5.5.4 Implementation Schedule

In preparing a realistic schedule for the implementation of the project, DAWSSA will organize the construction activities. Most construction works will be conducted by contractors and supervised by DAWSSA or it's designated consultant.

(1) District Meter Area (DMA) System project

Project is expected to start in 1998 and be completed in 2006 with financing signed in June of 1998, detailed design starting in January of 1999 and pipes procured in January of 2000, as shown Figure 5.5.1.

(2) Mezze-Razy & Kafar Souseh-Lawan System project

Project is expected to start in 1998 and be completed in 2001with financing signed in June of 1998, detailed design starting in January of 1999 and pipes procured in January of 2000, as shown in Figure 5.5.1.

Table 5.2.1 Flow Meters, Pipes and Valves for DMA System

Items	Description	Unit	Quantity	Remarks
1.Flow Meter for Standing Monitor				
Flow Meter and Sensor	ND1200mm,Ultrasonic type	nr	2	
"	ND1100mm,Ultrasonic type	nr	2	
"	ND1000mm,Ultrasonic type	nr	1	
"	ND800mm,Ultrasonic type	nr	3	
"	ND600mm,Ultrasonic type	nr	8	Including Mezze-Razy area
"	ND500mm,Ultrasonic type	nr	12	
"	ND400mm,Ultrasonic type	nr	3	
"	ND250mm,Ultrasonic type	nr	1	
Total of Meter			32	
2.Flow Meter for Seasonal Monitor				
Flow Meter	Ultrasonic type	nr	20	
Sensor of Flow Meter	ND600mm to ND800mm	nr	19	excluding sensor
"	ND300mm to ND500mm	nr	51	only sensor
"	ND100mm to ND250mm	nr	63	only sensor including Lawan area
Battery for Flow Meter		nr	20	
Total of Sensor			133	
3.Flow Meter Chamber				
Meter Chamber	ND1000mm to ND1200mm	nr	5	2.0m X 1.5m X 2.8m,RC
"	ND600mm to ND800mm	nr	30	2.1m X 1.5m X 2.4m,RC
"	ND300mm to ND500mm	nr	66	2.0m X 1.5m X 2.1m,RC
"	ND100mm to ND250mm	nr	64	2.0m X 1.5m X 1.65m,RC
Total of Meter Chamber			165	
4. Pipes and Valves for DMA Shared area				
Ductile iron Pipe				
"	ND600mm,push on joint	m	100	
"	ND400mm,push on joint	m	1250	
"	ND300mm,push on joint	m	600	
"	ND200mm,push on joint	m	52	
Butterfly Valve	ND500mm,Flange joint	nr	2	
Gate Valve	ND150mm,Flange joint	nr	3	
Reduction Valve	ND800mm,Flange joint	nr	1	
"	ND400mm,Flange joint	nr	1	
"	ND150mm,Flange joint	nr	1	

Table 5.3.1 LOOPED WATER DISTRIBUTION NETWORK (Existing)

Zone No.	Node No.	Length(m)	Dia.(m)	Q8(l/sec)	r	h8(m)	h8/Q8	@q(l/sec)	q(l/sec)	Q9(l/sec)	r	h9(m)	h9/Q9	@q(l/sec)	q(l/sec)	Q10(l/sec)
A	1-10	125	0.100	8.165	16533.920	2.267	0.278		-0.017	8.148	16533.920	2.259	0.277		-0.003	8.145
	10-11	180	0.080	3.800	70581.372	2.351	0.619		0.003	3.803	70581.372	2.355	0.619		0.006	3.809
	11-12	260	0.080	2.500	101950.871	1.565	0.626		0.003	2.503	101950.871	1.569	0.627		0.006	2.509
	12-14	215	0.080	0.700	84305.528	0.123	0.175		0.003	0.703	84305.528	0.124	0.176		0.006	0.709
	14-24	230	0.050	1.665	889630.661	6.440	3.868		-0.017	1.648	889630.661	6.318	3.834		-0.003	1.645
	24-8	340	0.050	-0.335	1315106.195	0.490	1.462		-0.017	-0.352	1315106.195	-0.537	1.526		-0.003	-0.355
	8-4.1(4.2)	470	0.100	-6.935	62167.540	-6.302	0.909		-0.017	-6.952	62167.540	-6.331	0.911		-0.003	-6.955
	4.1(4.2)-1	350	0.169	-30.235	3687.670	-5.698	0.188		-0.017	-30.252	3687.670	-5.704	0.189		-0.003	-30.255
	Total			0.000		0.257	8.125	-0.017				0.052	8.158	-0.003		
B	10-20	375	0.100	3.465	49601.761	1.393	0.402		-0.020	3.445	49601.761	1.378	0.400		-0.009	3.436
	20-21	165	0.200	6.965	746.335	0.076	0.011		-0.020	6.945	746.335	0.076	0.011		-0.009	6.936
	21-13	95	0.080	3.865	37251.280	1.281	0.331		-0.020	3.845	37251.280	1.268	0.330		-0.009	3.836
	13-14	205	0.080	2.665	80384.340	1.389	0.521		-0.020	2.645	80384.340	1.370	0.518		-0.009	2.636
	14-12	215	0.080	0.700	84305.528	-0.123	0.175		-0.003	-0.703	84305.528	-0.124	0.176		-0.006	0.709
	12-11	260	0.080	-2.500	101950.871	-1.565	0.626		-0.003	-2.503	101950.871	-1.569	0.627		-0.006	2.509
	11-10	180	0.080	3.800	70581.372	-2.351	0.619		-0.003	-3.803	70581.372	-2.355	0.619		-0.006	-3.809
	Total					0.100	2.686	-0.020				0.045	2.681	-0.009		

(Source:JICA)

Table 5.3.2 Summary of Flow Network Analysis (Existing)

Node No	Length (m)	Actual length (m)	EL of ground (m)	EL at center of pipe (m)	Height (m)	Diameter (m)	Static head (m)	Discharge (m3/sec)	Flow rate (m3/sec)	Head loss (m)	EL of Effective Head (m)	Hydraulic gradient	Effective head (m)	Velocity (m/sec)
Wali			801.27	800.17							800.17			
D05 P1			725.00	723.68	-76.50	0.25	76.50		0.0768	31.50	768.67		45.00	1.56
D05 P1			725.00	723.68							768.67			
M3-381*	2000	2000.02	715.00	713.68	-10.00	0.25	28.53		0.0768	26.42	742.25	0.0132	28.53	1.56
M3-381*			715.00	713.68							742.25			
13	130	130.01	713.80	712.52	-1.16	0.17	29.73		0.0303	2.07	740.18	0.0159	27.66	1.35
13			713.80	712.52			29.73				740.18			
41	359	359.02	711.15	709.87	-3.81	0.17	32.38	0.0006	0.0303	5.70	736.54	0.0159	26.68	1.35
41			711.15	709.87							736.54			
42	50	50.07	711.15	709.87	-2.65	0.17	32.38	0.0000	0.0303	0.80	739.38	0.0159	29.52	1.35
41			711.15	709.87			32.38				736.54			
8	470	470.02	707.00	705.75	4.12	0.10	36.50	0.0046	0.0070	6.33	730.21	0.0135	24.46	0.89
8			707.00	705.75			36.50				730.21			
9	700	700.01	703.07	701.82	-3.93	0.10	40.43	0.0020	0.0020	0.92	729.30	0.0013	27.48	0.25
8			707.00	705.75			36.50				730.21			
23	340	340.01	704.70	703.48	-2.27	0.05	38.77	0.0020	0.0004	0.55	729.67	0.0016	26.19	0.18
24			704.70	703.48			38.77				729.67			
13	230	230.01	706.63	705.41	1.93	0.05	36.84	0.0017	0.0016	6.30	723.37	0.0274	17.97	0.83
M3-381			755.00	753.68							742.25			
12	130	130.01	713.80	712.52	-1.16	0.17	29.73	0.0016	0.0303	2.07	740.18	0.0159	27.66	1.35
12			713.80	712.52			29.70				740.18			
10	125	125.02	711.70	710.45	-2.10	0.10	31.80	0.0009	0.0081	2.26	737.92	0.0181	27.47	1.04
10			711.70	710.45			31.80				737.92			
16	205	205.00	710.36	709.11	-1.34	0.10	33.14	0.0019	0.0034	0.75	737.17	0.0037	28.06	0.44
16			710.36	709.11			33.14				737.17			
20	170	170.00	710.00	708.75	-0.36	0.10	33.50	0.0021	0.0015	0.14	737.03	0.0008	28.28	0.26
20			710.00	708.75			33.50				737.03			
23	555	555.03	704.00	702.75	6.00	0.10	39.50	0.0031	0.0031	1.68	735.35	0.0030	32.60	0.40
20			710.00	708.75			33.50				737.03			
19	225	225.00	709.07	707.85	-0.90	0.05	34.40	0.0034	0.0034	23.22	713.81	0.1032	5.97	1.72
10			711.70	710.45			31.80				737.92			
11	180	180.01	710.01	708.77	-1.68	0.08	33.48	0.0043	0.0038	2.36	735.56	0.0131	26.79	0.76
11			710.01	708.77			33.48				735.56			
12	260	260.01	708.01	706.77	-2.00	0.08	35.48	0.0018	0.0025	1.58	733.99	0.0061	27.22	0.50
12			708.01	706.77			35.48				733.99			
14	215	215.00	706.63	705.39	-1.38	0.08	36.86	0.0017	0.0007	0.13	733.86	0.0006	28.47	0.14
14			706.63	705.39			36.86				733.86			
13	205	205.01	708.85	707.61	2.22	0.08	34.64	0.0012	0.0026	1.36	732.50	0.0066	24.89	0.52
13			708.85	707.61			34.64				732.50			
21	95	95.00	709.08	707.84	0.23	0.08	34.41	0.0002	0.0038	1.26	731.24	0.0133	23.40	0.76
M3-381**			755.00	753.68							742.25			
3	200	200.01	712.90	711.65	-2.02	0.10	30.60	0.0000	0.0110	6.34	735.90	0.0317	24.25	1.41
3			712.90	707.84			34.41				731.24			
15	120	120.03	712.60	710.55	2.71	0.50	31.70	0.0014	0.0014	0.00	731.24	0.0000	20.69	0.01
3			712.90	711.65			30.60				735.90			
17	105	105.03	710.50	709.25	-2.40	0.10	33.00	0.0021	0.0097	2.61	733.29	0.0249	24.04	1.23
17			710.50	709.25			33.00				733.29			
20	200	200.00	710.09	708.84	0.41	0.10	33.41	0.0021	0.0076	3.19	730.10	0.0159	21.26	0.97
20			710.09	708.84			33.41				733.29			
19	220	220.00	709.07	707.82	-1.02	0.10	34.43	0.0034	0.0034	0.78	732.52	0.0035	24.70	0.43
20			710.09	708.84			33.41				730.10			
21	165	165.00	709.08	707.83	1.01	0.10	34.42	0.0002	0.0069	2.21	727.89	0.0134	20.06	0.88
M3-381			755.00	753.80							742.25			
2	240	240.00	713.80	712.52	-1.28	0.17	29.73	0.0005	0.0303	3.81	738.43	0.0159	25.92	1.35
2			713.80	712.52			29.73				738.43			
12	200	200.00	712.90	711.62	-0.90	0.17	30.63	0.0016	0.0303	3.18	735.25	0.0159	23.64	1.35
2			713.80	712.52			29.73				738.43			
42	150	150.02	711.15	709.87	-2.65	0.17	32.38	0.0000	0.0303	2.38	736.05	0.0159	26.18	1.35
42			711.15	709.87			32.38				736.05			
43	60	60.00	711.15	709.91	0.04	0.08	32.34	0.0014	0.0233	22.45	713.60	0.3741	3.69	4.64
43			711.15	709.87			32.38				736.05			
51	425	425.00	711.25	710.01	0.14	0.08	32.24	0.0026	0.0219	141.82	594.23	0.3337	-115.78	4.36
51			711.25	710.01			32.24				594.23			
52	433	433.00	710.00	708.76	-1.25	0.08	33.49	0.0039	0.0193	113.93	480.30	0.2631	-228.46	3.83
52			710.00	708.76			33.49				480.30			
6	390	390.02	706.41	705.17	-3.59	0.08	37.08	0.0010	0.0091	25.74	454.56	0.0660	-250.61	1.82
51			711.25	710.01			32.24				594.23			
7	505	505.02	706.24	704.99	-5.02	0.10	37.26	0.0063	0.0063	5.61	588.62	0.0111	316.37	0.80
6			706.41	705.17							454.56			
25	165	165.00	706.11	704.87	-0.30	0.08	37.38	0.0047	0.0081	8.78	445.78	0.0532	-259.09	1.62
25			706.11	704.87			37.38				445.78			
28	230	230.00	705.04	703.80	-1.07	0.08	38.45	0.0000	0.0034	2.51	443.27	0.0109	-260.53	0.69
28			705.04	703.80			38.45				443.27			
29	95	95.01	704.06	702.81	-0.99	0.10	39.43	0.0000	0.0034	0.35	442.92	0.0037	-259.89	0.44
29			704.06	702.81			39.43				442.92			
30	165	165.00	704.23	702.98	0.17	0.10	39.27	0.0014	0.0034	0.61	442.31	0.0037	-260.67	0.43
30			704.23	702.98			39.27				442.31			
31	75	75.00	704.16	702.91	0.07	0.10	39.34	0.0015	0.0030	0.10	442.21	0.0014	-260.70	0.26
Wester S R.			755.00	753.73							755.00			
A			700.00	698.73	-56.28	0.15	56.28		0.0150		744.23		45.50	
A			700.00	698.73							744.23			
B	3030	3030.00	702.85	701.58	2.85	0.15	53.43		0.0150	23.58	720.65	0.0078	13.07	0.85
B			702.85	701.58							720.65			
26		1.72	701.13	699.86	1.72	0.15	55.15	0.0019	0.0150	0.01	720.63	0.0078	20.76	0.85
26			701.13	699.86			55.15				720.63			
27	85	85.00	701.11	699.84	0.02	0.15	55.17	0.0016	0.0032	0.04	720.60	0.0004	20.76	0.18
27			701.11	699.84							720.60			
37	300	300.03	705.50	704.23	4.39	0.15	50.78			0.00	720.60	0.0000	16.37	0.00
26			701.13	699.86							720.63			
32	500	500.02	696.64	695.39	4.47	0.10	59.61	0.0051	0.0100	13.15	707.49	0.0263	12.10	1.27
32			696.64	695.39							707.49			
33	115	115.01	698.04	696.79	1.40	0.10	58.21	0.0015	0.0049	0.80	706.68	0.0070	9.89	0.62
33			698.04	696.79							706.68			
35	185	185.00	698.08	696.83	0.04	0.10	58.17	0.0018	0.0053	1.50	705.19	0.0081	8.36	0.67
35			698.08	696.83							705.19			
36	190	190.00	698.70	697.45	0.62	0.10	57.55	0.0016	0.0046	0.17	705.02	0.0009	7.57	0.59
27			701.11	699.84							720.60			
34	540	540.00	701.84	700.59	0.75	0.10	54.41	0.0016	0.0016	0.48	720.12	0.0009	19.53	0.20

Table 5.3.3 Looped Water Distribution Network Analysis (Proposed)

Zone No.	Node No.	Length(m)	Dia (m)	Q(l/sec)	k	h(m)	h/Q	Q(l/sec)	q(l/sec)	Q(l/sec)	V(m/sec)
O	17 18	225	0.300	5.091	29761.057	1.703	0.335		0.000	5.091	0.65
	18 19	210	0.150	1.315	26454.275	0.124	0.094		0.000	1.315	0.17
	19 20	225	0.150	-3.886	29761.057	-1.034	0.266		0.000	-3.886	-0.50
	20 17	210	0.250	-40.052	3485.160	-0.793	0.020		0.000	-40.052	-0.82
	Total	870				0.000	0.714	0.000			
I	5 15(D150/250)	165	0.300	49.846	65.929	0.257	0.005		0.000	49.846	0.71
	15 20(D100/250)	200	0.250	40.052	3485.160	0.793	0.020		0.000	40.052	0.82
	20 16(D100)	130	0.100	1.522	22486.132	0.138	0.091		0.000	1.521	0.19
	16 15	430	0.100	-1.161	52938.545	-0.246	0.188		0.000	-1.162	-0.17
	15 5	120	0.100	4.304	35872.564	0.666	0.155		0.000	4.304	0.55
	Total	995				0.000	0.458	0.000			
II	10 16(D100)	205	0.100	4.456	27115.629	1.229	0.276		0.000	4.484	0.57
	16 20(D100)	130	0.100	1.522	22486.132	0.138	0.091		0.000	1.521	0.19
	20 21(D100/225)	165	0.250	32.986	251.757	0.457	0.014		0.000	32.984	0.67
	21 11	95	0.100	6.047	12565.779	0.989	0.163		0.000	6.046	0.77
	10 11	205	0.300	3.339	27115.629	0.731	0.219		0.000	3.339	0.43
	11 12	215	0.350	8.536	3947.661	0.588	0.069		0.000	8.536	0.48
	12 31	205	0.150	-12.526	4773.916	-1.445	0.115		0.000	-12.526	-0.71
	11 30	180	0.150	15.519	3365.019	1.487	0.096		0.000	15.518	0.88
	Total	1,455				0.063	1.035	-0.001			
III	21 22(D150/250)	215	0.200	26.368	972.492	1.167	0.044		0.001	26.368	0.84
	22 23(D150/150)	195	0.150	12.419	1927.927	0.539	0.043		0.001	12.418	0.69
	23 32	195	0.350	8.628	3580.437	0.548	0.063		0.001	8.627	0.49
	32 24	270	0.100	0.149	35718.268	0.003	0.020		0.001	0.148	0.02
	24 25(D50)	230	0.150	8.028	4223.079	0.561	0.070		0.001	8.027	0.45
	33 25(D80)	205	0.150	-3.339	27115.629	-0.731	0.219		0.000	-3.339	-0.43
	33 21(D80)	95	0.100	6.047	12565.779	0.989	0.163		0.000	6.046	0.77
	Total	1,315				0.001	0.619	0.001			
IV	1 13(D150/200)	125	0.200	22.142	565.495	0.491	0.022		0.002	22.140	0.71
	30 11(D80)	180	0.150	15.519	3365.019	1.487	0.096		0.000	15.518	0.88
	11 12(D80)	260	0.150	12.526	4773.916	1.445	0.115		0.000	12.526	0.71
	12 14(D80)	215	0.150	8.536	3947.661	0.588	0.069		0.000	8.536	0.48
	14 24(D50)	230	0.150	8.028	4223.079	0.561	0.070		0.001	8.027	0.45
	24 0(D80)	340	0.150	-1.370	6242.813	-0.092	0.023		0.000	-1.372	-0.08
	0 4(D100/200)	470	0.200	-28.838	2825.923	-3.045	0.106		0.004	-28.835	-0.92
	4 3(D150/100)	150	0.500	165.368	7.827	0.260	0.002		0.002	165.369	0.84
	2 3(D150/200)	295	0.200	28.445	904.648	1.249	0.044		0.002	28.447	0.91
	Total	2,170				0.042	0.545	0.002			
V	8 9(D100/200)	470	0.200	28.838	2825.923	3.049	0.106		0.004	28.835	0.92
	9 9(D100/200)	290	0.200	17.065	3166.269	1.698	0.100		0.005	17.060	0.54
	9 38	80	0.200	15.633	363.859	0.165	0.011		0.005	15.635	0.50
	38 39	270	0.150	7.247	4957.528	0.545	0.075		0.001	7.246	0.41
	39 40	95	0.350	8.243	3718.315	0.243	0.030		0.001	8.245	0.47
	40 41	175	0.350	9.242	3213.212	0.554	0.060		0.001	9.242	0.52
	41 7	220	0.150	9.831	4039.467	0.781	0.079		0.001	9.831	0.56
	7 5 3(D150/100)	565	0.200	16.814	2258.237	2.192	0.073		0.004	16.814	0.54
	5 1 4	425	0.400	131.995	65.739	0.552	0.012		0.005	131.995	1.05
	Total	2,940				0.005	0.541	0.005			
VI	5 1 7(D100/100)	505	0.200	16.813	2258.231	2.192	0.073		0.004	16.813	0.53
	7 41	220	0.150	9.831	4039.467	0.781	0.079		0.001	9.831	0.56
	41 42	195	0.150	6.393	3580.437	0.312	0.049		0.001	6.391	0.36
	42 5 2(D80)	245	0.300	100.997	37.897	0.545	0.005		0.000	101.003	0.80
	5 2 5 1	435	0.400	169.191	66.976	1.113	0.007		0.000	169.197	0.87
	Total	1,595				0.002	0.215	0.000			
VII	32 41	195	0.150	6.393	3580.437	0.312	0.049		0.001	6.391	0.36
	31 40	175	0.150	9.242	3213.212	0.554	0.060		0.001	9.242	0.52
	40 39	95	0.150	8.243	1718.315	0.243	0.030		0.001	8.245	0.47
	39 38	270	0.150	7.247	4957.528	0.545	0.075		0.001	7.246	0.41
	38 43	205	0.250	21.889	927.261	0.788	0.036		0.005	21.885	0.70
	43 45(D150)	560	0.250	19.182	2533.015	1.697	0.088		0.005	19.177	0.61
	45 26(D150)	110	0.250	16.471	497.557	0.250	0.015		0.005	16.470	0.52
	26 27(D150)	85	0.100	-0.955	11243.066	-0.029	0.030		0.001	-0.956	-0.12
	27 29(D150)	395	0.150	14.423	7124.151	2.799	0.194		0.005	14.418	0.82
	28 25(D80)	230	0.300	69.738	141.415	1.047	0.015		0.005	69.743	0.99
	25 6(D80)	165	0.300	76.436	25.522	0.219	0.003		0.005	76.441	0.51
	6 42(D80)	360	0.400	86.411	25.980	0.261	0.003		0.005	86.415	0.69
	Total	2,650				0.005	0.508	0.005			
VIII	26 46(D150/150)	160	0.150	17.429	1765.162	0.953	0.055		0.003	17.426	0.79
	46 32(D150/150)	330	0.150	14.579	3389.780	1.359	0.093		0.003	14.576	0.65
	32 33(D150/150)	115	0.150	8.879	1181.287	0.189	0.021		0.003	8.876	0.40
	33 35(D150/150)	185	0.150	5.459	1906.331	0.124	0.023		0.003	5.456	0.24
	35 36(D150/150)	190	0.150	14.919	1951.692	0.816	0.055		0.003	14.922	0.67
	36 45	80	0.250	38.004	131.239	0.310	0.008		0.003	38.007	0.77
	45 31	355	0.150	8.123	6518.231	0.856	0.106		0.013	8.115	0.36
	31 27	177	0.150	9.959	3249.935	0.637	0.064		0.003	9.956	0.45
	27 29(D150)	85	0.100	0.955	11243.066	0.029	0.030		0.001	0.956	0.12
	Total	1,690				0.003	0.458	0.003			
IX	27 34(D50)	180	0.150	9.958	3365.019	0.618	0.062		0.010	9.856	0.56
	31 45	355	0.150	8.124	6518.231	0.856	0.139		0.010	8.115	0.46
	45 44	225	0.200	31.669	1068.683	1.697	0.054		0.013	31.673	1.01
	44 31	120	0.100	3.592	16930.734	0.508	0.141		0.007	3.599	0.46
	31 30	70	0.100	4.624	10317.366	0.393	0.085		0.007	4.631	0.59
	30 29	80	0.100	5.657	10581.769	0.736	0.130		0.007	5.664	0.72
	29 28	95	0.100	5.657	12565.779	0.874	0.154		0.007	5.664	0.72
	28 27(D150)	395	0.150	14.423	7124.151	2.799	0.194		0.005	14.418	0.82
	Total	1,525				0.023	0.955	0.013			
X	29 29(D100)	95	0.100	5.657	12565.779	0.874	0.154		0.007	5.664	0.72
	29 30(D100)	80	0.100	5.657	10581.769	0.736	0.130		0.007	5.664	0.72
	30 31(D100)	70	0.100	4.624	10317.366	0.493	0.107		0.007	4.631	0.59
	31 44	120	0.100	3.592	16930.734	0.508	0.141		0.007	3.599	0.46
	44 54	125	0.200	-29.102	565.495	-0.811	0.028		0.006	-29.106	-0.93
	54 53	275	0.250	-39.897	419.595	-1.083	0.027		0.006	-39.903	-0.81
	53 28(D150)	320	0.250	-49.658	383.056	-0.768	0.015		0.006	-49.664	-1.01
	Total	960				0.002	0.692	0.006			

(Source: JICA)

Remarks: The network is analized by the Hazen-Williams' equation.

