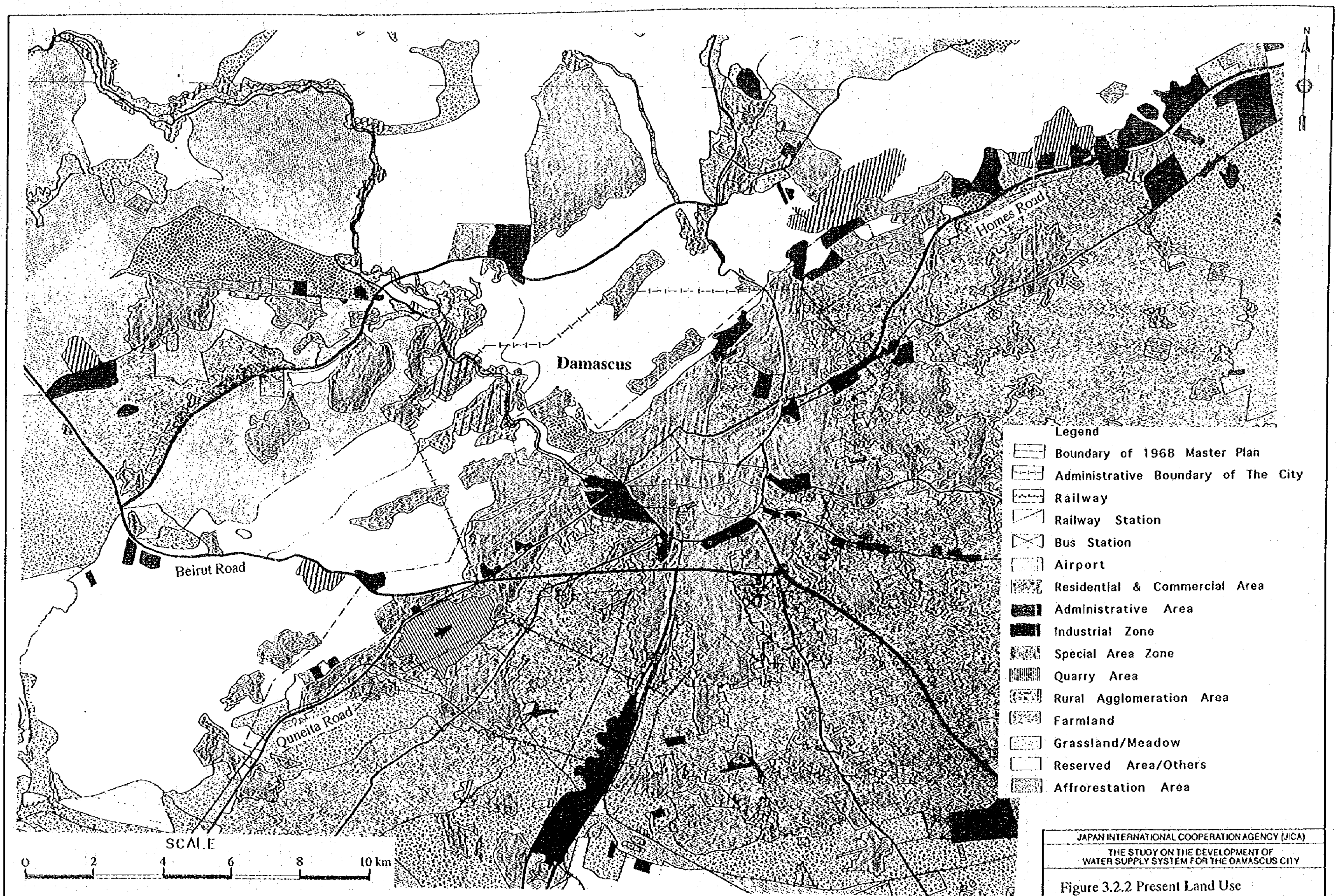

(Source : Damascus Municipality)

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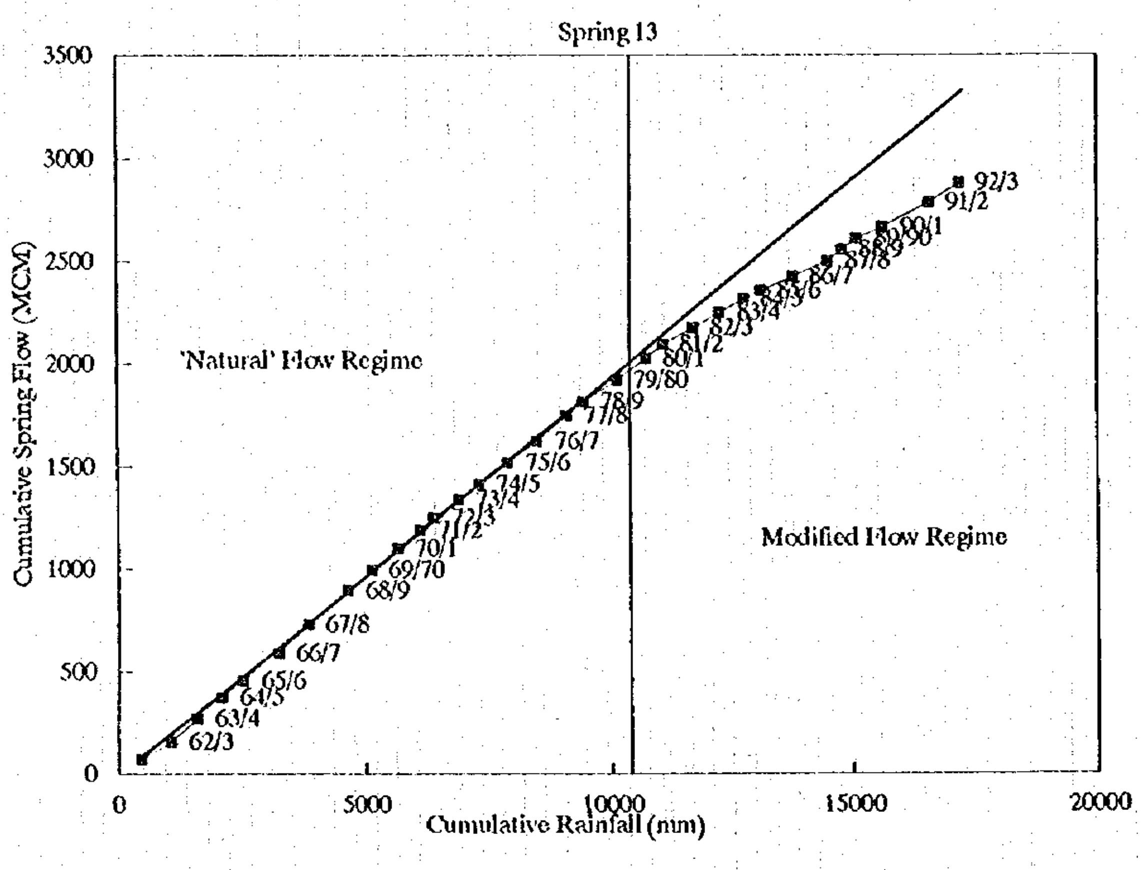
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.2.2 Present Land Use

NIPPON KOEI CO., LTD.



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

Figure 3.3.1
Cumulative Discharge and Rainfall for Barada Spring

NIPPON KOEI CO., LTD.

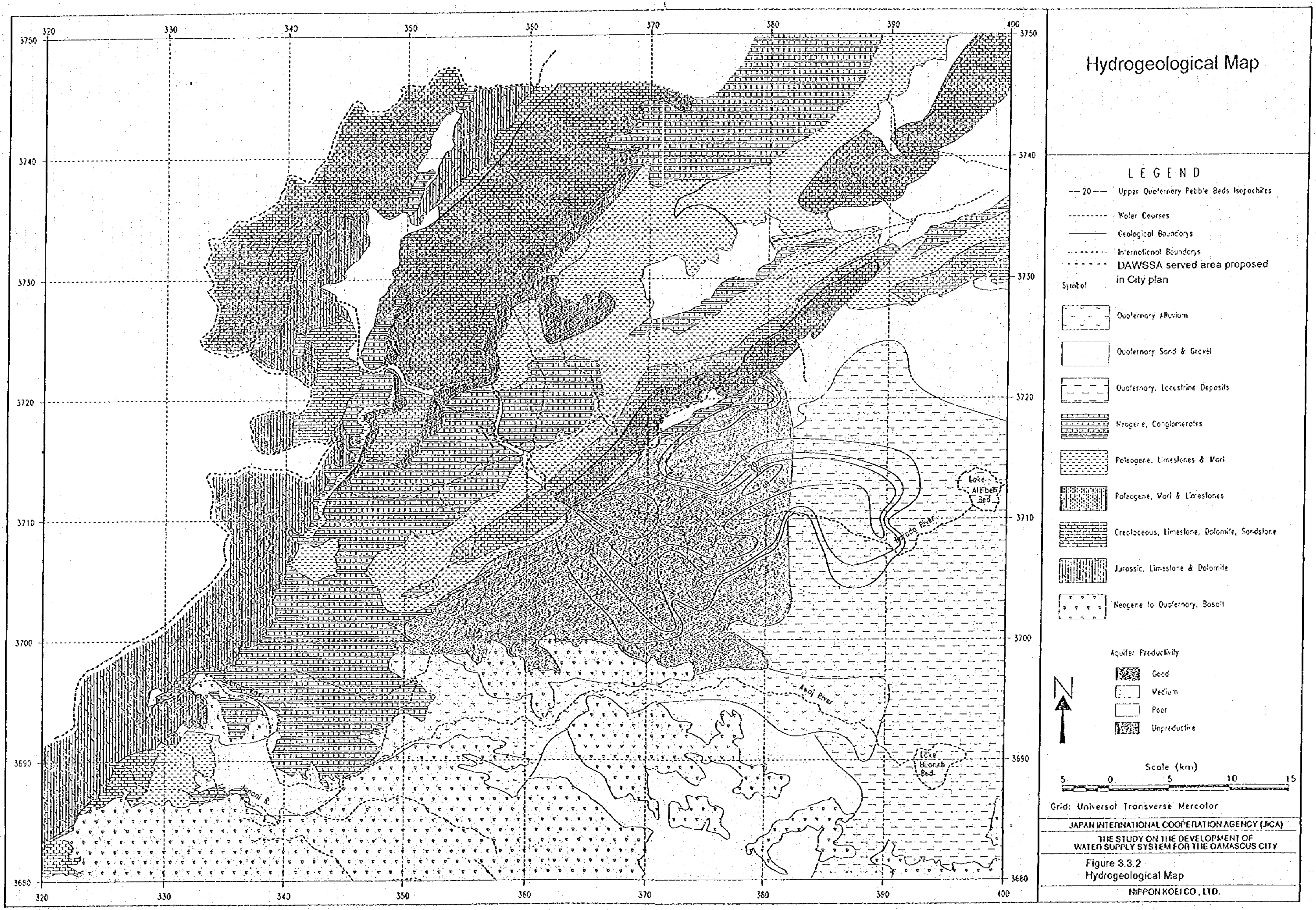
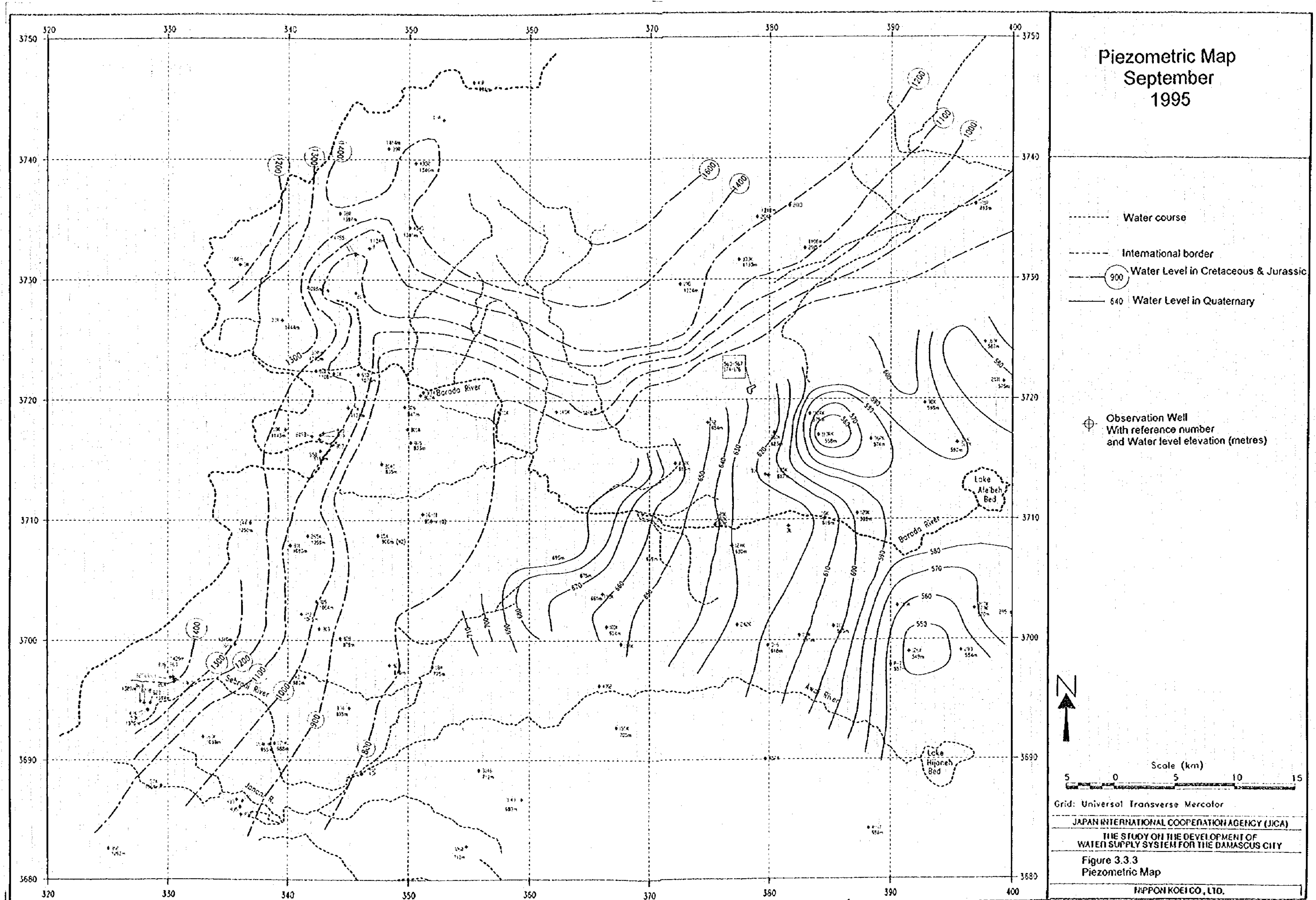
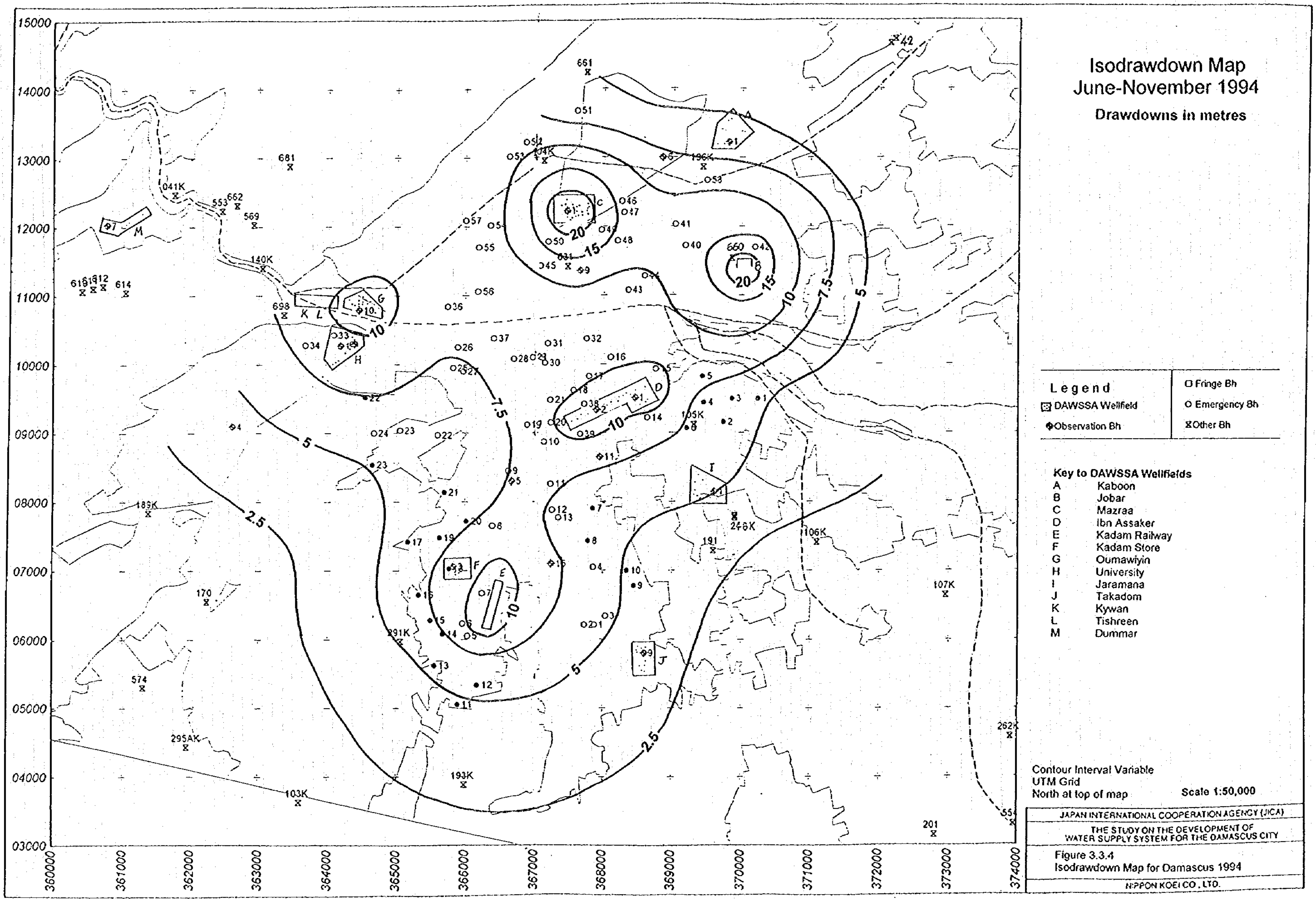
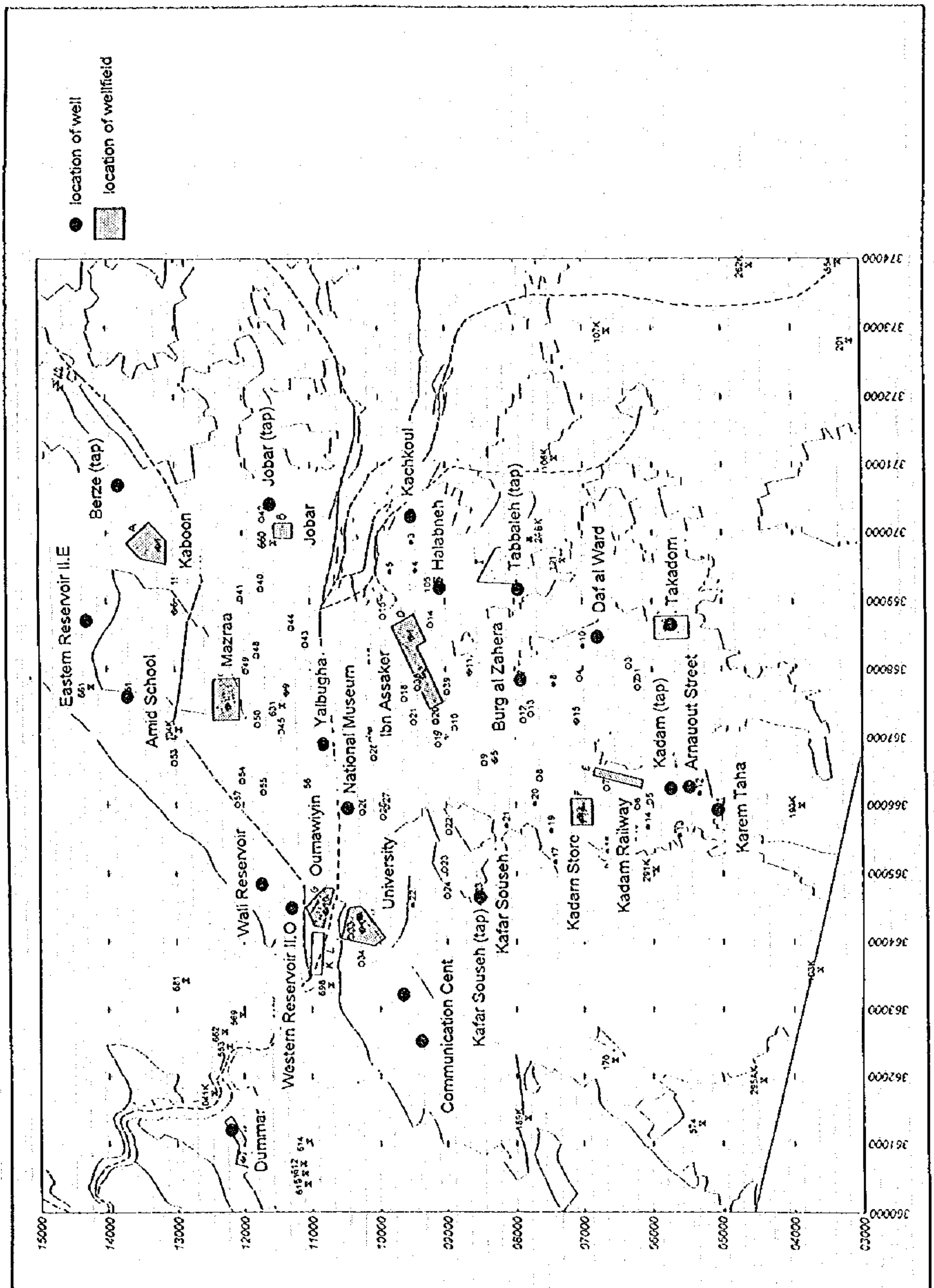


