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ARAB REPUBLIC OF EGYPT
THE MINISTRY OF HOUSING AND RECONSTRUCTION

Alexandria Wastewater Master Plan Study

VOLUME III
APPENDICES

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with Chas. T. Main International Inc.
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This Master Plan Consists of Four Volumes:

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II TECHNICAL REPORT

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APPENDIX A

POPULATION AND LAND USE

Appendix A covers background information on demographic trends and projected populations for the entire study area and various sub-districts of Alexandria.

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TABLE A-1

POPULATION STATISTICS AND ANNUAL RATE OF NET MIGRATION TO ALEXANDRIA

Year	Alexandria Population	Compound Annual Rate, %[a] Growth	Natural Increase	Net Migration
1947	919 024			
1960	1 516 234	3.93	2.87	1.06
1966	1 801 057	2.91	2.53	0.38
1976[b]	2 382 000[c]	2.85	2.2 (Est.)	0.65

[a] Based upon compound interest formula: $P_f = P_i(1 + i)^n$;
where: P_f = final population;
P_i = initial population;
i = interest rate;
n = number of years.

[b] Central Agency for Public Mobilization and Statistics (CAPMAS).

TABLE A-2

ALEXANDRIA LABOR FORCE BY ECONOMIC ACTIVITY - 1974

Activity	Number of Employees[a]	Percent
Manufacturing	192 700	33
Commerce, Transportation & Communications	149 700	26
Service & Insurance	144 200	25
Agriculture, Forestry & Fishery	24 300	4
Construction	19 300	3
Gas & Electricity	5 800	1
Mines & Quarries	3 400	1
Other	42 600	7
TOTAL	582 000	100

[a] Central Agency for Public Mobilization and Statistics (CAPMAS)

TABLE A-3

HISTORIC POPULATION OF ALEXANDRIA

Year	Number of Inhabitants[a]	Average Annual Increase
1882	233 000	-
1897	316 000	5 500
1907	354 000	3 800
1917	445 000	9 100
1927	573 000	12 800
1937	685 000	11 300
1947	919 000	23 300
1960	1 516 000	45 900
1966	1 801 000	47 500
1976	2 382 000	58 500

[a] Values from published census figures are rounded to nearest thousand persons.

3'

TABLE A-4

PRESENT DISTRICT POPULATION - 1976

District	Permanent Population[a]	General Economic Classification[b]
Gomrok	166 000	low to middle
Manshia	48 000	middle to low
Labban	91 000	low to middle
Attarine	80 000	middle to low
Karmouz	235 000	low
Moharrem Bey	371 000	low to middle
Bab Sharky	354 000	middle to low
Ramleh	454 000	middle
Montazah	249 000	middle to high
Minet el Bassal	260 000	low
Dekheila	54 000	low
Ameria	20 000	low
TOTAL	2 382 000	

(a) Based on CAPMAS mid-76 census information rounded to nearest thousand persons.

(b) Based on estimation of average family income level, the initial classification being predominant while the latter is secondary (e.g., low to middle means lower incomes in general although ranging to middle income level in some neighborhoods within the district).

(c) Population is roughly approximated in this district due to the transient nature of many inhabitants (i.e., there are significant numbers of nomadic Bedouin and yet unsettled recent arrivals).

TABLE A-5

ADIMINISTRATIVE ZONES OF ALEXANDRIA

Sub-Area[a]	Kism	Sheyakha(s)
MB1	Minet el Bassal	Om Kebeba, Wardian
MB2	Minet el Bassal	Kafr Ashry South
		Gabbary West
		Borsa Kafr Ashry
		Mafrooza
		Tabiet Saleh
		Amoud
		Kom el Shokafa East
		Kom el Shokafa West
MB3	Minet el Bassal	Gabbary East
BS1	Bab Sharky	Mazarita Chatby
BS2	Bab Sharky	Bab Sharky
		Baboor el Mayya
BS3	Bab Sharky	Hadara Kebly
BS4	Bab Sharky	Ibrahimia North
		Ibrahimia South
		Sidi Gaber
BS5	Bab Sharky	Ezbet Saad
BS6	Bab Sharky	Ezbet Nouzha
		Ezbet Gamaa
R1	Ramleh	Mostafa Pasha Bulkley
		Flemming
		San Stefano
		Abu el Nawateer
R2	Ramleh	Zaarabana
		Hamam
R3	Ramleh	Mahroosa
		Zahria
		Ezbet Safeeh
		Hagar el Nawatia

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Sub-Area[a]	Kism	Sheyakha(s)
R4	Ramleh	Kasie South
		Kasie North
		Akessa Bacos
R5	Ramleh	Danna Geddeda
M1	Montazah	Siouf North
M2	Montazah	Siouf South
Villages (M3)	Montazah	Tewfikia
		Abbis
		Nasria
		Manshia
		Ezbet Nubar wa Khorshed
M4	Montazah	Mandara Bahari
		Sidi Bishr
		Ezbet Babeyn wa Dar Issa
M5	Montazah	Mandara South
M6	Montazah	Maamoura
M7	Montazah	Abu Kir

[a] Refer to Figure A-3.

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TABLE A-6

HISTORIC AND PROJECTED SUBDISTRICT POPULATIONS AND DENSITY

District & Subdistrict	Gross Area (ha)	Economic[a] Class	Gross Density, persons/ha 1966	1976	1980	1990	2000	Population, Thousand 1960	1966	1976	1980	1990	2000
Gomrok	178	LM	855	930	945	950	955	141	152	166	168	169	170
Labban	105	LM	770	870	905	980	1065	78	81	91	96	103	112
Manshia	58.5	ML	764	831	870	940	955	42	45	49	51	55	56
Attarine	174	ML	430	458	470	505	535	71	75	80	82	88	93
Karmouz	409	L	504	574	580	595	615	193	206	235	238	244	252
Moharrem Bey	470	LM	638	790	800	810	820	262	300	371	375	380	385
BS1	110	ML	180	213	215	220	230	17	20	23	24	24	25
BS2	87	M	74	103	110	120	140	5	6	9	9	11	12
BS3	80	LM	889	1146	1175	1245	1315	60	71	92	94	99	105
BS4	322	LM	435	510	525	535	545	126	140	164	170	172	175
BS5	411	LM	79	109	125	380	380	27	33	45	52	155	155
BS6	600	L	8	-	-	-	-	5	11	21	42	52	60
Bab Sharky Total	1610	-	-	-	-	-	-	240	281	354	391	513	532
R1	458	HM	123	230	255	300	320	50	57	105	117	138	146
R2	38	M	690	964	990	1190	1350	23	26	37	38	45	51
R3	171	M	358	427	485	680	770	45	61	73	83	117	132
R4	133	M	612	578	715	775	800	69	81	90	95	103	107
R5	292	L	210	501	670	860	915	13	61	146	196	251	267
R6	-	L	-	-	-	-	-	2	2	2	3	3	3
Ramleh Total	1092	-	-	-	-	-	-	202	288	453	532	657	706
M1	72	M	247	379	400	420	460	12	18	27	29	30	33
M2	427	LM	58	104	180	325	435	21	25	44	77	139	185
M3	-	L	-	-	-	-	-	-	37	47	50	50	50
M4	356	MH	122	163	180	240	310	27	43	58	65	86	110
M5	477	M	37	142	180	320	570	10	18	67	85	153	273
M6	-	L	-	-	-	-	-	6	7	8	9	13	17
M7	-	LM	-	-	-	-	-	14	16	21	41	115	177
Montazah Total	1332	-	-	-	-	-	-	-	164	272	356	586	845
MB1	226	L	368	706	750	990	1175	60	83	160	170	223	265
MB2	166	L	359	412	415	420	420	55	57	68	69	70	70
MB3	99	L	303	318	340	345	355	16	30	32	34	34	35
Minetel Bassal Total	491	-	-	-	-	-	-	131	170	260	273	327	370
Ameria	-	L	-	-	-	-	-	-	-	40	60	175	500
Dekheila	-	L	-	-	-	-	-	23	37	55	63	106	145

Note: (a) L, M, and H describe the general economic classifications of each district as low, middle, or high income.

TABLE A-7

PROJECTED PERMANENT AND SEASONAL POPULATION BY SEWER AREA
(Population, thousand)

Sewer Area	1980	1990	2000	1980	1990	2000	1980	1990	2000
Presently Sewered									
East Zone	845	1013	1190	200	227	260	1045	1240	1450
West Zone	666	713	780	14	17	20	680	730	800
Central Zone	728	755	777	102	130	153	830	885	930
Presently Unsewered									
Nouzha	50	60	72	-	-	-	50	60	72
Ras el Soda	107	224	326	-	-	-	107	224	326
Siouf Keblia	80	125	157	-	-	-	80	125	157
Sadat City	-	125	500	-	-	-	-	125	500
Abu Kir	41	110	177	4	6	8	45	116	185
Dekheila	63	115	145	-	-	-	63	115	145
Ameria	60	280	500	-	-	-	60	280	500
Others[a]	10	20	36	70	110	154	80	130	190
TOTAL	2650	3540	4660	390	490	595	3040	4030	5255

[a] Primarily in the Agamy area - not expected to require sewering by year 2000.

TABLE A-8 (1)

LAND USE/POPULATION INVENTORY

Area: Western

District [Kism]: Minet el Bassal

Sub-district [Sheyakha(s)]: Om Kebeba, Wardian

Economic Classification [primary]: Low Income

[secondary]:

Map Designation: MB1[a]

Land Use (ha)

Gross Area	226		
Parks/Sports Club		Industrial Zones	
Hospitals	1	Storage	57
Universities	18	Transport Corridors	
Government Buildings		Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[b]	150

Year	Gross Density	Persons/ha Net[b]	Population
1960	268	403	60 463
1966	368	554	83 132
1976	706	1064	159 600
1980	750	1130	169 600
1990	990	1485	223 000
2000	1175	1765	265 000

General Comments: Due to limited alternative housing locations in the port area, population has been rising very rapidly. Housing is generally 2, 3 and 4 floors built on relatively wide streets, thus permitting vertical expansion. Expansion of port facilities and industry is expected to accelerate increase in the density of the area between 1980 and 1990.

[a] Refer to Figure A-3

[b] Residential and commercial only.

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TABLE A-8 (2)

LAND USE/POPULATION INVENTORY

Area: Western

District [Kism]: Minet el Bassal

Sub-district [Sheyakha(s)]: Kafr Ashry South, Gabbary West, Borsa, Kafr Ashry, Mafrooza, Tabiet Saleh, Amoud, Kom el Shokafa East, Kom el Shokafa West.

Economic Classification [primary]: Low Income

[secondary]:

Map Designation: MB2

Land Use (ha)

Gross Area	166		
Parks/Sports Club		Industrial Zones	11
Hospitals	4	Storage	80
Universities		Transport Corridors	6
Government Buildings	2	Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	-

Year	Gross Density	Persons/ha Net[a]	Population
1960	330	-	54 780
1966	359	-	56 695
1976	412	-	68 400
1980	415	-	69 000
1990	420	-	69 500
2000	420	-	70 000

General Comments: Housing is generally mixed with storage zone buildings and cotton manufacturing facilities. For this reason, net residential area was not calculated. The population growth rate may be very low due to expansion of storage zone facilities which may replace some existing, poorly constructed housing.

[a] Residential and commercial only.

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TABLE A-8 (3)

LAND USE/POPULATION INVENTORY

Area: Western
District [Kism]: Minet el Bassal
Sub-district [Sheyakha(s)]: Gabbary East

Economic Classification [primary]: Low Income
[secondary]:

Map Designation: MB3

Land Use (ha)

Gross Area	99		
Parks/Sports Club		Industrial Zones	4
Hospitals	4	Storage	20
Universities		Transport Corridors	45
Government Buildings		Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	24

Year	Gross Density	Persons/ha Net[a]	Population
1960	160	658	15 791
1966	303	1249	29 982
1976	318	1313	31 500
1980	340	1400	33 700
1990	345	1415	34 000
2000	355	1460	35 000

General Comments: Public housing was built between 1960 and 1966, thus contributing to the area's high growth rate. Some new housing may be added in the near-term, however, the predominance of public housing in the district will limit future population density.

[a] Residential and commercial only.

TABLE A-8 (4)

LAND USE/POPULATION INVENTORY

Area: Western

District [Kism]: Gomrok

Sub-district [Sheyakha(s)]:

Economic Classification [primary]: Low Income

[secondary]: Low Middle Income

Map Designation:

Land Use (ha)

Gross Area	178		
Parks/Sports Club		Industrial Zones	
Hospitals	6	Storage	
Universities		Transport Corridors	
Government Buildings	67	Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	105

Year	Gross Density	Persons/ha Net[a]	Population
1960	792	1343	140 960
1966	855	1450	152 214
1976	930	1581	166 000
1980	945	1600	168 000
1990	950	1610	169 000
2000	955	1620	170 000

General Comments: It is assumed that the area has very nearly reached saturation. Some new construction, however, is scattered through the district.

[a] Residential and commercial only.

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TABLE A-8(5)

LAND USE/POPULATION INVENTORY

Area: Western

District [Kism]: Labban

Sub-district [Sheyakha(s)]:

Economic Classification [primary]: Low Middle Income

[secondary]: Low Income

Map Designation:

Land Use (ha)

Gross Area	105		
Parks/Sports Club		Industrial Zones	
Hospitals		Storage	17
Universities		Transport Corridors	
Government Buildings	11	Open for Industry	
Workshops	28	Open for Residential	
Cemeteries		Other	
		Net Area[a]	49

Year	Gross Density	Persons/ha Net[a]	Population
1960	740	-	77 698
1966	770	-	80 864
1976	870	-	91 300
1980	905	-	95 500
1990	980	-	103 000
2000	1065	-	112 000

General Comments: Labban consists of generally older housing mixed with workshops, storage areas and numerous institutional buildings. Predominance of workshops limits potential growth in population density.

[a] Residential and commercial only.

TABLE A-8 (6)

LAND USE/POPULATION INVENTORY

Area: Western

District [Kism]: Karmouz

Sub-district [Sheyakha(s)]:

Economic Classification [primary]: Low Income

[secondary]:

Map Designation:

Land Use (ha)

Gross Area	409[b]		
Parks/Sports Club	2	Industrial Zones	71
Hospitals		Storage	158
Universities		Transport Corridors	40
Government Buildings	2	Open for Industry	
Workshops		Open for Residential	
Cemeteries	16	Other	
		Net Area[a]	120

Year	Gross Density	Persons/ha Net[a]	Population
1960	472	1608	192 911
1966	504	719	206 272
1976	574	1955	234 580
1980	580	1985	238 000
1990	595	2035	244 000
2000	615	2100	252 000

General Comments: Karmouz is one of the oldest and densest residential areas in the city. Reasons for expected slight increases in density relate to the district's proximity to the port as well as labor intensive industries such as spinning and weaving

(a) Residential and commercial only.

(b) Area north of Lake Maryut.

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TABLE A- 8 (7)

LAND USE/POPULATION INVENTORY

Area: Western

District [Kism]: Ameria

Sub-district [Sheyakha(s)]:

Economic Classification [primary]:

[secondary]:

Map Designation:

Land Use (ha)

Gross Area

Parks/Sports Club

Hospitals

Universities

Government Buildings

Workshops

Cemeteries

Industrial Zones

Storage

Transport Corridors

Open for Industry

Open for Residential

Other

Net Area[a]

Year	Gross Density	Persons/ha Net[a]	Population
1960			
1966			
1976			40[b]
1980			60
1990			175
2000			500

General Comments: Background information derived from Master Plan-New Ameria City - ILACO (Prof. Dr. Hassan Ismail & Partners). Report prepared for MOHR, November 1977.

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[a] Residential and commercial only.

[b] Based on preliminary estimate of present population.

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TABLE A-8 (8)

LAND USE/POPULATION INVENTORY

Area: Western

District [Kism]: Dekheila

Sub-district [Sheyakha(s)]: Dekheila , Bittash, Agamy, Mex

Economic Classification [primary]: Low Income

[secondary]:

Map Designation:

Land Use (ha)

Gross Area

Parks/Sports Club

Hospitals

Universities

Government Buildings

Workshops

Cemeteries

Industrial Zones

Storage

Transport Corridors

Open for Industry

Open for Residential

Other

Net Area[a]

Year	Gross Density	Persons/ha Net[a]	Population
1960			22 791
1966			36 597
1976			54 600
1980			63 000
1990			106 000
2000			145 000

General Comments: Area not clearly defined in terms of extent and land uses, although predominantly industrial.

[a]Residential and commerical only.