$h = c^{*}Q^{*}1.85$

where, h: Friction head loss (m)

c: Coefficient of pipe diameter

Q: Allocated flow (l/sec)

Table 5.3.4 (1/2) Summary of Flow Network Analysis (Tentative)

Node No	Length (m)	Actual length (m)	EL of ground (m)	EL at center of pipe (m)	Height (m)	Diameter (m)	Static head (m)	Discharge (m3/sec)	Flow rate (m3/sec)	Head loss (m)	EL of Effective Head (m)	Hydraulic gradient	Effective head (m)	Velocity (m/sec)
Wall			801.27	800.17							800.170			
D05-P1			725.00	723.55	-76.62	0.50	76.62		0.2505	31.500	768.670	0.0040	45.12	1.28
D05-P1			725.00	723.55							768.670			
M3-381*	2000	2000.02	715.00	713.55	-10.00	0.50	47.06		0.2505	8.058	760.612	0.0040	47.06	1.28
M3-351*			715.00	713.55		0.50					760.612			
1	130	130.00	713.80	712.52	-1.03	0.17	48.10		0.0350	3.149	757.463	0.0242	44.95	1.69
1			713.80	712.55			45.06				757.463			
2	200	200.01	711.72	710.42	-2.13	0.20	50.19	0.0009	0.0276	1.184	756.279	0.0059	45.86	0.88
1			713.80	712.55			45.06				757.463			
10	125	125.02	711.70	710.40	-2.15	0.20	50.21	0.0015	0.0229	0.524	756.938	0.0042	46.54	0.73
10			711.70	710.40			50.21				756.938			
16	205	205.00	710.36	709.11	-1.29	0.10	51.50	0.0030	0.0048	1.394	755.544	0.0068	46.43	0.61
16			710.36	709.11			51.50				755.544			
20	170	170.00	710.00	708.75	-0.36	0.10	51.86	0.0033	0.0010	0.061	755.483	0.0004	46.73	0.12
10			711.70	710.40							755.483			
11	180	180.01	710.01	708.74	-1.67	0.15	51.88	0.0021	0.0160	1.574	753.909	0.0087	45.17	0.91
11			710.01	708.74			51.88				753.909			
12	260	260.01	708.01	706.74	-2.00	0.15	53.88	0.0028	0.0130	1.550	752.359	0.0060	45.62	0.74
12			708.01	706.74			53.88				752.359			
14	215	215.00	706.63	705.36	-1.38	0.15	55.26	0.0027	0.0090	0.651	751.708	0.0030	46.35	0.51
14			706.63	705.38			55.23				751.708			
13	205	205.01	708.85	707.60	2.22	0.10	53.01	0.0019	0.0036	0.800	750.907	0.0039	43.31	0.45
13			708.85	707.60			53.01				750.907			
21	95	95.00	709.08	707.83	0.23	0.10	52.78	0.0004	0.0063	1.056	749.852	0.0111	42.02	0.80
14			706.63	705.38							751.708			
24	340	340.00	705.24	703.97	-1.41	0.15	56.65	0.0032	0.0087	0.969	750.738	0.0029	46.77	0.49
M3-351**			715.00	713.55		0.50					760.612			
3	200	200.01	712.90	711.58	-1.93	0.25	49.04	0.0000	0.0551	1.431	759.181	0.0072	47.61	1.12
3			712.90	711.58			49.04				759.181			
15	120	120.00	712.00	710.75	-0.82	0.10	49.86	0.0021	0.0034	0.426	758.754	0.0036	48.00	0.43
15			712.00	710.75							758.754			
16	400	400.00	710.36	709.14	-1.62	0.05	51.48	0.0030	0.0005	0.995	757.759	0.0025	45.62	0.23
3			712.90	711.58			49.04				759.181			
17	105	105.03	710.50	709.18	-2.40	0.25	51.44	0.0033	0.0507	0.644	758.536	0.0061	49.36	1.03
17			710.50	709.18			51.44				758.536			
20	200	200.00	710.09	708.77	-0.41	0.25	51.85	0.0033	0.0416	0.851	757.656	0.0043	48.92	0.85
20			710.09	708.84			51.77				758.536			
19	220	220.00	709.07	707.82	-1.02	0.10	52.79	0.0053	0.0046	1.362	757.174	0.0062	49.35	0.58
19			709.07	707.85			52.77				757.686			
18	200	200.00	709.64	708.42	0.57	0.05	52.20	0.0053	0.0006	0.938	756.747	0.0047	48.33	0.32
18			709.64	708.39			52.22				757.174			
17	225	225.00	710.50	709.25	0.86	0.10	51.36	0.0053	0.0041	1.306	755.869	0.0058	46.62	0.56
20			710.09	708.77			51.85				757.686			
21	165	165.00	709.03	707.76	-1.01	0.25	52.86	0.0004	0.0333	0.465	757.221	0.0028	49.47	0.68
21			709.03	707.76			52.86				757.221			
22	215	215.01	707.24	705.94	-1.81	0.20	54.67	0.0170	0.0265	1.175	756.046	0.0055	50.11	0.84
22			707.24	705.94			54.67				756.046			
23	105	105.00	707.24	705.97	0.02	0.15	54.65	0.0049	0.0122	0.557	755.489	0.0053	49.52	0.69
23			707.24	705.97			54.65				755.489			
37	195	195.02	704.56	703.29	-2.68	0.15	57.33	0.0049	0.0087	0.555	754.933	0.0028	51.65	0.49
37			704.56	703.29			57.33				754.933			
24	340	340.00	705.24	704.02	0.73	0.05	56.60	0.0032	0.0002	0.283	754.650	0.0008	50.64	0.13
24			705.24	704.02			56.60				754.650			
8	340	340.01	708.01	706.71	2.70	0.20	53.90	0.0073	0.0077	0.190	754.460	0.0006	47.75	0.25
M3-381			715.00	713.55		0.50					760.612			
2	240	240.00	713.80	712.43	-1.13	0.35	48.19	0.0009	0.0970	0.950	759.662	0.0040	47.24	1.01
2			713.80	712.43			48.19				759.662			
4	150	150.02	711.15	709.75	-2.67	0.40	50.86	0.0032	0.1646	0.824	758.838	0.0055	49.09	1.31
4			711.15	709.75			50.86				758.838			
8	470	470.01	705.01	706.71	-3.04	0.20	53.90	0.0073	0.0255	2.911	755.597	0.0063	49.19	0.91
8			708.01	706.71			53.90				755.597			
9	700	700.02	703.07	701.77	-4.94	0.20	58.84	0.0031	0.0175	1.781	754.116	0.0025	52.35	0.56
9			703.07	701.77			58.84				754.116			
35	80	80.01	702.00	700.70	-1.07	0.20	59.91	0.0007	0.0161	0.174	753.942	0.0022	53.24	0.51
35			702.00	700.73			59.89				753.942			
39	270	270.00	703.61	702.34	1.61	0.15	58.28	0.0007	0.0081	0.670	753.272	0.0025	50.94	0.46
39			703.61	702.34			58.28				753.272			
40	95	95.00	704.00	702.73	0.39	0.15	57.89	0.0007	0.0091	0.292	752.980	0.0031	50.26	0.52
40			704.00	702.73			57.89				752.980			
41	700	700.00	705.76	704.49	1.76	0.15	56.13	0.0049	0.0101	2.610	750.370	0.0037	45.59	0.57

Table 5.3.4 (2/2) Summary of Flow Network Analysis (Tentative)

Node No	Length (m)	Actual length (m)	EL of ground (m)	EL at center of pipe (m)	Height (m)	Diameter (m)	Static head (m)	Discharge (m3/sec)	Flow rate (m/sec)	Head loss (m)	EL of Effective Head (m)	Hydraulic gradient	Effective head (m)	Velocity (m/sec)
4			711.15	709.75			50.56				758.838			
5.1	425	425.00	711.25	709.85	0.10	0.40	50.76	0.0042	0.1315	1.542	757.296	0.0036	47.45	1.05
5.1			711.25	709.85			50.76				757.296			
7	505	505.02	706.24	704.94	-4.91	0.20	55.67	0.0049	0.0203	1.697	755.599	0.0034	50.66	0.65
7			710.00	708.63			51.99				755.305			
41	220	220.01	705.76	704.49	-4.14	0.15	56.13	0.0049	0.0020	0.039	755.266	0.0002	50.78	0.11
41			710.00	708.63			51.99				754.336			
42	195	195.04	705.76	704.49	-4.14	0.15	56.13	0.0058	0.0046	0.169	754.166	0.0009	49.68	0.26
5.1			711.25	709.85			50.76				757.296			
5.2	433	433.00	710.00	708.63	-1.23	0.35	51.99	0.0058	0.1052	1.991	755.305	0.0046	46.68	1.09
5.2			710.00	708.63			51.99				755.305			
42	245	245.00	710.00	708.63	0.00	0.35	51.99	0.0058	0.0970	0.970	754.336	0.0040	45.71	1.01
42			710.00	708.63			51.99				754.336			
6	390	390.02	706.41	705.04	-3.59	0.35	55.58	0.0070	0.0851	1.212	753.124	0.0031	48.09	0.89
6			706.41	705.04							753.124			
25	165	165.00	706.11	704.74	-0.30	0.35	55.88	0.0047	0.0751	0.407	752.717	0.0025	47.95	0.78
25			706.11	704.74			55.88				752.717			
28	230	230.00	705.04	703.69	-1.05	0.30	56.92	0.0000	0.0681	1.011	751.706	0.0044	48.02	0.97
28			705.04	703.69			56.92				751.706			
29	95	95.00	704.06	702.81	-0.68	0.10	57.80	0.0000	0.0061	0.993	750.713	0.0105	47.90	0.77
29			704.06	702.81			57.80				750.713			
30	80	80.00	704.23	702.98	0.17	0.10	57.63	0.0007	0.0061	0.836	749.877	0.0105	46.90	0.77
30			704.23	702.98			57.63				749.877			
31	75	78.00	704.16	702.91	-0.07	0.10	57.70	0.0007	0.0050	0.577	749.300	0.0074	46.39	0.64
31			704.16	702.91			57.70				749.300			
41	125	125.00	704.53	703.28	0.37	0.10	57.33	0.0007	0.0004	0.010	749.290	0.0001	46.01	0.05
28			705.04	703.69			56.92				751.706			
53	120	120.01	706.80	705.45	1.78	0.25	55.14	0.0137	0.0479	0.663	751.043	0.0055	45.57	0.98
53			706.80	705.45			55.14				751.043			
54	275	275.00	706.20	704.85	-0.60	0.25	55.74	0.0007	0.0352	0.997	750.045	0.0036	45.17	0.78
54			706.20	704.85			55.74				750.045			
44	125	125.01	704.53	703.23	-1.64	0.20	57.38	0.0007	0.0274	0.727	749.315	0.0058	46.09	0.87
44			704.53	703.23			57.38				749.315			
45	223	223.03	701.07	699.77	-3.46	0.20	60.84	0.0013	0.0303	1.565	747.751	0.0070	47.98	0.97
45			701.07	699.77			60.84				747.751			
36	86	86.01	699.70	698.35	-1.40	0.25	62.24	0.0162	0.0375	0.302	747.449	0.0035	49.07	0.76
36			699.70	698.35			62.24				747.449			
35	190	190.01	695.08	696.80	-1.55	0.17	63.82	0.0150	0.0141	0.763	746.686	0.0040	49.89	0.61
35			702.00	700.73			59.59				753.942			
43	203	203.01	703.59	702.29	1.57	0.20	58.32	0.0019	0.0232	0.869	753.074	0.0043	50.78	0.74
43			703.59	702.29			58.32				753.074			
48	560	560.01	700.38	699.08	-3.21	0.20	61.53	0.0019	0.0205	1.904	751.169	0.0034	52.09	0.65
48			700.38	699.08			61.53				751.169			
26	110	110.00	701.13	699.83	0.75	0.20	60.78	0.0011	0.0173	0.288	750.882	0.0026	51.05	0.57
26			701.13	699.83			60.78				750.882			
27	85	85.00	701.11	699.89	0.05	0.05	60.73	0.0025	0.0002	0.042	750.840	0.0005	50.95	0.10
27			701.11	699.89			60.73				750.840			
28	358	358.02	705.04	703.77	3.88	0.15	56.85	0.0000	0.0141	2.808	748.032	0.0072	41.27	0.82
26			701.13	699.83			60.78				750.882			
46	166	166.01	699.40	698.12	-1.71	0.17	62.50	0.0020	0.0150	1.006	749.876	0.0061	51.76	0.80
46			699.40	698.12			62.50				749.876			
32	330	330.01	696.64	695.36	-2.76	0.17	65.26	0.0040	0.0151	1.452	748.424	0.0044	53.07	0.67
32			696.64	695.36			65.26				748.424			
33	115	115.01	698.04	696.76	1.40	0.17	63.86	0.0024	0.0094	0.211	748.213	0.0015	51.46	0.42
33			698.04	696.76			63.86				748.213			
35	185	185.00	698.08	696.80	0.04	0.17	63.83	0.0150	0.0060	0.147	748.066	0.0008	51.27	0.27
27			701.11	699.89			60.73				750.840			
34	150	150.00	701.84	700.57	0.68	0.15	60.05	0.0013	0.0107	0.747	750.093	0.0042	49.53	0.61
34			701.84	700.57			60.05				750.093			
45	355	355.00	701.07	699.80	-0.77	0.15	60.82	0.0013	0.0089	1.052	749.041	0.0030	49.25	0.50
Wester S.R.				755.00							755.000			
A			700.00	698.63	-56.38	0.35	56.38	0.0105	0.0750		744.125		45.50	
A			700.00	698.63							744.125			
B	3030	3030.00	702.85	701.43	2.85	0.35	53.53	0.0628	0.0642	5.588	738.537	0.0018	37.06	0.67

(Source: DAWSSA & JICA)

Table 5.3.5 (1/2) Summary of Flow Network Analysis (Alternative 2)

Node No	Length (m)	Actual length (m)	EL of ground (m)	EL at center of pipe (m)	Height (m)	Diameter (m)	Static head (m)	Discharge (m3/sec)	Flow rate (m3/sec)	Head loss (m)	EL of Effective Head (m)	Hydraulic gradient	Effective head (m)	Velocity (m/sec)
Mezze			772.25	770.25		0.60					770.250			
M3-381	1800	1800.89	715.00	713.50	-56.75	0.60	56.75		0.2505	2.936	767.264	0.0017	53.76	0.89
M3-381*			715.00	713.60		0.40					767.264			
1	250	250.00	713.80	712.52	-1.08	0.17	54.75		0.0380	6.056	761.208	0.0242	48.69	1.69
1			713.80	712.55			54.71				761.208			
2	200	200.01	711.72	710.42	-2.13	0.20	56.81	0.0009	0.0276	1.184	760.024	0.0059	49.60	0.88
1			713.80	712.55			54.71				761.208			
10	125	125.02	711.70	710.40	-2.15	0.20	56.86	0.0015	0.0229	0.524	760.684	0.0042	50.28	0.73
10			711.70	710.40			56.86				760.684			
16	205	205.00	710.36	709.11	-1.29	0.10	58.15	0.0030	0.0048	1.394	759.290	0.0068	50.18	0.61
16			710.36	709.11			58.15				759.290			
20	170	170.00	710.00	708.75	-0.36	0.10	58.51	0.0033	0.0010	0.061	759.229	0.0004	50.48	0.12
10			711.70	710.40							759.229			
11	180	180.01	710.01	708.74	-1.67	0.15	58.53	0.0021	0.0160	1.574	757.655	0.0087	48.92	0.91
11			710.01	708.74			58.53				757.655			
12	260	260.01	708.01	706.74	-2.00	0.15	60.53	0.0028	0.0130	1.550	756.104	0.0060	49.37	0.74
12			708.01	706.74			60.53				756.104			
14	215	215.00	706.63	705.36	-1.38	0.15	61.91	0.0027	0.0090	0.651	755.453	0.0030	50.10	0.51
14			706.63	705.38			61.88				755.453			
13	205	205.01	708.85	707.60	2.22	0.10	59.66	0.0019	0.0036	0.800	754.653	0.0039	47.05	0.45
13			708.85	707.60			59.66				754.653			
21	95	95.00	709.03	707.83	0.23	0.10	59.43	0.0004	0.0063	1.056	753.597	0.0111	45.77	0.80
14			706.63	705.38							755.453			
24	340	340.00	705.24	703.97	-1.41	0.15	63.30	0.0032	0.0087	0.969	754.484	0.0029	50.52	0.49
M3-381**			715.00	713.60		0.40					767.264			
3	30	30.07	712.90	711.58	-2.03	0.25	55.69	0.0000	0.0551	0.215	767.049	0.0072	55.47	1.12
3			712.90	703.97			63.30				767.049			
15	120	120.19	712.00	710.75	6.78	0.10	56.51	0.0021	0.0034	0.427	766.622	0.0036	55.87	0.43
15			712.00	710.75							766.622			
16	400	400.00	710.36	709.11	-1.62	0.05	58.13	0.0030	0.0005	0.995	765.627	0.0025	56.49	0.23
3			712.90	711.58			55.69				767.049			
17	105	105.03	710.50	709.18	-2.40	0.25	58.09	0.0033	0.0507	0.644	766.404	0.0061	57.23	1.03
17			710.50	709.18			58.09				766.404			
20	200	200.00	710.09	708.77	-0.41	0.25	58.50	0.0033	0.0416	0.851	765.554	0.0043	56.79	0.85
20			710.09	708.84			58.42				766.404			
19	220	220.00	709.07	707.82	-1.02	0.10	59.41	0.0053	0.0046	1.362	765.043	0.0062	57.22	0.58
19			709.07	707.82			59.41				765.554			
18	200	200.00	709.61	708.39	0.57	0.10	58.87	0.0053	0.0006	0.032	765.522	0.0002	57.13	0.08
18			709.61	708.39			58.87				765.043			
17	225	225.00	710.50	709.25	0.56	0.10	58.01	0.0053	0.0041	1.306	763.737	0.0055	54.49	0.56
20			710.09	708.77			58.50				765.554			
21	165	165.00	709.03	707.76	-1.01	0.25	59.51	0.0004	0.0333	0.465	765.089	0.0028	57.33	0.68
21			709.03	707.76			59.51				765.089			
22	215	215.01	707.24	705.94	-1.81	0.20	61.32	0.0170	0.0265	1.175	763.914	0.0055	57.97	0.84
22			707.24	705.94			61.32				763.914			
23	105	105.00	707.24	705.97	0.02	0.15	61.30	0.0049	0.0122	0.557	763.357	0.0053	57.39	0.69
23			707.24	705.97			61.30				763.357			
37	195	195.02	704.56	703.29	-2.65	0.15	63.93	0.0049	0.0087	0.555	762.801	0.0028	59.52	0.49
37			704.56	703.29			63.93				762.801			
24	340	340.00	705.24	704.02	0.73	0.05	63.25	0.0032	0.0002	0.293	762.518	0.0008	58.50	0.13
24			705.24	704.02			63.25				762.518			
5	340	340.01	708.01	706.71	2.70	0.20	60.55	0.0073	0.0077	0.190	762.328	0.0006	55.62	0.25
M3-381			715.00	713.60		0.40					767.264			
2	250	250.00	713.80	712.45	-1.15	0.30	54.81	0.0009	0.0970	2.096	765.168	0.0084	52.72	1.37
2			713.80	712.45			54.81				765.168			
4	150	150.02	711.15	709.75	-2.70	0.40	57.51	0.0032	0.1646	0.824	764.344	0.0055	54.59	1.31
4			711.15	709.75			57.51				761.341			
8	470	470.01	708.01	706.71	-3.04	0.20	60.55	0.0073	0.0255	2.941	761.404	0.0063	54.69	0.91
8			708.01	706.71			60.55				761.404			
9	700	700.02	703.07	701.77	-4.94	0.20	65.49	0.0031	0.0175	1.781	759.623	0.0025	57.85	0.56
9			703.07	701.77			65.49				759.623			
35	80	80.01	702.00	700.70	-1.07	0.20	66.56	0.0007	0.0161	0.174	759.449	0.0022	58.75	0.51
35			702.00	700.73			66.54				759.449			
39	270	270.00	703.61	702.34	1.61	0.15	64.93	0.0007	0.0081	0.670	758.779	0.0025	56.44	0.46
39			703.61	702.34			64.93				758.779			
40	95	95.00	704.00	702.73	0.39	0.15	64.54	0.0007	0.0091	0.292	758.456	0.0031	55.76	0.52
40			704.00	702.73			64.54				758.456			
41	700	700.00	705.76	704.49	1.76	0.15	62.78	0.0049	0.0101	2.610	755.876	0.0037	51.39	0.57
4			711.15	709.75			57.51				764.344			
5.1	425	425.00	711.25	709.85	0.10	0.40	57.41	0.0042	0.1315	1.542	762.803	0.0036	52.95	1.05
5.1			711.25	709.85			57.41				762.803			
7	505	505.02	706.24	704.94	-4.91	0.20	62.32	0.0049	0.0204	1.697	761.106	0.0034	56.17	0.65
7			710.00	708.65			58.61				758.595			
41	220	220.04	705.76	704.49	-4.16	0.15	62.78	0.0049	0.0020	0.039	758.515	0.0002	54.06	0.11
41			710.00	708.65			58.61				756.531			
42	195	195.04	705.76	704.49	-4.16	0.15	62.78	0.0058	0.0016	0.169	756.361	0.0009	51.58	0.26