Figure 3.3.2
Hydrogeological Map



Piezometric Map
September
1995
Water course
International border
900 Water Level in Cretaceous & Jurassic
640 Water Level in Quaternary
Observation Well
With reference number
and Water level elevation (metres)
Barada River
Sebrani River
Awaj River
Lake Ate'beh 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 3.3.3
Piezometric Map
NIPPON KOEI CO., LTD.


Isodrawdown Map
June-November 1994
Drawdowns in metres
Legend
DAWSSA Wellfield
Observation Bh
Fringe Bh
Emergency Bh
Other Bh
Key to DAWSSA Wellfields
A Kaboon
B Jobar
C Mazraa
D Ibn Assaker
E Kadam Railway
F Kadam Store
G Oumawiyin
H University
I Jaramana
J Takadom
K Kywan
L Tishreen
M Dummar
Contour Interval Variable
UTM Grid
North at top of map
Scale 1:50,000
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 3.3.4
Isodrawdown Map for Damascus 1994
NIPPON KOEI CO., LTD.



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

Figure 3.4.1a
Sampling Locations (Damascus)

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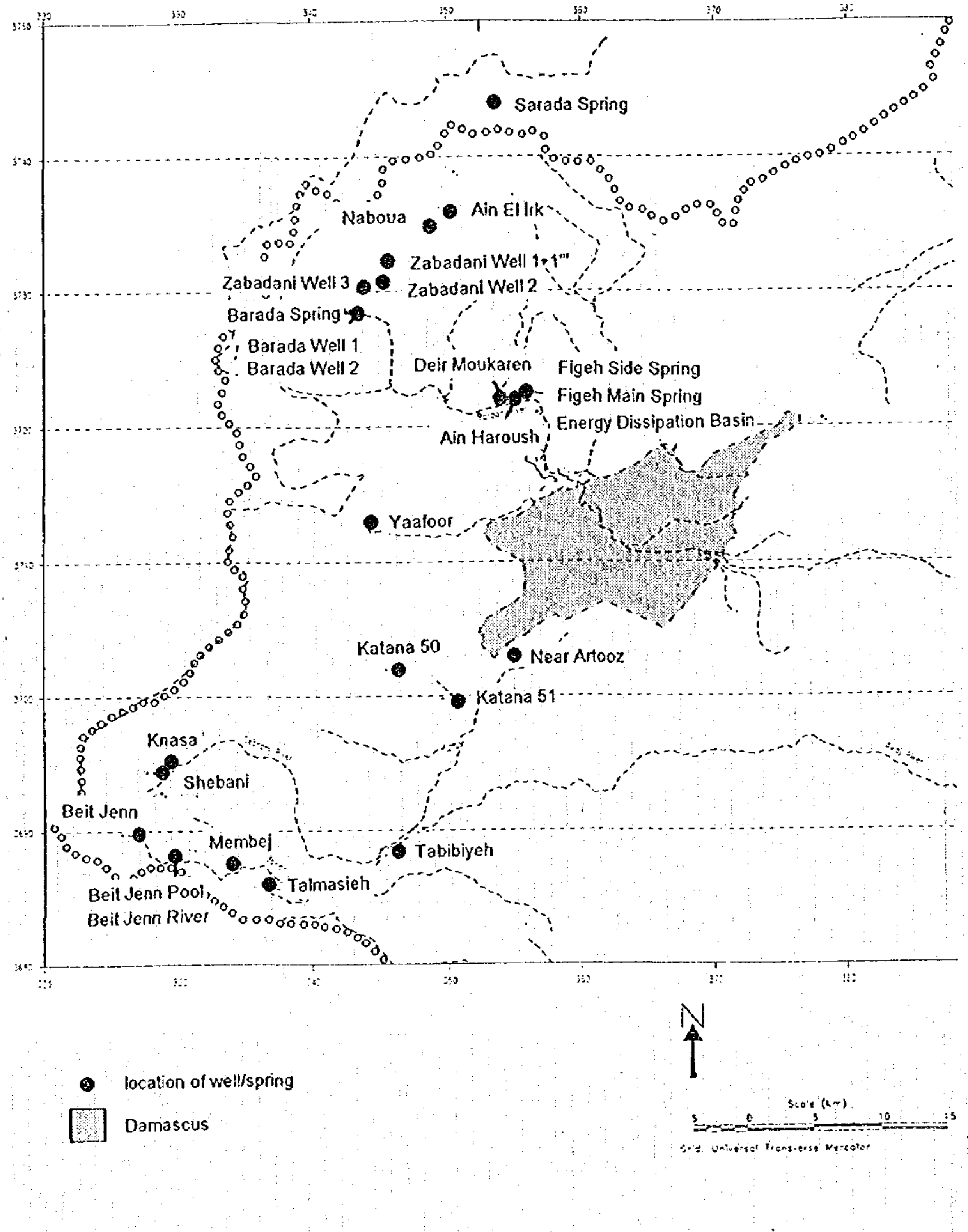

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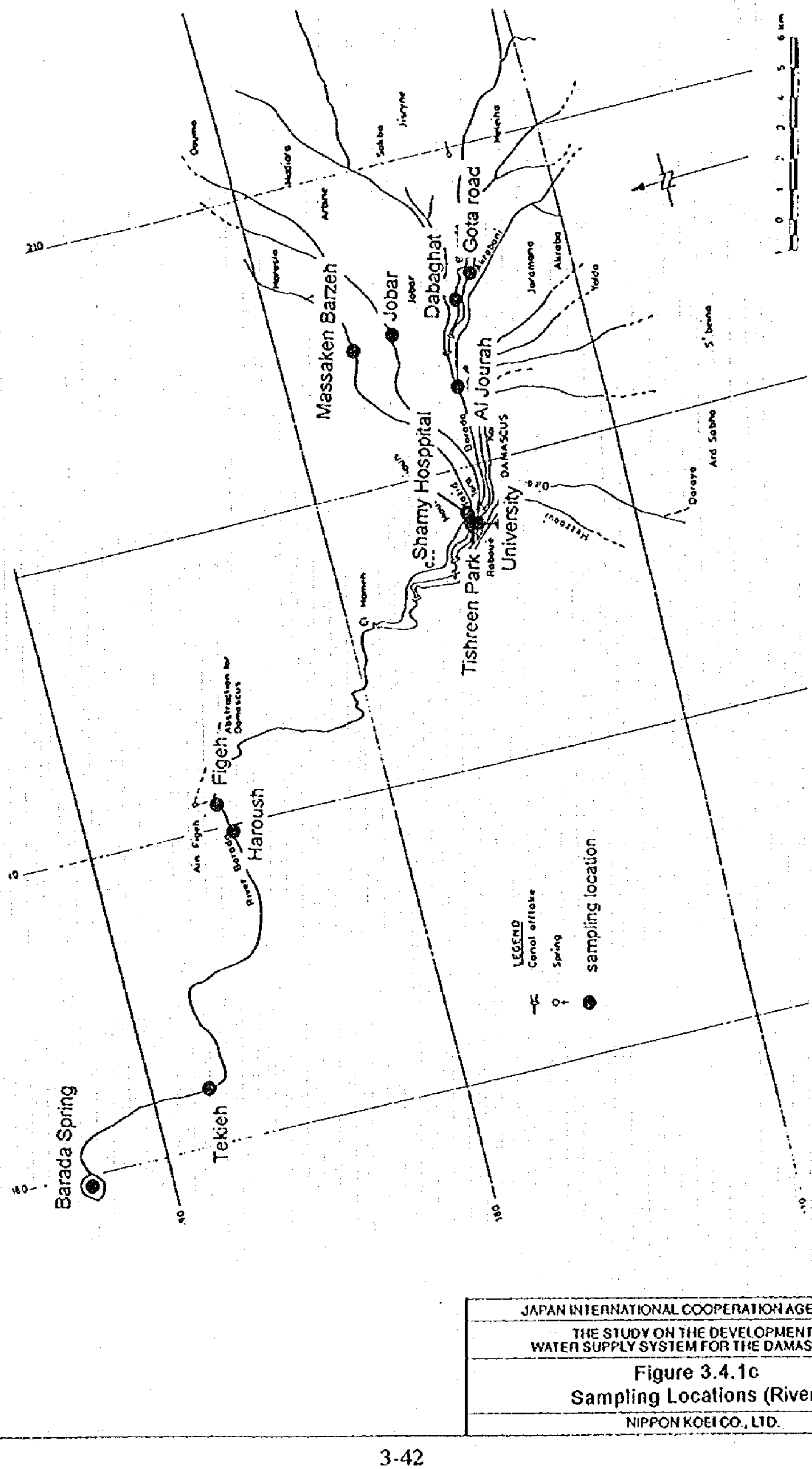
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.4.1b
Sampling Locations (Mountains)

NIPPON KOEI CO., LTD.