TABLE A-8 (9)

LAND USE/POPULATION INVENTORY

Area: Central

District [Kism]: Manshia

Sub-district [Sheyakha(s)]:

Economic Classification [primary]: Middle Income

[secondary]: Low Middle Income

Map Designation:

Land Use (ha)

Gross Area	58.5		
Parks/Sports Club	3.5	Industrial Zones	
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	
Workshops	4[b]	Open for Residential	
Cemeteries		Other	4
		Net Area[a]	51

Year	Gross Density	Persons/ha Net[a]	Population
1960	726	835	42 494
1966	764	878	44 714
1976	831	953	48 600
1980	870	1000	51 000
1990	940	1080	55 000
2000	955	1100	56 000

General Comments: Manshia contains hotels, offices, public markets and residential areas. Although office and hotel expansion may limit increases in residential population densities, Manshia's proximity to office and commercial areas makes it desirable place for middle and lower middle income office workers to live. For this reason Manshia's population should continue to increase gradually.

[a] Residential and commercial only.

[b] Housing mixed with workshop.

TABLE A-8 (10)

LAND USE/POPULATION INVENTORY

Area: Central Zone

District [Kism]: Attarine

Sub-district [Sheyakha(s)]: High Income, Middle Income
Low Middle Income

Economic Classification [primary]:
[secondary]:

Map Designation:

Land Use (ha)

Gross Area	174		
Parks/Sports Club	20	Industrial Zones	
Hospitals	9	Storage	
Universities		Transport Corridors	
Government Buildings	15	Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	130

Year	Gross Density	Persons/ha Net[a]	Population
1960	409	-	71 148
1966	430	-	74 794
1976	458	-	79 700
1980	470	-	82 000
1990	505	-	88 000
2000	535	-	93 000

General Comments: Attarine is the commercial center of Alexandria. Housing is mixed with commercial areas so that net residential areas could not be determined. Office expansion may tend to limit increased residential expansion.

[a] Residential and commercial only.

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TABLE A-8 (11)

LAND USE/POPULATION INVENTORY

Area: Central

District [Kism]: Moharrem Bey

Sub-district [Sheyakha(s)]:

Economic Classification [primary]: Low Middle Income

[secondary]: Low Income, Middle Income

Map Designation:

Land Use (ha)

Gross Area	470		
Parks/Sports Club		Industrial Zones	114
Hospitals	13	Storage	
Universities	7	Transport Corridors	
Government Buildings	4	Open for Industry	64
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	268

Year	Gross Density	Persons/ha Net[a]	Population
1960	557	977	261 955
1966	638	1119	299 793
1976	790	1385	371 077
1980	800	1400	375 000
1990	810	1420	380 000
2000	820	1435	385 000

General Comments: The eastern portion of Moharrem Bey is dominated by extensive public housing. This in combination with expanded middle income areas west of Suez Canal Street will tend to limit the population density. The Western portion of the district contains very dense, low income housing where population is not expected to grow significantly.

[a] Residential and commercial only.

TABLE A-8 (12)

LAND USE/POPULATION INVENTORY

Area: Central
District [Kism]: Bab Sharky
Sub-district [Sheyakha(s)]: Mazarita Chatby

Economic Classification [primary]: Middle Income
[secondary]: Low Middle Income

Map Designation: BS1

Land Use (ha)

Gross Area	110		
Parks/Sports Club	14	Industrial Zones	
Hospitals	7	Storage	
Universities	22	Transport Corridors	
Government Buildings		Open for Industry	
Workshops	8[b]	Open for Residential	
Cemeteries	31	Other	
		Net Area[a]	36

Year	Gross Density	Persons/ha Net[a]	Population
1960	152	466	16 764
1966	180	551	19 853
1976	213	650	23 400
1980	215	660	23 700
1990	220	680	24 400
2000	230	700	25 200

General Comments: The area is dominated by Alexandria University. Some older, low middle income areas exist in the central part of the zone. Land devoted to workshop activities tends to limit the overal density of the area.

[a] Residential and commercial only.

[b] Housing mixed with workshops.

TABLE A-8 (13)

LAND USE/POPULATION INVENTORY

Area: Central
District [Kism]: Bab Sharky
Sub-district [Sheyakha(s)]: Bab Sharky, Baboor el Maya

Economic Classification [primary]: High Income
[secondary]: Middle Income

Map Designation: BS2

Land Use (ha)

Gross Area	87		
Parks/Sports Club	18	Industrial Zones	8
Hospitals	6	Storage	
Universities		Transport Corridors	7
Government Buildings	1	Open for Industry	
Workshops		Open for Residential	
Cemeteries	3	Other	14
		Net Area[a]	30

Year	Gross Density	Persons/ha Net[a]	Population
1960	60	173	5 187
1966	74	213	6 400
1976	103	300	9 000
1980	110	315	9 400
1990	120	355	10 600
2000	140	400	12 000

General Comments: The area contains upper income housing (both apartments and villas) and governmental office buildings. The existence of upper income housing limits growth potential; however, as some areas currently occupied by single family villas are utilized for apartment development, the density of the area will increase.

[a] Residential and commercial only.

TABLE A-8 (14)

LAND USE/POPULATION INVENTORY

Area: Central
District [Kism]: Bab Sharky
Sub-district [Sheyakha(s)]: Hadara Hebly

Economic Classification [primary]: Low Middle Income
[secondary]: Low Income

Map Designation: BS3

Land Use (ha)

Gross Area	80		
Parks/Sports Club		Industrial Zones	24[b]
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	
Workshops	9	Open for Residential	
Cemeteries		Other	
		Net Area[a]	

Year	Gross Density	Persons/ha Net[a]	Population
1960	745	-	59 580
1966	889	-	71 093
1976	1146	-	91 650
1980	1175	-	93 900
1990	1245	-	99 400
2000	1315	-	105 000

General Comments: The area can be characterized as a mixed low and low middle income industrial area.

[a] Residential and commercial only.

[b] Housing and industrial zones not clearly defined, therefore net residential population densities were not calculated.

TABLE A-8 (15)

LAND USE/POPULATION INVENTORY

Area: Central

District [Kism]: Bab Sharky

Sub-district [Sheyakha(s)]: Ibrahimia North, Ibrahimia South, Sidi Gaber

Economic Classification [primary]: Middle Income

[secondary]: Low Middle Income

Map Designation: BS4

Land Use (ha)

Gross Area	322		
Parks/Sports Club	41	Industrial Zones	2
Hospitals	7	Storage	
Universities	43	Transport Corridors	
Government Buildings		Open for Industry	
Workshops	4[b]	Open for Residential	
Cemeteries	13	Other	
		Net Area[a]	216

Year	Gross Density	Persons/ha Net[a]	Population
1960	392	584	126 013
1966	435	649	139 938
1976	510	760	163 984
1980	525	785	169 600
1990	535	800	172 100
2000	545	810	174 700

General Comments: The area is considered to be a well established middle and low middle income district. Very little new construction is expected.

[a] Residential and commercial only.

[b] Housing mixed with workshops.

TABLE A-8 (16)

LAND USE/POPULATION INVENTORY

Area: Central
District [Kism]: Bab Sharky
Sub-district [Sheyakha(s)]: Ezbet Saad

Economic Classification [primary]: Low Middle Income
[secondary]: Middle Income

Map Designation: BS5

Land Use (ha)

Gross Area	411		
Parks/Sports Club	95	Industrial Zones	23
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	27
Workshops	7	Open for Residential	
Cemeteries		Other	
		Net Area[a]	259

Year	Gross Density	Persons/ha Net[a]	Population
1960	66	105	27 281
1966	79	126	32 669
1976	109	173	44 921
1980	125	200	51 800
1990	380	600	155 400
2000	380	600	155 400

General Comments: Current plans call for dramatically increasing the residential development of the area primarily for middle income and university student housing. By 1980, a labor city for 900 families is planned for construction on 4.5 hectares, south of the Smouha Sporting Club.

[a] Residential and commercial only.

TABLE A-8 (17)

LAND USE/POPULATION INVENTORY

Area: Central
District [Kism]: Bab Sharky
Sub-district [Sheyakha(s)]: Ezbet Nouzha, Ezbet Gamaa

Economic Classification [primary]: Low Income
[secondary]:

Map Designation: BS6

Land Use (ha)

Gross Area	600		
Parks/Sports Club		Industrial Zones	59
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	202
Workshops		Open for Residential	22
Cemeteries		Other	
		Net Area[a]	-

Year	Gross Density	Persons/ha Net[a]	Population
1960	-	-	4 585
1966	-	-	10 714
1976	-	-	20 585
1980	-	-	42 000
1990	-	-	52 000
2000	-	-	60 000

General Comments: Includes area south of Mahmoudia Canal bordered on the south and east by railroad tracks. A labor city is planned in Ezbet Gamaa adding approximately 20 000 people between 1976 and 1980. Future open industrial zones may also contain some associated employee housing.

[a] Residential and commercial only.

TABLE A-8 (18)

LAND USE/POPULATION INVENTORY

Area: Eastern

District [Kism]: Ramleh

Sub-district [Sheyakha(s)]: Mostafa Pasha, Bulkley, Flemming, San Stefano, Abu el Nawateer

Economic Classification [primary]: High Income

[secondary]: Middle Income

Map Designation: R1

Land Use (ha)

Gross Area	458		
Parks/Sports Club	3	Industrial Zones	
Hospitals	8[b]	Storage	
Universities	14	Transport Corridors	3
Government Buildings	56	Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	374

Year	Gross Density	Persons/ha Net[a]	Population
1960	109	133	49 797
1966	123	151	56 550
1976	230	281	105 270
1980	255	310	116 500
1990	300	370	138 000
2000	320	390	146 000

General Comments: All areas have apartments interspersed with villas. There have been dramatic increases in new apartment construction, particularly along wide tram and auto transportation corridors. Abu el Nawateer is the most stable area, while Mostafa Pasha, Bulkley, and San Stefano are developing rapidly.

[a] Residential and commercial only.

[b] Under construction.

TABLE A-8 (19)

LAND USE/POPULATION INVENTORY

Area: Eastern
District [Kism]: Ramleh
Sub-district [Sheyakha(s)]: Zaarabana, Haman

Economic Classification [primary]: Low Income
[secondary]: Middle Income

Map Designation: R2

Land Use (ha)

Gross Area	38		
Parks/Sports Club		Industrial Zones	
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	38

Year	Gross Density	Persons/ha Net[a]	Population
1960	606	606	23 041
1966	690	690	26 230
1976	964	964	36 639
1980	990	990	37 600
1990	1190	1190	45 100
2000	1350	1350	51 200

General Comments: The zone is approximately 25% middle income and 75% low income. Densities in both areas are expected to increase.

[a] Residential and commercial only.

TABLE A-8 (20)

LAND USE/POPULATION INVENTORY

Area: Eastern

District [Kism]: Ramleh

Sub-district [Sheyakha(s)]: Mahroosa, Zahria, Ezbet Safeeh, Hagar el Nawatia.

Economic Classification [primary]: Low Income

[secondary]:

Map Designation: R3

Land Use (ha)

Gross Area	171			
Parks/Sports Club		Industrial Zones	73	
Hospitals		Storage		
Universities		Transport Corridors		
Government Buildings		Open for Industry	10	331[b]
Workshops		Open for Residential	10	
Cemeteries	4	Other		
		Net Area[a]	74	

Year	Gross Density	Persons/ha Net[a]	Population
1960	261(Est)	604	44 672 (Est)
1966	358	827	61 161
1976	427	987	73 057
1980	485	1120	82 700
1990	680	1575	116 600
2000	770	1780	131 700

General Comments: The development of the area is closely tied with the expansion of industrial zone. 19.7 hectares of open agricultural area within Mahroosa may, in the future be utilized both for housing and industrial expansion.

[a] Residential and commercial only.

[b] South of Mahmoudia Canal.

TABLE A-8 (21)

LAND USE/POPULATION INVENTORY

Area: Eastern

District [Kism]: Ramleh

Sub-district [Sheyakha(s)]: Kasie South, Kasie North, Akessa Bacos

Economic Classification [primary]: Middle Income, Low Middle Income

[secondary]: Low Income

Map Designation: R4

Land Use (ha)

Gross Area	133		
Parks/Sports Club		Industrial Zones	
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	
Workshops	12	Open for Residential	
Cemeteries		Other	
		Net Area[a]	121

Year	Gross Density	Persons/ha Net[a]	Population
1960	518	570	68 935
1966	612	673	81 412
1976	678	745	90 144
1980	715	785	94 900
1990	775	850	103 100
2000	800	880	106 600

General Comments: Northern portions consist of 60-75% middle income housing. The southern portion of these districts, as well as Bacos bordering on Shari Mostafa Kamal, contains low middle and low income housing districts which are not expected to expand extensively. The existence of workshops tends to lower residential density of the area.

[a] Residential and commercial only.

TABLE A-8 (22)

LAND USE/POPULATION INVENTORY

Area: Eastern
District [Kism]: Ramleh
Sub-district [Sheyakha(s)]: Danna Gedeeda

Economic Classification [primary]: Low Income
[secondary]:

Map Designation: R5

Land Use (ha)

Gross Area	292		
Parks/Sports Club		Industrial Zones	73
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	28
Workshops		Open for Residential	12
Cemeteries		Other	
		Net Area[a]	179

Year	Gross Density	Persons/ha Net[a]	Population
1960	-	-	12 556 (Est)
1966	210	342	61 371
1976	501	835	146 392
1980	670	1095	196 000
1990	860	1400	250 600
2000	915	1495	267 000

General Comments: The area is adjacent to a rapidly expanding industrial zone. Between 1976 and 1980 a labor city is planned on 12 hectares of open land. This will add 17 500 people without increasing net density. Beyond 1980, density in expanded residential zones is expected to increase.

[a] Residential and commercial only.

TABLE A-8 (23)

LAND USE/POPULATION INVENTORY

Area: Central
District [Kism]: Ramleh
Sub-district [Sheyakha(s)]: Khorshed South

Economic Classification [primary]: Low Income
[secondary]:

Map Designation:

Land Use (ha)

Gross Area (b)
- Parks/Sports Club
- Hospitals
- Universities
- Government Buildings
- Workshops
- Cemeteries
- Industrial Zones
- Storage
- Transport Corridors
- Open for Industry
- Open for Residential
- Other

Net Area[a]

Year	Gross Density	Persons/ha Net[a]	Population
1960	-	-	2 417
1966	-	-	2 499
1976	-	-	2 499
1980	-	-	2 600
1990	-	-	3 000
2000	-	-	3 300

General Comments: Small farming villages, not expected to undergo development.

[a] Residential and commercial only.
[b] Boundaries not identified.

TABLE A-8 (24)

LAND USE/POPULATION INVENTORY

Area: Eastern
District [Kism]: Montazah
Sub-district [Sheyakha(s)]: Siouf North

Economic Classification [primary]: Low Middle Income
[secondary]: Low Income

Map Designation: M1

Land Use (ha)

Gross Area	72		
Parks/Sports Club		Industrial Zones	
Hospitals		Storage	
Universities	8	Transport Corridors	
Government Buildings	3	Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	61

Year	Gross Density	Persons/ha Net[a]	Population
1960	164	193	11 820
1966	247	292	17 803
1976	379	450	27 300
1980	400	470	28 800
1990	420	500	30 400
2000	460	540	33 000

General Comments: The tram line which runs through the district separates low income, relatively low density areas from low middle income areas. The low income areas have relatively low densities due to prevalance of old, small, single family villas on narrow, generally unpaved streets.

[a] Residential and commercial only.

TABLE A-8 (25)

LAND USE/POPULATION INVENTORY

Area: Eastern
District [Kism]: Montazah
Sub-district [Sheyakha(s)]: Siouf South

Economic Classification [primary]: Low Income, Low Medium Income
[secondary]: Middle Income

Map Designation: M2

Land Use (ha)

Gross Area	427		
Parks/Sports Club	3	Industrial Zones	75
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings	11	Open for Industry	32
Workshops		Open for Residential	148
Cemeteries		Other	
		Net Area[a]	154

Year	Gross Density	Persons/ha Net[a]	Population
1960	49	135	20 856
1966	58	162	24 954
1976	104	288	44 418
1980	180	500	77 000
1990	325	905	139 000
2000	435	1200	185 000

General Comments: Siouf South is one of the most rapidly expanding industrial and residential areas within Alexandria. The Ras el Soda area is essentially low density, middle income whose density is expected to increase considerably. A 96 hectare low and low middle income housing project and administrative complex is planned to be completed by 1980. It is assumed, however, that only 70% of the 8500 apartments will be completed by 1980 and that the remaining units be completed by 1990.

[a] Residential and commercial only.

TABLE A-8 (26)

LAND USE/POPULATION INVENTORY

Area: East

District [Kism]: Montazah

Sub-district [Sheyakha(s)]: Tewfikia, Abbis, Nasria, Manshia, Ezbet Nubar, Khorshed

Economic Classification [primary]: Low Income

[secondary]:

Map Designation: M3

Land Use (ha)

Gross Area

Parks/Sports Club

Hospitals

Universities

Government Buildings

Workshops

Cemeteries

Industrial Zones

Storage

Transport Corridors

Open for Industry

Open for Residential

Other

Net Area[a]

Year	Gross Density	Persons/ha Net[a]	Population
1960			-
1966			36 559
1976			47 000
1980			50 000
1990			50 000
2000			50 000

General Comments: Area is comprised of small villages which are not expected to grow significantly after 1980 due to lack of job opportunities. Precise boundaries were not identified, however villages are located within agricultural zones in the southern portion of Montazah.

