Table 5.5.12 Pumping Details for Tishreen and Kywan Wellfields

Well	Static Water Level (m)	Pumping Water Level (m)	Pump Capacity (l/s)	Installation Depth (m)
Phase I				
Tishreen 3	5	20	25	45
Tishreen 4	5	22	25	45
Tishreen 8	10	36	25	60
Kywan 2	5	27	30	35
Kywan 3	5	27	30	35
Phase II				
Tishreen 1	5	55	15	65
Tishreen 2	5	50	15	60
Tishreen 5	10	47	25	60
Tishreen 6	15	80	10	90
Tishreen 7	13	80	10	90
Tishreen 9	8	36	25	50
Tishreen 10	5	50	10	60
Kywan 4	5	45	12.5	50
Kywan 5	5	45	7.5	50
Phase III				
Tishreen 11	10	35	25	50
Tishreen 12	5	25	25	40

Table 5.5.13 Details Fringe Wells to be Re-equipped

Well Number	Proposed Installed Capacity (l/s)	Anticipated Drawdown (m)	Anticipated dynamic water level (m bgl)
1	30	4.3	24
2	30	3.2	20
3	30	2.9	20
4	30	6.4	23
5	30	9.3	27
10	20	9.2	22
17	20	8.6	19
21	25	9.3	24

Table 5.5.14 Determination of Water Levels in Pumped Boreholes

Parameter	Ibn Assaker		Mazraa		Kaboon		Jobar		Kadam	
	current	future	current	future	current	future	current	future	current	future
Pump Rate (m3/hr)	100	108	100	100	60	60	100	100	100	135
Number of Boreholes	19	19	24	24	5	5	14	14	13	13
Utilisation (%)	65	80	50	50	80	50	90	90	85	85
Total Pumped (m3/d)	**29,640**	**39,398**	**28,800**	**28,800**	**5,760**	**3,600**	**30,240**	**30,240**	**26,520**	**35,802**
Transmissivity (m2/d)	1000	1000	500	500	175	175	500	500	600	600
delta s (m/cycle)	**5.42**	**7.21**	**10.54**	**10.54**	**6.02**	**3.76**	**11.07**	**11.07**	**8.09**	**10.92**
Time zero (day)	10	10	10	10	10	10	10	10	10	10
Time end (day)	200	365	200	365	200	245	200	365	200	365
Observation Bh DD (m)	**7.06**	**11.26**	**13.71**	**16.47**	**7.84**	**5.23**	**14.40**	**17.29**	**10.52**	**17.06**
Observation Bh WI (mbgl)	22.06	26.26	21.71	24.47	40.84	38.23	30.40	33.29	17.52	24.06
delta r (m/cycle)	**0.44**	**0.47**	**0.88**	**0.88**	**1.51**	**1.51**	**0.88**	**0.88**	**0.73**	**0.99**
Well diam (inch)	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25
Radius to Obs (m)	50	50	50	50	50	50	50	50	50	50
Obs to Bh DD (m)	**1.10**	**1.19**	**2.20**	**2.20**	**3.76**	**3.76**	**2.20**	**2.20**	**1.83**	**2.47**
Ideal Q/s (l/s/m)	13.73	13.73	15.97	15.97	7.59	7.59	5	5	20.58	20.58
Test Rate (m3/hr)	86	86	113	113	82	82	144	144	120	120
Test Drawdown (m)	4.9	4.9	6.33	6.33	22.75	22.75	9.5	9.5	7.16	7.16
'a' parameter	**0.020**	**0.020**	**0.017**	**0.017**	**0.037**	**0.037**	**0.056**	**0.056**	**0.013**	**0.013**
Aquifer Loss (m)	**2.02**	**2.18**	**1.74**	**1.74**	**2.20**	**2.20**	**5.56**	**5.56**	**1.35**	**1.82**
'b' parameter	**4.3E−04**	**4.3E−04**	**3.4E−04**	**3.4E−04**	**2.9E−03**	**2.9E−03**	**7.2E−05**	**7.2E−05**	**3.8E−04**	**3.8E−04**
Well Losses (m)	**1.81**	**3.19**	**0.85**	**0.85**	**6.77**	**2.64**	**0.59**	**0.59**	**2.78**	**5.07**
Regional Recession (m)	3	3	3	3	2	2	3	3	3	3
Water level May (mbgl)	12	12	5	5	31	31	13	13	4	4
Predicted Water Level (mbgl)	**24.96**	**30.64**	**24.76**	**27.52**	**51.37**	**44.64**	**33.18**	**36.07**	**22.13**	**31.60**

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	Option 1 and 2		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 5team 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	Option 1, 2,3,4 and 5	Improve Quality	Reduce high nitrate concentration
		1.10 Reinforcement of Existing Water Resources	Ain Figeh Area	Increase Production	PA; Total 205 MCM/y by Main+Extend Side+ Extend Ain Harush++Dier Mouk area
			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	Formalized	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		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 Basateen		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 Souseh	Increase Production	PA; Total 1.68 MCM/y by 5 wells
			Faculty of Agriculture		No land acquisition
			Kyan & Tishreen		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 Extension	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)		WP; - MCM/y, implemented after 2015
		3.3 Water Resources Development Schemes in Damascus (New Stations)	Sheikh 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 Improvement Plan of Master Meter

Discharge Pipe Dia. (mm)	NO.	Name of Station	Facility	Supply to	Remarks
ELECTRICMAGNETIC FLOW METER					
100	1	M.3 Kassioun High	Discharge main-3	K.8 (2 old pump)	Replace
	2	M.3 Kassioun High	Discharge main-1	K.8 (2 Kubota pump)	Replace
250	1	I.A Wali Old	Discharge main-1	K.1 reservoir	New
	2	II.E Eastern	Discharge main-2	B.1v Berze Village	New
	3	C.k Kaboon Booster	Discharge main-1	Tishreen	New
300	1	I.A Wali Old	Discharge main-2	K.3 reservoir	New
	2	C.k Kaboon Booster	Discharge main-2	Warwar	New
	3	M.a2 Mazraa	Discharge main-2	N.1	New
400	1	G Jemarya	Discharge main	Reservoir	New
	2	D Dummar	Discharge main	D.1 Reservoir	New
	3	II.E Eastern	Discharge main-3	B.2 Akrad High	New
	4	Kaboon Well Field	Collecting main	Booster pump/Network	New
500	1	M.1 Mezze	Discharge main	M.2 Mezze High	Replace
	2	II.E Eastern	Discharge main-1	B.1b Berze Bobooth	New
	3	A Ibo Assaker	Dicharge main	Network	New
600	1	K.m New Kadam Store	Discharge main	Network	New
700	1	II.O Western	Reservoir	M.1 Mezze	Replace
	2	Figeh Main Spring	Well pump-1	Collecting main	Replace
	3	Figeh Main Spring	Well pump-2	Collecting main	New
	4	Figeh Main Spring	Well pump-3	Collecting main	New
	5	Figeh Main Spring	Well pump-4	Collecting main	New
1,200	1	Figeh Side Spring	Collecting main	Figeh	New
ULTRASONIC FLOW METER					
100	1	M.1 Mezze		Network-4 (Mezze #86)	New
150	1	G Jemarya	High reservoir	Koddsia	New
	2	K.7 Kassioun Superior	Reservoir	Network	New
	3	M.2 Mezze High	Reservoir	Villat	New
200	1	G Jemarya	High reservoir	Jemraya village	New
	2	G Jemarya	High reservoir	Jecliade village	New
	3	G Jemarya	High reservoir	Koddsia	New
	4	D.2 Dummar Regulation-1	Discharge main	D.3 & Network	New
	5	K.2 Akrad Middle	Reservoir	Network-1	New
250	1	D.4 Dummar Regulation-3	Discharge main	Network	New
	2	K.1 Kassioun Middle	Reservoir	Network-1	New
	3	K.1 Kassioun Middle	Reservoir	Network-2	New
	4	K.2 Akrad Middle	Reservoir	Network-2	New
	5	K.2 Akrad Middle	Reservoir	Network-3	New
	6	B.1v Berze Village	Reservoir	Network	New
	7	M.2 Mezze High	Reservoir	Mezze West	New
	8	M.2 Mezze High	Reservoir	Mezze West	New
300	1	K.3 Kassioun High	Reservoir	Network-1 (Mohajerin)	Replace
	2	K.3 Kassioun High	Reservoir	Network-2 (Akrad)	Replace
	3	D.3 Dummar Regulation-2	Discharge main	D.4 & Network	New
	4	M.2 Akrad High	Reservoir	Network	New
400	1	I.A Wali Old	Reservoir	Network-1	New
	2	I.A Wali Old	Reservoir	Network-2	New
	3	M.1 Mezze	Reservoir	Network-1 (Old Mezze)	New
	4	M.2 Mezze High	Reservoir	Network & Air port Zone	New
500	1	I.A Wali Old	Reservoir	Network-3	Replace
	2	I.A Wali Old	Reservoir	Network-4	Replace
	3	M.1 Mezze	Reservoir	Network-2 (Mezze Outstrad)	Replace
	4	M.1 Mezze	Reservoir	Network 3 (Mezze Jobal)	Replace
	5	K.1 Kassioun Middle	Reservoir	K.2 reservoir	New
	6	I.E Akrad Low	Reservoir	Network	New
600	1	I.A Wali Old	Reservoir	I.E Akrad Low	Replace
	2	II.E Eastern	Reservoir	Network	New
	3	B.1b Berze Bobooth	Reservoir	Network	New
1,200	1	I.S Wali New	Reservoir	II.O Western-1	Replace
	2	I.S Wali New	Reservoir	II.O Western-2	Replace
WATER LEVEL GAUGE					
250	1	Figeh 1	Discharge main-2	Irrigation channel	New

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	649,000	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. SOMAREYA 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 (1/3) Comparison of Economic Internal rate of Return

Distribution System Project Ranking

Project	Incremental Water (m^3/year)	Sensitivity Analysis 1. (Base case)	2. (Costs+10%)	3. (Benefits-10%)	4. (1 year lag)	5. (2 and 3)	6. (2 and 4)	7. (2, 3 and 4)
1 Kassioun Mountain	2,480,175	23.4%	23.4%	21.1%	19.6%	21.1%	19.6%	17.9%
2 Al Yarmouk	6,283,110	18.5%	18.4%	16.6%	15.8%	16.5%	15.8%	14.2%
3 Tishreen	1,128,215	12.3%	12.2%	10.8%	10.7%	10.7%	10.7%	9.3%
4 Kudsaya	1,518,400	12.0%	11.9%	10.5%	10.5%	10.4%	10.4%	9.1%
5 Jobar	1,876,465	11.6%	11.6%	10.2%	10.2%	10.1%	10.1%	8.8%
6 Dummar	1,083,320	10.2%	10.1%	8.8%	9.0%	8.8%	8.9%	7.6%
7 Kadam	2,701,365	5.3%	5.2%	4.1%	4.6%	4.1%	4.4%	3.4%
8 Mezze-Razy	2,393,305	3.5%	3.4%	2.4%	3.0%	2.4%	2.8%	1.8%
9 Al Quazaz & Shagour Bassateen	780,370	3.0%	2.9%	1.9%	2.4%	1.9%	2.3%	1.3%
10 Somareya	335,070	0.0%	-0.2%	-1.0%	-0.4%	-1.1%	-0.6%	-1.6%
11 Tabbaleh	924,910	-2.3%	-2.6%	-3.3%	-2.6%	-3.3%	-2.8%	-3.8%
12 Total program	21,504,705	10.5%	10.5%	9.2%	9.3%	9.1%	9.3%	8.1%

Table 5.6.4 (2/3) Comparison of Economic Internal rate of Return

Project	Incremental Water (m^3/year)	Water Resources Project Ranking						
		Sensitivity Analysis						
		1. (Base case)	2. (Costs+10%)	3. (Benefits-10%)	4. (1 year lag)	5. (2 and 3)	6. (2 and 4)	7. (2, 3 and 4)
1 Takadom	2,960,000	443.8%	402.2%	398.1%	166.0%	360.6%	156.2%	145.9%
2 Tischreen Phase1,2,3	1,058,400	78.0%	71.0%	70.3%	53.9%	63.8%	50.1%	46.0%
3 Shokry	3,600,000	23.6%	22.9%	20.6%	19.7%	19.9%	19.2%	16.9%
4 Ibn Assaker	2,500,000	22.4%	21.8%	19.6%	18.8%	19.1%	18.4%	16.2%
5 Kadam Rail	2,280,000	22.3%	21.9%	19.7%	18.8%	19.3%	18.5%	16.5%
6 Barada Springs	20,000,000	20.2%	20.2%	20.2%	20.2%	20.2%	20.2%	20.2%
7 Fringe wells	1,760,000	20.0%	19.6%	17.6%	17.0%	17.2%	16.7%	14.8%
8 Kaboon	2,540,000	13.6%	13.0%	11.5%	11.8%	10.9%	11.4%	9.6%
9 Jaramana	3,600,000	13.2%	12.2%	10.7%	11.5%	9.6%	10.6%	8.4%
10 Kanawat	1,690,000	10.4%	9.6%	8.3%	9.1%	7.5%	8.4%	6.5%
11 Karfa Souseh	1,690,000	10.2%	9.4%	8.1%	9.0%	7.3%	8.3%	6.3%
12 Deir al Ashayer	3,200,000	7.0%	6.8%	6.0%	6.5%	5.7%	6.4%	5.4%
13 Beit Jen	19,700,000	6.5%	5.7%	5.6%	6.1%	4.8%	5.3%	4.5%
14 Hermon 2	24,180,000	4.9%	4.1%	4.1%	4.5%	3.4%	3.9%	3.1%
15 Hermon 1	24,180,000	4.7%	4.0%	3.9%	4.4%	3.2%	3.7%	2.9%
16 Hermon 3	24,180,000	4.5%	3.8%	3.7%	4.2%	3.0%	3.5%	2.8%
20 Rimeh	4,480,000	3.0%	2.9%	2.2%	2.8%	2.0%	2.6%	1.9%
21 Sergaya	2,900,000	1.9%	1.6%	1.0%	1.7%	0.8%	1.5%	0.7%

Table 5.6.4 (3/3) Comparison of Economic Internal rate of Return

Project	Incremental Water (m³/year)	Sensitivity Analysis 1. (Base case)	2. (Costs+10%)	3. (Benefits-10%)	4. (1 year lag)	5. (2 and 3)	6. (2 and 4)	7. (2, 3 and 4)
1 Meter replacement, foreign	27,890,000	51.6%	46.4%	51.6%	35.8%	46.4%	32.6%	32.6%
2 Meter replacement, Syrian	27,890,000	29.8%	22.5%	21.7%	12.9%	14.4%	0.0%	1.5%
3 Leakage control, DMA, pressure control & master metering	18,170,000	42.6%	38.4%	37.9%	31.7%	34.3%	29.3%	29.1%
4 Cast iron pipe replacement	14,674,949	11.4%	11.9%	10.3%	n/a	10.4%	n/a	n/a
5 Water quality laboratory reinforcement		0.0%	n/a	n/a	n/a	0.0%	n/a	n/a
6								
7								
8								
9								
10								

Table 5.6.5 (1/2) Preliminary Assessment of Environmental Impact

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: Dons 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:Dons 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
			Oumawiyin	-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
			Jobar Surrounding-Al Aksab Mosque	+/-	-L	-L	+M	-L	+H	-L	Low
			East-West Tabbleh	+/-	-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