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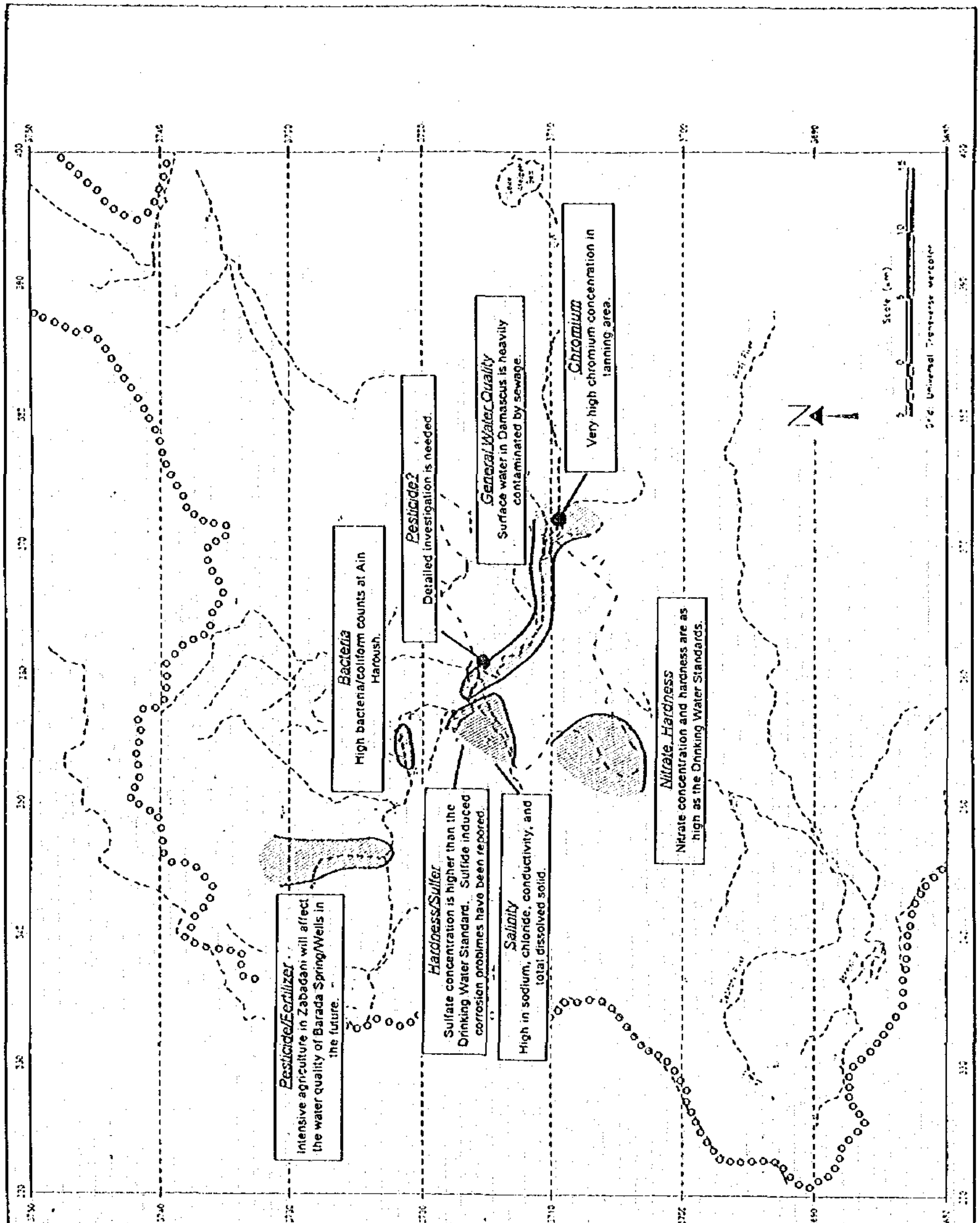
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 3.4.1c
Sampling Locations (River)

NIPPON KOEI CO., LTD.



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 3.4.2
Major Water Quality Problems

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4. PRESENT CONDITIONS OF WATER SUPPLY SYSTEM

4.1 General

Damascus Governate consists of two Mohafazas, Damascus city and Damascus rural. Water supply is managed generally by the water supply and sewerage authorities under the Ministry of Housing and Utilities. In Damascus, there are four kinds of waterworks according to the waterworks law.

i)	Public Urban Water Supply :	with Damascus City and seven villages to be served (managed by DAWSSA)
ii)	Public Rural Water supply :	with rural area out of Damascus city to be served (managed by Damascus Rural Water Supply)
iii)	Bulk Water Supply :	to supply raw water for water supply bodies (managed by the Ministry of Housing and Utilities)
iv)	Bulk Water Supply :	to supply raw water for irrigation (managed by the Ministry of Irrigation)
v)	Private Water Supply :	for private use, such as factories, farms and sanitarium

The main source of drinking water is the Figeh spring. Other water sources, such as underground water in the Barada spring and Damascus city, are utilized as required to supplement. 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 the Damascus Rural area is supplied from Figeh and Jamraya reservoirs. Water is conveyed to Wali reservoir in Damascus City, through a transmission pipeline consisting of a box culvert with a length of 16 km and a new tunnel with a length of 15 km. From Wali reservoir water is distributed to several service reservoirs located throughout the city.

Several production well sites are located throughout the city. Groundwater is pumped up to a service reservoir located in the vicinity of each borehole and chlorinated for being delivered to house connections through the net work.

4.2 Present Service Area and Population

4.2.1 Present Service Area

DAWSSA supplies water to eight villages, Figeh, Al Khadra, Bassime, Ashrafye Wadi, Judayde with the military area, Jemraya Hame with slum area, Kudasaya with a new residential area, and Takadom in Damascus Rural. Special Area Zones are seviced by a bulk water supply system connected to the transmission tunnel from Figeh. The existing service area of villages is estimated at 5.12 km^2.

Damascus City consists of fifteen districts. DAWSSA has responsibility for water supply to the whole area with 106 km^2 and 103 wells managed by Damascus municipality.

4.2.2 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
Informal Resident	407,000
Service Level (%)	74 %

Excepting for the large number of informal residents, DAWSSA system provides 100 % coverage in 1995. The total population in informal areas 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

4.3.1 Source of Supply

The existing source for drinking water supply consists of three water sources, wells at Barada Spring, Ain Figeh area and wellfields/fringe wells in Damascus City. The existing water supply system is illustrated in Figure 4.3.1. The record of water production in 1995 are as follows.

	Amount of Water Supplied (Million m^3/year)	Ratio (%)
Wells at Barada Spring	6.8	3.1
Ain Figeh area	177.4	81.3
Wellfields in Damascus	30.1	13.8
Fringe wells	4.0	1.8
Total	218.3	100.0

(Source : Data for 1995 from DAWSSA)

4.3.2 Production Wells

There are 3 existing production wells areas: Barada spring area, Ain Figeh area and Damascus city well field. Pumped water from the wells of Barada and Figeh is conveyed into Wali service reservoirs through the two transmission tunnels by gravity flow. The wells in Damascus city are used mostly during water shortage periods from June to February. Well water is boosted into the distribution network by pumping stations located at the production well centers.

The annual average operation rate of well pumps was 44 % and the operation period was mainly from July to February, according to the operation record in 1995. During no pump operation period, the periodical maintenance for pumps and motors was carried out by the mechanical department of production directorate of DAWSSA. Equipment appears to be well maintained, however it seems there is a shortage of vehicles, tools and equipment necessary for maintenance and in general most of the tools are outdated and in need of replacement.

(a) Barada spring area

The operation of well pumps in this area started in September 1995. Pumped water from each well is once storage into the collecting reservoir and conveyed to Wali service reservoir through Barada transmission main to Figeh energy dissipation basin and two tunnels. As of July 1996, 15 wells located around the perimeter of Barada spring are in service and operational. Electrical power for the existing operating wells is supplied from both a transmission line from the national grid and a diesel generator with a rated capacity of 1000 KVA.

(b) Figeh spring area

In Figeh area, there are four well groups : Deir Moukaren, Ain Haroush, Figeh side spring and Figeh main spring. The well groups are operated actually from June to February when Figeh spring flow decrease and become insufficient to cover the demand. Pumped water from each well group is joined at Figeh energy dissipation basin and chlorinated in front of the entrance to the tunnels feeding Wali service reservoir.

Seven submersible pumps with a total capacity of 1,104 m^3/h are installed in the deep wells located at Deir Moukaren. Installed pumping capacity at Ain Haroush spring is 4,500 m^3/h with five pumps. Installed capacity at Figeh main spring and side spring is 26,100 m^3/h with a total of seventeen pumps.

As of July 1996, three wells with a total pump capacity of 6,000 m^3/h and transmission main feeding Barada conduction main were under construction at Ain Haroush and scheduled to complete by end of year 1997.

(c) Damascus city

As of July 1996, there are 101 wells in total at 8 separate production well fields in Damascus city. In addition, there are 23 fringe wells and 58 emergency wells located in Damascus city.

The production well fields are having with a total pump capacity of 9,940 m^3/h. Each well field is consisted of several deep wells and production well center which equipped with a collecting reservoir, several booster pumps, a hypo chlorite dosing equipment, control room, power receiving apparatus and stand-by diesel generator. Pumped water is collected to a reservoir in each production well center and feeding into the network by booster pumps.

The fringe wells have with a total pump capacity of 1,160 m^3/h and each well is equipped with a motor driven vertical shaft type well pump, a stand-by diesel generator, a motor driven horizontal shaft type booster pump, a hypo chlorite dosing pump and a 25 m^3 steel made spherical elevated tank. The operation of the fringe wells feeding the network are operated for 16 hours (two 8 hour shifts per day with two operators). DAWSSA has scheduled to replace all vertical shaft type well pump to submersible motor pumps within the next five years.

The emergency wells are located in parks, schools and hospitals for back-up of main water supply system from Wali service reservoir and having with a total pump capacity of 2,320 m^3/h. The pump type is engine driven vertical shaft. The pump set maintenance department of emergency well check the well pumps twice a week for fifteen minutes to three hours operation at one time.

4.3.3 Pumping Stations

The two main functions of the existing pumping stations are to convey water from reservoir to reservoir, and to supply water into the distribution network. There are 15 pumping stations in total, 7 stations are located at service reservoirs and the others are located at the production well centers. A schematic diagram showing pipe connections between pumping stations and reservoirs is illustrated in Figure 4.3.2. and locations are shown in Figure 4.3.3. The number of installed pumps and their capacity are as follows;

Location of Pumping Stations	No. of Stations	No. of Pumps	Installed Capa. (x 10^3 m^3/h)
Service Reservoirs	7	59	14.4
Production Well Centers	8	40	10.8
Total	15	99	25.2

All pumping stations are equipped with a step-down transformer and a stand-by diesel generator for emergency use. However some of the diesel generators installed do not have enough capacity for all pumps to operate at the same time. Chlorine dosing equipment is provided at the production well centers for disinfecting water before it is distributed. Pumping station operators are on site 24 hours (3 x 8 hour shift per day).

The two types of pumps installed in the existing system are single suction horizontal volute pump and submersible pump. The volute pumps are mainly used at service reservoirs for boosting water to other reservoirs and the submersible pumps are used at production well centers to supply water into the distribution network.

4.3.4 Transmission and Distribution Mains

The total length of the existing transmission and distribution mains is around 1,221 km. DAWSSA has replaced a total of 479 km length (44 %) of cast iron pipe transmission and distribution mains with ductile iron pipes during the period from 1982 to 1992.

(1) Transmission mains

Transmission mains between Figeh Spring and Wali reservoirs consist of a new tunnel about 15 km long with an inside diameter 2,550 mm and an older horseshoe-shaped tunnel about 16 km long, 1,360 mm wide and 1,880 mm most current height. Tunnel transmission capacities are 11.3 m^3/s (new) and 3.5 m^3/s (old) for a total combined capacity of 14.8 m^3/s. Transmission mains between reservoirs are mainly ductile iron pipes laid underground and their diameters vary between 80 mm to 1,200 mm. Total lengths of the transmission main are summarized as follows:

(unit : km)

Ductile iron	Cast iron	Steel	Concrete	Total
62.5	0.7	6.2	33.0	102.4
(61.0 %)	(0.7 %)	(6.1 %)	(32.2 %)	

(Source : DAWSSA)

(2) Distribution main

The existing water distribution system covers the villages along Barada river valley and Damascus city. The system in Damascus city is divided into the four service districts of Damascus Center, Berze, Berze East and Mezze. Each service district is classified into pressure zones based on five pressure ranges as illustrated in Figure 4.3.4. The pressure classifications are low, medium, high I, high II and superior high on the basis of the elevations of the district served as follows. DAWSSA's design criteria specifies a minimum service pressure for distribution mains of 30 m (water head) and a maximum of 60 m.

Classification of Pressure Zone	Elevation (m)
Low	less than 690
Medium	less than 730
High I	less than 780
High II	less than 830
Superior High	less than 935

(Source : DAWSSA)

Distribution mains are mostly made of ductile iron pipe and their diameters vary between 60 mm to 1,200 mm. Most of the water for the center of Damascus is supplied through one 800 mm line and one 600 mm line from the Eastern reservoir and two 1,200 mm lines from the Western reservoir. Distribution mains are provided with a total 5,337 numbers of control and sectionalizing valves for optimizing distribution network operations. There are a total of 541 fire hydrants with a 4 inches bore. The hydrants are typically located in utility boxes below grade. Total lengths of the distribution main are summarized as follows:

(unit : km)

Ductile iron	Cast iron	Steel	Total
927.8	124.4	66.7	1,118.9
(82.9 %)	(11.1 %)	(6.0 %)	

(Source : DAWSSA)

About 124 km (12 %) of existing distribution mains as shown in Table 4.3.1, from nominal diameter 80 mm to 600 mm, are made of cast iron pipe and the connections are lead joint method. Many water leakage occur caused by these cast iron pipes and joints and valves.

