JAPAN INTERNATIONAL COOPERATION AGENCY

DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY
SYRIAN ARAB REPUBLIC

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

PHASE I

VOLUME I

FINAL REPORT
EXECUTIVE SUMMARY

FEBRUARY 1997

NIPPON KOEI CO.,LTD.

JAPAN INTERNATIONAL COOPERATION AGENCY

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SYRIAN ARAB REPUBLIC

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ESTIMATE OF PROJECT COST

Estimate of Base Cost : as of September 1996 Price Level

Currency Exchange Rate : US$1 = SL 42 = Yen 108

PREFACE

In response to a request from the Government of the Syrian Arab Republic, the Government of Japan decided to conduct a study on the Development of Water Supply System for the Damascus City (Phase I) and entrust the study to the Japan International Cooperation Agency (JICA).

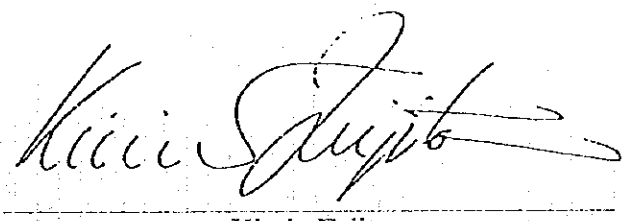
JICA sent to Syria a study team headed by Mr. Masato Fujinami Nippon Koei Co., Ltd., three times between January 1995 and December 1996.

The team held discussions with the officials concerned of the Government of Syrian Arab Republic, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of Syrian Arab Republic for their close cooperation extended to the team.

February, 1997



Kimio Fujita
President
Japan International Cooperation Agency

February, 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Dear Sir,

We have the pleasure of submitting to you the Final Report of "The Study on the Development of Water Supply System for the Damascus City (Phase I)", in accordance with the Scope of Work agreed upon between the Damascus City Water Supply and Sewerage Authority and Japan International Cooperation Agency. The study was carried out for a total period of 14 months from January 1996 to February 1997, aiming to formulate water supply master plan for the Damascus city.

The report consists of five volumes. The Executive Summary (Volume I) contains the summary of the study result. The Main Report (Volume II)presents the formulation of overall and strategic master plan for the water supply system in Damascus city. The Supporting Report (Volume III & IV) describes the analysis and discussion in the sector of socio-economy, urban development plan and land use, water resources, water quality and environment, water supply system and facilities, unaccounted for water, water demand forecast, organization and institution, finance, and economic evaluation to support the main report. Data Book (Volume V) contains basic data of the study.

The study team sincerely hopes that the study result would contribute to the future water supply plan in Damascus city.

We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency and Office in Syria, the Embassy of Japan in the Syrian Arab Republic, as well as officials concerned of the Government of Syrian Arab Republic.

Sincerely yours,

藤浪正人

Masato Fujinami
Team Leader
The Study on the Development of Water
Supply System for the Damascus City (Phase I)

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320 330 340 350 360 370 380 390 400

3750 3740 3730 3720 3710 3700 3690 3680

Barada Spring

Figeh Spring

Deir al Ashayer

Kassioun

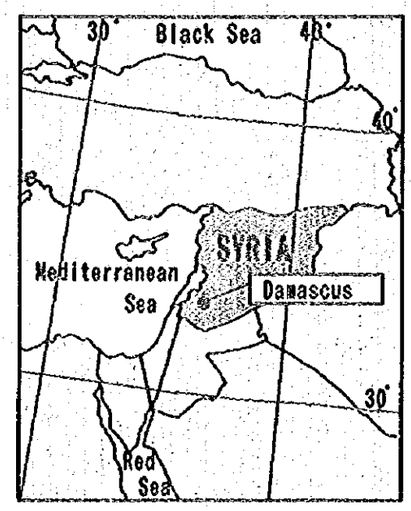
Damascus

Rimeh

Tabibiyeh

Beit Jenn

Location Map of the Study Area



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Scale (km)

5 0 5 10 15

Grid: Universal Transverse Mercator

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Location Map of the Study Area

NIPPON KOEI CO., LTD.

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY PHASE I

Study Period: January 1996 - February 1997

Counterpart Agency: Damascus City Water Supply and Sewerage Authority

OUTLINE OF THE STUDY

1. BACKGROUND

Damascus City is the national capital of the Syrian Arab Republic and is the economic and culture center of the country. The Damascus City Water Supply and Sewerage Authority (DAWSSA) provides water for Damascus City. In 1995, DAWSSA supplied a total of approximately 218 MCM. There was an estimated approximately 25 MCM demand which was not met in 1995. Water restrictions mainly occurred in Damascus during the dry season, in spite of the supplemental water pumped from wells within the City.

Only 36% of all water produced is billed and an estimated 64% is Unaccounted for Water (UFW). An aging infrastructure, and informal pipe connection contribute to these high levels of UFW. Therefore new measures for reducing leakage losses in the distribution network are required in addition to finding source of water.

2. OBJECTIVE

The Study's objectives are: (1) to formulate an overall and strategic master plan for appropriately phased improvement / development of the water supply system in Damascus City up to year 2015, (2) to conduct a feasibility study for priority project(s) to be selected from the master plan, and to study changes needed in management of DAWSSA to promote systematic development of water supply services in the city, and (3) to transfer technology on planning methods and skills to the counterpart personnel of DAWSSA.

3. STUDY AREA

The Study area for the Master Plan Study covers existing serviced administrative area and future extension area of Damascus City. Water resources located in Zabadani valley, Figeh Spring area and Hermon area are also included.

4. OUTLINE OF THE PROPOSED PLANS

4.1 Basic Concepts for the Formulations of Plans

The master plan covers a 20 year period up to the target year 2015. It is aimed at addressing deficiencies in the existing system, and improving water supply to meet the demands of a growing population. The plan is centered around the following concepts:

i) Reducing unaccounted for water (UFW) in the existing distribution system,
ii) Maximizing the use of all existing water resources,
iii) Looking for opportunities to increase available water by sharing existing resources with others before developing new resources, and
iv) Developing a water supply master plan that is consistent with the proposed Damascus City Urban Development Master Plan.

4.2 Outline of the Master Plan

The selected master plan projects are divided into two program streams, namely "rehabilitation and improvement" and "expansion", according to the chronological need identified by the water demand forecast for Damascus City. Projects in the "rehabilitation and improvement" program stream will be carried out in the early stages of the master plan starting in 1997 and be completed by the year 2007, with the exception of the water leakage survey program which will continue until the year 2015.

Projects in the "expansion" program which include the development of new water resources will follow sequenced construction starting in 1997 until the year 2005. The selected master plan projects are identified as follows:

Rehabilitation and Improvement Program

A-1 Distribution rehabilitation projects:
- A-1.1 Water main replacement: approximately 98 km by 2003
- A-1.2 Water meter replacement: approximately 106,486 by 2003
- A-1.3 Improvement in meter testing and repairing: one additional testing set by 1998

A-2 Leakage reduction program:
- A-2.1 District meter area (DMA) system: approximately 70 blocks by 2005
- A-2.2 Pressure control: approximately 40% of DMA blocks by 2007

A- 2.3 Improvements to master metering: Installation 59 meters by 2000

A- 2.4 Leakage survey: development of 5 teams by 2006

A-3 Water quality and pumping equipment improvement projects:

A- 3.1 Improvements to water quality testing laboratory: development of analysis capacity

A- 3.2 Improvements of pumping equipment for existing wells in Damascus City:

Ibn Assaker: upgrade booster pump for an additional estimated 120 l/s (2.5 MCM/y)

Kadam Railway: upgrade well pumps for an additional 115 l/s (2.3 MCM/y)

Fringe Wells: upgrade well pumps at 8 sites for an additional estimated 1.76 MCM/y

Expansion Program

B-1 Water supply projects for informal areas.

No.	Water supply system	Area (ha)	Population	Water demand (m^3/d)
B-1.1	Kassioun Mountain Foot	30.9	33,977	6,562
B-1.2	Tishreen	36.2	15,488	2,980
B-1.3	Jobar Surrounding- Al Aksab Mosque	63.7	25,704	4,964
B-1.4	East-West Tabbaleh	135.2	12,669	2,447
B-1.5	Mokhayam Al Yarmouk	118.0	86,068	16,621
B-1.6	Naher Eshah- Dahhadil & Asalie Kadam	170.4	37,005	7,146
B-1.7	Al Qazzaz & Shaghour Basateen	64.2	10,692	2,065
B-1.8	Mezze-Razy & Kafar Souseh- Lawan	170.3	46,786	6,332
B-1.9	Somareych	37.6	4,590	918
B-1.10	Dummar-Wadi Al Mashare	41.9	14,841	2,866
B-1.11	Kudsaya	50.0	20,800	4,017
	Total	868.4	308,680	61,716

B-2 Water resources development projects

No.	Project	Area	Pumping rate (l/s)	(MCM/y)
B-2.1	New Well Center for Informal Areas	Jaramana	290	6.12
B-2.2	New Well Center for Formal Areas	(1) Kafar Souseh	80	1.69
		(2) Tishreen and Kywan	250	5.30
B-2.3	Water Resources Development Schemes in Hermon Area	Deir al Ashayer	200	3.16
B-2.4	Water Resources Development Schemes in Damascus	(1) Shokry al Qouwatly	170	3.60
	(New Stations)	(2) Kanawat Garden	80	1.69

4.3 Outline of the Priority Projects

Certain projects have been identified as "Priority" projects because they are urgently required for public health or operational reasons such as reducing water losses. The scale of the selected priority project makes it relatively easy to fast track the process and complete the feasibility study and design within the given time constraints.

Selection of priority projects includes the District Meter Area (DMA) system to enhance leakage detection efforts, and the extension of the distribution network into the Mezze-Razy /Kafar Souseh-Lawan in informal area. The outline of the projects are shown as follows:

Water leakage reduction program based on the District Meter Area (DMA) system

Location : Existing distribution network in Damascus City area
Total number of DMA : Development of approximately 70 blocks with flow meters by 2005
Average size of DMA : 2,000 - 6,000 properties
Average number of flow meters per DMA : 2 - 4
Type of meter : mechanical meters, electromechanical meters, electromagnetic meters, ultrasonic meters

Water supply project for the Mezze - Razy & Kafar Souseh - Lawan informal area

Location : in Kafar Souseh district
Implementation Schedule : completed at the end of 2000
Area to be improved: 170.3 ha
Estimated Population : 46,786
Water Demand : 6,322 m3/d estimated
Project cost for distribution : US$ 7.1 million approximately
Work Items : 7,260 m main pipe length, service pipe and 7,800 meters

5. PROJECT COST

The total project costs of each proposed scheme are summarized as follows:

(Unit: US$ 1000)

Items	L.C.	F.C.	Total
1. Rehabilitation and Improvement Program			
1.1 Distribution Rehabilitation Project	4,037	20,384	24,421
1.2 Leakage Reduction Program	299	3,417	3,716
1.3 Water Quality and Pumping Equipment Improvement Projects	444	3,835	4,279
2. Expansion Program			
2.1 Water Supply Projects for Informal Areas	4,762	17,048	21,810
2.2 Water Resources Development Projects	2,625	10,111	12,736
3. Tax and Duty	6,730	0	6,730
4. Administration Cost	1,217	0	1,217
5. Engineering Cost	1,217	5,530	6,747
Sub-Total (Items 1 To 5)	21,331	60,325	81,656
6. Physical Contingency	1,457	6032	7489
Sub-Total (Items 1 To 6)	22,788	66,357	89,145
7. Price Contingency	804	2,904	3,708
Total	23,592	69,261	92,853

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

2. Physical contingency is 10% of sum of items 1, 2, 4 and 5.

3. Price contingency is 5% of local currency portion and 3% of foreign currency portion of items 1, 2, 4, 5 and 6.

6. EVALUATION

The proposed projects in this report are technically feasible, and are economically and financially viable.

(1) Economic Evaluation

The estimated economic benefit for the master plan project is $26 million in the year 2010. The estimated economic cost of the master plan project is approximately $83 million. Incremental operation and maintenance costs after implementing the master plan project at the end of 2007 will be $1.7 million.

Economic evaluation is based on the economic internal rate of return EIRR for the estimated project benefit and cost stream assuming an economic life of 25 years after the completion of the last project in mid 2007. The resulting EIRR of 34% indicates the project is economically justifiable.

(2) Financial Evaluation

The incremental revenue generated by the project will be (in US$) 1.43 million in 1997, 6.5 million by 2000, and will reach a maximum of 12.2 million in 2010. The total investment cost for the project is $95 million. Incremental operation and maintenance costs including equipment replacement is $1.73 million per year. The resulting a 9.8% internal rate of return indicates the project is financially viable. The results are very sensitive to variations in the cost and benefit parameters. Therefore an increase in tariff is required to ensure the project will be viable should unfavorable conditions prevail. The average tariff required to make the project financially viable under assumed worse case conditions of a 10% increase in cost and a 10% reduction in benefits is US$ 0.15 per m^3.

(3) Environmental Examination of the Proposed Projects

Initial Environmental Examination (IEE) was conducted to assess the positive and negative environmental impacts of the proposed projects. The quality of the supplied water and exploitation of groundwater resources are the most important environmental factors. The results of the IEE indicated that most of the proposed projects will benefit the area through the supply of safe drinking water.

7. RECOMMENDATIONS

(1) It is recommended that the following priority projects proceed immediately to the feasibility study stage:

- water leakage reduction program based on the District Meter Area (DMA) system
- water supply project for the Mezze-Razy and Kafar Souseh-Lawan informal areas

(2) A target figure of 25% total UFW has been set for the year 2015 which given the right conditions is achievable. Measures which have been recommended are as follows :

a) Transfer all informal housing areas from informal status to formal status,

b) Embark on a program to replace all defective meters,

c) Reduce system losses by a combination of different programs which are as follows:

- Carry out mains renewal program to replace old distribution mains
- Carry out a program to monitor leakage levels by district metering area (DMA)
- Introduce pressure control where high pressures exist to reduce leakage quantity
- Intensify leakage control from passive to active control

(3) The water demand identified after the year 2005 will be larger than the water resources capacity currently allocated to DAWSSA. The estimated water deficit by the year 2015 will reach approximately 47 MCM. Reallocation of other resources, for example those used for irrigation, will be required in the future since existing water rights are insufficient to meet the forecast demand.

(4) Financial performance of DAWSSA to improve accounting, metering, billing and collection. It is recommended that number of meter readers be increased to a level that will allow reading at quarterly intervals. It is also recommended that billing and accounting be automated and integrated with the accounting function.

(5) Restructure DAWSSA in the medium term to (i) rationalize and reduce the number of operational and technical directorates by amalgamation, (ii) create a new Directorate of Information Technology (I.T.), and (iii) create new departments for Personnel and Training.

THE STUDY
ON
THE DEVELOPMENT OF WATER SUPPLY SYSTEM
FOR
THE DAMASCUS CITY
PHASE I
EXECUTIVE SUMMARY

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ABBREVIATIONS

Organizations

ACSAD	-	The Arab Center for the Studies of Arid Zone and Dry Lands
BRGM	-	Bureau de Reche rche Geologique et Miniere, France
CBS	-	Central Bureau of Statistics
CGE	-	Compaginie Generale des Eaux, France
DAWSSA	-	Damascus City Water Supply and Sewerage Authority
EDWSSR	-	Establishment of Drinking Water Supply and Sewerage in the Rural Province of Damascus
EPEF	-	Establishment Public Des Eau De Damas (Figeh)
HISAT	-	Higher Institute of Applied Sciences and Technology
JICA	-	Japan International Cooperation Agency
MOHU	-	Ministry of Housing and Utilities
MOI	-	Ministry of Irrigation
SAR	-	Syrian Arab Republic
SPC	-	The State Planning Commission
WHO	-	World Health Organization

Others

EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
GDP	-	Gross Domestic Product
IEE	-	Initial Environmental Evaluation
NPV	-	Net Present Value
O&M	-	Operation and Maintenance
PE	-	Polyethylene
PVC	-	Polyvinyl Chloride
SCADA	-	Supervisory Control and Data Acquisition (System)
UFW	-	Unaccounted for Water
VAT	-	Value Added Tax

ABBREVIATIONS OF MEASUREMENT

Length

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

Area

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

Volume

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

Weight

mg	=	milligram
g	=	gram
kg	=	kilogram

Time

s	=	second
min	=	minute
h	=	hour
d	=	day
y	=	year

Electrical Measurement

V	=	Volt
A	=	Ampere
Hz	=	Herz
W	=	Watt
kW	=	kilowatt
MW	=	Megawatt

Other Measures

%	=	percent
HP	=	horsepower
°C	=	Celcius degree

Derived Measures

l/s	=	liter per second
m^3/s	=	cubic meter per second
m^3/h	=	cubic meter per hour
m^3/d	=	cubic meter per day
lpcd	=	liter per capita per day
kWh	=	kilowatthour
MWh	=	megawatthour
kVA	=	kilovolt ampere
mg/l	=	milligram per liter
μg/l	=	microgram per liter
meq/l	=	milliequivalents per liter
μS/cm	=	microsiemens per centimeter

Currency

US$	=	US Dollar
SL	=	Syrian Pound

CURRENCY EQUIVALENT

(as of September 1996)

US$ 1 = SL 42

TRANSLITERATIONS OF ARABIC PLACE NAMES (1/2)

عباسيين	Abasiyin	بيت جن	Beit Jenn
أبو زاد	AbuZad	بيت تيما	Beit Tima
أشرفية	Achrafye	برزة	Berze
عين عوينات	Ain Awenad	بلودان	Bloudan
عين بدا	Ain Beda	بقين	Boukein
عين حبيب	Ain Habib	دحاديل	Dahadil
عين حداد	Ain Hadad	دار المعلمات	Dar al Moalimat
عين حاروش	Ain Haroush	داريا	Daraya
عين حور	Ain Hour	دير مقرن	Deir Moukaren
عين عيسى	Ain Issa	دير العشاير	Deir al Ashayer Shahour
عين نورية	Ain Nourieh	حوض التشتيت	Dissipation Basin
عين رضوان	Ain Roudwan	دربل	Dourbol
عين صبا	Ain Saba	دمر	Dummar
عين صالح	Ain Saleh	عسالي	El Esaly
عين الباردة	Ain el Baradeh	الفوار	El Fawar
عين الخضرة	Ain el Khadra	الفيض	El Feid
عين الملحة	Ain el Malha	حفيرية	El Hafirieh
عين الصاحب	Ain el Saheb	الهامة	El Hame
عين التينة	Ain el Tineh	العرق	El Irk
أكراد	Akrad	الشواط	El Shuwhat
جامع القصاب	Al Aksab Mosque	عش الورور	Esh al Warwar
الضاحية	Al Dahia	فاسرّيا	Fasraya
الخضرة	Al Khadra	نبع الفيحة	Figeh Spring
المشارع	Al Mashare	فراسكن	Fraskin
القزاز	Al Qazzaz	الغوطة	Ghouta
السهل	Al Sahl	حفير الفوقة	Hafir el Foka
عرطوز	Artooz	حاليا	Halaya
قدم عسالي	Asalie Kadam	حسيبة	Hassibeh
الاعوج	Awaj	حسينية	Huseiniyeh
باب مصلى	Bab Mosallah	ابن النفيس	Ibn Alnafeas
باب شرقي	Bab Sharki	ابن عساكر	Ibn Assaker
باب السلام	Bab el Salam	جناني	Janani
شارع بغداد	Baghdad Street	جرمانا	Jaramana
بردى	Barada	جمرايا	Jemarya
بساتين	Basateen	جوبر	Jobar
بسيمة	Bassime	جوبر عكاش	Jobar Akache

