5. MITIGATING PLANS AND ENVIRONMENTAL MONITORING

Based on the EIA, it was found that the environmental impacts of the proposed projects are generally not very large and mostly mitigatable. In this section, a series of guidelines for mitigating plans are presented along with the suggested environmental monitoring programs.

5.1 Construction Stage

5.1.1 Wastewater

Wastewater problems (e.g., pollution of surface water and shallow aquifers) will be the most serious environmental impact of the proposed projects. However, Damascus is developing a sewerage system, and it is still possible to solve this problem in environmentally sound manner. DAWSSA should inform the proposed projects to the competent local authorities (e.g., Ministry of Housing and recently established authority in charge of sewerage works in Damascus), and address the potential impacts of the projects, as reviewed in Chapter 4 of this Appendix.

5.1.2 Minimizing the impact to local residents

Impacts of construction activities to the local residents can be greatly reduced by 1) informing the residents about the plan, and 2) controlling construction activities. The following list provides a set of environmental considerations that can be easily implemented in the construction stage.

- Notify the residents about the work schedule and the contact address in advance.
- The cut off of water supply due to construction has to be minimized. If the cut off is long, an alternative water supply plan during the cut off has to be developed and implemented.
- Safety of residents and workers has the highest priority.
- No construction work at late night and early morning. According to the result of interview survey, some people prefer the construction work to be done in summer.

- Water, if necessary, to control dust.
- Minimize the use of construction machinery.
- Minimize blocking traffic. The access road for pedestrians has to be secured.

5.1.3 Preventing secondary contamination

Any potential of secondary contamination from distribution networks should be minimized in the construction stage.

- Educate the workers about the importance of preventing secondary contamination.
- Develop and enforce appropriate quality control programs, in which the procured materials are closely inspected for defect, and proper installation are ensured.
- If water supply pipes are installed under the road, the water supply pipes has to be placed over the sewage pipes. Make sure to keep enough distance between the water supply pipe and the sewage pipe.
- To protect pipes from corrosion and other damages, the pipes shall be coated with appropriate materials, such as mortar lining for inner surface and tar-epoxy resin for external surface. The soil used for backfill should be free of corrosive or contaminating substances. Polystyrene sleeve or anti-corrosion tape/resin may be used as needed.

5.1.4 Cultural Assets

The importance of cultural assets should not be judged by non-professionals. The assistance of relevant authority shall be sought in the earlier stage of the work to minimize the potential damage to cultural assets.

- Before starting construction works, notify the municipality, and obtain a permit.
- Organize the construction activity under the guidance of the relevant authority.
- Conduct through site investigation before the construction. The information may be needed later to clarify any claims of damages, and to restore damaged object.
- Many cultural assets are vulnerable to vibration. Do not use construction machinery with high level of vibration.

- Under the guidance of the relevant authority, give structural support or any other protection to cultural asset.
- If any cultural asset is discovered during construction work, stop the work, and immediately report to the relevant authority.

5.2 Operation Stage

5.2.1 Water Quality Monitoring

1) Water quality testing prior to service

The water left in the system during the construction may be contaminated, and there would be no residual chlorine in the system. Furthermore, there may be a defect in the newly constructed system. Therefore, before starting the service to residents, water has to be thoroughly tested to ensure that the steady supply of safe water that satisfies the Syrian Drinking Water Standards.

2) General water quality monitoring program

To ensure the safety of supplied water, regular water quality monitoring is essential. DAWSSA regularly inspects supplied waters from 34 district in Damascus for sanitary condition (residual chlorine and microbial activities), and water qualities of major water resources are also monitored for the compliance with the Syrian Drinking Water Standards. However, DAWSSA's capacity to conduct basic water quality testing is very limited, and the need to improve water quality testing at DAWSSA, as it has been already discussed in the Master Plan (for details, see Master Plan, Appendix D, Section 5.4.1), is yet to be fulfilled.

3) Pesticides monitoring program

Pesticide monitoring program is urgently needed, as stressed in Chapter 2. Currently, DAWSSA lacks the capability to analyze pesticides mainly due to the lack of steady supply of analytical equipment and lack of human resource specialized in pesticide analysis (also see Master Plan, Appendix D, Section 5.4.1). These problems have to be solved before

DAWSSA can run reliable pesticide monitoring program. Some suggestions have been given in the Master Plan Report (Appendix D).

5.2.2 Maintenance of Water Supply Systems

Maintenance of water supply systems is very important to minimize secondary contamination problems. DMA program will help diagnose system for low pressure or stagnant pipes. A guidelines for system inspection has been discussed in Appendix A.

5.2.3 Education and Participation of Users

Education of water users will be another important aspect of water quality control. The user should be educated about the importance of saving water, and overuse of high quality water should be condemned. It is likely that illegal connection, cross-connection, and poorly constructed storage tank is the source of water contamination. As a part of customer service, DAWSSA can provide instruction about how to insepct storage tanks and pipe connections. DAWSSA should also encourage the user to report leakage and abnormality of water.

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TABLES

Table C-3.1 Summary of Questions in the Questionnaire

Component	Items	Question #	Result
Socio-Economy	family structure	1	Table C-3.2
	household income	1	Table C-3.2
	occupation	1	Table C-3.3
	building type	16	Table C-3.5
	possession, ownership	1	Table C-3.4
Water Use	water consumption	2	Table C-3.6
	water source	3 13	Table C-3.8 Table C-3.7
	satisfaction and problem	4 5	Table C-3.11 Table C-3.12
	water storage device	17,18 19-22	Table C-3.9 Table C-3.10
Public Health	water borne disease	6 7	Table C-3.13 Table C-3.14
Waste Control	wastewater	8	Table C-3.18
	garbage	9	Table C-3.20
	human waste	10	Table C-3.19
Public Utilities	monthly payment	12	Table C-3.15
	willingness-to-pay	14	Table C-3.16 Table C-3.17
Environmental Condition	most serious problem	11	Table C-3.21
Impact of Proposed Project	major concern	15	Table C-3.22

Table C-3.2 Family Size and Household Income

District	Formality	Total Households	Family Size: Children Total	Children Average	Adults Total	Adults Average	Total Total	Total Average	Total Household Income Average
Mezze	Formal	32	166	5.19	176	5.50	342	10.69	4000-7000
Razy	Informal	38	134	3.53	108	2.84	242	6.37	4000-7000
Sub-Total		70	300	4.28	284	4.10	584	8.40	4000-7000
Kafar Souseh	Formal	12	55	4.58	50	4.17	105	8.75	3000-5000
Lawan	Informal	18	72	4.00	46	2.56	118	6.56	3000-5000
Sub-Total		30	127	4.23	96	3.20	223	7.43	3000-5000
Total		100	427	4.27	380	3.88	807	8.07	3500-6000

Table C-3.3 Occupation

District	Formality	Total Households	Public sector wage labor: Total	Percentage	Private sector wage labor: Total	Percentage	Agriculture wage labor: Total	Percentage	Business / Commercial self-employed: Total	Percentage	Agriculture self-employed: Total	Percentage	Other: Total	Percentage
Mezze	Formal	32	6	18.8%	3	9.4%	2	6.3%	19	59.4%	4	12.5%	1	3.1%
Razy	Informal	38	6	15.8%	6	15.8%	0	0.0%	25	65.8%	1	12.6%	0	0.0%
Sub-Total		70	12	17.0%	9	13.0%	2	2.8%	44	62.8%	5	7.1%	1	1.0%
Kafar Souseh	Formal	12	2	16.7%	1	8.3%	0	0.0%	9	75.0%	0	0.0%	0	0.0%
Lawan	Informal	18	4	22.2%	1	5.6%	0	0.0%	12	66.7%	0	0.0%	1	5.6%
Sub-Total		30	6	20%	2	6.70%	0	0.00%	21	70%	0	0.00%	1	3.30%
Total		100	18	18%	11	11%	2	2.00%	65	65.0%	5	5.0%	2	2.0%

Table C-3.4 Possessions (1/2)

District	Formality	Total Households	Possession: Land Total	Land Percentage	House (rooms) Total	House (rooms) Average	Electric laundry machine Total	Electric laundry machine Average	refrigerator Total	refrigerator Average	Automobile Total	Automobile Average	TV Total	TV Average
Mezze	Formal	32	8	25.0%	153	4.78	34	1.06	42	1.31	8	0.25	37	1.16
Razy	Informal	38	2	5.3%	124	3.26	34	0.89	42	1.11	3	0.08	42	1.11
Sub-Total		70	10	14.3%	277	3.96	68	0.97	84	1.20	11	0.16	79	1.13
Kafar Souseh	Formal	12	0	0.0%	46	3.83	12	1.00	12	1.00	0	0.00	12	1.00
Lawan	Informal	18	3	16.7%	50	2.78	19	1.06	14	0.78	1	0.06	21	1.17
Sub-Total		30	3	10.0%	96	3.20	31	1.03	26	0.87	1	0.03	33	1.10
Total		100	13	13.0%	373	3.73	99	0.99	110	1.1	12	0.12	112	1.12

Table C-3.4 Possessions (2/2)

District	Formality	Total Households	Possession: Private Bath Total	Private Bath Average	Flush Toilet Total	Flush Toilet Average
Mezze	Formal	32	35	1.09	35	1.09
Razy	Informal	38	43	1.13	42	1.11
Sub-Total		70	78	1.11	77	1.10
Kafar Souseh	Formal	12	12	1.00	12	1.00
Lawan	Informal	18	18	1.00	18	1.00
Sub-Total		30	30	1.00	30	1.00
Total		100	108	1.08	107	1.07

Table C-3.5 Buildings

District	Formality	Total of Households	Building Status House / Apartment House <= 2 stories Total	Percentage	House >= 3 stories Total	Percentage
Mezze	Forma	32	30	93.8%	2	6.3%
Razy	Informal	38	38	100.0%	0	0.0%
Sub-Total		70	68	97.1%	2	2.9%
Kafar Sousch	Formal	12	12	100.0%	0	0.0%
Lawan	Informal	18	17	94.4%	1	5.6%
Sub-Total		30	29	96.7%	1	3.3%
Total		100	97	97.0%	3	3.0%

Table C-3.6 Water Consumption

			Water Use									
		Total	<=160		170		180		190		>=200	
District	Formality	Households	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	13	40.6%	1	3.1%	9	28.1%	5	15.6%	4	12.5%
Razy	Informal	38	15	39.5%	1	2.6%	16	42.1%	3	7.9%	3	7.9%
Sub-Total		70	28	40.0%	2	2.9%	25	35.7%	8	11.4%	7	10.0%
Kafar Souseh	Formal	12	6	50.0%	2	16.7%	4	33.3%	0	0.0%	0	0.0%
Lawn	Informal	18	14	77.8%	0	0.0%	4	22.2%	0	0.0%	0	0.0%
Sub-Total		30	20	66.7%	2	6.7%	8	26.7%	0	0.0%	0	0.0%
Total		100	48	48.0%	4	4.0%	33	33.0%	8	8.0%	7	7.0%

Table C-3.7 Connection to Water Supply System

			House connection to the public (DAWASSA) water supply system									
		Total	Not connected		Official individual house connection		Private pipe with valve		Private pipe without valve		Private pump with booster pump	
District	Formality	Households	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	0	0.0%	32	100.0%	0	0.0%	0	0.0%	0	0.0%
Razy	Informal	38	0	0.0%	0	0.0%	37	97.4%	1	2.6%	0	0.0%
sub-Total		**70**	**0**	**0.0%**	**32**	**45.7%**	**37**	**52.9%**	**1**	**1.4%**	**0**	**0.0%**
Kafar Souseh	Formal	12	0	0.0%	12	100.0%	0	0.0%	0	0.0%	0	0.0%
Lawan	Informal	18	4	22.2%	0	0.0%	13	72.2%	1	5.6%	0	0.0%
sub-Total		30	4	13.3%	12	40.0%	13	43.3%	1	3.3%	0	0.0%
Total		**100**	**4**	**4.0%**	**44**	**44.0%**	**50**	**50.0%**	**2**	**2.0%**	**0**	**0.0%**

Table C-3.8 (1/6) Water Sources (Drinking and Cooking)

District	Formality	Total	Drinking & Cooking											
			DAWSSA Individual house connection		DAWSSA shared house connection		Bottled Water		Private spring or well		Communal spring or well		Other	
		Households	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	30	93.8%	2	6.3%	0	0.0%	0	0.0%	2	6.3%	0	0.0%
Razy	Informal	38	0	0.0%	38	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sub-Total		**70**	**30**	**42.9%**	**40**	**57.1%**	**0**	**0.0%**	**0**	**0.0%**	**2**	**2.9%**	**0**	**0.0%**
Kafar Souseh	Formal	12	12	100.0%	6	50.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lawan	Informal	18	0	0.0%	15	83.3%	2	11.1%	0	0.0%	0	0.0%	1	5.6%
Sub-Total		**30**	**12**	**40.0%**	**21**	**70.0%**	**2**	**6.7%**	**0**	**0.0%**	**0**	**0.0%**	**1**	**3.3%**
Total		**100**	**42**	**42.0%**	**61**	**61.0%**	**2**	**2.0%**	**0**	**0.0%**	**2**	**2.0%**	**1**	**1.0%**

Table C-3.8 (2/6) Water Sources (Laundering)

District	Formality	Total	Laundering											
			DAWSSA Individual house connection		DAWSSA shared house connection		Bottled Water		Private spring or well		Communal spring or well		Other	
		Households	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	28	87.5%	2	6.3%	0	0.0%	2	6.3%	2	6.3%	0	0.0%
Razy	Informal	38	0	0.0%	37	97.4%	0	0.0%	1	2.6%	0	0.0%	0	0.0%
Sub-Total		**70**	**28**		**39**		**0**		**3**		**2**		**0**	
Kafar Souseh	Formal	12	9	75.0%	0	0.0%	0	0.0%	4	33.3%	0	0.0%	0	0.0%
Lawan	Informal	18	0	0.0%	12	66.7%	0	0.0%	6	33.3%	0	0.0%	0	0.0%
Sub-Total		**30**	**9**	**30.0%**	2	**6.7%**	**0**	**0.0%**	**10**	**33.3%**	**0**	**0.0%**	**0**	**0.0%**
Total		**100**	**37**	**37.0%**	**41**	**41.0%**	**0**	**0.0%**	**13**	**13.0%**	**2**	**2.0%**	**0**	**0.0%**

Table C-3.8 (3/6) Water Sources (Bathing)

			Bathing											
		Total	DAWSSA Individual house connection		DAWSSA shared house connection		Bottled Water		Private spring or well		Communal spring or well		Other	
District	Formality	Households	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	29	90.6%	2	6.3%	0	0.0%	1	3.1%	2	6.3%	0	0.0%
Razy	Informal	38	0	0.0%	38	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sub-Total		70	29	41.4%	40	57.1%	0	0.0%	1	1.4%	2	2.9%	0	0.0%
Kafar Souseh	Formal	12	9	75.0%	0	0.0%	0	0.0%	4	33.3%	0	0.0%	0	0.0%
Lawan	Informal	18	0	0.0%	13	72.2%	0	0.0%	5	27.8%	0	0.0%	0	0.0%
Sub-Total		30	9	30.0%	13	43.3%	0	0.0%	9	30.0%	0	0.0%	0	0.0%
Total		100	38	38.0%	53	53.0%	0	0	10	10.0%	2	2.0%	0	0.0%

Table C-3.8 (4/6) Water Sources (Toilet)