4.3.5 Service Reservoirs

There are 30 reservoirs providing a total capacity of about 0.2 million m^3. Existing service reservoirs are classified into the following 8 different types:

- Reservoirs fed directly from the Figeh main spring	1 only
- Reservoirs fed directly from the tunnels by gravity or by pumping	5 total
- Reservoirs fed from other reservoirs by gravity	3 total
- Reservoirs fed from other reservoirs by pumping	10 total
- Reservoirs feeding other reservoirs through the distribution network	2 total
- Reservoirs fed only from local wells, supplying distribution network	6 total
- Reservoirs fed only from local wells, supplying local networks	3 total
- Reservoirs for regulating the pressure of transmission mains	4 total

In general, reservoirs are constructed under ground and provided with pumping station, control house, transformer house and diesel generator house. At production well centers, hypo chlorite dosing pumps are provided to disinfect stored water before distributing it into network. The dosing rate for hypo chlorite is determined by the results of water quality tests carried out with laboratory at DAWSSA headquarters. Water sampling is scheduled every morning except on Fridays and National holidays. Water from Figeh Spring, is a chlorinated at the plant located in a separate building in front of the entrance to the tunnels feeding Wali reservoirs. This chlorinating plant uses chlorine gas, with cylinders having a capacity of 800 kg each.

As for measuring water flow at reservoirs, flow measurement devices are located at the entrance of both tunnels in Figeh spring, Western service reservoir and production well centers in Damascus city. Other service reservoirs and principal distribution mains need flow metering to establish a plan of operation and analysis for water leakage.

4.3.6 House Connection and Water Meters

According to the DAWSSA's standard specifications, the service pipe from the distribution main to the individual premises is generally made of polyvinyl chloride pipe (PVC), or galvanized steel pipe. Saddles, brass union sockets and stop cocks are used for branch connection. A typical connection diagram is illustrated in Figure 4.3.5. The size of the service line depends on the number of dwellings being serviced as follows:

(unit : inch)

Number of dwellings	Size of service pipe
1	1/2
2 ~ 3	3/4
4 ~ 6	1
6 ~ 11	1-1/4
11 ~ 16	1-1/2
16 ~ 50	2

(Source : DAWSSA)

There are two methods for connecting individual subscribers in multiple unit dwellings. The preferred method consists of individually metering each subscriber. A second more commonly used method consists of providing one metered connection for all consumers. DAWSSA is responsible for all aspects of the service from the distribution main to the meter box. The meter box is the responsibility of the subscriber. Water meters for individual house connection are generally of the multi jet type, half inch pipe size, and of Syrian make. Meters above a half inch diameter are imported from France, Germany and other countries. According to DAWSSA's records for 1994 and 1995, there is a total of 1,833 water meters for large consumption users and 235,975 meters for normal subscribers.

According to water meter reading in 1995, 84,112 meters (36.5 %) recorded less than 5 m^3 consumption per quarter. DAWSSA has carried out replacement and install in total of 7,546 water meters of half inch pipe size. The meter checking department of consumer affairs directorate has a capacity to carry out 10 meter repairs a day at the meter repair shop located at DAWSSA headquarters, staff consists of one technician for repairing and nine workers for dismantling/mounting meters. The meter repair shop is equipped with a meter test bench, a small size lathe and a drilling machine, and those are seemed to be in well operation condition.

4.3.7 SCADA System

The SCADA system (Supervisory Control And Data Acquisition system) is to ensure optimum water production and distribution operations of the Damascus City Water Supply. The contract for supply and installation of the SCADA system, which started in 1994 is being carried out by the Italian contractor Nuovo Pignone. The total project cost is 12 million dollars including 7.5 million dollars in foreign currency covered by a loan from the Arab Fund (6 million dollars) and the Syrian Government (1.5 million dollars).

The project is scheduled to be completed in April 1997, however actual progress as of July 1996 is about 6 months behind the original schedule due to delays in supplying communication equipment. Overseas training of the DAWSSA operation and maintenance staff will start at the contractor's factory in Italy this October for a total of 600 man-day according to the contract. After the completion of installation work, the contractor has a obligation to supervise the DAWSSA staff for operation and maintenance of the system during the 30 month guarantee period.

The system consists of three control centers with Wali reservoir being the main control center, DAWSSA headquarters the alternative control center and Figeh Spring the secondary control center. Remote terminal units are provided at each reservoir, pumping station and control valve in the distribution network. The system has two main functions: firstly, to collect data from each facility through remote terminal units and secondly, to provide remote control capabilities for each facility from the main control center (or the alternative control center). The system schematic is shown in Figure 4.3.6 and a summary of the main functions is provided as follows:

Data collection	Remote control
- Water level in reservoirs	- Pumps (on/off)
- Pump status (on/off)	- Valves (open/close)
- Valves status (open/close)	- Penstock gates (open/close)
- Penstock gate status (open/close)	
- Pressure	
- Water flow (velocity)	

In addition to the above covered area, DAWSSA has a plan to expand the SCADA system to Barada spring area.

4.4 Present Water Use and Customer Consciousness

4.4.1 General

An interview survey was carried out to identify water supply service conditions in the City and areas facing water shortages. A total of 650 families were surveyed covering 15 districts in the city including the informal areas. The survey was carried out in July and August in 1996.

The interview survey was conducted in person using a questionnaire, written in both English and Arabic attached hereinafter. The effective number of the samples used for this study was reduced to 600 by screening out questionnaires which were incomplete or had obviously been answered incorrectly.

Interviewees were selected on the assumption that they were representative one of the following four income classes. The number of families for each class was determined as follows ;

		Number of Samples	Assumed Monthly Income
1)	High Class	100 families	more than SL 50,000
2)	Middle Class	100 families	SL 10,000 to 50,000
3)	Low Class	200 families	less than SL 10,000
4)	Informal resident	200 families	
Total		600 families	

Data obtained from the interview survey was analyzed by data processing and the main results are summarized in Table 4.4.1.

4.4.2 Family Size and Number of Households

The average family size based on the survey is 6.01 persons per family as summarized in Table 4.4.1. This figure is almost similar to the result of 1994 Census. The number of households including informal households is estimated at 237,000 (total population of 1,422,000 persons ÷ 6 persons). Approximately 42,000 (18 %) of households in the City are assumed to be either unbilled consumers or unconnected households , since the total number of the billed domestic connections recorded in 1995 was about 195,000.

Family size appears to vary significantly by district. For example, family size in Kadam and Kafar Souseh is the highest at 7.26 and 7.25 respectively, while in Kaboon and Mezze it is the lowest at 4.83 and 4.86 respectively. Family size also varies by income level. The middle and informal classes show the highest figure with 6.33 persons.

4.4.3 Monthly Average Income per Household

Monthly average income per family in the City is approximately SL 16,400 as shown in Table 4.4.1. Income level classification in the City is summarized from the result of the interview survey as follows;

	(Unit : % to the Total Population)
High Class	16.7
Middle Class	18.0
Low Class	39.3
Informal Residents	(26.0)
- Middle Class	4.5
- Low Class	21.5
Total	100.0

In consequence of the above classification in the City, the existing population including informal areas consists of 16.7 % of High class, 22.5 % of Middle class and 60.8 % of Low class.

4.4.4 Consumption and Source for Domestic Water

(1) *Monthly water consumption*

Average monthly water consumption per household is 32 m^3/m (177 lpcd) in Damascus. The highest consumption occurs in Rukn Aldyn with 50 m^3/m and Kadam with 46 m^3/m. The lowest consumption is Midan with 22 m^3/m. Monthly water consumption for each income class is estimated below;

- High Class : 35 m^3/m (194 lpcd)
- Middle Class : 33 m^3/m (183 lpcd)
- Low Class : 32 m^3/m (177 lpcd)
- Informal Residents : 31 m^3/m (172 lpcd)

Although the demand is not always met, 95% of formal users are satisfied with the present quantity of water available for consumption. Only 5% of users want 1.5 times of the present amount and only 1% of users desire 2 times. The percentage of respondents that indicated a need for 50% more water is shown for the following areas: Yarmouk (32%), Kadam (18%), Midan (9%), and Sarouja, Kafar Souse (7%).

(2) Water source

Just over 90% of residents in the City use water supplied from DAWSSA as shown in Table 4.4.1. In the low pressure zones, such as Kadam, Kaboon, Yarmouk and Midan, the residents rely heavily on bottled water, springs and wells for drinking and cooking.

As suspected, a rather large 78.5% of informal residents use water supplied from informal connection to DAWSSA's system. Informal connections are made as follows: 69% with a valve, 13% without a valve and 18% with a booster pump. The availability of water in informal areas is variable. Only 53% of residents get water 24 hours per day, 21% get water for less than 4 hours per day, 12% for less than 8 hours per day and 14% for less than 12 hours per day. Almost all residents surveyed in informal areas indicated a desire to have stable and safe drinking water supply.

4.4.5 Customer Satisfaction

Table 4.4.1 shows that 70 % of residents are satisfied with DAWSSA's existing water supply services. Results for Jobar, Kadam, Midan, Yarmouk, Kafar Souse and Mezze show that the percentage of unsatisfactory responses is spatially distributed. The reasons for unsatisfactory service from the existing water supply are distributed poor water quality 13.5 % and low pressure 9.3 %. These areas belong to the Low Pressure Zone in the distribution system and are supplied with water mainly from DAWSSA's wells in the City. About 85 % of the residences have water storage devices with 1 m3 capacity.

Results of household water use condition are summarized as follows;

a) 90 % of residents drink water directly from the tap without boiling except in Jobar where 75 % of resident use boiled water. Results show that quality of supplied water is good enough for drinking.

b)73 % of residents consider that water pressure is adequate to meet their needs, while 11 % said it was too high and 13 % said it was too low. Low pressure is reported mainly in Midan (46 %), Yarmouk (43 %) and Kafar Souse (30 %).

c) 92 % of residents do not use water purifiers. 12 % of high income class and informal residents use purifiers. The limited use of purifiers indicates that water quality is satisfactory to most households.

d) House pumps are used by 29 % of residents on average. Residents in the low pressure zones, such as Yarmouk (79 %), Midan (62 %), Kadam (46 %) and Kafar Souse (43 %) show a high percentage of use. Informal residents are the highest users with 45 %.

As for availability of DAWSSA Water Supply, the majority of consumers get water everyday (83 %). However, only 55 % of consumers are supplied water over 12 hours per day during the dry season. 5 % get water for less than 4 hours per day, 5 % for less than 8 hours per day and 35 % for less than 12 hours per day. About 9 % of residents took counter measures against the shortage of water in the dry season as shown in Table 4.4.1. Kafar Souse, Kaboon and Mezze seem to have the least daily water availability. Almost all residents installed water storage devices as a coping against water service interruptions.

4.4.6 Waterborne Diseases

Table 4.4.1 indicates that not many residents got, in spite of drinking unboiled water, waterborne diseases with 109 reported cases. Total percentage of water related diseases is 18.2 % consisting of Typhoid (2.5 %), Cholera (0.2 %) and 15 % for other diseases. Other diseases seem to occur from a lack of hygiene based on the observations of the interviewers. It is a proof water is supplied with good hygienic standard.

Cases of typhoid are reported in Rukn Aldyn, Kadam, Midan and Kafar Souse, and Cholera in Mezze. As for waterborne diseases at each class, Low (40 cases) and Informal (36 cases) show higher than High (15 cases) and Middle (18 cases).

4.4.7 Water Cost per Household and Willingness to Pay

Monthly average payments for water, sewerage and electricity are reported by surveyed families as follows;

- Water	:	147	SL/month/family (0.9 % to Average Income)
- Sewerage	:	75	SL/month/family (0.5 % to Average Income)
- Electricity	:	450	SL/month/family (2.8 % to Average Income)

On average 72 % of official consumers for water consider that the present payments are reasonable as shown in Table 4.4.1. It should be noted that 40 % residents in Kadam, Kafar Souse, Jobar, Shagour and Midan complained that water charges are too high for poor service conditions and payments are too expensive compared to their incomes. Residents in Yarmouk claim that existing payments should be lower because they receive less quantity and lower pressure. The level of customer satisfaction by income Class drops from 84 % for high income class to 65 % for low income class.

As for willingness to pay for water in the informal areas, 93 % of informal residents show their willingness to pay for water supplied from DAWSSA. Only 7 % of residents in the informal areas indicated they would not pay tariff because they considered their income unaffordable.

The interview survey asked consumers their opinion on affordable tariffs if the infrastructures are improved such as water supply, sewerage system and electricity supply. Affordable tariffs to the following infrastructures is summarized below ;

- Water Tariff : 151 SL (147 SL/month at present)
- Garbage Tariff : 77 SL (75 SL/month at present)
- Electricity Tariff : 433 SL (450 SL/month at present)

4.5 Unaccounted for Water (UFW)

4.5.1 General

The unaccounted for water study was carried out to assess the current situation in Damascus, and formulate recommendations for reducing the unaccounted for water figure. The objectives of the study were to :

i) Identify the present condition of unaccounted for water in Damascus
ii) Make recommendations and set achievable targets for the reduction of UFW
iii) Make recommendations of measures to be used for the reduction of UFW

Detailed analysis of the unaccounted for water in DAWSSA's water supply system has been made and is presented in Appendix F.

4.5.2 Components of UFW

Unaccounted for Water (UFW) can be described as, that water which is the difference between that supplied and that which is accounted for. The water balance of DAWSSA as at 1995 is shown below :

Economic	Number	Description	MCM/Year	Percentage	Revenue	Technical
Billed	1	Domestic Use	46.1	21.1%	Meter	Delivered
	2	Government	13.6	6.2%		
	3	Commercial	2.8	1.3%		
	4	Industrial Use	0.5	0.2%		
	5	Water rights	14.9	6.8%		
Un - Billed	6	Religious & Public Use	3.8	1.7%	Un metered	
	7	Meter Malfunction	31.4	14.4%	Under estimation	
	8	Informal Use	29.7	13.6%	not metered	
	1 to 8	Sub Total	142.8			
	9=10-subtotal	System Losses	75.5	34.7%		Losses
Production	10	Total	218.3	100%		

The unaccounted for water study was carried out, and assessed the current situation in Damascus, where 64% of the total water production in 1995 was attributed as being unaccounted for water.