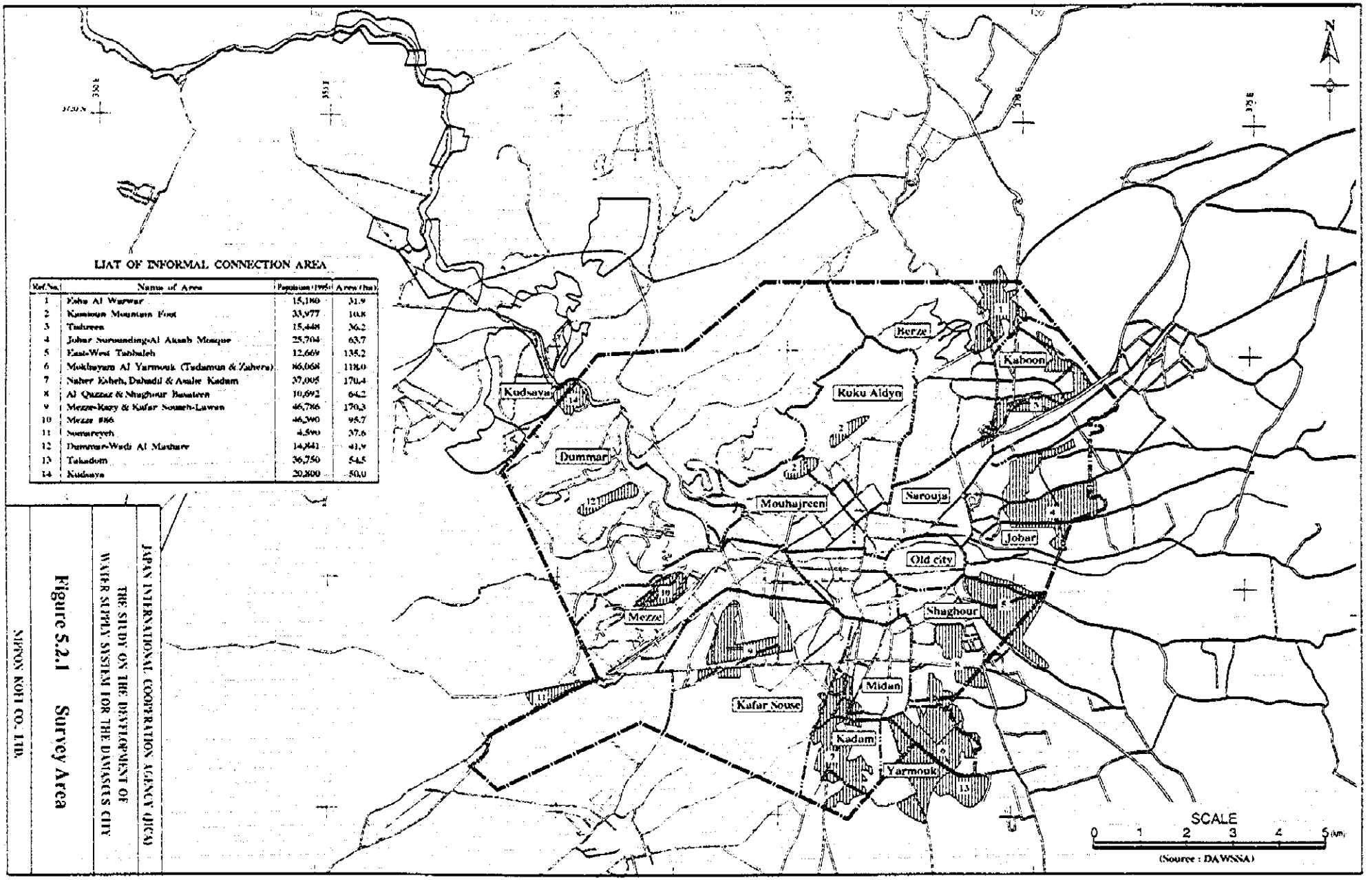
Table 5.6.5 (2/2) Preliminary Assessment of Environmental Impact

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
		Kiwan & Tishreen	+/-	- L	- L	+ L	- L	+ H	- L	Low
	2.4 Water Resources Development Schemes in Hermon area	Rimeh/ Earneh	- 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 Gardens	+/-	- M	- L	+ L	- L	+ L	- L	Low
		3.4 Water Resources Schemes in Hermon and Zabadani	Bert 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



LIST OF INFORMAL CONNECTION AREA

Ref.No.	Name of Area	Population (1995)	Area (ha)
1	Kaba Al Warwar	15,180	31.9
2	Kassioun Mountain Foot	33,977	10.8
3	Tahreen	15,448	36.2
4	Jobar Surrounding-Al Akaab Mosque	25,704	63.7
5	East-West Tahbaleh	12,669	135.2
6	Mokhayam Al Yarmouk (Tadamun & Yahera)	86,068	118.0
7	Naher Eshek, Dahadil & Asalie Kadam	37,005	170.4
8	Al Qazzaz & Shaghour Basateen	10,692	64.2
9	Mezze-Kasy & Kafar Soumeh-Lawan	46,786	170.3
10	Mezze #86	46,390	95.7
11	Sumareyeh	4,590	37.6
12	Dummar-Wadi Al Mashare	14,841	41.9
13	Takadom	36,750	54.5
14	Kudsaya	20,800	50.0

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

Figure 5.2.1 Survey Area

NIPPON KOEI CO., LTD.

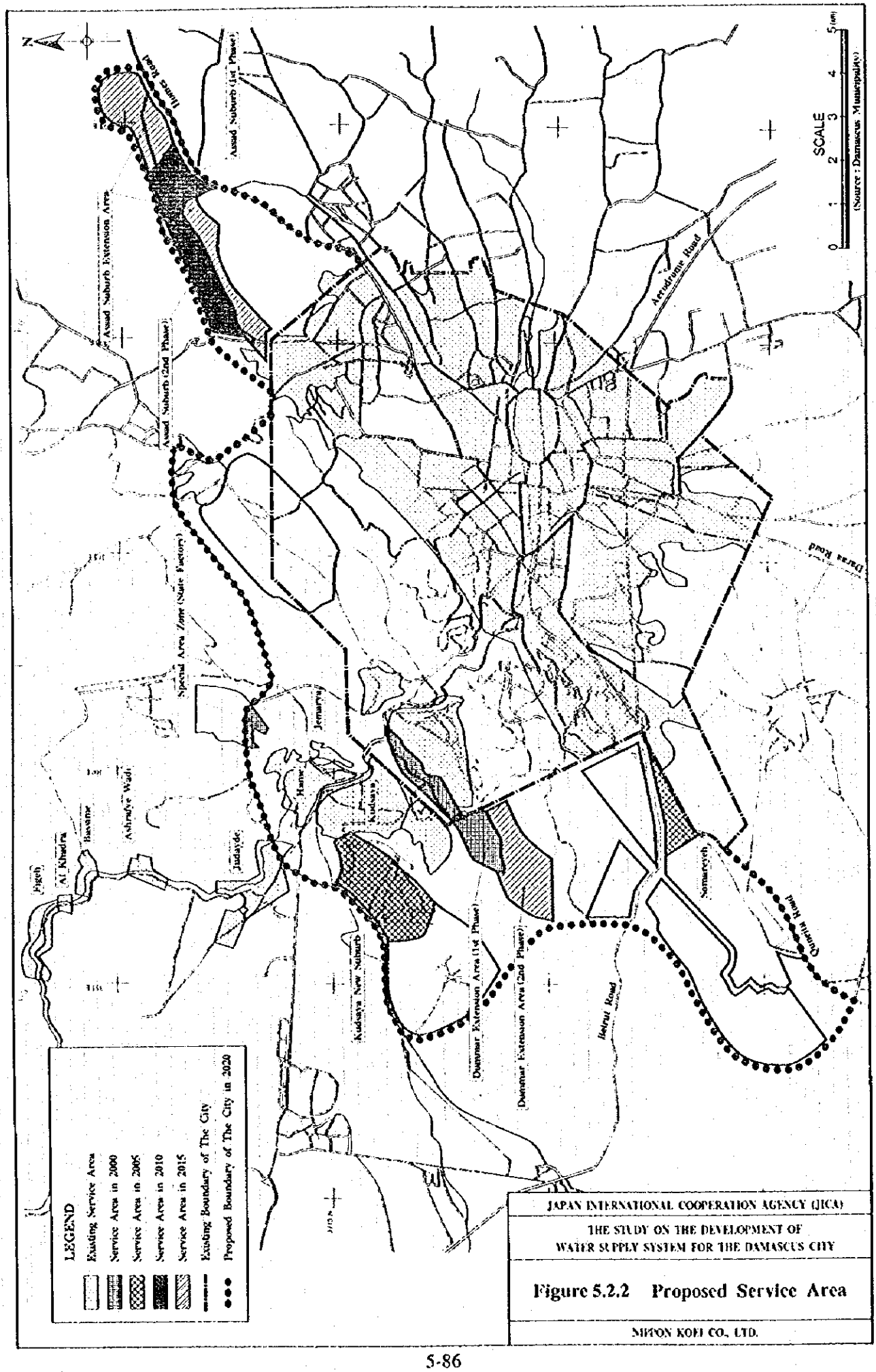

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Figure 5.2.2 Proposed Service Area

NIPPON KOEI CO., LTD.

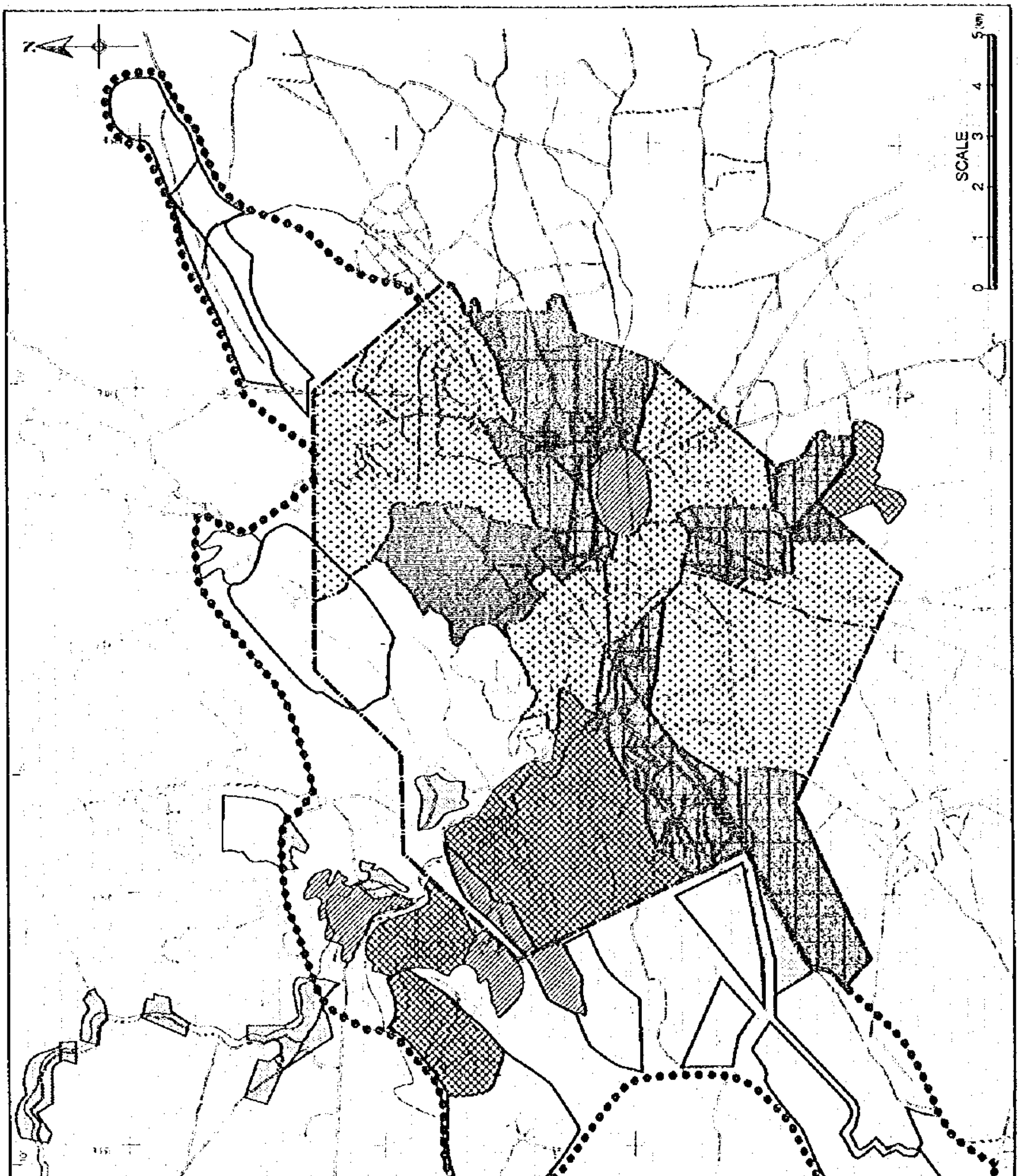

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Figure 5.4.1
Water Requirement (2005)

NIPPON KOEI CO., LTD.