Table 5.3.5 (2/2) Summary of Flow Network Analysis (Alternative 2)

Node No	Length (m)	Actual length (m)	EL of ground (m)	EL at center of pipe (m)	Height (m)	Diameter (m)	Static head (m)	Discharge (m3/sec)	Flow rate (m3/sec)	Head loss (m)	EL of Effective Head (m)	Hydraulic gradient	Effective head (m)	Velocity (m/sec)
5.1			711.25	709.85			57.41				762.803			
	5.2	433	433.00	710.00	708.65	-1.20	0.30	58.61	0.0058	0.1052	4.218	758.585	0.0097	49.93	1.49
5.2				710.00	708.65			58.61				758.585			
	42	245	245.00	710.00	708.65	0.00	0.30	58.61	0.0058	0.0970	2.054	756.531	0.0084	47.88	1.37
42				710.00	708.65			58.61				756.531			
	6	390	390.02	706.41	705.06	-3.59	0.30	62.20	0.0070	0.0851	2.567	753.964	0.0066	48.90	1.20
6				706.41	705.06							753.964			
	25	165	165.00	706.11	704.76	-0.30	0.30	62.50	0.0047	0.0751	0.862	753.102	0.0052	48.34	1.06
25				706.11	704.76			62.50				753.102			
	28	230	230.00	705.04	703.69	-1.07	0.30	63.57	0.0000	0.0684	1.011	752.091	0.0044	48.40	0.97
28				705.04	703.69			63.57				752.091			
	29	95	95.00	704.06	702.81	-0.85	0.10	64.45	0.0000	0.0061	0.993	751.098	0.0105	45.29	0.77
29				704.06	702.81			64.45				751.098			
	30	80	80.00	704.23	702.93	0.17	0.10	64.28	0.0007	0.0061	0.836	750.262	0.0105	47.28	0.77
30				704.23	702.93			64.28				750.262			
	31	78	78.00	704.16	702.91	-0.07	0.10	64.35	0.0007	0.0050	0.577	749.685	0.0074	46.77	0.64
31				704.16	702.91			64.35				749.685			
	44	128	128.00	704.53	703.28	0.37	0.10	63.98	0.0007	0.0004	0.010	749.675	0.0001	46.40	0.05
28				705.04	703.69			63.57				752.091			
	53	120	120.01	706.50	705.48	1.78	0.25	61.79	0.0137	0.0479	0.663	751.427	0.0055	45.95	0.95
53				706.80	705.48			61.79				751.427			
	54	275	275.00	706.20	704.85	-0.60	0.25	62.39	0.0007	0.0382	0.997	750.430	0.0036	45.55	0.78
54				706.20	704.85			62.39				750.430			
	44	125	125.01	704.53	703.23	-1.61	0.20	64.03	0.0007	0.0274	0.727	749.703	0.0058	46.47	0.87
44				704.53	703.23			64.03				749.703			
	45	223	223.03	701.07	699.77	-3.46	0.20	67.49	0.0013	0.0303	1.568	748.135	0.0070	48.37	0.97
45				701.07	699.77			67.49				748.135			
	36	86	86.01	699.70	698.35	-1.40	0.25	68.89	0.0162	0.0375	0.302	747.834	0.0035	49.46	0.76
36				699.70	698.38			68.89				747.834			
	35	190	190.01	695.08	696.80	-1.58	0.17	70.47	0.0150	0.0141	0.763	747.071	0.0040	50.28	0.64
38				702.00	700.73			66.54				759.449			
	43	203	203.01	703.59	702.29	1.57	0.20	64.97	0.0019	0.0232	0.869	758.580	0.0043	56.29	0.74
43				703.59	702.29			64.97				758.580			
	45	560	560.01	700.38	699.08	-3.21	0.20	68.18	0.0019	0.0205	1.904	756.676	0.0034	57.60	0.65
45				700.38	699.08			68.18				756.676			
	26	110	110.00	701.13	699.83	0.75	0.20	67.43	0.0011	0.0178	0.255	756.353	0.0026	56.56	0.57
26				701.13	699.83			67.43				756.353			
	27	55	85.00	701.11	699.86	0.03	0.10	67.40	0.0025	0.0002	0.001	756.387	0.0000	56.53	0.02
27				701.11	699.86			67.40				756.387			
	28	358	335.02	705.01	703.77	3.90	0.15	63.50	0.0000	0.0141	2.808	753.579	0.0072	49.81	0.82
26				701.13	699.83			67.43				756.353			
	46	166	166.01	699.40	698.12	-1.71	0.17	69.15	0.0020	0.0150	1.000	755.382	0.0061	57.27	0.80
46				699.40	698.12			69.15				755.382			
	32	330	330.01	696.64	695.36	-2.76	0.17	71.91	0.0040	0.0151	1.452	753.930	0.0044	58.57	0.67
32				696.64	695.36			71.91				753.930			
	33	115	115.01	698.04	696.76	1.40	0.17	70.51	0.0024	0.0094	0.211	753.720	0.0018	56.96	0.42
33				698.04	696.76			70.51				753.720			
	35	135	135.00	695.08	696.80	0.04	0.17	70.47	0.0150	0.0060	0.147	753.572	0.0008	56.78	0.27
27				701.11	699.86			67.40				756.387			
	34	150	150.00	701.81	700.57	0.71	0.15	66.70	0.0013	0.0107	0.747	755.640	0.0042	55.07	0.61
34				701.81	700.57			66.70				755.640			
	45	355	355.00	701.07	699.50	-0.77	0.15	67.47	0.0013	0.0059	1.052	754.588	0.0030	54.79	0.50
Wester S.R.*					755.00							755.000			
	A			700.00	698.60	-56.40	0.40	56.40	0.0108	0.0750		744.100		45.50	
A				700.00	698.60							744.100			
	B	3030	3030.00	702.85	701.45	2.85	0.40	53.55	0.0628	0.0642	2.916	741.184	0.0010	39.73	0.51

(Source: DAWSSA & JICA) *Western S.R improvement exludes from the perused project.

Table 5.3.6 (1/2) Summary of Flow Network Analysis (Proposed: Alternative 1)

Node No	Length (m)	Actual length (m)	EL of ground (m)	EL at center of pipe (m)	Height (m)	Diameter (m)	Static head (m)	Discharge (m3/sec)	Flow rate (m3/sec)	Head loss (m)	EL of Effective Head (m)	Hydraulic gradient	Effective head (m)	Velocity (m/sec)
Wali			796.00	796.00							796.000			
N508			714.90	713.30	-82.70	0.80	82.70		0.3574	21.700	763.300	0.0008	50.00	0.71
N508			714.90	713.30							763.300			
N508-1	550	550.00	715.17	713.67	0.37	0.60	82.33	0.1982	0.2483	0.900	762.400	0.0016	48.73	0.88
N508-1			715.17	713.97							762.400			
1	250	250.00	713.80	712.49	-1.48	0.23	83.51		0.0506	2.551	759.849	0.0102	47.36	1.27
1			713.80	712.55			83.45				759.849			
2	200	200.01	711.72	710.42	-2.13	0.20	85.58	0.0009	0.0281	1.249	758.600	0.0062	48.18	0.91
1			713.80	712.55			83.45				759.849			
10	125	125.02	711.70	710.40	-2.15	0.20	85.60	0.0015	0.0221	0.491	759.358	0.0039	48.96	0.71
10			711.70	710.40			85.60				759.358			
16	205	205.00	710.36	709.11	-1.29	0.10	86.89	0.0030	0.0045	1.227	758.131	0.0060	49.02	0.57
16			710.36	709.11			86.89				758.131			
20	170	170.00	710.00	708.75	-0.36	0.10	87.25	0.0033	0.0015	0.138	757.993	0.0008	49.24	0.19
10			711.70	710.40							759.358			
11	150	150.01	710.01	708.74	-1.67	0.15	87.27	0.0021	0.0155	1.487	757.871	0.0083	49.14	0.88
11			710.01	708.74			87.27				757.871			
12	260	260.01	708.01	706.74	-2.00	0.15	89.27	0.0028	0.0125	1.445	756.426	0.0056	49.69	0.71
12			708.01	706.74			89.27				756.426			
14	215	215.00	706.63	705.36	-1.38	0.15	90.65	0.0027	0.0085	0.588	755.839	0.0027	50.48	0.48
14			706.63	705.38			90.62				755.839			
13	205	205.01	708.85	707.60	2.22	0.10	88.40	0.0019	0.0033	0.711	755.128	0.0035	47.53	0.43
13			708.85	707.60			88.40				755.128			
21	95	95.00	709.08	707.83	0.23	0.10	88.17	0.0004	0.0060	0.988	754.140	0.0104	46.31	0.77
14			706.63	705.38							755.839			
24	340	340.00	705.24	703.97	-1.41	0.15	92.04	0.0032	0.0080	0.829	755.009	0.0024	51.04	0.45
N508			714.90	713.30							763.300			
N508-3	250	250.01	712.20	710.75	-2.55	0.50	85.25	0.0545	0.1087	0.215	763.085	0.0009	52.34	0.55
N508-3			712.20	711.00							763.085			
3	30	30.01	712.90	711.55	0.55	0.30	84.45	0.0000	0.0542	0.086	763.000	0.0029	51.45	0.77
3			712.90	703.97							763.000			
15	120	120.19	712.00	710.75	6.78	0.10	85.25	0.0021	0.0043	0.667	762.333	0.0055	51.55	0.55
15			712.00	710.75							762.333			
16	400	400.00	710.36	709.11	-1.61	0.10	86.89	0.0030	0.0013	0.246	762.086	0.0006	52.98	0.17
3			712.90	711.55			84.45				763.000			
17	105	105.03	710.50	709.15	-2.40	0.30	86.85	0.0033	0.0498	0.257	762.743	0.0024	53.59	0.71
17			710.50	709.15			86.85				762.743			
20	200	200.00	710.09	708.77	-0.38	0.25	87.24	0.0033	0.0401	0.793	761.950	0.0040	53.18	0.82
20			710.09	708.84			87.16				761.950			
19	220	220.00	709.07	707.82	-1.02	0.10	88.18	0.0053	0.0039	1.011	760.939	0.0046	53.12	0.50
19			709.07	707.82			88.18				760.939			
18	200	200.00	709.61	708.39	0.57	0.10	87.61	0.0053	0.0013	0.124	760.815	0.0006	52.43	0.17
18			709.61	708.39			87.61				760.815			
17	225	225.00	710.50	709.25	0.86	0.10	86.75	0.0053	0.0051	1.703	759.112	0.0076	49.86	0.65
20			710.09	708.77			87.24				761.950			
21	165	165.00	709.08	707.76	-1.01	0.25	88.25	0.0004	0.0330	0.457	761.493	0.0028	53.74	0.67
21			709.08	707.76			88.25				761.493			
22	215	215.01	707.24	705.94	-1.81	0.20	90.06	0.0170	0.0264	1.166	760.326	0.0054	54.39	0.84
22			707.24	705.94			90.06				760.326			
23	105	105.00	707.24	705.97	0.02	0.15	90.04	0.0049	0.0121	0.549	759.778	0.0052	53.81	0.69
23			707.24	705.97			90.04				759.778			
37	195	195.02	704.56	703.29	-2.68	0.15	92.72	0.0049	0.0086	0.544	759.234	0.0028	55.95	0.49
37			704.56	703.29			92.72				759.234			
24	340	340.00	705.24	703.99	0.71	0.10	92.01	0.0032	0.0001	0.004	759.230	0.0000	55.24	0.02
24			705.24	703.99			92.01				759.230			
8	340	340.01	708.01	706.71	2.72	0.20	89.29	0.0073	0.0014	0.008	759.222	0.0000	52.51	0.04
N508-1			715.17	713.67							762.400			
N508-2	150	150.00	715.00	713.50	-0.17	0.60	82.50	0.0545	0.1982	0.161	762.239	0.0011	48.74	0.70
N508-2			715.00	713.80			82.50				762.239			
2	250	250.00	713.80	712.35	-1.45	0.50	83.65	0.0009	0.1437	0.360	761.878	0.0014	49.53	0.73
2			713.80	712.35			83.65				761.878			
4	150	150.02	711.15	709.70	-2.65	0.50	86.30	0.0032	0.1654	0.250	761.593	0.0019	51.90	0.84
4			711.15	709.70			86.30				761.593			
5	470	470.01	708.01	706.71	-2.99	0.20	89.29	0.0073	0.0288	3.009	758.589	0.0064	51.55	0.92
5			708.01	706.71			89.29				758.589			
9	700	700.02	703.07	701.77	-4.94	0.20	94.23	0.0031	0.0171	1.697	756.892	0.0024	55.12	0.54
9			703.07	701.77			94.23				756.892			
38	80	80.01	702.00	700.70	-1.07	0.20	95.30	0.0007	0.0156	0.165	756.727	0.0021	56.03	0.50
38			702.00	700.73			95.23				756.727			
39	270	270.00	703.61	702.34	1.61	0.15	93.67	0.0003	0.0072	0.545	756.182	0.0020	53.85	0.41
39			703.61	702.34			93.67				756.182			
40	95	95.00	704.00	702.73	0.39	0.15	93.28	0.0007	0.0082	0.244	755.939	0.0026	53.21	0.47
40			704.00	702.73			93.28				755.939			
41	700	700.00	705.76	704.49	1.76	0.15	91.52	0.0019	0.0092	2.216	753.722	0.0032	49.24	0.52
4			711.15	709.70			86.30				761.593			
5.1	425	425.00	711.25	709.80	0.10	0.50	86.20	0.0042	0.1320	0.523	761.075	0.0012	51.27	0.67
5.1			711.25	709.80			86.20				761.075			
7	505	505.02	706.24	704.94	-4.86	0.20	91.06	0.0049	0.0163	1.192	759.883	0.0024	54.94	0.54
7			710.00	708.60			87.40				759.883			
41	220	220.04	705.76	704.49	-4.12	0.15	91.52	0.0049	0.0093	0.781	759.102	0.0035	51.62	0.56
41			710.00	708.60			87.40				759.102			
42	195	195.04	705.76	704.49	-4.12	0.15	91.52	0.0058	0.0061	0.312	758.789	0.0016	51.30	0.36

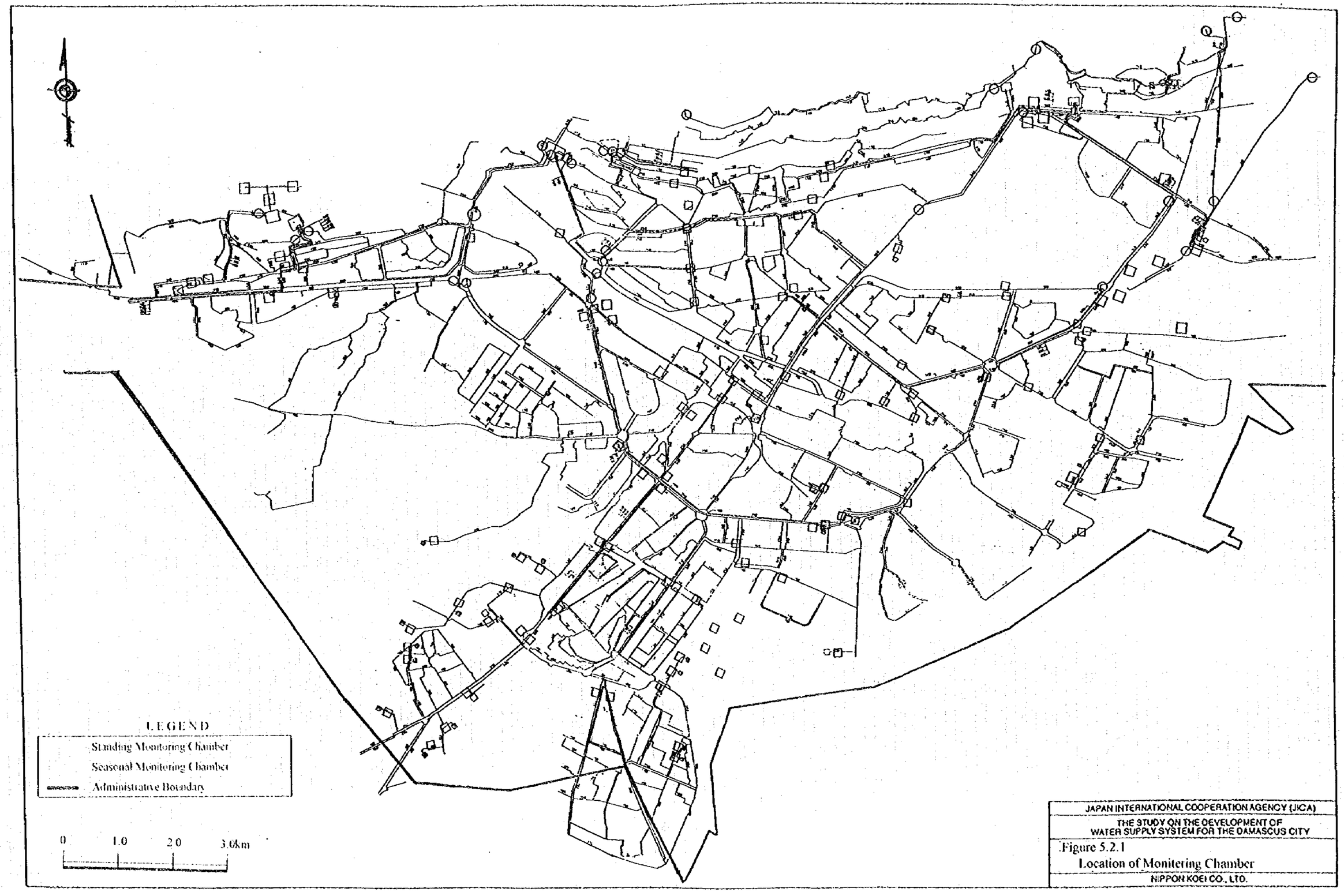
Table 5.3.6 (2/2) Summary of Flow Network Analysis (Proposed: Alternative 1)