			Toilet											
		Total	DAWSSA Individual house connection		DAWSSA shared house connection		Bottled Water		Private spring or well		Communal spring or well		Other	
District	Formality	Households	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	28	87.5%	2	6.3%	0	0.0%	2	6.3%	2	6.3%	0	0.0%
Razy	Informal	38	0	0.0%	38	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sub-Total		70	28	40.0%	40	57.1%	0	0.0%	2	2.9%	2	2.9%	0	0.0%
Kafar Souseh	Formal	12	9	75.0%	0	0.0%	0	0.0%	4	33.3%	0	0.0%	0	0.0%
Lawan	Informal	18	0	0.0%	12	66.7%	0	0.0%	6	33.3%	0	0.0%	0	0.0%
Sub-Total		30	9	30.0%	12	40.0%	0	0.0%	10	33.3%	0	0.0%	0	0.0%
Total		100	37	37.0%	52	52.0%	0	0	12	12.0%	2	2.0%	0	0.0%

Table C-3.8 (5/6) Water Sources (Agriculture)

			Agriculture											
		Total	DAWSSA Individual house connection		DAWSSA shared house connection		Bottled Water		Private spring or well		Communal spring or well		Other	
District	Formality	Households	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	1	3.1%	0	0.0%	0	0.0%	4	12.5%	1	3.1%	5	15.6%
Razy	Informal	38	0	0.0%	1	2.6%	0	0.0%	0	0.0%	0	0.0%	2	6.3%
Sub-Total		70	1	1.4%	1	1.4%	0	0.0%	4	5.7%	1	1.4%	7	10.0%
Kafar Souseh	Formal	12	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lawan	Informal	18	0	0.0%	0	0.0%	0	0.0%	2	6.3%	0	0.0%	1	3.1%
Sub-Total		30	0	0.0%	0	0.0%	0	0.0%	2	6.7%	0	0.0%	1	3.3%
Total		100	1	1.0%	1	1.0%	0	0.0%	6	6.0%	1	1.0%	8	8.0%

Table C-3.8 (6/6) Water Sources (Other)

			Other											
		Total	DAWSSA Individual house connection		DAWSSA shared house connection		Bottled Water		Private spring or well		Communal spring or well		Other	
District	Formality	Households	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	31	96.9%	0	0.0%	0	0.0%	1	3.1%	0	0.0%	0	0.0%
Razy	Informal	38	0	0.0%	12	31.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sub-Total		70	31	44.3%	12	17.1%	0	0.0%	1	1.4%	0	0.0%	0	0.0%
Kafar Souseh	Formal	12	1	8.3%	0	0.0%	0	0.0%	2	16.7%	0	0.0%	0	0.0%
Lawan	Informal	18	0	0.0%	0	0.0%	0	0.0%	3	16.7%	0	0.0%	0	0.0%
Sub-Total		30	1	3.3%	0	0.0%	0	0.0%	5	16.7%	0	0.0%	0	0.0%
Total		100	32	32.0%	12	12.0%	0	0.0%	6	6.0%	0	0.0%	0	0.0%

Table C-3.9 Water Storage Device (Capacity)

			Availability of Water Storage Device									
			No		Yes							
			Total	Percentage	Total of Tanks	Percentage	Capacity of water storage device					
							<=0.5 (m3)		1.0 m3		> 1.0 m3	
District	Formality	Total Households					Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	1	3.1%	31	96.9%	10	32.3%	18	58.1%	3	9.7%
Razy	Informal	38	1	2.6%	37	97.4%	16	43.2%	20	54.1%	1	2.7%
Sub-Total		**70**	**2**	**2.9%**	**68**	**97.1%**	**26**	**37.1%**	**38**	**54.3%**	**4**	**5.7%**
Kafar Souseh	Formal	12	0	0.0%	12	100.0%	8	66.7%	4	33.3%	0	0.0%
Lawan	Informal	18	1	5.6%	17	94.4%	7	41.2%	9	52.9%	1	5.9%
Sub-Total		**30**	**1**	**3.3%**	**29**	**96.7%**	**15**	**50.0%**	**13**	**43.3%**	**1**	**3.3%**
Total		**100**	**3**	**3.0%**	**97**	**97.0%**	**41**	**41.0%**	**51**	**51.0%**	**5**	**5.0%**

Table C-3.10 (1/2) Water Storage Device (Fill UP)

District	Formality	Total	Availability of Water Storage Device (Cont.)															
			Yes (Cont.)															
			Frequency of filling up the water storage device in the day						Time of filling up the water storage device				Control of filling up the water storage device			
			One time per day		Two times per day		Three times or more per days		Day time		Night time		Automatic control		Hand-operated control	
		Tanks	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	31	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	3.2%	30	96.8%	1	3.2%
Razy	Informal	37	1	2.7%	0	0.0%	0	0.0%	1	2.7%	0	0.0%	37	100.0%	1	2.7%
Sub -Total		68	1	1.5%	0	0.0%	0	0.0%	1	1.5%	1	1.5%	67	98.5%	2	2.9%
Kafar Souseh	Formal	12	4	33.3%	4	33.3%	0	0.0%	1	8.3%	8	66.7%	4	33.3%	8	66.7%
Lawan	Informal	17	9	52.9%	2	11.8%	0	0.0%	1	5.9%	11	64.7%	7	41.2%	11	64.7%
Sub -Total		29	13	44.8%	6	20.7%	0	0.0%	2	6.9%	19	65.5%	7	24.1%	19	65.5%
Total		97	14	14.4%	6	6.2%	0.006535948	0.0%	3	3.1%	20	20.6%	74	76.3%	21	21.6%

Table C-3.10 (2/2) Water Storage Device (Fill Up)

District	Formality	Total	Availability of Water Storage Device (Cont.)							
			Yes (Cont.)							
			Time use of water storage device							
			All year		Winter		Summer		Every six months	
		Tanks	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	31	24	77.4%	1	3.2%	6	19.4%	1	3.2%
Razy	Informal	37	29	78.4%	0	0.0%	8	21.6%	0	0.0%
Sub -Total		68	53	77.9%	1	1.5%	14	20.6%	1	1.5%
Kafar Souseh	Formal	12	11	91.7%	0	0.0%	1	8.3%	0	0.0%
Lawan	Informal	17	9	52.9%	0	0.0%	8	47.1%	0	0.0%
Sub-Total		29	20	69.0%	0	0.0%	9	31.0%	0	0.0%
Total		97	73	75.3%	1	1.0%	23	23.7%	1	1.0%

Table C-3.11 Present Water Supply - Satisfaction / Problems

District	Formality	Total Households	Water Satisfaction: Yes		No: Poor water quality		No: Low pressure		No: Insufficient quantity		No: Expensive		No: Other	
			Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	24	75.0%	0	0.0%	4	12.5%	6	18.8%	1	3.1%	1	3.1%
Razy	Informal	38	21	55.3%	1	2.6%	14	36.8%	12	31.6%	0	0.0%	0	0.0%
Sub-Total		70	45	64.3%	1	1.4%	18	25.7%	18	25.7%	1	1.4%	1	1.4%
Kafar Souseh	Formal	12	4	33.3%	0	0.0%	7	58.3%	7	58.3%	0	0.0%	1	8.3%
Lawan	Informal	18	5	27.8%	3	16.7%	10	55.6%	13	72.2%	0	0.0%	0	0.0%
Sub-Total		30	9	30.0%	3	10.0%	17	56.7%	20	66.7%	0	0.0%	1	3.3%
Total		100	54	54.0%	4	4.0%	35	35.0%	38	38.0%	1	1.0%	2	2.0%

Table C-3.12 Present Water Supply - Needs and Obstacles

District	Formality	Total Households	More Water: No		Yes: Too Expensive		Yes: Lack of water resource		Yes: Other	
			Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	22	68.8%	3	9.4%	7	21.9%	2	6.3%
Razy	Informal	38	22	57.9%	0	0.0%	16	42.1%	0	0.0%
Sub-Total		70	44	62.9%	3	4.3%	23	32.9%	2	2.9%
Kafar Souseh	Formal	12	4	33.3%	0	0.0%	8	66.7%	0	0.0%
Lawan	Informal	18	5	27.8%	0	0.0%	13	72.2%	3	16.7%
Sub-Total		30	9	30.0%	0	0.0%	21	70.0%	3	10.0%
Total		100	53	53.0%	3	3.0%	44	44.0%	5	5.0%

Table C-3.13 Water-borne Diseases

District	Formality	Total Households	Water-borne diseases in the past 5 years: Typhoid/ typhus/ paratyphoid Total	Percentage	Cholera Total	Percentage	Dysentery Total	Percentage	Others Total	Percentage
Mezze	Formal	32	0	0.0%	0	0.0%	2	6.3%	6	18.8%
Razy	Informal	38	0	0.0%	0	0.0%	0	0.0%	6	15.8%
Sub-Total	Sub-Total	70	0	0.0%	0	0.0%	2	2.9%	12	17.1%
Kafar Souseh	Formal	12	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lawan	Informal	18	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sub-Total	Sub-Total	30	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total		100	0	0.0%	0	0.0%	2	2.0%	12	12.0%

Table C-3.14 Water-related Diarrhea

District	Formality	Total Households	Water Diarrhea: None Total	Percentage	Once per month Total	Percentage	2-3 times per month Total	Percentage	3-5 times per month Total	Percentage	More than 5 times per month Total	Percentage
Mezze	Formal	32	28	87.5%	3	9.4%	0	0.0%	0	0.0%	1	3.1%
Razy	Informal	38	32	84.2%	4	10.5%	1	2.6%	1	2.6%	0	0.0%
Sub-Total		70	60	85.7%	7	10.0%	1	1.4%	1	1.4%	1	1.4%
Kafar Souseh	Formal	12	12	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lawan	Informal	18	14	77.8%	4	22.2%	0	0.0%	0	0.0%	0	0.0%
Sub-Total		30	26	86.7%	4	13.3%	0	0.0%	0	0.0%	0	0.0%
Total		100	86	86.0%	11	11.0%	1	1.0%	1	1.0%	1	1.0%

Table C-3.15 Present Tariffs on Public Utilities

District	Formality	Total Households	Average tariff paid for the present public utilities: Water Supply Average	Electricity Average
Mezze Razy	Formal	32	125	484
Kafar Souseh Lawan	Formal	12	85	181
Sub-Total		**44**	**114**	**401**
Mezze Razy	Informal	38	-	367
Kafar Souseh Lawan	Informal	18	-	233
Sub-Total		**56**	**-**	**324**

Table C-3.16 Affordable Water Charge - Willingness-to-Pay

District	Formality	Total Households	Average tariff paid for the future Water Supply									
			None		Minimum		Less		Meter		Same	
			Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	2	6.3%	3	9.4%	6	18.8%	8	25.0%	13	40.6%
Razy	Informal	38	1	2.6%	17	44.7%	1	2.6%	16	42.1%	3	7.9%
Sub-Total		**70**	**3**	**4.3%**	**20**	**28.6%**	**7**	**10.0%**	**24**	**34.3%**	**16**	**22.9%**
Kafar Souseh	Formal	12	0	0.0%	1	8.3%	3	25.0%	3	25.0%	5	41.7%
Lawan	Informal	18	1	5.6%	7	38.9%	0	0.0%	10	55.6%	0	0.0%
Sub-Total		**30**	**1**	**3.3%**	**8**	**26.7%**	**3**	**10.0%**	**13**	**43.3%**	**5**	**16.7%**
Total		**100**	**4**	**4.0%**	**28**	**28.0%**	**10**	**10.0%**	**37**	**37.0%**	**21**	**21.0%**

Table C-3.17 Affordable Electricity Charge - Willingness-to-Pay

District	Formality	Total Households	Average tariff paid for the future Electricity									
			None		Minimum		Less		Meter		Same	
			Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	2	6.3%	3	9.4%	10	31.3%	7	21.9%	10	31.3%
Razy	Informal	38	1	2.6%	11	28.9%	10	26.3%	9	23.7%	7	18.4%
Sub- Total		**70**	**3**	**4.3%**	**14**	**20.0%**	**20**	**28.6%**	**16**	**22.9%**	**17**	**24.3%**
Kafar Souseh	Formal	12	0	0.0%	1	8.3%	2	16.7%	3	25.0%	6	50.0%
Lawan	Informal	18	1	5.6%	5	27.8%	1	5.6%	9	50.0%	2	11.1%
Sub- Total		**30**	**1**	**3.3%**	**6**	**20.0%**	**3**	**10.0%**	**12**	**40.0%**	**8**	**26.7%**
Total		**100**	**4**	**4.0%**	**20**	**20.0%**	**23**	**23.0%**	**28**	**28.0%**	**25**	**25.0%**

Table C-3.18 Wastewater Control

			Waste Water							
		Total of	Public sewer system		Septic Tank		Ditch / Creek		Other	
District	Formality	Houses or Buildings	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	0	0.0%	0	0.0%	31	96.9%	1	3.1%
Razy	Informal	38	0	0.0%	0	0.0%	38	100.0%	0	0.0%
Sub-Total		70	0	0.0%	0	0.0%	69	98.6%	1	1.4%
Kafar Souseh	Formal	12	3	25.0%	0	0.0%	9	75.0%	0	0.0%
Lawan	Informal	18	9	50.0%	1	5.6%	8	44.4%	0	0.0%
Sub-Total		30	12	40.0%	1	3.3%	17	56.7%	0	0.0%
Total		100	12	12.0%	1	1.0%	86	86.0%	1	1.0%

Table C-3.19 Human Waste Control

			Human Waste											
		Total	Public sewer system		Septic Tank		Regularly collected by the city		Regularly collected by private company		Used for agriculture		Other	
District	Formality	Households	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	1	3.1%	0	0.0%	0	0.0%	0	0.0%	27	84.4%	4	12.5%
Razy	Informal	38	1	2.6%	0	0.0%	0	0.0%	0	0.0%	26	68.4%	11	28.9%
Sub-Total		70	2	2.9%	0	0.0%	0	0.0%	0	0.0%	53	75.7%	15	
Kafar Souseh	Formal	12	2	16.7%	0	0.0%	0	0.0%	0	0.0%	9	75.0%	1	8.3%
Lawan	Informal	18	9	50.0%	0	0.0%	0	0.0%	0	0.0%	6	33.3%	3	16.7%
Sub-Total		30	11	36.7%	0	0.0%	0	0.0%	0	0.0%	15	50.0%	4	13.3%
Total		100	13	13.0%	0	0.0%	0	0.0%	0	0.0%	68	68.0%	19	19.0%

Table C-3.20 Garbage Control

			Garbage							
		Total	Regularly collected by the city		Regularly collected by private collector		Bury or incinerate		Other	
District	Formality	Households	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	30	93.8%	0	0.0%	1	3.1%	1	3.1%
Razy	Informal	38	38	100.0%	0	0.0%	0	0.0%	0	0.0%
Sub-Total		70	68	97.1%	0	0.0%	1	1.4%	1	1.4%
Kafar Souseh	Formal	12	11	91.7%	1	8.3%	0	0.0%	0	0.0%
Lawan	Informal	18	18	100.0%	0	0.0%	0	0.0%	0	0.0%
Sub-Total		30	29	96.7%	1	3.3%	0	0.0%	0	0.0%
Total		100	97	97.0%	1	1.0%	1	1.0%	1	1.0%