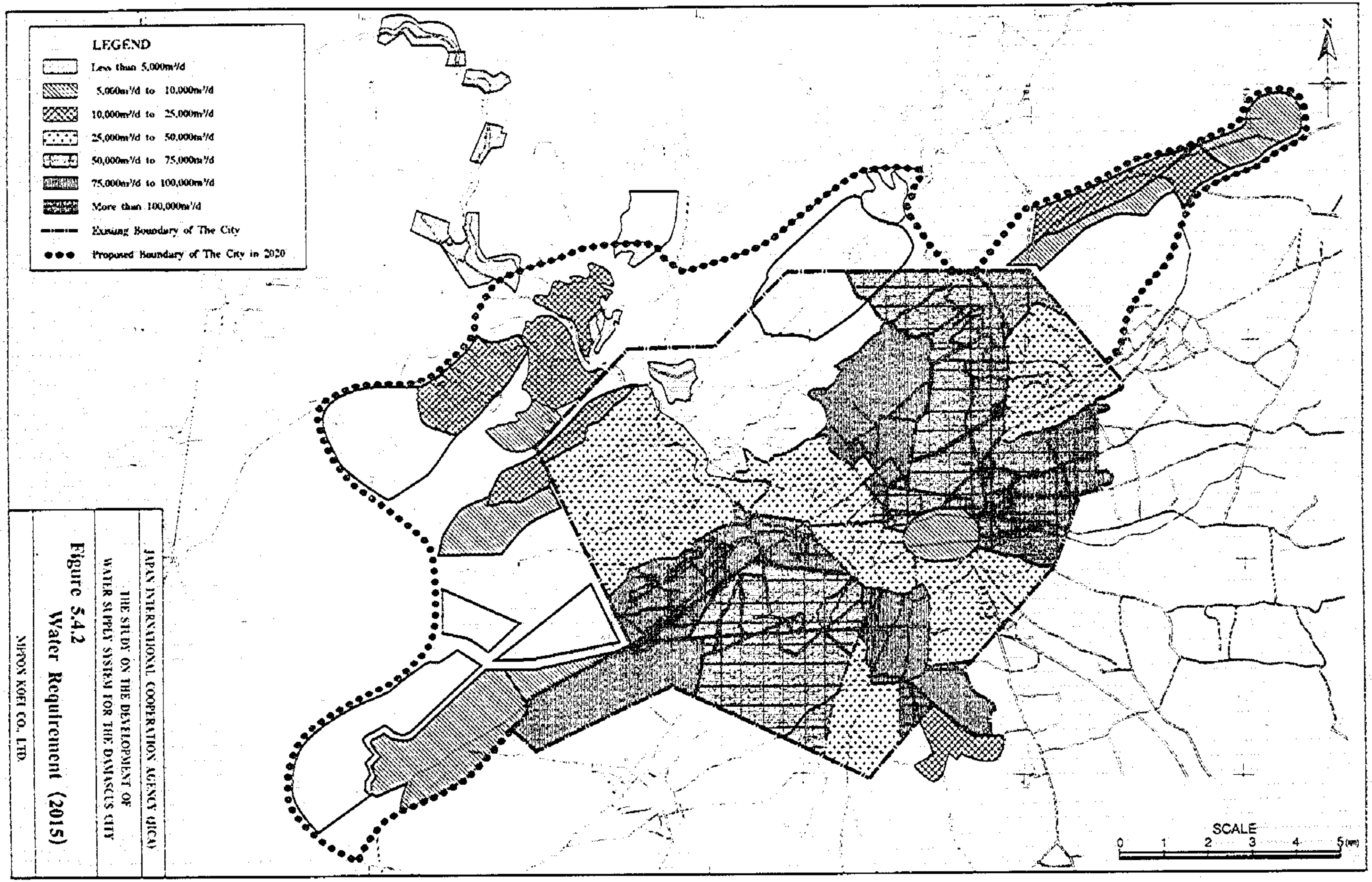

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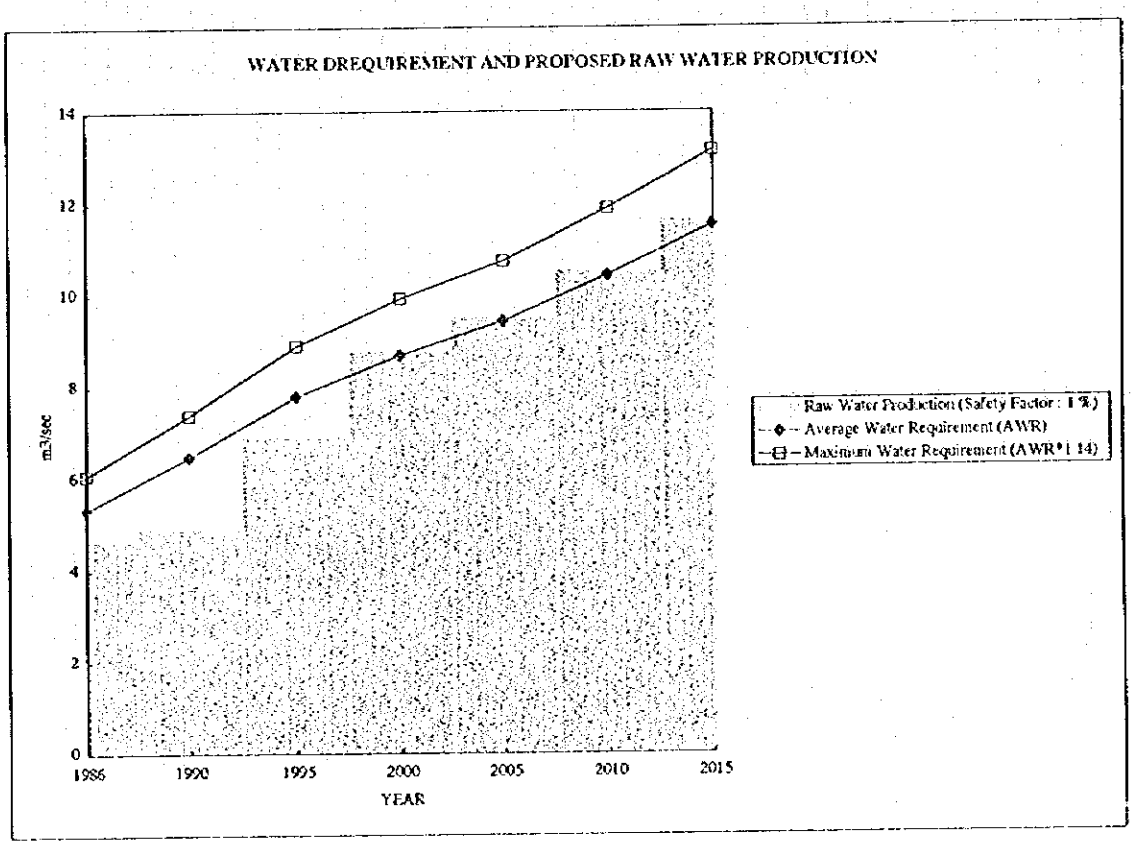
Figure 5.4.2 Water Requirement (2015)

NIPPON KOEI CO., LTD.

(Unit : m3/sec)

Year	1986	1990	1995	2000	2005	2010	2015
Average Water Requirement (AWR)	5.3	6.5	7.8	8.7	9.4	10.4	11.5
Maximum Water Requirement (AWR*1.14)	6.1	7.4	8.9	9.9	10.7	11.9	13.1
Raw Water Production (Safety Factor : 1 %)	4.7	4.9	6.9	8.8	9.5	10.5	11.6

(Remark) : Assumed from the result of study on the water supply conditions in 1995



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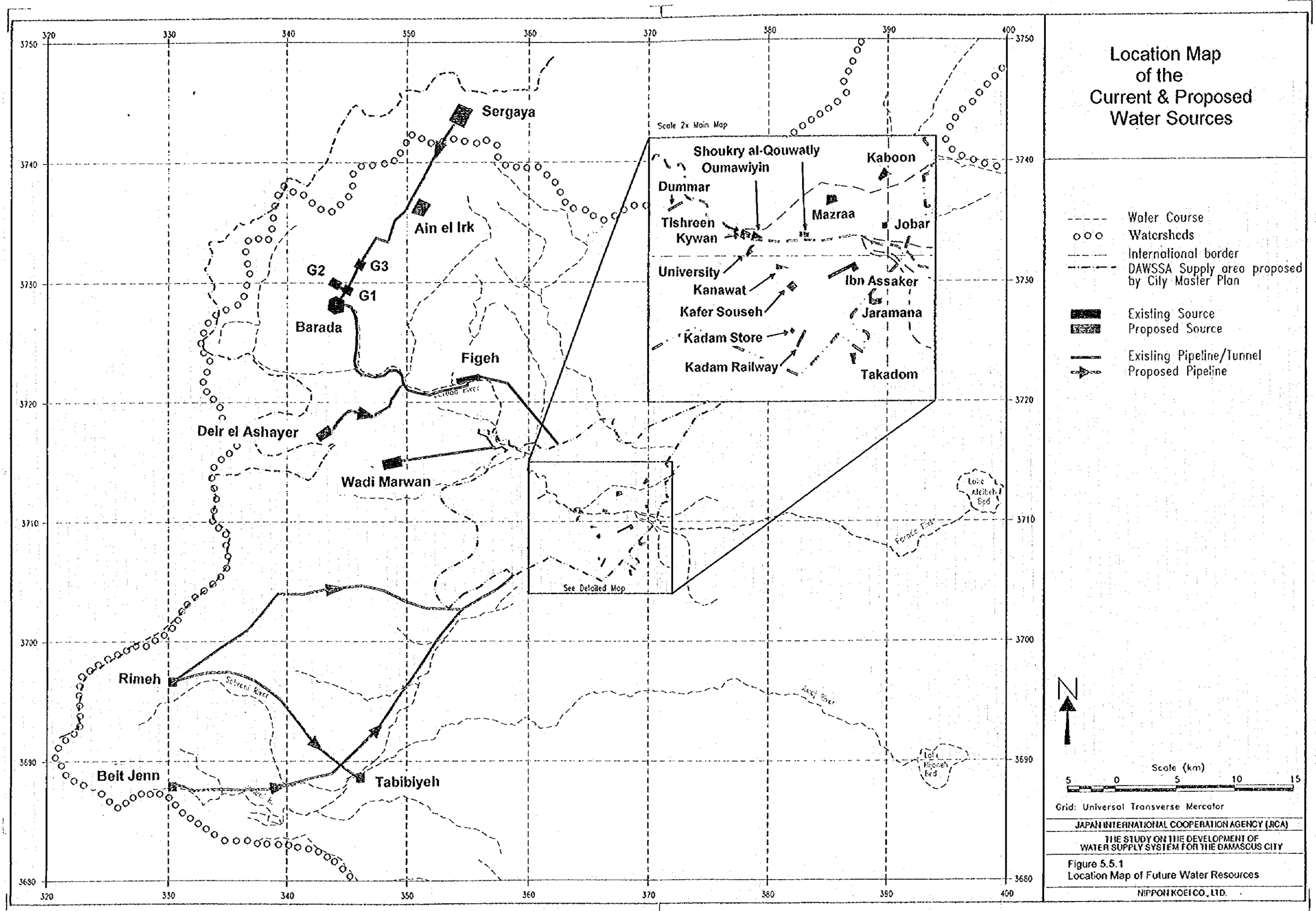
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.4.3 Water Requirement and Proposed Raw Water Production
NIPPON KOEI CO., LTD.


Location Map
of the
Current & Proposed
Water Sources
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
Mazraa
Tishreen
Kywan
Jobar
University
Kanawat
Ibn Assaker
Kafer Souseh
Jaramana
Kadam Store
Kadam Railway
Takadom
See Detailed Map
Water Course
Watersheds
International border
DAWSSA Supply area proposed by City Master Plan
Existing Source
Proposed Source
Existing Pipeline/Tunnel
Proposed Pipeline
N
Scale (km)
5 0 5 10 15
Grid: Universal Transverse Mercator
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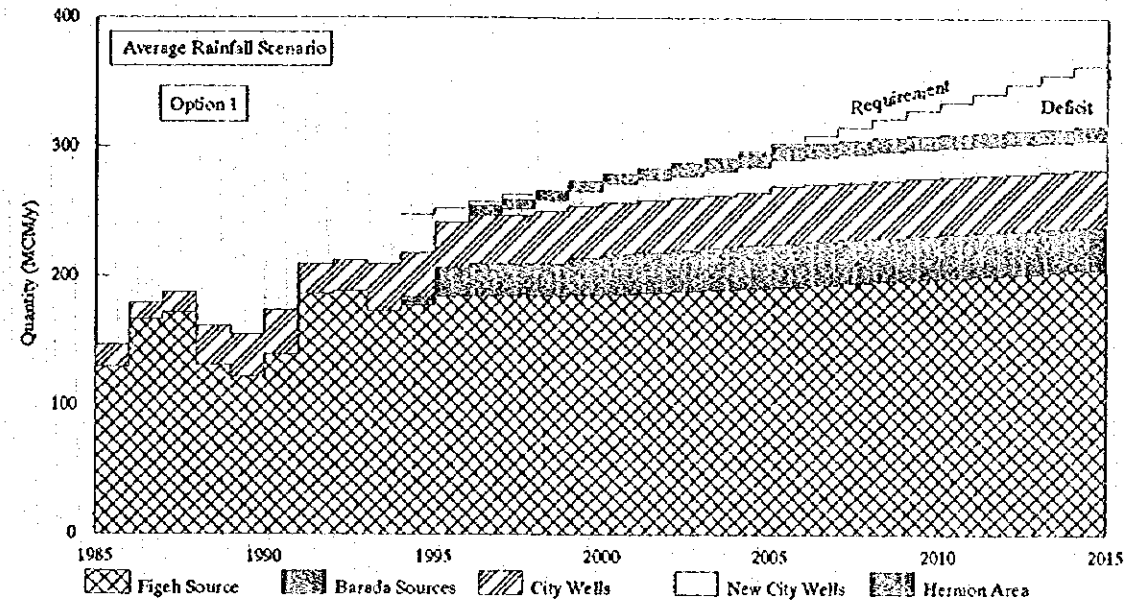
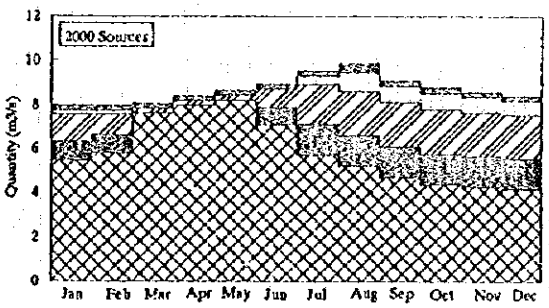
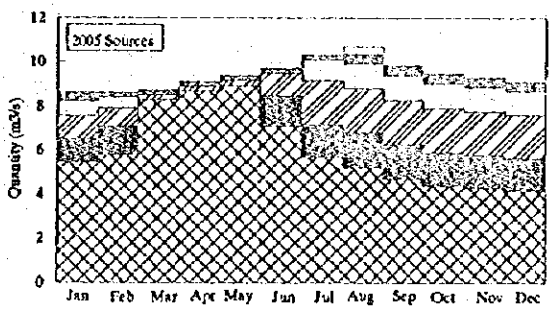
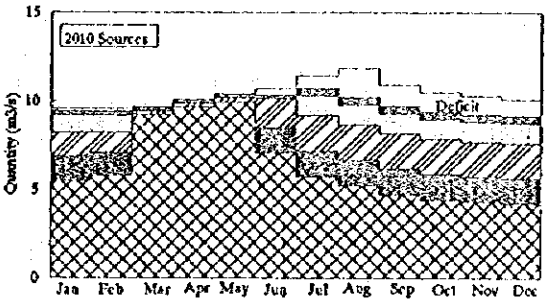
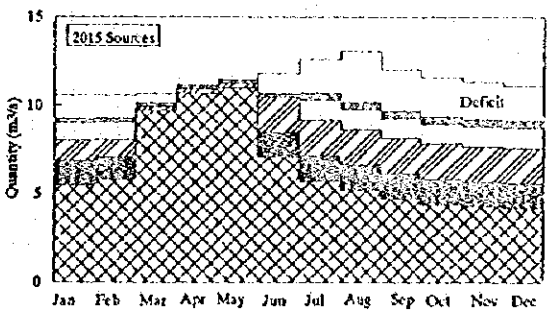
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.5.1
Location Map of Future Water Resources
NIPPON KOEI CO., LTD.











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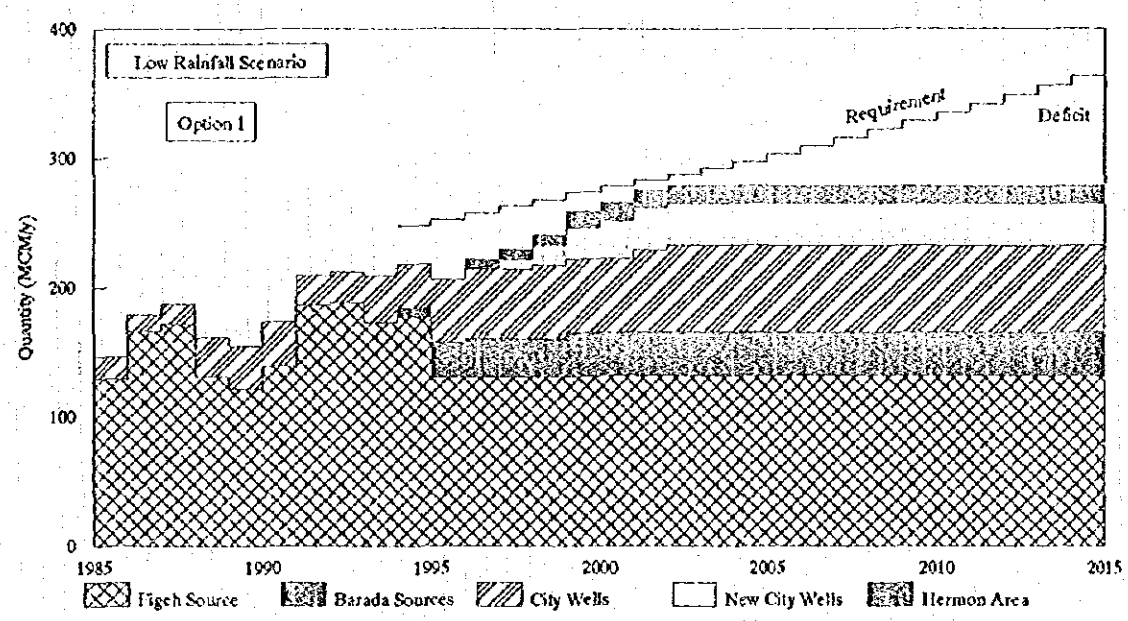
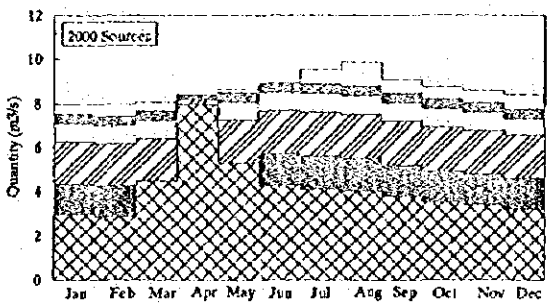
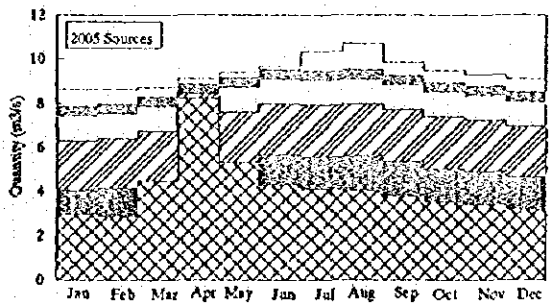
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

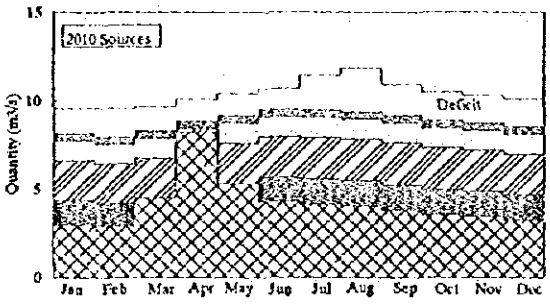
Figure 5.5.2
Water Production Plan for Average Conditions

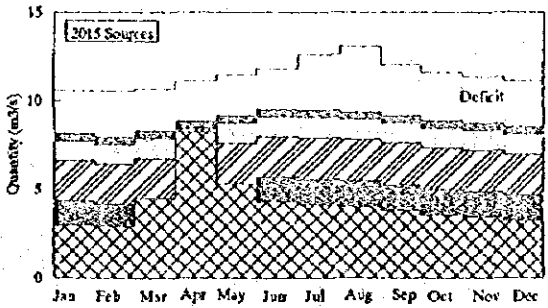
NIPPON KOEI CO., LTD.











