,440	12,600	13,000	14,000	14,850	14,850	14,000	16,740	14,000	14,000	437
Al-Karama	4,380	4,500	4,590	3,700	4,000	4,800	4,800	6,324	4,800	4,800	4,800	4,000	152
Al-Wathba	2,100	2,030	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	69
Al-Kadiseea	2,120	2,640	2,700	2,740	3,500	3,500	3,500	4,260	3,500	3,500	3,500	3,000	105
Al-Doura	1,660	1,660	1,660	2,410	3,000	3,000	3,000	2,810	3,000	2,410	2,300	1,600	78
Al-Rasheed	890	900	1,000	1,300	1,300	1,300	1,300	1,560	1,300	1,300	1,300	1,000	40
Al-Wihda	1,400	1,650	1,650	1,680	1,680	1,680	1,760	1,760	1,860	1,680	1,680	1,570	55
Total	59,150	57,310	60,500	60,870	64,530	66,380	68,310	71,053	66,260	69,530	64,380	58,770	2,101
Daily	1,908	2,047	1,952	2,029	2,082	2,213	2,204	2,292	2,209	2,243	2,146	1,896	p=1.09

1996

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily
Karkh	32,388	28,647	31,390	32,760	36,450	35,131	38,501	37,389	37,380	36,540	35,000	35,600	1,143
7Nissan	10,035	10,035	10,035	12,150	12,555	14,040	14,850	14,850	14,000	12,500	12,100	10,100	403
Al-Karama	3,410	3,960	4,370	4,822	5,555	5,454	5,555	6,324	6,120	6,000	3,800	4,000	163
Al-Kadiseea	2,850	1,800	2,120	3,700	3,750	4,104	4,100	4,260	4,250	4,210	3,500	3,500	115
Al-Wathba	2,100	1,960	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	69
Al-Doura	1,800	1,800	2,100	2,268	2,720	2,720	2,815	2,810	2,720	2,410	2,410	1,660	77
Al-Rasheed	800	680	730	1,026	1,410	1,300	1,560	1,560	1,510	1,430	900	890	38
Al-Wihda	1,730	1,730	1,730	1,750	1,760	1,760	1,760	1,760	1,650	1,750	1,740	1,760	57
Total	55,113	50,612	54,575	60,576	66,300	66,609	71,241	71,053	69,730	66,940	61,550	59,610	2,066
Daily	1,778	1,808	1,760	2,019	2,139	2,220	2,298	2,292	2,324	2,159	2,052	1,923	p=1.13

1.1.4 UFW

Data in 1999: UFW= (1.775 – 0.860)/1.775= 0.52= 52%

UNICEF 2000 Estimates:

Rough Estimates:

Average UFW = Average water produced - Average water billed

= 67,245,600 m^3/month - 26,179,274 m^3/month

= 41,066,326 m^3/month

Operational Losses = 62%

1.2 Water Supply Management

1.2.1 Management Body

Sector Management: Mayoralty of Baghdad

Water Supply Operation: BWA (BAGHDAD Water Authority)

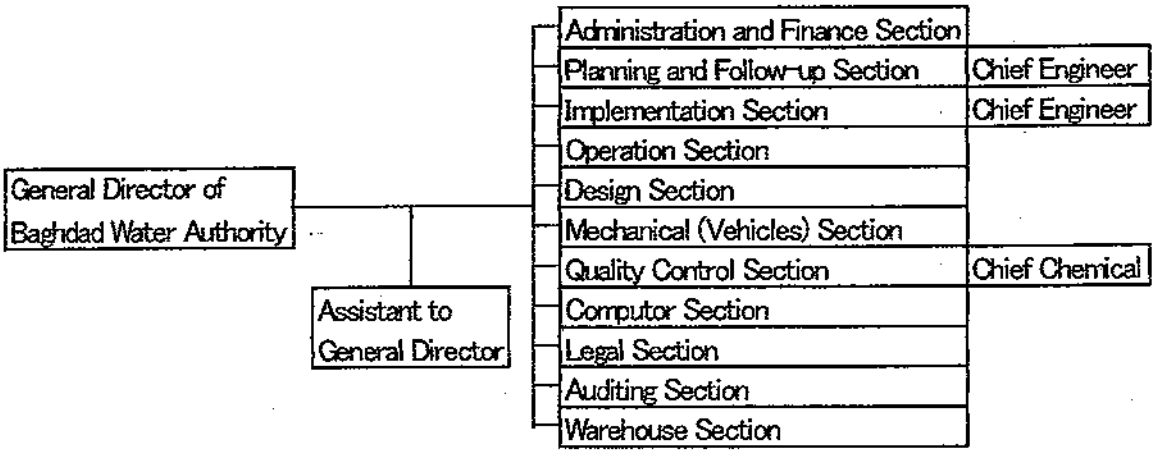
Sewerage Operation: BSA (BAGHDAD Sewerage Authority)