TRANSLITERATIONS OF ARABIC PLACE NAMES (2/2)

جوبر عمادية	Jobar Imadye
جوبر قباني	Jobar Kabani
جرجانية	Jourjaniyeh
قابون	Kaboon
قدم	Kadam
كفرسوسة	Kafar Souseh
كفر العوامد	Kafar el Awamid
قنوات	Kanawat
قاسيون	Kassioun
قطنا	Katana
الكرش	Kersh
خان الفندق	Khan el Founduk
خورشيد	Khorshead
قدسيا	Kudsaya
كيوان	Kywan
لوان	Lawan
معلولا	Maaloula
معرونة	Maaroune
مضايا	Madaya
مهدي بن بركة	Mahadi Bin Baraka
شارع الملكي	Malki street
مزرعة	Mazraa
ميسلون	Meisaloun
ممبج	Membej
مزة	Mezze
ميدان	Midan
منين	Mnin
مخيم	Mokhayam
مهاجرين	Mouhajreen
النبوع	Naboua
نهر عيشة	Naher Eshch
ناظم باشا	Nazem Basha
النبك	Nebk
أمية	Omayad
أمويين	Ommawiyin
منطقة الرئاسة	Presidential Area
قطيفة	Qutayfch
رنكوس	Rankous
رأس الحاجب	Ras Hasib
رأس الوادي	Ras el Wadi
الرازي	Razy
ريمة	Rimeh
ركن الدين	Rukn Aldyn
سعسع	Saasaa
صفصافة	Safsafi
سردا	Sarada
ساروجة	Sarouja
صيافي	Sayafeh
سبيراني	Sebrani
صيدنايا	Sednaya
شاغور	Shaghour
شخاب	Shakhab
ينابيع جانبية	Side Spring
سومرية	Somareyeh
سيرونكس	Syronics
طبالة	Tabbaleh
طبيبة	Tabibiyeh
تضامن	Tadamoun
تقدم	Takadom
تلمنية	Talmasieh
تكية	Tekieh
المدينة القديمة	The Old City
تشرين	Tishreen
المدينة الجامعية	University City
وادي مروان	Wadi Marwan
الوالي	Wali
يعفور	Yaafoor
يرموك	Yarmouk
زبداني	Zabadani

1. INTRODUCTION

1.1 Background

This report describes the results of the master plan study (Phase I) of "The study on the development of water supply system for the Damascus City". The study area is located in the southwest of the Syrian Arab Republic. Damascus City has a population of about 1.4 million and in recent years has grown at rate of more than 2.0 %.

The Damascus City Water Supply and Sewerage Authority (DAWSSA) provides water for Damascus City. In 1995, DAWSSA supplied a total of approximately 218 MCM. There was an estimated demand of 25 MCM which was not met in 1995. Water restrictions occurred in Damascus mainly during the dry season, in spite of the supplemental water pumped from wells within the City.

Only 36 % of all water produced is billed and an estimated 64 % is Unaccounted for Water (UFW). An aging infrastructure, and informal pipe connection contribute to these high levels of UFW. Therefore measures for reducing leakage losses in the distribution network are required in addition to finding new source of water.

In February 1994, the Government of the Syrian Arab Republic (hereinafter referred to as the Government of Syria) requested the Government of Japan to conduct a Study on the Development of the Water Supply System for the Damascus City. In response to the official request from the Government of Syria, received in March 1995, the Government of Japan dispatched a JICA Preparatory Study Team to review and identify the Scope of Works for the Project. The JICA Preparatory Study Team and the Government of Syria discussed the details of the Study and singed the Scope of Work for the Study on March 23, 1995.

1.2 The Scope of Works

The objectives of the Study are to formulate an overall and strategic master plan for appropriately phased improvement / development of the water supply system in Damascus City up to year 2015, to conduct a feasibility study for priority project(s) to be selected from the master plan, and to study changes needed in management of DAWSSA to promote systematic development of water supply services in the City.

The Study consists of two phases, according to the tentative schedule outlined in the " Scope of Work " for the Study. Phase I is the Master Plan Study which consists of three field

investigation periods and two home work periods as follows:

A. Preparatory work in Japan (January 1996)
B. The First Field Investigation (Basic Study; January - March 1996)
C. The Second Field Investigation (Detailed Study & Analysis; June - September 1996)
D. The First Home Work (Formulation of Master Plan; October - November 1996)
E. The Third Field Investigation
(Explanation and Discussion of Draft Final Report; December 1996)
F. The Second Home Work
(Preparation and Submitting of Final Report; January 1997))

Phase II is the Feasibility Study on priority project(s) which will be selected by mutual consent from the Master Plan formulated during Phase I.

The JICA study team dispatched its engineers to the study area on the schedule described in the Inception Report, for the execution of the study. The Study has gone smoothly. Engineers of the JICA study team has enjoyed excellent cooperation from DAWSSA's team of the counterpart personnel. The transfer of knowledge to the counterpart personnel has been carried out throughout the Study in the field operations and in the office work. Two counterparts were also been invited to Japan by JICA to obtain training on water supply planning in 1996.

2. NATIONAL BACKGROUND

2.1 Land and Population

Syria is located on the Eastern Mediterranean. It's total land mass is 185,180 square kilometers. The country's capital city is Damascus. Between the census years of 1981 and 1994, the average annual growth rate was 3.3%. The mid year population estimates for 1995 is 14.186 million. About 60% of the population are under the age of twenty. The rate of urbanization is high, with an estimated 51% of the population living in cities.

2.2 National Economy

The GDP in 1994 was 496,500 million Syrian pounds or 35,866 million Syrian pounds per capita in current prices (1994). The domestic economy relies heavily on a seasonally fluctuating agricultural output which represented about 21% of GDP in 1994. Transportation & communications are the fastest growing sectors seeing real growth of 16.5% between 1993 and 1994.

Annual inflation rates have historically been high at 15% to 20% in 1994. Following the government's liberalization program in the late 1980's consumer price increases slowed but continued to fluctuate because food subsidies were partially lifted and exchange rate adjustments devalued the Syrian pound. The exchange rate has changed continuously over the past five years as the government has gradually moved towards unifying rates with neighboring countries to deter the active black market on currency exchange. The official exchange rate is now 42 Syrian pounds to 1 US dollar.

The 1995 budget set total expenditures at SL 162 billion, a 12.5% increase over the 1994 level but a net reduction in real terms given the estimated inflation rate of 20%. The total amount allocated to investment spending in 1995 was SL 74.1 billion. The 1996 investment budget has increased by 23% to SL 91.1 billion. Local resources fund about 75% of the budget (SL 68.7 billion). External resources will be used to cover the balance of SL 22.4 billion. The national income for 1994 was SL 475.8 billion resulting in a per capita income of SL 34,366.

3. PRESENT CONDITIONS OF THE STUDY AREA

3.1 Socio-Economy

Damascus City Governate is the second largest urban center in Syria, Alleppo being the first. Damascus is the nation's capital and an important administrative center. Most of the economic activity in the region centers around the tourism and trade industry.

Since 1970, the population growth rate has been declining steadily and has been lower than the growth rates experienced in the other large urban centers. According to the 1994 census, the total population in Damascus City was 1,394,000. On average there are 6.0 persons per dwelling. About 60% of the families surveyed for this study receive less than SL 10,000 per month which is classified as low income. Another 20% receive less than SL 25,000 per month, classified as middle income. The average household income for all income groups is SL 16,254.

The average life expectancy in Syria was 66.6 for men and 67.7 for women while infant mortality was 37 per 1000. Estimates for Damascus Governate are not available but should be better than the national average given the better standard of living, and better health services coverage.

3.2 Urban Development Plan and Land Use

Damascus Municipality is currently working on a new master plan for Future Damascus City and Regional Area (hereinafter called the New City M/P) to promote sustainable growth to the year 2020. Conceptual plan in the year 2020 is shown in Figure 3.2.1.

Population and area is projected as follows;

	Year	1995	2000	2005	2010	2015	2020
Population	(1,000 persons)	1,468	1,621	1,722	1,878	1,934	2,000
Area in the City	(km^2)	106					180

Percentage of each income Levels to total population in 2020 is classified as follows;

Year	1995*	2020**	
Area	Damascus	Syria	Damascus
High Income	16.7 %	18 %	20 %
Medium Income	18.0 %	34 %	40 %
Low Income	39.5 %	48 %	40 %
Informal (Medium)	4.5 %	0 %	0 %
Informal (Low)	21.3 %	0 %	0 %

(Source : * JICA & DAWSSA, ** Damascus Municipality)

The composition of land use in 2020 is presented in Table 3.2.1. The residential and commercial land area is approx. 86 km^2 of 48 % of total land area of the City. The future land use patterns will likely not change significantly from the existing land use pattern. New development areas in the City are planned for residential and commercial use, such as Kudsaya New Suburb, Dummar Extension Area and Assad New Suburb.

3.3 Water Resources

The city of Damascus lies on the boundary between the Anti-Lebanon Mountains and the plains of the El-Arab Trough. The mountains are formed from Jurassic and Cretaceous karstic limestone that receive ample winter precipitation that percolates into the ground during the snow melt before issuing from springs. Two major springs, Barada and Figeh, form the Barada River, while smaller springs feed the Awaj River. The location of rivers and aquifers is illustrated on the hydrogeological map, Figure 3.3.1.

Water resources used by DAWSSA are confined to the major springs and the alluvial aquifer underling Damascus. The springs are very seasonal with a peak in March to May followed by a recession until December or January. Barada Spring has an estimated natural recharge of 100 MCM/y fed by Jurassic limestones west of the Zabadani Valley. In the last 10 years the discharge has declined to about 70 MCM/y, this is considered to be a result of abstractors using water within the spring catchment area. The average discharge of Figeh has remained unchanged at 220 MCM/y though does vary from over 300 MCM in a wet year to as low as 129 MCM in a dry year.

The springs in the Awaj catchment are smaller, and used for local water supply and irrigation. The largest spring, located in the head waters of the Janani River, is Beit Jenn, with an average flow of 23 MCM/y.

The Quaternary alluvial fan aquifer is exploited by wellfields during periods when spring flow is insufficient to meet demand. The total water resources are estimated to be about

360 MCM/y but in the area of good water quality an annual abstraction of as little as 50 MCM/y is considered the safe yield for planning purposes.

All the water resources are intensively used, the largest single use is for irrigation. The main irrigated area is the Gouta covering 370 km^2 with significant areas along the course of the Awaj River and in the intermontane valleys. In total about 1,000 MCM are used for irrigation.

3.4 Water Quality and Environment

As much as 80 % (1995) of the water supplied by DAWSSA is available from Figeh Main Spring; a major spring which has been recognized for its superb water quality and abundant yield for centuries. The water from this spring is characterized by low conductivity (around 300 μS/cm), neutral pH (around 7.7), and low hardness (around 150 mg as $CaCO_3$/L). The water satisfied the Syrian Drinking Water Standard for all criteria examined this time. Consequently, the overall quality of the water supplied by DAWSSA is high. With the recent increase in water demand, however, DAWSSA is being forced to use other water resources with less desirable water quality, especially during dry season when the yield from Figeh Main Spring is low. This increase in production from secondary water resources is creating seasonal and regional variations in the quality of the supplied water.

There are numerous secondary water resources in the area. In general, the quality of water in the mountain areas (Zabadani, Figeh and Hermon areas) is satisfactory. For example, Barada well field, which provided approximately 7 % of the water used by DAWSSA last year, produces water with good quality. The groundwater in Damascus is not as good as the water in the mountains, although the water from most city wells still meet the Syrian Drinking Water Standard. Typically the conductivity is around 700 - 1000 μS/cm, hardness is around 300 - 400 mg as $CaCO_3$/L, and the nitrate concentration is around 25 mg/L. The major groundwater problems in Damascus are localized to south Damascus (hardness and nitrate problems) and Dummar-Mezze area (hardness, sulfate and salinity problems) as shown in Figure 3.4.1.

In the first pesticide pollution study conducted in July, 1996, chlorinated pesticides (dieldrin and heptachlor) banned by Decision No. 10 (1990) were found from Oumawiyin wellfield. Two additional investigations, including an independent analysis of the same sample at an analytical institute in Japan, were carried out. The analyses in Syria again showed the presence of pesticides in the Oumawiyin samples, but no pesticide were found

when the same sample was tested in Japan. Use of pesticides in Syria is not well-controlled, and the possibility of pesticide pollution at Oumawiyin cannot be rejected. Therefore, further investigation is strongly recommended.

Surface water in the study area is not a suitable source of drinking water as it is heavily contaminated by sewage and industrial discharge. A serious heavy metal pollution (chromium) was found in the tannery area (Dabaghat). Some pesticides were found in the surface water in Zabadani, which is an intensive agricultural zone.

According to the result of the sanitary condition monitoring carried out as part of this study, over 97 % of the tap water examined contained more than 0.1 mg/L of residual chlorine, and no microbe was found in any potable water sample. However, in the southern Damascus (Kadam area), the water supplied from the wells contains rather high concentrations of hardness and nitrate. Several countermeasures were suggested in the main report. Some distribution systems are old. To avoid secondary pollution, replacement of damaged pipes is recommended.

Table 3.2.1 Future Land Use Classification

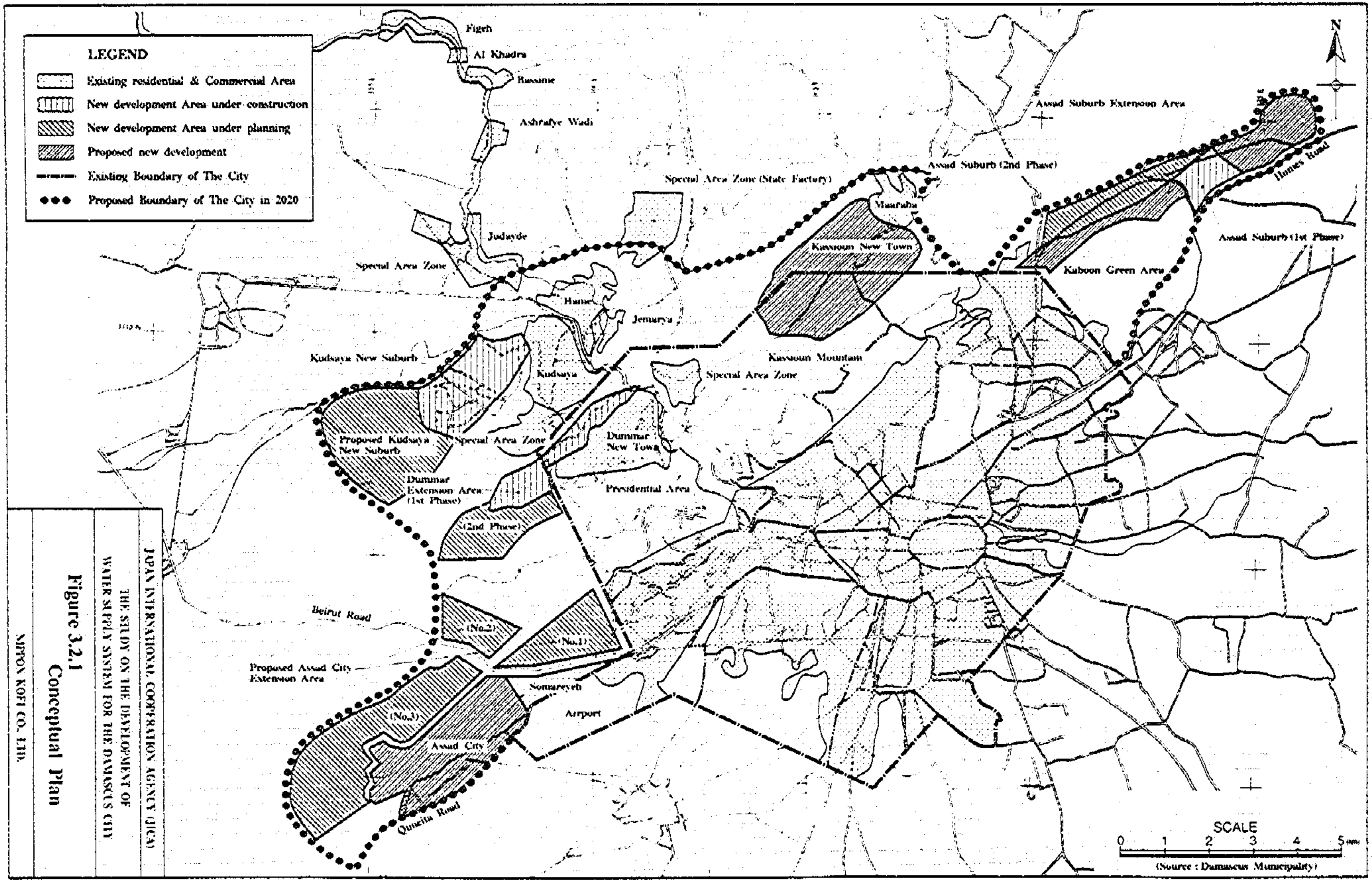
Name of Area	Land Use Classification (ha)								
	Total Area	Agricultural	Agriculture & Residential	Green & Park	Special Area & Airport	Industrial Zone	Residential & Commercial	Reserved / Others	Kassioun Mountain
1. Proposed Villages*									
1.1 Hame	56					2	54		
1.2 Jemarya	5						5		
1.3 Kudsaya	158					2	156		
1.4 Special Area Zone (Military)	85						85		
1.5 Maaraba	75						75		
Sub-total	380	0	0	0	0	4	376	0	0
2. Proposed New Development Area									
2.1 Kudsaya New Suburb	300						300		
2.2 Proposed Kudsaya New Suburb	200						200		
2.3 Dummar Extension Area (1st phase)	124						124		
2.4 Dummar Extension Area (2nd phase)	216						216		
2.5 Kassioun New Town (650 ha)**	340					13	274	363	-310
2.6 Assad Suburb (1st phase)	40						40		
2.7 Assad Suburb (2nd phase)	193						193		
2.8 Assad Suburb Extension Area	298						298		
2.9 Kaboon Green Area	530			530					
2.10 Assad City	655						655		
2.1 Proposed Assad City Extension Area (1)	200						200		
2.1 Proposed Assad City Extension Area (2)	124						124		
2.1 Proposed Assad City Extension Area (3)	575						575		
2.1 Special Area Zone (State Factory)	25						25		
2.2 Others	3,177							3,177	
Sub-total	6,995	0	0	530	0	13	3,222	3,540	-310
3. Existing Damascus City									
3.1 Ruku Aldyn	437			27			410		
3.2 Mouhajeen	363			53			310		
3.3 Mezze & Kafar Sousch	2,428	605	256	47	355	13	1,037	117	
3.4 Kanawat	269						269		
3.5 Kadam & Midan	596	95				11	490		
3.6 Old City & Shaghour	716	89		21		28	577		
3.7 Sarouja	349			8			341		
3.8 Yarmouk	227						227		
3.9 Jobar	642	107	124	25		50	335		
3.10 Berze & Kaboon	1,170	110	33	229		121	677		
3.1 Dummar	473			93			380		
3.1 Kassioun Mountain	2,956								2,956
Sub-total	10,625	1,006	414	503	355	222	5,053	117	2,956
Total (ha)	18,000	1,006	414	1,033	355	239	8,651	3,657	2,646

(Source : Damascus Governate & DAWSSA)

(Remarks)

* : Area of Villages is water served area due to lack of information on administrative area.