[a] Residential and commercial only.

TABLE A-8 (27)

LAND USE/POPULATION INVENTORY

Area: Eastern

District [Kism]: Montazah

Sub-district [Sheyakha(s)]: Mandara Bahari, Sidi Bishr, Ezbet Babeyn, Dar Issa (permanent population)

Economic Classification [primary]: Middle Income (seasonal and permanent)

[secondary]: Low Middle Income, Low Income

Map Designation: M4

Land Use (ha)

Gross Area	356		
Parks/Sports Club		Industrial Zones	
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	
Workshops		Open for Residential	74
Cemeteries		Other	
		Net Area[a]	282

Year	Gross Density	Persons/ha Net[a]	Population
1960	75	95	26 869
1966	122	154	43 455
1976	163	205	57 911
1980	180	180[b]	64 800
1990	240	240[b]	85 600
2000	310	310[b]	110 000

General Comments: Total peak summer population is expected to rise from 168 000 to 265 000 by year 2000.

[a] Residential and commercial only.

[b] Assuming 356 hectares utilized for housing.

TABLE A-8 (28)

LAND USE/POPULATION INVENTORY

Area: Eastern
District [Kism]: Montazah
Sub-district [Sheyakha(s)]: Mandara South, Ras el Soda

Economic Classification [primary]: Low Middle Income
[secondary]: Low Income

Map Designation: M5

Land Use (ha)

Gross Area	477		
Parks/Sports Club		Industrial Zones	8
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	
Workshops		Open for Residential	241
Cemeteries	127	Other	
		Net Area[a]	101

Year	Gross Density	Persons/ha Net[a]	Population
1960	21	99[b]	9 993
1966	37	176[b]	17 750
1976	142	668[b]	67 500
1980	180	250[c]	85 400
1990	320	445[c]	152 800
2000	570	800[c]	273 000

General Comments: Only 20-25% of total land area is currently utilized for residential and commercial purposes. The remainder is open land, some of which is used for agriculture The Housing and Reconstruction Directorate map of Alexandria in the Year 2000 designates 127 hectares in the south east portion of the zone to be used as a park and cemetery. It is envisioned that rapidly expanding low income housing in the northern and western portions of the

Mandara South (cont.)

zone will eventually utilize all remaining open space, although high water table in the central part of the district may temporarily limit rapid increase in overall housing density. Reasons for assuming the district will continue to grow relate to its proximity to expanding industrial areas along the Mahmoudia Canal and its access to rail transportation along the Northern Border.

---

[a] Residential and commercial only.

[b] Assuming 100 hectares utilized for housing.

[c] Assuming 340 hectares utilized for housing.

TABLE A-8 (29)

LAND USE/POPULATION INVENTORY

Area: Eastern

District [Kism]: Montazah

Sub-district [Sheyakha(s)]: Maamoura (permanent population)

Economic Classification [primary]: Low Income

[secondary]:

Map Designation: M6

Land Use (ha)

Gross Area	-		
Parks/Sports Club		Industrial Zones	
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	
Workshops		Open for Residential	
Cemeteries		Other	
		Net Area[a]	-

Year	Gross Density	Persons/ha Net[a]	Population
1960	-	-	5 720
1966	-	-	6 616
1976	-	-	8 320
1980	-	-	9 400
1990	-	-	12 900
2000	-	-	17 000

General Comments: Gross area not determined due to lack of current maps defining Maamoura's boundaries. Peak summer, resort population is estimated to be 20 000 and is expected to rise to 40 000 by the year 2000.

[a] Residential and commercial only.

TABLE A-8 (30)

LAND USE/POPULATION INVENTORY

Area: Eastern
District [Kism]: Montazah
Sub-district [Sheyakha(s)]: Abu Kir

Economic Classification [primary]: Low Middle Income
[secondary]: Low Income

Map Designation: M7

Land Use (ha)

Gross Area	-		
Parks/Sports Club		Industrial Zones	289
Hospitals		Storage	
Universities		Transport Corridors	
Government Buildings		Open for Industry	256
Workshops		Open for Residential	248
Cemeteries		Other	
		Net Area[a]	-

Year	Gross Density	Persons/ha Net[a]	Population
1960	-	-	13 658
1966	-	-	16 100
1976	-	-	21 200
1980	-	-	41 000
1990	-	-	115 000
2000	-	-	177 000

General Comments: Relatively good soil conditions for housing construction and Abu Kir's proximity to expanding industrial areas along Abu Kir Bay suggest that residential land use will become more predominant. Population projections assume planned public housing projects will add 20 000 people between 1976 and 1980. Further housing construction on 248 hectares of open private land and land currently utilized by the Navy is expected to increase the population densities per hectare in expanded housing zones will average 550. Exact boundaries undefined, therefore gross area is unspecified.

[a] Residendial and commercial only.

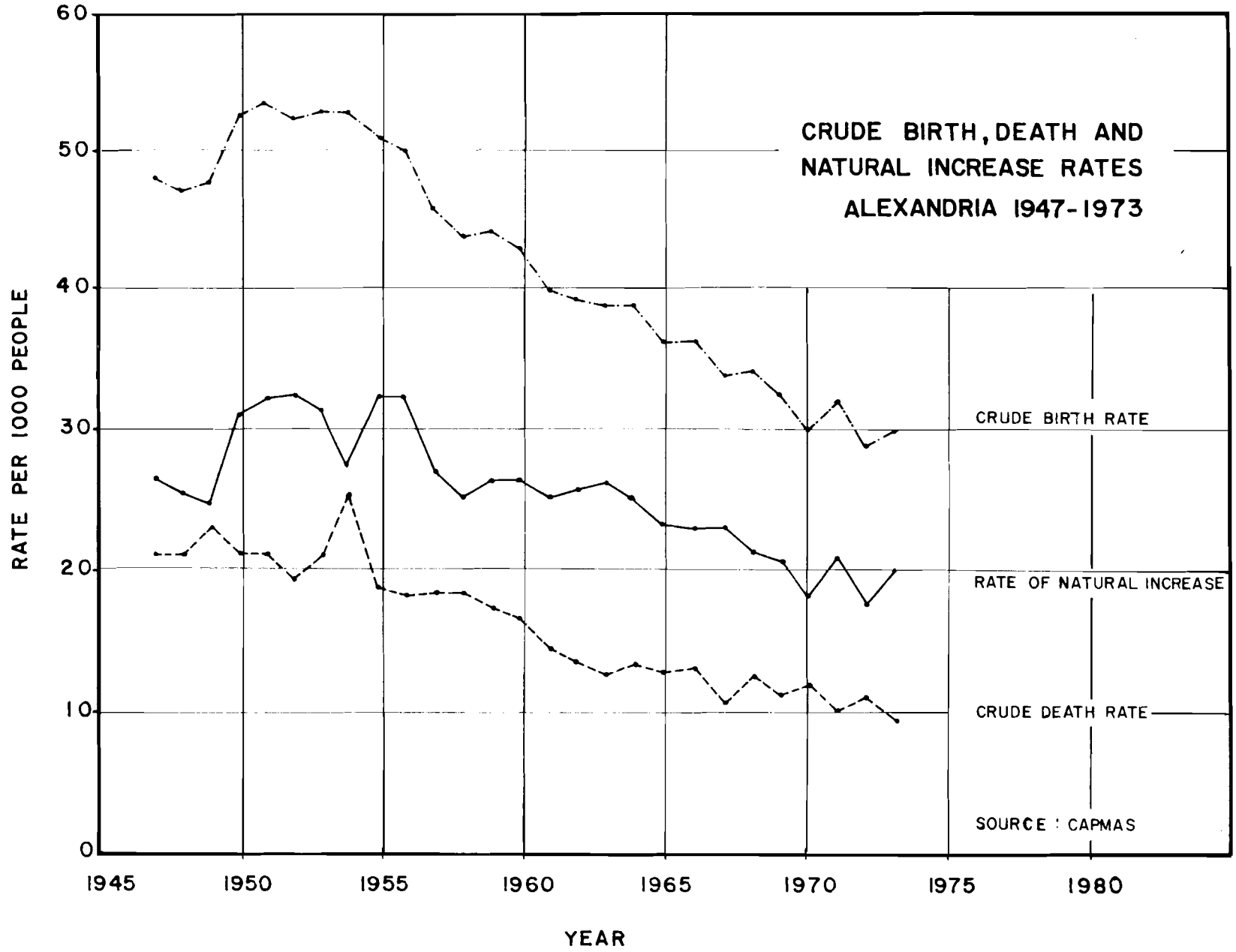
CRUDE BIRTH, DEATH AND
NATURAL INCREASE RATES
ALEXANDRIA 1947-1973
CRUDE BIRTH RATE
RATE OF NATURAL INCREASE
CRUDE DEATH RATE
SOURCE : CAPMAS
RATE PER 1000 PEOPLE
0
10
20
30
40
50
60
1945
1950
1955
1960
1965
1970
1975
1980
YEAR

FIGURE A-1

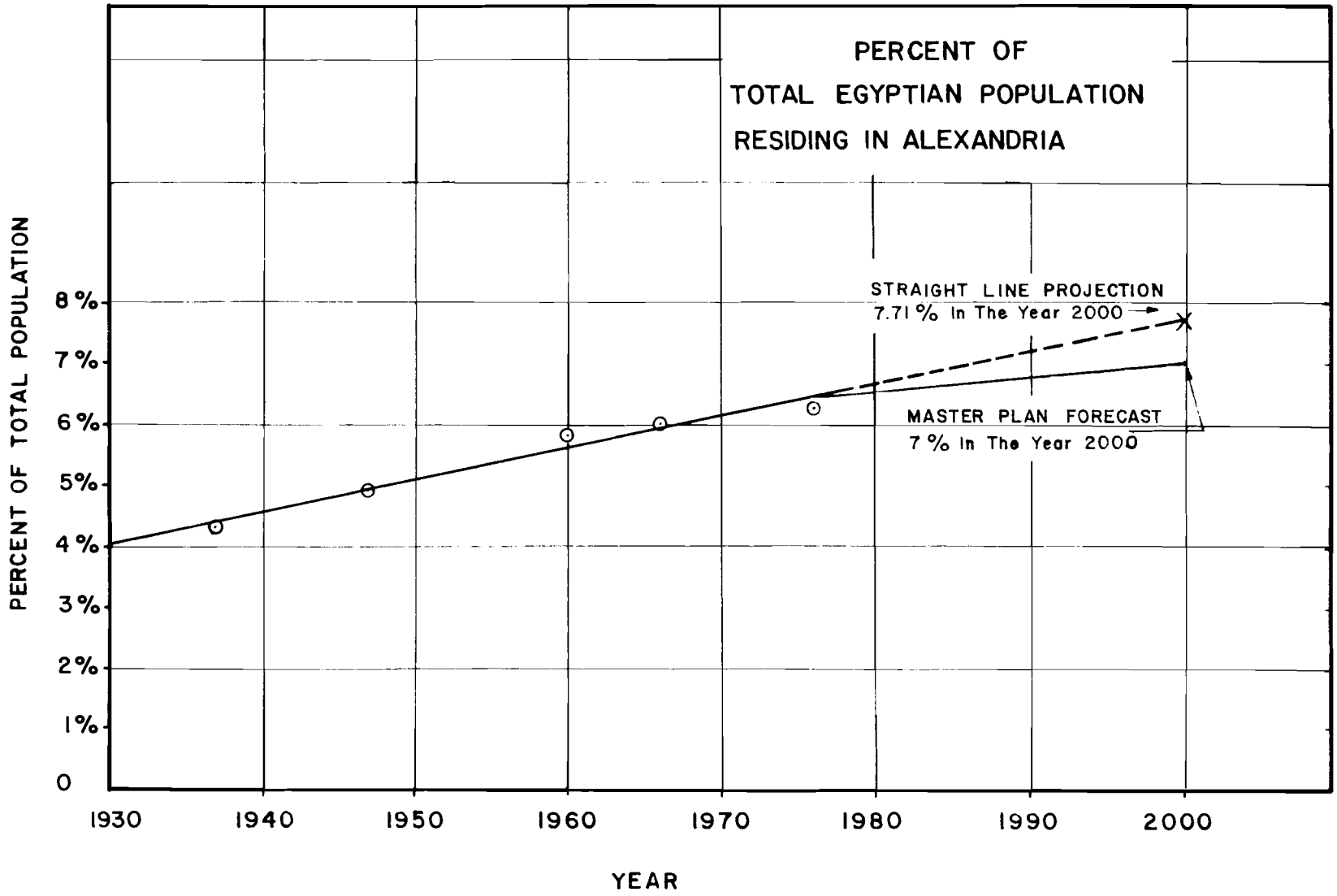
PERCENT OF
TOTAL EGYPTIAN POPULATION
RESIDING IN ALEXANDRIA
STRAIGHT LINE PROJECTION
7.71 % In The Year 2000
MASTER PLAN FORECAST
7 % In The Year 2000
PERCENT OF TOTAL POPULATION
8 %
7 %
6 %
5 %
4 %
3 %
2 %
1 %
0
1930
1940
1950
1960
1970
1980
1990
2000
YEAR

FIGURE A-2

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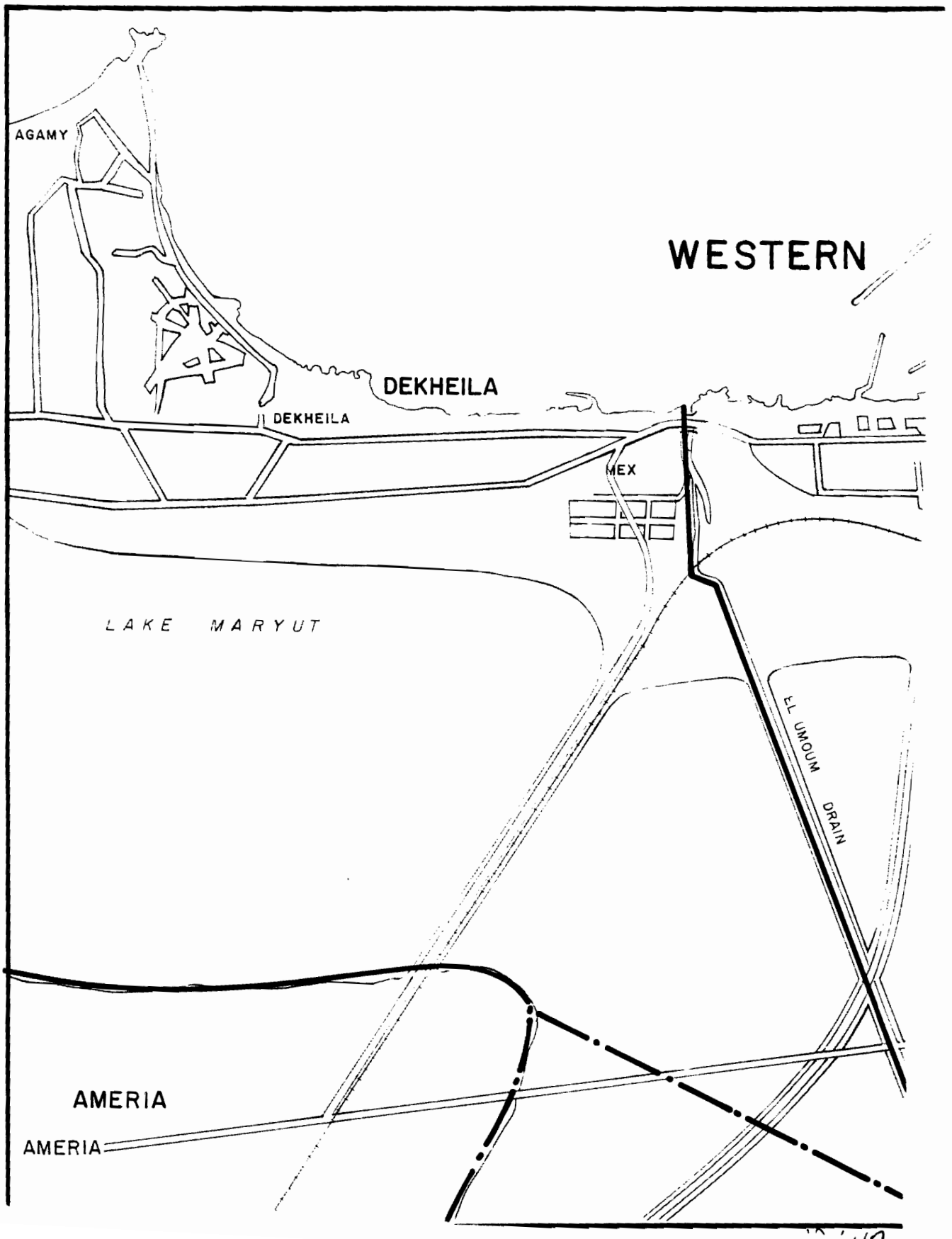