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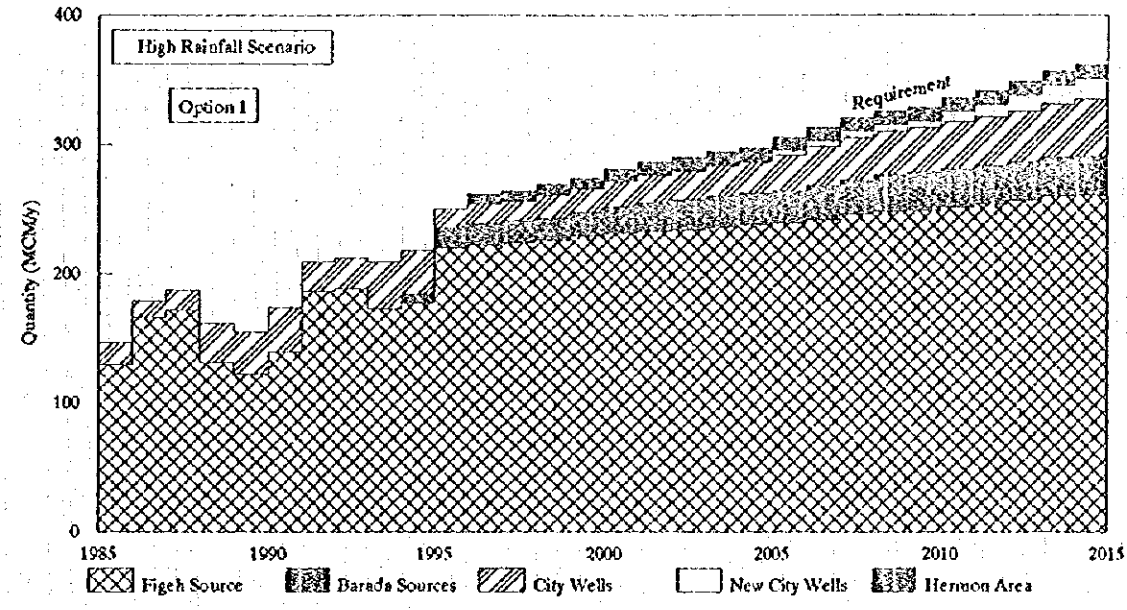
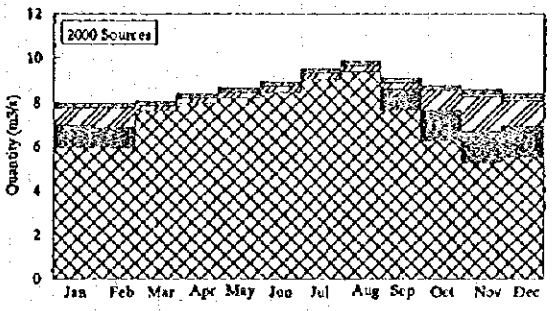
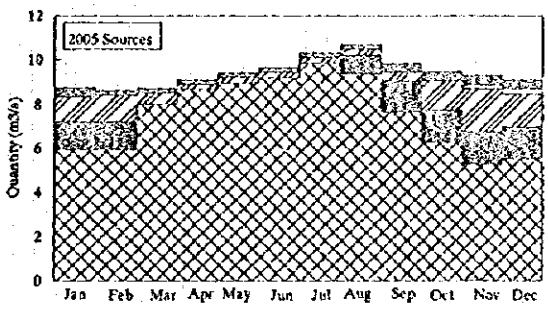
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

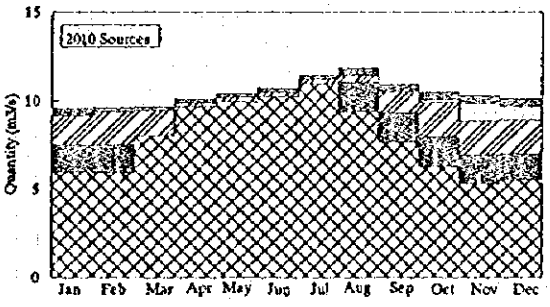
Figure 5.5.3
Water production Plan for Dry Conditions

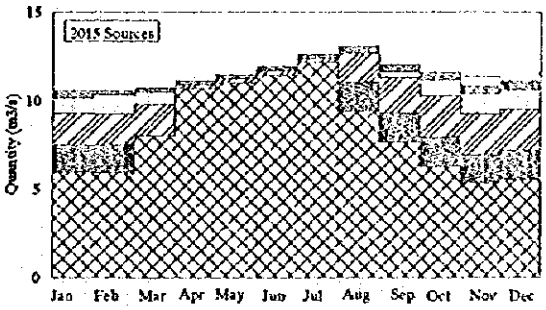
NIPPON KOEI CO., LTD.









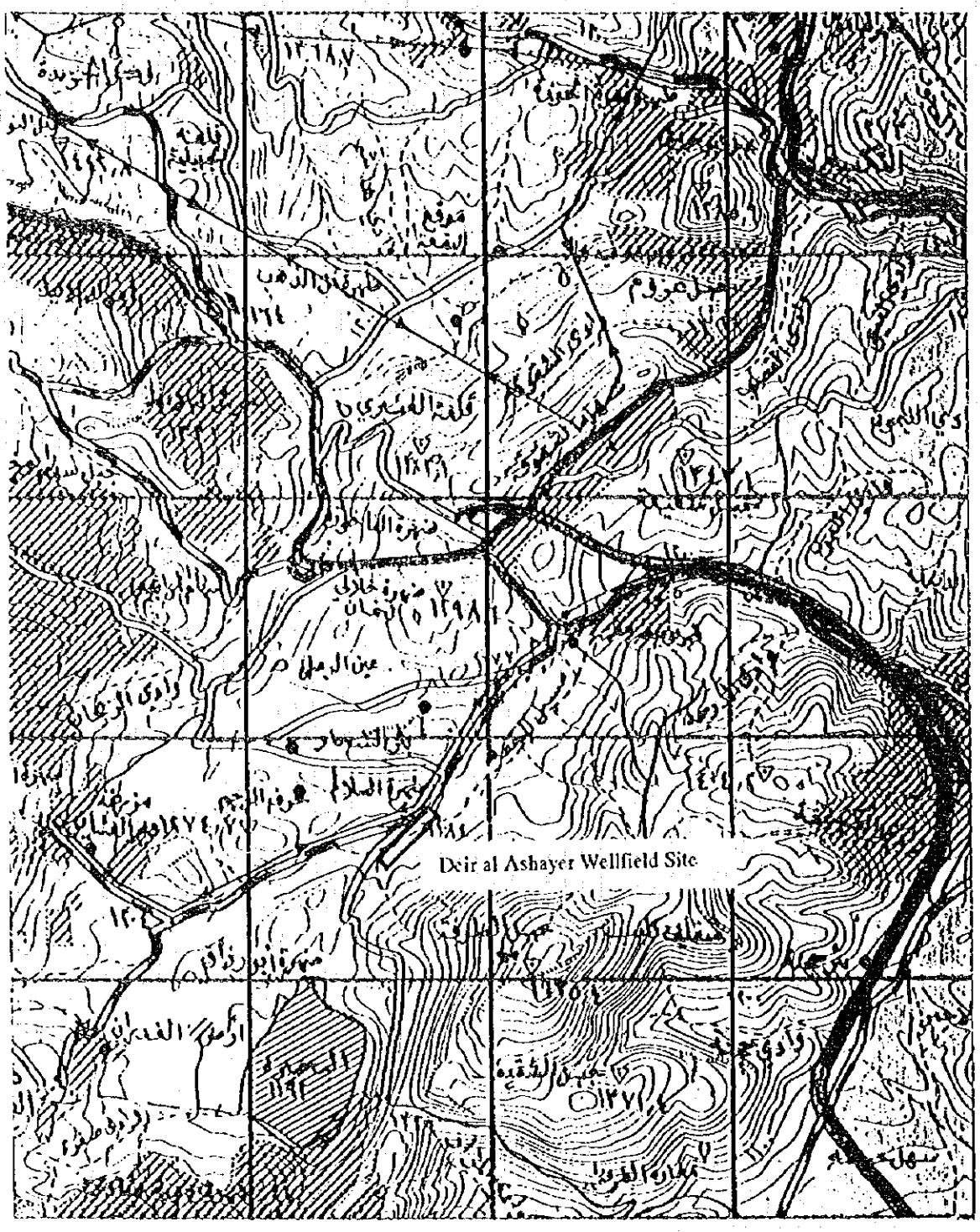


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 5.5.4
Water Production Plan for Wet Conditions

NIPPON KOEI CO., LTD.



Scale 1:50,000 (Enlarged from 1:100,000 Map)

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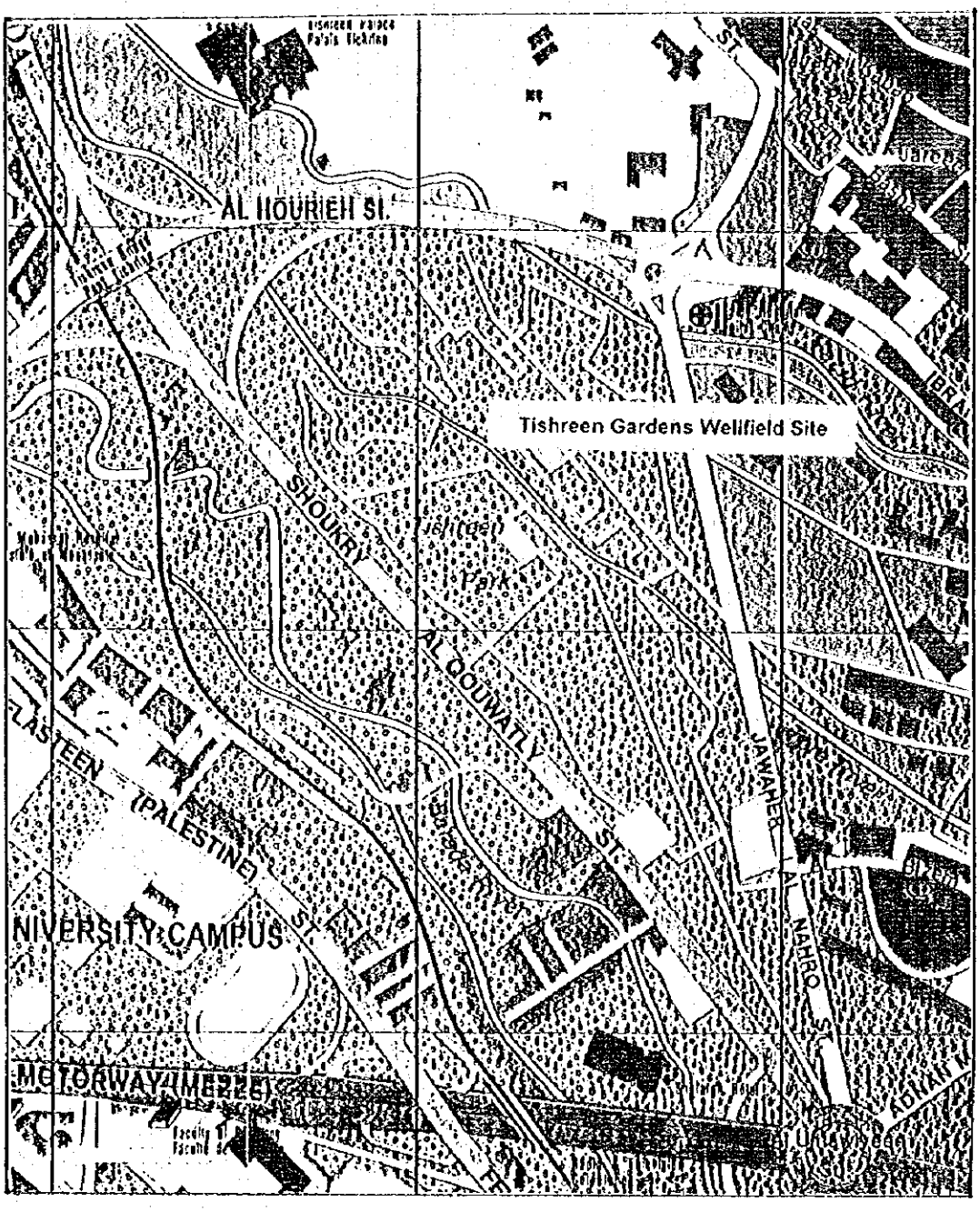
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.5.5 Location Map for Deir al Ashayer
NIPPON KOEI CO., LTD.



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THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.5.6 Location Map for Tishreen Gardens
NIPPON KOEI CO., LTD.

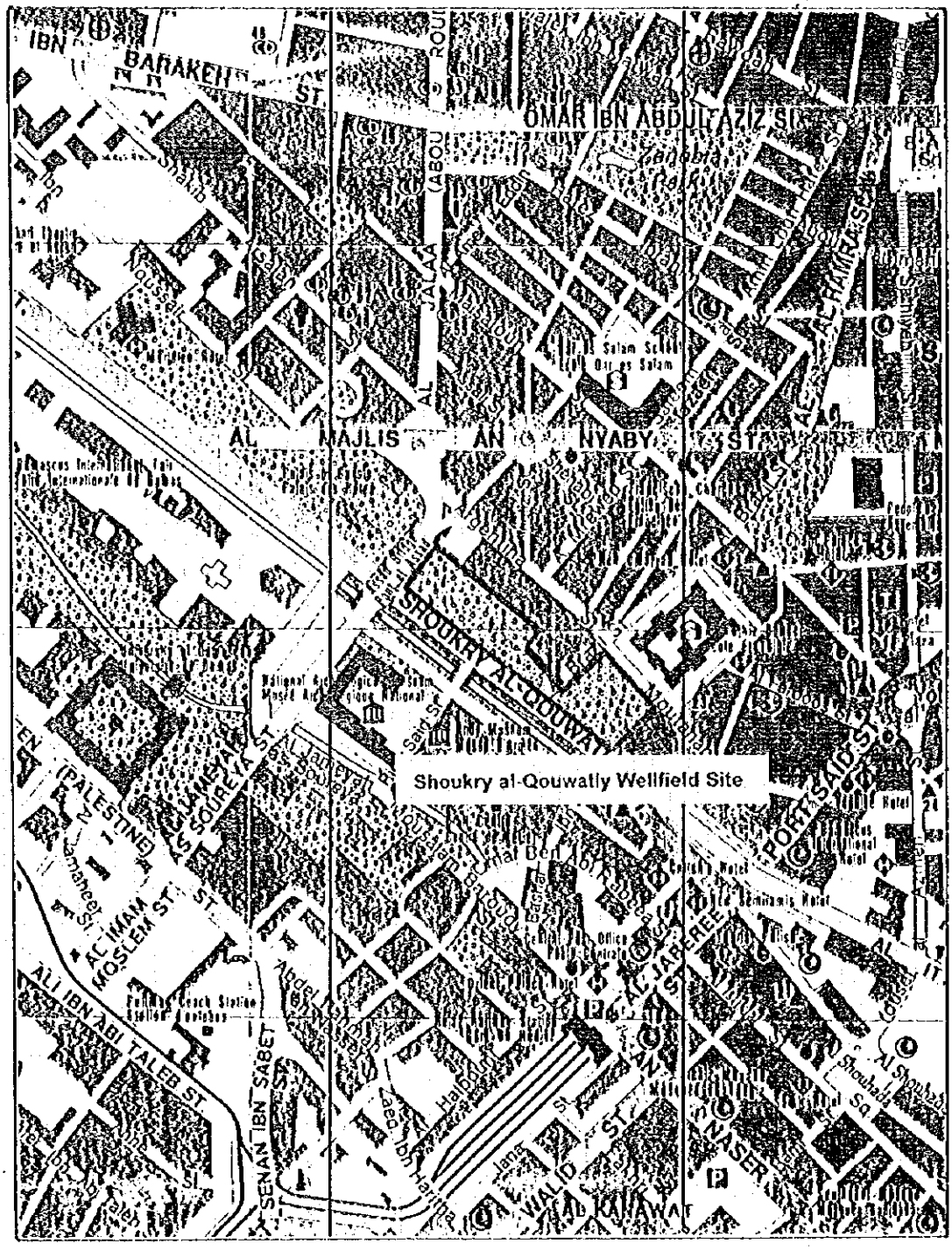

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Figure 5.5.7 Location Map for Shoukry al Qouwatly Street
NIPPON KOEI CO., LTD.