1.2.2 Organization

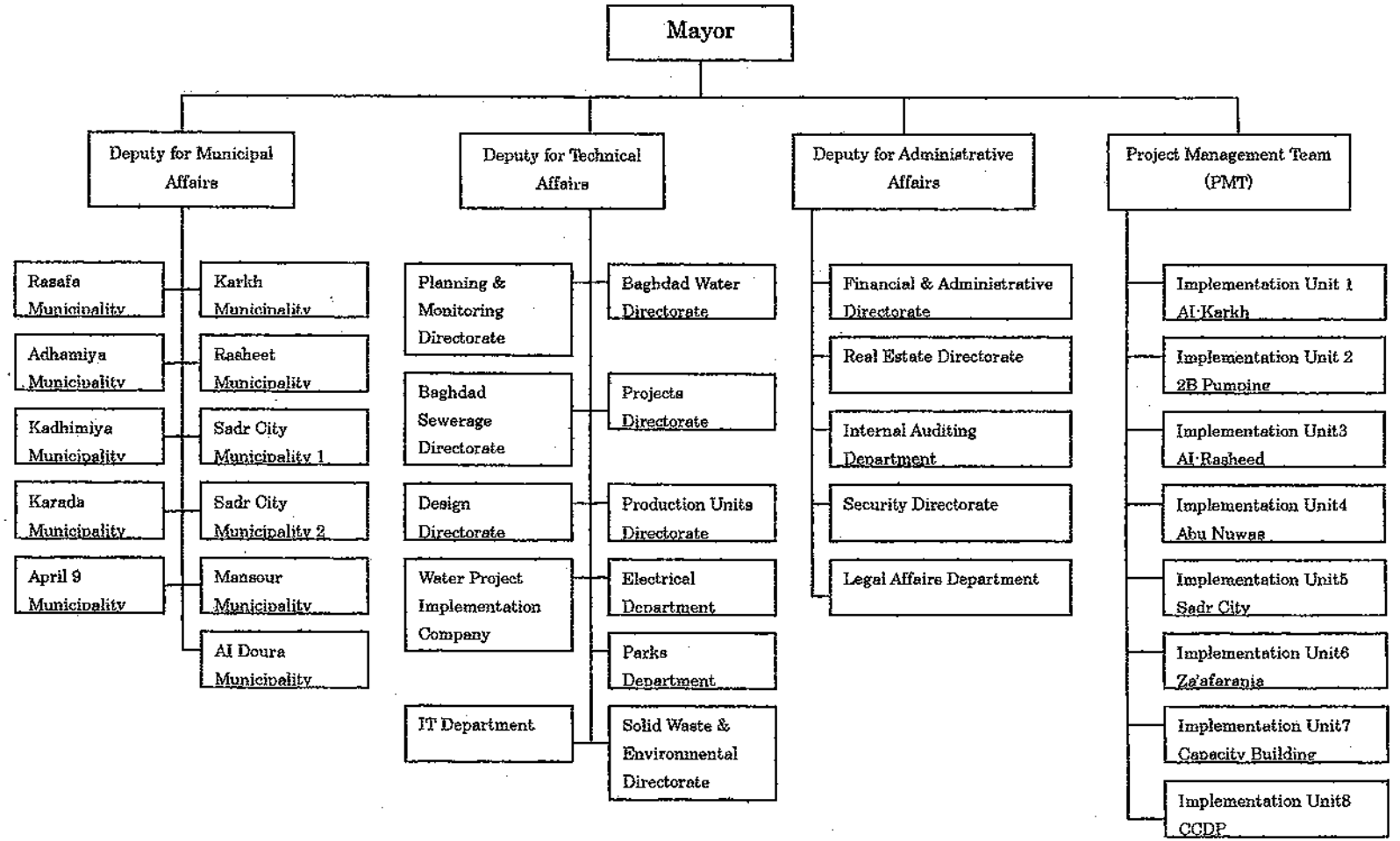
No. of personnel of BWA: 1,420 (including 14% of Sanitation Services)

Organization Chart of Baghdad City : Next Page

Organization Chart of Baghdad Water Authority: Below



Mayoralty of Baghdad Organizational Chart



1.2.3 Finance and Water Rates

(1) Service Connections

Numbers of Service Connections: 567,551

including Domestic Connections; 66%

Numbers of persons per connection:

Served population/Numbers of domestic connection = 12.7

Numbers and categories of connections:

	Metered	Unmetered	Total	%
Domestic	48,219	328,061	376,280	66%
Industrial & Commercial	10,469	43,005	53,474	9%
Government		121,899	121,899	21%
Public(Place of Worship, etc.)		15,898	15,898	3%
Total Sevices	58,688	508,863	567,551	
%	10%	90%	100%	100%
Billed Sevices	58,688	492,965	551,653	97%

(2) Water Rates

Rate of Bill Collection is 55% to 60%.

Water Tariff

Water tariffs are established by the GOI.

Household: Progressive rates but very low tariff.

Office and Other uses:

Very high tariff compared with household uses.

Offices are charged at the flat rates.

Unit water rate : 1,288.1／314 = 4.1 ID/m³

The water sales revenue includes raw water sales income.

Water Tariff

Household	Water Rates (ID/m³)		Estimated Consumption	
	1998/1999	2000	Household	Consumption
1-30 m³/month	0.66	2.0	1-4 rooms	1.5 m³/day
31-60 m³/month	1.50	5.0	5-6 rooms	2.0 m³/day
61-90 m³/month	1.50	7.5	6-7 rooms	3.0 m³/day
Above 90 m³/month	10.00	20.0	Above 7 rooms	3.5 m³/day
			Garden 50m²	0.5 m³/day
Category	Water Rates (ID/m³)		Estimated Consumption	
	1998/1999	2000	Institution	Consumption
Public Institution	5	20	Coffee House<30m²	4 m³/day
Private Commercial	15	30	Coffee House>30m²	6 m³/day
			Restaurant<30m²	4 m³/day
			Restaurant<100m²	6 m³/day
			Restaurant etc.>100m²	8 m³/day
			Car Service etc.	60 m³/day

(3) Finance

Financial situation of Baghdad Water Supply Authority was as shown in Table-x. In the O&M expenditure on the table, municipality operating expenditure for distribution mains of 250 mm and below and treatment chemical fee are not included.