Table C-3.21 Environmental Problems

District	Formality	Total	Environmental Problems															
			None		Air Pollution		Lack of clean and safe drinking water		Polluted river		Noise		Odor		Filthy environment due to lack of waste control		Other	
		Households	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Mezze	Formal	32	3	9.4%	3	9.4%	11	34.4%	24	75.0%	0	0.0%	21	65.6%	5	15.6%	0	0.0%
Razy	Informal	38	4	10.5%	1	2.6%	8	21.1%	25	65.8%	3	7.9%	23	60.5%	9	23.7%	3	7.9%
Sub-Total		70	7	10.0%	4	5.7%	19	27.1%	49	70.0%	3	4.3%	44	62.9%	14	20.0%	3	4.3%
Kafar Souseh	Formal	12	1	8.3%	0	0.0%	2	16.7%	8	66.7%	1	8.3%	7	58.3%	2	16.7%	4	33.3%
Lawan	Informal	18	0	0.0%	0	0.0%	9	50.0%	9	50.0%	2	11.1%	10	55.6%	7	38.9%	2	11.1%
Sub-Total		30	1	3.3%	0	0.0%	11	36.7%	17	56.7%	3	10.0%	17	56.7%	9	30.0%	6	20.0%
Total		100	8	8.0%	4	4.0%	30	30.0%	66	66.0%	6	6.0%	61	61.0%	23	23.0%	9	9.0%

Table C-3.22 Enviromental Impacts of Construction Activities

			Concerns regarding the impacts of construction activities									
		Total	None		The area becomes noisy		The area becomes dusty		The traffic jam makes commuting difficult		Other	
District	Formality	Households	Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Mezze	Formal	32	26	81.3%	2	6.3%	3	9.4%	1	3.1%	5	15.6%
Razy	Informal	38	29	76.3%	2	5.3%	2	5.3%	3	7.9%	6	15.8%
Sub-Total		70	55	78.6%	4	5.7%	5	7.1%	4	5.7%	11	15.7%
Kafar Souseh	Formal	12	8	66.7%	0	0.0%	0	0.0%	0	0.0%	4	33.3%
Lawan	Informal	18	17	94.4%	0	0.0%	0	0.0%	0	0.0%	1	5.6%
Sub-Total		30	25	83.3%	0	0.0%	0	0.0%	0	0.0%	5	16.7%
Total		100	80	80.0%	4	4.0%	5	5.0%	4	4.0%	16	16.0%

Table C-3.23 Correlations between Selected Parameters

Correlations

Variable	M/K	F/I	Family	Income	consumption	satisfaction	low pressure	insufficient	no more water	no diarrhea	water charge	electricity charge	no concern
M/K	1.0000	0.0291	0.1149	0.2231	0.3443	0.3214	-0.2843	-0.3799	0.3071	-0.0111	0.1060	0.1806	-0.0382
F/I	0.0291	1.0000	0.4501	0.0901	0.0829	0.1409	-0.1396	-0.1039	0.0722	0.1097	0.5889	0.0792	-0.0601
Family	0.1149	0.4501	1.0000	0.2928	0.2411	0.0582	-0.0644	-0.0786	0.0582	-0.0526	0.6125	0.3570	0.0570
Income	0.2231	0.0901	0.2928	1.0000	0.3167	0.2946	-0.2217	-0.3095	0.2288	-0.0435	0.3276	0.4363	-0.1290
consumption	0.3443	0.0829	0.2411	0.3167	1.0000	0.1814	-0.1401	-0.1977	0.2338	-0.0109	0.1898	0.3196	-0.1350
satisfaction	0.3214	0.1409	0.0582	0.2946	0.1814	1.0000	-0.8025	-0.8589	0.9362	0.1465	0.1586	0.1294	-0.2067
low pressure	-0.2843	-0.1396	-0.0644	-0.2217	-0.1401	-0.8025	1.0000	0.6624	-0.7855	0.0040	-0.1081	-0.1035	0.1584
insufficient	-0.3799	-0.1039	-0.0786	-0.3095	-0.1977	-0.8589	0.6624	1.0000	-0.8407	-0.0911	-0.1269	-0.2117	0.1886
no more water	0.3071	0.0722	0.0582	0.2288	0.2338	0.9362	-0.7855	-0.8407	1.0000	0.0776	0.1517	0.1423	-0.2172
no diarrhea	-0.0111	0.1097	-0.0526	-0.0435	-0.0109	0.1465	0.0040	-0.0911	0.0776	1.0000	-0.2021	-0.1934	-0.1361
water charge	0.1060	0.5889	0.6125	0.3276	0.1898	0.1586	-0.1081	-0.1269	0.1517	-0.2021	1.0000	0.6085	0.0536
electricity charge	0.1806	0.0792	0.3570	0.4363	0.3196	0.1294	-0.1035	-0.2117	0.1423	-0.1934	0.6085	1.0000	-0.0779
no concern	-0.0382	-0.0601	0.0570	-0.1290	-0.1350	-0.2067	0.1584	0.1886	-0.2172	-0.1361	0.0536	-0.0779	1.0000

Parameter	Meaning
M/K :	Mezze-Razy =1/ Kafar Souseh-Lawan=0
F/I :	Formal=1/Informal=0
Family :	Number of Family Members
Income :	Monthly Household Income (SL/household/month)
Consumption :	Water Consumption (lpcd)
Satisfaction :	Satisfaction with current water supply, Yes=1/No=0
Low Pressure :	Low Pressure Problem, Low=1/Other=0
Insufficient :	Insufficient Supply, Insufficient=1/Other=0
No More Water :	No Need to Use More Water, No Need=1/Need More Water=0
No Diarrhea :	Diarrhea Frequency, Zero/month=1/more=0
Water Charge :	Ave. Monthly Water Charge, SL/household/month
Electricity Charge :	Ave. Monthly Electricity Charge, SL/household/month
No Concern :	Concern Regarding Construction Activities, No Concern=1/Concern=0

Table C-4.1 Population in Damascus City by Census District (1994)

Census District No.	Population (1)	Families	Occupied Dwellings	no. of persons per dwelling	no. of persons per family	Dwellings under construction
1	47,295	9,262	8,022	5.9	5.1	1,656
2	29,886	5,909	5,347	5.6	5.1	1,522
3	18,476	3,494	2,908	6.4	5.3	551
4	25.825	5,106	4,205	6.1	5.1	570
5	22,707	4,675	3,685	6.2	4.9	738
6	22,368	5,394	4,857	4.6	4.1	1,136
7	10,986	2,474	2,348	4.7	4.4	735
8	8,995	1,993	1,912	4.7	4.5	530
9	4,133	981	966	4.3	4.2	738
10	5,916	737	559	10.6	8.0	208
11	6,763	1,325	1,129	6.0	5.1	538
12	86,843	16,946	16,287	5.3	5.1	6,242
13	21,002	4,159	3,445	6.1	5.0	557
14	48,446	9,746	9,138	5.3	5.0	4,683
15	19,309	4,377	4,296	4.5	4.4	1,615
16	16,781	4,123	4,036	4.2	4.1	2,005
17	10,169	2,083	1,812	5.6	4.9	762
18	5,741	1,115	1,090	5.3	5.1	332
19	8,813	1,506	1,300	6.8	5.9	275
20	8,101	1,605	1,242	6.5	5.0	317
21	8,186	1,678	1,602	5.1	4.9	321
22	19,946	3,762	3,610	5.5	5.3	1,094
23	26,315	4,956	3,958	6.6	5.3	2,740
24	67,823	12,083	9,629	7.0	5.6	1,495
25	62,917	10,720	7,864	8.0	5.9	732
26	23,278	3,964	3,687	6.3	5.9	802
27	13,105	2,384	1,955	6.7	5.5	500
28	10,274	1,942	1,414	7.3	5.3	455
29	9,519	1,689	1,470	6.5	5.6	413
30	9,641	1,827	1,571	6.1	5.3	220
31	30,948	5,925	5,184	6.0	5.2	1,567
32	7,423	1,414	1,219	6.1	5.2	349
33	46,217	8,443	7,878	5.9	5.5	2,048
34	6,192	1,156	1,115	5.6	5.4	301
35	3,682	758	500	7.4	4.9	272
36	8,990	1,868	1,361	6.6	4.8	322
37	6,346	1,259	948	6.7	5.0	201
38	6,815	1,373	973	7.0	5.0	236
39	3,950	771	650	6.1	5.1	190
40	1,020	244	207	4.9	4.2	23
41	3,342	705	469	7.1	4.7	77
42	3,343	706	483	6.9	4.7	92
43	8,876	1,797	1,540	5.8	4.9	528
44	12,481	2,574	2,269	5.5	4.8	475
45	10,615	2,196	1,527	7.0	4.8	267
46	12,263	2,846	1,852	6.6	4.3	371
47	2,569	524	390	6.6	4.9	119
48	50,422	9,345	7,644	6.6	5.4	1,748
49	19,936	4,200	3,894	5.1	4.7	1,099
50	21,222	4,757	4,699	4.5	4.5	1,571
51	25,240	5,172	4,359	5.8	4.9	1,196
52	9,930	2,087	2,062	4.8	4.8	1,033
53	26,403	4,957	4,412	6.0	5.3	895
54	11,934	2,889	2,830	4.2	4.1	1,050
55	50,580	9,644	6,548	7.7	5.2	1,470
56	74,411	13,809	12,568	5.9	5.4	3,104
57	24,683	4,909	4,625	5.3	5.0	1,211
58	55,700	10,666	10,325	5.4	5.2	2,781
59	34,086	6,425	6,043	5.6	5.3	1,231
60	73,041	13,318	10,941	6.7	5.5	1,363
61	22,969	5,134	3,608	6.4	4.5	393
62	39,134	7,491	5,392	7.3	5.2	787
	1,394,322	271,377	233,859	6.0	5.1	62,852

(1) includes informal population

Table C-4.2 Land Use in Damascus City

No.	land use classification	area (ha)
1	agricultural area	1,006.4
2	mixed regions	413.7
3	sports and green regions	510.4
4	special usage regions	354.5
5	industrial regions	222
6	Kassioun Mountain	2,956
7	open areas	116.8
8	residential areas	4,589.8
9	adminstirative / social areas	455.4
total	-	10,625

source: Damascus Municipality, 1997

Table C-4.3 Roads in Mezze-Razy & Kafar Sousch-Lawan Area

(unit km)

width	Mezze - Razy	Kafar Sousch - Lawan
< 4 m	0.509 (5.5 %)	0.394 (9.9 %)
4 - 6 m	5.641 (61.4 %)	1.18 (29.7 %)
6 - 8 m	3.035 (33.0 %)	1.376 (34.5 %)
> 8 m	-	1.017 (25.6 %)
Total	9.185	3.967

Table C-4.4 Volume-Averaged Water Quality of Supplied Water
(estimated yearly average for 1996)

Item	Unit	Syrian Std.	Vol. Ave. Conc.	
			Damascus	Informal*
EC	μS/cm	1500	350	290
pH		6.5 - 8.5	7.7	7.9
Total Hardness	mg $CaCO_3$/L	500	190	150
Ca	mg/L	-	51	41
Mg	mg/L	-	14	12
Na	mg/L	-	4.5	2
K	mg/L	-	0.77	0.51
Total Alkalinity	meq/L	-	3.4	2.9
HCO_3	mg/L	-	200	170
SO_4	mg/L	250	10	6
Cl	mg/L	250	10	5
NO_3	mg/L	44	6.9	4.0
Total Bacteria	count/100 mL	200	130**	90**
Total Coliform	count/100 mL	n.d.	62**	52**
$KMnO_4$ Demand	mg O_2/L	2	0.016	0.007
Fe	μg/L	300	8.0	7.6
Mn	μg/L	100	0.6	0.6

- : no standrd
n.d. : not detected
* : for Mezze-Razy & Kafar Sousch-Lawan areas
assuming no production from University wellfield
** : before disinfection

Table C-4.5 Climatic Statistics for Damascus

	Air Temperature (°C)			Ave. Precip.	Ave. Relative
Month	Ave.	Max.	Min.	(mm/month)	Humidity (%)
January	7.0	22.7	-8.3	51.2	72
February	8.7	25.0	-5.3	38.7	66
March	11.7	31.1	-3.7	28.3	57
April	16.1	35.5	-3.3	17.6	48
May	21.0	38.4	3.5	6.8	40
June	25.1	40.9	9.2	0.1	35
July	26.9	43.6	10.8	0.0	38
August	26.9	44.0	10.8	0.0	40
September	24.1	42.0	8.7	0.2	42
October	20.0	36.6	3.8	7.1	46
November	13.7	29.7	-4.4	27.2	58
December	8.6	26.1	-6.4	46.2	72

Note: Data for Mezze Meteorological Station 1947-84, Damascus

Table C-4.6 (1/2) List of Fauna and Flora

Mammals

Canis lupus
Felis sylvestris
Martes poina
Phinolophus earyale
Pouseitus aegryptiacu
Sciurus anomalus
Spalax ehrenbergi
Spalax leucodon

Birds

Accipiter brevipes
Acrocephelus arundin
Acrocephalus seirpac
Alcedo atthis
Anser albifrons
Aquila pomarina
Botaurus stellaris
Bubulcus ibis
Calandrella brachyda
Charadriida asiaticu
Corvus frugilegus
Corvus monedula
Coturnix coturnix
Eiconia nigra
Emberiza citrinella
Falco concolor
Falco naumanni
Falco peregrinus
Falco subbuteo
Falco vespertinus
Fringilla coelebs
Gallinula shloropus
Hirunod rustica
Monticola solitarus
Neophron perenopteru
Oenanthe deserti
Otus scope
Parus lugubris
Pernis apivorus
Phoeniceuras phoeneuras
Porzana parua
Prunella collaris
Prunella modularis
Piparia rupestnis
Scolopax rusticola
Steptoperia senegal
Sylvia curruca
Todrona ferruginea
Turdus philomelos
Vanellus vanellus
Carduelis chloris