Node No	Length (m)	Actual length (m)	EL of ground (m)	EL at center of pipe (m)	Height (m)	Diameter (m)	Static head (m)	Discharge (m3/sec)	Flow rate (m3/sec)	Head loss (m)	EL of Effective Head (m)	Hydraulic gradient	Effective head (m)	Velocity (m/sec)
5.1			711.25	709.80			86.20				761.075			
	5.2	433	433.00	710.00	708.60	-1.20	0.40	87.40	0.0058	0.1092	1.113	759.961	0.0026	51.36	0.87
5.2				710.00	708.60			87.40				759.961			
	42	245	245.00	710.00	708.60	0.00	0.40	87.40	0.0058	0.1010	0.545	759.416	0.0022	50.82	0.80
42				710.00	708.60			87.40				759.416			
	6	390	390.02	706.41	705.01	-3.59	0.40	90.99	0.0070	0.0864	0.650	758.766	0.0017	53.76	0.69
6				706.41	705.01			90.99				758.766			
	25	165	165.00	706.11	704.71	-0.30	0.40	91.29	0.0047	0.0764	0.219	758.547	0.0013	53.84	0.61
25				706.11	704.71			91.29				758.547			
	28	230	230.00	705.04	703.69	-1.02	0.30	92.31	0.0000	0.0097	1.047	757.499	0.0046	53.81	0.99
28				705.04	703.69			92.31				757.499			
	29	95	95.00	704.06	702.81	-0.85	0.10	93.19	0.0000	0.0057	0.876	756.623	0.0092	53.81	0.72
29				704.06	702.81			93.19				756.623			
	30	80	80.00	704.23	702.98	0.17	0.10	93.02	0.0007	0.0057	0.733	755.886	0.0092	52.91	0.72
30				704.23	702.98			93.02				755.886			
	31	78	78.00	704.16	702.91	-0.07	0.10	93.09	0.0007	0.0046	0.495	755.390	0.0061	52.48	0.59
31				704.16	702.91			93.09				755.390			
	43	128	128.00	704.53	703.28	0.37	0.10	92.72	0.0007	0.0036	0.510	754.881	0.0040	51.60	0.46
28				705.04	703.69			92.31				757.499			
	53	120	120.01	706.80	705.45	1.78	0.25	90.53	0.0137	0.0497	0.709	756.791	0.0059	51.32	1.01
53				706.80	705.45			90.53				756.791			
	54	275	275.00	706.20	704.85	-0.60	0.25	91.13	0.0007	0.0399	1.093	755.708	0.0039	50.83	0.81
54				706.20	704.85			91.13				755.708			
	44	125	125.01	704.53	703.23	-1.64	0.20	92.77	0.0007	0.0291	0.814	754.893	0.0065	51.66	0.93
41				704.53	703.23			92.77				754.893			
	45	223	223.03	701.07	699.77	-3.46	0.20	96.23	0.0013	0.0317	1.693	753.195	0.0076	53.42	1.01
45				701.07	699.77			96.23				753.195			
	36	86	86.01	699.70	698.35	-1.40	0.25	97.63	0.0162	0.0380	0.310	752.885	0.0036	54.51	0.77
36				699.70	698.35			97.63				752.885			
	35	190	190.01	698.68	696.50	-1.58	0.17	99.20	0.0150	0.0149	0.817	752.069	0.0043	55.27	0.67
38				702.00	700.73			95.28				756.727			
	43	203	203.01	703.59	702.29	1.57	0.20	93.71	0.0019	0.0219	0.780	755.947	0.0038	53.65	0.70
43				703.59	702.29			93.71				755.947			
	48	560	560.01	700.38	699.08	-3.21	0.20	96.92	0.0019	0.0192	1.686	754.262	0.0030	55.18	0.61
48				700.38	699.08			96.92				754.262			
	26	110	110.00	701.13	699.83	0.75	0.20	96.17	0.0011	0.0165	0.250	754.012	0.0023	54.18	0.52
26				701.13	699.83			96.17				754.012			
	27	85	85.00	701.11	699.86	0.03	0.10	96.14	0.0025	0.0010	0.029	753.983	0.0003	54.12	0.12
27				701.11	699.86			96.14				753.983			
	25	355	355.02	705.01	703.77	3.90	0.15	92.24	0.0000	0.0141	2.796	751.187	0.0072	47.42	0.82
26				701.13	699.83			96.17				754.012			
	46	166	166.01	699.40	698.12	-1.71	0.17	97.88	0.0020	0.0174	0.951	753.061	0.0057	54.95	0.78
46				699.40	698.12			97.88				753.061			
	32	330	330.01	696.64	695.36	-2.76	0.17	100.64	0.0040	0.0146	1.355	751.703	0.0041	56.35	0.65
32				696.64	695.36			100.64				751.703			
	33	115	115.01	698.04	696.76	1.40	0.17	99.24	0.0021	0.0089	0.189	751.514	0.0016	54.76	0.40
33				698.04	696.76			99.24				751.514			
	35	185	185.00	698.08	696.50	0.04	0.17	99.20	0.0150	0.0055	0.124	751.391	0.0007	54.60	0.24
27				701.11	699.86			96.14				753.983			
	34	150	150.00	701.84	700.57	0.71	0.15	95.43	0.0013	0.0099	0.647	753.336	0.0035	52.77	0.56
34				701.84	700.57			95.43				753.336			
	45	355	355.00	701.07	699.80	-0.77	0.15	96.20	0.0013	0.0081	0.884	752.452	0.0025	52.66	0.46

(Source: DAWSSA & JICA)

Table 5.3.7 Distribution Facilities for Mezze-Razy & Kafar Souseh-Lawan Area

Items	Description	Unit	Quantity	Remarks
1. Distribution Pipeline				
Ductile iron pipe	ND600 mm, push-on joint	m	700	from N508 branch point
"	ND500 mm, "	m	1,200	
"	ND400 mm, "	m	1,400	
"	ND300 mm, "	m	400	
"	ND250 mm, "	m	1,000	
"	ND200 mm, "	m	4,500	
"	ND150 mm, "	m	4,700	
"	ND100 mm, "	m	1,700	
Polyethylene pipe	ND 80 mm,	m	4,600	
"	ND 50 mm,	m	16,100	
Total Length		m	36,300	
2. Valve and Fire-hydrant				
Butterfly valve	ND600 mm, flange joint	nr	1	
"	ND500 mm, "	nr	1	
"	ND400 mm, "	nr	2	
Gate valve	ND300 mm, "	nr	2	
"	ND250 mm, "	nr	2	
"	ND200 mm, "	nr	12	
"	ND150 mm, "	nr	8	
"	ND100 mm, "	nr	7	
"	ND 80 mm, "	nr	50	
"	ND 50 mm, "	nr	196	
Fire-hydrants	ND100 mm, underground type	nr	25	
3. Flow Meter				
Ultrasonic type flow meter	ND600 mm, including Sensor	nr	1	
Flow meter sensor	ND400 mm,	nr	1	
"	ND200 mm	nr	1	
4. Service Meter				
Water meter	ND 13 mm, multi-jet type	nr	5,400	



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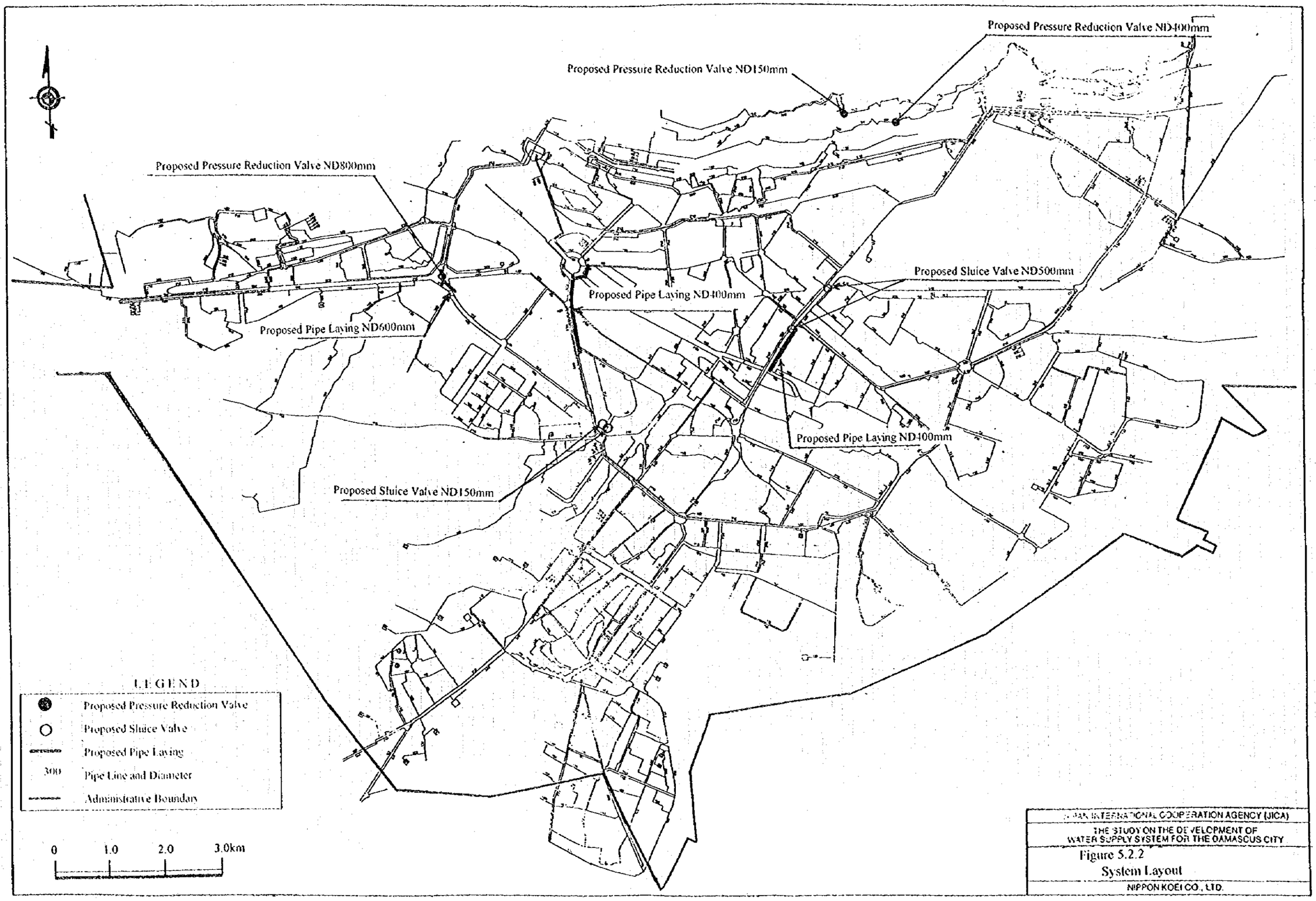
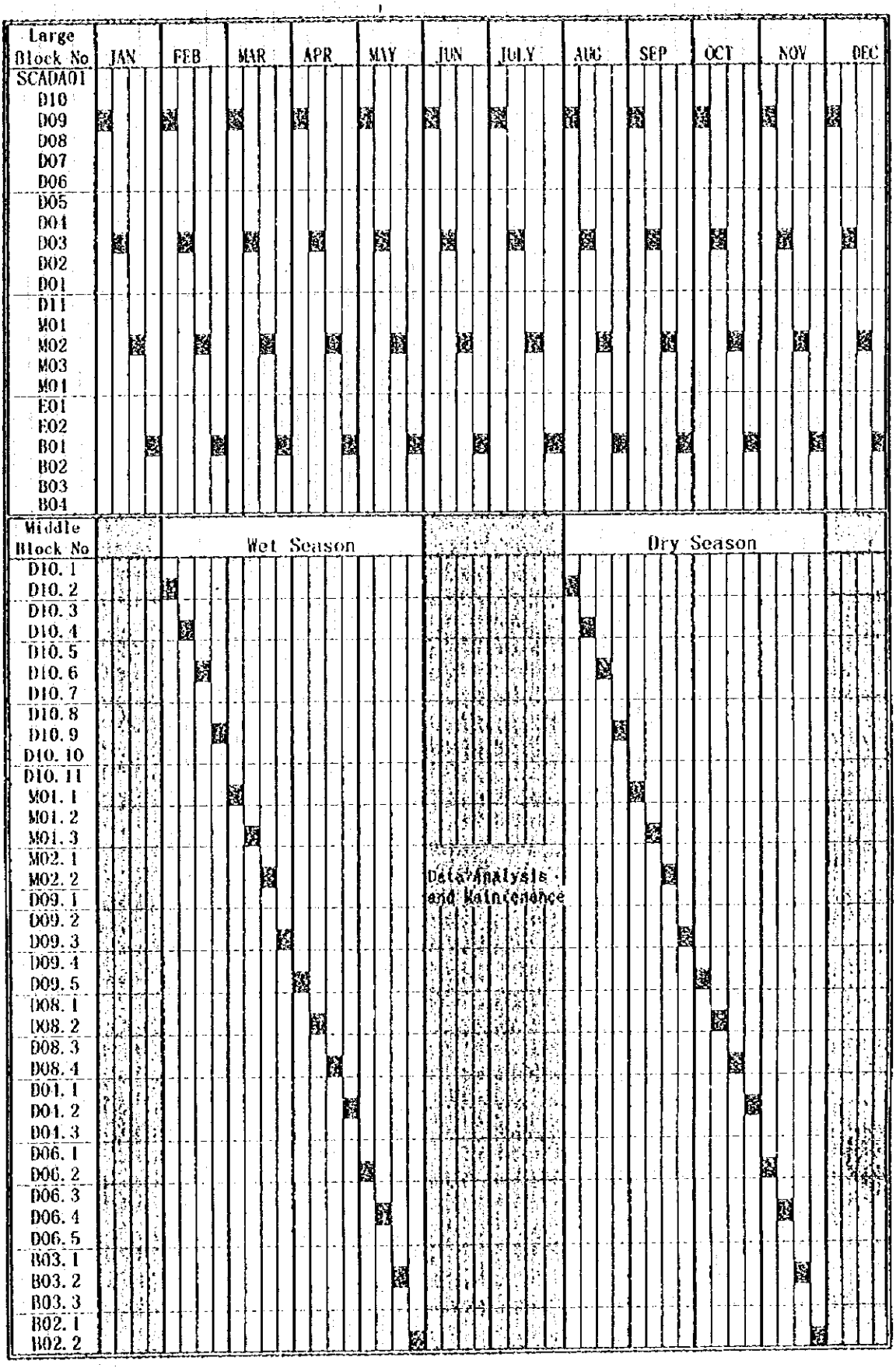
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

Figure 5.2.1
Location of Monitering Chamber

NIPPON KOEI CO., LTD.


Proposed Pressure Reduction Valve ND400mm
Proposed Pressure Reduction Valve ND150mm
Proposed Pressure Reduction Valve ND800mm
Proposed Sluice Valve ND500mm
Proposed Pipe Laying ND400mm
Proposed Pipe Laying ND600mm
Proposed Pipe Laying ND400mm
Proposed Sluice Valve ND150mm
LEGEND
Proposed Pressure Reduction Valve
Proposed Sluice Valve
Proposed Pipe Laying
300 Pipe Line and Diameter
Administrative Boundary
0 1.0 2.0 3.0km
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.2.2
System Layout
NIPPON KOEI CO., LTD.



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

Figure 5.2.3

Monitaring Schedule of DMA System

NIPPON KOEI CO., LTD.

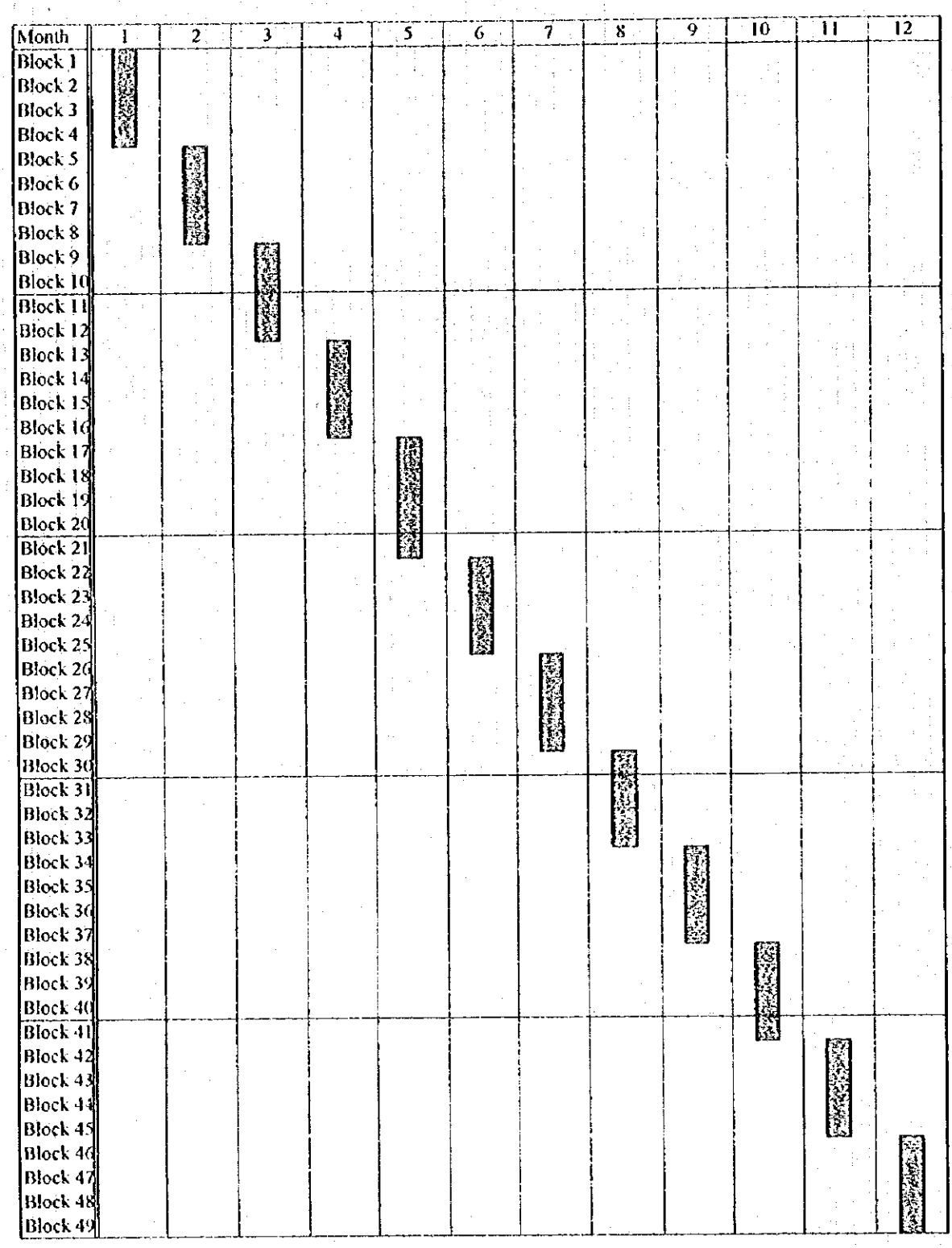

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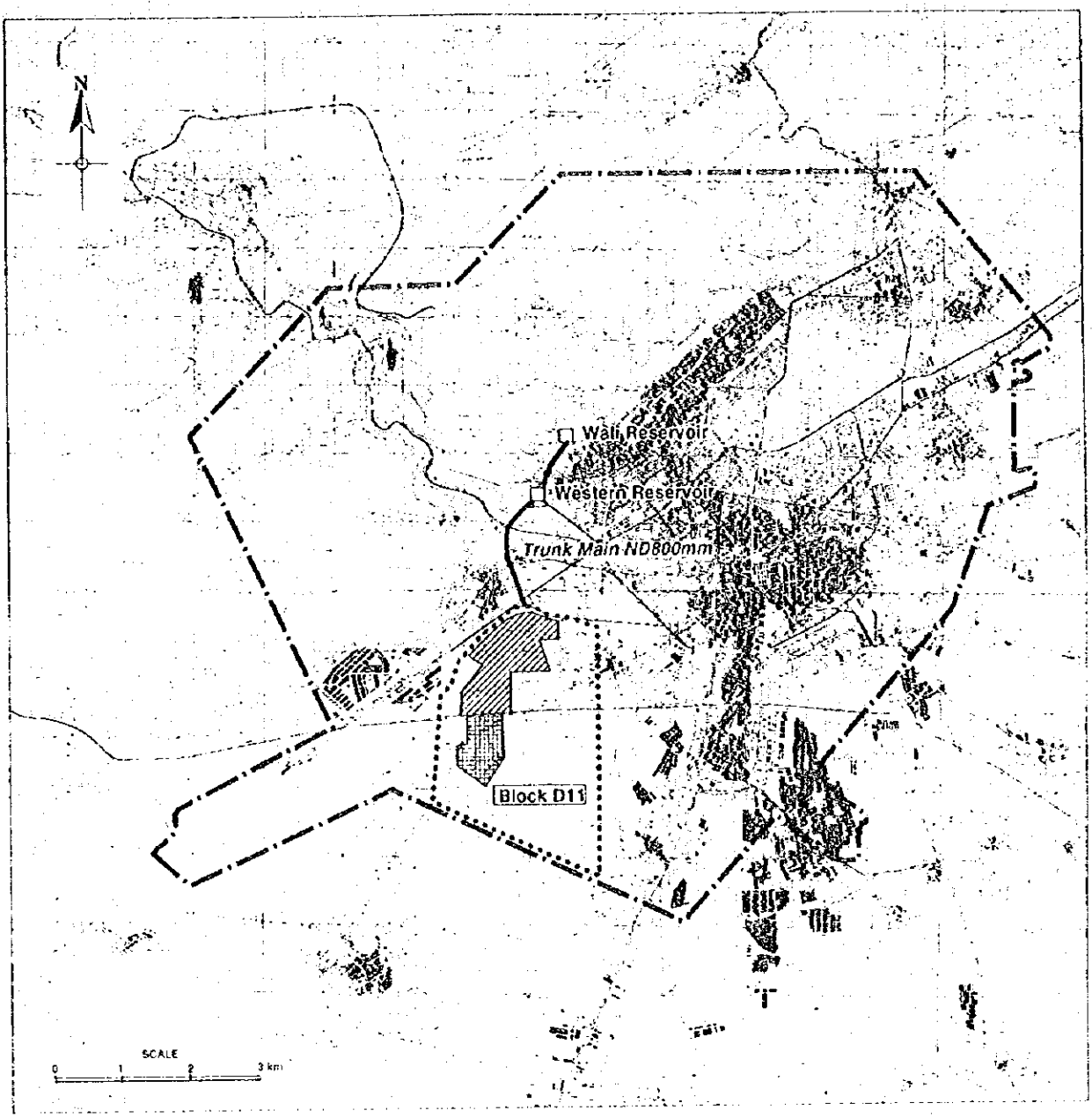
Figure 5.2.4 Leakage Survay Schedule
NIPPON KOEI CO., LTD.