UFW consist of four main components which are :

a)	Meter Malfunction	(14.4%)
b)	Religious and Public Fountain Use	(1.7%)
c)	Informal Use	(13.6%)
d)	System Losses	(34.7%)
	Total UFW =	(64.4%)

4.5.3 Field Survey

Field surveys were conducted in the following areas :

Berzze Village	(Reservoir Zone)
Esh Al Warwar	(Informal Area)
Mahadi Bin Barakeh & Malki Street	(Leak Detection)
Dar Al Moalimat & Ruku Aldyn	(Meter Survey)
The Army Camp at Tishreen	(Leak Detection
20 Mosques	(Meter Survey)

Major findings of the survey are as follows :

i) Informal use

There are 14 informal housing areas scattered throughout Damascus. The population in these areas exceeds 407,000 and there is a substantial leakage problem at most sites. None of the residents pay for any water consumed and in the unaccounted for water calculation, the informal areas are a major contributory factor.

ii) Old water mains

In the city of Damascus there are many pipes which have a history of leakage and are in urgent need of replacement. Many of these pipes are old cast iron pipes with lead joints that frequently leak . Replacing these water mains will strengthen supplies and further reduce the amount of leakage in the system.

iii) Domestic Water Meters

Meter malfunction in Damascus is very high with over 84,000 meters currently awaiting repairs resulting in a figure of 14.4% for un-billed water. The most common meter in use is a locally made meter called the Doris meter which is of the multijet variety and does not record accurately at low flows.

iv) Religious and Public Fountain Use

Water which is used at the mosques and public fountain is un-billed water and as such is a constant source of misuse and general waste. In the unaccounted for water figure they account for 1.7% of water produced and unless precautions are taken this figure will rise.

4.5.4 Strategic Plan of Reduction of UFW

In order to reduce the unaccounted for water figure, various countermeasures have been proposed. All of these countermeasures are technically and economically possible. They would also provide for better management of the system and information about the system which is not available at this moment. A reasonable target of 25% has been suggested for the year 2015 which should be achievable. If one compares this figure to typical English targets, then they are very similar and in Jakarta a target figure of 25% has also been set.

These targets are seen as realistic targets and ones that can be achieved It is therefore important that this goal is maintained by DAWSSA otherwise, there would be serious shortfalls in the supply of water to the detriment of both the customer and DAWSSA.

The table below shows the target reduction and timetable of events.

* This does not include the Religious or Public Fountain Use

Items	Present 1995	2000	2005	2010	2015
Informal Use	13.6%	4%	1%	0%	0%
Meter malfunction	14.4%	3%	0%	0%	0%
System Leakage	34.7%	32%	30%	28%	25%
Total Unaccounted for water	62.7%	39%	31%	28%	25%

4.5.5. Recommended Countermeasures for Reducing UFW

(1) Water supply improvements for informal areas

It is proposed to transfer all of these informal housing areas from informal status to formal status. The reason for this is to save water from leakage and encourage the residents to pay their due water rates for water consumed. By transferring all of these connections, the ratio of un-billed customers should be reduced by the year 2006 and the high leakage rates that exist at present at these informal housing areas will eventually be eliminated.

(2) Leakage control and supply improvement

The alternative plan for leakage control falls into 4 main groups. They are as follows :

i) A program of mains renewal to reduce the level of leaking lead joints on cast iron mains and reinforce the existing distribution system thus safeguarding supplies. Many of the pipes are old cast iron mains with lead run joints which frequently leak and by replacing these pipes the frequency of leakage will be reduced. The oldest pipes to be replaced date back to the early part of this century from 1906 dating to the late 60s and are cast iron pipes.

Each year, there are many instances where these pipes leak and rapid attention is called for. In addition to the leaking joints, other fittings such as sluice valves and air valves are constantly leaking. Each time a leak develops, there is quite a substantial loss of water. The repairs of such leaks can be expensive, as roads have to be excavated and the mains have to be emptied of water so as repairs can be carried out.

ii) A program for setting up approximately 67 district meter areas which will enable DAWSSA to monitor the distribution system and identify areas of high leakage. The size of these areas would be determined by a number of factors, such as the size of the pipe supplying the zone or its geographical boundaries. As a rough guide, District meter areas with medium scale should be no more than 6000 properties and no less than 2000 properties. Consumption into these areas should be measured at night when leakage is assumed to be a major element because of low domestic and industrial use.

After allowances have been made for these uses (normally 1.9 liters/Property/Hour) the difference is assumed to be leakage. However, in Damascus, consideration will have to be given to the fact that is some areas, there is a possibility that overhead storage tanks might be filling during the night, therefore allowances will have to be made, such information will become known once measurements have been carried out at each district meter area. Once information from the system becomes available, it will be possible to generate monthly reports. Comparisons can then be made with former monthly reports and present monthly reports and calculations of leakage rates will be possible. As each area is completed, then the condition of leakage, the pressure range and consumption figures will become available, and in those areas of high leakage, the leakage teams could then be directed to investigate and find the leaks. Having completed the leakage survey and repair of leaks, it will then be possible to determine a leakage trigger level, whereby, once a certain level is reached, then it would make economic sense to investigate the area for leakage (see Table 4.5.1). Therefore, it is recommended that the leakage from the distribution system is obtained my measurements of night time flows and night consumption. This method can be used to obtain a measure of the absolute level of leakage, but to do so, it would be necessary to make a deduction for night time consumption.

iii) A program of setting up pressure regulated zones which will reduce the levels of leakage in high pressure zones. A critical element of leakage control is the maximum use of pressure control. This will have an effect of reducing the level of leakage, the rate at which leaks happen and further reduce the actual loss when a leak does develop. Advantage should be taken, where appropriate, to use the latest available pressure control valves that automatically adjust to varying demand patterns. Reducing the pressure will not only reduce the level of leakage, but will also reduce the quantity of water used in what can be described as open tap use (widespread in Damascus) and it will also reduce the frequency of pressure type burst.

iv) Increased leak detection surveys to locate and report leakage from the distribution system. At the start of 1996, there was only one leakage team for the whole of DAWSSA s distribution system. Clearly, this was insufficient and following recommendations in June, the section was increased to three teams. The information regarding leaks is now being stored in a computer database and it is expected that the DAWSSA staff will be able to produce monthly reports for higher management. With such information available, management at DAWSSA will have a valuable tool at their disposal which will enable them to make sound decisions based on factual information in the future.

(3) Meter replacement scheme

The study and provisional conclusions of the meter replacement program is that the supply of qualified water meters would be advantageous to DAWSSA and would reduce the exceptionally high proportion of unaccounted for water caused by meter error & malfunction.

It is therefore recommended that the Doris meter be eventually phased out in preference to better quality meter which must have a higher degree of accuracy and are less likely to malfunction. These recommendations are made on the grounds that it would help reduce the unaccounted for water figure and that it would make economic sense.

(4) Implementation schedule

The implementation schedule for each program is shown in Tables 4.5.2 to 4.5.6.

4.6 Organization and Institutional Status

4.6.1 Institutional Setting of DAWSSA

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.

The Authority came into being in 1984 taking over responsibilities from EPEF (L'Etablissement Public des Eaux de Damas (Figeh)) for water supply and with a requirement also to take over responsibility for wastewater from the Municipality of Damascus.

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.

Only now, with the setting up of a DAWSSA subsidiary 'Company', are moves being made for taking over responsibilities for wastewater from the Municipality (involving the transfer of some seven hundred staff).

4.6.2 Present Organization

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 one from 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.

4.6.3 Problems of the Present Organization

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.

It would also benefit DAWSSA considerably if institutional changes could be made to enhance their autonomy in respect of constitution, finances, and manpower and to improve water resources planning and regulation.

4.7 Financial Affairs

A summary statement of incomes and expenditures for the 1990-95 period is shown below with further details contained in Appendix I of the supporting report. 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. Water sales reached SL 293.5 million and accounted for 80% of total 1995 revenues. This large improvement is due to substantial tariff increases and growth in the number of metered connections.

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

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.

Although production increased over the 1990-95 period the percentage of water sold decreased from 34% to 29%. Meanwhile, unmetered water use increased from 56% to 64% over the same period, possibly indicating increased losses in an aging distribution network, or an increase in informal use or both. 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 expense statements for the 1990-95 period reveals the following:

a) Staffing and Salaries: While staffing levels have remained more or less constant at around 1300 employees, salary costs have increased by 220% over the 1990-95 period. Salary costs are the largest component of direct operating expenses representing 50% of the total.

b) Energy: Energy is the second largest component of direct operating expenses, accounting for 21% of the total in 1995. This relatively small amount is due to the extensive use of diesel generators for pumping at remote well sites and low, preferential electricity tariffs. In line with the development of a free market economy there will likely be a significant increase in electricity tariffs in the near future. Because DAWSSA will become increasingly dependent on pumped water supplies it is clear that improving the efficiency of pumping operations and equipment is of the utmost importance to reduce future energy costs.

c) Maintenance: Maintenance costs associated with various operational activities are difficult to identify because there is no cost accounting. Estimated maintenance expenditures for 1995, were about SL 33 million which is only 15% of annual direct operating expenses. The amount of maintenance related to the water distribution system alone is about 10% of the total. This relatively low proportion indicates a significant level of deferred maintenance.

d) Service fees. Service fees in 1995 reached a high of SL 36 million and accounted for 16% of direct operating expenses. Service fees included approximately SL 15 million for maintenance contract services, SL 6 million for equipment and transportation rentals, SL 1.5 million for insurance and SL 14 million classified as "miscellaneous services" expenses. Without accurate cost accounting it is difficult to explain this significantly high level of expenditure.

A review of the balance sheet for the 1990-95 period indicates that fixed asset values appear to be considerably lower than replacement costs. For example the estimated replacement cost for the water distribution network is approximately SL 5,200 million ($US 124 million). However, the asset book value is only SL 445 million ($US 10.6 million). Fixed assets have never been re-valued since DAWSSA's inception and current annual depreciation allowances are insufficient to provide for the on-going rehabilitation and replacement of the distribution system.

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

(a) DAWSSA has no clearly defined financial objectives. Historically the main aim of the utility has been to provide safe drinking water to domestic consumers at affordable levels. Heavy government subsidy has discouraged the concept of providing cost effective service. Management's efforts to operate on a more commercial basis is hampered by politically determined tariffs which undercharge consumption by a large margin, and a relatively high profit tax.

(b) The accounting of income is substantially delayed by an inefficient billing and collection process. Meters reading has slipped from 3 to 6 month intervals. 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 hampers 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. All income and expenses are accounted for centrally and entered manually in ledgers. The system does not facilitate accountability of public funds. For example, funds collected from network improvement charges are not segregated from other funds and may be used to cover any kind of expense.

Water tariffs are set uniformly by the Central Government for the whole country and variations to reflect the individual operating costs of each water supply utility are not permitted. Domestic consumption is charged on the basis of a stepped tariff structure where unit rates become progressively higher with increased consumption. Other consumers pay on the basis of a fixed tariff structure. Domestic users account for 80% of the total metered water consumption and 63% of total water sales. The industrial/commercial tariff is higher than the domestic tariff and is intended to provide a cross subsidy to domestic consumers. Unfortunately industrial/commercial use is only 4 % of the total metered consumption and as a result generates only a small 14% of the total revenues. There is a strong internal cross subsidy between domestic consumers. For example, large volume domestic consumers (over 30 m3/month) who account for 20% of the total consumption generate a substantial 40% of the total income while low volume consumers (less than 20 m3/month) who account for a relatively large 32 % of the total consumption only generate 16% of the total income.

Until 1986, domestic users could purchase, for a one time lump sum payment, a perpetual water right for the consumption of an agreed upon monthly volume of water not subject to water tariffs. Water consumed under water right agreements represents 20% of the total metered consumption. Although these water right agreements served to generate needed capital funds, they unfortunately created a situation where a substantial proportion of the water delivered by DAWSSA is consumed without generating revenue.

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. There is an obvious need to increase water tariffs to cover the costs of investment spending and increasing debt service charges associated with investment loans.

Capital investment reached a high of SL 334 million ($ 8 million US) in 1993 and has decreased since then to SL 240 million ($5.7 million US) in 1995. The amounts invested in new capital projects has fluctuated over the 1990-95 period, however spending as a proportion of funding sources has increased steadily from 28% in 1990 to a high of 43% in 1995. This trend indicates management's continued commitment to meet the demands of a growing population. Most of the efforts to date have focused on providing new infrastructure. More emphasis will be required in the near future on maintenance and rehabilitation expenditures in order to protect this extensive investment in infrastructure.

Table 4.3.1 Distribution Mains in Damascus City

Materials	D25	D40	D50	D60	D80	D100	D125	D150	D200	D250	D300	D350	D400	D450	D500	D600	D700	D800	D1000	D1200	Total
Ductile Iron Pipe 897.97km	0.00	0.00	0.00	8.03	150.30	451.81	0.00	93.71	38.80	47.71	18.91	2.85	12.16	0.60	36.11	23.61	0.90	10.19	1.09	1.20	897.97 km
Cast Iron Pipe 124.38km	0.00	0.00	0.00	0.00	0.89	22.58	0.25	16.33	22.03	31.90	0.55	0.00	9.56	0.00	6.83	13.46	0.00	0.00	0.00	0.00	124.38 km
Steel Pipe 35.05km	0.18	3.17	23.09	0.20	1.14	2.05	1.76	0.19	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58	35.05 km
Total Length (km)	0.18	3.17	23.09	8.23	152.33	476.43	2.01	110.23	62.53	79.61	19.46	2.85	21.72	0.60	42.94	37.07	0.90	10.19	1.09	2.78	1,057.40 km
(%)	0.0%	0.3%	2.2%	0.8%	14.4%	45.1%	0.2%	10.4%	5.9%	7.5%	1.8%	0.3%	2.1%	0.1%	4.1%	3.5%	0.1%	1.0%	0.1%	0.3%	
Cast Iron Pipe (%)	0%	0%	0%	0%	1%	5%	12%	15%	35%	40%	3%	0%	44%	0%	16%	36%	0%	0%	0%	0%	12%

(Source : DAWSSA)