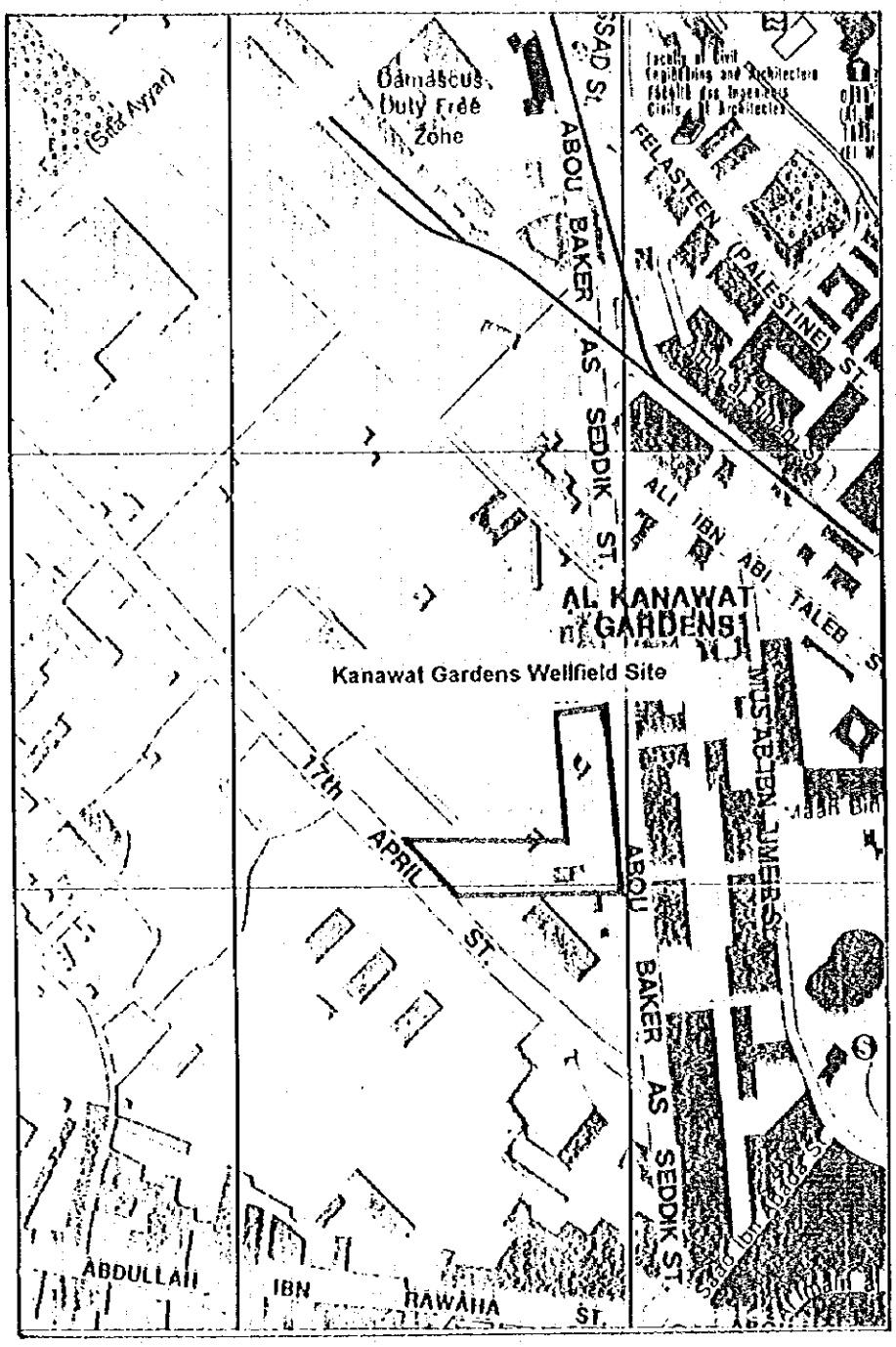

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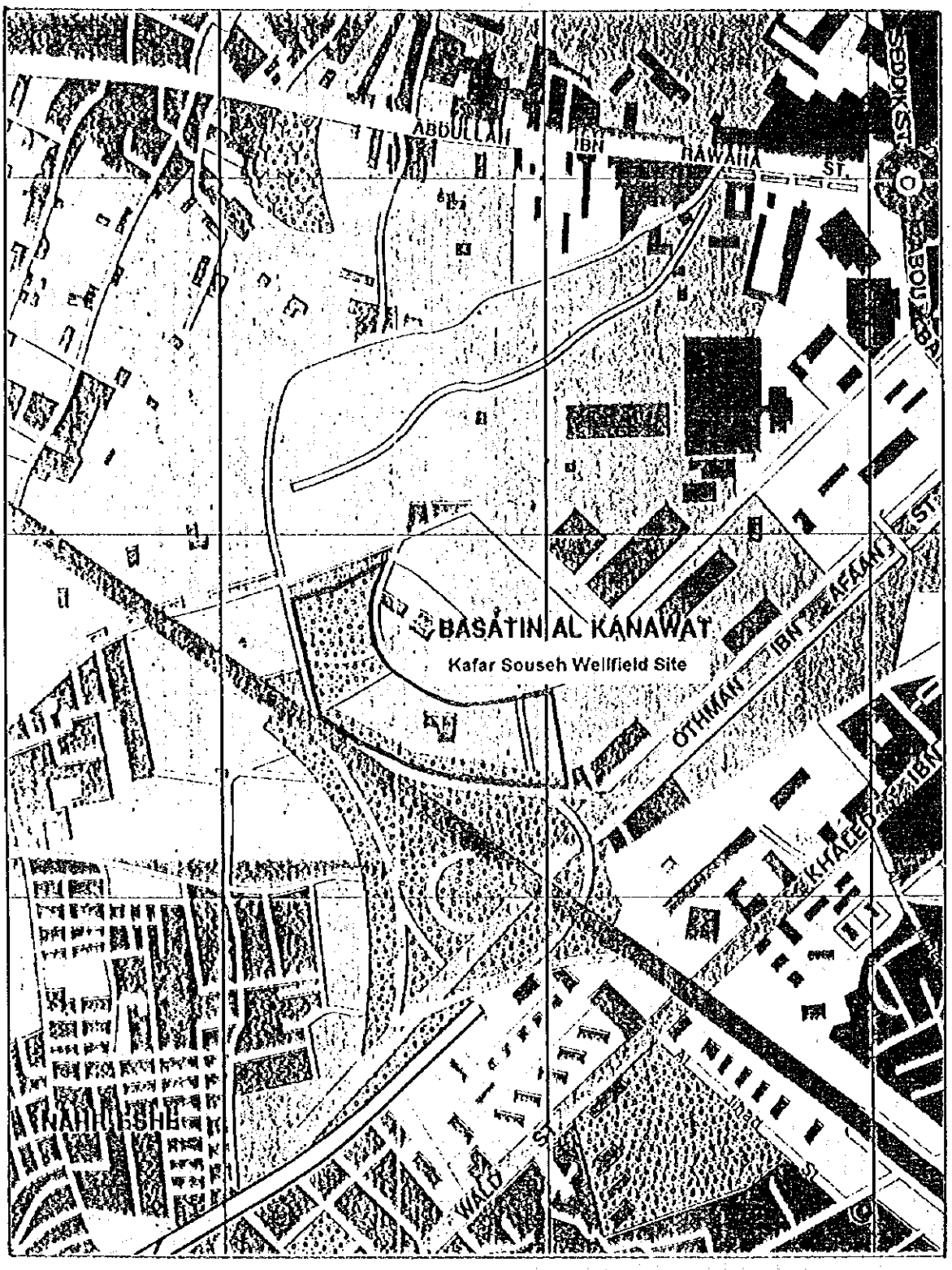
Figure 5.5.8 Location Map for Kanawat Gardens
NIPPON KOEI CO., LTD.



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.5.9 Location Map for Kafar Souseh
NIPPON KOEI CO., LTD.

6. PROPOSED MASTER PLAN PROJECTS

6.1 Implementation Approach

The screening of project alternatives was carried out as discussed in section 5.6. Based on the results of the screening, a preliminary list of projects has been selected for the master plan as shown in Table 6.1.1. Overall proposed Master Plan projects are shown in Figure 6.1.1. The selected 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. These projects consist of distribution system rehabilitation projects, and improvement aimed at reducing UFW and reinforcement of existing water supply resources. Projects in the "expansion" program include extension of the water distribution system into informal areas and the development of new water resources.

6.2 Rehabilitation and Improvement Program

Projects in the rehabilitation and improvement program to improve water supply and reduce system losses are classified into the following three categories:

i) countermeasures to reduce UFW
ii) improvements to the water quality testing laboratory
iii) reinforcement of existing supply wells in Damascus City

6.2.1 Countermeasures to Reduce UFW

(1) Water main replacement

There is an urgent requirement to replace old cast iron distribution mains to reduce system leakage and improve the reliability of the system as a whole as shown in Figure 6.2.1. The total estimated cost to replace 98,000 meters of old, leaking distribution mains over the 1997 to 2000 period is US$ 22.9 million.

(2) Water meter replacement

The replacement of malfunctioning meters is of strategic importance to the financial well being of the organization as well as an essential requirement for reducing unaccounted for

water. The total estimated cost to replace 106,000 meters over the 1997 to 2003 period is US$ 11.3 million. The program includes a requirement to improve the meter testing and repair facilities for the maintenance of foreign supplied meters.

(3) Leakage reduction program

The leakage reduction program is required to reduce losses, improve the amount of water available for consumption, and to focus maintenance and pipe rehabilitation activities by identified priority areas. The program includes implementation of District Meter Areas (DMA), increasing leakage survey efforts, a pressure control system and improvement of system wide master metering. The various elements of the program will cost an estimated US$ 5.9 million and are summarized as follows:

i) District Meter Area (DMA) System; approximately 70 DMA districts (1998 - 2005)
ii) Pressure control; 40 % of DMA districts (1999-2007)
iii) Improvement of master meter; 22 for electromagnetic type and 36 for ultrasonic type and one for level gauge at Figeh irrigation canal (1998 - 2000)
iv) Leakage survey (1996 - 2015)

6.2.2 Improvements to Water Quality Testing Laboratory

It is an essential requirement for any water supply utility to ensure public health and safety. This requires regular and comprehensive water quality testing. The proposed improvements will cost an estimated US$ 0.9 million. The following improvements are recommended to achieve appropriate performance in the coming years :

- increase the general analytical capacity by a factor of 3 to 5 times over existing levels.
- develop capabilities to conduct specialized analysis (toxic organic chemicals, pathogens, and others).
- initiate systematic quality assurance/control programs.
- develop a computer-based water quality data base.
- establish an emergency response program.

Achieving these improvements will require a corresponding reinforcement in human resources, training, space, and equipment, as summarized below:

	current	future	implementation plan	target year
Staff	7 laboratory 3 driver	15 laboratory 5 driver	- as needed	1996 - 2015
Training	lacking	a series of training programs	- Pesticide extraction - GC-MS analysis - Virus/Pathogen analysis - Automated Ion analysis - Computer use	1997 1997 1998 1999 1996 -
Space	130 m^2	300 m^2	- Construction of new laboratory	1997 - 1998
Equipment	inadequate	adequate	- priority based systematic procurement plan	1996 - 2015

6.2.3 Improvements of Pumping Equipment for Existing Wells in Damascus

Wellfields that have an under-utilized capacity are selected for reinforcement as part of the Maser Plan. The under-utilization is generally the result of hydraulic limitations in the sizing of the well pumps or the pumps supplying the distribution system from the reservoir. Three sites meet this criteria; Ibn Assaker wellfield, Kadam Railway wellfield and some of the Fringe Wells. Increases in site capacity are given in Table 5.5.5.

The Ibn Assaker site is currently limited by the size of the pumps between the reservoir and the distribution network. Upgrading these pumps will provide an estimated extra 120 l/s (2.5 MCM/y). At Kadam Railway the well pumps are the limiting factor. An extra 115 l/s (2.3 MCM/y) could be produced from these wells. All of the Fringe Wells have the same pump capacity but the hydraulic conditions differ at each location. The replacement of pumps at eight sites where the wells give a good yield could increase the overall capacity by 1.76 MCM/y. These improvements must be made on time to meet the additional demand requirements identified in the Master Plan which will occur in the year 2002 for the Fringe and Ibn Assaker wells, and 2003 for the Kadam Railway wells. The total estimated costs are US$ 4.6 million.

6.3 Expansion Program

6.3.1 Water Supply Projects for Informal Area

It is proposed to improve water supply in informal areas by 2005 as described in the Section 4.5. Water supply schemes for informal areas aims at providing consumers with properly connected and metered services. Benifits include improving public health, increasing revenue and preventing system losses at informal connection points. Eleven schemes are selected and total implementation costs are estimated to reach US$ million 27.7. The total population benefiting from improvements is estimated at 308,680 covering an area of 8.68 km^2

as shown in Figure 5.2.1. Implementation plan of water supply schemes for informal area is summarized as follows;

Water Supply Schemes (Implementation schedule)	Area (ha)	Population (persons)	Water Demand (m^3/day)	Pipe Length (m)
B-1.1 Kassioun Mountain Foot System (2002 to 2004)	30.9	33,977	6,562	3,550
B-1.2 Tishreen System (2001 to 2002)	36.2	15,488	2,980	3,550
B-1.3 Jobar Surrounding - Al Aksab Mosque System (2000 to 2001)	63.7	25,704	4,964	3,550
B-1.4 East - West Tabbleh System (2003 to 2005)	135.2	12,669	2,447	8,330
B-1.5 Mokhayam Al Yarmouk System (2002 to 2003)	118.0	86,068	16,621	7,260
B-1.6 Naher Eshah - Dahhadil & Asalie Kadam Systems (1997 to 1999)	170.4	37,005	7,146	7,260
B-1.7 Al Qazzaz & Shagour Bassateen Systems (2000 to 2001)	64.2	10,692	2,065	7,260
B-1.8 Mezze - Razy & Kafar Souseh - Lawan Systems (1999 to 2000)	170.3	46,786	6,332	7,260
B-1.9 Somareya System (2003 to 2004)	37.6	4,590	918	6,950
B-1.10 Dummar - Wadi Al Mashare System (1998 to 1999)	41.9	14,841	2,866	6,950
B-1.11 Kudsaya System (2004 to 2005)	50.0	20,800	4,017	6,950
Total	868..4	308,680	61,716	68,870

6.3.2 Development of New Water Resources

New water resources identified in the Master Plan are selected on the basis of economic and technical feasibility. Another important selection criteria is to consider all resources located in areas where DAWSSA already has water rights. Based on these criteria six schemes have been identified; five to serve existing formal areas and one to serve the informal area south east of the City.

The Jaramana wellfield site is on a highly productive part of the aquifer. It is recommended that the wellfield be equipped to provide 290 l/s or 6.12 MCM/y. Since only the wells exist the project will require the construction of a complete pumping and distribution scheme. The additional water that can be produced from this site is scheduled in the Master Plan to be available in 1999. The existing wellfields at Tishreen and Kywan will also be equipped, essentially as an extension to the Oumawiyin wellfield. A phased implementation

approach will gradually increase the production capacity of these two sites to 250 l/s or 5.3 MCM/y over the project period. New wellfields at Kanawat and Kafar Souseh are in a similar geological area of Damascus. It is anticipated that both sites will have a yield of 80 l/s or 1.69 MCM/y. The new wellfield planned for Skokry al Qouwatly street is likely to be more productive with an estimated yield of 170 l/s or 3.6 MCM/y. The only project outside Damascus City selected for the Master Plan is the development of a source at Deir al Ashayer. This site is expected to yield 200 l/s over a six month operation period, thus providing an extra 3.16 MCM/y via a new pipeline feeding to the existing aqueducts to the City. The timetable of works provides increments of production capacity at Tishreen and Kywan in 1998 (110 l/s), 2000 (100 l/s) and 2002 (40 l/s). The Kafar Souseh and Deir el Ashayer schemes should be available for production in 2001, Kanawat Gardens in 2003. The total estimated costs are US$ 17.0 million.