Income Statement of BWA & BSA for 1999

Accounts	Water Supply		Sewerage		Total	
	ID Million	%	ID Million	%	ID Million	%
Expenditures						
O&M Cost	1085.3	79	631.3	47	1716.5	63
Depreciation	58.2	4	1.3	0	59.5	2
Others	78.3	6	78.3	6	156.6	6
Total Expenditure	1221.8	89	710.9	53	1932.6	71
Revenues						
Water/Sewer Sales	1288.1	94	685.9	51	1974.1	73
Others	86.2	6	651.3	49	737.4	27
Total Revenue	1374.3	100	1337.2	100	2711.5	100
Net Income	152.5	11	626.3	47	778.8	29

1.3 Water Sources

1.3.1 Water Source in Iraq

Current patterns of water use in the country are unlikely to be sustainable. Water scarcity is about to become a limiting factor to economic growth.

Water Source

Renewable water source	90-100 Bm^3/year	Domestic use	5%
Total withdrawal volume	45- 50 Bm^3/year	Industrial use	8%
High water stress > 40%	50/100=50%	Agricultural use	87%

Supply Source in Year 2000

Watershed	Project	(m^3/d) Urban	(m^3/s)	(m^3/d) Rural	(m^3/s)	(m^3/d) Total	(m^3/s)
Euphrates	290	799,445	9.25	210,485	2.44	1,009,930	11.69
Tigris	350	3,947,252	45.69	341,700	3.95	4,288,952	49.64
Others	878	2,350,835	27.21	474,015	5.49	2,824,850	32.70
Total	1,518	7,097,532	82.15	1,026,200	11.88	8,123,732	94.02

Euphrates and Tigris (Quantity unit: Bm^3)

Euphrates River Basin			Tigris River Basin		
2,700km Long 444,000km² Area			1,900km Long 444,000km² Area		
Kerbala, Al Hillah, Najaf supplied			Mosul, Baghdad supplied		
High and acute political tension			Be much less vulnerable		
Country	Water Potential	Consumption Target	Country	Water Potential	Consumption Target
Turkey	31.6 (89%)	18.4	Turkey	25.2 (52%)	6.9
Syria	4.0 (11%)	11.3	Syria	0.0 (0%)	2.6
Iraq	0.0 (0%)	23.0	Iraq	23.4 (48%)	45.0
Total	35.6(100%)	52.7	Total	48.6(100%)	54.5

Quality: Raw Water

Salinity: Tigris (TDS: 280-1,500 mg/l), Euphrates(6---3,000 mg/l)

Contamination/organic pollution is affecting both rivers.

1.3.2 Water Source for Baghdad Water Supply

(1) Water Source

The main water source for Baghdad water supply is the Tigris River. The average flow of Tigris at Sarai Baghdad site indicates a gradual decrease as shown below and this fact gives a warning for acquisition of the future stable water source.

Year	1997	1998	1999	2000
Flow:m3/s	800	890	584	405

(2) Water Quality

Turbidity of Tigris water decreased greatly after construction of Al-Adhim dam on Uthaim tributary in a few years ago. However, control of the dam discharge especially in the rainy season should be as low as possible in order not to cause high turbidity of the Tigris river water.

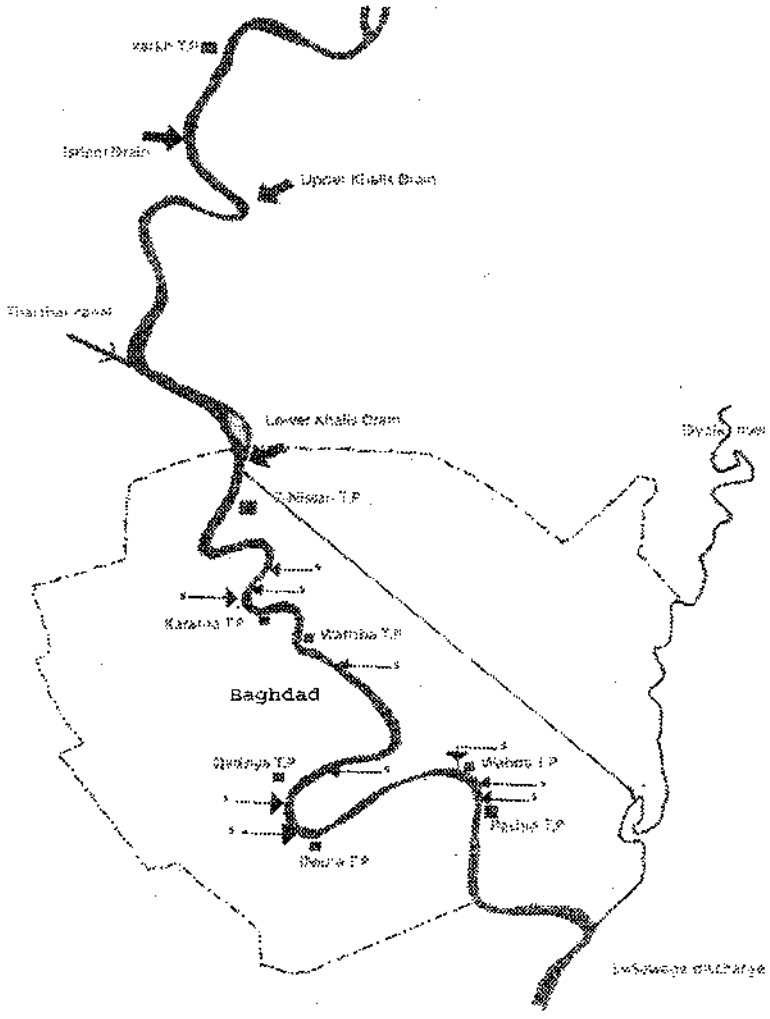
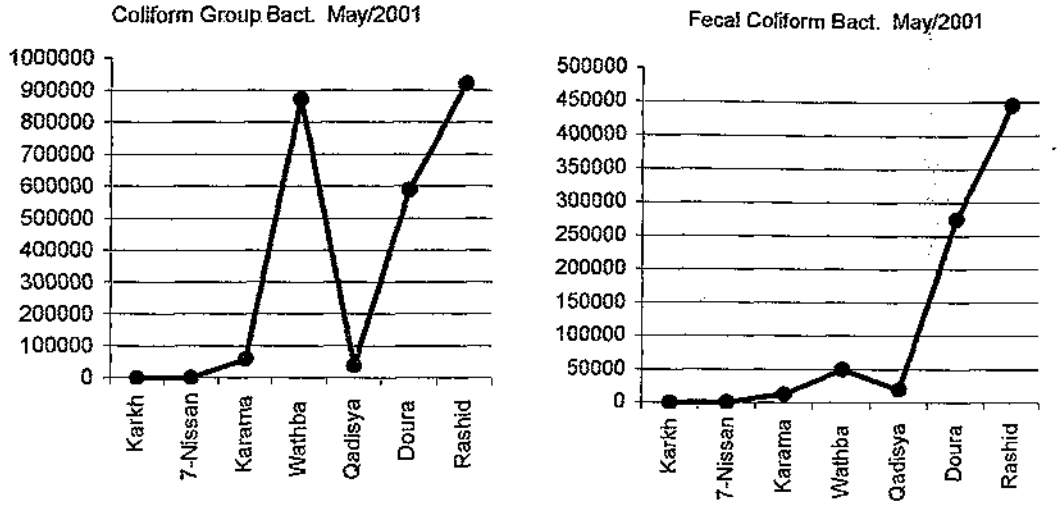