** : The development area of Kassioun New Town includs the area with 310 ha insid the Existing Damascus City.



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.2.1 Conceptual Plan

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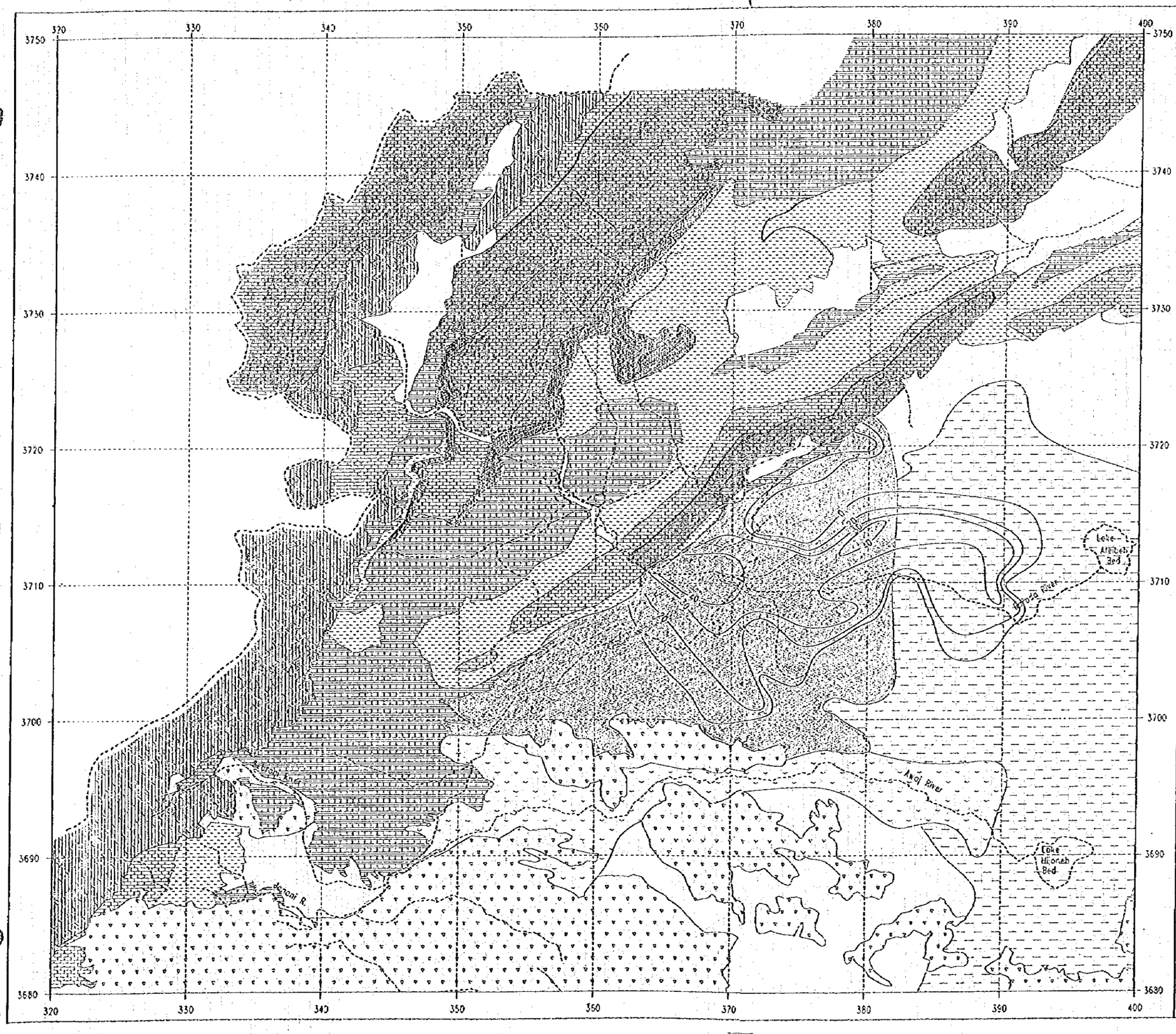
Hydrogeological Map



LEGEND

- 20 — Upper Quaternary Pebble Beds Isopachites
- Water Courses
- Geological Boundarys
- International Boundarys
- DAWSSA served area proposed in City plan

Symbol

- Quaternary Alluvium
- Quaternary Sand & Gravel
- Quaternary, Lacustrine Deposits
- Neogene, Conglomerates
- Paleogene, Limestones & Marl
- Paleogene, Marl & Limestones
- Creataceous, Limestone, Dolomite, Sandstone
- Jurassic, Limestone & Dolomite
- Neogene to Quaternary, Basalt

Aquifer Productivity

- Good
- Medium
- Poor
- Unproductive

N

Scale (km)

5 0 5 10 15

Grid: Universal Transverse Mercator

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.3.1
Hydrogeological Map

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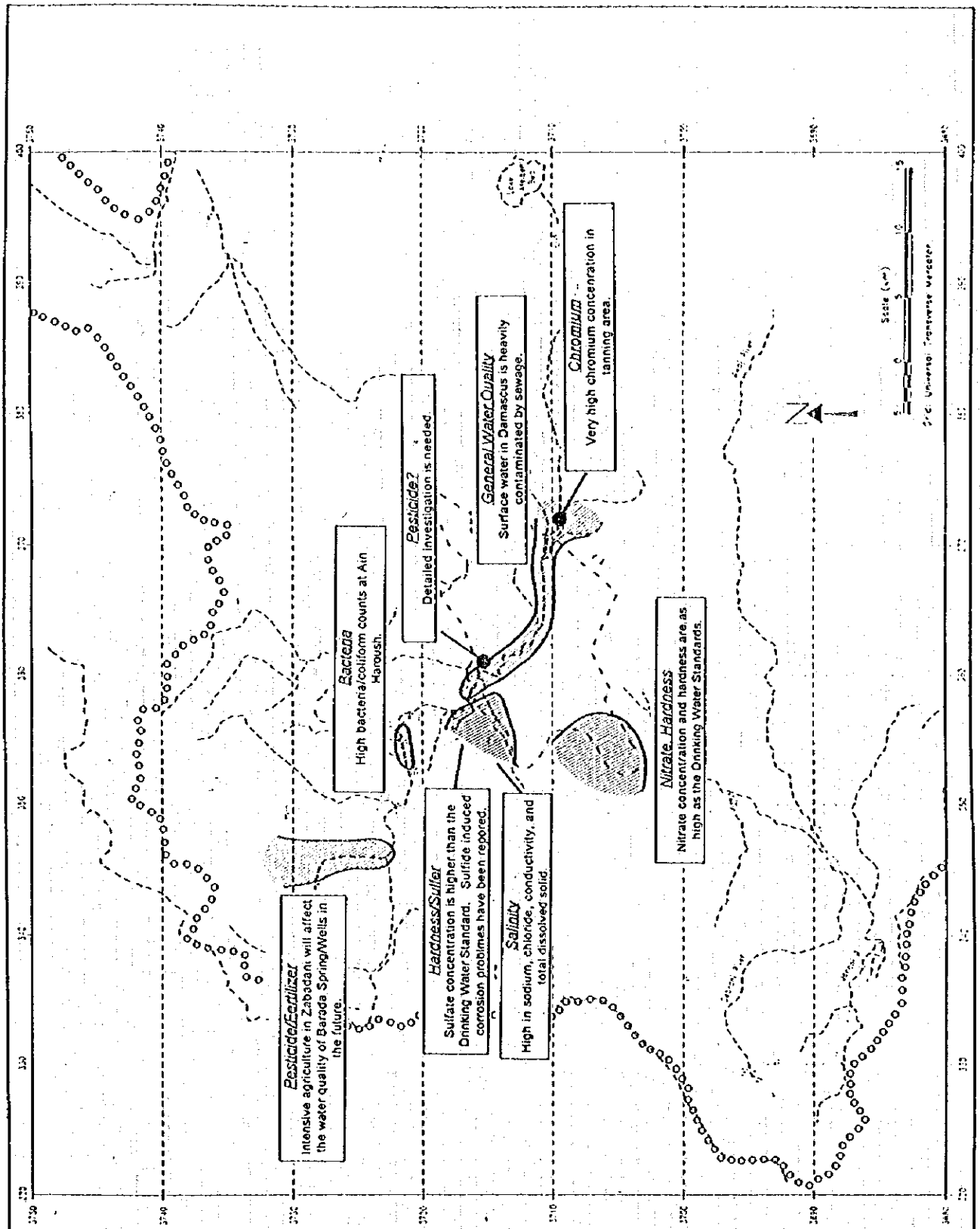

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.4.1
Major Water Quality Problems

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4. PRESENT CONDITIONS OF WATER SUPPLY SYSTEM

4.1 GENERAL

Damascus consists of two Mohafazas, Damascus city and Damascus rural. Water supply to Damascus city and 8 villages along the Barada river is managed generally by Damascus City Water Supply and Sewerage Authorities (DAWSSA) under the Ministry of Housing and Utilities.

Main water source is the Figeh spring and other water sources, such as underground water in the Barada spring and Damascus city, are supplementary utilized. The portable water is derived from groundwater sources in the Barada spring wells and the Figeh spring. The water is conveyed to three service reservoirs after being chlorinated at the Figeh dispersion basin, and stored at each reservoir. Water to the villages in Damascus Rural is supplied from Figeh and Jamraya reservoirs. Water conveyed to Damascus City, through the transmission pipeline consisting of the box culvert with the length of 16 km and the new tunnel with the length of 15 km, is stored at Wali reservoir and then distributed to several service reservoirs located in the city. The groundwater in the city is pumped up to a service reservoir located in the vicinity of each borehole and delivered to house connections through the net work with chlorinating treatment.

4.2 Present Service Area and Population

(1) Present Service Area

The DAWSSA supply water to eight villages, Figeh, Al Khadra, Bassime, Ashrafye Wadi, Judayde with the special area zone, Hame, Jemarya, Kudasaya with a new residential area and Takadom in Damascus Rural. Special Area Zones is a bulk water supply system through transmission pipe from Figeh. The existing service area of villages is estimated at 5.12 km^2. Damascus City consists of fifteen districts. The DAWSSA has responsibility for water supply to the whole area with 106 km^2.

(2) Population Served in Present Service Area

The existing population served is estimated at 1,150,950 based on the billing data and 1994 Census as follows:

Total Population	: 1,557,950	Population Served	: 1,150,950
Infomal Resident	: 407,000	Service Level (%)	: 74 %

The residents have water supply from DAWSSA with 100 % excepting the number of informal residents, in 1995. Total population in informal area is estimated tentatively at 407,000 persons based on the Census and the results of the interview survey.

4.3 Existing Water Supply System and Facilities

The existing water source for water supply consists of three water sources, wells at Barada Spring, Ain Figeh area and wellfields/fringe wells in Damascus City, and record of water production in 1995 are 218.3 million m^3/year.

Water from the wells of Barada and Figeh is conveyed into Wali service reservoirs through the two transmission tunnels by gravity flow which have a total conveyance capacity of 14.8 m^3/sec. The Wali reservoirs feed a number of smaller service reservoirs and the East and West main storage reservoirs. In addition, water supply is supplemented by a number of production wells located throughout Damascus. These wells which are connected to the distribution network are used mostly during water shortage periods. The existing water supply system is illustrated in Figure 4.3.1.

A total of 34 storage and service reservoirs provide a capacity of about 0.2 million m^3. The existing water distribution system in Damascus city is divided into fifteen service districts and each district is sub divided into pressure zones which are regulated on the basis of the elevations of the service district. The total length of the existing transmission and distribution mains is around 1,221 km. Approximately 124 km (12%) of the distribution mains are cast iron piping with lead joints. The cast iron piping is over 25 years old and in questionable condition.

Pumping stations are used throughout the system to convey water from reservoir to reservoir, and to supply water into the distribution network. In total there are 15 pumping stations providing a pumping capacity of 25.2 thousand m^3/h with a total of 99 pumps. All pumping station are equipped with a step-down transformer and a stand-by diesel generator for emergency use. However some of the diesel generators do not have enough capacity for all pumps to operate at the same time.

Water from Figeh Spring is disinfected at chlorination plant located in Figeh at entrance of the tunnels feeding Wali reservoirs. Disinfection is achieved using chlorine gas. At the production well centers, hypochlorite dosing equipment is provided for disinfecting water before it is distributed.

Water meters for individual house connections are generally of the multi jet type, half inch pipe size, and of Syrian make. Meter larger than a half inch diameter are imported from France, Germany and other countries. There is a total of 1,833 water meters for large consumption users and 235,975 meters for normal subscribers.

The SCADA system project (Supervisory Control And Data Acquisition system) is currently under construction and will greatly enhance DAWSSA's ability to optimize water production and distribution operations.

4.4 Present Water Use and Customer Consciousness

Main results obtained from the interview survey during in this study is summarized as follows.

An average family size in the City is 6.01 persons per family. 78.5 % of the informal residents unofficially used water supplied by DAWSSA. More than 90 % of informal users have willingness to pay in case of establishment of official water supply. Monthly income, water consumption and payment at each class is estimated below;

Class	Income (per month)	Consumption (m^3/month)	Payment (per month)	% to income
High	SL 50,000	35 (194 lpcd)	SL 162	0.3
Medium	SL 20,500	33 (183 lpcd)	SL 152	0.7
Low	SL 5,665	32 (177 lpcd)	SL 142	2.5
Informal Residents	SL 7,820	31 (172 lpcd)	(SL 146)*	(1.9)*
Average	SL 16,423	32 (177 lpcd)	SL 147	0.8

(Note: * Assumed for the informal residents)

More than 70 % of formal consumers are satisfied with the existing water supply, such as quantity, pressure, quality and payments. As availability of DAWSSA Water Supply in dry season, only 55 % of consumers are supplied water over 12 hours per day.

4.5 Unaccounted for Water (UFW)

In 1995, about 64 % of the total water production was unaccounted for water. The main components of UFW are attributed to meter malfunction (14.4%), religious and public fountain use (1.7%), informal use (13.6%), and system losses (34.7%). The recommended target level for reduced UFW has been set at 25% of total production for the year 2015. Measures to reduce UFW includes an active leakage detection and control program, water main

rehabilitation, meter replacement, and providing informal dwellings with properly connected and metered service connections.

4.6 Organization and Institutional Status

DAWSSA is legally designated an autonomous unit within the public sector under the sponsorship of the Minister of Housing and Utilities. In reality, all of DAWSSA's activities are State controlled and it has little freedom on budgets, wages, tariffs, and direction. For the development of water resources, other than Figeh, outside the city boundaries DAWSSA is required to seek licenses from the Ministry of Irrigation who have responsibilities for water planning and regulation; within the city boundary that Ministry, DAWSSA, and the Municipality all have varying rights and responsibilities for water but no-one has overall control.

DAWSSA is managed through a Board of Directors comprising required executive directors - the General Director and his Deputy plus the Directors of Finance and Planning, one other selected director - currently the Director of Consumer Affairs, and two nominated worker representatives - currently from one finance and one technical directorate.

DAWSSA comprises 16 main directorates, the General Directorate, and two service departments (see Figure 4.6.1). The recent response by DAWSSA to the Minister regarding his proposed 'model' structure could imply a reduction to just eight main directorates. Overall there are some 1,340 staff (including a small proportion who are either temporary or contract); staff remuneration and tenure of position are regulated by legislation (the Labor Laws). The current 'manning ratio' of 5.4 staff / 1,000 connections is reasonable by international standards.

Paramount among DAWSSA's current problems are excessive water losses and low revenue income, at the same time as deteriorating levels of service to customers. Organizationally, judged against 'best modern practice', there are problems of an over fragmented organization structure; absence of functions for personnel, training, and information technology; inadequate remuneration and motivation of staff; excessive bureaucracy; and lack of customer orientation.

4.7 Financial Affairs

A summary statement of incomes and expenditures for the 1990-95 period is shown below. In terms of revenue growth, financial performance has improved significantly from a pre-tax net income of SL 5.5 million in 1990 to SL 252.5 million in 1995. This large

improvement is due to substantial tariff increases and growth in the number of metered connections. Substantial increases in pre-tax revenues have not resulted in a corresponding improvement in the overall financial position. Accounts receivable have remained unacceptably high at 190% of total revenue in 1995, equivalent to 23 months of water sales.