6.4 Implementation Program

The implementation of Master Plan projects consists of "on-going projects", "rehabilitation and improvement projects" and "expansion projects". The on-going projects identified in DAWSSA's five year plan are expected to be completed to improve water supply conditions as planned. The rehabilitation and improvement projects program will start in 1997 and be completed by the year 2006, with the exception of the water leakage survey project which will continue until the year 2015. The implementation of expansion projects, which includes improvement of water supply to informal areas and the development of new water resources with water right, will be sequenced from 1997 to the year 2005.

The rehabilitation and improvement projects program consists of rehabilitation of facilities, leakage reduction and reinforcement of water resources. The rehabilitation of facilities includes replacement of about 98 km of water main in 6 years, replacement of about water meters 106,500 in 7 years and improvements to meter testing and repair facilities in one year. The leakage reduction program includes establishing a district meter area (DMA) system in 9 years, a pressure control program in 10 years and a master meter improvement program (59 numbers) in 3 years. The reinforcement of water resources includes improvements to water quality testing equipment in 3 years and 3 Damascus city wells in 2 years.

The expansion projects include water supply the improvement schemes for 11 informal areas to be complete in 9 years and the 6 new water resources development schemes completed in 5 years.

The implementation schedule for the whole of the Master Plan is shown in Figure 6.4.1.

6.5 Cost Estimate

6.5.1 Construction Costs

The construction costs were estimated at current price the (August, 1996) levels for the respective proposed schemes. They comprise local and foreign currency components and are divided into direct and indirect construction costs, contingency, and tax and duty. The direct construction cost is based on the work quantity and the unit price of the corresponding work item including materials and equipment. The indirect construction costs include land acquisition and engineering services. The contingency consists of the physical contingency and the price escalation.

As for the direct construction cost, the local currency component consists of the costs for labors and materials locally producted, handling and inland transportation of imported materials and equipment. The foreign currency component includes imported materials and equipment in CIF price.

The main construction materials and equipment will be procured as follows:

Local procurement: cement, sand, gravel, re-bar, forms, support and scaffolding materials

Foreign procurement: ductile cast iron, valves, flow meter, laboratory instrument, pumps and control panels

The engineering services are assumed to be 10 % of the direct construction cost summed up in foreign currency.

The physical contingency is assumed to be 10 % of the direct and indirect construction costs. The price contingency is also assumed to be 5 % per annum for the local currency component and 3 % for the foreign currency component.

The general services tax is assumed to be 18 % of the cost for manpower supply and administration work under both currencies. The import duty is assumed to be 7 to 29 % for the cost of foreign procurement. The stamp duty is assumed to be 1.248 % of contract amount. In case of a contract under loan DAWSSA has a responsibility to pay these tax and duty in SL 23 equivalent to a US dollar.

The total construction costs of each proposed scheme are summarized as follows, and details are shown in Table 6.5.1.

(Unit: US$ 1000)

Projects		L.C.	F.C.	Total
(1) Water main replacement	A-1.1	6,638	16,595	23,233
(2) Water meter replacement	A-1.2&3	2,359	9,303	11,662
(3) Water leakage reduction program	A-2.1 to 2.4	911	4,398	5,309
(4) Improvement of water quality testing	A-3.1	142	862	1,004
(5) Improvements of pumping equipment for existing wells in Damascus	A-3.2	740	4,011	4,751
(6) Water supply improvement for informal area	B-1.1 to 1.11	8,172	21,246	29,418
(7) Water resources development	B-2.1 to 2.4	4,630	12,846	17,476
Total		23,592	69,261	92,853

6.5.2 Operation and Maintenance Costs

The following factors are considered in estimating the incremental impact of each project on operation and maintenance costs:

(i) Staff expenses for operation of the water supply facilities,
(ii) Electricity tariff for the pumps,
(iii) Chemical costs for chlorination,
(iv) Repair expenses for the equipment and the water mains, and
(v) Repair expenses for the concrete structure.

The details of the O & M costs are summarized as follows:

(Unit: US$ 1000)

Projects		L.C.	F.C.	Total
(1) Water main replacement	A-1.1	63	0	63
(2) Water meter replacement	A-1.2&3	6	33	39
(3) Water leakage reduction program	A-2.1 to 2.4	125	0	125
(4) Improvement of water quality testing	A-3.1	39	68	107
(5) Improvements of pumping equipment for existing wells in Damascus	A-3.2	275	0	275
(6) Water supply improvement for informal area	B-1.1 to 1.11	65	0	65
(7) Water resources development	B-2.1 to 2.4	583	0	583
Total		1,156	101	1,257

Table 6.1.1 List of Selected Water Supply Master Plan Projects

A. Rehabilitation and Improvement Program

A-1 Distribution Rehabilitation Projects
- A- 1.1 Water Main Replacement
- A- 1.2 Water Meter Replacement
- A- 1.3 Improvement in Meter Testing and Repairing

A-2 Leakage Reduction Program
- A- 2.1 District Meter Area (DMA) System
- A- 2.2 Pressure Control
- A- 2.3 Improvements to Master Metering
- A- 2.4 Leakage Survey

A-3 Water Quality and Pumping Equipment Improvement Projects
- A- 3.1 Improvement to Water Quality Testing Laboratory
- A- 3.2 Improvements of Pumping Equipment for Existing Wells in Damascus
  - Ibn Assaker
  - Kadam Railway
  - Fringe Wells

B. Expansion Program

B-1 Water Supply Projects for Informal Areas
- B- 1.1 Kassion Mountains Foot
- B- 1.2 Tishreen
- B- 1.3 Jobar Surrounding-Al Aksab Mosque
- B- 1.4 East-West Tabbleh
- B- 1.5 Mokhayam Yarmouk
- B- 1.6 Naher Esheh-Dahadil & Asalie Kadam
- B- 1.7 Al Qazzaz &Shaghour Basateen
- B- 1.8 Mezze-Razy & Kafar Souseh-Lawan
- B- 1.9 Somareyeh
- B- 1.10 Dummar-Wadi Al Mashare
- B- 1.11 Kudsaya

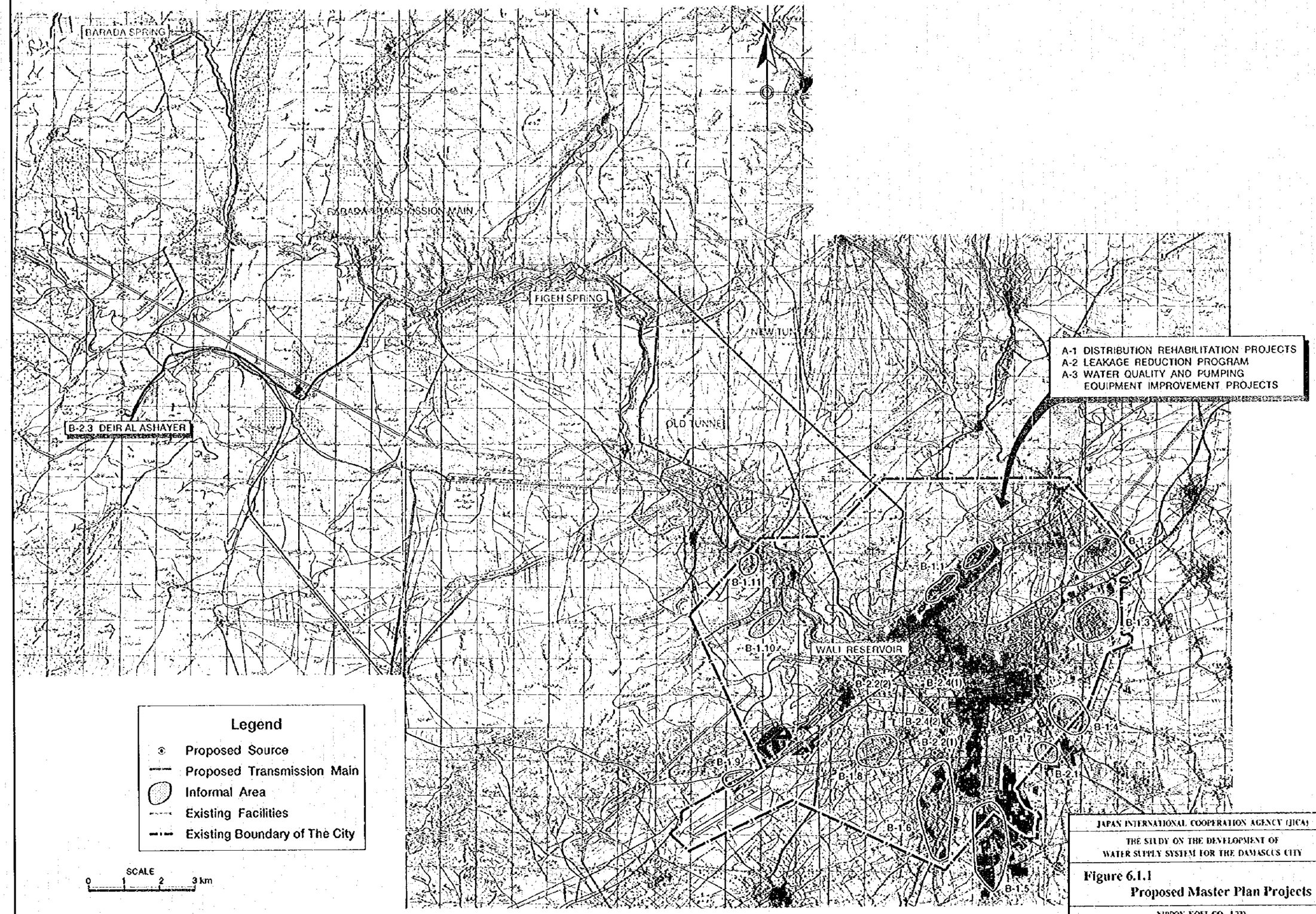
B-2 Water Resources Development Projects

B-2.1	New Well Centers for Informal Areas	Jaramana
B-2.2	New Well Centers for Formal Area	(1) Kafar Souseh (2) Tishreen & Kywan
B-2.3	Water Resources Development Schemes in Hermon area	Deir al Ashayer
B-2.4	Water Resources Development Schemes in Damascus (New Stations)	(1) Shoukry al Qouwatly (2) Kanawat Gardens

Table 6.5.1 Cost Estimate of the Project

(UNIT: US$ 1000)

Description	L.C.	F.C.	TOTAL
1. Distribution Rehabilitation Project			
1.1 Water main replacement	3,116	13,062	16,178
1.2 Water meter replacement	901	7,256	8,157
1.3 Improvement in meter testing and repairing	20	66	86
2. Leakage Reduction Program			
2.1 District meter area (DMA) system	102	713	815
2.2 Pressure control system	56	309	365
2.3 Improvement of master meter	141	2,272	2,413
2.4 Reinforcement of leakage survey team	0	123	123
3. Water Quality and Pumping Equipment Improvement Project			
3.1 Reinforcement of water quality testing laboratory	60	678	738
3.2 Reinforcement of Damascus wells			
(1) Ibn Assakar well field	146	1,097	1,243
(2) Kadam railway well ffield	65	1,165	1,230
(3) Fringe wells	173	895	1,068
4. Water Supply System Improvement for Informal Area			
4.1 Kassioun mountain foot system	68	738	806
4.2 Tishreen system	199	918	1,117
4.3 Jobar surrounding-al Aksab mosque system	350	1,594	1,944
4.4 East-west tabbleh system	223	801	1,024
4.5 Mokhayam Yarmouk sytem	195	1,084	1,279
4.6 Naher Esheh-DAhadil & Asalie Kadam system	937	3,719	4,656
4.7 Al Qazzaz & Shaghour Basateen system	353	1,345	1,698
4.8 Mezze-Razy & Kafar Souseh system	1,341	3,885	5,226
4.9 Somareyeh system	186	691	877
4.10 Dummar-Wadi al Mashare system	433	1,012	1,445
4.11 Kudsaya system	477	1,261	1,738
5. Water Resources Development			
5.1 Jaramana new well center	445	1,990	2,435
5.2 Kafar Souseh new well center	412	1,074	1,486
5.3 Tishreen & Kywan new well center			
(1) Phase-1	26	303	329
(2) Phase-2	11	178	189
(3) Phase-3	99	735	834
5.4 Deir al Ashayer scheme	770	3,462	4,232
5.5 Shoukry al Qouwatly scheme	449	1,291	1,740
5.6 Kanawat gardens scheme	413	1,078	1,491
Sub-toatl (1 to 5)	12,167	54,795	66,962
6. Tax and Duty	6,730	0	6,730
7. Administration Cost	1,217	0	1,217
8. Engineering Cost	1,217	5,530	6,747
9. Contingencies			
9.1 Physical contingency	1,457	6,032	7,489
9.2 Price contingency	804	2,904	3,708
Total Project Cost	23,592	69,261	92,853



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 6.1.1
Proposed Master Plan Projects

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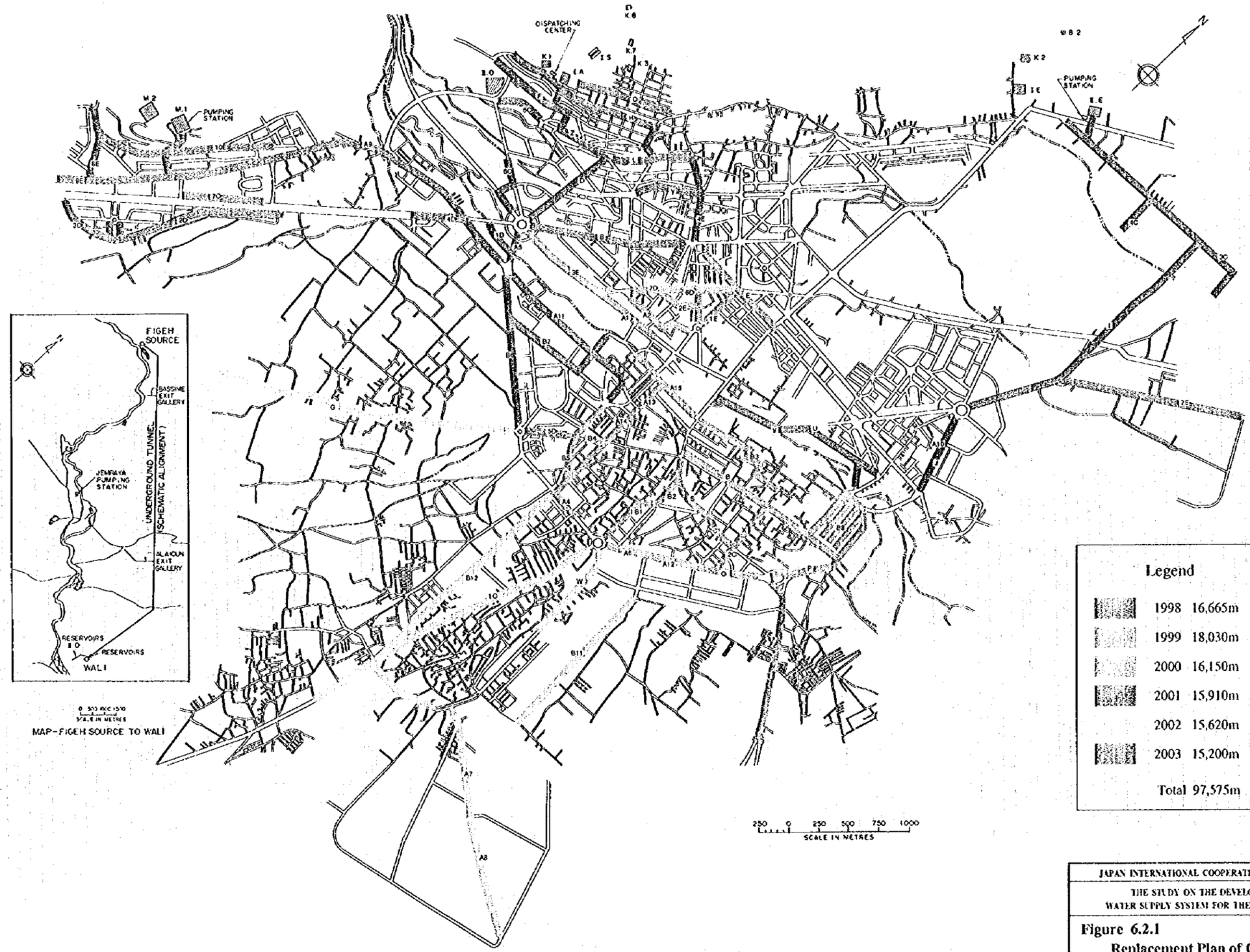