Plants

Acantholiumon damassanum
Achillea falcata
Achillea fragnantissma
Afuga orientalis
Alisma gramineum
Alisma plantago-aquatica
Alkanna strigoa
Anagallis arvensis
Anarrhinum orientale
Anchusa aegypfica
Anchusa strigosa
Anemene coronaria
Anthemis cotula
Anthemis haussknechtii
Anthemis pseudocotula
Arctium minus
Artemisia arborescenes
Artemisia verlotorum
Asperugo procumbens
Asperula rivalis
Atractylis cancellata
Ballota nigra
Ballota undulata
Borago officinalis
Calendula sinuata
Calysetgia sepium
Carduus pyconocephalus
Centaurea blancheana
Chrysanthemum coronarium
Cirsium libanoticum
Cirsium siculum
Cirsium vulgare
Clematis vitalba
Consolida ambigua

source : Ministry of State for Environmental Affairs, 1997

Table C-4.6 (2/2) List of Fauna and Flora

Convolvulus arvensis
Convolvuls lineatus
Crepis hierosolymitana
Crepis micrantha
Cruciata coronata
Echinochloa crus-gallii
Echinodorus ranunculoides
Erigeron bonariensis
Eupatorium cannabinum
Filago anatolica
Filago descrorum
Gastrocotyle hispida
Glaucidium leiocarpum
Gnaphalium luteo-albury
Heliotropium rotundifolium g.
Laula viscosa
Lepidium crassifolium
Limonium globulifenum
Limonium thouinii
Linaria albifrons
Linaria persica
Lithospermum tenuiflorum
Matricaria chamomilla
Micromeria nervosa
Nepeta cataria g.
Notobasis syriaca g.
Plantago lanceolata
Potamogeton crispus
Pulicaria dysenteria
Potamogeton nodosus
Potamogeton crispus
Ranunculus maginatus
Roemeria hybrida
Salvia syriaca
Scariola orientalis
Scolymus hispnicus
Scrophularia umbrosa
Scutellaria africulata
Senecio aquaticus
Senecio gallicus
Setaria viridis
Sonchus asper
Sonchus oleraceus
Solanum dulcamana
Stachys longispicata
Stipa barabata
Taraxmaxcum officinale
Tortella nitida
Tragopopgon echinata
Valerianella echinata
Veronica anagalis-aquafica
Veronica anagalloides
Veronica cymbalaria
Veronica polita
Vinca major
Xanthium strumarium

source : Ministry of State for Environmental Affairs, 1997

Table C-4.7 Ambient Air Quality in Damascus

location	period of measurement (days)	pollutant	number of times exceeding WHO 1hour guideline value	number of times exceeding WHO 24 hour guideline value
1	14	SO_2	none	none
		NO_x	14	9
2	21	SO_2	3	2
		NO_x	20	11
3	21	SO_2	38	14
		NO_x	184	21
4	14	SO_2	none	4
		NO_x	11	3
5	14	SO_2	1	none
		NO_x	5	4
6	14	SO_2	none	none
		NO_x	10	8
7	7	SO_2	none	none
		NO_x	3	2

source : Ministry of the State for the Environment Affairs, 1995

Table C-4.8 (1/2) Surface Water Quality in Damascus

	Month	Barada Spring	Tekieh	Upstream of Figeh	Raboue	Kafar Souseh	Dabaghat
Flux (m3/sec)	1	-	4.8	6.4	4.3	-	3.0
	2	5.1	8.7	8.8	5.4	-	7.8
	3	6.5	8.9	12.1	10.3	-	11.2
	4	6.2	7.0	10.0		0.0	23.6
	5	5.0	5.5	6.5	19.8	0.4	18.4
	6	2.4	4.5	4.1	13.8	0.0	12.0
	7	3.7	3.9	3.4	10.4	0.3	1.7
	8	4.1	3.4	2.6	5.2	0.0	1.4
	9	4.1	3.3	2.9	0.9	0.0	0.6
	10	3.1	2.5	1.7	1.5	0.0	1.7
	11	-	4.0	3.9	3.6	-	1.4
	12	-	5.5	7.5	8.3	-	3.4
BOD (mg/L)	1	-	8	21	24	-	214
	2	6	12	125	28	-	120
	3	6	8	18	21	-	90
	4	1.2	2	3	-	45	40
	5	5	8	18	20	70	100
	6	0.8	0.8	12	12	99	66
	7	15	10	15	15	85	80
	8	5	9.5	13	28	110	100
	9	7	15	18	25	95	135
	10	4	3.5	4	7	60	47
	11	-	5	5	10	-	57
	12	-	-	-	-	-	-
pH	1	-	8.0	7.9	7.9	-	7.3
	2	7.8	7.9	7.9	8.0	-	7.4
	3	7.7	7.8	7.8	7.8	-	7.3
	4	-	-	-	-	-	-
	5	-	-	-	-	-	-
	6	-	-	-	-	-	-
	7	-	-	-	-	-	-
	8	8.5	8.5	8.3	8.1	8.6	8.7
	9	7.7	7.8	7.8	7.7	7.9	8.2
	10	8.3	8.3	8.2	8.1	8.4	8.3
	11	-	7.9	7.8	8.0	-	7.9
	12	-	7.9	7.8	8.0	-	7.6
DO (%)	1	-	54	48	47	-	20
	2	62	64	59	68	-	29
	3	73	78	68	72	-	32
	4	-	-	-	-	-	-
	5	84	89	79	89	64	39
	6	-	-	-	-	-	-
	7	77	81	70	64	38	34
	8	69	68	76	63	58	26
	9	61	69	76	65	59	21
	10	69	76	-	25	76	14
	11	-	81	63	27	-	-
	12	-	94	117	94	-	29
SS (mg/L)	1	-	52	258	194	-	450
	2	45	60	240	213	-	470
	3	55	70	250	220	-	490
	4	-	-	-	-	-	-
	5	50	65	90	120	170	390
	6	15	68	101	132	628	33
	7	10	55	80	110	390	35

Table C-4.8 (2/2) Surface Water Quality in Damascus

	Month	Barada Spring	Tekieh	Upstream of Figeh	Raboue	Kafar Souseh	Dabaghat
	8	17	31	33	51	115	196
	9	12	40	40	55	125	220
	10	6	50	79	45	68	95
	11	-	55	80	45	-	95
	12	-	848	108	450	-	190
EC (μS/cm)	1	-	530	450	375	-	650
	2	300	330	380	370	-	600
	3	300	310	320	350	-	500
	4	275	250	350	-	510	410
	5	310	310	330	360	340	550
	6	275	310	600	500	825	500
	7	300	310	650	450	840	550
	8	250	350	250	350	700	900
	9	250	350	260	360	625	850
	10	325	725	350	425	700	700
	11	-	275	350	400	-	675
	12	-	360	410	440	-	530
NH3 (mg/L)	1	-	0.85	2.1	7.73	-	4.1
	2	0.31	0.65	1.7	6.3	-	3.8
	3	0.30	0.42	0.98	2.1	-	3.1
	4	0.12	0.36	0.85	-	25.6	2.44
	5	0.37	0.45	1.06	1.71	6.1	0.3
	6	1.46	1.32	1.53	0.36	11.3	4.89
	7	1.5	1.38	1.46	0.5	11.8	5.62
	8	0.20	0.25	0.5	1.6	49.8	21.5
	9	0.30	0.32	0.5	1.4	31.7	35.5
	10	0.18	0.42	0.61	3.9	4.27	12.2
	11	-	0.47	0.81	4.24	-	13.6
	12	-	21.2	2.92	10.7	-	4.57
Cl (mg/L)	1	-	26	60	31	-	155
	2	20	21	55	26	-	132
	3	20	20	35	22	-	112
	4	15	25	35	-	100.5	50
	5	20	20	37	25	45	122
	6	11	21	71	45	117	50
	7	15	17.5	65.3	48	123	63
	8	10	10	15	40	55	84
	9	15	15	20	45	51	75
	10	10	20	15	30	40	60
	11	-	15	20	30	-	65
	12	-	15	35	25	-	35

source : Ministry of Irrigation (1994)

Table C-4.9 (1/4) Syrian Drinking Water Standards

1. Microbiological Aspects

1-1. The Bacteriological Aspects

No.	Organisms	Unit	Maximum Permissible Limit	Remarks
General Conditions				
1	Total coliform bacteria	colony/100 mL	0	at 37 °C after 24-48 hours.
2	Faecal stepto cocci	colony/100 mL	0	at 37 °C after 24-48 hours.
3	Faecal coliform	colony/100 mL	0	at 44 °C after 24-48 hours.
4	Total bacteria count	colony/100 mL	200 or 2000	at 37 °C after 24 hours, or at 22 °C after 72 hours.
5	Free residual chlorine	mg/L	0.2 - 0.4	between the beginning to the end of network after at least 30 minutes contact time.
Emergency Conditions				
1	Total coliform bacteria	colony/100 mL	10	at 37 °C after 24-48 hours.
2	Faecal strepto cocci	colony/100 mL	0	at 37 °C after 24-48 hours.
3	Faecal coliform	colony/100 mL	0	at 44 °C after 24-48 hours.
4	Total bacteria count	colony/100 mL	200	at 37 °C after 24 hours.
5	Staphylo cocci pathogenes	colony/100 mL	0	
6	Salmonella	colony/100 mL	0	
7	Free residual chlorine	mg/L	0.5	At the end of network after at least 30 minutes contact time.

1-2. The Virological Aspects for Drinking Water

Driking water must be free from viruses (0/10) bacteriophages.

Table C-4.9 (2/4) Syrian Drinking Water Standards

2. Another Microbiological Aspects

Drinking water must be free from:

(1) Protozoa.

(2) Helminths (and phases).

(3) Free living organisms (algae fungi, plankton, snails, water fleas, ...).

3. Chemical and Physical Aspects

3-1. Health Relaed Inorganic Constituents

No.	Constituent	Symbol	Unit	Maximum Permissible Limit	Remarks
1	Arsenic	As	mg/L	0.01	
2	Cadmium	Cd	mg/L	0.005	
3	Total chromium	Cr	mg/L	0.05	
4	Cyanide	CN	mg/L	0.05	
5	Lead	Pb	mg/L	0.01	
6	Mercury	Hg	mg/L	0.001	
7	Selenium	Se	mg/L	0.01	
8	Molybdenum	Mo	mg/L	0.07	
9	Barium	Ba	mg/L	0.1	
10	Nickel	Ni	mg/L	0.2	
11	Fluoride	F	mg/L	1.5 0.7	From 8 - 12 °C. From 15 -30 °C.
12	Boron	B	mg/L	0.3	Provided that it is free of bacteria.
13	Ammonia	NH_4^+	mg/L	0.05	Provided that it is free of bacteria.
14	Nitrite	NO_2^-	mg/L	0.01	Estimated as N.
15	Nitrate	NO_3^-	mg/L	10	Estimated as N.
16	Phosphate	PO_4^{3-}	mg/L	0.5	
17	Chemical Oxygen Demand	COD	mg/L	2	
18	Iodine	I	mg/L		Under reserach.
19	Antimony	Sb	mg/L	0.005	

Table C-4.9 (3/4) Syrian Drinking Water Standards

3-2 Health Related Organic Constituents

No.	Constituent	Unit	Maximum Permissible Limit	Remarks
Chlorinated alkanes				
1	1,2-dichloroethane	μg/L	10	
2	carbontetrachloride	μg/L	2	
Chlorinated ethanes				
1	1,1-dichloroethene	μg/L	30	
2	1,2-dichloroethene	μg/L	50	
3	tricholoroochtene	μg/L	30	Guideline value.
4	trtrachloroethene	μg/L	10	Guideline value.
5	vinyl chloride	μg/L	5	Guideline value.
Pesticides				
1	D.D.T.	μg/L	1	
2	chlordane	μg/L	0.2	
3	hexachlorobenzene	μg/L	0.01	
4	heptachlor epoxide and heptachlor	μg/L	0.1	
5	lindane	μg/L	2	
6	methoxy chlor	μg/L	20	
7	2,4-D	μg/L	30	
8	aldrin/dieldrin	μg/L	0.03	
Chlorophenols				
1	2,4,6-trichloropheonl	μg/L	10	
2	pentachlorphenol	μg/L	10	Guideline value.
Benzenes				
1	benzene	μg/L	10	
2	detergents	μg/L	200	
Trihalomethane				
1	chlorform	μg/L	30	
Polynuclear Aromatic Hydrocarbons				
1	sum of PAHs	μg/L	0.2	
2	benzo-3,4-pyrene	μg/L	0.01	

Table C-4.9 (4/4) Syrian Drinking Water Standards

3-3 Aesthetic Aspects for Drinking Water

No.	Constituents	Symbol	Unit	Maximum Permissible Limit	Remarks
1	pH	pH		6.5 - 8.5	Preferably pH < 8.0 for effective disinfection.
2	Color	mg/L (Pt)	mg/L	15	
3	Taste / Odor			acceptable	
4	Temperature	T	°C	5 - 25	
5	Turbidity	Tur	NTU	5	Preferably < 1 NTU for effective disinfection.
6	Conductivity	Cond	μS/cm	1500	
7	Total Dissolved Oxygen	TDS	mg/L	1000	
8	Total Hardness	TH	mg/L	500	
9	Sulfate	SO_4	mg/L	250	
10	Chloride	Cl	mg/L	250	
11	Sodium	Na	mg/L	200	
12	Manganese	Mn	mg/L	0.1	
13	Iron	Fe	mg/L	0.3	
14	Copper	Cu	mg/L	1	
15	Aluminum	Al	mg/L	0.2	
16	Zinc	Zn	mg/L	3	
17	Hydrogen Sulfide	H_2S	mg/L	-	
18	Phenols		μg/L	0.5	
19	Free residual Chlorine				

4. Radioactive Constituents

No.	Constituents	Symbol	Unit	Maximum Permissible Limit	Remarks
1	Gross alpha acivity		Bq/L	0.1	if > 0.1 Bq/L, detailed radionuclide analysis is nesssesary
2	Gross beta activiy		Bq/L	1	Higher value does not necessarily mean the water is unusable.
3	Radium	^{226}Ra	Bq/L		Under research.
4	Strontium	^{90}SR	Bq/L		Under research.

Table C-4.10 Proposed Ambient Air Quality Standards

Name	Symbol	Standard	Ave. Period
carbon monooxide	CO	87 ppm	10 minutes
		52 ppm	30 minutes
		26 ppm	1 hour
		9 ppm	8 hours
ozone	O_3	0.07-0.1 ppm	1 hour
		0.05-0.06 ppm	8 hours
nitrogn dioxide	NO_2	0.21 ppm	1 hour
		0.07 ppm	24 hours
sulfur dioxide	SO_2	0.044 ppm	10 minutes
		0.031 ppm	1 hour
carbon sulfide	CS_2	32 ppm	24 hours
dichloroethane	$C_2H_4Cl_2$	0.17 ppm	24 hours
dichloroethene	CH_2Cl_2	0.20 ppm	24 hours
trichloroethene	C_2HCl_3	0.55 ppm	24 hours
	$CH_3C_6H_5$	2.12 ppm	24 hours
tetrachloroethene	C_2Cl_4	0.73 ppm	24 hoours
aldehyde	HCHO	83 ppm	30 minutes
hydrogen sulfide	H_2S	150 $\mu g/m^3$	24 hours
lead	Pb	0.5-1 $\mu g/m^3$	1
mercury	Hg	1 $\mu g/m^3$	1
cadmium	Cd	1-5 $\mu g/m^3$	1
		10-20 $\mu g/m^3$	1
manganese	Mn	1 $\mu g/m^3$	1
vanadium	V	1 $\mu g/m^3$	1
total suspended particulate	TSP	120 $\mu g/m^3$	24 hours
particulate < 10 μm	PM_{10}	70 $\mu g/m^3$	24 hours
smoke	smoke	125 $\mu g/m^3$	24 hours
		50 $\mu g/m^3$	1
	SO_2	125 $\mu g/m^3$	
		50 $\mu g/m^3$	

source : Ministry of State for the Environment Affairs, 1997

Table C-4.11 Syrian Guidelines for Discharge of Industrial Wastewater to Sewer (Draft)

Pollutant	Unit	Category 1	Category 2	Category 3
dilution	24 hours	< 1/400	1/400 - 1/200	> 1/200
pH	-	7.5 - 9.5	7.5 - 9.5	5.5 - 9.5
TSS	mg/L	500	600	600
BOD	mg/L	1000	600	500
N	mg/L	150	150	150
Temp.	°C	45	35	35

Category 1, 2 ,3 :

Pollutant	Standard	Pollutant	Standard
SS after 10 min. settling	5 cm^3/l	Mercury	0.01 mg/l
SS after 30 min. settling	10 cm^3/l	Nickel	5.0 mg/l
S	1 mg/l	Selenium	1.0 mg/l
SO_4	1000 mg/l	Ag	5.0 mg/l
NH_3	150 mg-N/l	Zinc	10 mg/l
PO_4	60 mg/l	CN	0.5 mg/l
oil and fat	100 mg/l	phenol	0.5 mg/l
solid	1 cm diameter	COD	2000 mg/l
Arsenic	0.1 mg/l	TDS	2000 mg/l
Barium	3.0 mg/l	chloride	600 mg/l
Boron	2.0 mg/l	fluoride	8 mg/l
Cadmium	0.5 mg/l	pesticide	0.005 mg/l
Total Chromium	4.0 mg/l	total toxic subst.	30 mg/l
Copper	1.0 mg/l	explosives, flammables	non
Lead	5.0 mg/l	radioactives	non
Copper	1.0 mg/l	radioactives	non

source : Ministry of State for Environment Affairs, 1996

Table C-4.12 (1/4) Scoping List

Project : DMA, Construction Stage

	EIA	reasons
Social Environment		
1) Resettlement	×	- the chambers are small in size, installed under existing roads, and the construction work is minor. No translocation or resettlement is expected.
2) Local Socio-Economy	×	- the chambers are small in size, and construction work is minor. The impact to local socio-economy will be small.
3) Transportation	×	- because the chambers are constructed under roads, the construction works may temporarilly affect traffic. However, the works will be done in a day or two, and major traffic problem is not expected.
4) Social Isolation	×	- no social isolation problem is anticipated.
5) Cultural Assets	○	- although the chambers are constructed under existing roads, it is important to design the work so that the environmental impact of the construction work is minimized.
6) Public Health	×	- as long as the construction is done properly, there is no change in water quality.
7) Waste	×	- the excavated soil will be properly disposed of by contractors.
Natural Environment		
8) Geology, Topology	×	- there will be no major change in topology
9) Climate	×	- the project will not change the climate
10) Hydrology	×	- the construction work will be limited to a few meters from the surface, and there will be no major change in groundwater flow.
11) Flora and Fauna	×	- the area has been already urbanized, and there is no important flora and fauna.
12) Landscape	×	- the construction work will be limited, and will not affect the landscape.
Pollution		
13) Air Pollution	×	- the construction activities are minor.
14) Water Pollution	×	- the construction will not lead to significant water pollution.
15) Soil Pollution	×	- no pollutant is involved in the operation.
16) Noise and Vibration	×	- the construction activities are minor.
17) Subsidence	×	- the work does not involve massive abstraction of groundwater.
18) Odor	×	- no odor source will be present

○: the impact is considered significant, and further EIA is to be carried out.