Summary Revenue and Expenditure Statement (SL millions)

	1990	1991	1992	1993	1994	1995
Revenue	135.6	221.8	209.2	225.1	379.8	353.2
Operating expenses	97.6	113.8	138.5	146.1	179.6	216.4
Operating income	38.0	108.0	70.7	79.0	200.2	136.8
Depreciation	32.4	36.1	40.0	39.7	50.2	54.1
Income	5.6	71.9	30.6	39.3	150.0	82.6
Profit tax	4.7	53.2	29.3	33.7	87.5	48.3
Net income	0.9	18.7	1.3	5.6	62.5	34.3
Financial Indicators						
Working ratio (%)	72	51	66	65	47	61
Operating ratio (%)	96	68	85	83	61	77
Profit margin (%)	4	32	15	17	39	23

Revenue generation is seriously undermined by a large proportion of malfunctioning meters and a high proportion of unmetered informal use. A review of 1995 billings reveals that as many as 33% of domestic meters could be malfunctioning. Approximately 30% of the domestic population (407,000 users) are connected informally to DAWSSA's system and account for an estimated unmetered consumption of 29.7 MCM per year. The potential revenue lost to these two sources is conservatively estimated at SL 157 million (US$ 3.7 million).

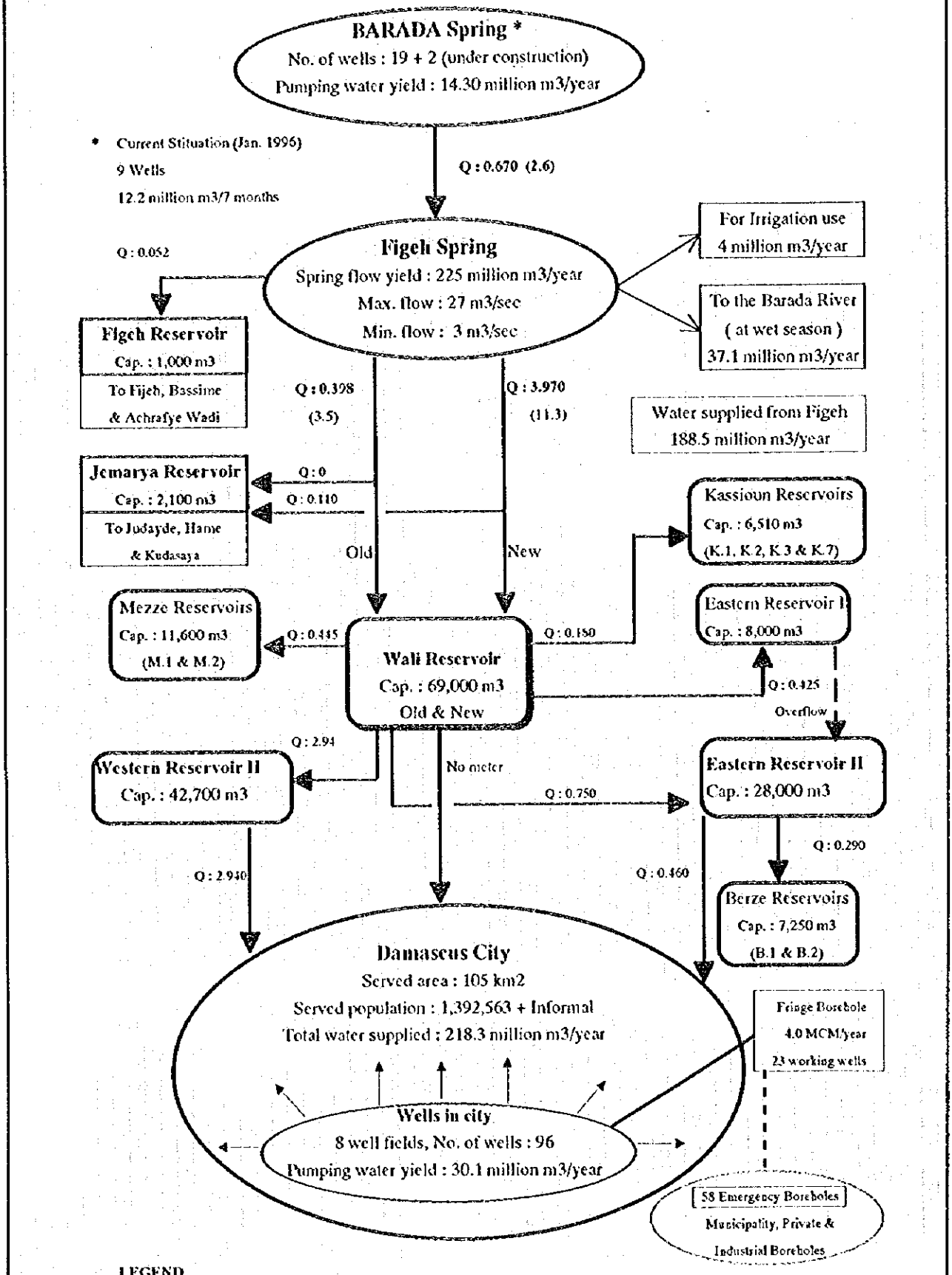
A review of the balance sheet for the 1990-95 period indicates that fixed asset values are considerably lower than replacement costs. The current levels for annual asset depreciation are insufficient to provide the funds required for the long term rehabilitation and replacement of the distribution system. A summary of the source and application of funds for the 1990-95 period indicates that operating income before taxes accounted for only 12.5 % of all available funding while loans accounted for 90 %. This relatively high proportion indicates a large dependency on government subsidy and foreign loans. More emphasis will be required in the near future on maintenance and rehabilitation expenditures in order to protect this extensive investment in infrastructure.

In terms of overall financial management there are three significant factors that impede good performance:

(a) DAWSSA has no clearly defined financial objectives. Management's efforts to operate on a more commercial basis are hampered by politically determined tariffs and a relatively high profit tax. The tariffs are set uniformly on a national basis and undercharge consumption by a large margin.

(b) The accounting of income is substantially delayed by an inefficient billing and collection process. The total billing and collection process takes about 11 months from the time the meter is read to the time the payment is received. The lack of timely financial information seriously affects management's ability to control costs, prepare budgets and provide accurate forecasts of future financial needs.

(c) The accounting system is based on the cash accounting principle and lacks the ability to provide the cost accounting typically needed by utility managers to control operating and maintenance expenditures.



LEGEND

Q : Average flow (m3/sec)
(Max. Flow m3/sec)

Cap. : Capacity

: Reservoir in Damascus City

K.1 : Official code of Reservoir

(Source : DAWSSA)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 4.3.1 Existing Water Supply System in Damascus (on Jan. 1996)

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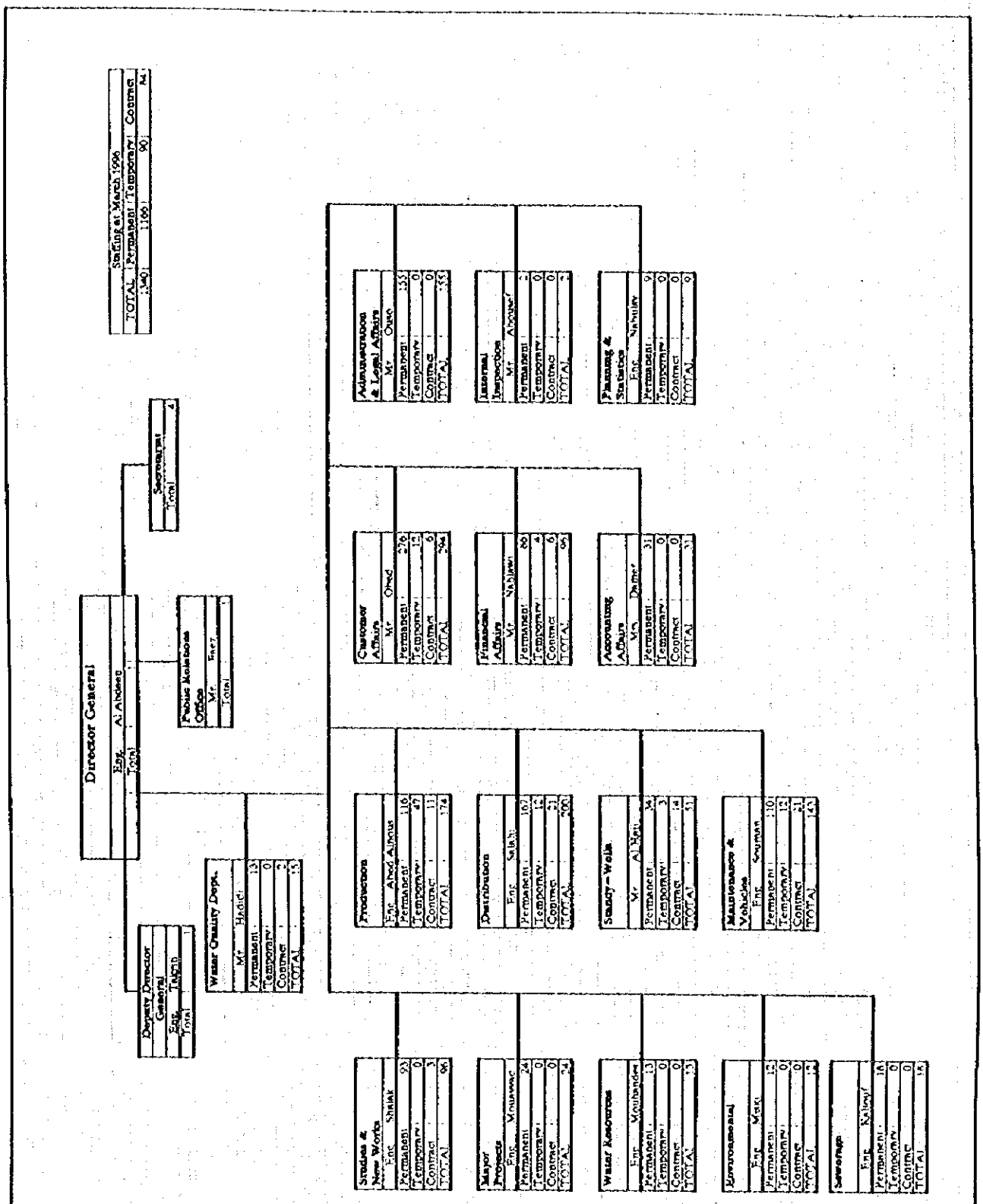

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THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 4.6.1 DAWSSA Organization Structure
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5. PLAN FORMULATION

5.1 Basic Concepts for the Formulations of Plans

The plan was made up to the year 2015 based on the deficiencies in the existing system, the results of water resources development potentials for DAWSSA examined, and considering the level of urgency for water requirements identified through the study.

The basic concepts for the formulations of plans are as follows:

i) Reducing unaccounted for water (UFW) in the existing distribution system,
ii) Maximizing the use of all existing water resources,
iii) Increasing availability of new water resources and sharing of resources with others, and
iv) Consisting with the Proposed Damascus City Urban Development Master Plan.

5.2 Served Area

Service area will be extended according to the New City Master Plan prepared by Damascus Municipality. Total served area including the existing villages at each 5 years is estimated respectively, 111.62 km^2 in 1995, 111.86 km^2 in 2000, 115.86 km^2 in 2005, 123.49 km^2 in 2010, and 135.17 km^2 in the year 2015 as shown in Figure 5.2.1.

5.3 Population Projection

Population projections for estimating future water demands are based on census data obtained from the Central Bureau of Statistics (CBS). Reference is also made to the Master Plan being prepared by the Municipality of Damascus for new development areas. The total population within DAWSSA's service area in 1995, including an estimated 407,000 informal residents, is approximately 1,557,000. The population currently serviced by DAWSSA through formally metered service connections is estimated at 1,150,000.

This study examines three possible population growth scenarios: a high growth forecast based on national growth trends, a moderate growth forecast which assumes de-concentration to other urban centers outside Damascus City Governate, and a slightly lower growth forecast based on projections in the municipal master plan which assumes a high level of migration to new development sites. Based on past urban growth trends and the population momentum created by the relatively young age distribution the present study assumes a moderately distributive growth forecast of 2.47 % per year which results in a total population serviced by DAWSSA of 1.56 million in the year 2000; 1.95 million in the year 2005; 2.21 million in the year 2010; and 2.50 million in the year 2015.

5.4 Water Requirement

(1) Water demand projection

Classified water demand projections at each 5 years are summarized as follows;

(Unit; 1,000 m³/d)

Year	1995*	2000	2005	2010	2015
A. Domestic Use	126.1	272.1	376.9	449.4	535.2
B. Non-Domestic Use					
B.1 Governmental Use	37.3	99.7	102.4	109.2	119.6
B.2 Commercial Use	7.8	23.9	24.6	26.2	28.7
B.3 Industrial Use	1.5	6.2	6.3	6.7	7.4
B.4 Water Right Obligation	40.7	42.5	42.5	42.5	42.5
B.5 Religious & Public Use	10.5	10.6	10.9	11.6	12.7
Total	224.1	455.0	563.6	645.6	746.1

* : Water consumption in 1995 is estimated from billing record.

(2) Daily water requirement

Accounted water demand and UFW are forecasted as shown in Figure 5.4.1. UFW in 1995 is estimated from actual water production amount (598,100 m³/d).

Daily water requirements is projected below :

(Unit : 1000 m³/d)

	1995*1	2000	2005	2010	2015
1. Accounted Water Demand	224.1	455.0	563.6	645.6	746.1
(%)	(37)	(61)	(69)	(72)	(75)
2. UFW	374.0	295.8	249.7	254.8	248.1
2.1 Meter Malfunction	88.6	23.5	0.0	0.0	0.0
2.2 Informal Use	81.4	31.0	8.1	0.0	0.0
2.3 System Losses	204.0	241.3	241.6	254.8	248.7
3. Average Water Requirement*2	678.0 (598.1)	750.8	813.3	900.4	994.8
4. Maximum Water Requirement (Load Factor : 1.14)	759.4	855.9	927.2	1,026.5	1,134.1
5. Water requirement per capita (lpcd)	285	291	289	293	298

*1 : Data in 1995 are provided by DAWSSA and JICA.

*2 : Average water requirement in 1995 is effective water requirement based on data of production on April.

Daily water requirement to proposed served areas is estimated as shown in Table 5.4.1. Water requirement is summarized at each 5 years as follows :

(Unit : 1000 m^3/d)

Year	2000	2005	2010	2015
Villages	53.7	56.9	60.5	65.3
New Development Areas	8.5	21.5	43.6	73.3
Existing City	688.6	737.9	796.3	856.2
Total	750.8	816.3	900.4	994.8

Figures 5.4.2 and 5.4.3 show water requirements at each served area in the year 2005 and the year 2015.

(3) Annual water requirement

Annual water requirement is proposed as the following estimation.

Year		2000	2005	2010	2015
Water Requirement	(MCM/year)	274.0	296.9	328.6	363.1
	(m^3/sec)	8.7	9.4	10.4	11.5

It is supposed that water deficit will be occurred after the year 2005, since the capacity of water resource is limited with 296.9 MCM/year (9.4 m^3/sec) estimated by the existing water rights of DAWSSA. It, therefore, is necessary that DAWSSA will develop the new water resources for the year 2010 and 2015 in consideration of the harmony between the water demand augmentation and water saving need, and in cooperation with Damascus Municipality and the Ministry of Irrigation (MOI).

The MOI would be expected for solving the water deficit in the City after the year 2005, because the MOI has the responsibility for formulation and arrangement of water resources development in the rural areas where have a potentiality of water resources, and is authorized for water rights in the rural areas.

5.5 Water Resources Development

The water resources that are available for use in the vicinity of Damascus are already almost fully committed to water supply and irrigation uses. The Master Plan proposes the maximum utilization of the existing sources together with limited development of new sources.

An estimate of the resources is given in the table below.

Source	Total Replenished Resource with acceptable water Quality (MCM/y)	Estimated Resource available to DAWSSA (MCM/y)
Figeh Source	220	220
Barada Source	100	34
Sergaya Area	9	3
Deir al Ashayer Area	7	3
Damascus Quaternary	50	50
Total	386	310

Currently about 130 to 185 MCM/y are used from Figeh Source and up to 35 MCM/y from Damascus. The development of the Barada source is ongoing and will provide an additional 34 MCM. All the anticipated yields of other ongoing schemes are included in the water production plan. The anticipated capacities of the sources are listed in Table 5.5.1.

The plan is able to increase production from Damascus and the new area of Deir al Ashayer to meet the anticipated requirements until the year 2005 in the case of average rainfall, Table 5.5.2 and Figure 5.5.1. By that time all the sources will be fully developed, small increases after this time are a result of a higher demand in the early part of the year met from Figeh source. The plan is formulated with a typical production from Figeh spring, drier or wetter years have a major influence on water availability since there is limited groundwater storage in the system to buffer the effects of variable meteorological conditions. At certain times in the plan there is surplus capacity, when this has arisen preference is made to the use of Jurassic and Cretaceous sources. The shortfall in water supply is eliminated for 1 year in 2. However there will still be a deficit in dry years, for the 1 year in 10 drought condition a small shortfall exists throughout the plan. This deficit will occur most readily in the peak demand months of July to September.

The use of the Quaternary aquifer under Damascus is limited by the area that has acceptable water quality and by the anticipated total resource assessment of 50 MCM/y. The plan anticipates the yield being able to occasionally exceed this amount and draw upon aquifer storage in dry years subject to the abstraction being reduced in wetter years.

Within the Master Plan formulation four alternative options for the development of identified water resources were examined. The preferred option was chosen so as to use only sources to which DAWSSA has been given the right to use, are technically possible and economically / financially feasible. The location of the schemes that were considered for the Master Plan are illustrated on Figure 5.5.2. Of the selected schemes they can be divided into:

- Equipping the existing, tested, but unused wellfields in Damascus.
- Re-equipping existing wells to increase their production in Damascus.
- Construction of new wellfields in Damascus

5.6 Comparison and Selection of Master Plan Projects

(1) Approach

Projects that are proposed as candidates for the master plan are listed in Table 5.6.1 and evaluated on the basis of technical, social impact, environmental and economic criteria. All projects and their alternative schemes are ranked in accordance with the criteria as shown in Table 5.6.2. Projects included at the evaluation stage are grouped into three broad categories and described as follows.