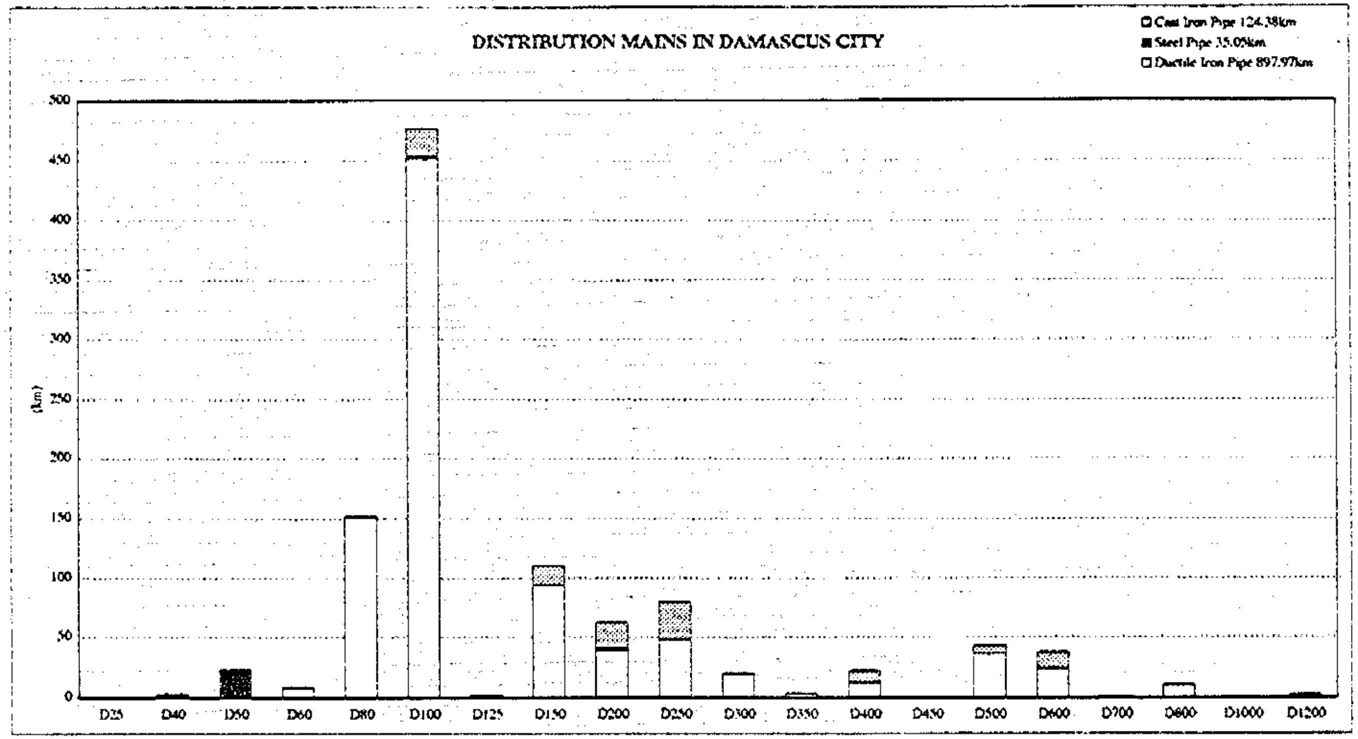

Table 4.4.1 Summary of Interview Survey (Average)

Designation			Number Of Family Members	Montly Income	Monthly Water Consumption	Percentage*1 Of Using Dawssa water	Percentage*2 Of Using Major Water Except DAWSSA in Dry Season	Percentage*3 Of Informal Connections	Number Of Waterborne Diseases	Ratio Of Water Availability: Every Day	Ratio Of Water Availability: Over 12 hrs	Present Payment Of Water	Feeling Of Satisfaction For Water Supply	Reasonability Of Present Payment	Affordable Tarrif for Water
				s.l./m	m3/m	%	%	%		%	%	s.l./m	%	%	s.l./m
Damascus			6.01	16423	32	91	9	33	109	85	59	147	70	71	148
District	1	Dummar	6.12	20840	29	94	6	32	0	100	100	118	88	88	116
District	2	Mouhajreen	5.98	29111	28	100	0	9	5	98	78	155	80	93	166
District	3	Rukn Aldyn	5.32	15411	50	100	0	34	9	46	22	162	84	70	160
District	4	Berze	6.04	11385	39	100	0	38	2	17	10	165	93	73	177
District	5	Jobar	6.45	8795	31	96	4	41	13	92	73	123	27	54	124
District	6	Sarouja	5.24	26402	33	100	0	0	5	95	61	166	93	80	173
District	7	Old City	6.27	18467	33	100	0	0	0	100	80	147	73	73	160
District	8	Kanawat	5.72	16724	31	98	2	7	1	93	67	133	93	89	133
District	9	Kadam	7.26	13057	46	89	11	51	21	82	76	171	24	41	166
District	10	Shaghour	6.35	13809	27	100	0	41	10	95	75	130	80	60	128
District	11	Midan	6.33	16913	22	86	14	35	9	97	35	140	41	62	131
District	12	Mezze	4.86	19310	28	98	2	36	11	94	69	161	66	72	168
District	13	Kabon	4.83	8733	34	84	16	47	3	94	69	134	94	88	133
District	14	Cafarsouse	7.25	18238	27	75	25	30	9	82	21	143	61	50	148
District	15	Yarmouk	6.43	9143	26	40	60	66	11	84	42	161	47	68	143
Class	HC	High	5.50	50000	35	98	2	0	15	88	52	162	72	84	171
Class	MC	Middle	6.33	20500	33	94	6	0	18	78	54	152	74	73	156
Class	LC	Low	5.79	5665	32	97	3	0	40	83	58	142	69	65	141
Class	IR	Informal	6.33	7820	31	71	29	100	36	0	0	0	0	0	146

Table 4.5.1 Typical Net Night Flow Analysis

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1	2	3	4	5	6	7	8	9	10	11	12	13	14
Zone No	DMA No	Site Location Of Meter	Total Number Properties	M.N.F. m3 Hour	M.N.F.C. m3 Hour	Domestic Night Allow m3/Hour	Therefore N.N.F m3/Hour	Leakage Litres Prop/Hour	Target Night Flow m3/Hour	Target Litres Prop/Hour	Difference Actual/Target m3/Hour	Assumed Service Leaks	Cost of Leakage Per Year
1	3	Akrad B2	1,350	97.54	1.34	2.31	93.89	69.55	24.71	18.30	69.18	88	£48,987
2	8	Mezze #86	3,476	82.18	3.41	5.94	72.83	20.95	10.16	2.92	62.67	79	£44,374
3	5	Naher Eshah	2,778	82.63	0.00	4.75	77.88	28.03	16.92	6.09	60.96	77	£43,166
4	5	Kassioun #1	5,342	74.51	0.00	9.13	65.38	12.24	20.15	3.77	45.23	57	£32,024
5	7	Kafarsouseh	934	45.19	2.25	1.60	41.34	44.26	3.82	4.09	37.52	47	£26,570
6	1	East Tabbaleh	4,524	56.45	26.20	7.74	22.51	4.98	6.83	1.51	15.68	20	£11,106
7	6	Somareya	1,411	31.56	3.81	2.41	25.34	17.96	12.55	8.89	12.79	16	£9,055
8	2	Shagoor Basateen	3,871	37.60	2.12	6.62	28.86	7.46	18.60	4.80	10.26	13	£7,266
9	4	Jober #1	2,895	29.98	0.00	4.95	25.03	8.65	16.52	5.71	8.51	11	£6,026
10	7	Tishreen #1	3,620	27.45	0.00	6.19	21.26	5.87	19.60	5.41	1.66	2	£1,175
Zonal Statistics			Total 30201	Ave 56.51	Ave 3.91	Ave 5.16	Ave 47.43	Ave 21.99	Ave 14.99	Ave 6.15	Ave 32.45	Ave 41.07	Total £229,747

1) Zone Number
2) District Meter Area Number (DMA)
3) Site Location Of Meter
4) Total Numbers of Properties in DMA
5) Minimum Night Flow m3/Hour
6) Minimum Night Flow (Commercial) m3/Hour
7) Domestic Night Time Allowance m3/Hour
(based on 1.71 Lts/Prop/Hour)

Target Losses	149.86 m3/d
Actual Losses Per/Day	474.32 m3/d

Typical wage bill for year for 4 Men
@ £16,800/Month = £201,600

Total Projected Savings = £28,147

8) Net Night Flow m3/Hour
9) Leakage/Property/Hour
10) Target Night Flow m3/Hour
11) Target Litres/Property/Hour
12) Difference/Target/Actual
13) Assumed Leaking service pipes
14) Annual Cost Of Water Losses
(based on S£ 1.94 per m3)

File: Specimen.WK3

Table 4.5.2 Program for Replacement of Mains

Diameter mm	1998	1999	2000	2001	2002	2003	Total Length Kilometres
600	6,100	960	1,250	4,800	1,000		14,110
500		1,700	2,200				3,900
400	1,975		1,900		1,000	2,600	7,475
300							0
250	6,950	7,670	2,400	4,150	3,420	2,400	26,990
200		5,050	2,700	4,800	3,000	1,000	16,550
150	700	2,000	1,900		3,600	3,500	11,700
125		250					250
100	940	400	3,800	1,560	3,600	5,700	16,000
80				600			600
	16,665	18,030	16,150	15,910	15,620	15,200	97,575

Table 4.5.3 Proposed District Meter Program

Activity	Area	Properties Covered	1997	1998	1999	2000	2001	2002	2003	2004	2005
Feasibility Study			>>>>>>								
Design/Drawings Preparation	Mouhajreen	12,910									
Intallation of Meter/Valves											
Check Area for Integrity	Ruku Aldyn	27,795									
First Run											
Leak Location Survey											
Monitor Each Month											
Design/Drawings Preparation	Barze	12,650									
Intallation of Meter/Valves											
Check Area for Integrity	Jober	17,351									
First Run											
Leak Location Survey											
Monitor Each Month											
Design/Drawings Preparation	Sarouja	19,603									
Intallation of Meter/Valves											
Check Area for Integrity	Old City	3,082									
First Run											
Leak Location Survey											
Monitor Each Month											
Design/Drawings Preparation	Kanawat	11,127									
Intallation of Meter/Valves											
Check Area for Integrity	Kadam	10,696									
First Run											
Leak Location Survey	Shagour										
Monitor Each Month											
Design/Drawings Preparation	Shagour	10,938									
Intallation of Meter/Valves											
Check Area for Integrity	Midan	23,930									
First Run											
Leak Location Survey											
Monitor Each Month											
Design/Drawings Preparation	Mezze	18,334									
Intallation of Meter/Valves											
Check Area for Integrity	Kaboon	8,599									
First Run											
Leak Location Survey											
Monitor Each Month											
Design/Drawings Preparation	Kafar Souseh	16,004									
Intallation of Meter/Valves											
Check Area for Integrity	Yarmouk										
First Run	Part 1	17,890									
Leak Location Survey											
Monitor Each Month											
Design/Drawings Preparation	Yarmouk										
Intallation of Meter/Valves	Part 2	17,890									
Check Area for Integrity											
First Run	Dummar	8,235									
Leak Location Survey											
Monitor Each Month											
Total Numbers of Properties covered by DMAs =		237,034									

**** Provisional Programme : Possible Ammendments

Table 4.5.4 Proposed Program for Pressure Reduction

Description	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Feasibility Study		▭									
Procurement and Setting up Pilot Zone			~ ~ ~								
Pressure Control for 11,852 Properties				5% Coverage							
Pressure Control for 23,704 Properties					10% Coverage						
Pressure Control for 35,556 Properties						15% Coverage					
Pressure Control for 46,224 Properties							20% Coverage				
Pressure Control for 58,076 Properties								25% Coverage			
Pressure Control for 69,928 Properties									30% Coverage		
Pressure Control for 81,780 Properties										35% Coverage	
Pressure Control for 96,632 Properties											40% Coverage

** Properties covered is a provisional figure only

Pressure Control to Follow District Meter Installations

Table 4.5.5 Implementation Program for Annual Leakage Surveys

Number of House Connections Sounded Each Year

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007	2009	2010	2011	2012	2013	2014	2015
Leak team 1	20,072	82,239	60,017	61,474	62,967	64,497	66,064	67,669	69,313	70,997	71,100	71,599	72,000	72,500	73,000	73,500	74,000	74,500	75,000	75,500

Number of House Connections Sounded Each Year

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007	2009	2010	2011	2012	2013	2014	2015
Leak team 2	22,389	68,799	60,017	61,474	62,967	64,497	66,064	67,669	69,313	70,997	71,100	71,599	72,000	72,500	73,000	73,500	74,000	74,500	75,000	75,500

Number of House Connections Sounded Each Year

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007	2009	2010	2011	2012	2013	2014	2015
Leak team 3	27,115	83,333	60,017	61,474	62,967	64,497	66,064	67,669	69,313	70,997	71,100	71,599	72,000	72,500	73,000	73,500	74,000	74,500	75,000	75,500

Number of House Connections Sounded Each Year

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007	2009	2010	2011	2012	2013	2014	2015
Leak team 4			60,017	61,474	62,967	64,497	66,064	67,669	69,313	70,997	71,100	71,599	72,000	72,500	73,000	73,500	74,000	74,500	75,000	75,500

Number of House Connections Sounded Each Year

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007	2009	2010	2011	2012	2013	2014	2015
Leak team 5											71,100	71,599	72,000	72,500	73,000	73,500	74,000	74,500	75,000	75,500