Fig.(3-1) Effluent discharges into Tigris river upstream and within Baghdad

Concentration of coliform in the raw water along the river stream is shown in the following figures, and inflow of sewage or tributary to the main Tigris is also shown in Fig-xx. From these data, it is considered better to intake raw water for the Baghdad water supply from upper stream as much as possible.

Fig-xx Coliform Concentration Along the Tigris



1.4 Water Supply Facilities

Production Capacity: 2,429,855 m³/day

Pipe Network Length: 7,746 km

Percentage of Old Pipes: 14% more than 35 years old

1.4 .1 Production Facilities

1) Treatment Plants

Water production facilities of Baghdad Water supply system consist of compact or conventional treatment plants. As shown in Fig-xx, out of 31 plants, large scale conventional treatment plants are 8 units of which total capacity is 2.6 Mm³/d and the compact plants are 23 units of which total capacity is only 0.17 Mm³/d. Due to deterioration or lack of spare parts, the actual capacity is about 84% of the designed capacity. The actual capacity of the compact units is 72% of the rated one.

Treatment Plants located in the east of Tigris river are four in numbers and their present capacity is 678,000m³／日 and the typical plant in the east is Saba Nissan. In the west side, four conventional plants including the biggest Karkh plant and all of the compact units are exist and their present capacity is 1,655,840m³／日.

East side of Tigris where bigger population exists has less production capacity of water than the west. This unbalance is thought to be by delay of implementation of Rasafa treatment plant.

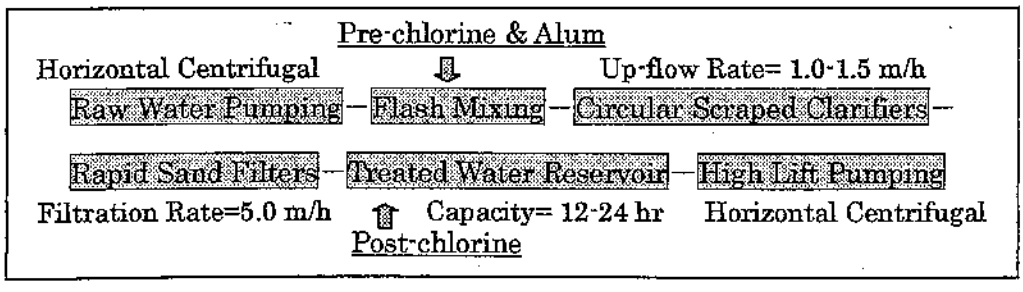
Table-xx Summary of Treatment Plants in Baghdad Water Supply

No.	Source	Type	Capacity (m3/d) Designed	Capacity (m3/d) Actual	Side of Tigris	Remarks
1	Nissan	WTP	540,000	500,000	East	Constructed in 1978. 20% extended in 1984
2	Al-Karkh	WTP	1,365,000	1,150,000	West	Constructed in 1985 Stage-1 & 1988 Stage-2
3	Al-Qadisiyah	WTP	135,000	100,000	West	Constructed in 1966 and 1978
4	Al-Rasheed	WTP	68,000	50,000	East	To be abundoned after Rasafa construction
5	Al-Wathba	WTP	78,000	70,000	East	Constructed in 1978
6	Al-karama	WTP	227,000	180,000	West	Constructed in 1956, 1961 and 1980
7	Al-Doura	WTP	115,000	100,000	West	Constructed in 1980
8	Al-Wahda	WTP	68,000	58,000	East	Constructed in 1953 and 1959
	Sub-total		2,596,000	2,208,000		Ratio of actual capacity 85.1%
9	Al-AUBOUR	C.U	19,200	16,000	All in East	To be aboandoned along with construction of new water treatment plants and in order with poor performance.
10	Al-Nasser	C.U	19,200	16,000		
11	Abu Nuaas	C.U	19,200	16,000		
12	Al-Buresha	C.U	1,200	1,000		
13	Al-Rashad	C.U	2,400	2,000		
14	Akad	C.U	4,800	4,000		
15	Tarik	C.U	4,800	4,000		
16	Al-Amin	C.U	28,800	24,000		
17	Al-Kamalya	C.U	14,400	12,000		
18	Al-Buaatha1	C.U	1,200	1,000		
19	Al-Buaatha2	C.U	2,400	2,000		
20	Um-Al-Assafer	C.U	3,600	3,000		
21	Al-Urfali	C.U	9,600	8,000		
22	Al-Thawra	C.U	2,400	2,000		
23	Al-Salam	C.U	1,200	1,000		
24	Al-Ekhaa	C.U	1,200	1,000		
25	Baghdad	C.U	24,000	2,000		
26	Taji1	C.U	4,800	4,000		
27	Taji2	C.U	1,536	1,280		
28	Taji3	C.U	2,400	2,000		
29	Al-Makaseb1	C.U	1,536	1,280		
30	Al-Makaseb2	C.U	1,536	1,280		
31	Al-Makaseb3	C.U	1,200	1,000		
	Sub-total		165,936	125,840		Ratio of actual capacity 72.5%
	Total Capacity		2,761,936	2,333,840		Ratio of actual capacity 84.3%