×: the impact will be small

Table C-4.12 (2/4) Scoping List

Project : DMA, Operation stage

	EIA	reasons
Social Environment		
1) Resettlement	×	- no translocation is expected because the DMA will be installed underground.
2) Local Socio-Economy	×	- DMAwill be installed underground. No impact to local socio-economy is anticipated.
3) Transportation	×	- the project will not affect the traffic because the water mains will be buried underground
4) Social Isolation	×	- the project will not affect the traffic because the water mains will be buried underground
5) Cultural Assets	×	- the impact is to be assessed in the construction stage
6) Public Health	○	- the quality of supplied water has to be closely monitored
7) Waste	×	- no waste will be produced once the system is installed
Natural Environment		
8) Geology, Topology	×	- there is no large-scale change in topology
9) Climate	×	- the project will not affect the local climate
10) Hydrology	×	- although leakage will be reduced, the overall quantity of water released to the environment will not change.
11) Flora and Fauna	×	- the area has been already urbanized, and there is no important flora and fauna.
12) Landscape	×	- the system will be buried underground, and it will not change landscape
Pollution		
13) Air Pollution	×	- there is no source of air pollution in the operation stage.
14) Water Pollution	○	- the amount of wastewater is expected to increase.
15) Soil Pollution	×	- there is no source of air pollution.
16) Noise and Vibration	×	- there is no source of noise or vibration problems.
17) Subsidence	×	- no abstraction of large quantity of water is involved.
18) Odor	×	- no odor source will be present

○: the impact is considered significant, and further EIA is to be carried out.

×: the impact will be small

Table C-4.12 (3/4) Scoping List

Project : Informal Area, Construction Stage

	EIA	reasons
Social Environment		
1) Resettlement	×	- water mains will be installed under roads, and the proposed water supply project will not directly result in a resettlement problem. - it is important to remember, however, the city has a master plan to develop informal areas. At this point no concrete rezoning plan is available.
2) Local Socio-Economy	○	- impact of the construction activities to the daily life of the local residents shall be assessed.
3) Transportation	○	- some roads may be blocked by the construction work
4) Social Isolation	×	- the construction work will be contained in small area, and social isolation due to the construction work will be minimal.
5) Cultural Assets	×	- there is no important cultural asset in the area
6) Public Health	×	- as long as the construction is done properly, there is no change in water quality.
7) Waste	×	- excavated soil will be disposed properly by contractors.
Natural Environment		
8) Geology, Topology	×	- there is no large-scale change in topology
9) Climate	×	- the project will not affect the local climate.
10) Hydrology	×	- because the mains are buried only a few meters from the surface, the project is not a threat to the groundwater resources.
11) Flora and Fauna	×	- the area has been already urbanized, and there is no important flora and fauna.
12) Landscape	×	- the construction activites will be minor, and will not change the landscape significantly.
Pollution		
13) Air Pollution	×	- the release of air pollutants from the construction machineries are not siginificant
14) Water Pollution	×	- construction will not lead to water pollution
15) Soil Pollution	×	- no pollutant is involved in the operation
16) Noise and Vibration	○	- the construction work may create noise and vibration problems
17) Subsidence	×	- the work does not involve massive abstraction of groundwater.
18) Odor	×	- no odor source will be present

○: the impact is considered significant, and further EIA is to be carried out.

×: the impact will be small

Table C-4.12 (4/4) Scoping List

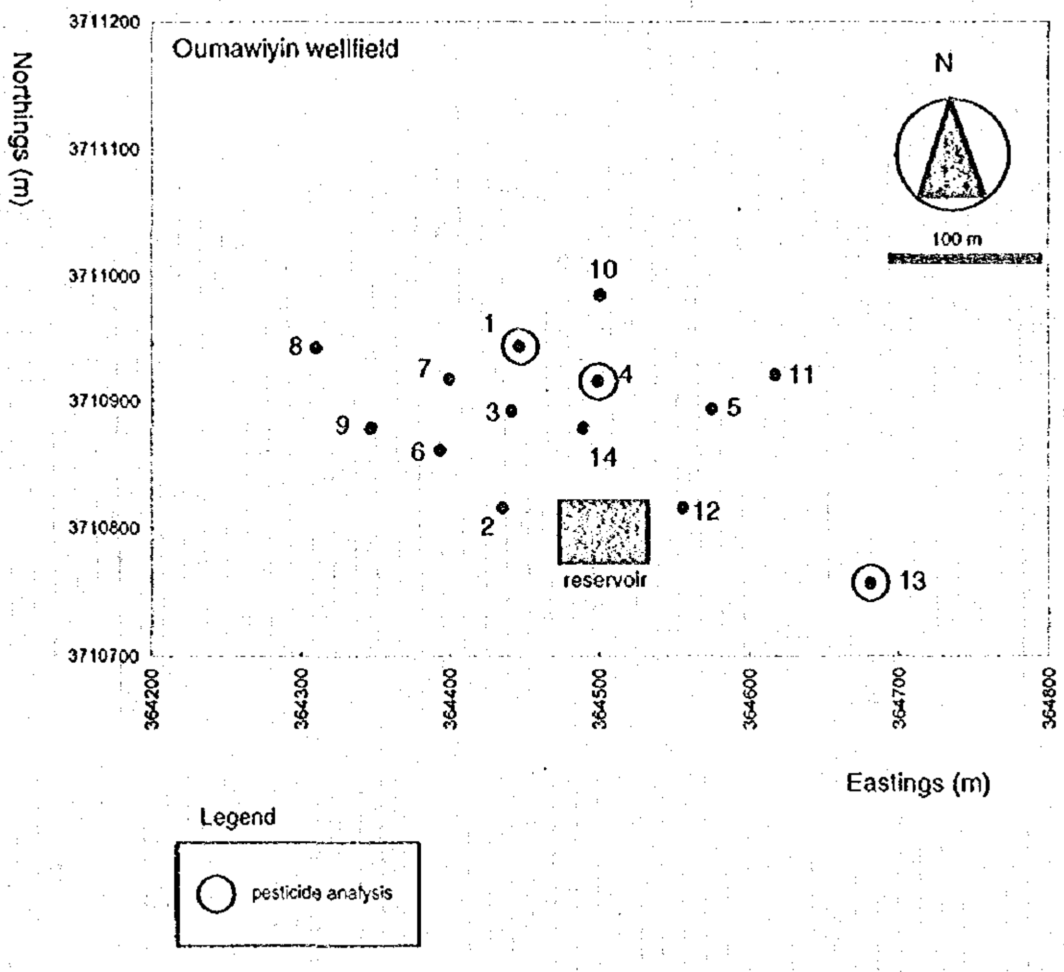
Project : Informal Area, Operation Stage

	EIA	reasons
Social Environment		
1) Resettlement	×	- no translocation is expected because the water mains will be buried underground
2) Local Socio-Economy	O	- people have to pay the tariff for water supply
3) Transportation	×	- the project will not affect the traffic because the water mains will be buried underground
4) Social Isolation	×	- the project will not affect the traffic because the water mains will be buried underground
5) Cultural Assets	×	- there is no important cultural asset in the area
6) Public Health	O	- safe drinking water will become available for the people in the area - the quality of supplied water has to be closely monitored
7) Waste	×	- no waste will be produceded in operation stage
Natural Environment		
8) Geology, Topology	×	- there is no large-scale change in topology
9) Climate	×	- the project will not affect the local climate
10) Hydrology	×	- because the mains are buried only a few meters from the surface, the project is not a threat to the groundwater resources.
11) Flora and Fauna	×	- the area has been already urbanized, and there is no important flora and fauna.
12) Landscape	×	- the system will be buried underground, and it will not change landscape
Pollution		
13) Air Pollution	×	- there is no source of air pollution in the operation stage.
14) Water Pollution	O	- the amount of waste water is expected to increase.
15) Soil Pollution	×	- there is no source of air pollution.
16) Noise and Vibration	×	- there is no source of noise or vibration problems.
17) Subsidence	×	- no abstraction of large quantity of water is involved.
18) Odor	×	- no odor source will be present

O: the impact is considered significant, and further EIA is to be carried out.

×: the impact will be small

FIGURES



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

Figure C-2.1
Location Map of Oumawiyin Wellfield

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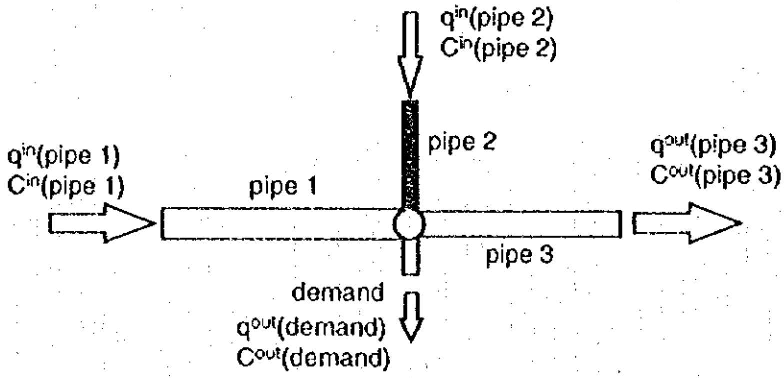

Mass Balance of Pollutant

$$q^{in}(\text{pipe 1})C^{in}(\text{pipe 1}) + q^{in}(\text{pipe 2})C^{in}(\text{pipe 2}) = q^{out}(\text{pipe 3})C^{out}(\text{pipe 3}) + q^{out}(\text{demand})C^{out}(\text{demand})$$

where q : flow rate (l/sec)
C : concentration (mg/l)

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

Figure C-2.2
Hypothetical Pipe Network

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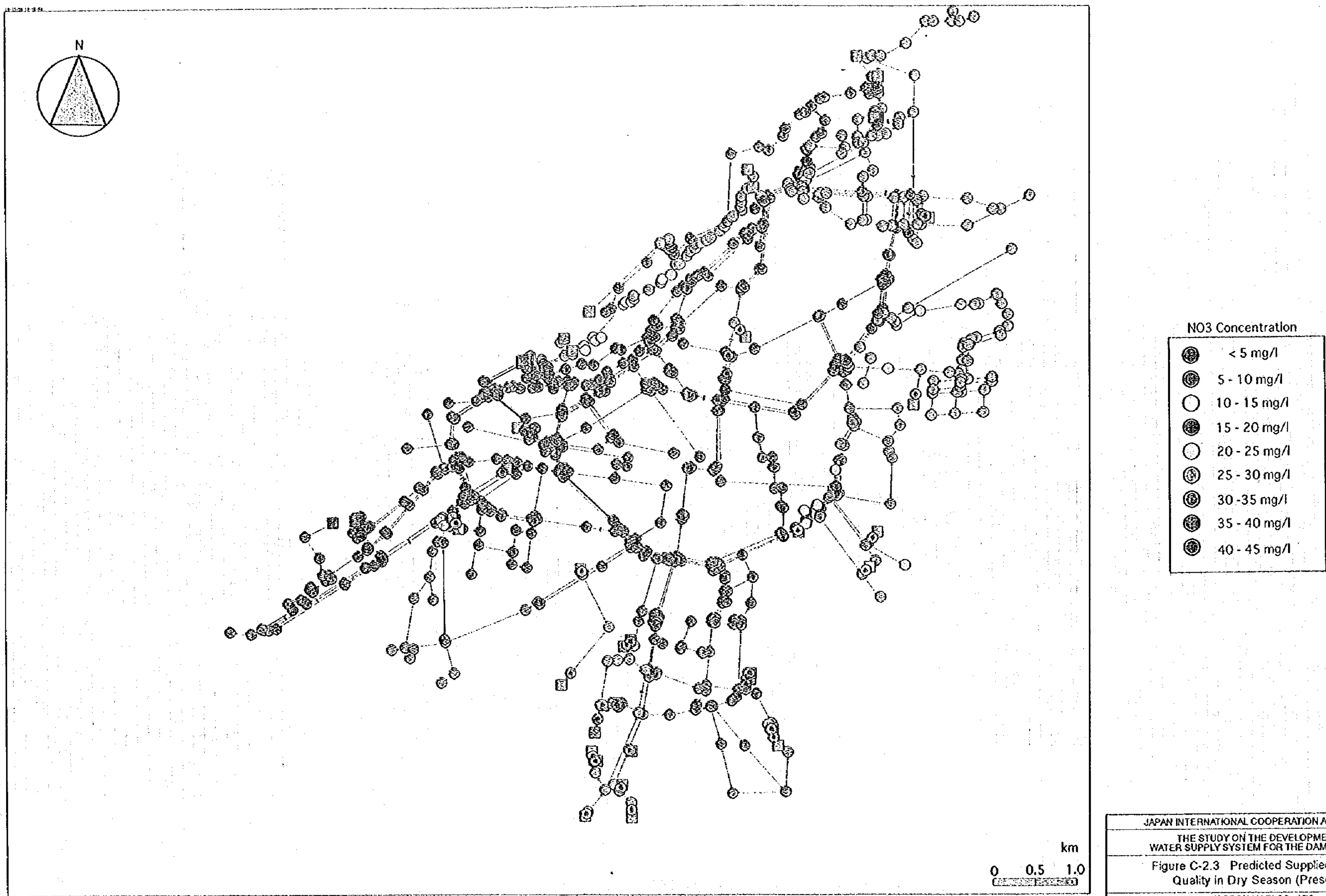

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THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure C-2.3 Predicted Supplied Water Quality in Dry Season (Present)