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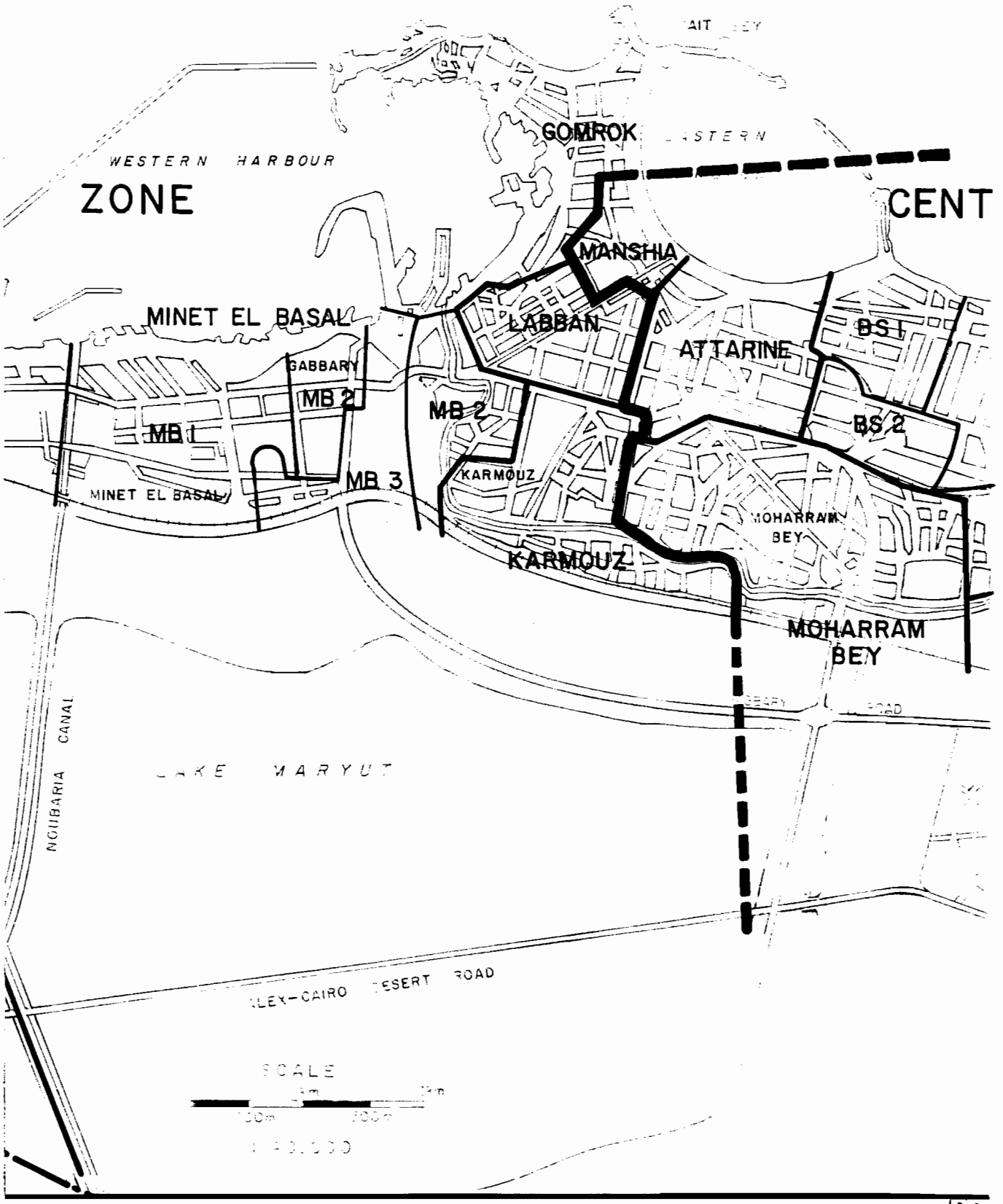

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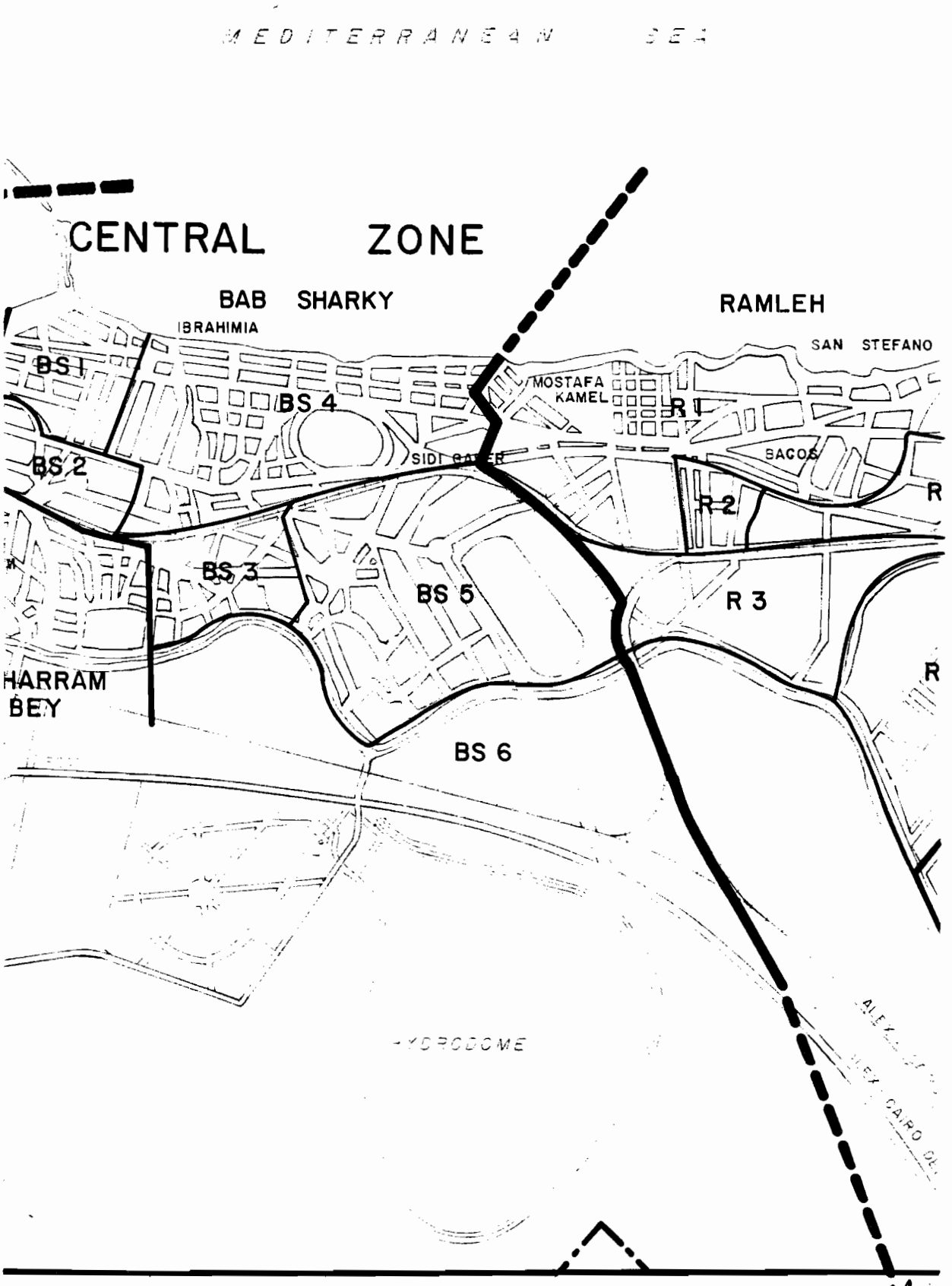

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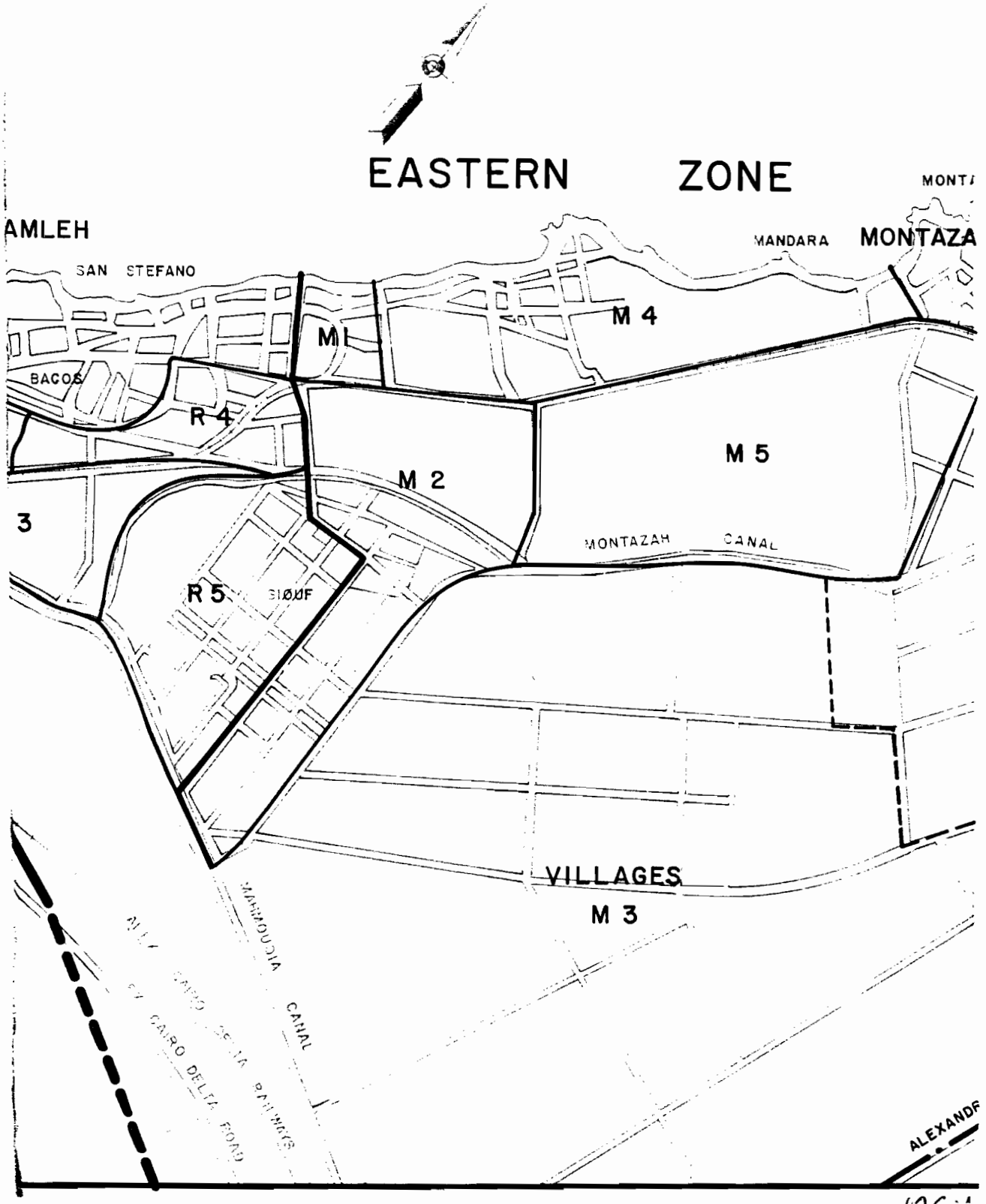

42C

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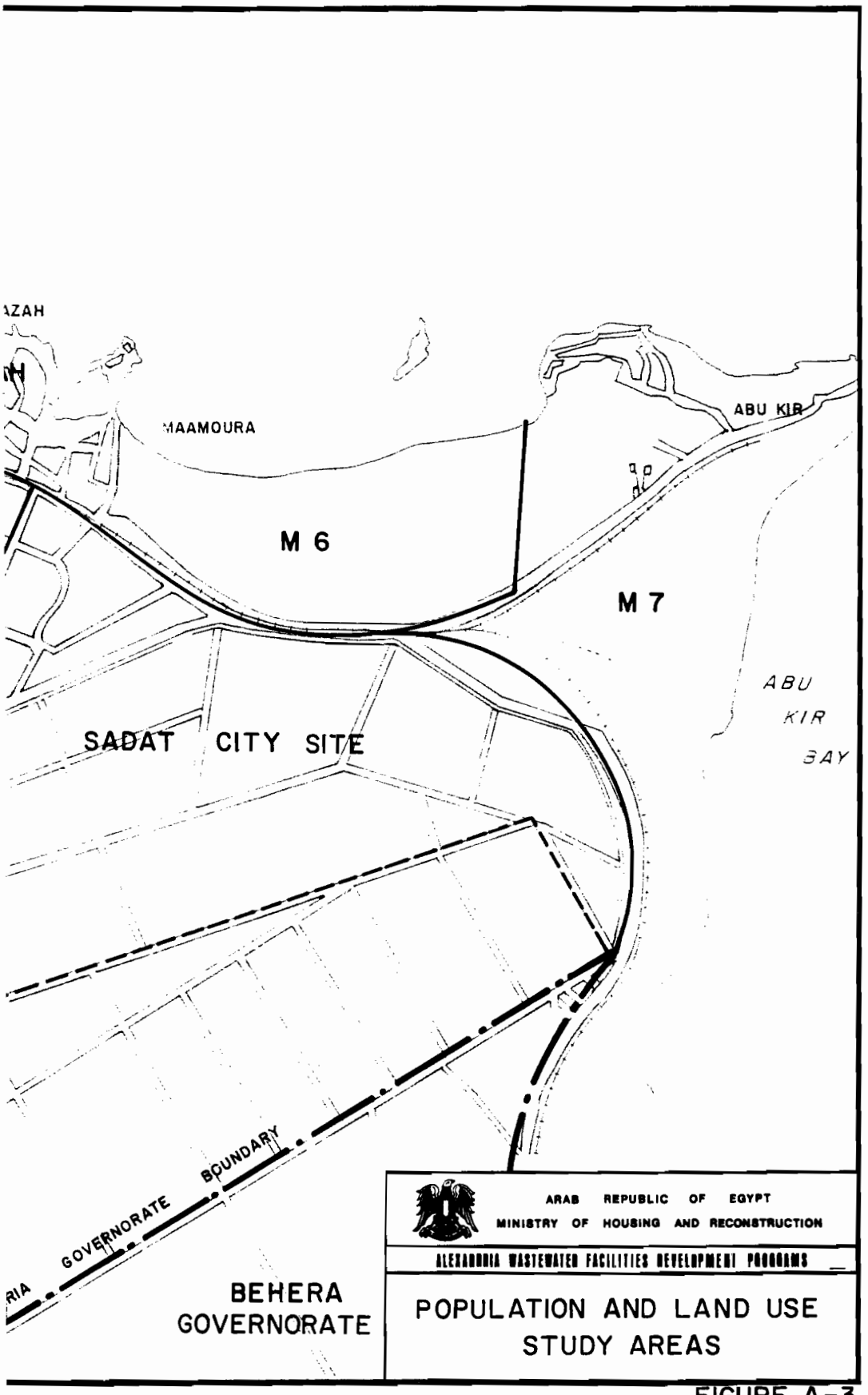

FIGURE A-3

APPENDIX B

WATER USE

Appendix B covers present and projected domestic and industrial water use trends. The information is composited from detailed data expressed in the Alexandria Immediate Phase Waterworks Master Plan Report (Part 1. August 1977).

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B-1 Water Demand Projection by Categories

B-2 Location of Water Supply Districts

TABLE B-1

RECENT WATER USE BASED ON REVENUE RECORDS

Type of Use		Annual Water Use, million m^3/year 1972	1973	1974	1975	1976
Domestic:	BR[a]	28	29	30	31	40
	ER[a]	44	45	47	48	50
	SR[a]	2	2	2	2	5
Industrial		20	21	24	31	30
Government		12	11	9	13	20
Other[b]		7	5	5	4	3
Total accountable		113	113	117	129	148
Total production		190	200	214	229	250
Unaccountable[c]		77 (41%)	87 (44%)	97 (45%)	100 (44%)	102 (41%)

[a] BR = base rate payment of 100 millemes for initial 10 m^3 per month.
ER = expected rate of 15.2 millemes for each additional m^3.
SR = special rate of 6.6 millemes/m^3.

[b] Includes harbor use, water sales stations, western desert consumption, and unmetered subscribers.

[c] Open to error as production figures may be over-estimated; the values in parentheses are percentage of total production.