(2) Rehabilitation and supply improvement projects

Projects in this group are aimed at reducing unaccounted for water, improving water quality testing, and reducing system losses to increase water available for consumption. The projects are:

Distribution rehabilitation projects:
- water main replacement
- water meter replacement
- improving meter testing and repair

Leakage reduction program:
- providing a District Meter Area system
- increasing leakage survey efforts(Active leakage detection program)
- installing a pressure control system
- improving system wide master metering

Water quality and pumping equipment improvement projects:
- improving water quality testing facilities
- providing water quality control in south Damascus
- reinforcing the production capacity of existing water resources

(3) On-going and planned water supply improvement projects:

Projects in this group are already identified in DAWSSA's five year plan for the 1996-2000 period and in some cases the work is in progress and nearing completion. The projects are:

Improving supply to informal areas:

-improving water supply to informal areas by extending the water distribution network and providing new metered service connections

Water resources development:

-Developing identified well centers for informal and formal areas

-Developing identified water resources in the Hermon area

Water supply distribution schemes for new development areas:

-Providing water supply and distribution networks for new development areas

(4) Proposed Improvement Projects

Projects in this group are essentially new proposals suggested by the JICA-DAWSSA study team as part of the second field investigation for this study. The projects are:

Supply improvements:

- providing water supply system in rural within the service area along the Barada river valley
- providing water supply and distribution system for future development areas proposed by the municipal master plan

Water resources development:

- developing newly identified water resources in Damascus (New station)
- developing newly identified water resources in the Hermon and Zabadani area

(5) Cost estimates

The principal facilities of each proposed master plan projects are shown in Table 5.6.3. The project cost was based on the brief design by the usual means of referring prices and foreign exchange rates in September 1996. Costs estimates included the direct construction costs and the annual operation & maintenance costs for each project alternatives. For the main construction materials and equipment, the cost were estimated in local and foreign currency

portions respectively.

(6) Economic Evaluations

One of the criteria used to screen proposed master plan projects is economic evaluation. The Economic Internal Rate of Return (EIRR) for each project was calculated on the basis of the estimated economic benefits and economic costs. The difference between the "with" and "without" project case provides the incremental water delivered to the consumer generated by each candidate project. Many of the candidate projects contribute to the general well being of the public, however, health benefits, and other social benefits from improved services are not considered in the economic evaluation since only increased water sales are quantifiable.

In general, the economic life for most of the candidate projects is assumed to be 25 years. Replacement of pumps and rehabilitation of conveyance components is assumed to occur after 15 years. The three Hermon Spring scenarios include significant conveyance elements and therefore are assumed to have a longer economic life of 35 years. Economic assessment of the cast iron pipe replacement program assumes a 75 year economic life based on the longevity of ductile iron mains.

In general, projects with a rate of return higher than 10% (assumed opportunity cost of capital in Syria) are deemed economically viable. A sensitivity analysis indicates that estimated EIRR's are robust to variations in costs, benefits and delays in implementation. The whole of the water supply improvement scheme for informal areas has an EIRR of 10.5%. Of all the new water resources schemes proposed, only those located in the Hermon & Zabadani areas are not economically feasible. All of the proposed rehabilitation, leakage reduction and reinforcement projects are economically viable.

(7) Environmental Evaluations

Initial Environmental Examination (IEE) was conducted to assess the potential environmental impacts of the proposed projects. The criteria for IEE were selected based on the Syrian Environmental Impact Assessment guideline, JICA Environmental Consideration guideline, and characteristics of the area. Among the most important environmental factors are :

(i) water quality of supplied water
(ii) exploitation of water resources

Both positive and negative environmental impacts were evaluated. The results of the IEE is given in Table 5.6.4. Most of the proposed projects will bring significant positive

environmental impact in public health through improved supply of safe drinking water. 5 projects that supply water from city wells were rated high (negative) for the overall environmental impact. This is because the water quality of these city wells are rather poor. If these projects are to be implemented, the water quality has to be monitored closely.

(8) Selection of master plan projects

All of the UFW countermeasures are selected for the master plan because reducing systems losses is an effective and low cost way of increasing water available for consumption and deferring the need for expensive water development schemes. The water leakage detection methods based on the DMA system will significantly reduce system losses. Selective replacement of old distribution mains will not only reduce leakage but also improve the reliability of the network and minimize the risk of unexpected large scale water losses from main breaks. The replacement of malfunctioning meter should be changed to recover the underestimated billed water.

Replacing informal connections with properly metered services is consistent with government policy to improve the living level of peoples and save the resources. The results of economic evaluations show that as a total package the conversion of informal areas shows high an attractive return on investment therefore all informal areas are selected for the master plan.

The water resources projects that are selected for the master plan are in areas where DAWSSA already has Water Rights. Only schemes that are economically as well as technically feasible are selected. Outside Damascus only the development of a source at Deir al Ashayer meets the selection criteria for the Master Plan.

Table 5.4.1 Water Demand Forecast at Each Area (2000 to 2015)

Name of Area	2000					2005					2010					2015				
	Population	Area (ha)	Density	Water Requirement (m3/d) Average	Maximum	Population	Area (ha)	Density	Water Requirement (m3/d) Average	Maximum	Served Population	Area (ha)	Density	Water Requirement (m3/d) Average	Maximum	Served Population	Area (ha)	Density	Water Requirement (m3/d) Average	Maximum
Villages*																				
Figeh	4,389	44	99	1,700	2,000	4,845	44	109	1,700	1,938	4,968	44	112	1,772	2,020	5,093	44	115	1,808	2,061
Al Khadra	2,463	12	211	900	1,100	2,719	12	232	1,000	1,140	2,788	12	238	994	1,134	2,858	12	244	1,005	1,146
Bassime	517	18	30	200	300	570	18	33	200	228	585	18	33	209	238	600	18	34	195	222
Ashrafye Wadi	3,656	27	136	1,400	1,600	4,037	27	150	1,400	1,596	4,138	27	154	1,476	1,683	4,243	27	158	1,503	1,713
Judayde	4,928	53	93	1,900	2,200	5,441	53	102	2,000	2,280	5,579	53	105	1,990	2,269	5,719	53	108	2,033	2,317
Hame	23,815	56	424	9,100	10,400	26,294	56	468	9,900	11,286	26,958	56	480	9,859	11,239	27,638	56	492	10,123	11,541
Jemarya	2,246	5	424	900	1,100	2,479	5	468	900	1,026	2,542	5	480	926	1,055	2,606	5	492	915	1,043
Kudsaya	46,134	158	293	17,300	19,800	49,109	158	311	18,300	20,862	55,951	158	355	20,505	23,375	63,412	158	402	23,091	26,324
Takadom	40,575	55	744	15,000	17,100	44,798	55	822	16,400	18,696	49,461	55	908	17,727	20,209	54,609	55	1,002	19,589	22,331
Military Area 4 (Residential)	14,040	85	165	5,200	6,000	14,040	85	165	5,100	5,814	14,040	85	165	5,008	5,709	14,040	85	165	5,021	5,724
Maaraba									0					0					0	
Sub-total	142,763	512	279	53,600	61,600	154,332	512	301	56,900	64,866	167,010	512	326	60,466	68,931	180,818	512	353	65,283	74,423
Proposed New Development Area																				
Kudsaya New Suburb				0	0	30,000	300	100	11,000	12,540	48,315	300	161	17,274	19,646	53,344	300	178	19,135	21,813
Proposed Kudsaya New Suburb				0	0				0	0				0	0				0	0
Dummar Extension Area (1st phase)	20,500	124	165	7,500	8,600	26,793	124	216	9,800	11,172	35,017	124	282	12,518	14,271	38,662	124	312	13,862	15,803
Dummar Extension Area (2nd phase)				0	0				0	0				0	0	25,000	216	116	8,956	10,210
Kassioun New Town (650 ha)				0	0				0	0				0	0				0	0
Assad Suburb (1st phase)				0	0				0	0	11,849	40	296	4,226	4,818	13,082	40	327	4,677	5,332
Assad Suburb (2nd phase)				0	0				0	0	25,000	193	130	8,917	10,166	33,456	193	174	11,993	13,672
Assad Suburb Extension Area				0	0				0	0				0	0	14,000	298	47	5,006	5,707
Kaboon Green Area				0	0				0	0		530	0	0	0		530	0	0	0
Assad City				0	0				0	0				0	0	25,000	655	38	8,956	10,210
Proposed Assad City Extension Area (1)				0	0				0	0				0	0				0	0
Proposed Assad City Extension Area (2)				0	0				0	0				0	0				0	0
Proposed Assad City Extension Area (3)				0	0				0	0				0	0				0	0
Special Area Zone (State Factory) **	3,500	25	140	667	760	4,000	25	160	667	760	4,204	25	168	667	760	4,418	25	177	667	760
Others (not classified)				0	0				0	0				0	0				0	0
Sub-total	24,000	149	161	8,200	9,400	60,793	449	135	21,467	24,472	124,385	1,212	103	43,562	49,661	206,962	2,380	87	73,253	83,508
Existing Damascus City																				
Rukn Aldyn	184,125	437	421	75,700	86,285	203,289	437	465	81,842	93,299	224,448	437	513	88,165	100,508	247,808	437	567	95,604	108,989
Mouhajreen	85,523	363	235	35,300	40,185	94,424	363	260	37,907	43,214	104,252	363	287	41,598	47,410	115,103	363	317	44,396	50,611
Mezze	121,651	1,328	91	64,500	73,485	134,092	1,328	101	67,115	76,511	148,048	1,328	111	72,048	82,135	163,457	1,328	123	77,239	88,053
Kafar Souseh	106,015	1,200	88	44,900	51,185	117,049	1,200	98	48,096	54,830	129,231	1,200	108	52,318	59,642	142,682	1,200	119	56,172	64,036
Kanawat	73,710	269	274	40,700	46,385	81,381	269	302	41,938	47,809	89,852	269	334	45,507	51,878	99,203	269	368	48,249	55,004
Kadam	70,855	300	236	30,100	34,285	78,229	300	261	32,078	36,560	86,372	300	288	35,361	40,312	95,361	300	318	37,535	42,790
Midan	158,523	296	536	66,900	76,185	175,022	296	591	72,017	82,099	193,239	296	653	77,641	88,511	213,351	296	721	84,003	95,763
Old City	20,417	145	141	8,600	9,785	22,542	145	155	8,897	10,143	24,889	145	172	10,835	12,352	27,479	145	190	10,583	12,065
Shaghour	72,462	470	154	30,700	34,985	80,004	470	170	32,811	37,404	88,331	470	188	36,136	41,195	97,524	470	207	38,387	43,761
Sarouja	129,859	349	373	53,400	60,785	143,375	349	411	57,662	65,735	158,297	349	454	62,531	71,285	174,773	349	502	67,421	76,860
Yarmouk	237,034	227	1,047	97,300	110,885	261,704	227	1,155	105,416	120,175	288,943	227	1,276	111,057	126,605	319,016	227	1,408	123,066	140,296
Jobar	114,942	642	179	48,600	55,385	126,905	642	198	52,163	59,466	140,113	642	218	56,623	64,550	154,696	642	241	60,903	69,429
Berze	83,799	673	125	45,500	51,785	92,521	673	137	47,083	53,674	102,150	673	152	50,911	58,038	112,782	673	168	54,147	61,728
Kaboon	56,961	497	115	24,200	27,585	62,890	497	127	25,749	29,354	69,436	497	140	28,661	32,674	76,662	497	154	30,171	34,395
Dummar	54,558	473	115	22,600	25,685	60,237	473	127	24,110	27,485	66,506	473	141	26,961	30,736	73,428	473	155	28,314	32,278
Kassioun Mountain		2,956					2,956					2,956					2,956			
Sub-total	1,570,234	10,624	148	689,000	784,875	1,733,664	10,624	163	734,884	837,768	1,914,107	10,624	180	796,343	907,831	2,113,325	10,624	199	856,190	976,056
Total	1,736,997	11,286	154	750,800	855,900	1,948,789	11,586	168	813,300	927,106	2,205,502	12,349	179	900,400	1,026,423	2,501,105	13,517	185	994,800	1,133,987

(Source : Damascus Governate, DAWSSA & JICA)

(Remarks)

* : Area of Villages is water served area.

** : It is a bulk water system to supply water from DAWSSA.

Table 5.5.1 Capacities of Proposed Water Sources

Source Name	Design Capacity (l/s)	Average Capacity (l/s)	Average Capacity (m^3/d)	Seasonal Capacity (MCM)
Existing Resources				
Average Year (1995)	16,070	8,800	766,020	249.74
Dry Year (1990)	9,830	6,870	593,020	186.74
On going schemes				
1. Wadi Marwan Wellfield	235	185	16,000	* 5.84
2. Barada Group 1 Wellfield	230	185	16,000	3.92
3. Barada Group 2 Wellfield	150	120	10,400	2.55
4. Barada Group 3 Wellfield	70	60	5,200	1.27
5. Takadom Wellfield	295	140	12,100	2.96
6. New Kaboon Wellfield				
Phase I	30	25	2,200	0.54
Phase II	120	95	8,200	2.00
7. Kadam Store Wellfield	275	170	14,700	3.60
8. Dumnar Wellfield	125	100	8,600	* 3.14
8. Figeh Side Spring	+ 500[1]	0	0	0
9. Ain Haroush	1500[2]	0	0	0
Master Plan Schemes				
1. Ibn Assaker Wellfield	75	120	10,200	2.50
2. Kadam Railway Wellfield	135	115	9,300	2.28
3. University Wellfield	no change	-200	-17,300	-4.24
4. Fringe Wells	100	110	9,600	1.76
5. Tishreen and Kywan Wf'd				
Phase I	135	110	9,500	2.33
Phase II	130	100	8,600	2.12
Phase III	50	40	3,500	0.85
6. Jaramana Wellfield	360	290	25,000	6.12
7. Kafar Souseh Wellfield	125	80	6,900	1.69
8. Kanawat Gardens Wellfield	125	80	6,900	1.69
9. Shokry al Qouwatly Wf'd	210	170	14,700	3.60
10. Deir al Ashayer	200	200	17,280	** 3.16
Schemes not in the Master Plan				
1. Sergaya and El Irk Wf'ds	180	140	12,000	2.94
2. Rimeh Wellfield	285	285	24,500	** 4.48
3. Beit Jenn Spring				
Average Year	500	485	42,000	10.30
Dry Year	483	335	29,000	7.09
4. Tabibiyeh Spring				
Average Year	500	440	38,400	9.40
Dry Year	449	225	19,400	4.75
5. Barada Wellfield				
Reinforcement	1,400	950	81,600	20.00

Notes Season of 245 days assumed unless indicated otherwise
* Season of 365 days operation
** Season of 183 days operation
1 Net increase in capacity for Figeh Side Spring
2 Will replace the existing pumps at Ain Haroush

Table 5.5.2 Summary of Water Production Plan, Average Conditions, Option 1

1986–95 Actual, 1996–2015 Forecasted, 1995 Hydro-meteorological conditions, M&E = Mechanical & Electrical Works

Source	Type	Calendar Year 1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ain Figeh Area																															
Figeh Sources	Spring/Wells											215	215	215	215	215	215	215	215	215	215	215	215	215	215	215	215	215	215	215	215
Overflow	Loss to River											31	30	30	30	30	29	28	27	25	24	23	21	20	18	17	15	14	13	11	10
Figeh Total to Supply		129.4	166.3	171.9	131.2	122.2	139.6	186.3	188.5	173.0	177.4	184	185	185	185	185	186	187	188	190	191	192	194	195	197	198	200	201	202	204	205
Barada & Al Sabi'																															
Spring Wells	Wellfield	–	–	–	–	–	–	–	–	–	6.8	22.6	22.6	22.6	22.6	22.6	23.3	24.0	24.6	25.3	26.9	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
Group 1	Wellfield	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	3.4	4.4	4.4	4.4	4.4	3.9	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Group 2	Wellfield	–	–	–	–	–	–	–	–	–	–	M&E	2.8	2.8	2.8	2.8	2.4	2.4	2.2	2.2	2.2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Group 3	Wellfield	–	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sub Total		0	0	0	0	0	0	0	0	0	6.8	22.6	25.4	25.4	25.4	28.8	31.0	31.7	32.3	32.9	33.9	33.8	33.8	33.8	33.8	33.9	33.8	33.8	33.8	33.8	33.9
Damascus (Existing Stations)																															
Mazraa	Wellfield	2.12	2.76	3.22	9.30	7.19	7.20	5.86	5.42	8.23	6.35	6.2	6.2	6.2	6.2	6.2	6.4	6.6	6.8	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ibn Assaker	Wellfield	3.33	1.71	2.66	7.30	7.00	6.57	3.57	3.89	4.91	5.64	7.3	7.3	7.3	7.3	7.3	6.3	6.3	6.3	6.3	6.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Ibn Assaker	Re-equiped	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jobar	Wellfield	3.76	1.77	0.95	2.25	5.23	5.16	4.22	3.47	6.37	5.80	7.4	7.4	7.4	7.4	7.4	6.9	6.9	6.9	6.9	6.9	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Kadam Railway	Wellfield	–	–	–	5.14	3.34	3.75	1.98	3.04	3.71	5.25	6.3	6.3	6.3	6.3	6.3	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Kadam Railway	Re-equiped	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Qunawiyn	Wellfield	0.09	0.00	0.00	0.23	1.18	3.94	2.99	3.82	4.14	3.31	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Kaboon	Wellfield	1.00	0.36	0.83	1.96	2.39	2.41	0.86	0.87	1.26	0.86	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
University	Wellfield	–	–	–	–	–	–	–	0.09	2.49	2.53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kadam Store	Wellfield	–	–	–	–	–	–	–	–	0.82	–	M&E	2.2	2.2	2.2	2.2	2.7	2.7	2.7	2.7	2.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Dummar	Wellfield	0.88	0.76	0.30	0.19	0.03	0.17	–	–	–	–	–	–	M&E	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Fringe Wells	23 wells	6.12	5.05	4.98	5.98	5.04	4.90	3.67	3.24	4.32	4.01	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Fringe Wells	8 Re-equiped	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emergency Wells	33 wells	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub Total		17.30	12.61	13.26	30.32	32.71	34.18	23.17	23.86	36.41	34.09	34.9	37.1	37.0	40.2	40.2	39.8	40.0	40.0	40.4	40.4	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
Damascus (New Stations)																															
New Kaboon	2 wells Phase I	–	–	–	–	–	–	–	–	–	–	Drill	M&E	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
New Kaboon	8 wells Phase II	–	–	–	–	–	–	–	–	–	–	–	–	Drill	M&E	1.3	1.4	1.5	1.6	1.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Kafar Souseh	5 wells	–	–	–	–	–	–	–	–	–	–	–	–	Drill	M&E	1.5	1.4	1.3	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Tshreen & Kywan	5 wells Phase I	–	–	–	–	–	–	–	–	–	–	M&E	M&E	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Tshreen & Kywan	9 wells Phase II	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	0.3	0.3	0.3	0.3	1.4	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Tshreen & Kywan	2 wells Phase III	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	0.0	0.0	0.0	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Jramana	9 wells	–	–	–	–	–	–	–	–	–	–	–	–	M&E	4.3	4.6	4.8	5.0	5.3	5.8	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Takadom	7 wells	–	–	–	–	–	–	–	–	–	–	–	M&E	2.4	1.8	1.6	1.9	2.0	2.1	2.2	2.2	2.4	2.6	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Sheikry al Qouwatly	5 wells	–	–	–	–	–	–	–	–	–	–	–	–	–	Drill	M&E	2.3	2.5	2.6	2.7	2.7	2.8	3.0	3.2	3.5	3.6	3.6	3.6	3.6	3.6	3.6
Yalbugh Centre	10 wells	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nawawi Gardens	5 wells	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Drill	M&E	0.6	0.8	1.0	1.1	1.1	1.4	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Sub Total		0	0	0	0	0	0	0	0	0	0	0.0	0.0	5.0	9.0	11.8	14.9	15.9	16.9	18.9	20.3	20.8	21.6	22.3	22.9	23.0	23.0	23.0	23.0	23.0	23.0
Hermon & Zabedani Area																															
Beit Jenn	Spring Intake	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tahbiyah	Spring Intake	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rimeh	8 wells	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wadi Marwan	13 wells	–	–	–	–	–	–	–	–	–	–	M&E	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Sergaya Wellfield	9 wells	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Deir al Ashayer	4 wells	–	–	–	–	–	–	–	–	–	–	–	–	–	M&E	0.5	0.5	1.3	3.0	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Sub Total		0	0	0	0	0	0	0	0	0	0	0.0	7.3	7.3	7.3	7.8	7.8	8.8	10.3	10.5	10.4	10.5	10.5	10.5	10.5	10.4	10.5	10.5	10.5	10.5	10.4
TOTAL SOURCES (MCM)		146.7	178.9	187.1	161.5	154.9	173.7	209.7	212.3	209.4	218.3	241	254	259	266	274	280	284	288	292	296	301	303	306	308	309	311	312	313	315	316
Water Requirement (MCM)											248	252	257	263	268	274	278	283	288	292	297	303	309	316	322	329	335	342	349	356	363
Deficit (MCM)											29.2	11.0	3.2	3.5	1.5	0.2	0.0	0.0	0.0	−0.0	1.1	1.9	3.8	9.9	14.5	19.2	24.5	30.0	33.5	41.2	46.7