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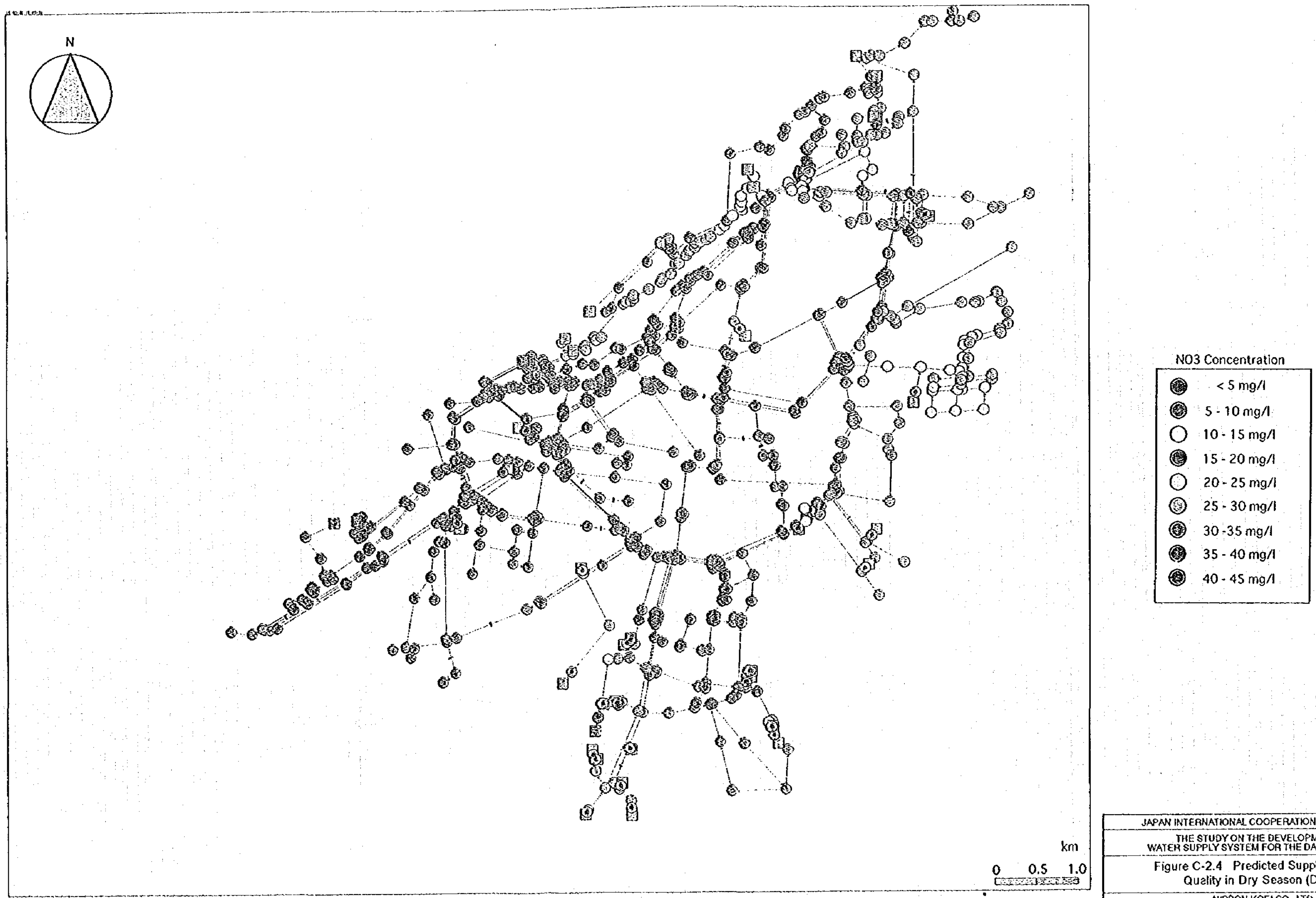

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THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure C-2.4 Predicted Supplied Water Quality in Dry Season (DMA)

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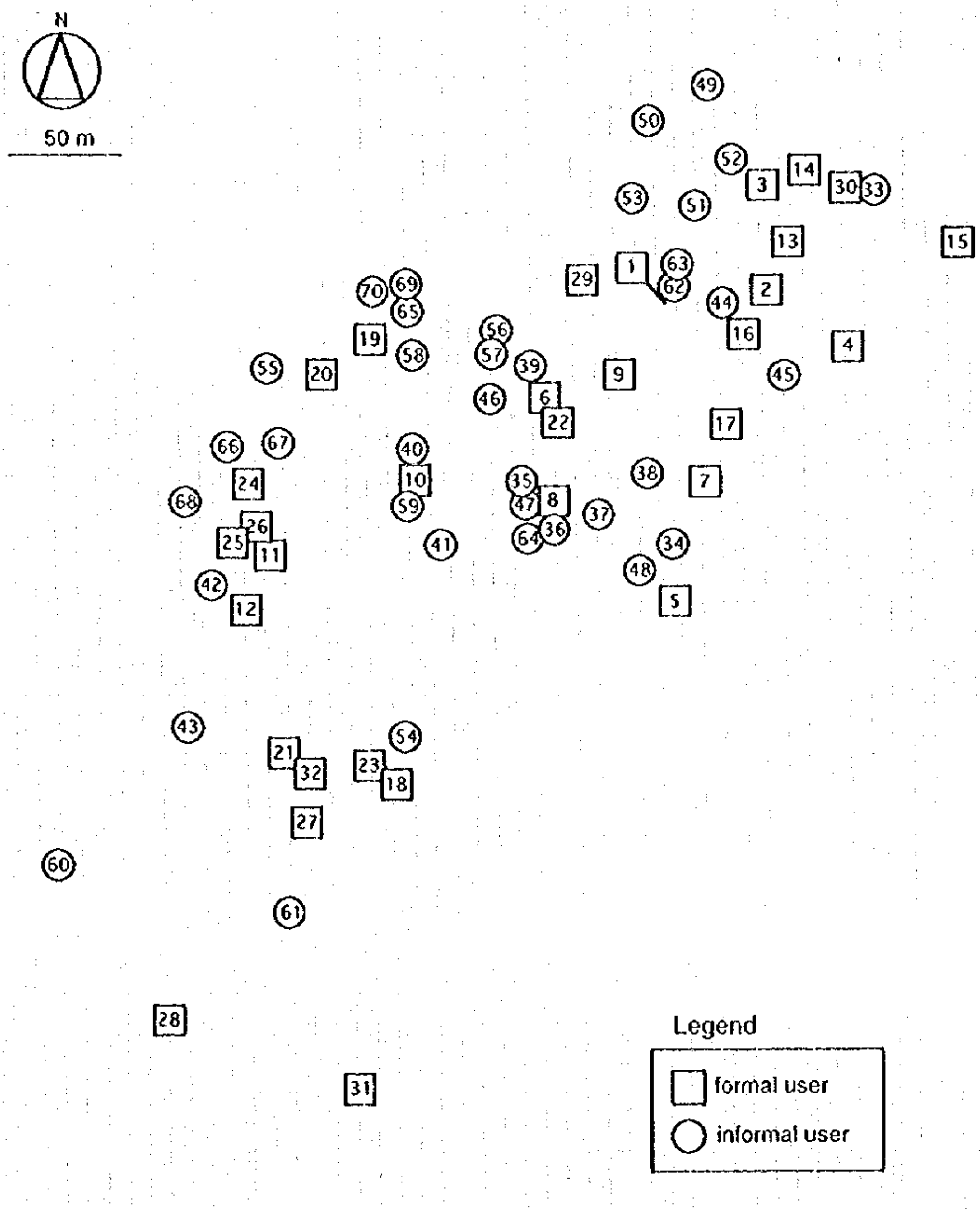

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THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure C-3.1(1/2) Location Map of Interviewees (Mezze-Razy)

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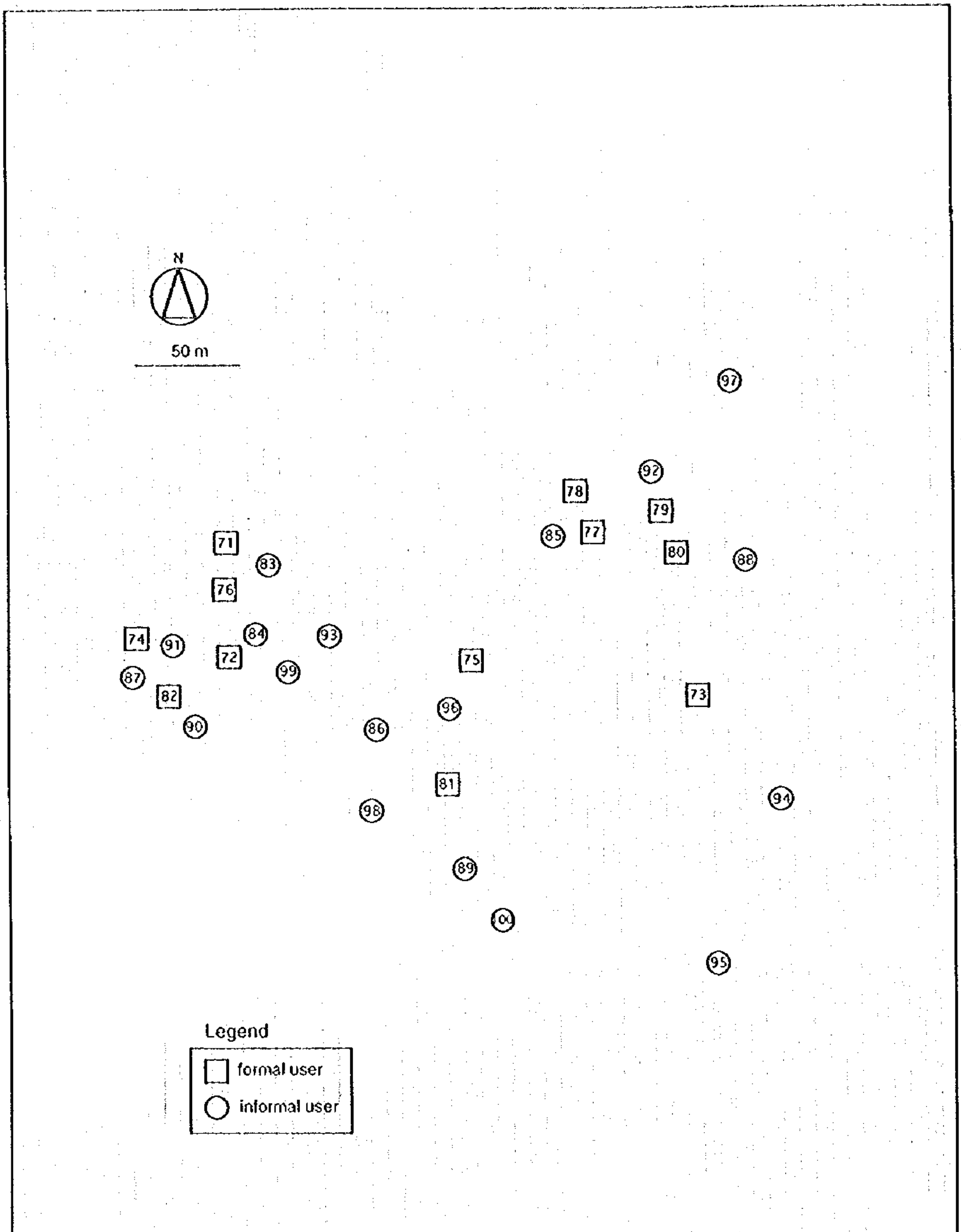

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THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure C-3.1(2/2) Location Map of Interviewees (Kafar Souseh-Lawan)

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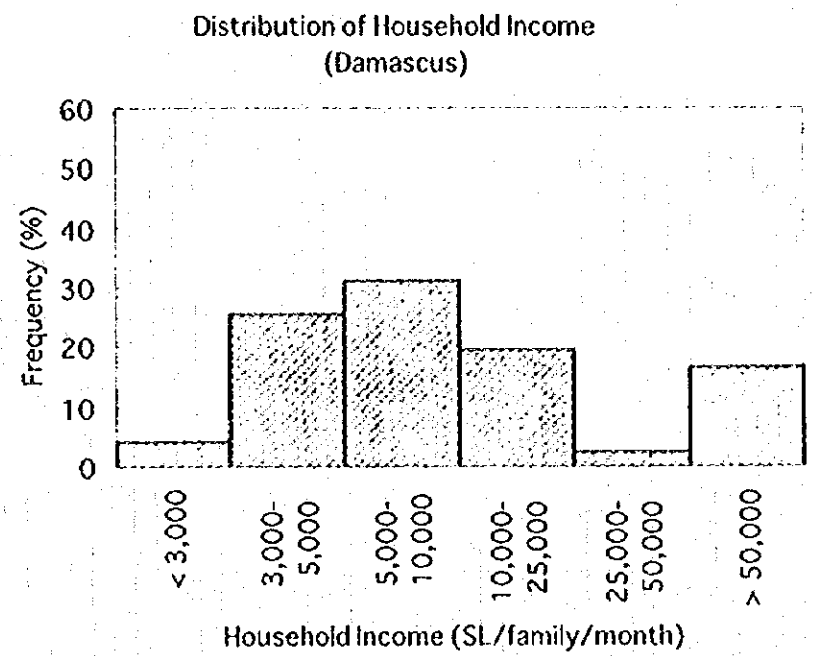

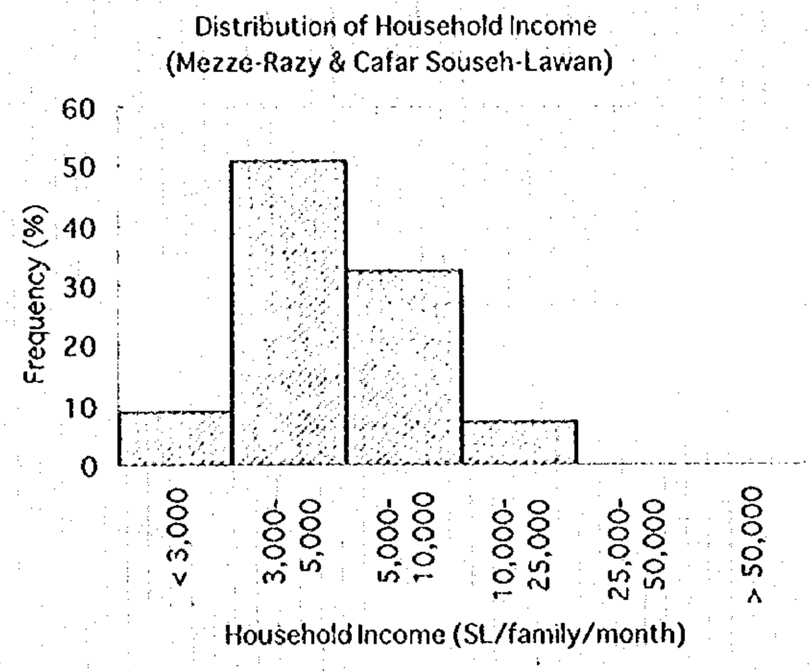

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Figure C-4.1
Distribution of Household Income