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 6.2.1
Replacement Plan of Cast Iron Pipe

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PROJECT		CONT*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ON GOING PROJECTS																						
1 Protection of Figeh Spring		890																				
2 SCADA System		5,090																				
3 Reinforcement of Ain Figeh Area		4,604																				
4 Reinforcement of Barada & Al Sahl		4,103																				
5 Ein al Warwar System		443																				
6 Mezze #86 System		681																				
7 Takadom System		738																				
8 New Well Center for Informal area	New Kahoon	60																				
	Takadom	262																				
9 New Water Resources Schemes in Hermon and Zabadani area	Wadi Marwan	-																				
10 Kudsaya New Suburb System		4,257																				
11 Dummar Extension area (1st phase) System		488																				
12 Special Area Zone (State Factory) System		420																				
MASTER PLAN PROJECTS																						
A. REHABILITATION AND IMPROVEMENT PROGRAM																						
A-1 DISTRIBUTION REHABILITATION PROJECTS		36,903			1,865	10,063	5,462	5,462	6,392	4,533	3,628											
A-1.1 Water Main Replacement																						
A-1.2 Water Meter Replacement																						
A-1.3 Improvement in Meter Testing and Repairing																						
A-2 LEAKAGE REDUCTION PROGAM		5,842			193	886	1,726	1,372	179	237	202	234	311	99	99	38	38	38	38	38	38	38
A- 2.1 District Meter Area (DMA) System																						
A- 2.2 Pressure Control																						
A- 2.3 Improvement of Master Meter																						
A- 2.4 Leakage Survey																						
A-3 WATER QUALITY AND PUMPING EQUIPMENT IMPROVEMENT PROJECTS		5,755			335	335	334		3120	1634												
A- 3.1 Reinforcement of Water Quality Testing																						
A- 3.2 Reinforcement of Damascus Wells																						
	Ibn Assakar																					
	Kadam Railway																					
	Fringe Wells																					
B. EXPANSION PROGRAM																						
B-1 WATER SUPPLY PROJECTS FOR INFORMAL AREA		29,418			2,075	5,777	5,774	4,709	2,846	1,991	1,817	2,508	1,921									
B- 1.1 Kassion Mountains Foot																						
B- 1.2 Tishreen																						
B- 1.3 Jobar Surrounding-Al Aksab Mosque																						
B- 1.4 East-West Tabbieh																						
B- 1.5 Mokhayam Yarmouk																						
B- 1.6 Naher Eaheh-Dahadal & Assire Kadam																						
B- 1.7 Al Qazzaz &Shaghour Baaseen																						
B- 1.8 Mezze-Hazy & Kafar Souseh																						
B- 1.9 Somareyeh																						
B- 1.10 Dummar-Wadi Al Mashare																						
B- 1.11 Kudsaya																						
B-2 WATER RESOURCES DEVELOPMENT		17,476			443	8,298	4,426	2,189	2,130													
B- 2.1 New Well Center for Informal Areas	Jaramana																					
B- 2.2 New Well Center for Formal Area	(1) Kafar Souseh																					
	(2) Tishreen &Kywan																					
B- 2.3 Water Resources Development Schemes in Hermon area	Deir al Ashayer																					
B- 2.4 Water Resources Development Schemes in Damascus (New Stations)	(1) Shoukry al Qouwatly																					
	(2) Kanawat Gardens																					

Note :*: Unit US$1,000, Source: On going project according to DAWSSA's information ,
** Constant price as of September 1996 for Master Plan

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 6.4.1 Projects Implementation Schedule (Proposed Plan)

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7. PROJECT EVALUATION AND PRIORITY

7.1 Economic Evaluation

7.1.1 General

Water available for consumption will increase through the significant reduction in unaccounted for water and the development of new water resources proposed in the master plan project. This increase in available water will generate many economic benefits which will enhance the socio-economic conditions in the study area. Only the benefits that are quantifiable in terms of increased revenue are considered in the economic analysis. Improvements to water supply in the informal areas will also have a significant impact on reducing the incidence of water borne and water related diseases.

One aspect of the project which must be emphasized to complement physical rehabilitation and improvements is the importance of initiating a customer education program aimed at reducing wasteful use of water. This program should include close cooperation with large volume consumers. From an economics perspective, reducing water use will have a positive effect on DAWSSA's financial performance by deferring capital expenditures and thereby reducing the need for loan funding.

Economic evaluation of the project is discussed in the following paragraphs and details of the analysis are presented in Appendix J of the Supporting Report.

7.1.2 Economic Benefit

The economic benefits from increased water supply are evaluated using the following methods and assumptions:

1) economic benefit is estimated by taking the difference between the "with" and "without project" condition on an incremental basis.

2) all costs and benefits are expressed in constant prices (1996) excluding taxes and duties

3) increases in water supply created by reductions in leakage are evaluated at the marginal production cost of \$0.22 per m^3 because rehabilitation defers the need to produce the next increment of water to meet the demand.

4) increases in water supply created by the development of new resources are evaluated at the cost that consumers are willing to pay of \$0.18 per m^3. This is higher than the current tariff of \$0.11 per m^3 but is a realistic estimate of the maximum tariff that could be charged and therefore represents the economic value of the incremental water produced by the project.

5) increases in water sales resulting from improvements to metering and the distribution systems in informal areas are also evaluated at the "willingness to pay" cost.

The estimated economic benefit for the master plan project is \$26 million in the year 2010.

7.1.3 Economic Cost

The estimated construction cost is converted to the economic cost by applying the shadow exchange rate to the local cost components. 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.

7.1.4 Economic Evaluation

Economic evaluation is based on the economic internal rate of return EIRR for the estimated project benefit and cost stream. The economic life of the project is assumed to be 25 years after the completion of the last project in mid 2007. The estimated EIRR is 34% indicating that the project is economically justifiable. Results of a sensitivity analysis demonstrate that the EIRR is robust to variations in the cost and benefit parameters. For example, assuming a worse case scenario where costs are increased by 10%, and benefits reduced by 10%, the EIRR is 25.8%. Details of economic evaluation for the total master plan project are presented in Table 7.1.1.

7.2 Financial Evaluation

7.2.1 General

The proposed master plan project investment must generate the revenue required to meet the more stringent financial objectives of repaying investment loans and the aim of financially self sustaining development. Therefore affordability of tariffs and ability of customers to pay

are key parameters in assessing if the project is financially viable. The capacity to pay for increased water tariffs is assessed using the results of the household income survey to compare incomes as a proportion of existing monthly water charges.

7.2.2 Capacity to Pay

(1) Distribution of water consumption

The distribution of household water consumption is reviewed in order to assess the impact of increasing tariffs. As indicated in the following table 41% of domestic consumers use less than 30 m^3 per month tariff band and 40% use more than 60m^3 per month.

Domestic consumption (m^3/month)	Volume (000 m^3)	No. of bills	% Volume	% No. of bills
0-20	24,636	256,854	54	35
21-30	6,300	40,584	14	6
31-60	7,531	146,692	17	20
> 60	6,987	287,639	15	39
Total	45,454	731,769	100	100

It is assumed that the 35% of consumers using less than 20 m^3 per month are in the low income group and would be the most seriously affected by changes in the tariff. This group represents 54% of all domestic consumption.

(2) Income distribution

Distribution of household income according to the survey is presented as follows:

Income range (SL/month)	%
1 -3,000	4
3,001 - 5,000	25
5,001 - 10,000	31
10,001 - 25,000	20
25,001 - 50,000	3
> 50,000	17
Total	100

About 60% of the surveyed households are in the low income group earning less than SL 10,000 per month. Another 20% of the households are in the middle income group earning less than SL 25,000 per month. The average household income is SL 16,254.

(3) Capacity to pay

Based on the income distribution and domestic consumption profile, the capacity to pay is assessed for the two lowest income groups. Monthly water bills are calculated for each income group based on existing tariff levels with the following results:

Income class	Consumption (m^3/month)	Tariff band (m^3/month)	Tariff (1996) (SL/m^3)	Water bill (SL/month)	Average Income (SL)	% monthly income
Low income						
present	19.8	0 - 20	2.0	39.6	5,665	0.7
future (2015)	34.2	30 - 60	7.5	256.5	7,624	3.36
Middle income						
present	30.6	20 - 30	3.0	91.8	20,500	0.45
future (2015)	38.7	30 - 60	7.5	290.3	27,590	1.05

The normally acceptable Affordability ratio is 3 to 5% of income for water charges. At present per capita consumption levels both income groups enjoy the benefits of a relatively low tariff and it is clear that there is ample capacity to absorb increases in water tariffs. If per capita consumption levels increase then both income classes will be paying the higher rates of the 30 to 60 m^3 per month tariff band. Under these conditions, lower income groups will be spending up to 3.36% of their income on water charges and would reach the upper limit of their capacity to absorb further price increases. The middle income group on the other hand would still have that capacity to pay for further tariff increases. At existing consumption levels, increases in tariffs appear to be feasible.

7.2.3 Financial Internal Rate of Return (FIRR)

Financial viability is assessed by calculating the FIRR on the basis of the estimated incremental revenue and incremental costs. Rehabilitation and expansion of the water supply system as well as reductions in unaccounted for water are expected to generate significant incremental revenue. The average tariff obtained from the sale of water in 1995 was $0.11 per m^3. Revenue from the incremental sales generated by the master plan project are estimated by applying the average tariff.

Incremental benefit	1997	2000	2005	2010	2015
water sales (000 m^3/year)	13,000	58,990	100,120	111,060	111,400
revenue (US$ 000's)	1,430	6,489	11,013	12,217	12,254

The incremental costs are based on the estimated project investment costs, operation and long term maintenance costs. Incremental costs are also included for replacing equipment or elements of the project which have a useful life that is less than the project life of 25 years. The total investment cost for the project is $95 million. The incremental operation and maintenance cost is $1.73 million per year.

Analysis of the discounted cash flow based on estimated incremental costs and revenues indicates the project provides a 9.8% internal rate of return. The results are very sensitive to variations in the cost and benefit parameters. For example a 10% increase in cost combined with a 10% decrease in benefits would yield an unfavorable internal rate of return of 6.8%. Assuming the worse case scenario from the sensitivity analysis, the project is not financially viable. The average incremental cost required to make the project financially viable at different discount rates is as follows:

Rate of return %	Average tariff US$/$m^3$
8	0.13
10	0.15
12	0.17

7.2.4 Least Cost Solution

Estimated costs and the amount of water sales produced by each project are identified as follows:

Project	Incremental Water (MCM / year)	Project Cost (US$ 000's)	Incremental Cost ($/$m^3$)
A-1.1 Mains replacement	2.76	25,241	9.15
A-1.2 Meter replacement	38.53	11,662	0.30
A-2 Leakage reduction	24.08	5,842	0.24
A-3+B-2 New resources	23.51	23,231	0.99
B-1 Informal areas	22.52	29,418	1.31
Total	111.40	95,394	0.86

The most expensive solution per incremental unit of water made available for consumption is the replacement of water mains. The least cost solution is the active leakage reduction program. Although the per unit cost of developing new water resources and reinforcing existing capacity is relatively inexpensive, the large capital cost makes this a less attractive option than leakage reduction. Financial constraints and the fact that the existing per capita production capacity is sufficient to meet demands if the system did not leak, make active leakage detection and control the most feasible and least cost solution.

7.2.5 Investment Funding Requirement

Another key parameter in assessing financial feasibility is DAWSSA's ability to secure the funding required for the master plan project. Past trends in investment spending are reviewed to see if the amounts proposed by the master plan are within the usual spending levels identified in the national investment budget for infrastructure development. The annual investment costs identified for the master plan project vary from a low of $2 million in 2005 to a high of $25.2 million in 1998. The bulk of the investment expenditure will occur over a 10 year implementation period requiring an average annual investment of $9.5 million. A review of DAWSSA's investment expenditures for the 1990-95 period indicates that annual spending levels reached a high of $5.73 million in 1995. The annual funding identified by the master plan exceeds this level of investment by a significant amount therefore funding assistance will be required from external sources.

7.3 Environmental Examination of the Proposed Projects

7.3.1 Initial Environmental Examination (IEE) of Master Plan Projects

Environmental impacts of the proposed master plan projects have been evaluated in Section 5.6.7. The results are summarized in Table 7.3.1. According to the IEE (Section 5.6.7), most of the proposed projects do not cause significant negative environmental impacts. The projects with moderate to high environmental impacts are :

- Improvement of Pumping Equipment for Damascus Wells, Kadam Railway (A-3.2.2) : The groundwater quality at Kadam Railway is less than ideal. The quality of supplied water needs to be closely monitored. If the water quality falls below the acceptable level, countermeasures proposed in Chapter 5 (Water quality control in South Damascus) may be implemented.

- Improvement of Pumping Equipment for Damascus Wells, Fringe Wells (A-3.2.3) : The groundwater quality of some fringe wells is less than ideal. The quality of supplied water needs to be closely monitored. If the water quality falls below the acceptable level, countermeasures similar to the ones proposed for Kadam Railway (Chapter 5, Water quality control in South Damascus) may be implemented.

- Water Resources Development Scheme in Hermon Area (B-2.3) : The exploitation of water resources for Damascus will affect the people in the region, and the flora and fauna that rely on the precious water resources in the area. Conflict about water rights has to be resolved.

7.3.2 Important Environmental Factors

The environmental studies in the area revealed that the following environmental factors are crucial for the implementation of proposed projects.

(1) Social Environment

- Cultural Asset : Damascus is an ancient city, and there are numerous known and yet-to-be-discovered cultural assets.

- Water Right : Conflict of interest is anticipated in some area (e.g., Hermon region).

- Public Health : The water supplied by these projects has to be safe for drinking. To ensure this, the water quality has to be closely monitored. Projects have to be designed to minimize any pollution problems.

- Waste : Potential problems are the disposal of excavated soil and the increase in waste water.

(2) Natural Environment

- Groundwater : Projects A-3 (Pumping Equipment Improvement Projects) and Projects B-2 (Water Resources Development) may exhaust groundwater resources.

- Surface Water : Although the proposed projects will not use surface water, exploitation of groundwater resources will affect the surface water (e.g., Barada river, Awaj river). Surface water is rare in the study area, and loss of surface water environment will result in secondary environmental impacts, such as loss of

indigenous fish and amphibian species. The surface water pollution problems are also expected to be worsen.

- Flora and Fauna : The exploitation of groundwater resources in Hermon area may lead to the loss of indigenous flora and fauna that rely on the precious water resources in the area.

(3) Pollution

- Air Pollution : During construction, the release of dust and exhaust gas has to be minimized.

- Water Pollution : The increase in the water supply leads to the increase in the waste water. The projects has to be coordinated with the construction of the sewerage system. In project 3.1 (Water Quality Testing Improvement), a new laboratory was proposed. The disposal of waste water from the laboratory has to be regulated, as it may contain various toxic chemicals such as heavy metals and pesticides.

- Noise and Vibration : The level of noise and vibration during the construction has to be minimized.

7.3.3 Scoping for Feasibility Study Level EIA

Detailed EIA based on the Syrian EIA guideline shall be conducted in the Feasibility Studies. The proposed scope of the work for the Feasibility Study level EIAs are summarized in Table 7.3.1.