LEGEND

:Mezze-Razy Area

:Kafar Souseh-Lawan Area

:Boundary of DMA Block D11

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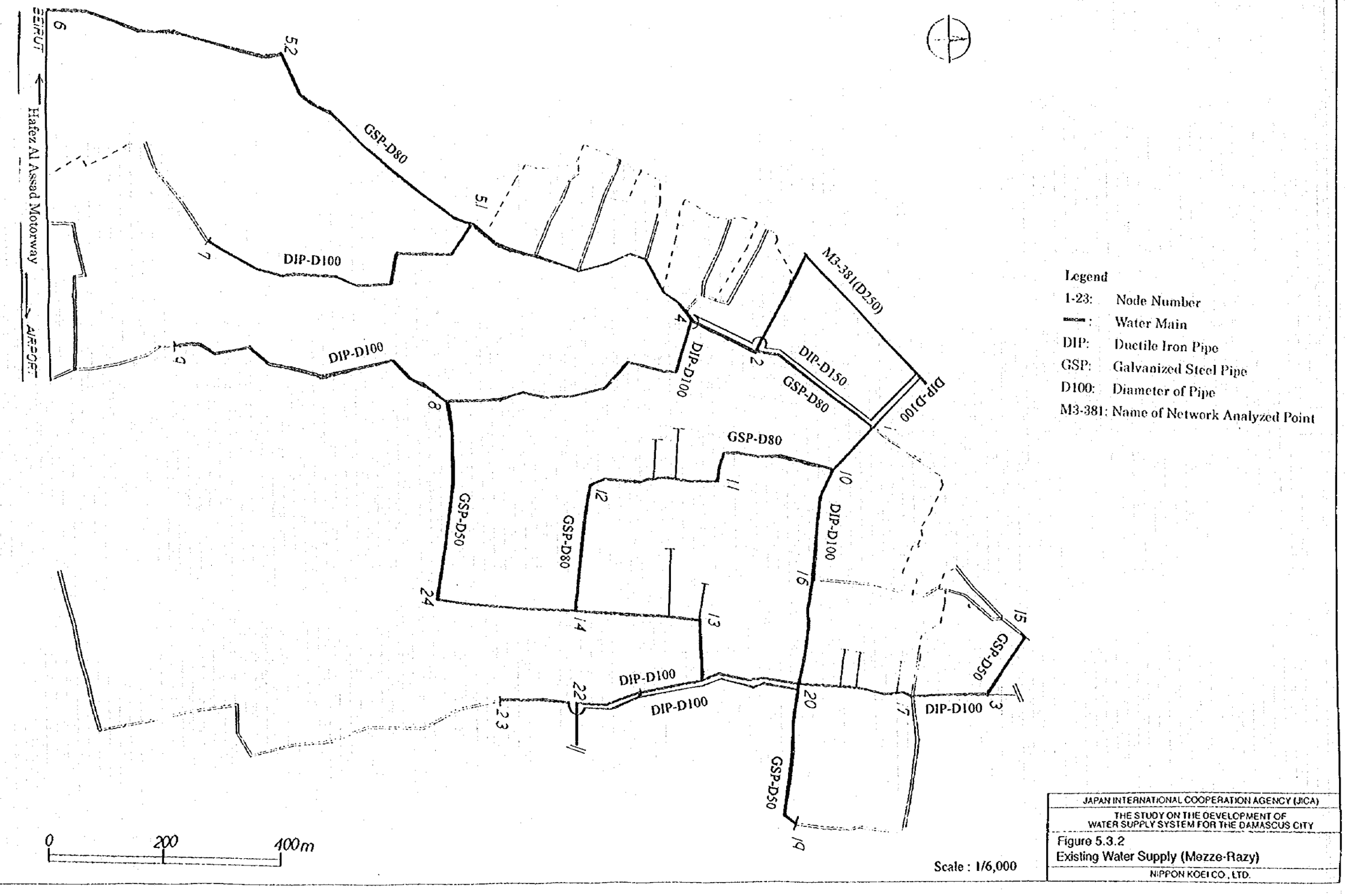
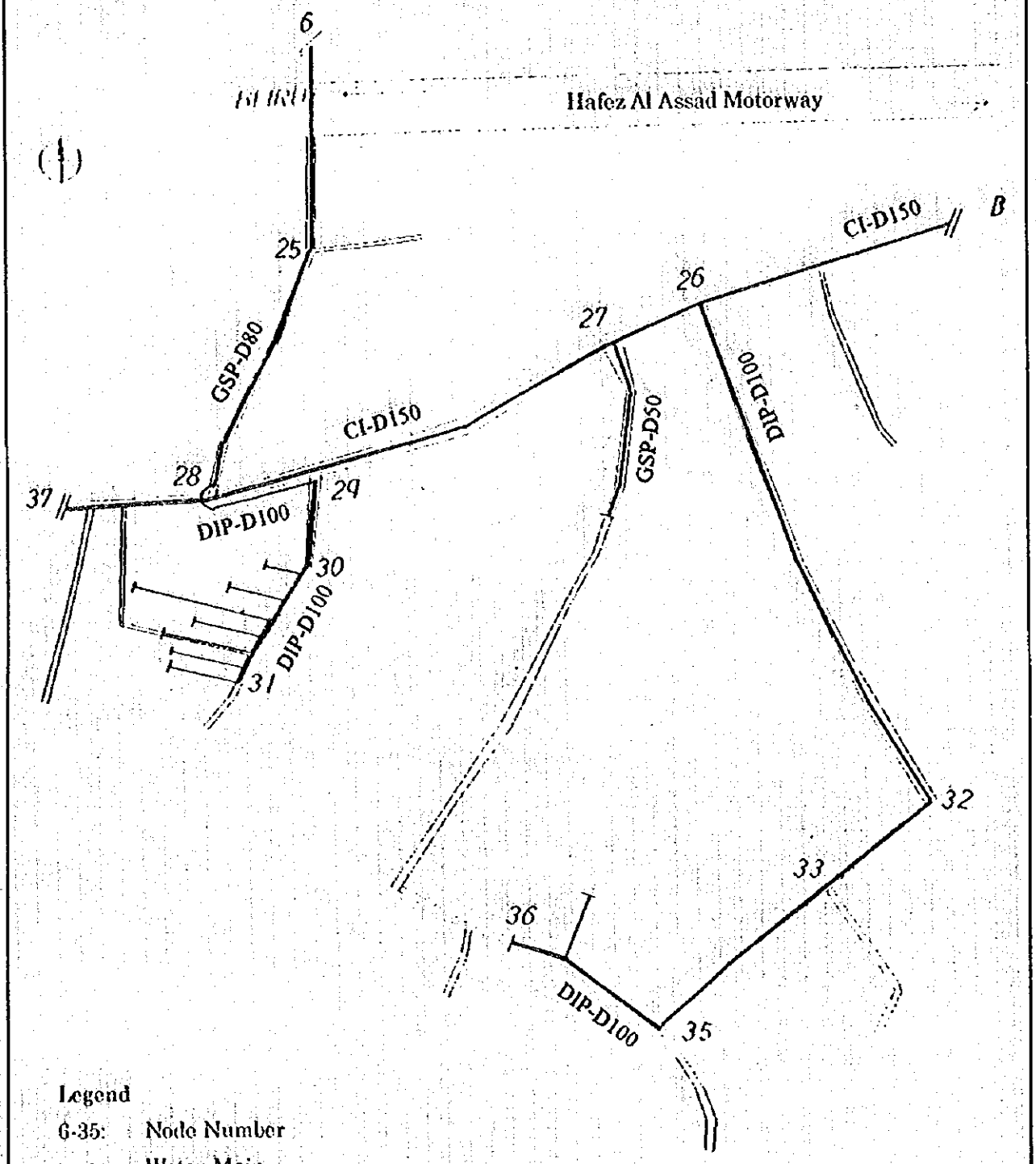
Figure 5.3.1 Trunk Main for Mezze-Razy & Kafar Souseh- Lawan Area

NIPPON KOEI CO., LTD.


BEIRUT
Hafez Al Assad Motorway
AIRPORT
6
5.2
GSP-D80
5.1
1
DIP-D100
4
M3-381(D250)
DIP-D150
2
GSP-D80
DIP-D100
5
DIP-D100
3
GSP-D80
10
DIP-D100
12
GSP-D80
11
GSP-D50
24
16
14
13
15
GSP-D50
DIP-D100
22
DIP-D100
20
DIP-D100
3
23
GSP-D50
19
0
200
400m
Legend
1-23: Node Number
: Water Main
DIP: Ductile Iron Pipe
GSP: Galvanized Steel Pipe
D100: Diameter of Pipe
M3-381: Name of Network Analyzed Point
Scale : 1/6,000
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.3.2
Existing Water Supply (Mezze-Razy)
NIPPON KOEI CO., LTD.



Legend

6-35: Node Number
—: Water Main
DIP: Ductile Iron Pipe
GSP: Galvanized Steel Pipe
CI: Cast Iron Pipe
D100: Diameter of Pipe

0 200 400m

Scale : 1/6,000

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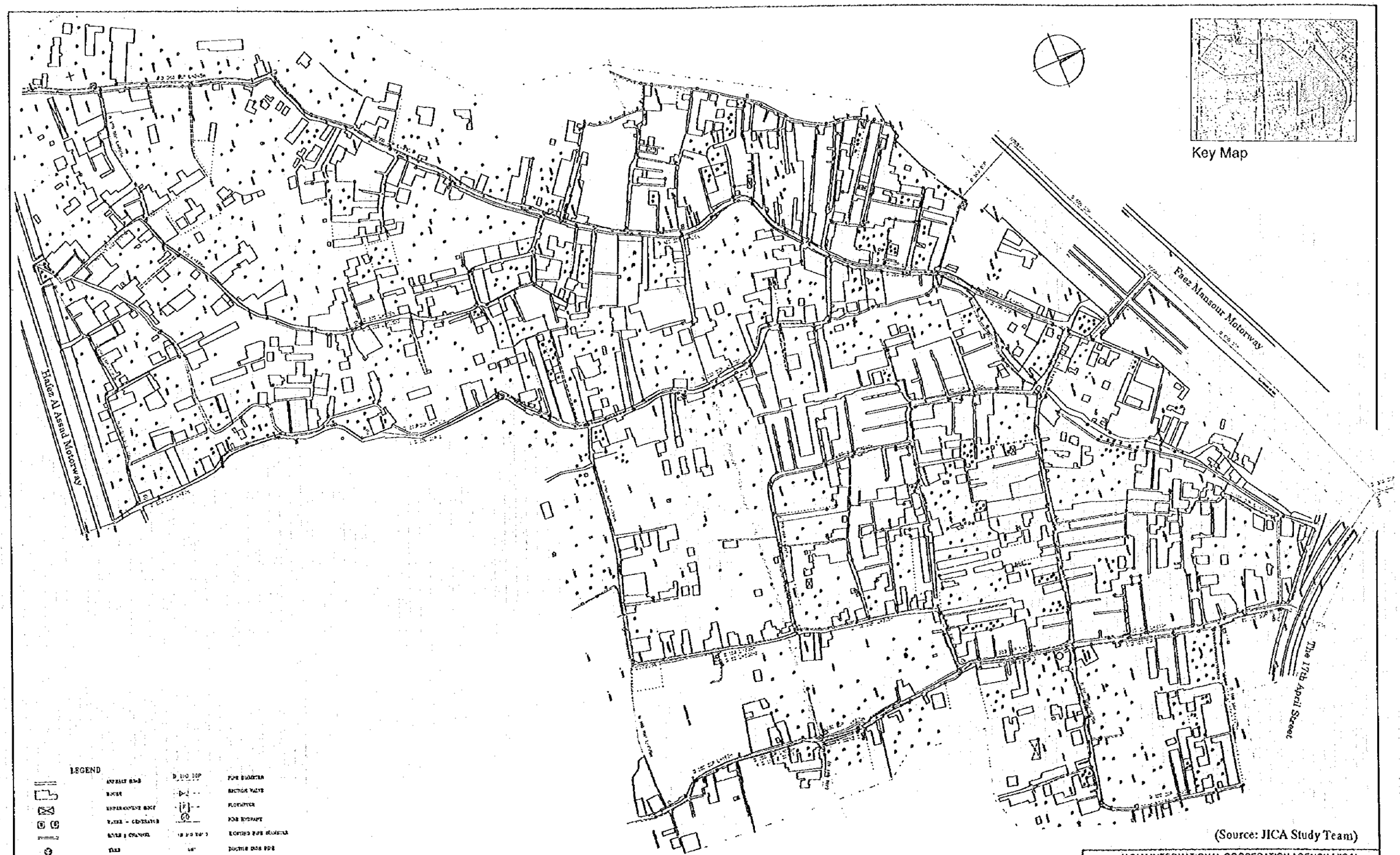
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY

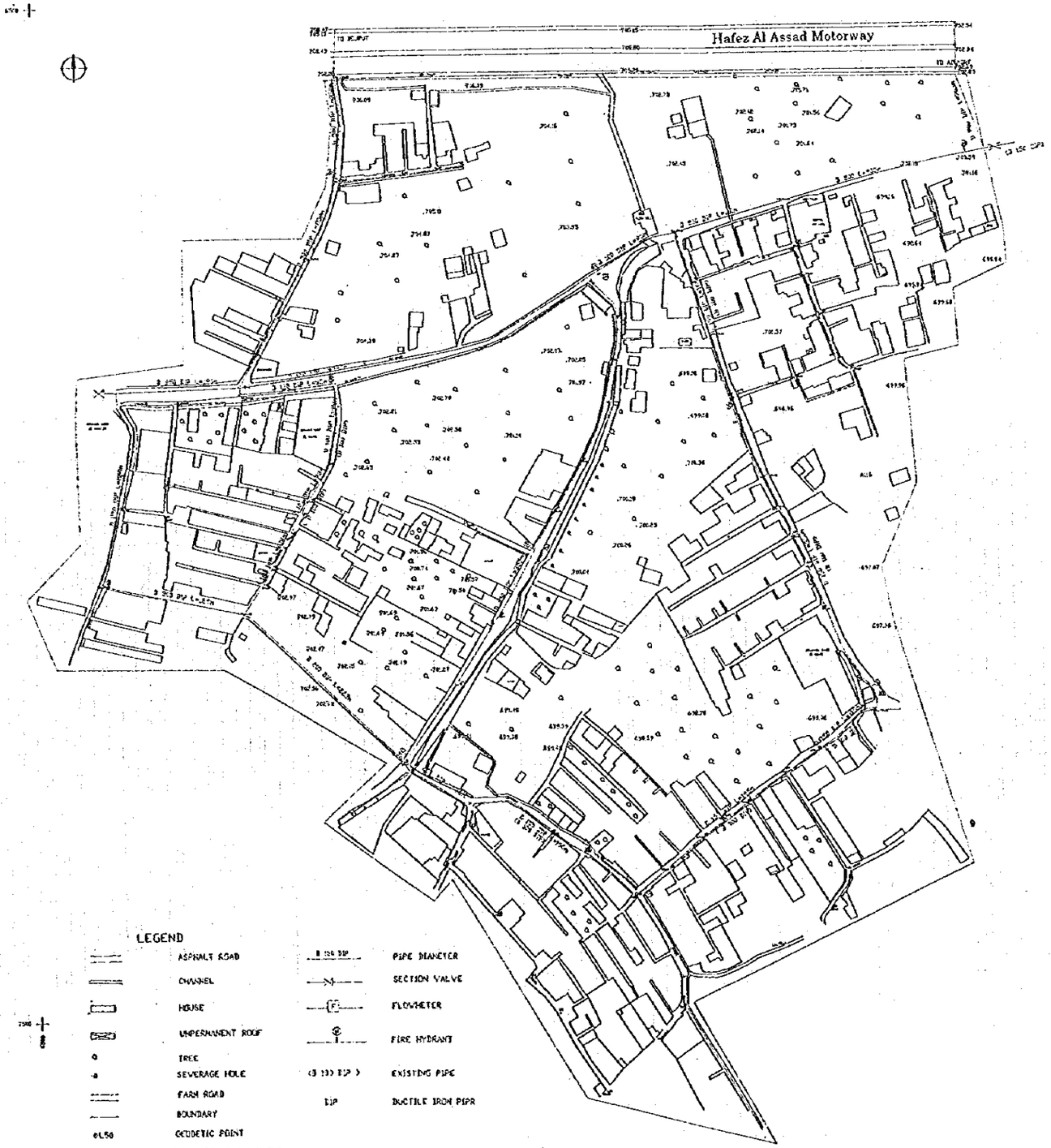
Figure 5.3.3
Existing Water Supply (Kafar Souseh-Lawan)

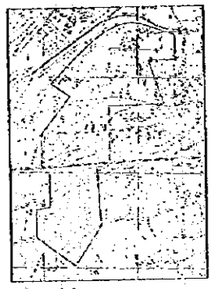
NIPPON KOEI CO., LTD.



(Source: JICA Study Team)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.3.4(1/2) Overall Water Supply Improvement Plan (Mezze-Razy)
NIPPON KOEI CO., LTD.




Key Map

(Source: JICA Study Team)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON THE DEVELOPMENT OF WATER SUPPLY SYSTEM FOR THE DAMASCUS CITY
Figure 5.3.4(2/2) Overall Water Supply Improvement Plan (Kafar Souseh-Lawan)
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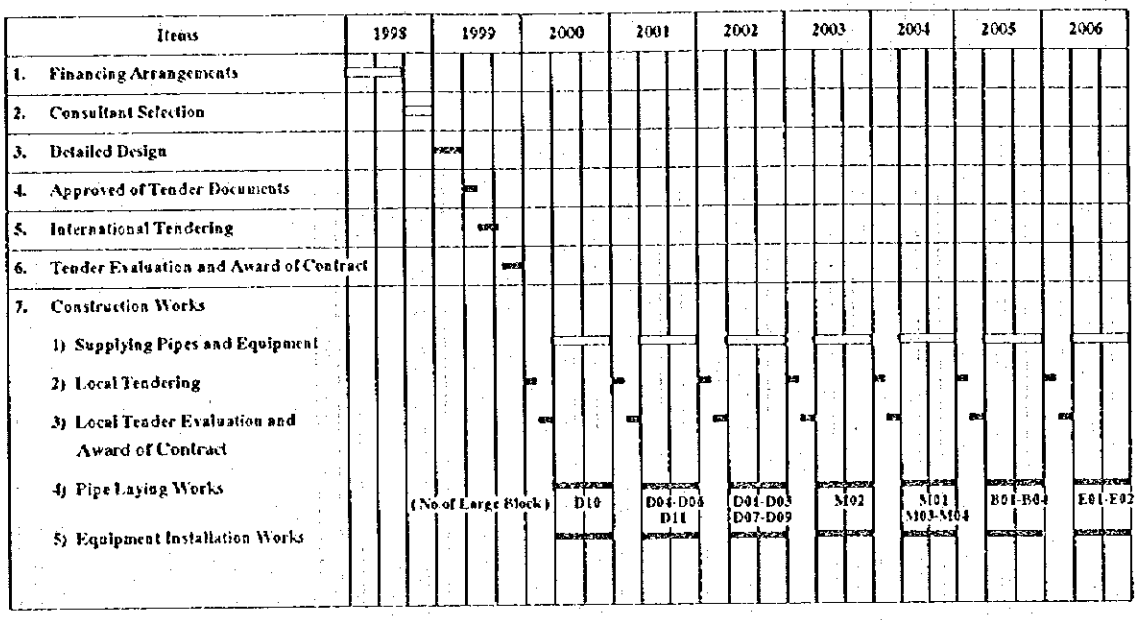
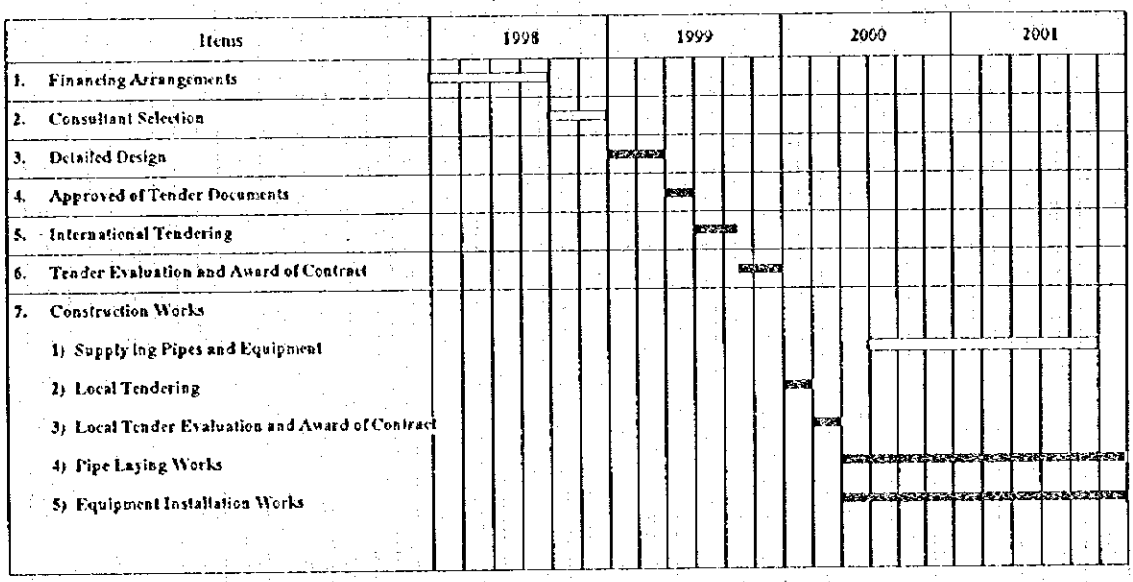
District Meter Area (DMA)



Mezze Razy & Kafar Sousch - Lawan System



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Fig.- 5.5.1 Implementation Schedule

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6. PROJECT EVALUATION

6.1 Economic Internal Rate Of Return (EIRR)

6.1.1 General

Water available for consumption will increase through the significant reduction in unaccounted for water. This increase in available water will generate many economic benefits which will enhance socio-economic conditions in the study area. 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. The economic evaluation of the 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 are evaluated as two separate projects. Economic evaluation is discussed in the following paragraphs with supporting details presented in appendix D.