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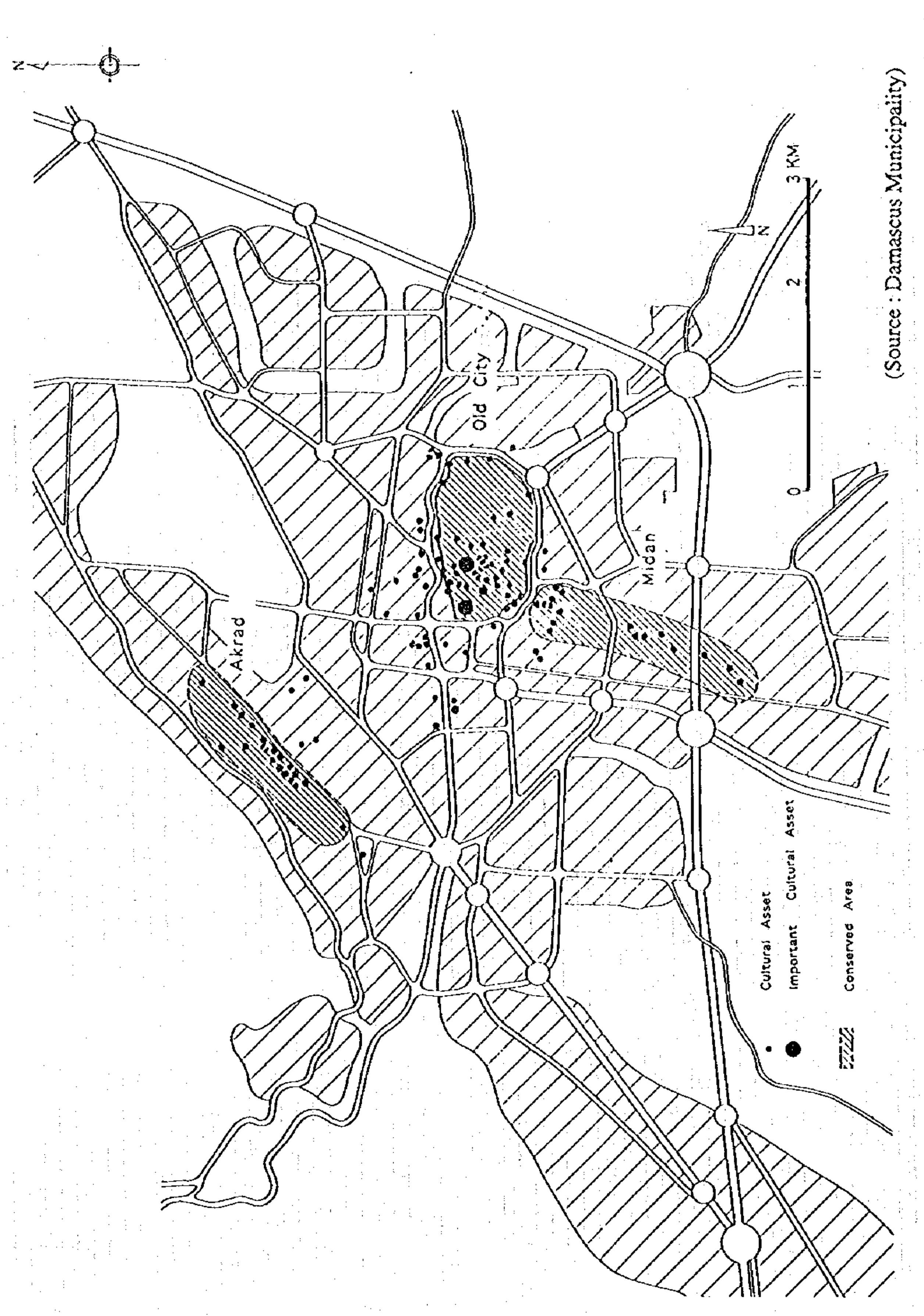

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Figure C-4.2
Important Cultural Assets in Damascus

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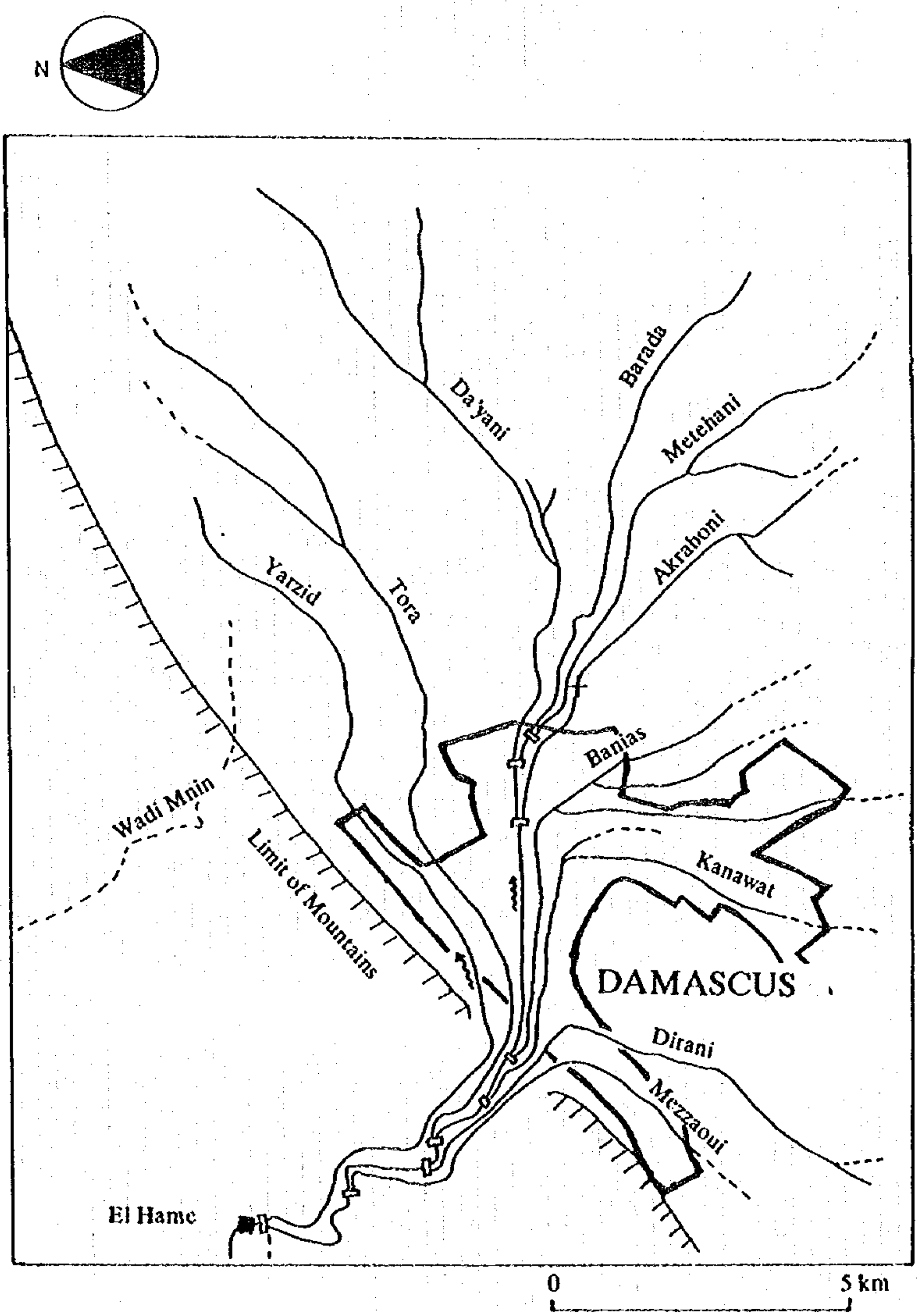

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Figure C-4.3 Major Hydrological Network in Damascus Basin

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APPENDIX D

ECONOMIC AND FINANCIAL EVALUATION

APPENDIX D
ECONOMIC AND FINANCIAL EVALUATION

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1. ECONOMIC INTERNAL RATE OF RETURN (EIRR)

1.1 General

The economic evaluation of the Damascus water supply improvement project is made on the basis of the economic internal rate of return (EIRR). The two main components of the EIRR analysis are 1) economic cost and 2) economic benefit. Each component is discussed separately in the sub-sections that follow.

All costs and benefits are estimated in US$ at constant 1997 economic prices excluding taxes and duties. The DMA, and distribution improvement works in the Mezze-Razy & Kafar Souseh-Lawan system are evaluated as two separate projects. The DMA projects will reduce the amount of leakage resulting in a net increase in the amount of water available for sale. This incremental water is evaluated using the Unit Cost of Leakage (UCL) which reflects expected cost savings in annual operations and deferred capital expenditures over the 30-year life of the project. The extension of the distribution system into informal areas will increase the number of metered consumers. These works are evaluated on the basis of customers' capacity to pay and estimated savings in health costs attributable to the project.

1.2 Costs

The capital costs of the proposed investment in the Damascus water supply system are summarized in terms of economic costs in Table D-1.2. The estimated project construction costs are converted to the economic costs by applying the shadow exchange rate (50SL=1US$) to the local cost components excluding taxes and duties. Economic costs include engineering, administration and contingency allowances. Replacement capital costs for the DMA project have been included every 15 years for leakage detection and master flow metering equipment. Assets are assumed to have no residual value at the end of their useful economic life.

Incremental operational and maintenance costs are also estimated on the "with" and "without" project basis and include related increases in staffing, materials and electricity. The incremental O&M costs for the distribution network in Mezze-Razy & Kafar Souseh-Lawan informal area is assumed to be negligible. Incremental costs for leakage detection crews and DMA flow monitoring are estimated at $32,000 per year starting in 2001, one year after the first stage of the DMA system is implemented. An allowance is made to increase the spending levels for leakage repairs and network maintenance since the DMA system is expected to increase the number of leaks detected. The current spending level is estimated at approximately $350,000 US per year. This amount is increased by a total of 70% over the 7 year DMA implementation period to provide a total of $600,000 US per year by the year 2007. This new level of spending represents approximately 0.5% of the total estimated network replacement value of $1,200,000 (1,200km x $100/km) which is considered within the normal range adopted by most utilities to adequately protect their existing investment in infrastructure.

1.3 Benefits

The benefits of the project are reduced leakage losses, improved cash flow and a safe and dependable water supply for 50,000 residents in the Mezze-Razy & Kafar Souseh-Lawan area with related health benefits. Implementation of the project will increase water available for consumption in all of DAWSSA`s service areas as a result of reduced leakage. This increase of water available for consumption, the reduction in operating expenses and the savings from deferred capital spending are important sources of economic benefit for DAWSSA.

The principle benefits of the distribution into Mezze-Razy & Kafar Souseh-Lawan area are: (1) public health benefits through a reduction in waterborne and water related diseases; and (2) incremental revenue from the sale of water to informal residents. The main benefit of the DMA project is the incremental revenue from water saved due to the expected reduction in leakage. These benefits are discussed separately in the following sub-sections.

1.3.1 Incremental Water Sales

The incremental water delivered is estimated on a "with" and "without" project basis. In the "with" project case, the projected water delivered is presented on an annual basis in Table D-1.1. The difference between the "with" and "without" project cases represents the incremental water delivered to the consumer which will be generated by the proposed DMA project. In the case of distribution improvements in the informal areas, the incremental water is the amount of water that is now consumed through informal connections in the Mezze-Razy & Kafar Souseh-Lawan areas.

1.3.2 Public Health Benefits

Significant public health benefits are expected from the extension of the distribution network into informal areas. However, these are difficult to quantify with any certainty because basic health statistics on the incidence of water borne disease are unavailable. The household surveys conducted in 1996 and in 1997 by the JICA study team identified a very low incidence of waterborne diseases in the survey sample. However, it is important to note that the sample sizes where very small and the results are likely subject to under reporting since most people do not seek medical attention or may not be aware of what is causing milder cases of diseases. Although most residents in the informal areas have access to potable water through informal connections, these connections are subject to contamination from the surface drainage of wastewater. Based on experience in other countries with similar informal urban developments it is highly likely that many water borne diseases (e.g. typhoid, hepatitis, dysentery, gastroenteritis, cholera and others) are prevalent in these informal areas. These are likely to be the source of considerable distress, and hardship to the informal residents.

The project can significantly improve living conditions therefore it is useful to establish an order of magnitude estimate for the economic costs of an inadequate water supply. In the absence of data, an estimate of costs & benefits is prepared based on the results of an economic evaluation carried out for a study area with similar socio-economic conditions (Baku water supply system study - World Bank 1995).

The quantification of health benefits is based on estimates of the economic loss related to the incidence of water borne diseases under two main headings: (a) Value of lost production time due to illness; and (b) Economic cost of medical treatment. The economic loss due to premature death is ignored in this study because the population in the study area is relatively small and the incidence of death related to waterborne disease would have an insignificant effect on economic costs. The economic cost calculation parameters are expressed as follows:

Total Economic Loss (TEL) = Cost of productive time due to illness (CTI) + Cost of medical expenses (CME)

CTI = BP x EAP x MBwd x ADwd x Wd

CME = BP x MBwd x Mf x ACME

where:

BP= benefiting population estimated at 50,000.

EAP= economically active population estimated as 50%,

Mbwd= morbidity rate attributable to waterborne and water related diseases, assumed incidence of 120 per 1000 population

Mf= morbidity factor defined as the average annual number of occasions ill with waterborne or water related diseases (mild = 3 per year, serious = 1 per year)

ADwd= average number of days lost due to illness from waterborne or water related diseases, estimated at 10 days for more serious reported cases.

Wd= average daily wage assumed to be US$ 1 per day for low-income wage earners.

ACME= average cost of medical expenses for incidence of waterborne and water related diseases (mild = US$ 2 per case, and serious = US$ 30 per case)

The estimated CTI costs are $30,000 and the CME costs are $216,000 resulting in a total economic loss of $246,000 per year attributable to waterborne diseases in the informal population of Mezze-Razy & Kafar Souseh-Lawan. The economic analysis assumes that only

50% of the health costs (i.e. $123,000 per year) will be savings attributable to the project since the absence of proper sanitary drainage will likely continue to be the source of health problems.

1.3.3 Benefits of Reduced Leakage

The benefit of undertaking leakage control is the effect upon the expected costs of supplying water due to the change in demand brought about by a change in leakage. Past expenditure cannot be affected by a change in demand and is therefore irrelevant to the analysis. This change in costs, which is considered a saving resulting from reduced leakage, consists of two components:

(a) a reduction in annual operating costs, and
(b) a deferment of demand-related schemes effecting a reduction in the programmed capital investment

The procedure for calculating the cost savings is based on guidelines published by the British National Water Council, Department of the Environment, Standing Technical Committee report number 26, "Leakage Control Policy and Practice". The cost reductions are expressed as a unit amount (SL/m^3) referred to as the unit cost of leakage.

(1) Operating costs

a) Sources of supply

The first step is to determine the sources of water supply where output would be reduced if demand decreased (through leakage detection efforts). Relevant annual operating costs depend upon the amount of water, which is actually supplied and consists of:

(i) Pumping at wells
(ii) Boosting to reservoirs
(iii) Water treatment (chlorinating)

In order to select which of the above costs should be included in the cost of leakage it is necessary to determine at which of the present sources output would be reduced if demand were to decrease. A reduction in leakage will then cause a reduction in the annual operating costs incurred at these sources. The unit operating cost of leakage is the reduction in these costs expressed per unit reduction in demand. In DAWSSA's case, reductions will be achieved at more than one source therefore the unit operating cost is the average of these individual costs suitably weighted by the proportions of the reductions in demand achieved at each source.