7.4 Selection of Priority Projects

Some of the proposed master plan projects have been selected as "priority" projects because they will require further study to scope out details at the feasibility stage and time constraints make it imperative to proceed as quickly as possible. Location of Priority Projects is shown in Figure 7.4.1. Other projects, classified as either rehabilitation or improvement projects, are not "priority" projects because they can proceed directly to the basic design stage without a feasibility study. Generally, projects are identified as a "priority" if they satisfy the following criteria:

i) the project reduces unaccounted-for water (UFW) losses,

ii) the project is urgently required for public health or operational reasons, and
iii) the scale of the project makes it relatively easy to proceed within the given time constraints

A preliminary selection of priority projects includes District Meter Area (DMA) system to assist in leakage detection efforts, and extending the distribution network into informal areas providing properly connected and metered services. Projects not selected as "priority" projects are the replacement of old mains and the replacement of defective and old meters which have been classified as rehabilitation projects. The meter testing and repair project, and the leakage detection survey project are classified as improvement projects. Although the pressure control project was initially selected as a priority it is omitted from the project list because it can only be implemented after the feasibility study for the DMA system.

The 11 informal areas proposed as priority projects are further ranked to determine implementation priority by applying three factors:

(i) the ratio of project cost the amount of water consumed through informal use, the lower the ratio the higher the benefit
(ii) the degree of urgency based on social needs and,
(iii) economic viability.

The following table shows the relative priority among the projects to improve water supply conditions in the informal area:

Project	Area (ha)	Population in 1995	Suitability of project scale	Degree of emergency	Economic viability	Priority ranking
Kassioun mountain Foot	30.9	33,977	B	B	A	4
Tishreen	36.2	15,448	C	C	A	8
Jobar Surrounding	63.7	25,704	B	C	A	7
East-West Tabbaleh	135.2	12,669	C	C	C	11
Mokhayam Yarmouk	118.0	86,068	A	C	A	5
Naher Esheh - Dahadil & Asalie Kadam	170.4	37,005	A	B	B	3
Al Qazzaz & Shaghour Basateen	64.2	10,692	C	B	C	9
Mezze-Razy & Kafar Souseh-Lawan	170.3	46,786	A	A	B	1
Somareych	37.6	4,590	C	A	C	10
Dummar - Wadi al Mashare	41.9	14,841	C	A	B	6
Kudusaya	50.0	20,800	B	A	A	2

The Mezze-Razy and Kafar Souseh-Lawan project is ranked as the highest priority. There is a large population living in this informal area which is located in the heart of Damascus City. Informal use is high and the projects are urgently required to meet basic human needs and generate large savings in unaccounted for water.

In conclusion it is recommended that the following priority projects proceed immediately to the feasibility study stage:

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

Table 7.1.1 EIRR Calculation, Total of Selected Master Plan Projects

Year	Economic Benefit (US$ 000's)	Economic costs (US$ 000's)			Net Benefits (US$ 000's)
		Capital	O & M	Total	
1997	2,520	4,216	98	4,314	(1,794)
1998	5,294	19,066	245	19,311	(14,017)
1999	8,675	15,499	837	16,336	(7,661)
2000	12,667	12,324	1,097	13,421	(754)
2001	15,316	12,626	1,451	14,077	1,239
2002	21,794	8,471	1,552	10,023	11,771
2003	23,393	6,760	1,558	8,318	15,075
2004	24,128	2,356	1,563	3,919	20,209
2005	24,416	1,948	1,675	3,623	20,793
2006	25,945	84	1,713	1,797	24,148
2007	25,945	1,770	1,713	3,483	22,462
2008	25,945	1,729	1,713	3,442	22,503
2009	25,945	1,729	1,713	3,442	22,503
2010	26,066	1,467	1,713	3,180	22,886
2011	26,066	1,467	1,713	3,180	22,886
2012	26,066	1,548	1,713	3,261	22,805
2013	26,066	2,413	1,713	4,126	21,940
2014	26,066	341	1,713	2,054	24,012
2015	26,141	1,444	1,713	3,157	22,984
2016	26,141	2,652	1,713	4,365	21,776
2017	26,141	2,170	1,713	3,603	22,538
2018	26,141	1,845	1,713	3,558	22,583
2019	26,141	1,771	1,713	3,484	22,657
2020	26,141	1,890	1,713	3,603	22,538
2021	26,141	1,467	1,713	3,180	22,961
2022	26,141	1,467	1,713	3,180	22,961
2023	26,141	1,467	1,713	3,180	22,961
2024	26,141		1,713	1,713	24,428
2025	26,141		1,713	1,713	24,428
2026	26,141		1,713	1,713	24,428
2027	26,141		1,713	1,713	24,428
2028	26,141		1,713	1,713	24,428
2029	26,141		1,713	1,713	24,428
2030	26,141		1,713	1,713	24,428
2031	26,141		1,713	1,713	24,428
Total	816,710	111,987	54,614	166,321	650,389

AIC (SUS) = 0.04 EIRR = 34.0%

Sensitivity Analysis Internal rate of return	%
1. Base case	34.0%
2. Costs +10%	29.7%
3. 2 and Benefits -10%	25.8%

Table 7.3.1 (1/2) Suggested Environmental Elements for EIA

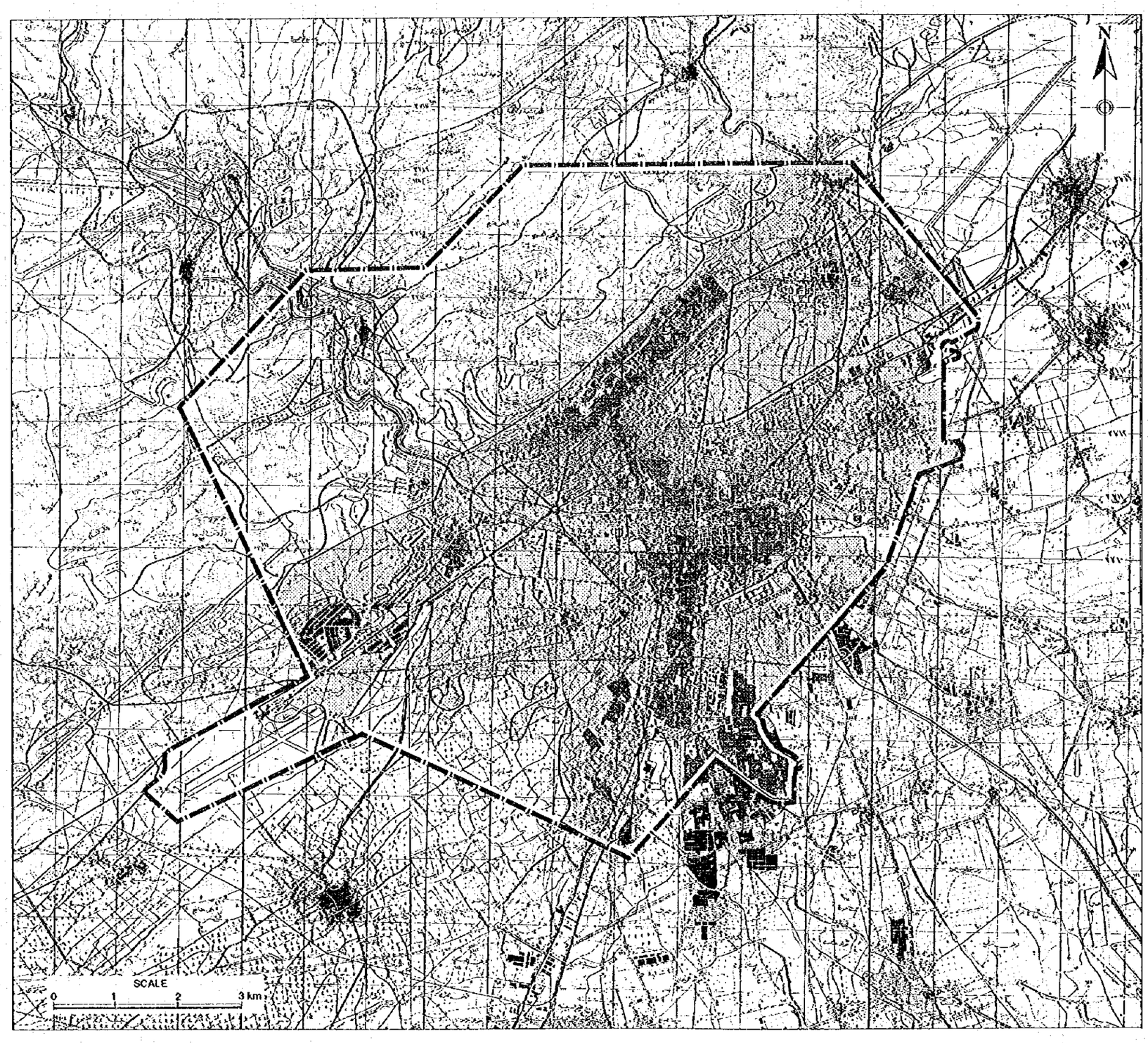
	IEE Result	Implementation Stage	Social Environment									Natural Environment								Pollution					
			resettlement	economic activity	public facilities	social separation	cultural asset	water right	public health	waste	risk of disaster	topology	erosion	groundwater	surface water	coast	flora, fauna	climate	landscape	air pollution	water pollution	soil pollution	noise, vibration	subsidence	odor
A-1 Rehabilitation Projects																									
1.1 Water Main Replacement	Low	construction								O										O			O		
		operation							O																
1.2 Water Meter Replacement	Low	construction																							
		operation							O																
1.3 Improvement in Meter Testing and Repairing	Low	construction																							
		operation							O																
A-2 Supply Improvements Projects (Leakage Reduction Program)																									
2.1 District Meter Area (DMA) System	Low	construction																							
		operation							O																
2.2 Pressure Control	Low	construction																							
		operation							O																
2.3 Improvement of Master Metering	Low	construction																							
		operation							O																
A-3 Supply Improvement Projects (Reinforcement)																									
3.1 Water Quality Testing Improvement	Low	construction					O	O												O			O		
		operation						O													O				
3.2 Reinforcement of Damascus Wells																									
1. Ibn Assaker	Low	construction																							
		operation							O	O				O										O	
2. Kadam Railway	High	construction																							
		operation							◎	O				O							O			O	
3. Fringe Wells	Low to Moderate	construction																							
		operation							◎	O				O										O	
B-1 Water Supply Improvement for Informal Areas																									
1.1 Kassion Mountains Foot	Low	construction					O			O													O		
		operation							O																
1.2 Tishreen	Low	construction					O			O													O		
		operation							O																
1.3 Jobar Surrounding - Al Aksab Mosque	Low	construction					O			O													O		
		operation							O																
1.4 East-West Tabbaleh	Low	construction					O			O													O		
		operation							O																

Table 7.3.1 (2/2) Suggested Environmental Elements for EIA

		IEE Result	Implementation Stage	Social Environment									Natural Environment								Pollution					
				resettlement	economic activity	public facilities	social separation	cultural asset	water right	public health	waste	risk of disaster	topology	erosion	groundwater	surface water	coast	flora, fauna	climate	landscape	air pollution	water pollution	soil pollution	noise, vibration	subsidence	odor
	1.5 Mokhayam Yarmouk	Low	construction					○			○													○		
			operation							○																
	1.6 Naher Esheh-Dahadil & Asalie Kadam	Low	construction					○			○													○		
			operation							○																
	1.7 Al Qazzaz & Shaghour Basateen	Low	construction					○			○													○		
			operation							○																
	1.8 Mezze-Razy & Kafar Souseh-Lawan	Low	construction					○			○													○		
			operation							○																
	1.9 Somareyeh	Low	construction					○			○													○		
			operation							○																
	1.10 Dummar-Wadi Al Mashare	Low	construction					○			○													○		
			operation							○																
	1.11 Kudsaya	Low	construction					○			○													○		
			operation							○																
B-2 Water Resources Development																										
	2.1 New Well Centers for Informal Areas	Low	construction					○			○													○		
			operation							○					○											
	2.2 New Well Centers for Formal Area																									
	1. Kafar Souseh	Low	construction					○			○													○		
			operation							○					○											
	2. Tishreen & Kywan	Low	construction					○			○													○		
			operation							○					○											
	2.3 Water Resources Development Schemes in Hermon Area	Moderate	construction																			○		○		
			operation						◎	○					○	○		○								
	2.4 Water Resources Development in Damascus (New Stations)																									
	1. Shoukry al Quowatky	Low	construction					○			○											○		○		
			operation						○	○	○				○										○	
	2. Kanawat Gardens	Low	construction					○			○											○		○		
			operation						○	○	○				○										○	

○ : limited environmental impact is anticipated

◎ : significant environmental impact is anticipated



Legend

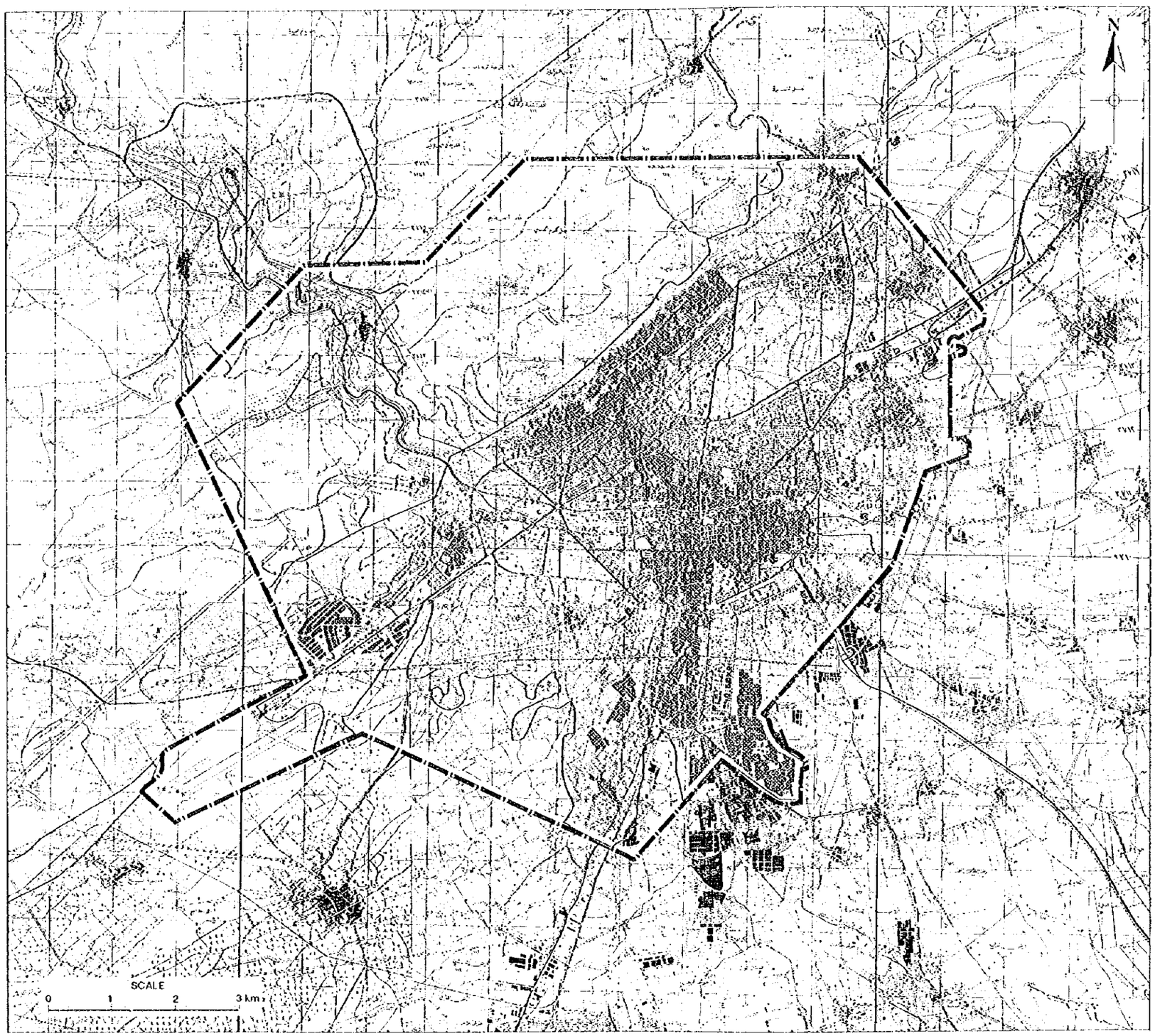
- Mezze-Razy & Kafar Souseh Informal Area
- Leakage Reduction Program Area
- Existing Boundary of The City

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 7.4.1
Location Map of Priority Projects

NIPPON KOEI CO., LTD.



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