Leakage Soundings/Connection/Leakage Team
Year on Year Increase

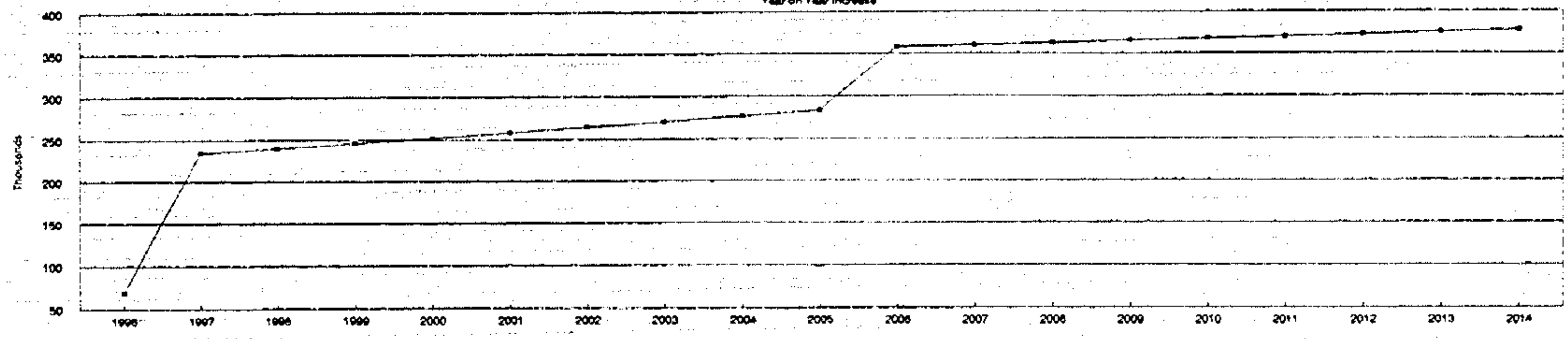
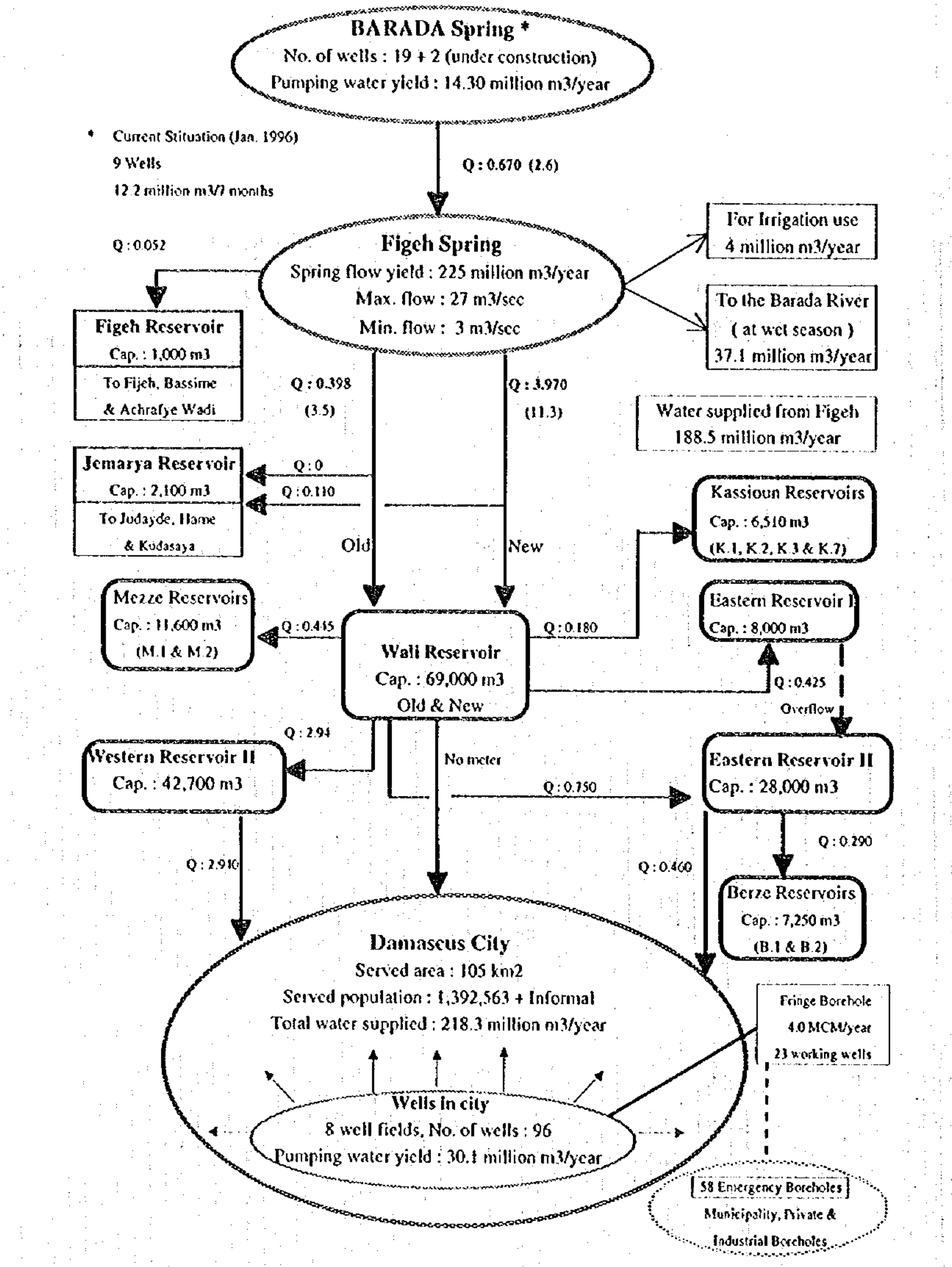


Table 4.5.6 Meter Replacement Program

Meter Sizes	Status @ 1995 ave	1997 Replaced	Backlog End 1997	1998 Replaced	Backlog End 1998	1999 Replaced	Backlog End 1999
Domestic Meters 15mm	39,687	5,979	35,268	7,000	29,828	7,000	24,388
Water Rights 15mm	27,448	8,000	21,008	7,000	15,568	7,000	10,128
Commercial 15mm	15,000	0	15,000	2,000	13,000	2,000	11,000
Commercial 20mm	2,585	0	2,585	0	2,585	0	2,585
Industrial 20mm	612	612	0	0	0	0	0
Industrial 32mm	300	300	0	0	0	0	0
Industrial 40mm	200	200	0	0	0	0	0
Governmental 20mm	609	609	0	0	0	0	0
Governmental 32mm	200	200	0	0	0	0	0
Governmental 40mm	100	100	0	0	0	0	0
Backlog of Meters=	86,741		73,361		60,981		48,101
Total Meters Replaced		16,000		16,000		16,000	

Meter Sizes	2000 Replaced	Backlog End 2000	2001 Replaced	Backlog End 2001	2002 Replaced	Backlog End 2002	2003 Replaced	Backlog End 2003
Domestic Meters 15mm	7,000	18,948	9,312	11,196	12,756	0	0	0
Water Rights 15mm	7,000	4,688	4,688	1,560	1,560	0	0	0
Commercial 15mm	2,000	9,000	2,000	7,000	1,684	5,316	7,901	0
Commercial 20mm	0	2,585	0	2,585	0	2,585	2,585	0
Industrial 20mm	0	0	0	0	0	0	0	0
Industrial 32mm	0	0	0	0	0	0	0	0
Industrial 40mm	0	0	0	0	0	0	0	0
Governmental 20mm	0	0	0	0	0	0	0	0
Governmental 32mm	0	0	0	0	0	0	0	0
Governmental 40mm	0	0	0	0	0	0	0	0
		35,221		22,341		7,901		0
Total Meters Replaced	16,000		16,000		16,000		10,486	



LEGEND

Q : Average flow (m3/sec)
(Max. Flow m3/sec)
Cap. : Capacity
( ) : Reservoir in Damascus City
K.1 : Official code of Reservoir

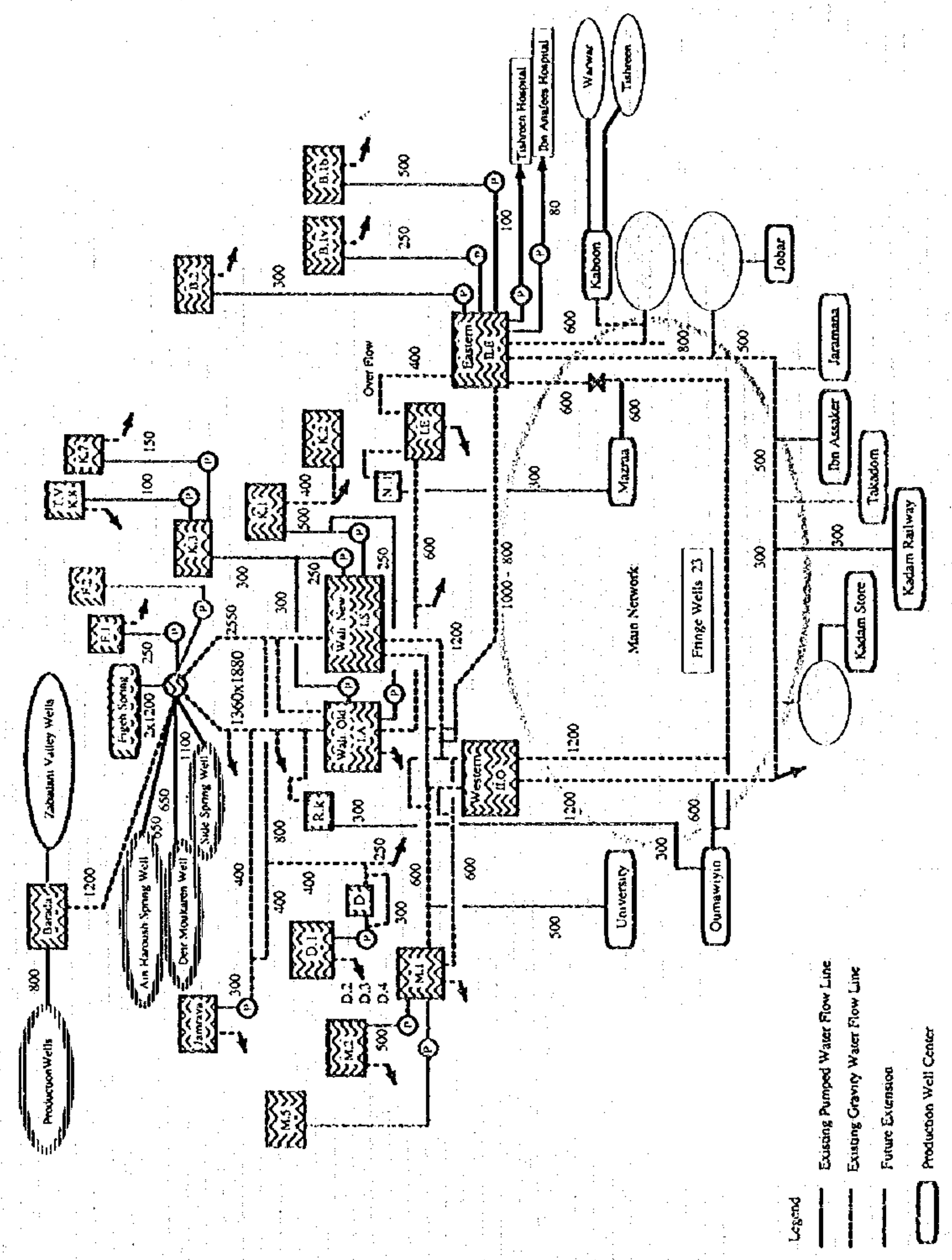
(Source : DAWSSA)

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)

NIPPON KOEI CO., LTD.

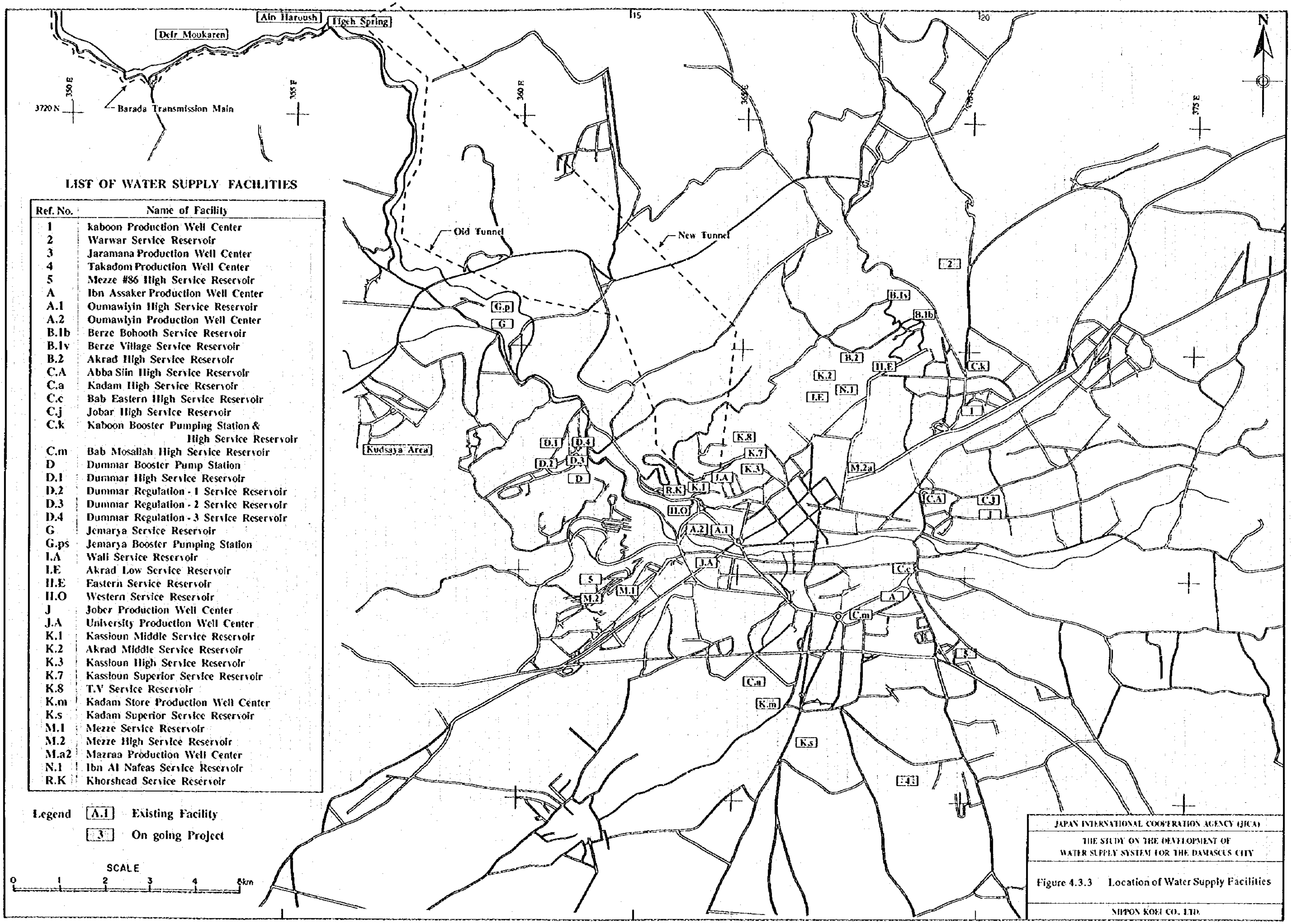


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 4.3.2 Schematic Diagram of Water Supply System

NIPPON KOEI CO., LTD.