6.1.2 Economic Costs

The capital costs of the proposed investment in the Damascus water supply system are summarized in terms of economic costs in Table 6.1.2. 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 meters 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 the Mezze-Razy & Kafar Souseh Lawan 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.

6.1.3 Economic Benefits

The main benefit of the DMA system is the incremental revenue from water saved due to reduction in leakage.

The principle benefits of the Mezze-Razy & Kafar Souseh-Lawan project has been quantified based on: (1) public health benefits through a reduction in waterborne diseases, and (2) incremental revenue from the sale of water to informal residents. Estimated economic benefits are presented in Table 6.1.1. The DMA projects will reduce the amount of leakage resulting in a net increase of 18.5 million in the amount of water available for consumption. This incremental water is evaluated using the average Unit Cost of Leakage (UCL= 0.04 US$) which reflects expected cost savings in annual operations and deferred capital expenditures over the 30 year life of the project. The DMA project will provide a total economic benefit of $738,360 per year by the end the year 2007.

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. Based on the existing average economic tariff of \$0.10 per m^3 the project will result in annual water sales of \$376,000.

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. 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.

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)

For the 50,000 residents, 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 population of Mezze-Razy & Kafar Souseh-Lawan area. 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 be the source of continuing health problems. The total annual economic benefit attributable to the improvement of distribution in informal areas is \$499,000.

6.1.4 Results of EIRR

Discounted cash flows produced for the DMA and Mezze-Razy & Kafar Souseh-Lawan area project are shown in Tables 6.1.3 and 6.1.4 respectively. Projects with an EIRR above 7% (assumed opportunity cost of capital) are deemed economically viable. 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 Mezze-Razy & Kafar Souseh-Lawan area 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 or 5% and the informal area project has an EIRR of 6% making both projects only marginally acceptable.

6.2 Financial Analysis

6.2.1 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 Mezze-Razy & Kafar Souseh-Lawan area 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.

6.2.2 Incremental revenue

The DMA leakage control project and the extension of the water network into Mezze-Razy & Kafar Souseh-Lawan area are 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 6.2.1. 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.

6.2.3 Incremental Costs

Incremental costs shown in Table 6.2.2 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 Mezze-Razy & Kafar Souseh-Lawan area is estimated at $6.3 million over a two-year period. There are no equipment replacement costs and O&M costs are assumed negligible.

6.2.4 FIRR Calculations

Based on incremental revenue and costs, the financial internal rate of return FIRR is calculated for the DMA and the informal area distribution project as shown in Table 6.2.3. The resulting FIRR of 16% indicates that the project is financially viable at present water tariff 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%.

6.2.5 Affordability

Affordability and ability to pay are key parameters in assessing whether the proposed investment in the distribution system for Mezze-Razy & Kafar Souseh-Lawan area 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 3,500 to 6,000 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. However, there is probably not much capacity to increase water tariffs beyond existing levels given the extreme poverty of the residents in Mezze-Razy & Kafar Souseh-Lawan area who do not currently have to pay for water and would have to re-allocate income now spent on other household expenditures.

6.2.6 Financial Projections

DAWSSA does not have the capital to invest in the projects. Therefore it is assumed that most of the 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 viability of proceeding with both projects at current tariff levels.

(1) Assumptions

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

i) 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 Mezze-Razy & Kafar Souseh-Lawan area.

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

iii) 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.

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

a) 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

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

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

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

vii) The DMA and the Mezze-Razy & Kafar Souseh-Lawan area 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) Future Financial Performance

Based on the assumptions mentioned in the previous sub-section projected future financial performance is summarized in Table 6.2.4 for the period 2000 to 2010. The financial projections show accumulated net capital remains positive for the term of the loan indicating the project is financially viable for the assumed on-lending conditions. This positive position will allow DAWSSA to build additional cash reserves for financing subsequent investments and equipment replacement. 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.

6.3 Environmental Impact Assessment (EIA) of the Proposed Projects

6.3.1 Overall Environmental Impacts of Proposed Project

The proposed project will significantly improve the environmental condition of Damascus by providing safe drinking water in larger quantity (saving of up to 18.5 MCM/year by leakage control programs) to more people (new service population of 32,000 in Mezze-Razy & Kafar Souseh-Lawan area) without exploiting new water resources. The inevitable environmental consequence of water supply project is the generation of wastewater. To deal with the wastewater problem, Damascus Municipality is currently developing a central water treatment facility in Damascus suburb, and the generated wastewater will be treated at this facility which is expected to become operational by the end of 1997 before the implementation of the proposed water supply project. Other negative environmental impacts of the proposed projects, such as construction related environmental problems (e.g., noise, traffic) will be minor.

6.3.2 EIA on DMA Project

(1) Public health (operation stage)

A set of leakage reduction programs including DMA project will save as much as 18.5 MCM/year of the supplied water, which is equivalent to the water consumption of 253,000 capita/year (assuming 200 lpcd). In addition to the water quantity, the DMA project will improve the quality of the supplied water in the following ways.

1) Saving of High Quality Water: Leakage loss of high quality water from Figeh Spring will be greatly reduced by the leakage control programs.

2) Reduction of Secondary Contamination: Leaky pipes and joints are important sources of secondary contamination. The DMA will detect any abnormally low pressure in the system, and help reduce the secondary contamination.

3) Strategic Allocation of High Quality Water: Water quality in south Damascus is poor in dry season (nitrate and hardness problems) because low quality water from local wells (e.g., Kadam Railway wellfield) is used to supplement the shortage of high quality water from Figeh Spring. The proposed DMA scheme allocates more water from Figeh Spring to south Damascus. This improved allocation of water will also partially improve the water quality in south Damascus in dry season (Figure 6.3.1), although large change in water quality is not expected.

These positive impacts of the DMA project can only be realized by constructing the DMA system properly. Guidelines to reduce secondary contamination in the construction stage are given in Chapter 5 of Appendix C. Another important practices that ensure safety of supplied water are water quality monitoring and maintenance of the system. These are also discussed in Appendix C.

(2) Wastewater issues (operation stage)

By implementing the DMA project along with other leakage control programs, a large amount of supplied water will be saved, which will, in turn, result in the net increase in wastewater. To deal with wastewater problems, Damascus Municipality is currently developing sewerage system in Damascus (see Section 4.2.1 of Appendix C for the synopsis of the plan). There are extensive networks of sewers already, and the treatment plant in Adrer (suburb of Damascus) is expected to become operational by the end of 1997 before the implementation of the proposed water supply projects. This sewerage system will be used to treat the wastewater.

6.3.3 EIA on Mezze - Razy & Kafar Souseh - Lawan System

(1) Construction related environmental problems

In the interview survey (Section 3.3), 80 % of the local residents expressed no environmental concern about the proposed project. The local residents are aware of the direct

benefit of the water supply project, and they are anticipating large long-term benefit over the short-term adverse impacts of the project. However, the local residents want the project to be done as fast as possible with minimum inconvenience. Many roads in these areas are narrow (e.g., 60% of the roads in Mezze-Razy are 4 to 6 m wide) and winding. To carry out construction, some roads will have to be closed during the construction. The area of significant noise exposure (e.g., above 65 dB(A)) will be limited within 20 to 30 m from the construction site. Nevertheless it is still important to minimize any construction-related nuisance and inconvenience to the local residents. Keeping good public relation with the local residents is the key to achieve this. The residents are to be informed about the construction plan in advance, and unnecessary noise, vibration, and traffic blocking should be minimized by planning the construction activities in environmentally-conscious ways. A set of guidelines to minimize environmental problems during construction are given in Appendix C.

(2) Equity (operation stage)

The people who are benefited by the proposed project will be limited to the residents in Mezze-Razy & Kafar Souseh-Lawan area. Nevertheless, the project will contribute to the equity among the people in Damascus for the following reasons.

- Currently public water supply in these areas is limited, while most other areas in Damascus are already serviced by DAWSSA.
- The living standard of the people in these areas is lower than the average of Damascus.
- Many people living in these areas are stealing water, while others are paying for water. The project will stop the stealing, and charge the water users according to their consumption. The impact of the proposed project on the household economy of the informal residents has been analyzed in Section 6.2.2.

The project, however, will not alleviate the public health condition outside of Damascus, where water resource is limited.

6.3.4 EIA on Construction Works in Old City

(1) Cultural assets (construction stage)

Listed in the World Heritage List of UNESCO (UNESCO, 1996), the Old City of Damascus is historical, religious and commercial center of Damascus, and about 20,000 people live in the Old City. Although the majority of distribution pipes in the Old City are in good condition, there are a number of old cast iron pipes, and the replacement of these pipes will be inevitable in the future. Most of the existing water supply mains are laid under existing roads, and direct impact of the construction activities to the historical buildings will be limited. However, many buildings in the Old City are old and vulnerable to structural damage. DAWSSA should discuss the construction plan with the relevant authority (Committee of the Old City of Damascus and the Ministry of Culture) in advance, and follow the guidelines provided by the Committee of the Old City of Damascus (see Chapter 5 of Appendix C for details).

Table 6.1.1 Estimated Economic Benefits

US dollars based on shadow exchange rate of 50 SL per dollar

DMA					Informal Areas				
Year	Net Incremental Water (000's m³)	Unit value	Gross benefits ($)	Year	Incremental Water (000's m³)	Unit Value	Water Sales ($)	Health Benefits ($)	Total Benefits ($)
		0.04				0.10			
2000	-	0.04	-	2000	-	0.10	-	-	
2001	2,637	0.04	105,480	2001	-	0.10	-	-	
2002	5,274	0.04	210,960	2002	3,760	0.10	376,000	123,000	499,000
2003	7,911	0.04	316,440	2003	3,760	0.10	376,000	123,000	499,000
2004	10,548	0.04	421,920	2004	3,760	0.10	376,000	123,000	499,000
2005	13,185	0.04	527,400	2005	3,760	0.10	376,000	123,000	499,000
2006	15,822	0.04	632,880	2006	3,760	0.10	376,000	123,000	499,000
2007	18,459	0.04	738,360	2007	3,760	0.10	376,000	123,000	499,000
2008	18,459	0.04	738,360	2008	3,760	0.10	376,000	123,000	499,000
2009	18,459	0.04	738,360	2009	3,760	0.10	376,000	123,000	499,000
2010	18,459	0.04	738,360	2010	3,760	0.10	376,000	123,000	499,000
2011	18,459	0.04	738,360	2011	3,760	0.10	376,000	123,000	499,000
2012	18,459	0.04	738,360	2012	3,760	0.10	376,000	123,000	499,000
2013	18,459	0.04	738,360	2013	3,760	0.10	376,000	123,000	499,000
2014	18,459	0.04	738,360	2014	3,760	0.10	376,000	123,000	499,000
2015	18,459	0.04	738,360	2015	3,760	0.10	376,000	123,000	499,000
2016	18,459	0.04	738,360	2016	3,760	0.10	376,000	123,000	499,000
2017	18,459	0.04	738,360	2017	3,760	0.10	376,000	123,000	499,000
2018	18,459	0.04	738,360	2018	3,760	0.10	376,000	123,000	499,000
2019	18,459	0.04	738,360	2019	3,760	0.10	376,000	123,000	499,000
2020	18,459	0.04	738,360	2020	3,760	0.10	376,000	123,000	499,000
2021	18,459	0.04	738,360	2021	3,760	0.10	376,000	123,000	499,000
2022	18,459	0.04	738,360	2022	3,760	0.10	376,000	123,000	499,000
2023	18,459	0.04	738,360	2023	3,760	0.10	376,000	123,000	499,000
2024	18,459	0.04	738,360	2024	3,760	0.10	376,000	123,000	499,000
2025	18,459	0.04	738,360	2025	3,760	0.10	376,000	123,000	499,000
2026	18,459	0.04	738,360	2026	3,760	0.10	376,000	123,000	499,000
2027	18,459	0.04	738,360	2027	3,760	0.10	376,000	123,000	499,000
2028	18,459	0.04	738,360	2028	3,760	0.10	376,000	123,000	499,000
2029	18,459	0.04	738,360	2029	3,760	0.10	376,000	123,000	499,000
2030	18,459	0.04	738,360	2030	3,760	0.10	376,000	123,000	499,000
2031	18,459	0.04	738,360	2031	3,760	0.10	376,000	123,000	499,000
2032	18,459	0.04	738,360	2032	3 760	0.10	376,000	123,000	499,000
2033	18,459	0.04	738,360						
2034	18,459	0.04	738,360						
2035	18,459	0.04	738,360						
2036	18,459	0.04	738,360						
Total	609,147		24,365,880	Total	116,560		11,656,000	3,813,000	15,469,000

Table 6.1.2 Estimated Economic Costs

US dollars based on shadow exchange rate of 50 SL per dollar

	DMA				Informal Areas		
Year	Capital Costs ($)	O&M Costs ($)	Total ($)	Year	Capitsl Costs ($)	O&M Costs ($)	Total ($)
2000	616,313	-	616,313	2000	2,611,400		2,611,400
2001	616,313	63,500	679,813	2001	2,611,400		2,611,400
2002	616,313	95,000	711,313	2002	-	-	-
2003	616,313	126,500	742,813	2003	-	-	-
2004	616,313	158,000	774,313	2004	-	-	-
2005	616,313	189,500	805,813	2005	-	-	-
2006	616,313	221,000	837,313	2006	-	-	-
2007	-	257,000	257,000	2007	-	-	-
2008	-	257,000	257,000	2008	-	-	-
2009		257,000	257,000	2009	-	-	-
2010	-	257,000	257,000	2010	-	-	-
2011	-	257,000	257,000	2011	-	-	-
2012	-	257,000	257,000	2012	-	-	-
2013	-	257,000	257,000	2013	-	-	-
2014	-	257,000	257,000	2014	-	-	-
2015	-	257,000	257,000	2015	-	-	-
2016	-	257,000	257,000	2016	-	-	-
2017	-	257,000	257,000	2017	-	-	-
2018	-	257,000	257,000	2018	-	-	-
2019	-	257,000	257,000	2019	-	-	-
2020	-	257,000	257,000	2020	-	-	-
2021	2,286,200	257,000	2,543,200	2021	-	-	-
2022	-	257,000	257,000	2022	-	-	-
2023	-	257,000	257,000	2023	-	-	-
2024	-	257,000	257,000	2024	-	-	-
2025	-	257,000	257,000	2025	-	-	-
2026	-	257,000	257,000	2026	-	-	-
2027		257,000	257,000	2027	-	-	-
2028		257,000	257,000	2028	-	-	-
2029		257,000	257,000	2029	-	-	-
2030		257,000	257,000	2030	-	-	-
2031		257,000	257,000	2031	-	-	-
2032		257,000	257,000	2032	-	-	-
2033		257,000	257,000				
2034		257,000	257,000				
2035		257,000	257,000				
2036		257,000	257,000				
Total	6,600,391	8,563,500	15,163,891	Total	5,222,800		5,222,800

Table 6.1.3 Economic Internal Rate of Return -DMA

Year	Total Costs	Total Benefit	Benefit - Cost
2000	616,313	-	(616,313)
2001	679,813	105,480	(574,333)
2002	711,313	210,960	(500,353)
2003	742,813	316,440	(426,373)
2004	774,313	421,920	(352,393)
2005	805,813	527,400	(278,413)
2006	837,313	632,880	(204,433)
2007	257,000	738,360	481,360
2008	257,000	738,360	481,360
2009	257,000	738,360	481,360
2010	257,000	738,360	481,360
2011	257,000	738,360	481,360
2012	257,000	738,360	481,360
2013	257,000	738,360	481,360
2014	257,000	738,360	481,360
2015	257,000	738,360	481,360
2016	257,000	738,360	481,360
2017	257,000	738,360	481,360
2018	257,000	738,360	481,360
2019	257,000	738,360	481,360
2020	257,000	738,360	481,360
2021	2,543,200	738,360	(1,804,840)
2022	257,000	738,360	481,360
2023	257,000	738,360	481,360
2024	257,000	738,360	481,360
2025	257,000	738,360	481,360
2026	257,000	738,360	481,360
2027	257,000	738,360	481,360
2028	257,000	738,360	481,360
2029	257,000	738,360	481,360
2030	257,000	738,360	481,360
2031	257,000	738,360	481,360
2032	257,000	738,360	481,360
2033	257,000	738,360	481,360
2034	257,000	738,360	481,360
2035	257,000	738,360	481,360
2036	257,000	738,360	481,360

Internal Rate of Return	%
1. Base Case	9%
2. Costs + 15%	7%
3. Benefits - 10%	7%
4. 2 and 3	5%

Table 6.1.4 Economic Internal Rate of Return -Informal Areas

Year	Total Costs	Total Benefit	Benefit - Cost
2000	2,611,400	-	(2,611,400)
2001	2,611,400	-	(2,611,400)
2002	-	499,000	499,000
2003	-	499,000	499,000
2004	-	499,000	499,000
2005	-	499,000	499,000
2006	-	499,000	499,000
2007	-	499,000	499,000
2008	-	499,000	499,000
2009	-	499,000	499,000
2010	-	499,000	499,000
2011	-	499,000	499,000
2012	-	499,000	499,000
2013	-	499,000	499,000
2014	-	499,000	499,000
2015	-	499,000	499,000
2016	-	499,000	499,000
2017	-	499,000	499,000
2018	-	499,000	499,000
2019	-	499,000	499,000
2020	-	499,000	499,000
2021	-	499,000	499,000
2022	-	499,000	499,000
2023	-	499,000	499,000
2024	-	499,000	499,000
2025	-	499,000	499,000
2026	-	499,000	499,000
2027	-	499,000	499,000
2028	-	499,000	499,000
2029	-	499,000	499,000
2030	-	499,000	499,000
2031	-	499,000	499,000
2032	-	499,000	499,000

Internal Rate of Return	%
1. Base Case	8%
2. Costs + 15%	7%
3. Benefits - 10%	7%
4. 2 and 3	6%

Table 6.2.1 Estimated Financial Benefits

US dollars based on official exchange rate of 45 SL per dollar

	DMA				Informal Areas		
Year	Incremental Water (000's m³)	Unit value	Gross benefits ($)	Year	Incremental Water (000's m³)	Unit value	Gross benefits ($)
		0.11				0.11	
2000	-	0.11	-	2000	-	0.11	-
2001	2,637	0.11	290,070	2001	-	0.11	-
2002	5,274	0.11	580,140	2002	3,760	0.11	413,600
2003	7,911	0.11	870,210	2003	3,760	0.11	413,600
2004	10,548	0.11	1,160,280	2004	3,760	0.11	413,600
2005	13,185	0.11	1,450,350	2005	3,760	0.11	413,600
2006	15,822	0.11	1,740,420	2006	3,760	0.11	413,600
2007	18,459	0.11	2,030,490	2007	3,760	0.11	413,600
2008	18,459	0.11	2,030,490	2008	3,760	0.11	413,600
2009	18,459	0.11	2,030,490	2009	3,760	0.11	413,600
2010	18,459	0.11	2,030,490	2010	3,760	0.11	413,600
2011	18,459	0.11	2,030,490	2011	3,760	0.11	413,600
2012	18,459	0.11	2,030,490	2012	3,760	0.11	413,600
2013	18,459	0.11	2,030,490	2013	3,760	0.11	413,600
2014	18,459	0.11	2,030,490	2014	3,760	0.11	413,600
2015	18,459	0.11	2,030,490	2015	3,760	0.11	413,600
2016	18,459	0.11	2,030,490	2016	3,760	0.11	413,600
2017	18,459	0.11	2,030,490	2017	3,760	0.11	413,600
2018	18,459	0.11	2,030,490	2018	3,760	0.11	413,600
2019	18,459	0.11	2,030,490	2019	3,760	0.11	413,600
2020	18,459	0.11	2,030,490	2020	3,760	0.11	413,600
2021	18,459	0.11	2,030,490	2021	3,760	0.11	413,600
2022	18,459	0.11	2,030,490	2022	3,760	0.11	413,600
2023	18,459	0.11	2,030,490	2023	3,760	0.11	413,600
2024	18,459	0.11	2,030,490	2024	3,760	0.11	413,600
2025	18,459	0.11	2,030,490	2025	3,760	0.11	413,600
2026	18,459	0.11	2,030,490	2026	3,760	0.11	413,600
2027	18,459	0.11	2,030,490	2027	3,760	0.11	413,600
2028	18,459	0.11	2,030,490	2028	3,760	0.11	413,600
2029	18,459	0.11	2,030,490	2029	3,760	0.11	413,600
2030	18,459	0.11	2,030,490	2030	3,760	0.11	413,600
2031	18,459	0.11	2,030,490	2031	3,760	0.11	413,600
2032	18,459	0.11	2,030,490	2032	3,760	0.11	413,600
2033	18,459	0.11	2,030,490				
2034	18,459	0.11	2,030,490				
2035	18,459	0.11	2,030,490				
2036	18,459	0.11	2,030,490				
Total	609,147		67,006,170	Total	116,560		12,821,600