TABLE B-2

ANNUAL WATER SALES REVENUE
(LE thousand)

	Fiscal Year (1 July - 30 June)					Calender Year (1 Jan. - 31 Dec.)				
	66/67	67/68	68/69	69/70	70/71	1972	1973	1974	1975	1976
Domestic Base Rate						334	342	357	365	356 (375)[a]
Domestic Excess Rate						676	690	717	735	755 (761)[a]
Special Rate						10	15	16	14	16
Industrial						276	285	329	423	414 (450)[b]
Subtotal	904	936	1024	1084	1182	1296	1332	1419	1537	1541(1602)
Government				346	341	388	310	267	388	510[c]
West Desert				112	109	59	50	52	36	32
Subtotal	257	300	321	458	450	447	460	327	424	542
Unmetered	161	161	145	117	75	30	9	8	8	8
Harbor	22	27	26	33	33	32	32	39	45	183[c]
Fire System	23	23	24	26	26	28	28	28	28	28
Raw Water	9	8	8	8	7	7	7	7	7	7
Subtotal	215	219	203	184	141	97	76	82	88	226
TOTAL Revenue	1376	1455	1548	1726	1773	1840	1868	1828	2049	2309 (2370)

(a) Invoices in portions of Alexandria were not prepared during last two months of 1976 thus understating domestic revenue by an estimated LE 25 000.

(b) Actual revenue in 1976 was low due to failure of some industrial water meters in the Gabbary area. Probable additional revenue, if meters were properly functioning, is estimated at LE 36 000.

(c) Increase primarly due to new tariff rates established in second half of 1976 which are now; 40 millemes/m^3 for government use and 550 millemes/m^3 for port or harbor use.

(d) Includes both domestic (20%) and government (80%) revenues received from the sale of water in the Western Desert Area.

(e) Untreated water used for garden irrigation purposes in the Ramleh and Sidi Bishr area.

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TABLE B-3

HISTORIC WATER USE BASED ON REVENUE
(Million cubic metres/annum)

	Tariff Rate Millemes/ m^3	Fiscal Year (1 July - 30 June) 66/67	67/68	68/69	69/70	70/71	Calender Year 1972	1973	1974	1975	1976
Domestic Base Rate	10.0						28	29	30	31	32
Domestic Excess Rate	15.2						44	45	47	48	50
Special Rate	6.6						2	2	2	2	2
Industrial	13.8						20	21	24	31	33
Subtotal		66	68	75	79	86	94	97	103	112	117
Government	30.8				10	11	12	11	9	13	23
Western Desert	33.0				3	3	2	2	2	1	1
Subtotal		8	9	10	13	14	14	13	11	14	24
Other[a]		18	18	17	14	10	5	3	3	3	3
Accounted for Water Use		92	95	102	106	110	113	113	117	129	144
TOTAL Water Supply[b]		143	146	161	174	185	193	203	216	231	252
Unaccounted for[c]		36%	35%	37%	39%	41%	41%	44%	46%	44%	43%

[a] Includes harbor, water sales stations, unmetered use and untreated water for garden irrigation.

[b] Estimated AWA water supply

[c] Percent of total water supply not accounted for by water sales revenue.

TABLE B-4

DISTRIBUTION OF INDUSTRIAL WATER DEMAND, 1976

Map Locations[a]	District	Estimated Use m^3/day	Percent of Use
A	Gomrok	130	0.14
B	Manshia	600	0.66
C	Labban	514	0.56
D	Attarine	90	0.10
E	Karmouz	5 926	6.48
F	Moharrem Bey	12 144	13.28
G1, G2	Bab Sharky	135	0.15
G3, 4, 6	Bab Sharky	1 160	1.27
G5	Bab Sharky	8 766	9.58
G7	Bab Sharky	4 086	4.47
G8	Bab Sharky	1 444	1.58
H1, 1, 2, 3, 6	Ramleh	545	0.60
H4	Ramleh	-	-
H5	Ramleh	14 867	16.25
H7, 8	Ramleh	15	0.02
H9, 10	Ramleh	6 816	7.45
J1	Montazah	-	-
J2	Montazah	5 819	6.36
J3	Montazah	-	-
J4	Montazah	2 200	2.41
J5	Montazah	-	-
J6	Montazah	642	0.70
J7	Montazah	995	1.09
I	Sadat City	-	-
K1, 2	Minet el Bassal	2 497	2.73
K3	Minet el Bassal	2 035	2.22
L	Dekheila	18 980	20.75
M	Ameria	-	-
N	Beheira Governorate	1 056	1.15
	Free Zone	-	-
TOTAL		91 462	100.00

[a] Refer to Figure B-2.

TABLE B-5

GEOGRAPHICAL DISTRIBUTION OF WATER DEMAND BY COMPONENT (Year 1976)

Area[a]		Population[b] Permanent	Permanent Served	Equiv. Seasonal	Total Equiv. Served	Percent Of Total Population	Industries	Economic Class[c]	Domestic Per Cap. Demand (Lpd)	Average Water Demand, 1000 m^3/day Domes.	Indust.	Gov't	Other	Sub-Total	Loss Etc.	Average Demand	Seasonal Adjustments[d] Added Population[b]	Added Domes. Demand	Avg.Day Total Demand	Max. Day Demand
A	Gomrok	166.0	166.0	-	166.0	6.6	0.1	L	65	10.8	0.1	5.0	2.8[e]	18.7	2.8	21.5	-	-	21.5	25.7
B	Manshia	48.6	48.6	-	48.6	1.9	0.6	LM	96	4.7	0.7	1.5	0.3	7.2	1.1	8.3	-	-	8.3	9.9
C	Labban	91.3	91.3	-	91.3	3.7	0.3	L	65	5.9	0.3	2.7	0.6	9.5	1.5	11.0	-	-	11.0	13.2
D	Attarine	79.7	79.7	-	79.7	3.2	0.1	ML	130	10.4	0.1	2.4	0.6	13.5	2.0	15.5	-	-	15.5	18.6
E	Karmouz	234.6	211.6	-	211.6	8.5	5.8	L	65	13.8	6.3	6.3	2.2[f]	28.6	4.4	33.0	-	-	33.0	39.5
F	Moharrem Bey	371.1	334.0	-	334.0	13.4	11.9	L/LM	80	26.7	12.8	10.0	2.3	51.8	7.8	59.6	-	-	59.6	71.4
	Inner City Subtotal	991.3	931.2	-	931.2	37.3	18.8		(74.5)[g]	72.3	20.3	27.9	8.8	129.3	19.6	148.9	-	-	148.9	178.3
G1, G2		32.4	32.4	6.0	38.4	1.5	0.1	ML/M	150	5.8	0.1	1.1	0.3	7.3	1.1	8.4	13.1	2.0	10.4	12.4
G3, G4, G6		164.0	164.0	31.0	195.0	7.8	1.1	MH	220	42.9	1.2	5.8	1.4	51.3	7.8	59.1	67.6	14.9	74.0	88.6
G5		91.7	91.7	-	91.7	3.7	8.6	ML	130	11.9	9.3	2.8	0.6	24.6	3.7	28.3	-	-	28.3	33.9
G7		44.9	44.9	-	44.9	1.8	4.0	LM	96	4.3	4.3	1.4	0.3	10.3	1.6	11.9	-	-	11.9	14.2
G8		20.6	15.0	-	15.0	0.6	1.4	L	65	1.0	1.5	0.4	0.1	3.0	0.4	3.4	-	-	3.4	4.1
	Bab Sharky Subtotal	353.6	348.0	37.0	385.0	15.4	15.2		(170.9)	65.9	16.4	11.5	2.7	96.5	14.6	111.1	80.7	16.9	128.0	153.2
H1, H2, H3, H6		105.3	105.3	11.0	116.3	4.6	9.0	HM	251	29.2	9.7	3.5	0.8	43.2	6.5	49.7	24.0	6.0	55.7	66.7
H4		36.6	36.6	-	36.6	1.5	-	M	171	6.3	-	1.1	0.3	7.7	1.2	8.9	-	-	8.9	10.6
H5		73.0	73.0	-	73.0	2.9	6.1	LM	96	7.0	6.6	2.2	0.5	16.3	2.5	18.8	-	-	18.8	22.5
H7, H8		90.1	90.1	-	90.1	3.6	-	ML/M	150	13.5	-	2.7	0.6	16.8	2.5	19.3	-	-	19.3	23.1
H9, H10		148.9	147.4	-	147.4	5.9	6.7	LM	96	14.2	7.2	4.4	1.0	26.8	4.1	30.9	-	-	30.9	37.0
	Ramleh Subtotal	453.9	452.4	11.0	463.4	18.5	21.8		(151.5)	70.2	23.5	13.9	3.2	110.8	16.8	127.6	24.0	6.0	133.6	159.9
J1		27.3	27.3	12.0	39.3	1.5	-	MH	220	8.7	-	1.2	0.3	10.2	1.5	11.7	26.2	5.8	17.5	21.0
J2		44.4	44.4	-	44.4	1.8	6.3	M	171	7.6	6.8	1.3	0.3	16.0	2.4	18.4	-	-	18.4	22.0
J3		57.9	57.9	34.0	91.9	3.7	-	M	171	15.7	-	2.8	0.6	19.1	2.9	22.0	74.2	12.7	34.7	41.5
J4		67.5	67.5	-	67.5	2.7	2.2	LM	96	6.5	2.4	2.0	0.5	11.4	1.7	13.1	-	-	13.1	15.7
J5		8.3	8.3	6.0	14.3	0.6	-	M	171	2.5	-	0.4	0.1	3.0	1.3	4.3	13.1	2.2	6.5	7.8
J6		47.0	42.0	-	42.0	1.7	0.6	ML	130	5.5	0.7	1.3	0.3	7.8	3.3	11.1	-	-	11.1	13.3
J7		21.2	16.0	8.0	24.0	0.9	0.5	MH	220	5.3	0.5	0.7	0.2	6.7	2.9	9.6	17.4	3.8	13.4	16.0
	Montazah	273.6	263.4	60.0	323.4	12.9	9.6		(160.2)	51.8	10.4	9.7	2.3	74.2	16.0	90.2	130.9	24.5	114.7	137.3
I	Sadat City	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
	Subtotal	273.6	263.4	60.0	323.4	12.9	9.6		(160.2)	51.8	10.4	9.7	2.3	74.2	16.0	90.2	130.9	24.5	114.7	137.3
K1, K2		159.6	159.6	-	159.6	6.4	2.4	L	65	10.4	2.6	4.8	1.1	18.9	2.9	21.8	-	-	21.8	26.1
K3		99.9	99.9	-	99.9	4.0	2.2	L	65	6.5	2.4	3.0	0.7	12.6	1.9	14.5	-	-	14.5	17.4
	Minet el Bassal	259.5	259.5	-	259.5	10.4	4.6		(65)	16.9	5.0	7.8	1.8	31.5	4.8	36.3	-	-	36.3	43.5
L	Dekheila	54.6	35.0	2.0	37.0	1.5	29.0	L	65	2.4	31.3	1.1	0.2	35.0	5.3	40.3	4.4	0.3	40.6	48.5
	Subtotal	314.1	294.5	2.0	296.5	11.9	33.6		(65)	19.3	36.3	8.9	2.0	66.5	10.1	76.6	4.4	0.3	76.9	92.0
	Alexandria City	2386.5	2289.5	110.0	2399.5	96.0	99.0		(114.6)	279.5	106.9	71.9	19.0	477.3	77.1	554.4	240.0	47.7	602.1	720.7
M	Ameria	15.0	14.2	-	14.2	0.6	-	ML	130	1.8	-	0.4	0.1	2.3	4.3	6.6	-	-	6.6	8.6
N	Desert Area	143.0	86.3	-	86.3	3.4	1.0	L	65	5.6	1.1	2.7	0.7	10.1	18.9	29.0	-	-	29.0	37.7
	Indust. Free Zone	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
	Subtotal	158.0	100.5	-	100.5	4.0	1.0		(68.3)	7.4	1.1	3.1	0.8	12.4	23.2	35.6	-	-	35.6	46.3
	Study Area TOTAL	2544.4	2390.0	110.0	2500.0	100.0	100.0		(114.8)	286.9	108.0	75.0	19.8	489.7	100.3	590.0	240.0	47.7	637.7	767.0

(a) Refer to Figure B-2.

(b) In 1000 persons.

(c) Economic classifications are low income (L), middle income (M), and high income (H).

(d) In 1000 m^3/day.

(e) Includes harbor facilities.

(f) Includes 700 m^3/day to Mersa Matruh by railroad.

(g) Parentheses indicate weighted average Lpd.

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TABLE B-6

GEOGRAPHICAL DISTRIBUTION OF WATER DEMAND BY COMPONENT(Year 1982)

Area (Refer to Figure B-2)	Population[a] Permanent	Permanent Served	Equiv. Seasonal	Total Equiv. Served	Percent Of Total Population	Industries	Econ. Class	Domestic Per Cap. Demand (Lpd)	Average Water Demand 1000 m³/day Domes.	Indust.	Gov't	Other	Sub-Total	Loss Etc.	Average Demand	Seasonal Adjustments[b] Added Population[a]	Added Domes. Demand	Avg.Day Total Demand	Max. Day Demand
A Gomrok	168.2	168.2	-	168.2	5.7	0.1	LM	103	17.3	0.1	5.2	3.3[e]	25.9	4.2	30.1	-	-	30.1	36.4
B Manshia	51.8	51.8	-	51.8	1.8	0.5	LM	103	5.3	0.9	1.6	0.4	8.2	1.3	9.5	-	-	9.5	11.4
C Labban	97.0	97.0	-	97.0	3.3	0.2	LM	103	10.0	0.3	3.0	0.7	14.0	2.3	16.3	-	-	16.3	19.6
D Attarine	83.2	83.2	-	83.2	2.8	0.1	ML	135	11.2	0.1	2.6	0.6	14.5	2.4	16.9	-	-	16.9	20.4
W Karmouz	239.2	219.6	-	219.6	7.4	4.8	L	71	15.6	8.9	6.8	2.2[d]	33.5	5.4	38.9	-	-	38.9	46.9
F Moharrem Bey	376.0	344.4	-	344.4	11.7	9.8	LM	103	35.5	18.4	10.7	2.4	67.0	10.8	77.8	-	-	77.8	93.8
Inner City Subtotal	1015.4	964.2	-	964.2	32.7	15.5		(98.0)	94.9	28.7	29.9	9.6	163.1	26.4	189.5	-	-	189.5	228.5
G1, G2	33.4	33.4	7.5	40.9	1.4	0.1	M	175	7.2	0.1	1.3	0.3	8.9	1.4	10.3	16.6	2.2	12.5	15.1
G3, G4, G6	170.1	170.1	36.7	206.8	7.0	1.0	MH	225	46.5	1.9	6.4	1.4	56.2	9.1	65.3	81.1	18.3	83.6	100.7
G5	95.0	95.0	-	95.0	3.2	6.9	ML	135	12.8	12.8	2.9	0.7	29.2	4.7	33.9	-	-	33.9	40.9
G7	64.5	64.5	-	64.5	2.2	3.6	LM	103	6.6	6.7	2.0	0.4	15.7	2.6	18.3	-	-	18.3	22.0
G8	43.8	39.0	-	39.0	1.3	1.9	L	71	2.8	3.5	1.2	0.3	7.8	1.3	9.1	-	-	9.1	11.0
Bab Sharky Subtotal	406.8	402.0	44.2	446.2	15.1	13.5		(170.2)	75.9	25.0	13.8	3.1	117.8	19.1	136.9	97.7	20.5	157.4	189.7
H1, H2, H6	120.5	120.5	13.3	133.8	4.5	7.7	HM	258	34.5	14.3	4.1	0.9	53.8	8.7	62.5	29.4	7.6	70.1	84.5
H4	39.0	39.0	-	39.0	1.3	-	M	175	6.8	-	1.2	0.3	8.3	1.3	9.6	-	-	9.6	11.6
H5	88.6	88.6	-	88.6	3.0	6.5	LM	103	9.1	12.0	2.8	0.6	24.5	4.0	28.5	-	-	28.5	34.3
H7, H8	96.5	96.5	-	96.5	3.3	-	M	175	16.9	-	3.0	0.7	20.6	3.3	23.9	-	-	23.9	28.8
H9, H10	208.6	207.3	-	207.3	7.1	5.9	LM	103	21.4	10.9	6.4	1.5	40.2	6.5	46.7	-	-	46.7	56.3
Ramleh Subtotal	553.2	551.9	13.3	565.2	19.2	20.1		(157.0)	88.7	37.2	17.5	4.0	147.4	23.8	171.2	29.4	7.6	178.8	215.5
J1	29.1	29.1	11.5	40.6	1.4	-	MH	225	9.1	-	1.3	0.3	10.7	1.7	12.4	25.4	5.7	18.1	21.8
J2	86.7	86.7	-	86.7	2.9	5.9	M	175	15.2	10.9	2.7	0.6	29.4	4.8	34.2	-	-	34.2	41.2
J3	68.5	68.5	40.0	108.5	3.7	-	M	175	19.0	-	3.4	0.8	23.2	3.8	27.0	88.4	15.5	42.5	51.3
J4	96.0	96.0	-	96.0	3.3	2.0	LM	103	9.9	3.7	3.0	0.7	17.3	2.8	20.1	-	-	20.1	24.2
J5	10.0	10.0	7.5	17.5	0.6	-	M	175	3.1	-	0.5	0.1	3.7	1.2	4.9	16.6	2.9	7.8	9.4
J6	50.0	45.7	-	45.7	1.5	0.8	ML	135	6.2	1.5	1.4	0.3	9.4	3.1	12.5	-	-	12.5	15.1
J7	50.4	46.0	6.7	52.7	1.8	0.9	MH	225	11.8	1.7	1.6	0.3	15.4	5.2	20.6	14.8	3.3	23.9	28.8
Montazah	390.7	382.0	65.7	447.7	15.2	9.6		(165.9)	74.3	17.8	13.9	3.1	109.1	22.6	131.7	145.2	27.4	159.1	191.8
I Sadat City	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
Subtotal	390.7	382.0	65.7	447.7	15.2	9.6		(165.9)	74.3	17.8	13.9	3.1	109.1	22.6	131.7	145.2	27.4	159.1	191.8
K1, K2	179.1	179.1	-	179.1	6.1	2.0	L	71	12.7	3.7	5.6	1.2	23.2	3.7	26.9	-	-	26.9	32.4
K3	136.6	136.6	-	136.6	4.6	1.7	L	71	9.7	3.1	4.2	1.0	18.0	2.9	20.9	-	-	20.9	25.2
Minet el Bassal	315.7	315.7	-	315.7	10.7	3.7		(71)	22.4	6.8	9.8	2.2	41.2	6.6	47.8	-	-	47.8	57.6
Dekheila	69.9	53.2	4.8	58.0	2.0	25.0	L/MH	84[c]	4.9	46.2	1.8	0.4	53.3	8.6	61.9	10.6	2.4	64.3	77.5
Subtotal	385.6	368.9	4.8	373.7	12.7	28.7		(73.1)[c]	27.3	53.0	11.6	2.6	94.5	15.2	109.7	10.6	2.4	112.1	135.1
Alexandria City	2751.7	2669.0	128.0	2797.0	94.8	87.6		(129.1)	361.1	161.7	86.7	22.4	631.9	107.1	739.0	282.9	57.9	796.9	960.6
M Ameria	45.5	43.0	-	43.0	1.5	0.2	ML	135	5.8	0.3	1.3	0.3	7.7	6.7	14.4	-	-	14.4	18.7
N Desert Area	164.4	110.0	-	110.0	3.7	1.6	L	71	7.8	3.0	3.4	0.8	15.0	13.2	28.2	-	-	28.2	36.7
Indust. Free Zone	-	-	-	-	-	10.8		-	-	20.0	-	-	20.0	-	20.0	-	-	20.0	26.0
Subtotal	209.9	153.0	-	153.0	5.2	12.4		(89.0)	13.6	23.3	4.7	1.1	42.7	19.9	62.6	-	-	62.6	81.4
Study Area TOTAL	2961.6	2822.0	128.0	2950.0	100.0	100.0		(127.0)	374.7	185.0	91.4	23.5	674.6	127.0	801.6	282.9	57.9	859.5	1042.0