Note: WTP means Conventional Water Treatment Plants and C.U. means Compact Treatment Units.

2) Plant Design

All of the conventional treatment plants have similar plant design as shown in the Fig below. Pre-settling of sand particles in the raw water is adopted only at Al-Karkh Treatment plant.



3) Treated Water Quality

Treatment unit operators have difficulty in respecting the guideline of treated water turbidity below 5 NTU. Chlorine residual is frequently above 2 mg/l.

Table-xx Analysis of Water Quality

Analysis	Raw Water			Treated Water			Drinking water standard
	Min	Max	Aver	Min	Max	Aver	
Color (tcu)	<5	<5	<5	<5	<5	<5	5 (tcu)
Temperature C	7	32	20	8	34	20	
Turbidity N.T.U	11	140	25	0.2	26.5	3.9	5
PH	7.4	8.3	8	7.1	8	7.7	6.5-8.5
Alkalinity's $CaCo_3$ mg/l	118	171	146	114	162	141	125-200
Total Hardness as $CaCo_3$ mg/l	211	592	367	210	588	372	500
Calcium as Ca mg/l	53	159	94	52	155	97	75
Magnesium as Mg mg/l	18	57	34	18	57	34	50
Chloride as Cl mg/l	39	179	94	39	173	93	250
Conductivity micro µs/cm	540	1980	950	520	1710	935	2000
Aluminum as Al mg/l	Nil	0.16	0.01	Nil	0.20	0.08	0.2
Total dissolved Solids mg/l	350	1194	693	350	1062	680	1000
Suspended solids mg/l	15	172	51				
Iron as Fe mg/le	0.1	4.6	0.77	0.01	0.88	0.134	0.3
Sulfate as SO_4 mg/l	90	445	266	90	440	263	250
Fluoride as F mg/l	0.07	0.30	0.15	0.04	0.5	0.14	1
Ammonia as NH_3 mg/l	<0.01	0.36	0.08	<0.01	0.08	0.01	0.5
Nitrite as No_2 mg/l	0.001	0.03	0.006	<0.001	0.002	0.001	0.1
Silica as Sio_2 mg/l	2.0	70	5.9	2	70	5.3	
Nitrate as No_3 mg/l	<1	<1	<1	<1	<1	<1	40
Po_4 Mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Manganese as Mn mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Cadmium as Cd mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.01
Lead as Pb mg/l	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	0.05
Copper as Cu mg/l	0.15	0.28					1
Zinc as Zn mg/l	0.07	0.14					5
Chromium as Cr mg/l	<0.005	0.028	0.013	<0.005	0.026	0.011	0.05
Mercury as Hg mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002

4) Iraqi Water Quality Standard

Parameter	Guideline	Parameter	Guideline
Turbidity NTU	10	Calcium	200 mg/l
Color	5 units	Magnesinm	150 mg/l
T	Accept	Chloride	600 mg/l
PH	6.5 – 8.5	Sulfate	400 mg/l
TDS	1,500 mg/l	Sodium	200 mg/l
Electrical Conductivity	2,000 μ S/cm	Fluoride	1 mg/l
Total Alkalinity (as CaCO3)	125-200 mg/l	Iron	0.3 mg/l
Total Hardness (as CaCO3)	500 mg/l		

1.4.2 Transmission System

Basic idea of water distribution of Baghdad water supply system is the zoning system. The previous master plan for Baghdad water supply proposed a restructuring of the network system which entailed splitting the network into pressure zones, each supplied by distribution pumps from a terminal reservoir. The distribution zones consist of 25 areas including two zones in the suburban areas. But most of zoning works postponed, and poor sectorization of the existing system complicates its operation and a significant impact on service pressures.

1.4.3 Distribution System

1) Distribution Mains

Pipe Network Length: 7,746 km

Percentage of Old Pipes: 14% more than 35 years old

Table-1.xx Pipe Materials and Length in MB (Mayoralty of Baghdad): in km and mm

Materials	AC	DI	CI	PVC	STE	Total	%
1600-1000		250					3.2
900- 500		375			165	540	6.9
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	46.8
Length	3,700	2,400	800	556	290	7,746	100%
Diameter	126.5	351.5	124.5	127.5	575.5	Mean	
Very Old			10.7		3.7		14.4%
Old	49.6						49.6%
Medium		28.5		7.5			36.0%
Total	49.6	28.5	10.7	7.5	3.7		100%

Very old; more than 35 years, Old; 34 - 20 years, Medium; 19-10 years.