Table 6.2.2 Estimated Financial Costs

US dollars based on official exchange rate of 45 SL per dollar

	DMA				Informal Areas		
Year	Capital Costs ($)	O&M Costs ($)	Total ($)	Year	Capital Costs ($)	O&M Costs ($)	Total ($)
2000	664,715	-	664,715	2000	3,141,500		3,141,500
2001	664,715	70,555	735,270	2001	3,141,500		3,141,500
2002	664,715	105,555	770,270	2002	-	-	-
2003	664,715	140,555	805,270	2003	-	-	-
2004	664,715	175,555	840,270	2004	-	-	-
2005	664,715	210,555	875,270	2005	-	-	-
2006	664,715	245,555	910,270	2006	-	-	-
2007	-	285,555	285,555	2007	-	-	-
2008	-	285,555	285,555	2008	-	-	-
2009		285,555	285,555	2009	-	-	-
2010	-	285,555	285,555	2010	-	-	-
2011	-	285,555	285,555	2011	-	-	-
2012	-	285,555	285,555	2012	-	-	-
2013	-	285,555	285,555	2013	-	-	-
2014	-	285,555	285,555	2014	-	-	-
2015	-	285,555	285,555	2015	-	-	-
2016	-	285,555	285,555	2016	-	-	-
2017	-	285,555	285,555	2017	-	-	-
2018	-	285,555	285,555	2018	-	-	-
2019	-	285,555	285,555	2019	-	-	-
2020	-	285,555	285,555	2020	-	-	-
2021	3,013,700	285,555	3,299,255	2021	-	-	-
2022	-	285,555	285,555	2022	-	-	-
2023	-	285,555	285,555	2023	-	-	-
2024	-	285,555	285,555	2024	-	-	-
2025	-	285,555	285,555	2025	-	-	-
2026	-	285,555	285,555	2026	-	-	-
2027	-	285,555	285,555	2027	-	-	-
2028	-	285,555	285,555	2028	-	-	-
2029	-	285,555	285,555	2029	-	-	-
2030	-	285,555	285,555	2030	-	-	-
2031	-	285,555	285,555	2031	-	-	-
2032	-	285,555	285,555	2032	-	-	-
2033	-	285,555	285,555				-
2034	-	285,555	285,555				-
2035	-	285,555	285,555				-
2036	-	285,555	285,555				-
Total	7,666,705	9,514,980	17,181,685	Total	6,283,000	-	6,283,000

Table 6.2.3 Financial Internal Rate of Return

1 US$ = 45 SL

Year	Total Costs	Total Benefit	Benefit - Cost
2000	3,806,215	-	(3,806,215)
2001	3,876,770	290,070	(3,586,700)
2002	770,270	993,740	223,470
2003	805,270	1,283,810	478,540
2004	840,270	1,573,880	733,610
2005	875,270	1,863,950	988,680
2006	910,270	2,154,020	1,243,750
2007	285,555	2,444,090	2,158,535
2008	285,555	2,444,090	2,158,535
2009	285,555	2,444,090	2,158,535
2010	285,555	2,444,090	2,158,535
2011	285,555	2,444,090	2,158,535
2012	285,555	2,444,090	2,158,535
2013	285,555	2,444,090	2,158,535
2014	285,555	2,444,090	2,158,535
2015	285,555	2,444,090	2,158,535
2016	285,555	2,444,090	2,158,535
2017	285,555	2,444,090	2,158,535
2018	285,555	2,444,090	2,158,535
2019	285,555	2,444,090	2,158,535
2020	285,555	2,444,090	2,158,535
2021	3,299,255	2,444,090	(855,165)
2022	285,555	2,444,090	2,158,535
2023	285,555	2,444,090	2,158,535
2024	285,555	2,444,090	2,158,535
2025	285,555	2,444,090	2,158,535
2026	285,555	2,444,090	2,158,535
2027	285,555	2,444,090	2,158,535
2028	285,555	2,444,090	2,158,535
2029	285,555	2,444,090	2,158,535
2030	285,555	2,444,090	2,158,535
2031	285,555	2,444,090	2,158,535
2032	285,555	2,444,090	2,158,535
2033	285,555	2,444,090	2,158,535
2034	285,555	2,444,090	2,158,535
2035	285,555	2,444,090	2,158,535
2036	285,555	2,444,090	2,158,535

Internal Rate of Return	%
1. Base Case	16%
2. Costs + 15%	14%
3. Benefits - 10%	15%
4. 2 and 3	13%

Table 6.2.4 (1/3) Projected Cash Flow

in US $

I. Income Statement	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.1 Revenue											
(1) Incremental Water Sales (000 m3)	-	2,637	9,034	11,671	14,308	16,945	19,582	22,219	22,219	22,219	22,219
(2) Average Water Tariff	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
(3) Total Revenue	-	290,070	993,740	1,283,810	1,573,880	1,863,950	2,154,020	2,444,090	2,444,090	2,444,090	2,444,090
1.2 Expenditure											
(1) Salary	-	12,462	12,462	12,462	12,462	12,462	12,462	12,462	12,462	12,462	12,462
(2) Electricity	-	175	175	175	175	175	175	175	175	175	175
(3) Depreciation	-	-	138,700	138,700	138,700	138,700	138,700	138,700	339,633	339,633	339,633
(4) Repair & Others	-	57,918	92,918	127,918	162,918	197,918	232,918	272,918	272,918	272,918	272,918
(5) Foreign Loan Interest							539,243	560,987	545,978	529,920	512,737
(6) Total Expenditures	-	70,555	244,255	279,255	314,255	349,255	923,498	985,242	1,171,166	1,155,108	1,137,925
1.3 Revenue - Expenditure	-	219,515	749,485	1,004,555	1,259,625	1,514,695	1,230,522	1,458,848	1,272,924	1,288,982	1,306,165
1.4 Profit Taxes	-	131,709	449,691	602,733	755,775	908,817	738,313	875,309	763,754	773,389	783,699
1.5 Net Revenue (after interest and taxes)	-	87,806	299,794	401,822	503,850	605,878	492,209	583,539	509,169	515,593	522,466
1.6 Accumulated Net Revenue(Deficit)	-	87,806	387,600	789,422	1,293,272	1,899,150	2,391,359	2,974,898	3,484,068	3,999,661	4,522,127
II. Cash Flow											
2.1 Cash Inflow											
(1) Cash Flow from Operations 1.5 + 1.2(3)	-	87,806	438,494	540,522	642,550	744,578	630,909	722,239	848,802	855,226	862,099
(2) Foreign Loan	2,854,661	2,854,661	498,536	498,536	498,536	498,536	498,536				
(3) Foreign Loan Accumulated	2,854,661	5,709,323	6,207,859	6,706,395	7,204,931	7,703,468	8,202,004				
(4) Government Contribution	951,554	951,554	166,179	166,179	166,179	166,179	166,179				
(5) Government Contribution Accumul.	951,554	1,903,108	2,069,286	2,235,465	2,401,644	2,567,823	2,734,001				
(6) Total Cash Inflow	3,806,215	3,894,021	1,103,209	1,205,237	1,307,265	1,409,293	1,295,624	722,239	848,802	855,226	862,099
2.2 Cash Outflow											
(1) Investment	3,806,215	3,806,215	664,715	664,715	664,715	664,715	664,715				
(2) Foreign Loan Repayment							187,910	214,401	229,409	245,468	262,651
(3) Total Outflow	3,806,215	3,806,215	664,715	664,715	664,715	664,715	852,625	214,401	229,409	245,468	262,651
2.3 Net Cash Flow											
2.1(6) - 2.2(4)	-	87,806	438,494	540,522	642,550	744,578	442,999	507,838	619,393	609,758	599,448
2.4 Accumulated Net Cash Flow	-	87,806	526,300	1,066,822	1,709,372	2,453,950	2,896,949	3,404,787	4,024,180	4,633,938	5,233,386

Table 6.2.4 (2/3) Projected Cash Flow

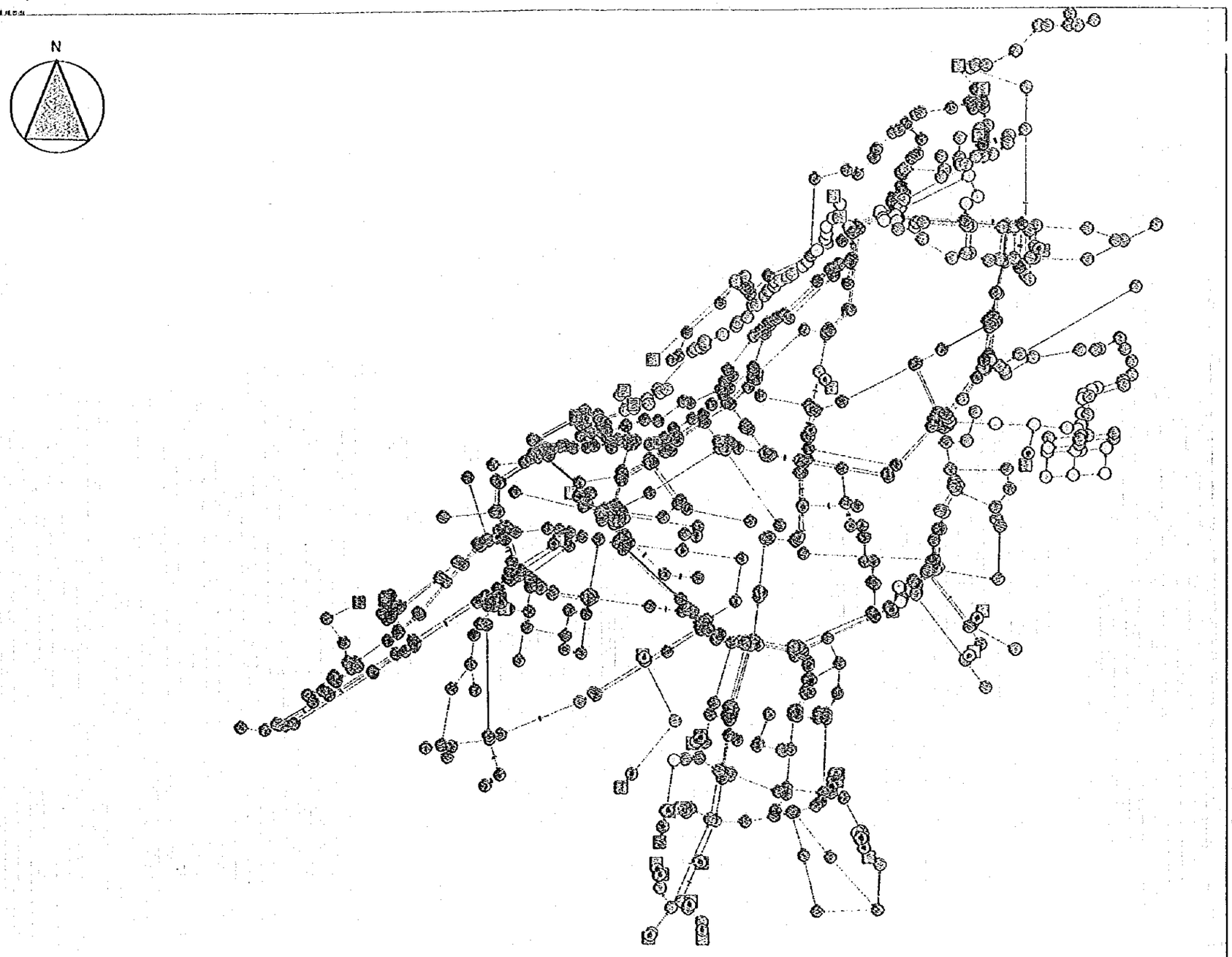
inUS $

I. Income Statement	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1.1 Revenue											
(1) Incremental Water Sales (000 m3)	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219
(2) Average Water Tariff	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
(3) Total Revenue	2,444,090	2,444,090	2,444,090	2,444,090	2,444,090	2,444,090	2,444,090	2,444,090	2,444,090	2,444,090	2,444,090
1.2 Expenditure											
(1) Salary	12,462	12,462	12,462	12,462	12,462	12,462	12,462	12,462	12,462	12,462	12,462
(2) Electricity	175	175	175	175	175	175	175	175	175	175	175
(3) Depreciation	339,633	339,633	339,633	339,633	339,633	339,633	339,633	339,633	339,633	339,633	339,633
(4) Repair & Others	272,918	272,918	272,918	272,918	272,918	272,918	272,918	272,918	272,918	272,918	272,918
(5) Foreign Loan Interest	494,352	474,679	453,629	431,106	407,007	381,220	353,628	324,105	292,515	258,714	222,547
(6) Total Expenditures	1,119,540	1,099,867	1,078,817	1,056,294	1,032,195	1,006,408	978,816	949,293	917,703	883,902	847,735
1.3 Revenue - Expenditure	1,324,550	1,344,223	1,365,273	1,387,796	1,411,895	1,437,682	1,465,274	1,494,797	1,526,387	1,560,188	1,596,355
1.4 Profit Taxes	794,730	806,534	819,164	832,677	847,137	862,609	879,164	896,878	915,832	936,113	957,813
1.5 Net Revenue (after interest and taxes)	529,820	537,689	546,109	555,118	564,758	575,073	586,110	597,919	610,555	624,075	638,542
1.6 Accumulated Net Revenue(Deficit)	5,051,947	5,589,636	6,135,745	6,690,863	7,255,621	7,830,694	8,416,804	9,014,723	9,625,277	10,249,352	10,887,894
II. Cash Flow											
2.1 Cash Inflow											
(1) Cash Flow from Operations 1.5 + 1.2(3)	869,453	877,322	885,742	894,751	904,391	914,706	925,743	937,552	950,188	963,708	978,175
(2) Foreign Loan											
(3) Foreign Loan Accumulated											
(4) Government Contribution											
(5) Government Contribution Accumul.											
(6) Total Cash Inflow	869,453	877,322	885,742	894,751	904,391	914,706	925,743	937,552	950,188	963,708	978,175
2.2 Cash Outflow											
(1) Investment											3,013,700
(2) Foreign Loan Repayment	281,036	300,709	321,758	344,281	368,381	394,168	421,760	451,283	482,873	516,674	552,841
(3) Total Outflow	281,036	300,709	321,758	344,281	368,381	394,168	421,760	451,283	482,873	516,674	3,566,541
2.3 Net Cash Flow											
2.1(6) - 2.2(4)	588,417	576,613	563,984	550,470	536,010	520,538	503,983	486,269	467,315	447,035	(2,588,366)
2.4 Accumulated Net Cash Flow	5,821,803	6,398,417	6,962,401	7,512,871	8,048,881	8,569,419	9,073,402	9,559,671	10,026,986	10,474,020	7,885,655

Table 6.2.4 (3/3) Projected Cash Flow

in US $

I. Income Statement	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.1 Revenue											
(1) Incremental Water Sales (000 m3)	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219	22.219
(2) Average Water Tariff	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
(3) Total Revenue	2.444.090	2.444.090	2.444.090	2.444.090	2.444.090	2.444.090	2.444.090	2.444.090	2.444.090	2.444.090	2.444.090
1.2 Expenditure											
(1) Salary	12.462	12.462	12.462	12.462	12.462	12.462	12.462	12.462	12.462	12.462	12.462
(2) Electricity	175	175	175	175	175	175	175	175	175	175	175
(3) Depreciation	339.633	339.633	339.633	339.633	339.633	339.633	339.633	339.633	339.633	339.633	339.633
(4) Repair & Others	272.918	272.918	272.918	272.918	272.918	272.918	272.918	272.918	272.918	272.918	272.918
(5) Foreign Loan Interest	183.848	142.440	98.134	50.726							
(6) Total Expenditures	809.036	767.628	723.322	675.914	625.188	625.188	625.188	625.188	625.188	625.188	625.188
1.3 Revenue - Expenditure	1.635.054	1.676.462	1.720.768	1.768.176	1.818.902	1.818.902	1.818.902	1.818.902	1.818.902	1.818.902	1.818.902
1.4 Profit Taxes	981.032	1.005.877	1.032.461	1.060.905	1.091.341	1.091.341	1.091.341	1.091.341	1.091.341	1.091.341	1.091.341
1.5 Net Revenue (after interest and taxes)	654.022	670.585	688.307	707.270	727.561	727.561	727.561	727.561	727.561	727.561	727.561
1.6 Accumulated Net Revenue(Deficit)	11.541.916	12.212.501	12.900.808	13.608.078	14.335.639	15.063.200	15.790.760	16.518.321	17.245.882	17.973.443	18.701.004
II. Cash Flow											
2.1 Cash Inflow											
(1) Cash Flow from Operations 1.5 + 1.2(3)	993.655	1.010.218	1.027.940	1.046.903	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194
(2) Foreign Loan											
(3) Foreign Loan Accumulated											
(4) Government Contribution											
(5) Government Contribution Accumul.											
(6) Total Cash Inflow	993.655	1.010.218	1.027.940	1.046.903	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194
2.2 Cash Outflow											
(1) Investment											
(2) Foreign Loan Repayment	591.540	632.947	677.254	724.661							
(3) Total Outflow	591.540	632.947	677.254	724.661	-	-	-	-	-	-	-
2.3 Net Cash Flow											
2.1(6) - 2.2(4)	402.115	377.270	350.687	322.242	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194	1.067.194
2.4 Accumulated Net Cash Flow	8.287.770	8.665.040	9.015.726	9.337.968	10.405.162	11.472.356	12.539.550	13.606.744	14.673.937	15.741.131	16.808.325



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

Figure 6.3.1 Predicted Supplied Water Quality in Dry Season (DMA)

NIPPON KOEI CO., LTD.

7. FINANCIAL MANAGEMENT IMPROVEMENT PLAN

7.1 Implementation Priorities

A summary of the management recommendations that form the change strategy is presented in Figure 7.1.1. The figure provides an overview of the implementation priority for each recommendation and the extent to which the improvement objectives are dependent on the implementation of computer systems.

First and immediate priority : It is recognized that DAWSSA does not currently have the financial resources to embark on an extensive "automation" program. Therefore DAWSSA should begin by optimizing the billing and collection processes that are currently inefficient to yield some preliminary financial benefits and set the stage for further productivity improvements when computers are finally implemented. DAWSSA's first efforts should consist of implementing the following improvements:

(1) implement meter installation standards to increase meter reading productivity

(2) improve efficiency of the billing process by: 1) entering meter reading data as soon as meter readings for one district are complete; 2) carry out error verification only once before printing the bills; 3) issue the bills directly to the cashiers once the bills are printed.

(3) adopt a four (4) month meter reading and billing cycle to improve cash flow.

(4) implement a new payment policy to speed up collection of revenue. Change the payment period to 30 days, and implement active follow-up of delinquent accounts on a monthly basis, disconnecting delinquent accounts after six (6) months.

Second priority : before any more computer systems are purchased, DAWSSA should carry out a detailed planning study to assess computer needs across the organization, and develop a strategy for implementing integrated information systems. The remaining elements of the change strategy depend on the implementation of two modernization projects to

implement computer and information technology: 1) a new customer information system (CIS) including meter reading, billing, and customer accounting functions; and 2) a new financial management information system (FMIS) including budget preparation, cost accounting, and reporting. The future will bring more computer applications and not less therefore it will be essential for DAWSSA to prepare itself for the technological revolution that has already started. The risks of introducing computers to obtain the desired productivity improvements can be reduced by creating an information technology plan. Planning is a smart investment that provides many benefits: 1) systems can be designed to easily communicate information with each other; 2) support multiple applications; and 3) systems can be designed in a modular way to allow implementation of smaller parts over a longer period of time to reduce the burden on financial resources. Although information technology involves many issues and challenges, proper planning can deal with these issues sequentially to ensure that the organization's priorities and goals are met.. The result will be beneficial to the organization and customers will benefit because the long term costs of providing information technology will be reduced.

Third priority: before implementing new client server applications a new Information Technology Directorate should be created to group all activities related to planning, implementing and supporting computer systems and all other information technology based systems such as SCADA, data communications, and radio communication. The role of the existing Computer Department will change considerably from the current accounting and billing functions to supporting a wide variety of client/server applications and multi-user networks. The need for planning the development of integrated systems will also require a central focus. The new Directorate should also be responsible for developing hardware and software standards for the organization. Staff of the existing Computer Department have limited experience with the recommended client/server environment, database management systems, network management and data communications. Although they have a technical background and can be retrained, new staff with specialized technical skills will also be required to manage the network, the database and provide support to the growing number of computer users. In addition systems engineers and computer technicians will be required to support users, provide hardware and software maintenance, and develop applications.

7.2 Implementation Strategy

The implementation of the first three priority tasks will set the stage for implementing the computer systems that are required to complete the change strategy for improved financial management. The Customer Information System (CIS) is considered the most urgent of the two systems because it directly affects the collection of revenue. After implementation of the CIS is underway, cash flow should improve, giving management the signal to focus on developing financial management information systems. With the implementation of a new FMIS, DAWSSA can then turn it's focus towards controlling expenditures.

Making changes will be much more difficult than business as usual and DAWSSA will need to devote sufficient resources to make the changes happen. DAWSSA has suggested that steering committees be tasked with overseeing the implementation of these changes - this approach is highly recommended but will require significant personal time and cooperation from the senior management team. Communications to the stakeholders affected by change will be essential in order to obtain their necessary support. Management will need to identify staff who are "strong and willing" and give them the mandate to champion the different tasks required to implement the changes.

An implementation team will be required to plan, coordinate and execute the work. It is recommended that DAWSSA form working groups under the leadership of a nominated Director. The working groups should begin by implementing the changes identified as first priorities. Afterwards, they will assist specialists consultant(s) and participate directly in the development of new procedures and systems. This approach will facilitate the gathering of information and the exchange of technology and is a good way to ensure that all systems will meet the requirements of the end users who have participated in their development. Five working groups are proposed: (1) Budget Preparation & Control; (2) Expenditure Control & Cost Accounting; (3) Billing and Customer Accounting; (4) Customer Services; (5) Computer Systems.

To overcome the shortage of technical staff it is recommended that detailed design and implementation be carried out by specialized consultants. Two consultancies are envisaged: 1)

Consultancy 1- project manager & short term experts and 2) Consultancy 2 - design, development and implementation of integrated CIS and FMIS system.