(a) In thousand persons.

(b) In 1000 m³/day.

(c) Domestic per capita demand for the permanent population (low income) is 71 Lpd; for the seasonal population (middle to high income) it is 225 Lpd. 84 Lpd represents a weighted average of both.

(d) Includes 700 m³/day to Mersa Matruh by railroad.

(e) Includes harbor facilities.

TABLE B-7

GEOGRAPHICAL DISTRIBUTION OF WATER DEMAND BY COMPONENT (Year 1990)

Area (Refer to Figure B-2	Population[a] Permanent	Population[a] Permanent Served	Population[a] Equiv. Seasonal	Population[a] Total Equiv. Served	Percent Of Total Population	Percent Of Total Industries	Econ. Class	Domestic Per Cap. Demand (Lpd)	Average Water Demand 1000 m^3/day Domes.	Indust.	Gov't	Other	Sub-Total	Loss Etc.	Average Demand	Seasonal Adjustments[b] Added Population[a]	Added Domes. Demand	Avg.Day Total Demand	Max. Day Demand
A Gomrok	169.0	169.0	-	169.0	4.5	0.1	LM	112	18.9	0.2	5.4	4.2[e]	28.7	3.9	32.6	-	-	32.6	39.3
B Manshia	55.0	55.0	-	55.0	1.5	0.4	LM	112	6.2	1.0	1.8	0.4	9.4	1.3	10.7	-	-	10.7	12.9
C Labban	103.0	103.0	-	103.0	2.7	0.1	LM	112	11.5	0.2	3.3	0.8	15.8	2.1	17.9	-	-	17.9	21.6
D Attarine	88.0	88.0	-	88.0	2.3	0.1	ML	140	12.3	0.2	2.8	0.7	16.0	2.2	18.2	-	-	18.2	21.9
E Karmouz	244.0	228.0	-	228.0	6.0	4.2	L	80	18.2	11.0	7.3	2.8[d]	39.3	5.3	44.6	-	-	44.6	53.8
F Moharrem Bey	380.0	354.2	-	354.2	9.4	8.7	LM	112	39.7	22.8	11.3	2.8	76.6	10.4	87.0	-	-	87.0	104.9
Inner City Subtotal	1039.0	997.2	-	997.2	26.4	13.6		(107.1)	106.8	35.4	31.9	11.7	185.8	25.2	211.0	-	-	211.0	254.3
G1, G2	35.0	35.0	9.5	44.5	1.2	0.1	M	182	8.1	0.2	1.4	0.4	10.1	1.4	11.4	20.5	3.7	15.2	18.3
G3, G4, G6	172.1	172.1	43.8	215.9	5.7	1.0	MH	231	49.9	2.6	6.9	1.7	61.1	8.3	69.4	94.6	21.9	91.3	110.1
G5	99.4	99.4	-	99.4	2.6	5.8	ML	140	13.9	15.1	3.2	0.8	33.0	4.4	37.4	-	-	37.4	45.1
G7	155.4	155.4	-	155.4	4.1	3.3	LM	112	17.4	8.6	5.0	1.2	32.2	4.4	36.6	-	-	36.6	44.1
G8	52.0	48.1	-	48.1	1.3	2.9	L	80	3.8	7.6	1.5	0.4	13.3	1.8	15.1	-	-	15.1	18.2
Bab Sharky Subtotal	513.9	510.0	53.3	563.3	14.9	13.1		(165.3)	93.1	34.1	18.0	4.5	149.7	20.3	170.0	115.1	25.6	195.6	235.8
H1, H2, H6	138.0	138.0	16.2	154.2	4.1	7.3	HM	267	41.2	19.0	4.9	1.2	66.3	9.0	75.3	35.0	9.3	84.6	102.0
H4	45.1	45.1	-	45.1	1.2	-	M	182	8.2	-	1.5	0.4	10.1	1.4	11.5	-	-	11.5	13.9
5	116.6	116.6	-	116.6	3.1	8.0	M	182	21.2	20.8	3.7	0.9	46.6	6.3	52.9	-	-	52.9	63.7
H7, H8	103.1	103.1	-	103.1	2.7	-	M	182	18.8	-	3.3	0.8	22.9	3.1	26.0	-	-	26.0	31.3
H9, H10	253.6	252.6	-	252.6	6.7	5.9	ML	140	35.3	15.3	8.1	2.1	60.8	8.2	69.0	-	-	69.0	83.2
Ramleh Subtotal	656.4	655.4	16.2	671.6	17.8	21.2		(185.7)	124.7	55.1	21.5	5.4	206.7	28.0	234.7	35.0	9.3	244.0	294.1
J1	30.4	30.4	10.3	40.7	1.1	-	MH	231	9.4	-	1.3	0.3	11.0	1.5	12.5	22.3	5.2	17.7	21.3
J2	139.0	139.0	-	139.0	3.7	6.3	M	182	25.3	16.4	4.4	1.1	47.2	6.4	53.6	-	-	53.6	64.6
J3	85.6	85.6	47.1	132.7	3.5	-	MH	231	30.7	-	4.3	1.1	36.1	4.9	41.0	101.7	23.5	64.5	77.8
J4	152.8	152.8	-	152.8	4.0	2.2	M	182	27.8	5.7	4.9	1.2	39.6	5.4	45.0	-	-	45.0	54.2
J5	12.9	12.9	9.5	22.4	0.6	-	HM	267	6.0	-	0.7	0.2	6.9	1.7	8.6	20.5	5.5	14.1	17.0
J6	50.0	46.5	-	46.5	1.2	0.9	ML	140	6.5	2.3	1.5	0.4	10.7	2.7	13.4	-	-	13.4	16.2
J7	115.0	111.4	5.0	116.4	3.1	1.6	MH	231	26.9	4.2	3.7	0.9	35.7	8.9	44.6	10.8	2.1	47.1	56.7
Montazah	585.7	578.6	71.9	650.5	17.2	11.0		(203.7)	132.6	28.6	20.8	5.2	187.2	31.5	218.7	155.3	36.7	255.4	307.8
Sadat City	150.0	150.0	-	150.0	4.0	-	ML	140	21.0	-	4.8	1.2	27.0	3.7	30.7	-	-	30.7	37.0
Subtotal	735.7	728.6	71.9	800.5	21.2	11.0		(191.8)	153.6	28.6	25.6	6.4	214.2	35.2	249.4	155.3	36.7	286.1	344.8
K1, K2	223.0	223.0	-	223.0	5.9	1.8	L	80	17.8	4.6	7.1	1.8	31.3	4.3	35 6	-	-	35.6	42.9
K3	103.5	103.5	-	103.5	2.7	1.3	L	80	8.3	3.4	3.3	0.8	15.8	2.1	17.9	-	-	17.9	21.6
Minet el Bassal	326.5	326.5	-	326.5	8.6	3.1		(80)	26.1	8.0	10.4	2.6	47.1	6.4	53.5	-	-	53.5	64.5
Dekheila	106.0	92.3	14.6	106.9	2.8	23.4	L/MH[c]	101[c]	10.8	60.8	3.4	0.9	75.9	10.3	86.2	31.5	7.3	93.5	112.7
Subtotal	432.5	418.8	14.6	433.4	11.4	26.5		(85.1)	36.9	68.8	13.8	3.5	123.0	16.7	139.7	31.5	7.3	147.0	177.2
Alexandria City	3377.5	3310.0	156.0	3466.0	91.7	85.4		(148.6)	515.1	222.0	110.8	31.5	879.4	125.4	1004.8	336.9	78.9	1083.7	1306.2
M Ameria	146.0	138.0	-	138.0	3.6	0.4	ML	140	19.3	1.0	4.4	1.1	25.8	15.5	41.3	-	-	41.3	53.7
N Desert Area	236.0	176.0	-	176.0	4.7	2.7	L	80	14.1	7.0	5.6	1.4	28.1	16.8	44.9	-	-	44.9	58.4
Indust.Free Zone	-	-	-	-	-	11.5		-	-	30.0	-	-	30.0	-	30.0	-	-	30.0	39.0
Subtotal	382.0	314.0	-	314.0	8.3	14.6		(106.4)	33.4	38.0	10.0	2.5	83.9	32.3	116.2	-	-	116.2	151.1
Study Area TOTAL	3759.5	3624.0	156.0	3780.0	100.0	100.0		(145.1)	548.5	260.0	120.8	34.0	963.3	157.7	1121.0	336.9	78.9	1199.9	1457.3

(a) In thousand persons

(b) In 1000m^3/day

(c) L - Permanent Population 80 Lpd; MH - Seasonal Population 231 Lpd; weighted average 101 Lpd

(d) Includes 700 m^3/day to Mersa Matruh by railroad

(e) Includes harbor facilities.

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GEOGRAPHICAL DISTRIBUTION OF WATER DEMAND BY COMPONENT (Year 2000)

Area (Refer to Figure B-2)	Population[a] Permanent	Population[a] Permanent Served	Population[a] Equiv. Seasonal	Population[a] Total Equiv. Served	Percent Of Total Population	Percent Of Total Industries	Econ. Class	Domestic Per Cap. (Lpd)	Average Water Demand 1000 m³/day Domes.	Indust.	Commt	Other	Sub-Total	Loss Etc.	Average Demand	Added Population[a]	Seasonal Added Domes. Demand	Adjustments[b] Avg.Day Total Demand	Adjustments[b] Max. Day Demand
A Gomrok	170.0	170.0	-	170.0	3.4	0.1	LM	125	21.3	0.3	5.4	4.9[e]	31.9	3.7	35.6	-	-	35.6	43.1
B Manshia	56.0	56.0	-	56.0	1.1	0.3	LM	125	7.0	1.0	1.8	0.4	10.2	1.2	11.4	-	-	11.4	13.8
C Labban	112.0	112.0	-	112.0	2.2	0.1	LM	125	14.0	0.3	3.6	0.9	18.8	2.2	21.0	-	-	21.0	25.4
D Attarine	93.0	93.0	-	93.0	1.9	0.1	ML	150	14.0	0.3	3.3	0.7[d]	18.0	2.1	20.1	-	-	20.1	24.4
E Karmouz	252.0	242.3	-	242.3	4.9	3.4	L	90	21.8	12.0	7.8	3.4	45.0	5.3	50.3	-	-	50.3	60.9
F Moharrem Bey	385.0	369.3	-	369.3	7.4	7.2	LM	125	46.2	25.3	11.8	3.0	86.3	10.1	96.4	-	-	96.4	116.7
Inner City Subtotal	1068.0	1042.6	-	1042.6	20.9	11.2		(119.2)	124.3	39.2	33.4	13.3	210.2	24.6	234.8	-	-	234.8	284.3
G1, G2	37.2	37.2	11.0	48.2	1.0	0.1	M	190	9.2	0.3	1.5	0.4	11.4	1.3	12.7	21.7	4.1	16.8	20.3
G3, G4, G6	174.7	174.7	47.0	221.7	4.4	0.8	MH	240	53.2	2.8	7.1	1.8	64.9	7.6	72.5	92.8	22.3	94.8	114.8
G5	105.0	105.0	-	105.0	2.1	4.3	ML	150	15.8	15.1	3.4	0.8	35.1	4.1	39.2	-	-	39.2	47.5
G7	155.4	155.4	-	155.4	3.1	3.2	LM	125	19.4	11.2	5.0	1.2	36.8	4.3	41.1	-	-	41.1	49.8
G8	60.0	57.6	-	57.6	1.2	4.3	L	90	5.2	15.1	1.8	0.5	22.6	2.7	25.3	-	-	25.3	30.6
Bab Sharky Subtotal	532.3	529.9	58.0	587.9	11.8	12.7		(174.9)	107.8	44.5	18.8	4.7	170.8	20.0	190.8	114.5	26.4	217.2	263.0
H1, H2, H3, H6	146.0	146.0	18.0	164.0	3.3	6.7	HM	280	45.9	23.4	5.3	1.3	75.9	8.9	84.8	35.6	10.0	94.8	114.8
H4	51.2	51.2	-	51.2	1.0	-	M	190	9.7	-	1.6	0.4	11.7	1.4	13.1	-	-	13.1	15.9
H5	131.7	131.7	-	131.7	2.6	9.7	M	190	25.0	34.0	4.2	1.1	64.3	7.6	71.9	-	-	71.9	87.1
H7, H8	106.6	106.6	-	106.6	2.2	-	M	190	20.3	-	3.4	0.8	24.5	2.9	27.4	-	-	27.4	33.2
H9, H10	270.3	269.7	-	269.7	5.4	5.8	ML	150	40.5	20.3	8.6	2.2	71.6	8.4	80.0	-	-	80.0	96.9
Ramleh Subtotal	705.8	705.2	18.0	723.2	14.5	22.2		(195.5)	141.4	77.7	23.1	5.8	248.0	29.2	277.2	35.6	10.0	287.2	347.9
J1	33.0	33.0	8.0	41.0	0.8	-	MH	240	8.8	-	1.3	0.3	10.4	1.2	11.6	15.8	3.8	15.4	18.7
J2	185.0	185.0	-	185.0	3.7	6.7	M	190	35.2	23.4	5.9	1.5	66.0	7.8	73.8	-	-	73.8	89.4
J3	110.0	110.0	50.0	160.0	3.2	-	MH	240	38.4	-	5.1	1.3	44.8	5.3	50.1	98.8	23.7	73.8	89.4
J4	273.0	273.0	-	273.0	5.4	2.2	M	190	51.9	7.7	8.8	2.2	70.6	8.3	78.9	-	-	78.9	95.5
J5	17.0	17.0	11.0	28.0	0.6	-	HM	230	7.8	-	0.9	0.2	8.9	1.8	10.7	21.7	6.1	16.8	20.3
J6	50.0	47.8	-	47.8	1.0	1.3	ML	150	7.2	4.5	1.5	0.4	13.6	2.7	16.3	-	-	16.3	19.7
J7	177.0	174.8	3.0	177.8	3.6	2.7	MH	240	42.7	9.4	5.7	1.4	59.2	11.8	71.0	5.9	1.4	72.4	87.7
Montazah	845.0	840.6	72.0	912.6	18.3	12.9		(210.4)	192.0	45.0	29.2	7.3	273.5	38.9	312.4	142.2	35.0	347.4	420.7
Sadat City	500.0	500.0	-	500.0	10.0	-	ML	150	75.0	-	16.0	4.0	95.0	11.1	106.1	-	-	106.1	128.5
Subtotal	1345.0	1340.6	72.0	1412.6	28.3	12.9		(189.0)	267.0	45.0	45.2	11.3	368.5	50.0	418.5	142.2	35.0	453.5	549.2
K1, K2	265.0	265.0	-	265.0	5.3	1.3	L	90	23.8	4.6	8.5	2.2	39.1	4.6	43.7	-	-	43.7	52.9
K3	105.0	105.0	-	105.0	2.1	0.9	L	90	9.5	3.1	3.4	0.8	16.8	2.0	18.8	-	-	18.8	22.8
Minet el Bassal	370.0	370.0	-	370.0	7.4	2.2		(90)	33.3	7.7	11.9	3.0	55.9	6.6	62.5	-	-	62.5	75.7
Dekheila	145.0	136.7	52.0	188.7	3.8	22.5	L/MH[c]	133[c]	24.8	78.8	6.0	1.5	111.1	13.0	124.1	102.7	24.6	148.7	180.1
Subtotal	515.0	506.7	52.0	558.7	11.2	24.7		(90)	58.1	86.5	17.9	4.5	167.0	19.6	186.6	102.7	24.6	211.2	255.8
Alexandria City	4166.1	4125.0	200.00	4325.0	86.7	84.3		(160.4)	693.6	292.9	138.4	39.6	1164.5	143.4	1307.9	395.0	86.0	1403.9	1700.2
M Ameria	468.0	445.0	-	445.0	8.9	0.6	ML	150	66.8	2.1	14.3	3.6	86.8	34.7	121.5	-	-	121.5	158.0
N Desert Area	255.0	220.0	-	220.0	4.4	4.3	L	90	19.8	15.0	7.0	1.8	43.6	17.4	61.0	-	-	61.0	79.3
Indust.Free Zone	-	-	-	-	-	11.4		-	-	40.0	-	-	-	-	40.0	-	-	40.0	52.0
Subtotal	723.0	665.0	-	665.0	13.3	15.7		(130.2)	86.6	57.1	21.3	5.4	130.4	52.1	222.5	-	-	222.5	289.3
Study Area TOTAL	4889.1	4790.0	200.0	4990.0	100.0	100.0		(156.4)	780.2	350.0	159.7	45.0	1294.9	195.5	1530.4	395.0	96.0	1626.4	1989.5