2) Storage Capacity

Treated Water Reservoirs: 300,000 m^3 out of 500,000 m^3 because of physical losses

Service Reservoirs: 19,750 m^3 out of 307,384 m^3 because of decommission

Private Storage: 60,000 m^3 from roof tanks and ground reservoir

1.5 Previous Studies

There are two recent studies on improvement of Baghdad water supply system. These are as shown below. The first one, UNICEF report placing the target year in 2010 describes planning of water supply, sewerage and sanitation sectors throughout Iraq country including Baghdad city. The latter plans the future water supply system of Baghdad city placing the target year in 2027. Outlines of these reports are described hereunder.

No	Name of Report	Prepared in	Prepared by
1	Assessment Project of The Water and Sanitation Sector in IRAQ (Final Report)	January 2003	UNICEF Prepared by SAFEGE
2	Integration Study of Drinking Water Requirements for The City of Baghdad up to year 2027	January 2003	The General Company for Water Projects Implementation

1.5.1 UNICEF Paper

1) Planning Frame

Goal: Coverage by water facilities should tend towards 100%.

The provision of potable water by public utilities should meet household needs in

accordance with an agreed standard per capita level.

Goal of Per Capita Water (2010):

Domestic	Industrial / Commercial	Government	UFW	Total	Production
330	40	55	75	500	555
66%	8%	11%	15%	100%	111%

Population Forecast: Growth rate; 2.99%/year

Urban population; 6,381,943, Rural 21,071, Total; 6,403,014

Required Production Capacity

Year	Urban	Rural	Total	Extension
2000	2,640,769 m^3/d	3,898 m^3/d	2,644,667m^3/d	
2010	3,545,524 m^3/d	5,233 m^3/d	3,550,757m^3/d	1,146,024m^3/d

2) UFW Reduction

Principle: Optimization (Cost effectiveness) — Monitoring (Before & After) — Sustainability (Durable)

A phased implementation policy is proposed.

The first phase would involve the setting-up of pilot areas.

UFW Goal: 50% (2000) – 15% (2010)

Implementation

First Stage	Second Stage
Setting up UFW Unit	Rehabilitation/Replacement of pipes subject to leaks
Replacement of the oldest pipes	Rehabilitation of service mains and connections
Installation of bulk meters	Rehabilitation of defective valves
Repair/Replace of source meters	Installation of meters at the consumer level
Survey of large consumers	Implementation of routine leak detection

Necessary UFW Organizations;

Unit	Role of Unit
Hydraulic Unit	Hydraulic analysis, Waste district metering
GIS Unit (Geological Information System)	Description of pipe network and consumer meters
MIS Unit (Management Information System)	Collect operational & billing data and treat. Prepare reports.
Leak Detection Unit	Tests and routine leak detection surveys
Consumer Survey Unit	Setting up of a customer management system. Reduction of non-physical losses.
Pipe Repair Unit	Repair of defective pipes

1.5.2 Integration Study

1) Population and Water Demand

Population and Water Demand (10^3m^3/day)

Year	Population	Average	Maximum
1997	4,567,598	2,267	3,174
2005	5,403,570	2,683	3,754
2010	6,188,640	3,072	4,301
2015	6,908,302	3,429	4,801
2020	7,810,460	3,878	5,429

Standard Per Capita Water Use

Category	lcd
Domestic	330
Industrial/ Commercial	40
Government	55
UFW	75

2025	8,850,410	4,394	6,151
2027	9,248,297	4,592	6,428

Total Water Use	500

2) Growth of Treatment Capacity

Area	Treatment plants	Capacity /demand Mld					
		2002	2005	2010	2015	2020	2027
Rasafa	7-Nissan	505	955	955	955	955	955
	Wahba	60	172				
	Tamouz	00	68				
	Wahda	52	74				
	Rashid	52	52				
	C.U	100	212				
	Rasafa			2275	2275	2275	2275
	New Rasafa						450
	Production capacity	769	1533	3230	3230	3230	3680
	demand	1877	1974	2193	2447	2795	3309
	Net	-1108	-441	1037	783	435	371
Karkh	Karkh	1280	1280	1280	1280	1280	1280
	Karama	200	425	425	425	425	425
	Qadsiya	115	206	206	206		
	Doura	105	105	105	105		
	New Karkh					910	910
	Production capacity	1700	2016	2016	2016	2615	2615
	demand	1383	1572	1863	2078	2352	2785
	Net	156	444	153	-62	263	-170
Baghdad	Production capacity	2469	3549	5246	5246	5845	6295
	Demand	3260	3546	4056	4525	5147	6094
	Net	-791	3	1190	721	698	201