The services of a project manager and short term consultancies from specialized experts will be required to assist the Project Director with implementation of reforms that will be defined by the working groups. A number of specialized short term experts will be required to assist DAWSSA to complete the detailed design and implementation of the new procedures and work practices. The following assignments are identified: (a) Budget formulation; (b) Budget implementation; (c) Chart of cost accounts; (d) Review payment/spending process; (e) Customer billing and accounting; (f) Procurement.

A consultant with extensive experience in the design, development and implementation of information systems in water utilities will be required. It is considered that most of the services can be satisfactorily carried out by a local firm. International consulting companies should be encouraged to enter into partnerships with a local firm to deliver services for parts of the project where local expertise is available. The scope of work should consist of the following tasks: (a) prepare a detailed functional design and systems specifications for each module of the integrated CIS and FMIS and develop related procedures and manuals; (b) design of the system architecture required for the information systems; (c) investigate alternatives for application software; (d) prepare tender documents for hardware (and "off the shelf" software); (e) Develop training program and provide training of DAWSSA staff; and (f) implement system.

7.3 Training

Modernization not only involves new systems and procedures but also the integration of automation into the work place. It will have an immediate and significant impact on human resources management and training within the organization. The training requirements of the organization are multi-dimensional. Retraining will be required to support new systems and procedures resulting from simplification and computerization. In addition training will be required to support entirely new requirements such as cost accounting, cost analysis, budget formulation and control.

The Computer Section has limited experience with client/server environments and database management systems. The implementation of new CIS and FMIS computer systems will require that new & existing computer section staff receive training on five subjects of modern computing: (1) introduction to computer systems hardware; (2) introduction to relational database management systems (DBMS); (3) DOS Operating system; (4) introduction to Client/Server computing, local and wide area networking, network management and data security.; (5) data communications.

Staff that will participate in the working groups during the design of systems and applications should also take the same training to become familiar with the system concepts. In addition it is recommended that new staff with the required technical skills be hired prior to the beginning of the project in order to have them involved directly in the working groups. The training should proceed before the implementation of the new systems in order to prepare staff to participate fully in the implementation program.

The implementation of a new CIS and FMIS will also create a need for training in the areas of financial management. A training program should be oriented at the senior management team and selected section heads who will be involved in using the FMIS. Topics should include: (1) budget formulation & planning; (2) cost accounting principles; (3) cost analysis and control; (4) formulation and evaluation of projects; (5) design and application of tariff structures.

7.4 Schedule

The detailed schedule of activities for the implementation of CIS and FMIS systems is shown in Figure 7.4.1. The implementation of changes to the billing procedures should take place first and should take about one year (1998). The implementation of the information technology planning study should also proceed as soon as possible (start 1998) and should take approximately one year to complete. It is recommended that both the revisions to billing procedures and the planning study be completed before starting the implementation of the and FMIS systems.

The schedule for implementing CIS and FMIS assumes customized application software. The process of implementing FMIS will take longer because it requires many new work procedures that do not already exist. The work on designing both systems should proceed in parallel in order to ensure full integration between both applications. The implementation of the CIS is expected to take about 2 years to complete (years 2000 to 2001). The process of implementing a FMIS will take about 3 years to complete (years 2000 to 2002).

7.5 Costs, Benefits and Risks

Project costs are calculated based on the estimated quantity of hardware, equipment and man-month estimates for the consultancies identified. Costs for consultant services are based on using local consultants. Two consultant, work packages are anticipated. Consultancy #1 will provide a project manager for an estimated 18 man months at a cost of US$ 270,000 and short term experts who will provide assistance in designing administrative procedures for an estimated 20 man-months at a cost of US$ 240,000. Consultancy #2 for computer system design will require an effort of approximately 100 man-months at a cost of US$ 800,000. Total software and consultant costs are estimated at US$ 1.9 million as shown in Table 7.5.1. Software costs assume the customized development of CIS and FMIS software by a local consultant. Software costs are expected to vary widely in an open international competitive bid depending on the final selection of packaged vs. completely customized development. In a recent computerization project at the Syrian Telephone Exchange (STE) local consultants developed all of the customized software and training at very competitive rates (one tenth the cost of international).

Computer equipment costs are based on budget estimates obtained from local suppliers in Damascus. Total hardware & equipment costs are estimated at US$ 1.6 million as shown in Table 7.5.2. Building modification if costs are excluded since none are anticipated at this time. Hardware installation costs are assumed to be 5% of the total hardware costs US$ 75,000. Total project costs are estimated at US$ 3.5 million over a 3 year period.

The modernization and automation of the customer information system and financial management system will greatly simplify work processes and data collection. The economic

benefits to DAWSSA are expected to be significant and will allow more sustainable development of the water supply system. It is expected that the new systems will also result in a number of other significantly important organizational and benefits such as: (a) Improved accountability and control; (b) Improved financial planning and management; (c) Improved operational planning; and finally (d) Improved customer service

The implementation of the proposed CIS and FMIS must be undertaken in a comprehensive and completely integrated way. There is the risk that some components such as computerization will appear attractive while other components involving hard decisions such as restructuring the organization or streamlining the billing procedures will be set aside. This would unbalance the proposed improvements and risk failing to realize their full benefits. There is also a risk that employees will not adapt to using new computer systems. This risk can be minimized by:

a) Setting up inter-Directorate working groups to ensure systems meet user needs
b) Providing extensive user training and support to ensure that users do can make full use of the implemented systems for their day to day work and do not revert to their manual work methods.
c) Providing an adequate number of trained technical staff available to implement and provide on-going support.

Table 7.5.1 Budget Estimates for Consultancies and Software

Item		Unit price [1]	Remote Sites		Computer Center		Headquarters		Total
			Qty.	Price	Qty.	Price	Qty.	Price	
Operating system	DOS	3,500	20	70,000	4	14,000	-	-	54,000
Database [2]	Oracle DBMS	570	80	45,600	-	10,000	-	-	50,000
Compiler	C+	500	-	-	1	500	-	-	40,500
Operating System for workstation	DOS Windows	500	80	40,000	3	1,500	-	-	1,500
Network software for LAN	Novell Netware	2,000	20	40,000	-	-	-	-	40,000
Application software	MicroSoft Office	500	80	40,000	3	1,500	-	-	41,500
Document management system	Kodak	10,000	-		-	-	1	10,000	10,000
Consultancy No.1 [3]	Project Management	15,000	-	-	-	-	18	270,000	270,000
Consultancy No.1 [3]	Short term experts	12,000	-	-	-	-	20	240,000	240,000
Consultancy No.2 [4]	FMIS & CIS development	8,000	-	-	-	-	100	800,000	920,000
				120,000		27,500		1,320,000	1,667,500

Physical contingency (10%) =	166,750
Price contingency (5%) =	91,713
Total cost =	1,925,963

(1) All prices in US $, including taxes; supplied by local vendors
(2) database costs include fixed cost of $10,000 + $570 per workstation
(3) unit cost is in US$ per Man-month of effort
(4) assumes most of the work is done through a local consultant

Table 7.5.2 Budget Estimates for Computer Hardware & Equipment

Remote Payment Collection Centers

Equipment		Function	Quantity	Unit price (US$)	Total cost
Server (PC)	CPU 64 MB, 200 Mhz	for customer information system	20	15,000	300,000
	X25 card	for communications with WAN			-
	Ethernet card	for LAN			-
	Hard Disk, 4 GB	storing data and processing applications			-
Printer	laser	for printing bills	20	3,000	60,000
	laser	for printing forms and reports	26	2,000	52,000
Workstations (PC)	CPU 32 MB, 166 Mhz	cashiers	54	2,500	135,000
	Hard Drive 2 GB				-
Workstations (PC)	CPU 32 MB, 166 Mhz	for customer service representatives	21	2,500	52,500
	Hard Drive 2 GB				-
Workstations (PC)	CPU 32 MB, 166 Mhz	for meter repair crews	5	2,500	12,500
	Hard Drive 2 GB				-
Bar code scanners	pen laser	for reading bar codes on bills	67	2,500	167,500
UPS	5 KVA, 15 minute battery,	power supply & transient protection	20	7,000	140,000

Computer Center at Headquarters

Equipment		Function	Quantity	Unit price (US$)	Total cost
Server (PC)	CPU, 128 MB, 200 Mhz	for CIS and FMIS (redundant configuration)	4	25,000	100,000
	Ethernet card	for LAN			-
	Floppy drive	for information transfer			-
	Hard Disks 4 GB x 2	storing data and processing applications			-
	Tape Backup	backing up & restoring files	1	2,000	2,000
Secondary Storage	Hard Disk, 4 GB x 2	on line data storage for FMIS	1	1,500	1,500
	Optical disk, 16 GB	on line data storage & retrieval for CIS	1	10,000	10,000
Printer	laser	for printing forms and reports	2	2,000	4,000
Printer	line, high speed	for printing bill statements	2	15,000	30,000
Workstations (PC)	CPU 32 MB, 166 Mhz	system operators	2	2,500	5,000
	Hard Drive 2 GB				
	Floppy Drive				
Workstations (PC)	CPU 32 MB, 166 Mhz	network management	1	2,500	2,500
	Hard Drive 2 GB				
	Floppy Drive				
UPS	5 KVA, 1/2 hour battery	power supply & transient protection	1	15,000	15,000

DAWSSA Headquarter LAN

Equipment		Function	Quantity	Unit price (US$)	Total cost
Network Server (PC)	CPU 128 MB, 200 Mhz	Novell Netware, newtwork management	1	25,000	25,000
	X25 card	for communications with WAN			-
	Ethernet card	for LAN			-
	Hard Disk, 8 GB				-
HDET's	portable data entry terminals	to input meter readings	35	2,000	70,000
Scanner	high resolution, A4 size	to digitize customer file documents	1	2,000	2,000
Printer	laser	for printing forms and reports	21	2,000	42,000
Workstations (PC)	CPU 32 MB, 166 Mhz	miscellaneous users	46	2,500	115,000
	Hard Drive, 2 GB				
	Floppy Drive				
Network	10 MBps, Ethernet co-ax bus	headquarters PC LAN	1	10,000	10,000

Total hardware cost =	1,353,500
Physical contingency (10%) =	135,350
Price contingency (5%) =	74,443
Total cost =	1,563,293

Area Affected by Change	Option No.	Recommended Change	implement modular and integrated systems to meet organizational priorities	accelerate decision making	clarify roles & responsibilities	improve access to account information	improve speed and accuracy of transactions	improve retrieval and archiving of customer information	reduce duration of the billing process	reduce billing errors	accelerate the collection of payments	provide accurate and timely financial information	provide cost information to control expenditures	provide the information required to prepare the budgets
				Improvement Objectives										
Planning		Computer needs planning study	◍											
Overall Organization	1b	Move payment collection operations to Finance Directorate		◉	◉									
	1c	Move stores management to New Works & Stores Directorate		◉	◉									
	1d	Create a new information technology directorate			◉									
Customer services	2a	Implement a document management system		●		●		●				●		
	2b	Implement a customer information system		●		●	●	●				●		
Metering, billing & collection	3a	Implement meter installation standards							○					
	3b	Implement hand held data entry terminals				●	●		●	●		●		
	3c	Enter meter data as soon as readings are completed							○					
	3d	Consolidate error detection and correction process			○				○					
	3e	Implement a billing and customer accounting system				●			●	●				
	3f	Adopt a 4 month billing cycle									○			
	3g	Reduce payment period to 30 days, and issue notices monthly									●			
Management Information	4a	Implement cost accounting										○	○	
	4b	Provide financial management information system		●								●	●	●

Priority 1 ○ can be implemented without organizational change or budget approval
Priority 2 ◍ requires funding for consultant study
Priority 3 ◉ requires approval for organizational change or budget increase
● requires the implementation of new computer systems

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Figure7.1.1

Summary Of Change Strategy

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No.	Description
A	**Review Procedures**
1	Implement working groups & steering committees
2	Develop & implement meter installation standards (option 3a)
3	Implement changes to billing procedures (options 3c & 3d)
4	Optimize meter reading and billing schedule (options 3f)
5	Change payment policy; implement active follow-up of delinquent accounts (option 3g)
6	Consultancy 1 - Resident project manager & short term experts
B	**Budget & Cost Accounting**
1	Propose the new cost accounting structure and codes
2	Prepare accounts, payroll and assets per cost center
3	Implement cost accounting using existing systems
4	Develop budget breakdown structure by Directorate
5	Design budget formulation and preparation procedure
6	Prepare divisional and master budget under new structure
C	***Computer Systems Development and Implementation***
1	Proceed with strategic planning study for Information Technology
2	Create new directorate for information technology and hire staff
3	Consultancy 2 - design and implementation CIS and FMIS system
4	Prepare functional analysis
5	Prepare system design and specifications for S/W, H/W
6	Investigate alternatives for application software
7	Prepare & issue tender documents for S/W
8	Evaluate vendor proposals & select
9	Develop or customize CIS
10	Develop or customize FMIS
11	Develop DMS
12	Prepare & issue an ICB to acquire H/W
13	Evaluate bids and award contract
14	Prepare sites & install systems
15	Convert existing data where required
16	Develop DMS
17	Scan documents in existing customer files
D	**Human Resources Management And Training**
1	Identify training requirements and develop training plan
2	Provide systems training
3	Provide applications training to users
4	Provide Financial management training

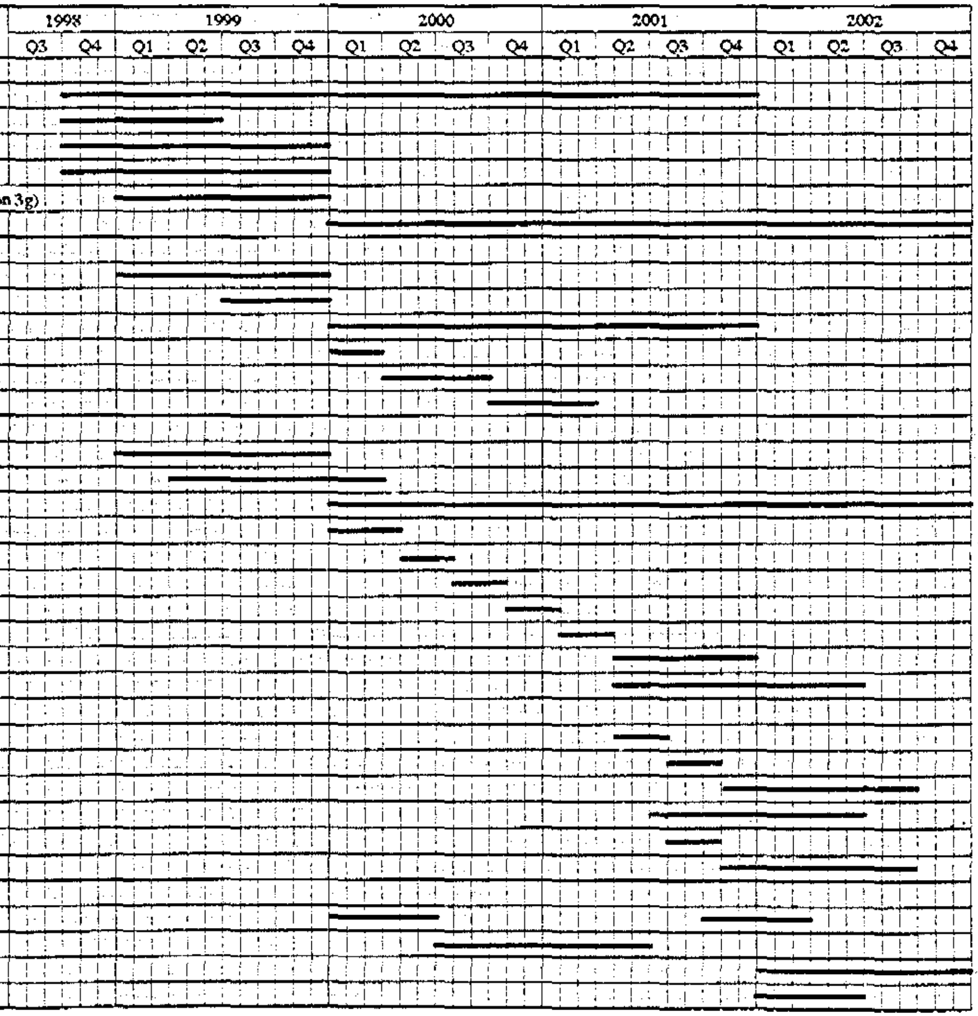

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Figure7.4.1 Implementation Schedule For Computer Systems

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8. CONCLUSIONS AND RECOMMENDATIONS

It is recommended that the following projects proceed immediately to the implementation stage follow the proposed schedule to minimize UFW figures for alleviate water shortage problems:

- District Meter Area (DMA) System Project
- Mezze-Razy & Kafar Souseh-Lawan System Project

DMA system

1) The installation of a DMA system is proposed to optimize water distribution and facilitate leakage control which will be sequenced from 1998 until the year 2006. Integration with DAWSSA's new SCADA system is taken into consideration for planning the DMA. The DMA system consists of two layers. The first layer is grouped as SCADA 01 block that contains, transmission pipelines that connect reservoirs, and distribution mains. The second layer consists of 21 large blocks which define each service area. The large blocks were subdivided into 37 medium blocks according to administrative boundary, road, elevation and pressure stabilization judged by network analysis.

2) Further subdivision to smaller blocks was also examined but is not proposed, since the small block system should only be introduced after the general monitoring system of the distribution system has been installed and sufficient data is available to evaluate the need for smaller blocks.

3) It is recommended that the following programs proceed immediately for efficient operation and maintenance of the proposed DMA system to minimize UFW figures:

   i) A program of mains replacement to reduce the level of leaking lead joints on CIP and reinforce the existing distribution system thus safeguarding supplies,
   ii) A program for setting up the DMA system that will enable DAWSSA to monitor the distribution system and identify areas of high leakage and,

iii) A program for reinforcement of regular acoustic sounding surveys for leak detection at the distribution system in cooperation with the DMA system.

4) The highest priority areas are selected from high population density which are the medium blocks located at south of D10 and M05 in the Kafar Souseh.

Mezze-Razy & Kafar Souseh-Lawan system

The proposed improvement plan will be carried out staring in 1998 and be completed by the year 2001 which is outlined as follows:

i) The existing trunk main (ND800 mm) from Wali service reservoir is used for transmission pipe.
ii) A new 700 m distribution main of ND600 mm is installed from a branch point of existing trunk main to a first and second connection point at a entrance of the network. A new 250 m distribution main of ND500 mm is extended from the branch point to a third connection point located at the 17th April Street. New three pipes of ND200 and 300 and 500 mm will be branched and jointed to the network at connection point respectively.
iii) A number of new distribution pipe will be provided to modify the existing branched distribution system into a looped network. Total length of distribution pipeline is about 13.7 km with a diameter varying from ND100 mm to ND400 mm.
iv) The distribution network will serve an area of 191 ha and a population of 46,800 persons including 32,000 existing informal residents.
v) The area will belong to the DMA medium block D11. The daily average water supply is estimated at 21,670 m^3/d (257 l/s). Daily maximum water supply and peak hourly supply is 286 l/s and 357 l/s respectively based on the DAWSSAis design criteria.

Water quality and environment issues

1) The potential of pesticide pollution at Oumawiyin well field is believed to be low. Nevertheless, pesticides including illegal ones are widely used in Syria. Therefore, capacity building for local pesticide monitoring is urgently needed.

2) Damascus is one of the oldest cities in the world, and protection of important cultural assets is going to be an important issue to carry out proposed leakage control projects. A set of law and guidelines for construction works in the historic Old City district was reviewed to assess and minimize any potential environmental impact of the proposed projects to cultural assets.

Organization and financial management issues

1) It is recognized that DAWSSA does not currently have the financial resources to embark on an extensive automation program. Therefore DAWSSA's first and immediate priority will be to optimize the billing and collection processes by implementing the following improvements:

   i) Implement meter installation standards to increase meter reading productivity.
   ii) Improve efficiency of the billing process by: a) forwarding meter readings for data entry as soon as meter readings are complete; b) reduce the number of error verification processes to only one before printing the bills; c) issue the bills directly to the cashiers from the computer center when the bills are printed.
   iii) Adopt a four (4) month meter reading and billing cycle to improve cash flow. Prepare and issue bills for meter districts in the same sequence as the meter readings.
   iv) Implement a new payment policy to speed up collection of revenue. Change the payment period to 30 days, and implement active follow-up of delinquent accounts on a monthly basis, disconnecting delinquent accounts after six (6) months.

2) DAWSSA should carry out a detailed planning study to assess computer needs across the organization, and develop a strategy for implementing integrated information systems.

And before implementing new client server applications is to create an Information Technology Directorate to plan and support the development of information technology throughout the organization.

3) It is recommended that DAWSSA implement CIS and FMIS. CIS should be provide the accurate and speed of customer service required to improve access to account information and achieving of customer information. FMIS should provide the accurate and timely financial information required to improve control expenditures and budget preparation.

4) To overcome the shortage of technical staff it is recommended that detailed design and implementation be carried out by specialized consultants. It is proposed that DAWSSA form working groups under the direction of the Director of New Works and Studies. The working groups should begin by implementing the changes identified as first priorities.

5) The implementation of changes to the billing procedures will take place first and should take about one year (1998). The implementation of the information technology planning study should also proceed as soon as possible (start 1998) and should take approximately one year to complete. It is recommended that both the revisions to billing procedures and the planning study be completed before starting the implementation of the CIS and FMIS systems. The work of designing the CIS and FMIS should proceed in parallel in order to ensure full integration between both applications. The implementation of the CIS is expected to take about 2 years to complete (years 1999 to 2000). The process of implementing a FMIS will take about 3 years to complete (years 1999 to 2001).

6) It is recommended that payment collection move from Consumer Affairs to the Finance Directorate. All cash collection activities will be under the management of the Finance Directorate allowing it to be fully accountable for collecting the revenues it needs to manage cash flow needs.

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