(a) In thousand persons

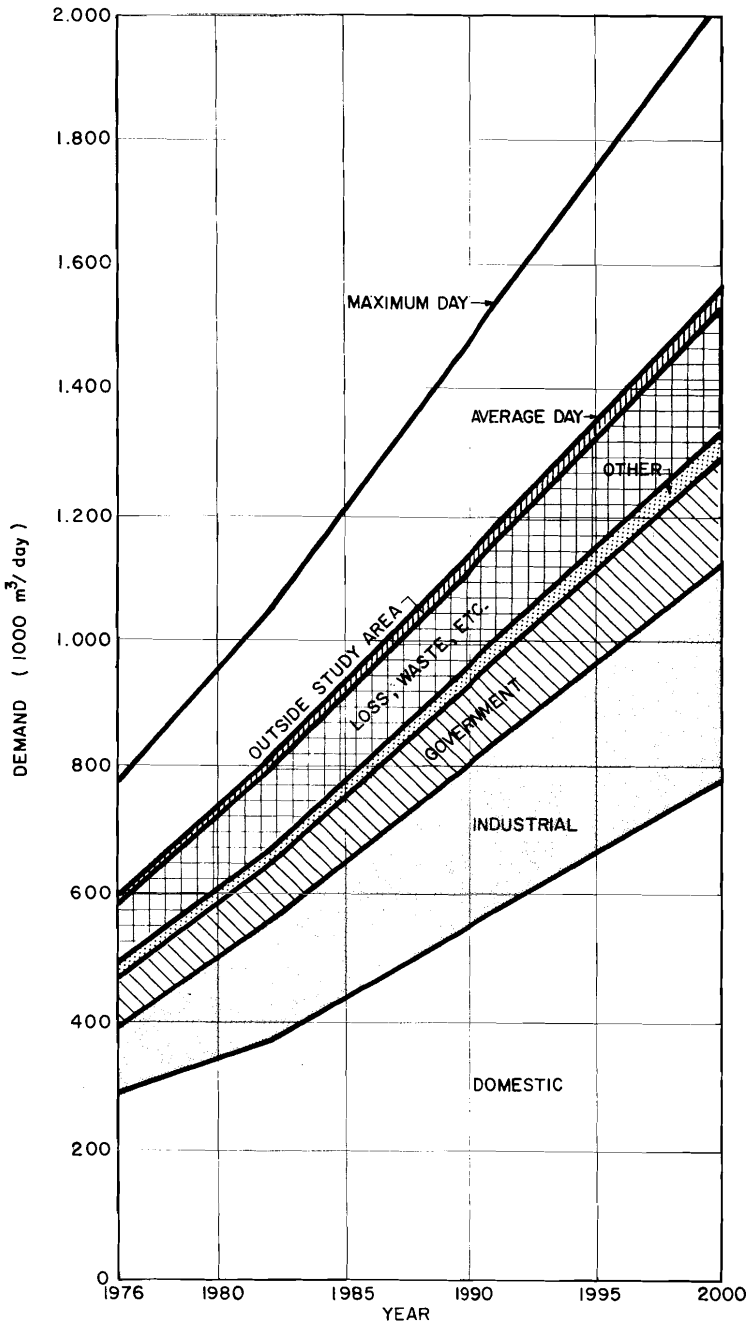
(b) In 100 m³/day

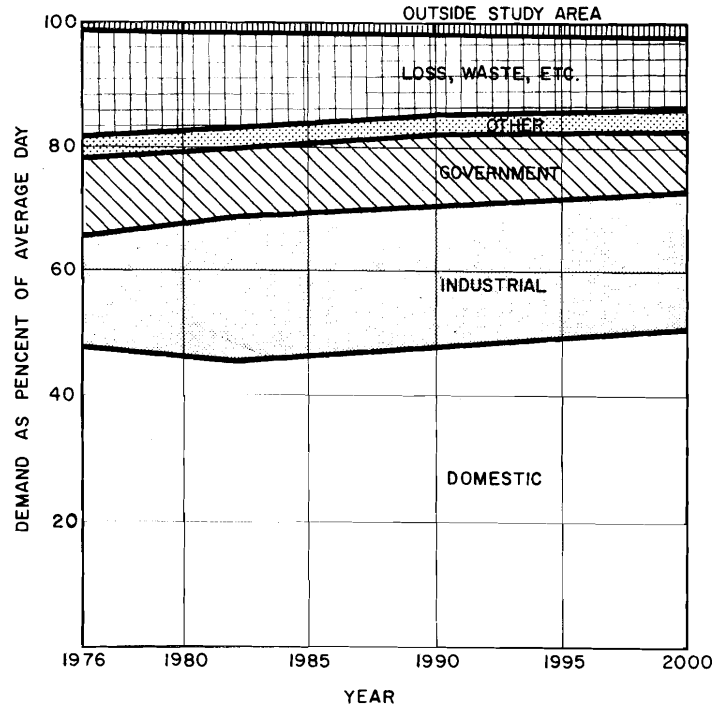
(c) L - Permament Population 90 Lpd; MH - Seasonal Population 240 Lpd; weighted average 133 Lpd

(d) Includes 700 m³/day to Mersa Matruh Railroad

(e) Includes harbor facilities

WATER DEMAND PROJECTION BY CATEGORIES





Q In 1000m³/ day

	1976		1987		1990		2000	
	Q	%	Q	%	Q	%	Q	%
DOMESTIC	286.9	47.8	374.7	45.9	548.5	48.4	780.2	49.8
INDUSTRIAL	108.0	18.0	185.0	22.7	260.0	22.7	350.0	22.4
GOVERNMENT	75.0	12.5	91.4	11.2	120.8	10.6	159.7	10.2
OTHER	19.8	3.3	23.5	2.9	34.0	3.0	45.0	2.9
LOSS, ETC.	100.3	16.7	127.0	15.6	157.7	13.8	195.5	12.5
OUTSIDE STUDY AREA	10.0	1.7	13.8	1.7	22.1	1.9	35.0	2.2
TOTAL	600.0	100.0	815.4	100.0	1143.1	100.0	1565.4	100.0
MAXIMUM DAY	780.0		1060.0		1486.0		2035.0	

FIGURE B-1

FIGURE B-1

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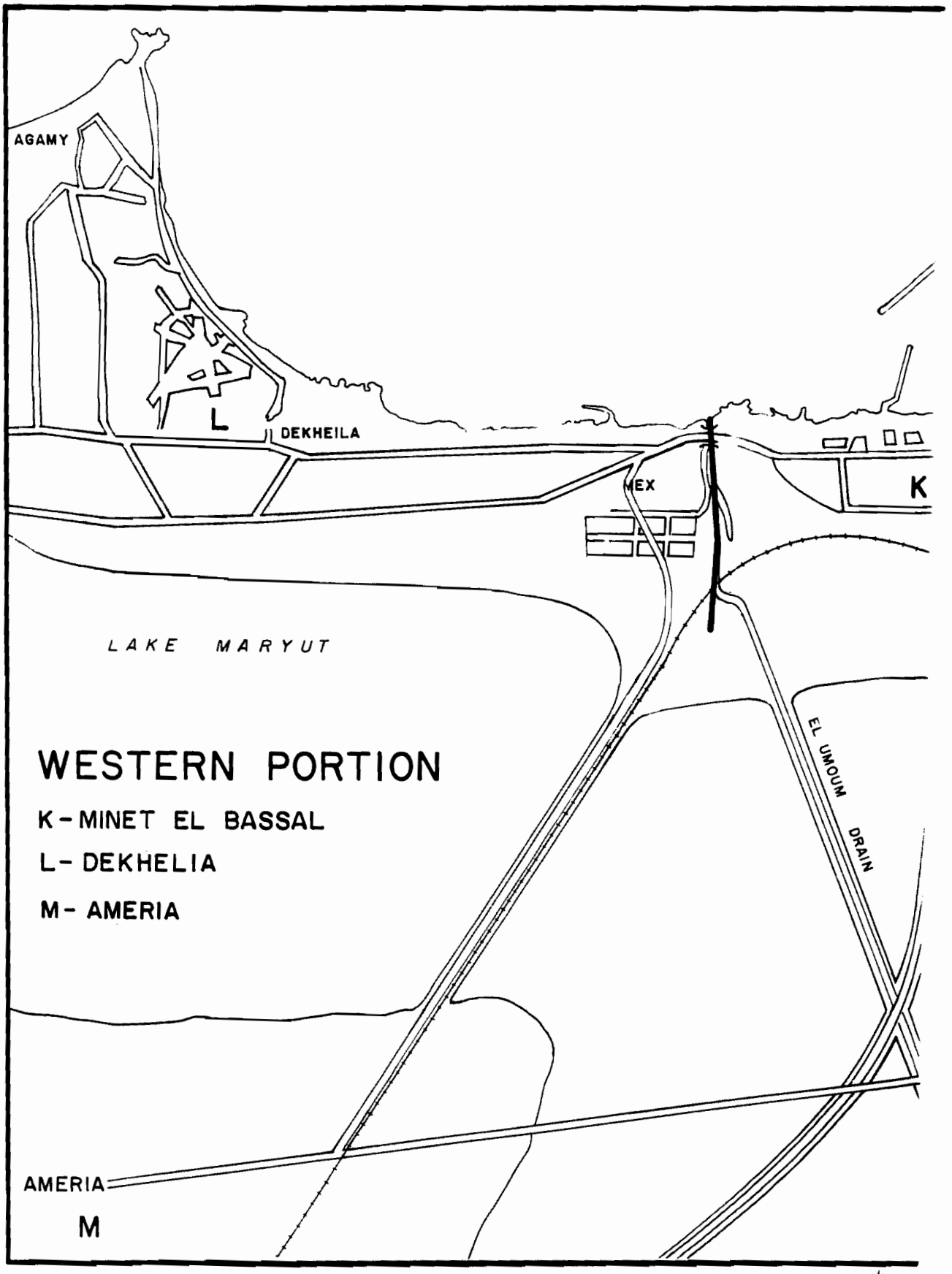

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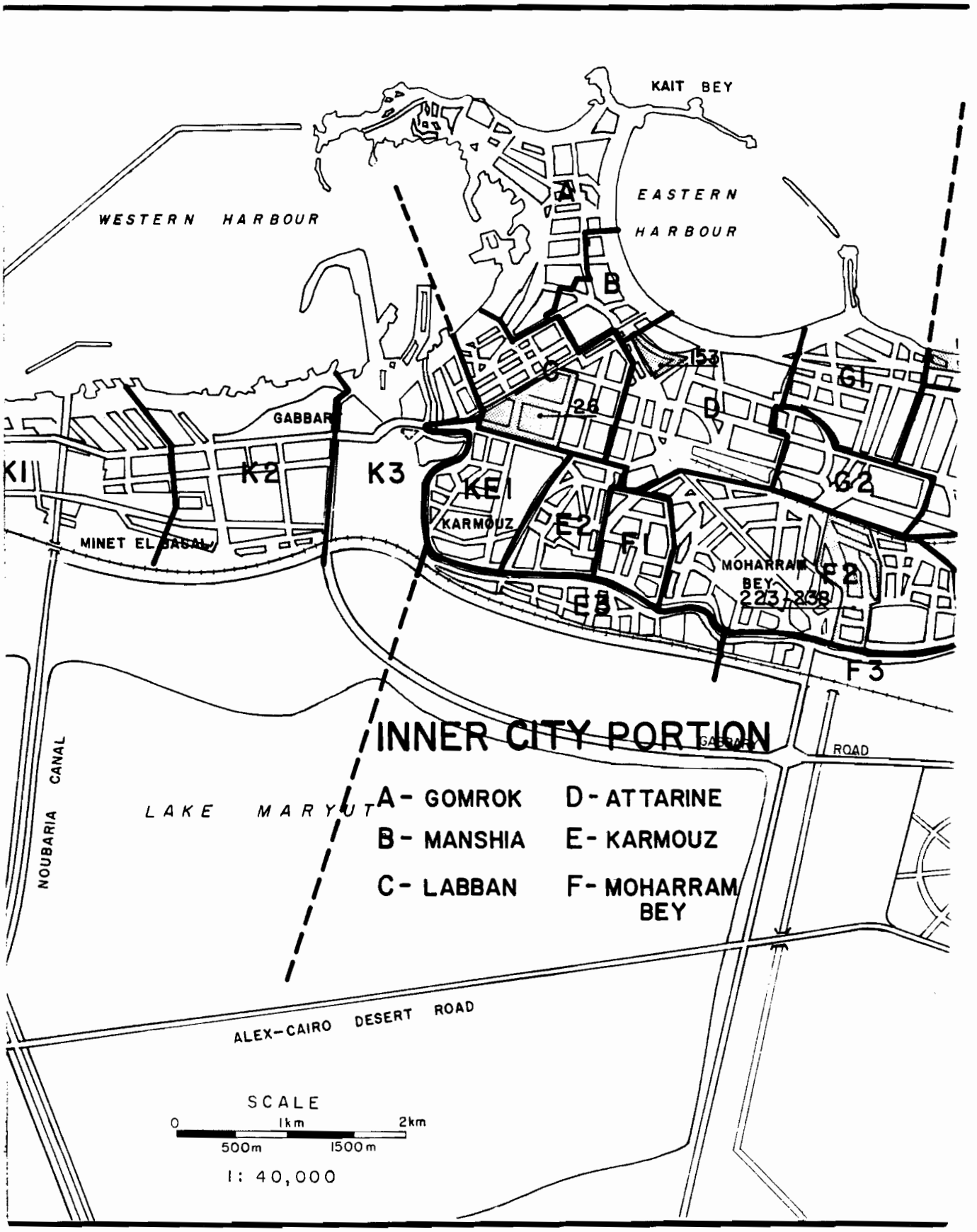