Table 5.6.1 List of Candidate Schemes for Water Supply Master Plan Projects

No.	Classification	Name of Scheme		Object	Outline of Project
1	Rehabilitation and Supply Improvement	1.1	Water Main Replacement	Reduction in UFW Losses	Distribution main 97 km
		1.2	Water Meter Replacement		Water meter 86,000 pcs
		1.3	Improvement in Meter Testing and Repairing		New work bench
		1.4	District Meter Area (DMA) System		70 DMA areas
		1.5	Leakage Survey		Total Steam with full equipment
		1.6	Pressure Control		40% of DMA areas
		1.7	Improvement Master Metering	Flow Management	Master meter 58 pcs
		1.8	Water Quality Testing Improvement	Maintain Safety Water	350 samples/day
		1.9	Water Quality Control in South Damascus	Improve Quality	Reduce high nitrate concentration
		1.10	Reinforcement of Existing Water Resources	Ain Figeh Area	PA; Total 205 MCM/y by Main+Extend Side+ Extend Ain Harush++Dier Moukarea
				Barada & Al Sahl	PA; Total 34 MCM/y by Spring wells+Group 1+Group2+Group3
				Damascus Wells	PA; Total 43.8 MCM/y by 9 well fileds+ Fringe Sites+Emergency Sites
2	On going and Planed Water supply Improvement	2.1	Distribution Improvement for Informal Area	Esh Al Warwar	WR; 1.11 MCM/y, On going
				Kassion Mountains Foot	WR; 2.48 MCM/y,
				Tishreen	WR; 1.13 MCM/y,
				Jobar Surrounding-Al Aksab Mosque	Formalized WR;1.88 MCM/y
				East-West Tabbleh	WR;0.92MCM/y
				Mokhayam Yarmouk	WR;6.28 MCM/y
				Naher Esheh-Dahadil & Asalie Kadam	WR; 2.70 MCM/y
				Kafar Souseh Lawan	WR; - MCM/y, Formalized in 1993
				Al Qazzaz &Shaghour Basaleen	WR; 0.78 MCM/y,
				Mezze-Razy	WR; 2.39 MCM/y,
				Mezze#86	WR; 3.39 MCM/y, On going
				Somareyeh	WR; 0.34 MCM/y
				Dummar-Wadi Al Mashare	WR; 1.08 MCM/y,
				Takadom	WR; 2.68 MCM/y, On going
				Kudsaya	WR; 1.52 MCM/y,
		2.2	New Well Centers for Informal areas	New Kaboon	Source for Informal area PA; Total 2.52 MCM/y by 10 wells
				Jaramana	PA; Total 6.1MCM/y by 9 wells
				Takadom	PA; Total2.94 MCM/y by 7 wells
		2.3	New Well Centers for Formal area	Kafar Sousch	PA; Total 1.68 MCM/y by 5 wells
				Faculty of Agriculture	No land acquisition
				Kyan & Tishreen	Increase Production PA; Total 2.31MCM/y by 5 wells
		2.4	Water Resources Development Schemes in Hermon area	Rimeh/ Earneh	PA; Total -- MCM/y by 0 wells
				Wadi Marwan	PA; Total 7.25 MCM/y by10 wells
				Deir al Ashayer	PA; Total3.15 MCM/y by 10 wells
		2.5	Water Supply Distribution Schemes for New Development Areas	Kudsaya New Suburb	System Extension WP; 8.81 MCM/y, On going
				Dummar Extension area (1st phase)	WP; 3.29 MCM/y, On going
				Special Area Zone (State Factory)	WP; 0.18MCM/y
3	Proposed Water Supply	3.1	Rural Areas	Maraba	System Annexation WP; - MCM/y, implemented after 2015
				Assad Suburb (1st phase)	WP; 3.34 MCM/y
		3.2	Distribution Schemes for New Development Area	Proposed Kudsaya New Suburb	System WP; - MCM/y, implemented after 2015
				Dummar Extension area (2nd phase)	WP; 2.83 MCM/y
				Kassioun New Town	WP; - MCM/y, implemented after 2015
				Assad Suburb (2nd phase)	WP; 5.20 MCM/y
				Assad Suburb Extension Area	WP; 2.12 MCM/y
				Kaboon Green Area	WP; - MCM/y, implemented after 2015
				Assad City	WP; - MCM/y, implemented after 2015
				Proposed Assad City Exten. Area (1)	WP; - MCM/y, implemented after 2015
				Proposed Assad City Exten. Area (2)	WP; - MCM/y, implemented after 2015
				Proposed Assad City Exten. Area (3)	Extension WP; - MCM/y, implemented after 2015
		3.3	Water Resources Development Schemes in Damascus (New Stations)	Shokri al Qouwatly	Additional Production of Water PA; Total 3.57 MCM/y by 5 wells
				Yalbuga Center	PA; Total -- MCM/y by 10 wells
				Kanawat Gardens	PA; Total 1.68MCM/y by 5wells
		3.4	Water Resources Development Schemes in Hermon Area & Zabadan	Beit Jenn	PA; --MCM/y by Spring intake
				Talibeyeh	PA; --MCM/y by Spring intake
				Sergaya	PA;2.94MCM/y by 9 wells

Note: WR;Water Requirement in year 1995 for Informal Area,
WP; Water Production Requirement in 2015 for Extension Damascus City Area,
PA; Production Amounts of Water Resources in year 2005.

Table 5.6.2 (1/2) Screening of Candidate Schemes for Water Supply Master Plan Projects

No.	Classification	Name of Scheme		Level of Planning	Implemented Period	Technical Assessment	Environmental Impact	Economic Assessment	Overview Assessment	Candidates for Master Plan
1	Rehabilitation and Supply Improvement	1.1 Water Main Replacement		B		Viable	L	Viable	High viability	Selected
		1.2 Water Meter Replacement	Option 1: Doris meter	E		Low	L	Low	Low	No
			Option 3: Rotary Disk meter	D		Viable	L	Viable	High viability	Selected
		1.3 Improvement in Meter Testing and Repairing		F		Viable	L	Viable	Viable	Selected
		1.4 District Meter Area (DMA) System		D		Viable	L	Viable	High viability	Selected
		1.5 Leakage Survey		D, F		Viable	L	Viable	High viability	Selected
		1.6 Pressure Control		D		Viable	L	Viable	Viable	Selected
		1.7 Improvement of Master Metering		D		Viable	L	Viable	High	Selected
		1.8 Water Quality Testing Improvement		A, D		Viable	L	Viable	Viable	Selected
		1.9 Water Quality Control in South Damascus	Option 1:On-Site Blending	A, D		Viable	M	-	Low	No
			Option 2:Off-Sire Blending	D		Low	H	-	Low	No
			Option 3:Water Treatment	A, D		Low	M	-	Low	No
			Option 4:Suspension of well operation	A, D		Viable	L	-	Low	Selected
			Option 5: No change	A, D		Viable	M	-	Low	No
		1.10 Reinforcement of Existing Water Resources	Ain Figeh Area	Main Spring	F		Status quo	L	-	Viable	In operation
				Extend Side Spring	F		Viable	M	-	Viable	On going
				Extend Ain Haroush	F		Viable	M	-	Viable	On going
				Dier Moukaren	F		Status quo	M	-	Viable	In operation
			Barada & Al Sahl	Spring Wells	F		Status quo	L/M	-	Viable	In operation
				Group 1 W.F	C		Viable	L/M	-	Viable	On going
				Group 2 W.F	C		Viable	L/M	-	Viable	On going
				Group 3 W.F	C		Viable	L/M	-	Viable	On going
			Damascus Wells	Mazzra	F		Status quo	L	-	Low	No
				Ibn Asaker	F		Viable	L	Viable	Viable	Selected
				Jobar	F		Status quo	L	-	Low	No
				Kadam Railway	F		Low	H	Viable	Viable	Selected
				Oumayin	F		Viable	H	-	Viable	Selected
				Kaboon	F		Status quo	L	Viable	Viable	Selected
				University	F		No	H	-	Low	No
				KadamStore	F		Viable	L	-	Viable	Selected
				Dummar	F		Viable	H	-	Viable	Selected
				Fringe Wells	F		Viable	L/M	Viable	Viable	Selected
				Emergency Sites	F		Status quo	L	-	Low	No

Note: W.F: Well Filed

A: Preliminary study by DAWSSA
B: F/S by DAWSSA
C:F/S by MOI
D: Newly proposed by JICA
E: In implement./ On going
F: In operation

H: High
M: Moderate
L: Low

Table 5.6.2 (2/2) Screening of Candidate Schemes for Water Supply Master Plan Projects

No.		Classification	Name of Scheme	Level of Planning	Implemented Period	Technical Assessment	Water Availability in 2005	Water Availability in 2015	Environmental Impact	Economic Assessment	Overview Assessment	Candidates for Master Plan
2	On going and Planned Water supply Improvement	2.1 Distribution Improvement for Informal Area	Esh Al Warwar	E	1995-1998	-	Full	Insufficient	-	-	-	On going
			Kassion Mountains Foot	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
			Tishreen	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
			Jobar Surrounding-Al Aksab Mosque	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
			East-West Tabbleh	A		Viable	Full	Insufficient	L	Low	Viable	Selected
			Mokhayam Yarmouk	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
			Naher Esheh-Dahadil & Asalie Kadam	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
			Kafar Souse Lawan	Formalized		-	Full	Insufficient	-	-	-	No
			Al Qazzaz &Shaghour Basateen	A		Viable	Full	Insufficient	L	Low	Viable	Selected
			Mezze-Razy	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
			Mezze86	E	1995-1998	-	Full	Insufficient	-	-	-	On going
			Somareyeh	A		Viable	Full	Insufficient	L	Low	Viable	Selected
			Dummar-Wadi Al Mashare	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
			Takadom	E	1995-1998	Viable	Full	Insufficient	L	-	-	On going
			Kudsaya	A		Viable	Full	Insufficient	L	Viable	Viable	Selected
		2.2 New Well Centers for Informal Areas	New Kaboon	E		Viable	-	-	L	Viable	Viable	On going
			Jaramana	B		Viable	-	-	L	Viable	Viable	Selected
			Takadom	B		Viable	-	-	L	Viable	Viable	Selected
		2.3 New Well Centers for Formal Area	Kafar Souseh	A		Viable	-	-	L	Viable	Viable	Selected
			Faculty of Agriculture	A		No	-	-	-	-	-	No
			Kywan & Tishreen	B		Viable	-	-	L	Viable	Viable	Selected
		2.4 New Water Resources Development Schemes in Hermon area	Rimeh/ Eamch	C		Viable	-	-	M	Low	Viable	Selected
			Wadi Marwan	E		Viable	-	-	M	-	Viable	Selected
			Deir al Ashaver	C		Viable	-	-	M	Viable	Viable	Selected
		2.4 Water Supply Distribution Schemes for New Development	Kudsaya New Suburb	E		Viable	Full	Insufficient	L	-	-	On going
			Dummar Extension area (1st phase)	E		Viable	Full	Insufficient	L	-	Viable	On going
			Special Area Zone (State Factory)	E		Viable	Full	Insufficient	L		Viable	On going
3	Proposed Water Supply	3.1 Rural Area	Maraba	F	After 2015	-	Full	Insufficient	-	-	-	No
			Assad Suburb (1st phase)	F		Viable	Full	Insufficient	L	-	-	Selected
		3.2 Distribution Schemes for New Development Area	Proposed Kudsaya New Suburb	A	After 2015	-	-		-	-	-	No
			Dummar Extension area (2nd phase)	A		No	No	No	L	-	Low	No
			Kassioun New Town	A	After 2015	-	-	-	-	-	-	No
			Assad Suburb (2nd phase)	A		No	No	No	L	-	Low	No
			Assad Suburb Extension Area	A		No	No	No	L	-	Low	No
			Kaboon Green Area	A	After 2015	-	-	-	-	-	-	No
			Assad City	A	After 2015	-	-	-	-	-	-	No
			Proposed Assad City Exten. Area (1)	A	After 2015	-	-	-	-	-	-	No
			Proposed Assad City Exten. Area (2)	A	After 2015	-	-	-	-	-	-	No
			Proposed Assad City Exten. Area (3)	A	After 2015	-	-	-	-	-	-	No
		3.3 Water Resources Development Schemes in Damascus (New Stations)	Shokri al Qouwatly	D		Viable	-	-	L	Viable	Viable	Selected
			Yalbuga Center	D		Low	-	-	L	-	Low	No
			Kanawat Gardens	D		Viable	-	-	L	Viable	Viable	Selected
		3.4 Water Resource Development Schemes in Hermon Area & Zabadani	Beit Jenn	C, D		Viable	-	-	M	Low	Low	No
			Talibeyeh	C, D		Viable	-	-	M	Low	Low	No
			Sergaya	C, D		Viable	-	-	M	Low	Low	No

A: Preliminary study by DAWSSA
B: F/S by DAWSSA
C:F/S by MOI
D: Newly proposed by JICA
E: In implement/ On going
F: In operation

H: High
M: Moderate
L: Low

Table 5.6.3 (1/2) Summary of Project Cost for Economic Evaluation

PROJECT NAME		L.C. (US$)	F.C. (US$)	TOTAL (US$)
1. SERGAYA PROJECT				
	Direct Construction Cost	1,143,000	5,930,000	7,073,000
	Operation and Maintenance Cost	117,000	0	117,000
2. DEIR AL ASHAYER PROJECT				
	Direct Construction Cost	770,000	3,462,000	4,232,000
	Operation and Maintenance Cost	82,000	0	82,000
3. BEIT JENN & TABIBIYEH PROJECT				
Option-1	Direct Construction Cost	9,899,000	21,280,000	31,179,000
	Operation and Maintenance Cost	346,000	0	346,000
Option-2	Direct Construction Cost	10,222,000	21,966,000	32,188,000
	Operation and Maintenance Cost	407,000	0	407,000
4. RIMEH PROJECT				
	Direct Construction Cost	2,296,000	10,031,000	12,327,000
	Operation and Maintenance Cost	124,000	0	124,000
5. HERMON AREA PROJECT : CASE-1				
	Direct Construction Cost	12,093,000	31,311,000	43,404,000
	Operation and Maintenance Cost	469,000	0	469,000
HERMON AREA PROJECT : CASE-2				
	Direct Construction Cost	13,960,000	28,850,000	42,810,000
	Operation and Maintenance Cost	470,000	0	470,000
HERMON AREA PROJECT : CASE-3				
	Direct Construction Cost	14,074,000	30,505,000	44,579,000
	Operation and Maintenance Cost	497,000	0	497,000
6. JARAMANA PRODUCTION WELL CENTER				
	Direct Construction Cost	445,000	1,990,000	2,435,000
	Operation and Maintenance Cost	233,000	0	233,000
7. KAFAR SOUSE PRODUCTION WELL CENTER				
	Direct Construction Cost	412,000	1,074,000	1,486,000
	Operation and Maintenance Cost	96,000	0	96,000
8. TISHREEN & KYWAN WELL FIELD				
(Oumawiyin Well Production Center)				
Phase-1	Direct Construction Cost	26,000	303,000	329,000
	Operation and Maintenance Cost	22,000	0	22,000
Phase-2	Direct Construction Cost	11,000	178,000	189,000
	Operation and Maintenance Cost	29,000	0	29,000
Phase-3	Direct Construction Cost	99,000	735,000	834,000
	Operation and Maintenance Cost	76,000	0	76,000
9. SHOUKRY AL QOUWATLY STREET PRODUCTION WELL CENTER				
	Direct Construction Cost	449,000	1,291,000	1,740,000
	Operation and Maintenance Cost	131,000	0	131,000
10. AL KANAWAT GARDENS PRODUCTION WELL CENTER				
	Direct Construction Cost	413,000	1,078,000	1,491,000
	Operation and Maintenance Cost	96,000	0	96,000
11. KABOON WELL FIELD EXTENSION PROJECT				
	Direct Construction Cost	467,000	1,611,000	2,078,000
	Operation and Maintenance Cost	105,000	0	105,000
12. YALBUGA PRODUCTION WEEL CENTER				
	Direct Construction Cost	479,000	1,886,000	2,365,000
	Operation and Maintenance Cost	168,000	0	168,000
13. TAKADOM WELL FIELD				
	Direct Construction Cost	22,000	88,000	110,000
	Operation and Maintenance Cost	0		0
14. IBN ASSAKER PRODUCTION WELL CENTER IMPROVEMENT				
	Direct Construction Cost	146,000	1,097,000	1,243,000
	Operation and Maintenance Cost	0		0
15. KADAM RAILWAY WELL FIELD IMPROVEMENT				
	Direct Construction Cost	65,000	1,165,000	1,230,000
	Operation and Maintenance Cost	0		0
16. FRINGE WELL IMPROVEMENT				
	Direct Construction Cost	173,000	895,000	1,068,000
	Operation and Maintenance Cost	0		0
17. REPLACEMENT OF CAST IRON PIPE				
	Direct Construction Cost	2,808,000	11,738,000	14,546,000
	Maintenance Cost	0		0