The costs incurred at those sources of supply where savings would be made, will consist of a fixed element and a variable element. The fixed element, e.g. labor, maintenance, maximum demand charge will, for practical purposes, be incurred independently of the quantity of water supplied and therefore is irrelevant to the unit cost of leakage. Only the variable elements of the costs e.g. electricity for pumping will increase as the amount of water supplied increases.

A diagrammatic sketch of the simplified water supply and distribution system is shown in Figure E-3.6 of Appendix E in the Master Planning Study (JICA 97). The main Figeh spring flows naturally from March to May and is the only source of supply required for meeting the demand during these months. From June to February water is pumped from Figeh main and side spring, Ain Haroush, Deir Moukaren and Barada springs. These sources are used to supply the base demand. The eight production wells-fields in Damascus are operated to meet changing demands and supply the main network when water from Figeh and Barada is insufficient to meet the demand. Fringe wells operate continuously all year round to supply smaller isolated areas along the peripheral boundary of the water distribution network where there is often insufficient flow to meet the demand. Production at these wells cannot be reduced until the network is reinforced to provide water supply from other main sources therefore fringe wells are not included in the economic analysis of costs and benefits.

b) Unit pumping costs

Pumping and boosting costs are considered together as both of these costs are incurred in a similar fashion. The figure required for economic analysis is the reduction in costs that would be achieved if supply where decreased and therefore it is possible to exclude any pump sets at the pumping stations where output is relatively constant. It is only those pump sets the output of which would be reduced that will affect the costs and are therefore relevant.

Having identified the relevant pump sets it is necessary to determine the energy they consume and the amount of water they pump. These quantities are available from DAWSSA records for 1995 operations, and are identified in Tables D-3.3, D-3.7, and D-3.8 of the Master Plan (JICA-1997). The remaining element of pumping costs is the cost of the energy consumed. Government heavily subsidizes the cost of electricity in Syria and DAWSSA pays at the lowest rate of 1.5 SL per kw.hr because it is a government agency.

unit pumping cost (SL/Kw.hr) = power input (Kw.hr) x electrical tariff (SL/Kw.hr) ÷ water supplied (m3/hr)

Current economic forecasts predict that electrical costs will increase at a rate higher than the general rate of inflation. Therefore an allowance is made for this increase in real costs by multiplying the unit pumping cost by the inflation multiplier as calculated from the formula:

inflation multiplier = discount rate ÷ (discount rate - differential inflation rate)

The discount rate is assumed to be 10% and the differential inflation rate is assumed to be 5% giving an inflation multiplier of 2. Pumping costs for the main source of supply (i.e. Figeh including Ain Haroush, Deir Moukaren, and Barada springs) are identified in Table D-1.5. The operating cost per unit for these sources is 0.30 SL per m^3.

Pumping costs for the 8 production well-field sites in Damascus are based on DAWSSA's 1995 records providing total annual electrical consumption and water production. The electrical consumption shown in Table D-1.6 is the sum of the energy consumed for pumping at the well site and for boosting the water into the distribution network and reservoirs.

Costs for boosting water at pumping stations located at the four main service reservoirs are identified in Table D-1.7. Although records are available for total electrical consumption, the quantity of water pumped at each station is not recorded. Therefore the costs are derived from individual pump ratings using power (kW) and capacity (m3/h) identified in the inventory of pumping equipment provided in the Master Plan (JICA 1997, Table E3.7). Where multiple pumps of different unit operating are installed, costs are based on a weighted average according to the number of pumps in operation.

c) Unit treatment costs

Treatment costs are relatively simple to obtain since the only variable for DAWSSA is the cost for chlorinating. This cost varies in direct proportion to the quantity of water supplied. The unit cost of treatment is calculated from the formula:

unit treatment cost (SL/m^3) = chlorine (Kg) x unit cost (SL/Kg) ÷ quantity of water (m^3)

Most recently available accounting figures show that in 1995, DAWSSA consumed 256,171 kg of chlorine at a cost of 5,442,000 SL. The unit cost of chlorine is therefore approximately 21.24 SL/Kg (US$ 0.48). This unit cost is applied to water supplied from the main spring sources and the eight well sources (Tables D1.5 and 1.6).

d) Calculation of unit operating costs

The unit operating costs for each of the sources of supply whose output would be reduced can the obtained by adding together the appropriate unit pumping and treatment costs. Each part of the system receives water from different sources and from different booster stations. Therefore each part of the system will have a different unit operating cost. The unit operating cost for each part of the system is the average of the sources of supply weighted according to the amount of water supplied by each relevant source in relation to the total water requirement.

The sources of supply for each DMA block are identified in Table D-1.8. The weighting factors for each source of supply are calculated based on the average capacity of each source related to the water demand in m^3/hr for each metering district. In most cases, water from Figeh/Barada is the main source of supply required to meet the demand. The weighting factors derived in Table D-1.8 are used in Table D-1.10 to calculate the total unit operating cost in each district meter area. Where boosting takes place, the unit boosting cost is only applicable to that part of the system located downstream of the booster pumps.

For the purposes of assessing benefits of leakage reduction and water pricing policy the unit cost for the whole system is the average of the individual unit costs, weighted according to the quantity consumed. The average unit operating cost is 2 SL/m^3 as calculated in Table D1.11.

(2) Capital costs

Capital costs are based on the least cost stream for the investment program proposed in the Master Plan (JICA-1997) and is calculated as an 'average' of the investment costs for a number of future years. This method has the advantage of providing DAWSSA with a means of determining appropriate adjustments to the present price of water to make allowances for the cost of water over a number of future years.

The calculation of the unit capital costs element of the unit cost of leakage involves setting out the costs of those capital projects, which will be incurred to satisfy future demands. These costs are then discounted and summed to produce a total discounted capital cost of supplying future demand. The change in this figure brought about by a reduction in supply of one year's growth, when expressed in terms of the magnitude of this change in supply, is the required unit capital cost component of the cost of leakage.

a) Relevant future capital costs

Costs for relevant capital projects are taken from the five year investment plan and from the recent Master Plan (JICA - 1997). The timing of the following types of capital projects would be affected by changes in the demand trend:

(i) source works

(ii) pumping stations

(iii) service reservoirs

(iv) trunk mains

(v) distribution mains reinforcement

A list of capital projects and costs are identified in Table D1.9. Costs for recurring annual capital programs such as the distribution mains reinforcement program are also identified. Some of this annual cost is used for work that could be deferred as a result of a decrease in demand. Therefore costs are entered in the first year only and converted to a total cost by a factor of $(1 + r) \div r = 11$ where "r" is the discount rate of 10%.

Fixed annual operating and maintenance costs should also be included in the capital cost since they will also be deferred. This annual cost should be entered in the year of commissioning of the capital project and converted to a total cost by multiplying by 11. In DAWSSA's case the fixed costs are for maintenance and labor and since these costs are very small they are considered insignificant to the analysis.

Reinforcement projects for Ibn Assaker and Fringe wells cannot be deferred because they are required for dry seasons when the demand cannot be met. These wells would be required even if leakage were reduced, therefore they are not included in the analysis. Wadi Marwan is also not included because it is required to meet the demand of a new development area and leakage reduction will not defer the need for this source.

b) Demand multipliers for each capital project

While most of the projects listed in Table D1.9 will be capable of being deferred in their entirety, some schemes like water main reinforcement and pumping station improvements will not. In this situation only a portion of the appropriate cost of the project is included by using a factor termed the demand multiplier which represents the proportion of the cost which is related to the increases in demand. For new sources, the demand multiplier is 1 since the whole scheme is required to meet demand. In the case of distribution mains and pumping station improvements it is assumed that only 25% of the cost contributes to an increase in capacity to satisfy demand therefore the demand multiplier is 0.25.

c) Total discounted capital cost

The first step in calculating the total discounted capital cost is to multiply the actual cost of each of the capital projects by the demand multiplier to obtain the modified capital cost. These values are entered in the lower half of the cell beneath the actual cost. Summing the values for each year produces the total modified capital cost incurred in that year which is then multiplied by the appropriate discount factor to obtain the discounted capital cost for each year. The sum of these costs is the total discounted capital cost (TDCC), which represents the present value of all future capital costs needed to satisfy the increasing demand.

d) The unit capital cost

In order to convert the total discounted capital cost into the unit capital cost it is necessary to calculate the change in this total brought about by a unit change in supply. This conversion is simplified by the use of the formula:

$$\text{Unit Capital Cost } (SL/m^3) = (TDCC \times r^2) \div [(1+r) \times 365 \times d]$$

Where r is the discount rate of 10% and d is the annual change in demand (m^3/day). If the supply were to be reduced by one year's growth (d), all capital projects would be deferred by one year. The unit capital cost shown in Table D-1.9 is 1.15 SL/m^3 (US$ 0.023)

(3) Unit cost of leakage

The unit cost of leakage shown in Table D-1.10 for each metering district is the cost saving (benefit) achieved for every cubic meter of water saved.

The unit cost of leakage = unit operating cost + unit capital cost

The unit cost of leakage (benefit) varies greatly from one district to the next ranging from 1.46 to 6.26 SL/m^3 (US$ 0.03 - 0.13). The weighted average unit cost of leakage for the whole system is 2 SL/m^3 (US$ 0.04). The unit cost of leakage is used to evaluate the economic benefit of the DMA system.

1.3.4 Results of EIRR

Discounted cash flows produced for the DMA and Mezze-Razy & Kafar Souseh-Lawan system project are shown in Tables D-1.3 and D1.4 respectively. Projects with an EIRR above 7% (assumed opportunity cost of capital) are deemed economically viable. A sensitivity analysis is conducted to verify that the project is feasible under the following conditions:

(a) Case 1 - project costs increase by 15%
(b) Case 2 - benefits decrease by 10%
(c) Case 3 - Case 1 + Case 2

The extension of the distribution system into the Mezze-Razy & Kafar Souseh-Lawan system has an EIRR of 8% while the DMA project has an EIRR of 9%. The results of the sensitivity analysis indicate that the economic viability of both projects is sensitive to changes in the cost/benefit stream. Under the worst case scenario the DMA project has an EIRR of 5% and the Mezze-Razy & Kafar Souseh-Lawan system project has an EIRR of 6% making both projects only marginally acceptable.

2. FINANCIAL ANALYSIS

2.1 Financial Internal Rate of Return (FIRR)

Financial analysis of the Damascus water supply improvement project is carried out to determine what tariff increases if any are required to provide sufficient revenue to cover operations and project funding requirements. The capacity of residents in the informal areas to pay for tariffs is assessed by comparing current monthly water charges to household incomes.

Financial viability of the water supply master plan as a whole is carried out by assessing the financial internal rate of return (FIRR) on the basis of project cost estimates and the incremental water revenue generated by the project.

2.1.1 Incremental Revenue

The DMA leakage control project and the extension of the water network into the Mezze-Razy & Kafar Souseh-Lawan area is expected to provide significant increases in the amount of revenue generated from water sales. Total incremental water sales resulting from the projects are identified in Table D-2.1. Revenue is calculated on the basis of the average tariff in 1995 (most recently available data) of $0.11 per m^3 obtained by dividing the total revenue from water sales by the volume of water sold. This tariff is assumed to be the same at 1997 prices for the purposes of evaluating financial benefits. This is a conservative assumption since planned tariff increases combined with a reduction in unaccounted for water will result in a higher average tariff.

2.1.2 Incremental Costs

Incremental costs shown in Table D2.2 are based on estimated project investment costs, and operation and maintenance costs. Incremental costs also include equipment replacement for projects with a useful life that is less than the assumed 30-year life of the project. The total investment costs for the DMA project is $4.65 million spread equally over a seven-year period. Equipment replacement costs of $3 million are allocated for DMA meter equipment in 2021, 15 years after the implementation of the project. Annual O&M costs for DMA flow monitoring and leakage detection are estimated at $35,555 per year. The leakage repair costs are estimated to increase gradually as a result of DMA starting with a $35,000 increase after the first year and a total increase of $250,000 after the program is fully implemented.

The total investment costs for the distribution system in the informal areas is estimated at $6.3 million over a two-year period. There are no equipment replacement costs and O&M costs are assumed negligible.

2.1.3 FIRR Calculations

Based on incremental revenue and costs, the financial internal rate of return FIRR is calculated as shown in Table D-2.3. The resulting FIRR of 16% indicates that the project is financially viable at present water tariffs levels. The financial viability of the project is robust to changes in the cost benefit stream. Even under the worst case scenario the project has a favorable FIRR of 13%.

2.2 Affordability

Affordability and ability to pay are key parameters in assessing whether the proposed investment in the distribution system for informal areas is affordable in view of the more stringent financial objectives, the need to repay the international loans and credits and the aim of sustaining a viable future development program.

The average household income in the study area is 3500 to 6000 SL per month, which is well below poverty levels (source: JICA study team, interview survey 1997). Most informal residents do not pay for water, either because they have unmetered connections or because they cannot afford to pay. Several households share connections and split the cost of monthly water charges. The average water charge for those households with a metered connection in the area is 125 SL, which represents from 2 to 3.5% of the total monthly household income. A figure of 5% is the widely accepted standard where households pay for water and sewer charges (i.e. 2.5% for water and 2.5% for sewerage). In this case there is no sewer charge so it is assumed that residents could pay up to 5% for water charges. As indicated by the household survey, most of the informal area residents do not pay for water and probably would find it difficult to re-allocate household income to pay for water charges given the extreme poverty.

2.3 Financial Projections

DAWSSA does not have the capital to invest in the projects, therefore, it is assumed that most of the required investment funding will be obtained from an international lending agency with soft loan conditions. This section contains financial cash flow projections at current tariff levels in order to assess the financial viability of proceeding with both projects at current tariff levels.

2.3.1 Assumptions

Projected cash flows are prepared for the project based on the following assumptions and conditions:

1) All financial projections are presented in US$ at current prices. Revenue is based on estimates of incremental water sales made available by reductions in leakage and metered connections in informal areas.

2) Depreciation allowances for new assets are calculated on a straight-line basis without annual revaluation:
30 years: civil works (distribution mains, valves)
15 years: flow meters

3) Unit costs for electricity and staff costs are not inflated. Increases in these costs are influenced by government decree rather than by market forces. Therefore these are unpredictable. For this reason, water tariffs will be indexed to future increases in electricity and worker salaries. By not including any increases in the financial projections, it will be easier to correct them for comparison to the real numbers in the future.

4) Financial projections reflect the following on-lending conditions:

- 75% of the project construction cost will be financed by an international financial organization with the following loan conditions:
  Interest rate = 7% p.a.
  Grace period = 5 years
  Repayment period = 25 years

- 25% of the project construction cost will be financed by the Syrian government as an equity contribution.

5) The Syrian government will repay principal and interest on the foreign loan. Interest payments are included in DAWSSA's operating budget to reflect current accounting practices.

6) Profit taxes are set at 60% of net income after depreciation and interest.

7) The DMA and the Mezze-Razy & Kafar Souseh-Lawan system project are assumed to proceed concurrently. Application of capital expenditure represents the planned phasing of the proposed investment program from the year 2000 to 2006.

2.3.2 Future Financial Performance

Based on the assumptions mentioned in the previous sub-section projected future financial performance is summarized in Table D-2.4 for the period 2000 to 2032. The accumulated net cash flow remains positive throughout the period indicating the project is financially viable for the assumed on-lending conditions without an increase in tariffs. This positive position will allow DAWSSA to build additional cash reserves for financing subsequent investments and replace metering equipment in the year 2021. Thus, DAWSSA can be financially self-sustaining, provided that: (i) water consumption grows in line with the projections; (ii) unaccounted for water is substantially reduced; and (iii) the revenue projections are fulfilled.