Implementation Program

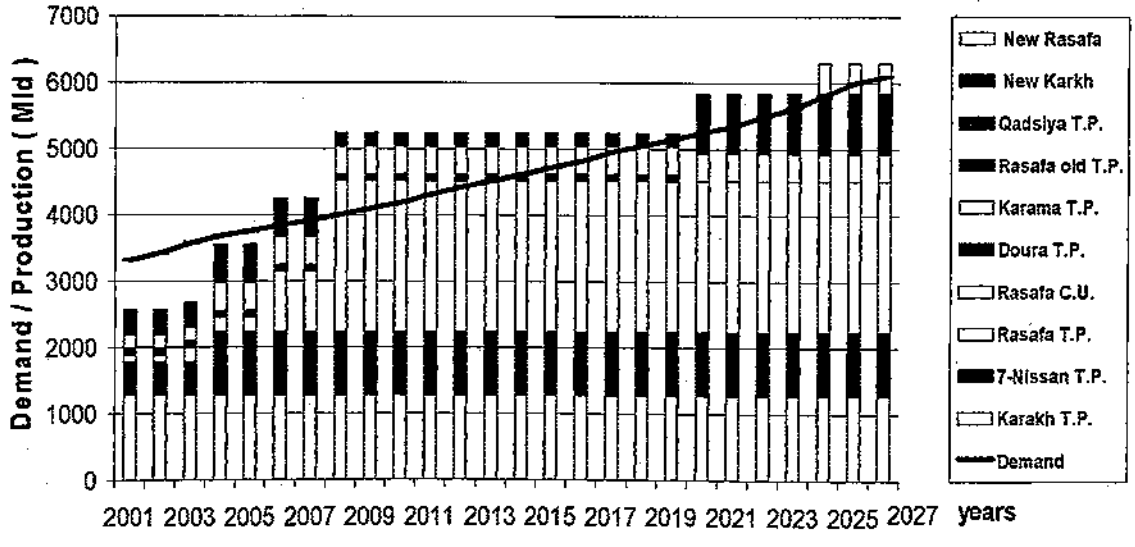


Figure (6-1) Growth of Treatment Plants Capacity and Demand

Appendix-2

Basic study Report by the Trainee

Integrated Study on improvement of The Baghdad Water Supply System in Republic Of Iraq

(Basic study Report)

March 2005

Policy & Development Planning

BWA- GCWPI engineers

Baghdad

A group of Engineers from Baghdad Water Administration (BWA) and General Company for Water Project Implementation(GCWPI)from Baghdad Mayoralty, participated a training course named (Policy and Development Planning for Water Supply System), the training course was of three stages, organized by JICA (Japan International Cooperation Agency) as below:

Course	Time
First Stage	28Nov.-12Dec./2004
Second Stage	14Feb-19Feb/2005
Third Stage	19Mar.-27Mar./2005

Herein our FINAL REPORT

Ahlam A. M.Ali
Chief Eng

Dijlah H.Yassin
Chief Eng

Zahraa .K. Mahdi
Chief Eng

Intisar Kalil
Chief Eng

Alaa L.Tawfik
Chief Eng

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Chief Eng Ass.

By the assistance of

K. IWASAKI JICA Expert on Water Supply

1. The Objective:-

The main objective of this Consulting Engineering study is to establish a long-term plan for estimating the water requirement for the increasing population of the city of Baghdad to meet the demand .

Consulting engineering studies on the same subject had been established during the period 1984-1994 concentration on Rasafa side of Baghdad, which suggested integrated plans for water work implementation to year 2000.

Unfortunately such plans were not implemented at the time schedule put for them because the prevailing situation of the economical sanction imposed on the country.

Such delay in implementation of the works according to the schedule, specially the head works of Rasafa treatment plant and the transmission lines and distribution reservoir , have created a big gap between water production capacities and water demand specially during the hot summer season, which put the city in a critical situation as to severe shortage in water supply.

Recently the Iraqi Government have put great emphasis to increase the water production capacities such as installing compact units and starting the steps toward building the proposed Rasafa treatment plant together with the transmission lines and distribution reservoirs.

The strategy of the Iraqi government is to base the socio-economical development on long –term as well as short term plans for all development sectors including various services such as water supply schemes, therefore this integration study for water requirements for the city of Baghdad as a long –term plan is to be established.

2. Methodology:-

To establish this consulting engineering work, the following activities well are considered:

1. Review of available reports and studies of concern.
2. Collection of data and information from different offices and establishments such as the central statistical organization, historic data and research studies of concern.
3. Make available maps of pipe network (existing & proposed) and city zoning and development.
4. Make site visits to existing water works in Baghdad .and evaluation of these site visits.
5. Collect data as to quantity and quality of water resources and evaluate these data.
6. Establish necessary factors for water requirements, from field studies, references and available data.

3. BWA duties and Functions

BWA found in 15th Dec. 1924.BWA duty is to prepare the plane regarding of treatment plants and in order to supply Baghdad city with potable water of world specifications according to WHO. Also BWA implements treated and raw water networks and runs and operates treatment plants with quality control of the produce.

The organizational framework of BWA consists of the following divisions:

1- Planning and follow up department.
2- Implementation projects Dep.
3- Operation Dep.
4- Vehicles Dep.
5- Quality control Dep.
6- Design and study Dep.
7- Computer Dep.
8- Administration and Financial Dep.

BWA is in charge of the main water intakes , treatment plants , transmission lines , storage reservoirs and water distribution network pipe with diameter of 250 mm. and large in the city of Baghdad within Amanat Baghdad boundaries . It is responsible of planning, design implementation and operation maintenance of all water supply works besides, the administration and policies, standard tariff setting and finance, and relationships with public consumers.

Since 1995 the water distribution network pipes with diameter smaller than 250mm. were transferred to the nine municipality directorates of Amanat Baghdad.

The water supply sector operation is governed by the following laws and regulations and other governmental institutions indirectly involved in the sector:

- Drinking water specification standard 417/1974 the Central Organization for Standardizations and Specification Standards.
- The constitution of Baghdad water supply Administration.
- Regulation 25/1967 Water Resources pollution control
- Law No.2 of 1997 establishing the National and Provincial Environmental Counsels in charge of protection and improving the environment.
- The Water resource department of the Ministry of Irrigation in charge of the quality and quantity of the water resources.
- The Ministry of industry –monitoring effluent discharges to water sources.
- Ministry of Municipalities and Public Work –in charge of water supply sector in Iraqi (excluding Amanat Baghdad).

4. Background and Current situation of potable water

The main water source for Baghdad is the Tigris River. Water is supplied by direct pumping from different points. Whilst there is water available in the Tigris the city is suffering sever water shortage, Primarily due to lack of adequate water treatment capacity .