Table 5.6.3 (2/2) Summary of Project Cost for Economic Evaluation

PROJECT NAME	L.C. (US$)	F.C. (US$)	TOTAL (US$)
18. REPLACEMENT OF WATER METER			
Direct Construction Cost	901,000	7,256,000	8,157,000
Maintenance Cost	0		0
19. KASSIOUN MOUNTAINS FOOT SYSTEM			
Direct Construction Cost	170,000	1,143,000	1,313,000
Maintenance Cost	4,000	0	4,000
20. TISHREEN SYSTEM			
Direct Construction Cost	199,000	918,000	1,117,000
Maintenance Cost	3,000	0	3,000
21. JOBAR SURROUNDING - AL AKSAB MOSQUE SYSTEM			
Direct Construction Cost	350,000	1,594,000	1,944,000
Maintenance Cost	6,000	0	6,000
22. EAST - WEST TABBALEH SYSTEM			
Direct Construction Cost	744,000	2,665,000	3,409,000
Maintenance Cost	10,000	0	10,000
23. MOKHAYAM AL YARMOUK SYSTEM			
Direct Construction Cost	619,000	3,612,000	4,261,000
Maintenance Cost	13,000	0	13,000
24. NAHER ESHAH - DAHADIL & ASALIE KADAM SYSTEM			
Direct Construction Cost	937,000	3,719,000	4,656,000
Maintenance Cost	14,000	0	14,000
25. AL QAZZAZ & SHAGOUR BASSATEEN SYSTEM			
Direct Construction Cost	353,000	1,345,000	1,698,000
Maintenance Cost	5,000	0	5,000
26. MEZZE-RAZY SYSTEM			
Direct Construction Cost	937,000	3,885,000	4,822,000
Maintenance Cost	14,000	0	14,000
27. SOMARIEYA SYSTEM			
Direct Construction Cost	207,000	759,000	966,000
Maintenance Cost	3,000	0	3,000
28. DUMMAR - WADI AL MASHARE SYSTEM			
Direct Construction Cost	230,000	1,012,000	1,242,000
Maintenance Cost	4,000	0	4,000
29. KUDSAYA SYSTEM			
Direct Construction Cost	275,000	1,261,000	1,536,000
Maintenance Cost	5,000	0	5,000
30. IMPROVEMENT OF MASTER METER			
Direct Construction Cost	172,000	2,922,000	3,094,000
Maintenance Cost	93,000	0	93,000
31. PRESSURE CONTROL SYSTEM			
Direct Construction Cost	56,000	309,110	365,110
Maintenance Cost	10,000	0	10,000
32. DISTRICT METER AREA (DMA) SYSTEM			
Direct Construction Cost	102,000	713,000	815,000
Maintenance Cost	24,000	0	24,000
33. BARADA SPRING REINFORCEMENT			
Direct Construction Cost	721,000	5,311,000	6,032,000
Operation and Maintenance Cost	408,000	0	408,000
34. REINFORCEMENT OF WATER QUALITY TESTING LABORATORY			
Direct Construction Cost	60,000	652,000	712,000
Operation and Maintenance Cost	39,000	65,000	104,000
35. REINFORCEMENT OF LEAKAGE SURVEY TEAM			
Direct Construction Cost	0	26,000	26,000
Operation and Maintenance Cost	19,000	0	19,000
36. METER TESTING AND REPAIRING			
Direct Construction Cost	20,000	66,000	86,000
Operation and Maintenance Cost	2,000	0	2,000

Table 5.6.4 (1/2) Initial Environmental Examination of Proposed Projects

No.	Classification	Name of Scheme		Natural Environment		Public Health / Pollution		Waste	Local Socio/Econo	Cultural Asset	Overall Evaluation
				water	others	constr.	operation				
1	Rehabilitation Improvement	1.1 Water Main Replacement		+/-	-L	-L	+M	-L	+L	-L	Low
		1.2 Water Meter Replacement	Option 1: Doris meter	+/-	+/-	-L	+M	-L	+L	+/-	Low
			Option 2: Rotary Disk meter	+/-	+/-	-L	+M	-L	+L	+/-	Low
		1.3 Improvement in Meter Testing and Repairing	Option 1:Doris meter	+/-	+/-	-L	+M	-L	+L	+/-	Low
			Option 2: Rotary Disk meter	+/-	+/-	-L	+M	-L	+L	+/-	Low
		1.4 District Meter Area (DMA) System		+/-	-L	-L	+M	-L	+L	-L	Low
		1.5 Leakage Survey		+/-	+/-	-L	+M	-L	+L	+/-	Low
		1.6 Pressure Control		+/-	+/-	-L	+M	-L	+L	+/-	Low
		1.7 Improvement of Master Metering		+/-	-L	-L	+M	-L	+L	+/-	Low
		1.8 Water Quality Testing Improvement		+/-	-L	-L	+H	-L	+L	-L	Low
		1.9 Water Quality Contorl in South Damascus	Option 1:On-Site Blending	+L	-L	-L	-M	-L	+L	-L	Moderate
			Option 2:Off-Site Blending	+/-	-L	-L	-H	-L	+L	-L	High
			Option 3:Water Treatment	-L	-L	-L	+H	-H	+L	-L	Moderate
			Option 4:Suspension of well operation	+L	-L	-L	+M	-L	+L	-L	Low
			Option 5: No change	+/-	+/-	+/-	+/-	+/-	+/-	+/-	Moderate
		1.10 Reinforcement of Existing Water Resources	Ain Figeh Area Main Spring	-M	-M	-L	+M	-L	-L	-L	Low
			Extend Side Spring	-M	-M	-L	+L	-L	-L	-L	Moderate
			Extend Ain Haroush	-M	-M	-L	+L	-L	-M	-L	Moderate
			Dier Moukaren	-M	-M	-L	+L	-L	-M	-L	Moderate
			Barada & Al Sahl Spring Wells	-M	-M	-L	+L	-L	-L	-L	Low/Moderate
			Group 1 W.F	-M	-M	-L	+L	-L	-M	-L	Low
			Group 2 W.F	-M	-M	-L	+L	-L	-M	-L	Low
			Group 3 W.F	-M	-M	-L	+L	-L	-M	-L	Low
			DamascusWells Mazzra	-M	-L	-L	+L	-L	+L	-L	Low
			Ibn Asaker	-M	-L	-L	+L	-L	+L	-L	Low
			Jobar	-M	-L	-L	+L	-L	+L	-L	Low
			Kadam Railway	-M	-L	-L	-H	-L	+L	-L	High
			Qumawiyin	-M	-L	-L	-H	-L	+L	-L	High
			Kaboon	-M	-L	-L	+L	-L	+L	-L	Low
			University	-M	-L	-L	-H	-L	+L	-L	High
			KadamStore	-M	-L	-L	+L	-L	+L	-L	Low
			Dummar	-M	-L	-L	-H	-L	+L	-L	High
			Fringe Site	-M	-L	-L	+L	-L	+L	-L	Low/Moderate
			Emergency Sites	-M	-L	-L	+L	-L	+L	-L	Low
2	On going and Planned Water supply Improvement	2.1 Distribution Improvement for Informal Area	Esh Al Warwar	+/-	-L	-L	+M	-L	+H	-L	Low
			Kassion Mountains Foot	+/-	-L	-L	+M	-L	+H	-L	Low
			Tishreen	+/-	-L	-L	+M	-L	+H	-L	Low
			Jober Surrounding-Al Aksab Mosque	+/-	-L	-L	+M	-L	+H	-L	Low
			East-West Tabbieh	+/-	-L	-L	+M	-L	+H	-L	Low
			Mokhayam Yarmouk	+/-	-L	-L	+M	-L	+H	-L	Low
			Naher Esheh-Dahadil & Asalie Kadam	+/-	-L	-L	+M	-L	+H	-L	Low

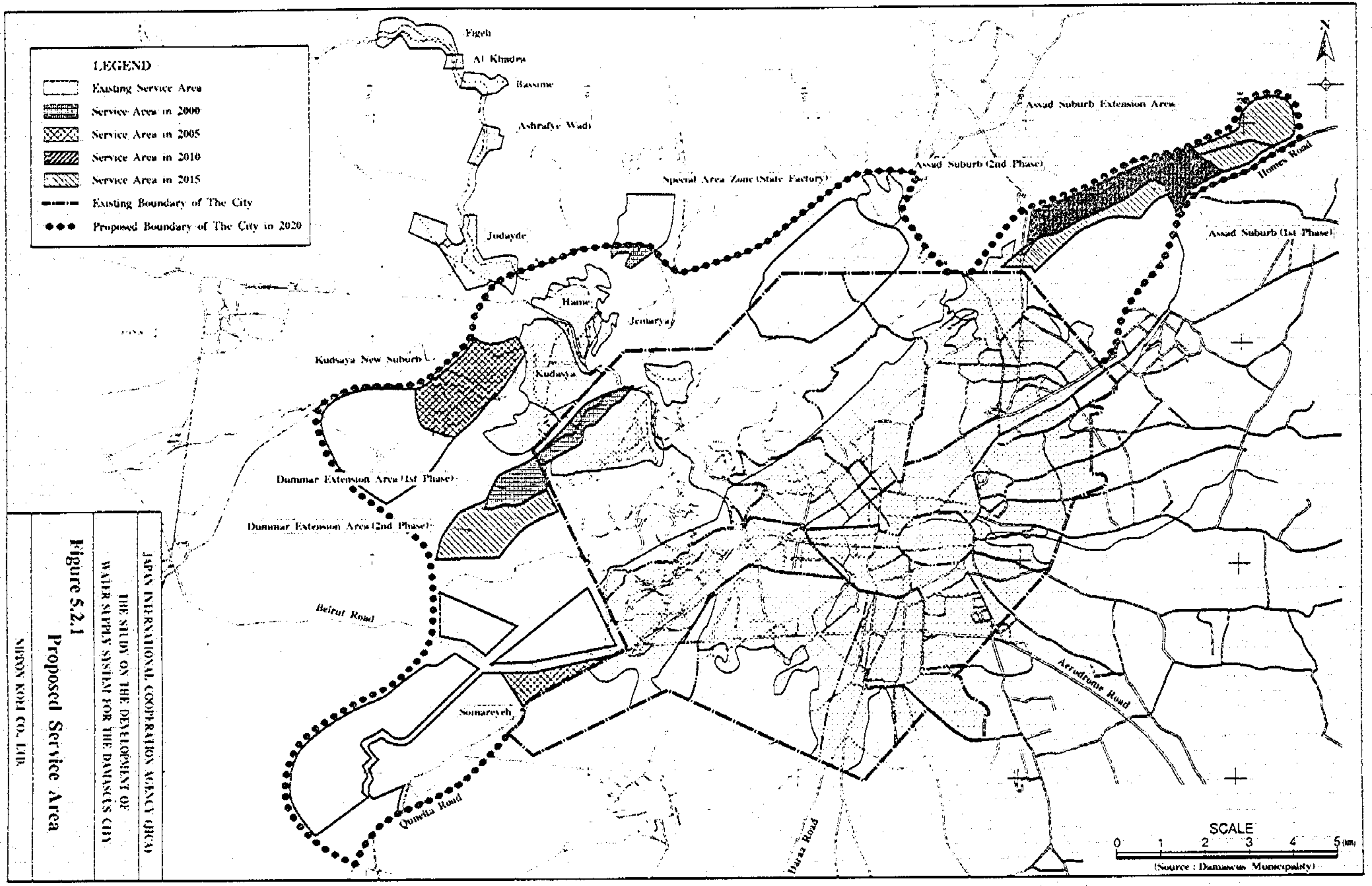
Table 5.6.4 (2/2) Initial Environmental Examination of Proposed Projects

No.	Classification	Name of Scheme	Natural Environment		Public Health / Pollution		Waste	Local Socio/Econo	Cultural Asset	Overall Evaluation
			water	others	constr.	operation				
		Kafar Souse Lawan	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Al Qazzaz &Shaghour Basateen	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Mezze-Razy	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Mezze#86	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Somareyeh	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Dummar-Wadi Al Mashare	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Takadom	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Kudsaya	+/-	- L	- L	+ M	- L	+ H	- L	Low
	2.2 New Well Centers for Informal Areas	New Kaboon	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Jaramana	+/-	- L	- L	+ M	- L	+ H	- L	Low
		Takadom	+/-	- L	- L	+ M	- L	+ H	- L	Low
	2.3 New Well Centers for Formal Area	Kafar Souseh	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Faculty of Agriculture	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Kywan & Tishreen	+/-	- L	- L	+ L	- L	+ H	- L	Low
	2.4 Water Resources Development Schemes in Hermon area	Rimeh/ Eameh	- M	- L	- L	+ L	- L	- L	- L	Moderate
		Wadi Marwan	- M	- L	- L	+ L	- L	- L	- L	Moderte
		Deir al Ashayer	- M	- L	- L	+ L	- L	- L	- L	Moderate
	2.5 Water Supply Dist'n Schemes for New Development Areas	Kudsaya New Suburb	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Dummar Extension area (1st phase)	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Special Area Zone (State Factory)	+/-	- L	- L	+ L	- L	+ H	- L	Low
3	Proposed Water Supply 3.1 Rural Area	Maraba	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Assad Suburb (1st phase)	+/-	- L	- L	+ L	- L	+ H	- L	Low
	3.2 Distribution Schemes for New Development Area	Proposed Kudsaya New Suburb	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Dummar Extension area (2nd phase)	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Kassioun New Town	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Assad Suburb (2nd phase)	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Assad Suburb Extension Area	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Kaboon Green Area	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Assad City	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Proposed Assad City Exten. Area (1)	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Proposed Assad City Exten. Area (2)	+/-	- L	- L	+ L	- L	+ H	- L	Low
		Proposed Assad City Exten. Area (3)	+/-	- L	- L	+ L	- L	+ H	- L	Low
	3.3 Water Resources Development Schemes in Damascus (New Stations)	Shokri al Qouwatly	+/-	- L	- L	+ L	- L	+ L	- L	Low
		Yalbuga Center	+/-	- L	- L	+ L	- L	+ L	- L	Low
		Kanawat Garcens	+/-	- M	- L	+ L	- L	+ L	- L	Low
	3.4 Water Resources Schemes in Hermon and Zabadani	Beit Jenn	- H	- M	- L	+ L	- L	- M	- L	Moderate
		Talibeyeh	- M	- M	- L	+ L	- L	- M	- L	Moderate
		Sergaya	- M	- M	- L	+ L	- L	- H	- L	Moderate

Impact rating + H > + M > + L > +/- > - L > - M > - H

+ : positive impact / - : negative impact

Overall Evaluation (Negative) High > Moderate > Low



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 5.2.1
Proposed Service Area

NIPPON KOEI CO., LTD.

(Unit : 1000 m3/d)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Accounted Water Demand	304.0	334.2	364.4	394.6	424.8	455.0	476.7	498.4	520.2	541.9	563.6	580.0	596.4	612.8	629.2	645.6	665.7	685.8	705.9	726.0	746.1
Meter Malfunction	88.6	75.6	62.6	49.5	36.5	23.5	17.6	11.8	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Informal Use	81.4	71.3	61.2	51.2	41.1	31.0	26.4	21.8	17.3	12.7	8.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
System Losses	204.0	209.3	215.9	225.2	231.8	241.3	240.8	244.4	247.2	249.4	241.6	253.3	253.2	252.7	252.0	254.8	251.2	251.1	250.6	249.8	248.7
Water requirement	678.0	690.4	704.1	720.5	734.2	750.8	761.5	776.4	790.5	804.0	813.3	833.3	849.6	865.5	881.2	900.4	916.9	936.9	956.5	975.8	994.8

(Remark) - 1995's water requirement is effective water requirement based on data of production on April.
- 1995's water demand is assumed from effective water requirement and UFW.