LIST OF WATER SUPPLY FACILITIES

Ref. No.	Name of Facility
1	kaboon Production Well Center
2	Warwar Service Reservoir
3	Jaramana Production Well Center
4	Takadom Production Well Center
5	Mezze #86 High Service Reservoir
A	Ibn Assaker Production Well Center
A.1	Oumawiyin High Service Reservoir
A.2	Oumawiyin Production Well Center
B.1b	Berze Bohooth Service Reservoir
B.1v	Berze Village Service Reservoir
B.2	Akrad High Service Reservoir
C.A	Abba Siin High Service Reservoir
C.a	Kadam High Service Reservoir
C.c	Bab Eastern High Service Reservoir
C.j	Jobar High Service Reservoir
C.k	Kaboon Booster Pumping Station & High Service Reservoir
C.m	Bab Mosallah High Service Reservoir
D	Dummar Booster Pump Station
D.1	Dummar High Service Reservoir
D.2	Dummar Regulation - 1 Service Reservoir
D.3	Dummar Regulation - 2 Service Reservoir
D.4	Dummar Regulation - 3 Service Reservoir
G	Jemarya Service Reservoir
G.ps	Jemarya Booster Pumping Station
I.A	Wali Service Reservoir
I.E	Akrad Low Service Reservoir
H.E	Eastern Service Reservoir
H.O	Western Service Reservoir
J	Jober Production Well Center
J.A	University Production Well Center
K.1	Kassioun Middle Service Reservoir
K.2	Akrad Middle Service Reservoir
K.3	Kassioun High Service Reservoir
K.7	Kassioun Superior Service Reservoir
K.8	T.V Service Reservoir
K.m	Kadam Store Production Well Center
K.s	Kadam Superior Service Reservoir
M.1	Mezze Service Reservoir
M.2	Mezze High Service Reservoir
M.a2	Mazraa Production Well Center
N.1	Ibn Al Nafeas Service Reservoir
R.K	Khorshead Service Reservoir

Legend [A.1] Existing Facility
[3] On going Project

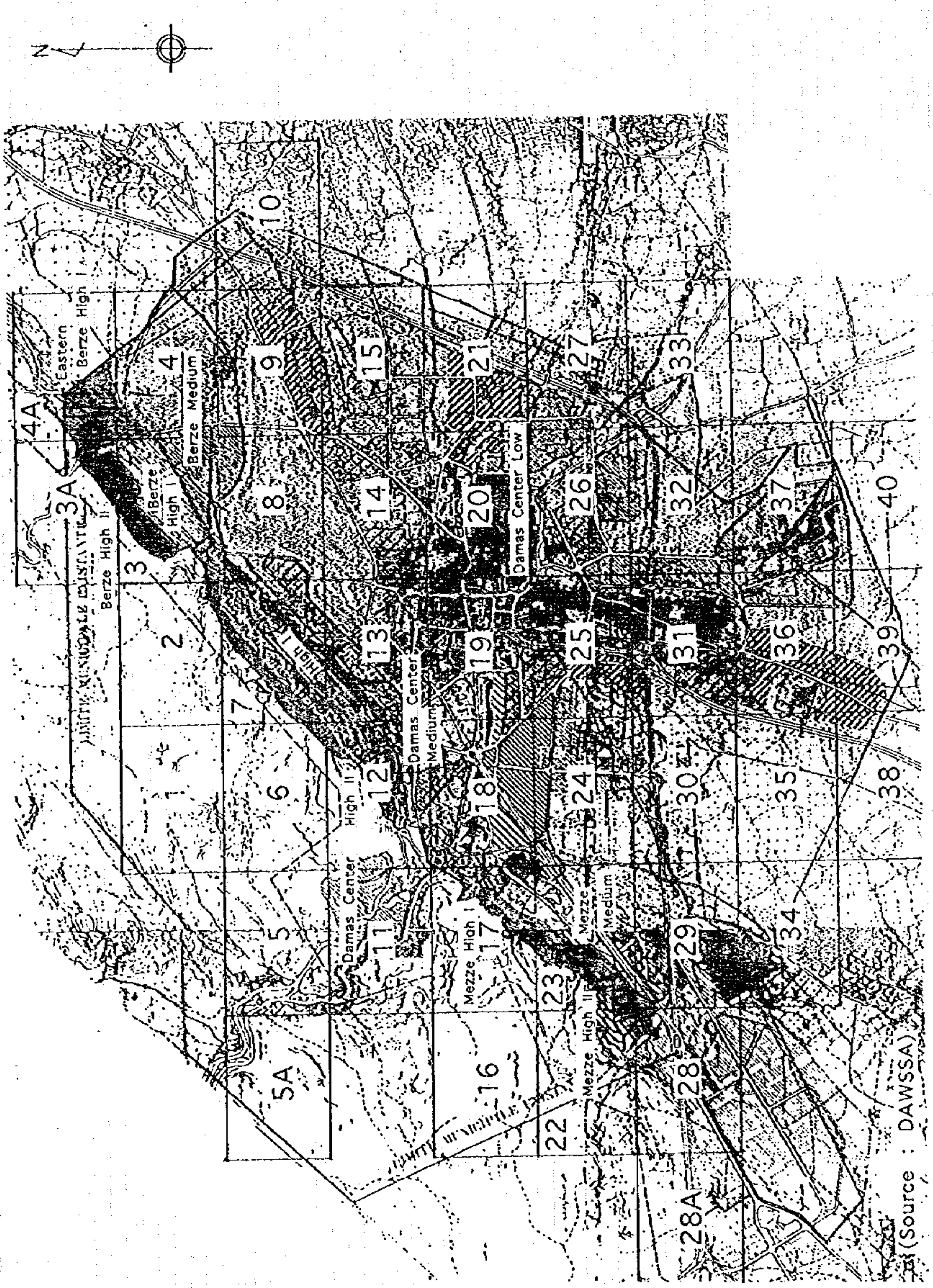
SCALE
0 1 2 3 4 5km

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 4.3.3 Location of Water Supply Facilities

NIPPON KOEI CO., LTD.



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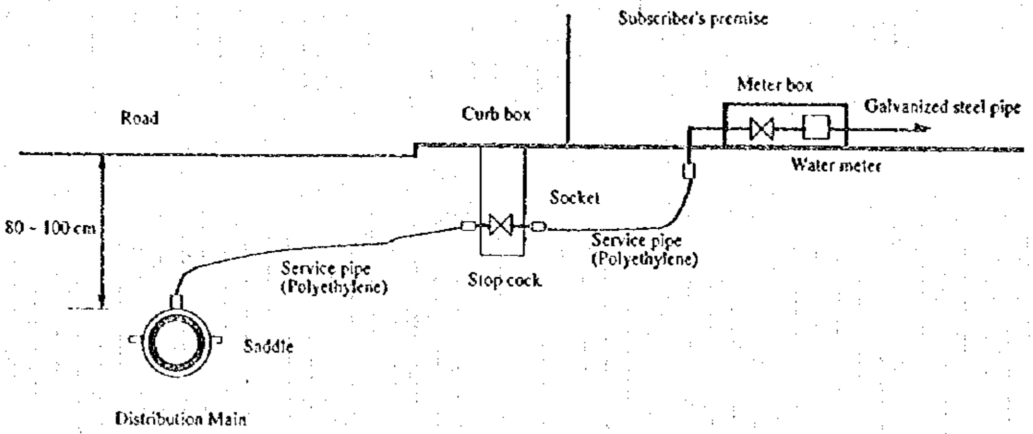
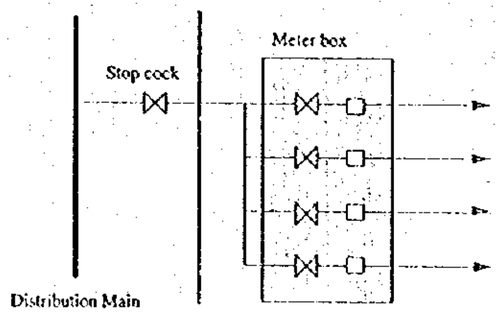
THE STUDY ON THE DEVELOPMENT OF
WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 4.3.4 Pressure Zones and Official Area No.

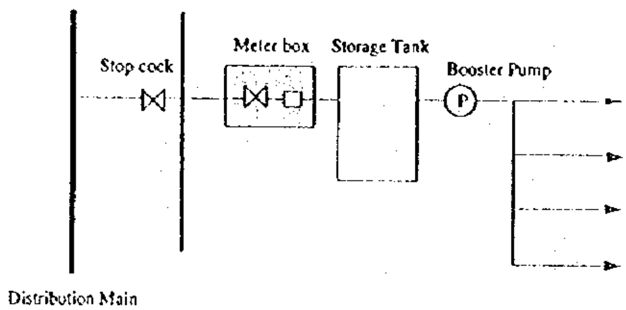
NIPPON KOEI CO., LTD.



House connection type for new building



House connection type for tall building

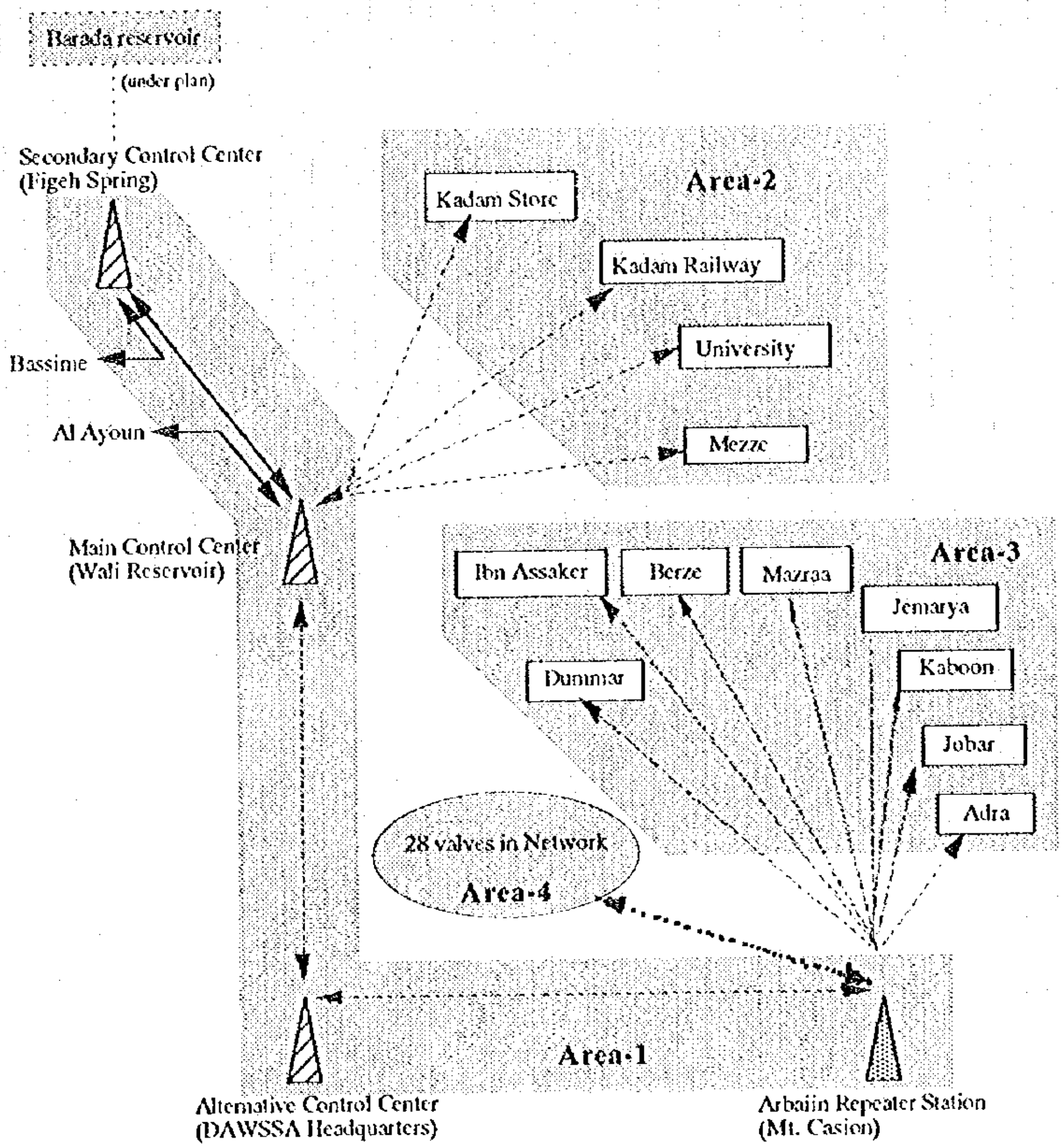


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 4.3.5 Typical House Connection

NIPPON KOEI CO., LTD.



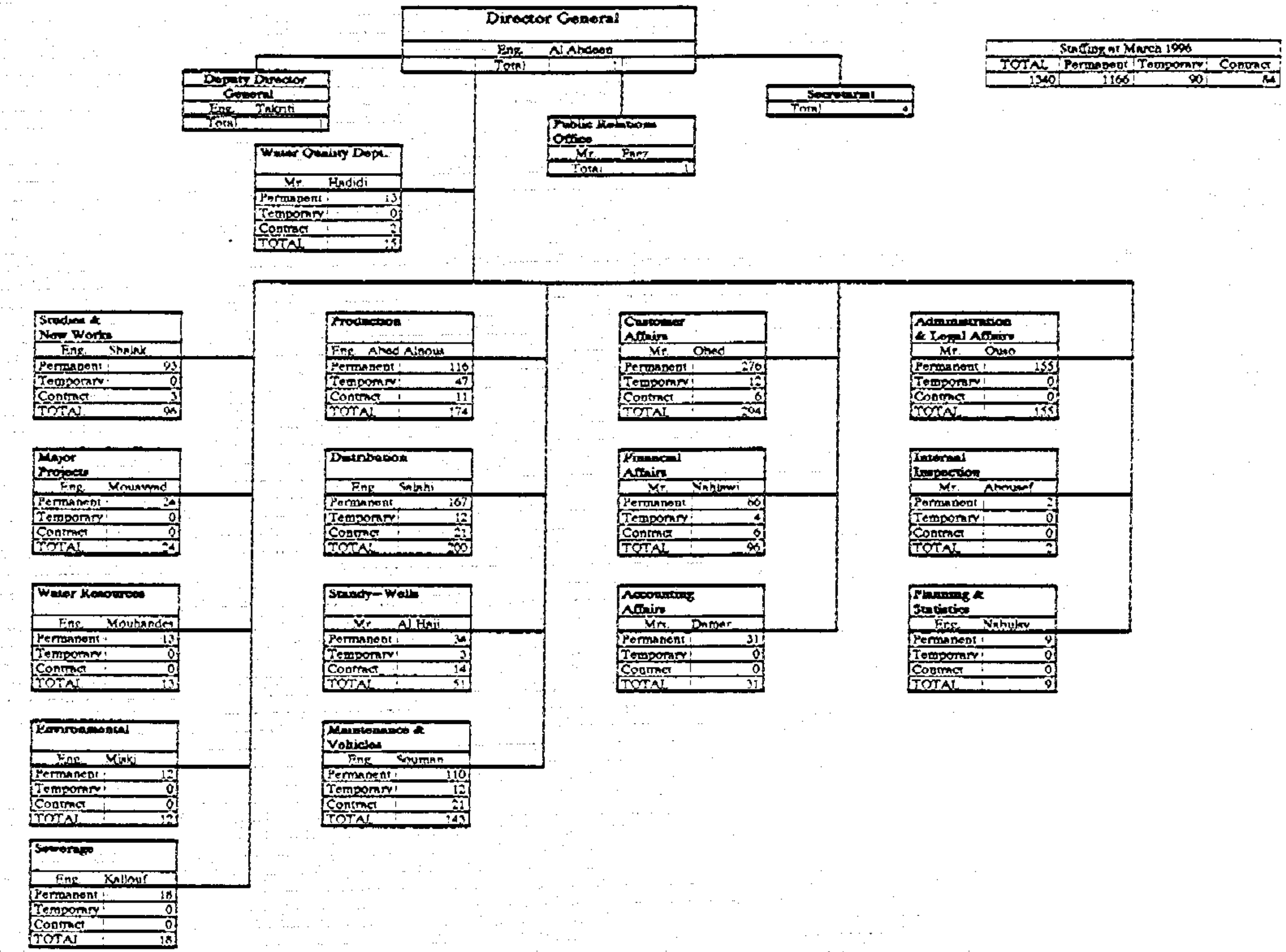
Legend : ◄---► Micro Wave

◄---► UHF

◄——► Optical Fiber Grass Cable in New Tunnel

Note : Existing PABX (private automatic branch exchanger) will be used for back-up system.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 4.3.6 Schematic Diagram of SCADA System
NIPPON KOEI CO., LTD.



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 4.6.1
DAWSSA Organization Structure

NIPPON KOEI CO., LTD.