In the mid 1980's and into the early 1990's, the BWSA initiated a major portion of their Master Plan with the construction of the "Sobea" pipelines, expansion of the Shark Dijiah Water Treatment Plant, construction of the Karkh Water Treatment Plant which added 1365 MLD to to the previous available capacity, Reservoirs and Trunk Lines, and upgrading compact' units (CUs), i.e., water treatment package plants. These CUs provide potable water to outlying areas beyond the reach of the water distribution system. In addition, BWA extended transmission lines to provide treated water from major treatment plants to selected outlying communities.

Now there are Eight water treatment plants serve Baghdad with a current production capacity of 2,016,000 m3/day compared with total design capacity of 2,774,000 m3/day .

The treatment plants are old, and are unable to meet the increased addition there are some 52 compact water treatment units supplied either directly from river Tigris or from raw water pumping systems that are used primarily for irrigation demand for water, The average demand is 3,400,000m3/day, the shortage of treated water capacity now is**1400 MLD(one million four hundreds Thousand cubic meter/day).**

The shortages of water have led to numerous uncontrolled and illicit connections into the networks in order to secure supplies . As a result, the pressure in the water networks is low and water cannot reach the elevated water tanks in residential houses .This has also exposed the networks to contamination from damaged sewers, polluted ground , and stagnant sewage . Approximately 40% of the water distribution network in the city urgently need to be rehabilitated to reduce distribution losses (estimated at 50 – 60 %). In addition , improvements are needed to ensure the network remains pressurized and thus improve the quality of the water delivered to consumers . This is a substantial undertaking, as Baghdad's primary and secondary distribution network consists of 12.500 km of pipe with diameters ranging from 90 mm to 2.300 mm . The network consists of ductile iron, steel, asbestos cement, polyvinylchloride (PVC) and cast iron pipe . Some of the cast iron pipes are over 40 years old and have suffered from deterioration due to the aggressive ground conditions and lack of maintenance . All in all, currently about 25% of Baghdad's population, approximately 1.5 million inhabitants, are still unconnected to the water network.

5. Master plans

The first water master plan was established in 1970 by Swiss consul in 1981 .the comprehensive integrated study for Baghdad water supply was completed by Bennie and partners based development master plan for the city of Baghdad for year2000 .this plan is :

1. Central treatment plants instead of the old project and should be operated in stages due to the real need , these projects are :- **AL-Karkh water project, AL-Rasafa new water project**

2. Erecting ground storages
3. Implementing the networks of secondary and distribution pipes
4. Implementing the main carrying pipes networks.
5. Erecting five raw water stations on Tigris river, part of this plan has been

implemented

6. Current and Future Baghdad Water Supply Authority Customers

The BWA 'service 'area includes the Mayoralty of Baghdad and communities outside of the mayoralty; for which it currently provides treated water to approximately 6.4 million[1] customers. The BWSA customer base is expected to grow to approximately 7.6 million in 2010 and to 11.9 million by the year 2025.

BWA Service Area and Census Tracts (see Attachment) shows the boundary limits of the Baghdad Mayoralty along with the approximate service limits for the BWSA. Historically BWSA serviced customers well inside the Mayoralty limits, but as population pressures increased, people moved outward toward the Mayoralty limits, as well as to the geographical limits of the water distribution system. Today the BWSA service area reaches to the Mayoralty limits and in some cases beyond into the Governorate. Neighborhoods served by BWSA beyond the Mayoralty limits are divided into two regions: AI-Rasafa on the east side of the Tigris River and AI-Karkh on the west side of the river. These neighborhoods are shown on Figure 1 and include the following:

AI-Rasafa District	AI-Karkh District
AI-Naser Wal-Salam Section	AI-Taji Section
	Al.Rashid1 Section

7. Census Data

The Government of Iraq, Central Administration of Census (CAC), has historically conducted a nationwide census every ten years. In 2003, with the establishment of the Interim Iraqi Government, an attempt-to update the census was initiated. However due to the continuing instability the census has been delayed.

The historical population trends of the Baghdad Governorate are shown in Table 1, along with the 17 other Governorates. In 1977 and 1987, the population for the Mayoralty of Baghdad was included in the Baghdad Governorate figures. In 1997, the population for the Mayoralty of Baghdad was reported separately as 4,399,516 with 1,009,143 living outside the Mayoralty but inside the Governorate.

Table 1

Historical Population Data

Governorate	1977	1987		1997	
	Population	Population	Annual Growth	Population	Annual Growth %
Anbar	466,059	820,690	6	1,020,695	2
Babil	592,016	1,109,574	6	1,186,015	1
Baghdad	3,189,700	3,841,268	2	1,009,143	-
Basrah	1,008,626	872,176	-	1,569,385	6
Diala	587,754	961,073	5	1,130,504	2
Dohuk	250,575	293,304	2	335,300	1
Erbil	541,456	770,439	4	1,557,000	7
Kerbala	269,822	469,282	6	594,616	2

[1] population estimates presented in this technical Memorandum are based on the 1997 Iraq census using an annual growth rate of 2.99 %.

Table 2, The Baghdad Mayoralty Population, shows a total Mayoralty population of 320,956 that is 1.8% less than the 4,399,516 reported in Table 1 from the Safeage Report. -this difference is understandable since the population data released by CAC required translation and the handling of some duplicate census tract entries.

Table 2 Baghdad Mayoralty Population

District	1997 Population	Source
Kadhimyari	492,108	Table A-1
Karkh	177,736	Table A-1
Rashid	755,181	Table A-1
Mansour	351,373	Table A-1
Sub Total	**1,776,398**	**Table A-3**