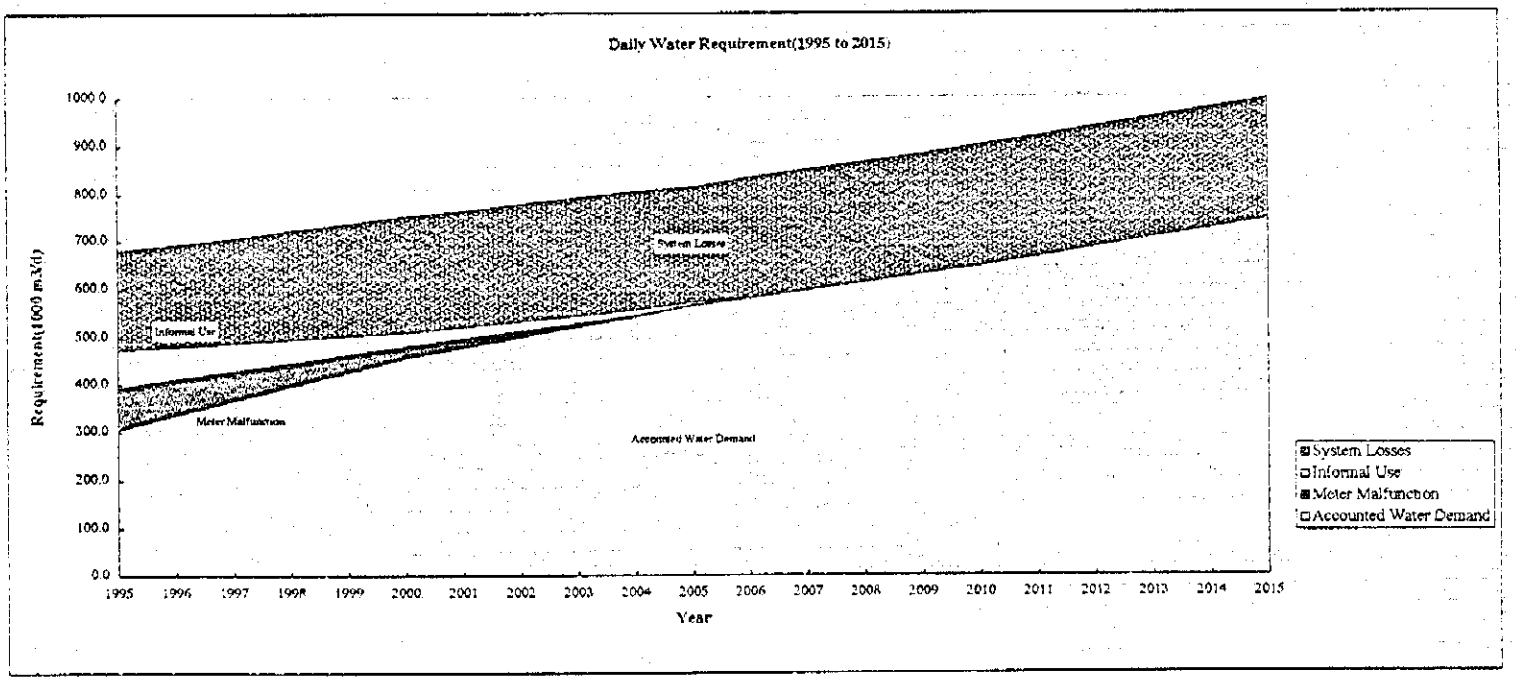
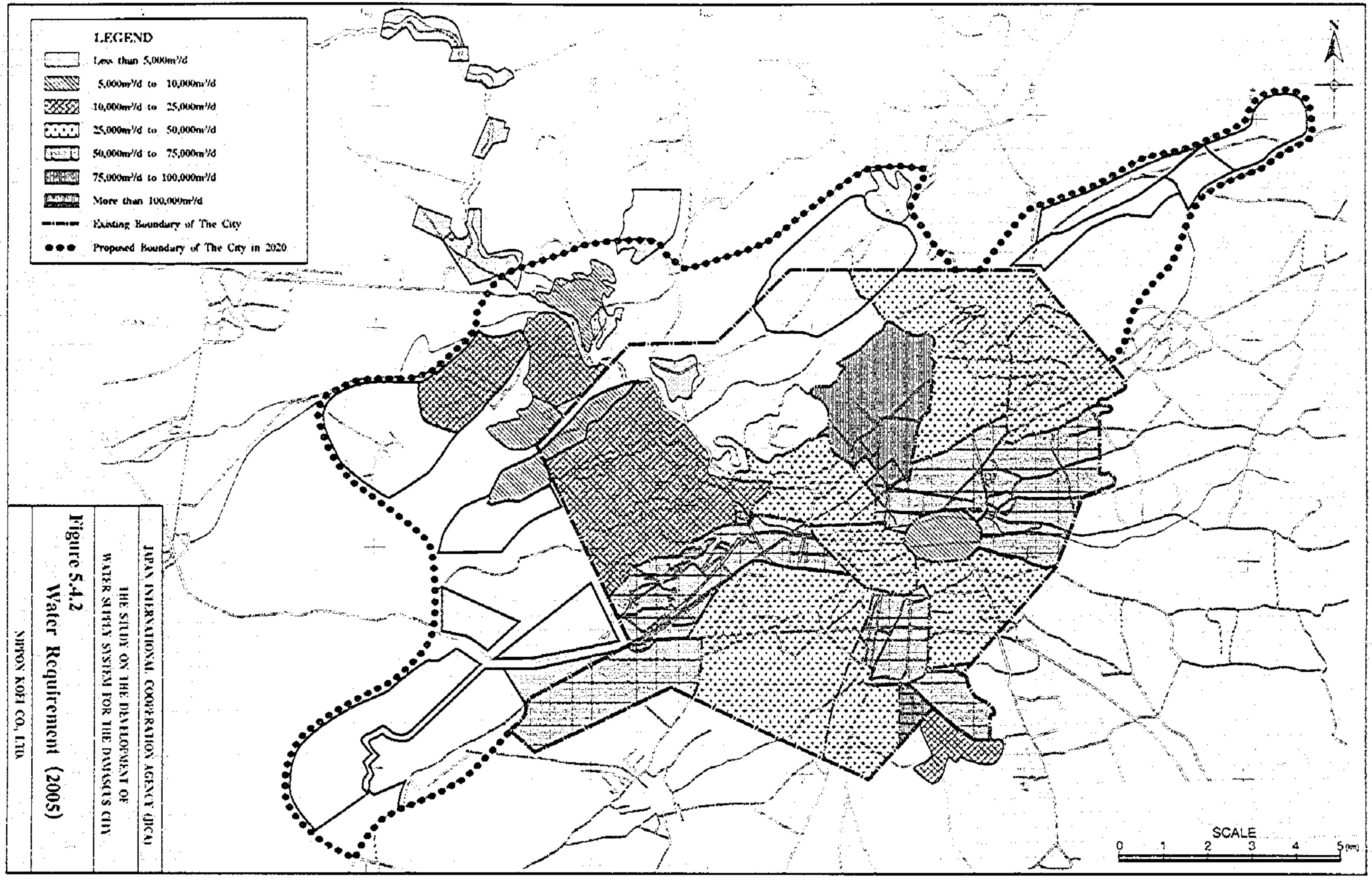


Figure 5.4.1 Daily Water Requirement

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
NIPPON KOEI CO., LTD.

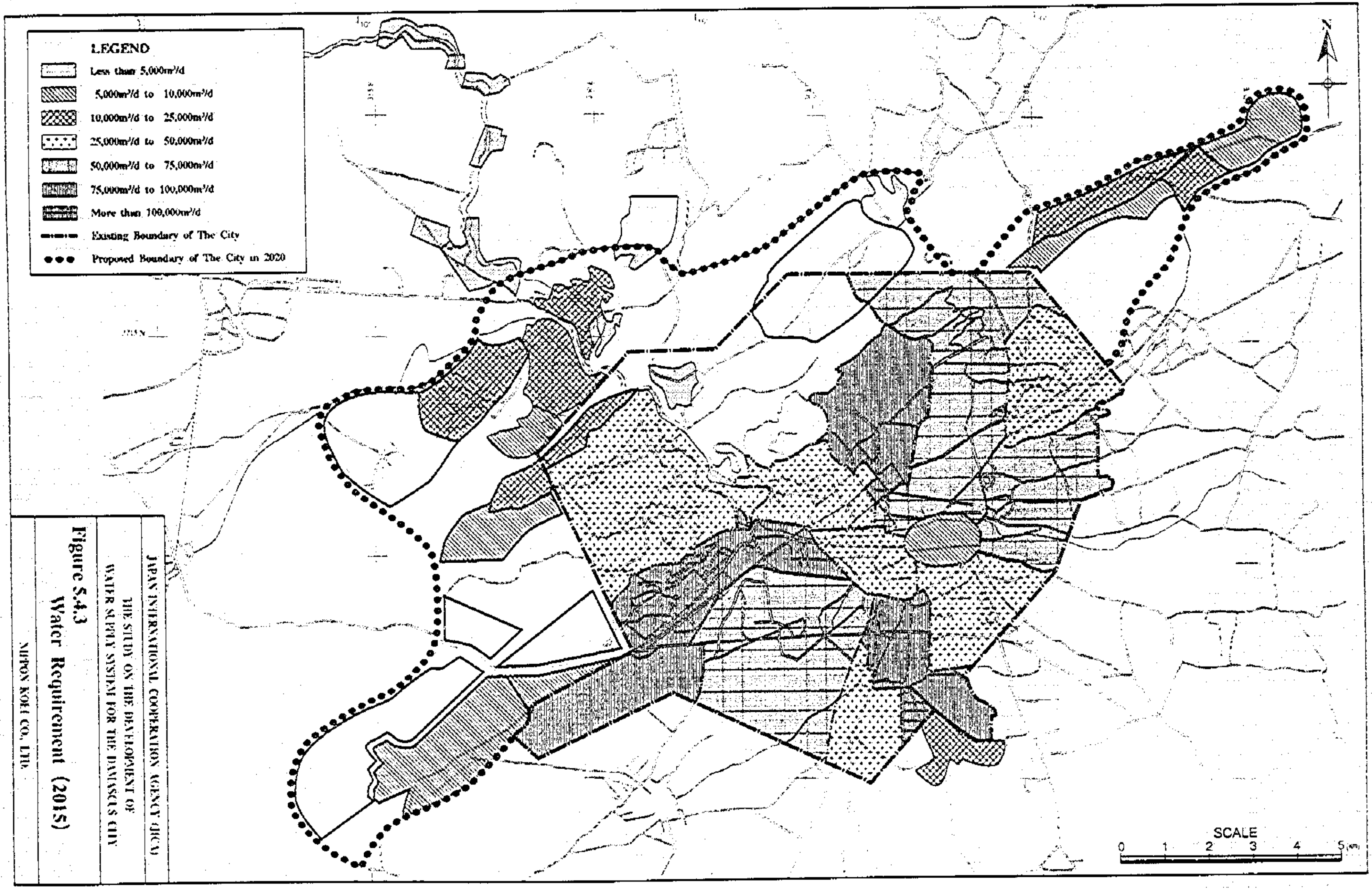


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 5.4.2 Water Requirement (2005)

NIPPON KOEI CO., LTD.

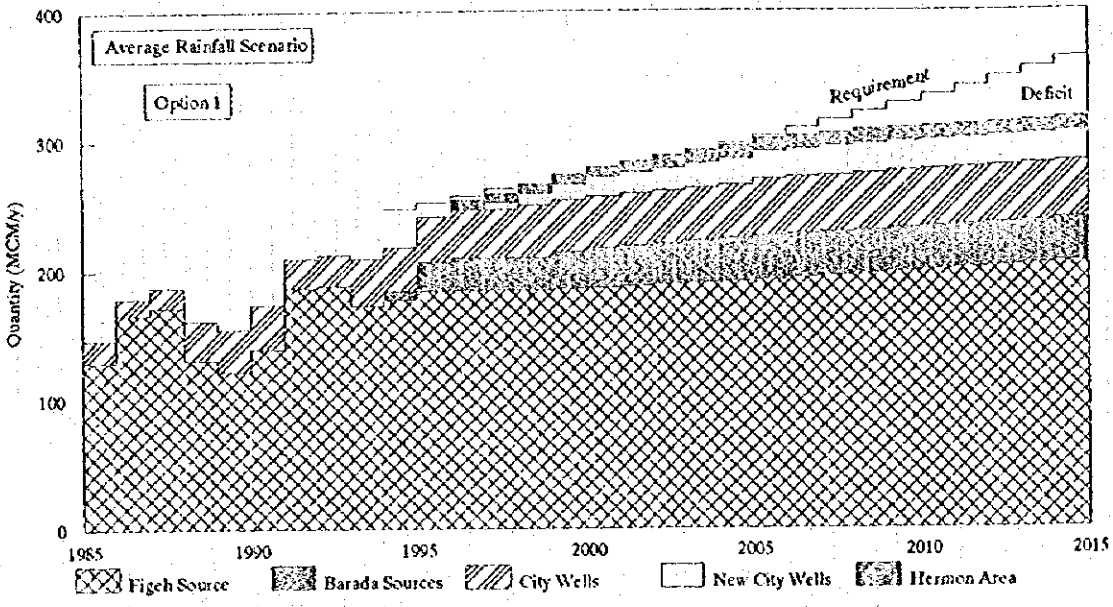


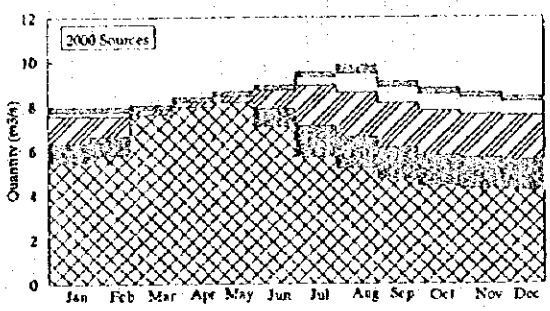
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

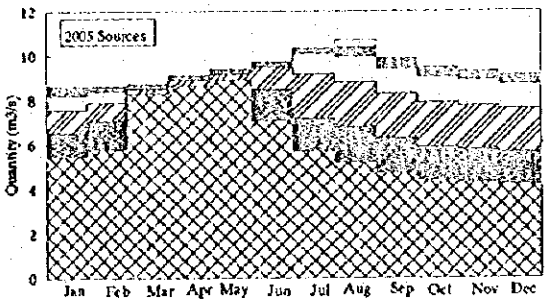
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

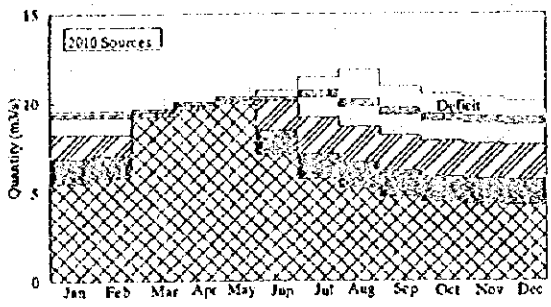
Figure 5.4.3 Water Requirement (2015)

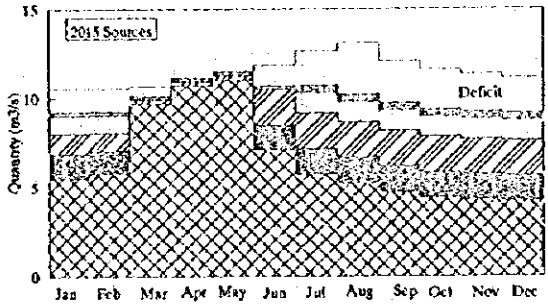
NIPPON KOEI CO., LTD.



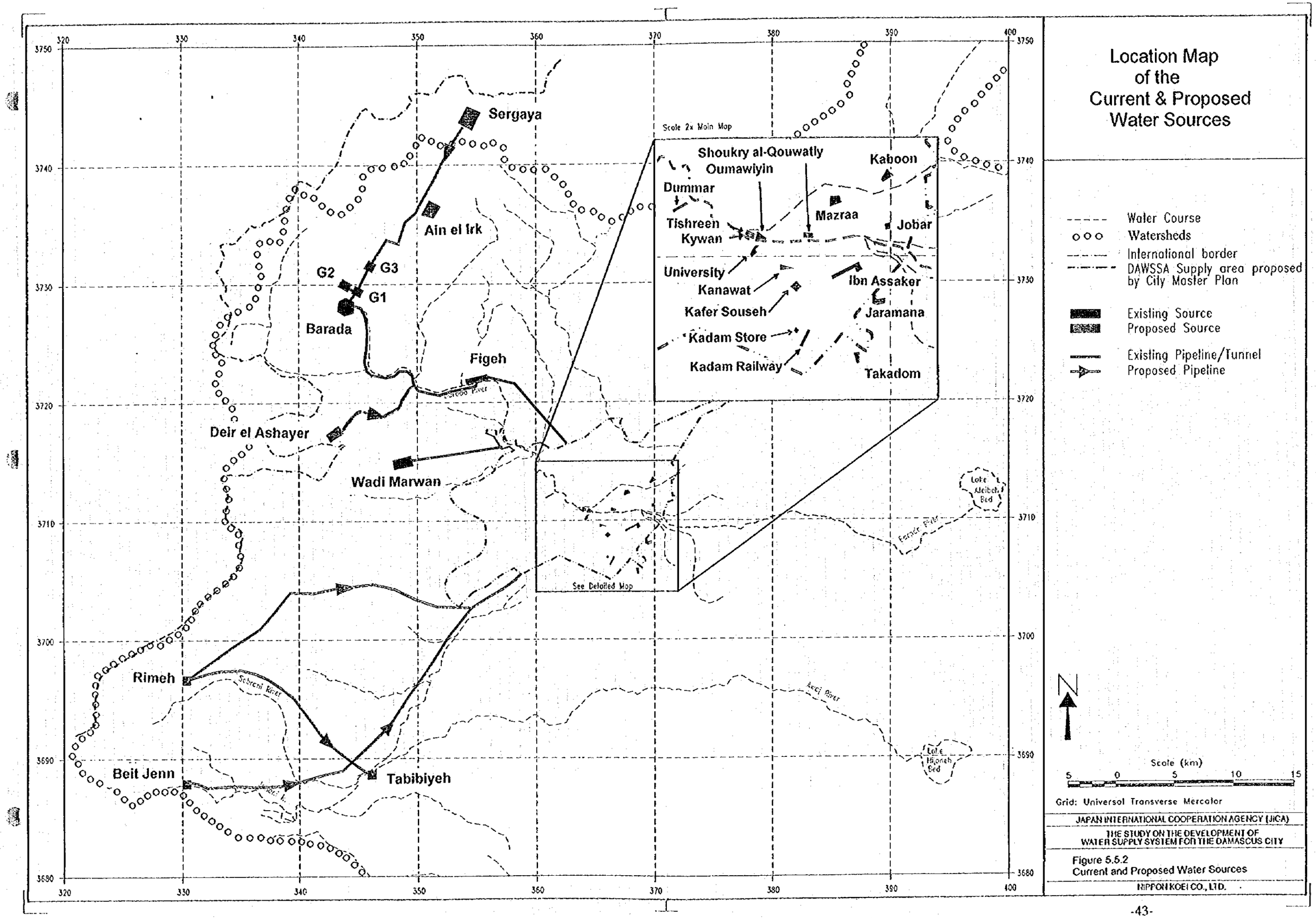








JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.5.1 Water Production Plan
NIPPON KOEI CO., LTD.


Location Map
of the
Current & Proposed
Water Sources
Water Course
Watersheds
International border
DAWSSA Supply area proposed by City Master Plan
Existing Source
Proposed Source
Existing Pipeline/Tunnel
Proposed Pipeline
Sergaya
Ain el Irk
G2
G3
G1
Barada
Figeh
Deir el Ashayer
Wadi Marwan
Rimeh
Beit Jenn
Tabibiyeh
Scale 2x Main Map
Shoukry al-Qouwatly
Oumawiyin
Kaboon
Dummar
Tishreen
Kywan
Mazraa
Jobar
University
Kanawat
Kafer Souseh
Kadam Store
Kadam Railway
Ibn Assaker
Jaramana
Takadom
See Detailed Map
Lake Aleibeh Bed
Lake Hijaneh Bed
Scale (km)
5 0 5 10 15
Grid: Universal Transverse Mercator
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.5.2
Current and Proposed Water Sources
NIPPON KOEI CO., LTD.