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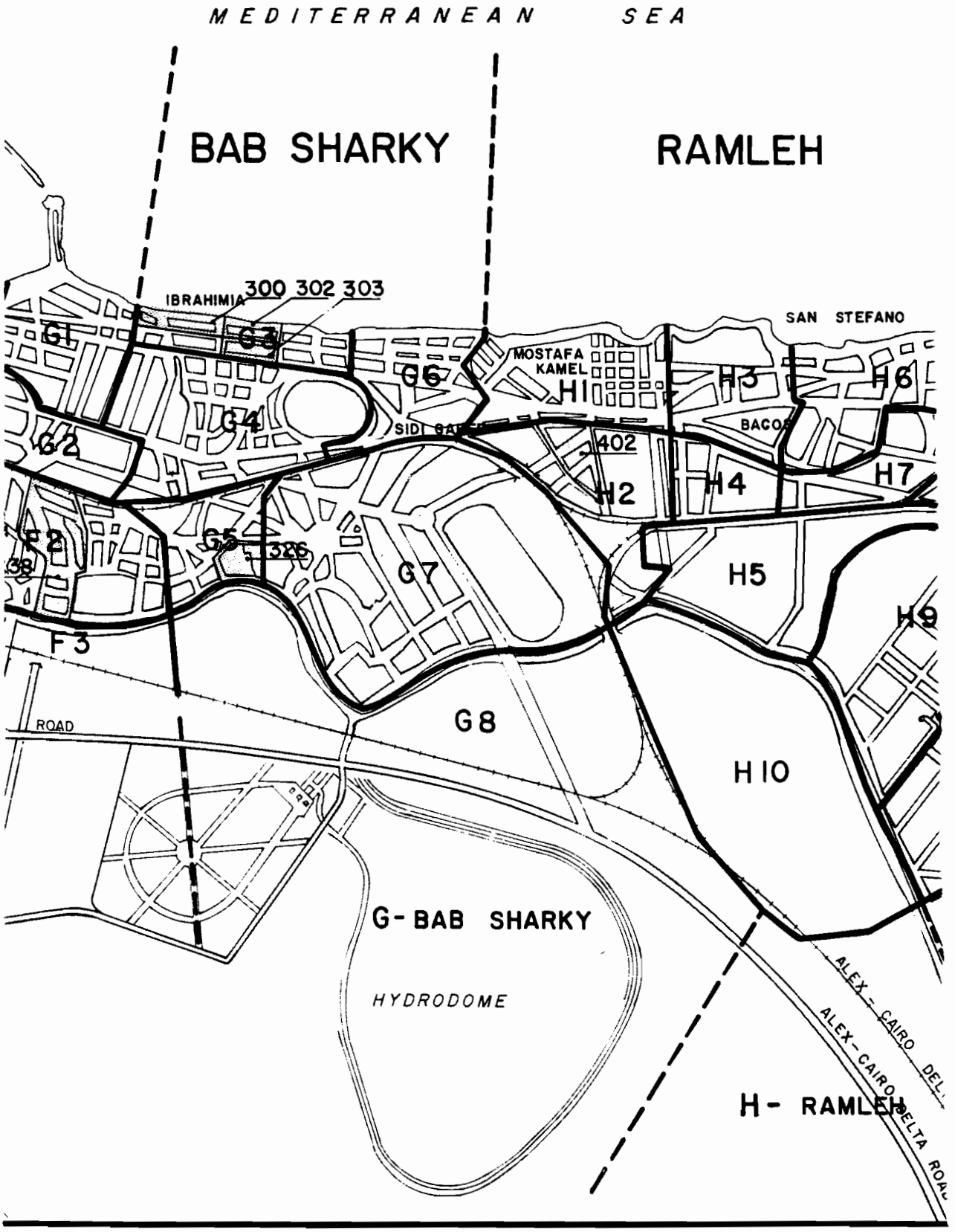

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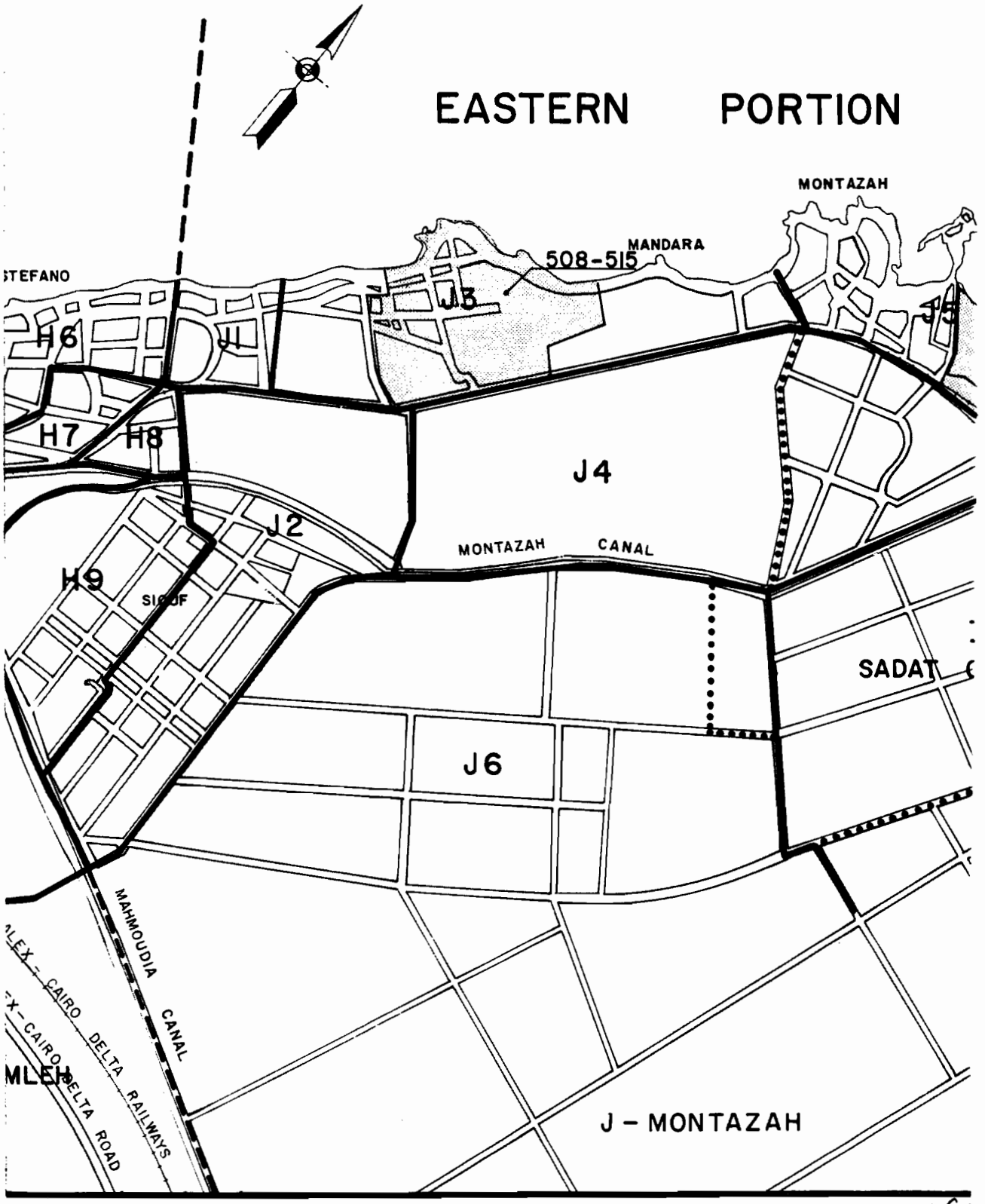

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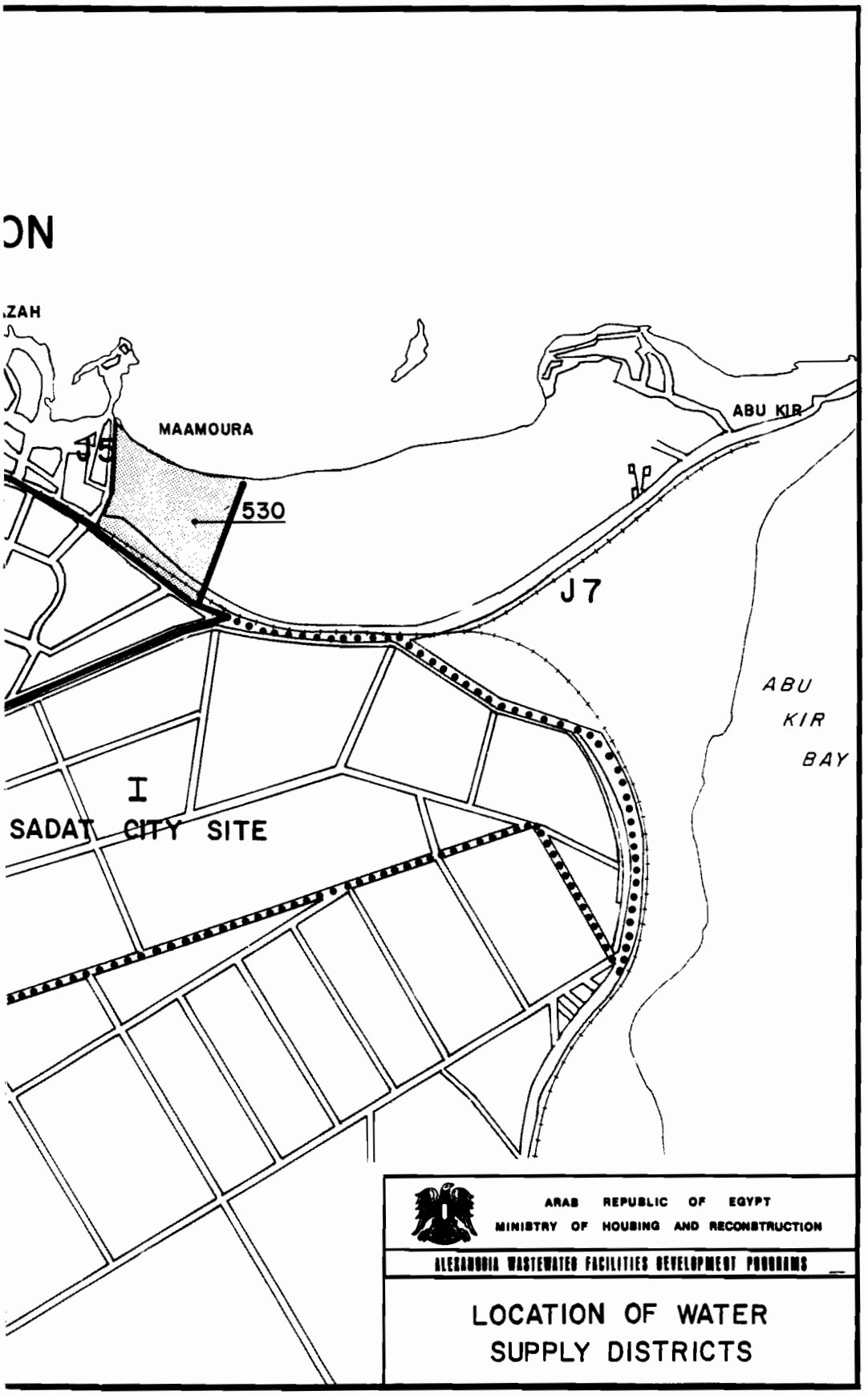

FIGURE B-2 54d

APPENDIX C

INDUSTRIAL WASTEWATER SURVEY

Appendix C contains a summary report on the Industrial Wastewater Survey carried out during the initial six months of the Master Plan Study. The appendix covers basic information collected on existing industries and projections of industrial waste flows and loads.

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APPENDIX C

INDUSTRIAL WASTEWATER SURVEY

C.1 Summary and Conclusions

1. An industrial wastewater survey of the Alexandria industries was conducted as a part of the Alexandria Wastewater Master Plan Study. The survey was conducted during the period January through June 1977.

2. The industries actually visited were those discharging about 90 percent of the industrial wastewaters generated in Alexandria. Descriptions of each industrial plant visited, summaries of wastewater sampling analyses, and estimates of pollutional loads discharged as industrial wastewaters are contained in this Appendix.

3. The industries of Alexandria discharge about 870 ML/day of wastewater of which about 226 ML/day carry a pollutional load. The latter wastewaters are termed "contaminated".

4. The estimated pollutional load from the industries of Alexandria is 160 tonnes/day BOD_5 and 315 tonnes/day COD. Concentrations of BOD_5 and COD in contaminated wastewaters are 700 mg/L and 1400 mg/L, respectively.

5. Higher than average organic loads are generated in the abattoir and tanning, food, beverage, paper, oil and soap, and starch and yeast industries.

6. Heavy metals are contained in the discharges from chemical, electric and electronic, metal processing, printing, tanning, and textile industries.

7. Large cooling water flows are discharged from oil refineries, power generating stations, and oil and soap plants.

8. Major industrial wastewater problem areas are: tanneries in Mex, chemical plants in Dekheila, paper mills near Abu Kir, miscellaneous strong wastewaters centered around Industries Pump Station, and discharges to the lower reach of the Mahmoudia Canal.

9. Projections indicate that contaminated wastewater volume will increase to about 647 ML/day by the year 2000 and the loading will be about 440 tonnes/day BOD_5, an increase of about 280 percent.

10. Discharge of contaminated industrial wastewaters should be to the public sewerage system, after in-plant pretreatment in compliance with sewer use regulations, for final disposal. Uncontaminated wastewater should be kept segregated and disposed of to the nearest appropriate surface drain.

11. A landfill/evaporation pond site should be established to receive and dispose of solid and low-volume liquid toxic materials generated in in-plant pretreatment works and in industrial operations.

12. A program should be instituted to encourage industries to segregate wastewater streams and to recycle and reuse water in cascading fashion for water conservation.

C.2 Introduction

General

As a result of Alexandria's mild climate and extensive beaches, a substantial resort business has developed in the city. More important for economic growth, however, has been the steady progress of industrial development in recent years, aided by the availability of a good port and positive government policies.

The industrial areas of Alexandria are widely distributed but tend mainly to be located along the Mahmoudia Canal, near the Cairo-Alexandria railroad and highway and near the port. Industrial development is taking place to the west along the north and south shores of western Lake Maryut, near Ameria, in Nouzha, and to the east along Abu Kir Bay. Continued industrial development will occur in these areas as well as along the Mahmoudia Canal upstream of the city and along the corridor of the railroad and delta highway. Thus, the industrial areas of Alexandria will occupy much of the long, narrow space bordering the Lake Maryut - Lake Idku marine lagoons inland from the city and seashore.

All types of industry exist, from very heavy iron and steel fabricating to very light electronic components manufacture. Factories of all sizes are found from large textile mills which employ thousands of workers to local shops and street-side stalls. The most widespread industries include textile mills, tanning, paper, oil refining, and food processing. A broad range of industrial products is manufactured.

Water for industrial use is derived from several sources. The basic supply is surface water from the Mahmoudia Canal. Much of the cooling water and poor quality fresh water is taken directly from the Mahmoudia Canal. Potable and treated water is purchased from the Alexandria Water General Authority (AWGA). Limited water supply is available from privately owned ground water sources. Very little use is made of the saline waters of the sea and agricultural drainage water; both of which are abundant in the area. Large diversions from Mahmoudia Canal and purchases from the Authority are expected to meet future water demand. Increased industrial use of Noubaria Canal water is expected to take place as the Ameria industrial areas develop.

The number of water-using industries in Alexandria is in excess of 200. Water use by industrial plants varies from more than 40 000 m^3/day to less than 25 m^3/day. Data from industries and from the AWGA on water use afford the best information available on wastewater production as few industries have the means or the need to determine the volume of wastewater discharged.

The industrial waste survey information provided a basis for assessment of the scope of Alexandria's wastewater problem. A comprehensive survey of the major industrial plants was performed, and as many of the smaller, predominantly "wet" industries were included as time and study funds permitted, in order to collect the most comprehensive data possible.

Industrial Survey Methods

A preliminary study of industry in Alexandria indicated that time and funds did not permit a complete survey to be made in any of the plants. Priority was given to those industries which produced large quantities of strong wastewater. The information to be obtained was limited to the quantity and characteristics of overall plant discharge. Accordingly, the survey was limited to those industries having water use greater than 25 m^3/day except where the nature of the industry would make it likely, or even suspect, that its wastewater might contain toxic materials, heavy metals, pesticides or other toxic organics. Therefore, the survey did not include an assessment of such factors as ease of in-plant separation of wastewater streams, area and existing facilities available for in-plant pretreatment, and possible modifications to plant processes and methods to reduce wastewater or to facilitate pretreatment.

An inventory of all major water-using industries was made during the survey. Plants accounting for 90 percent of the contaminated industrial wastewater produced in Alexandria were included.

A questionnaire was designed to record the desired information obtained by plant visit and interview. A copy of the questionnaire is shown as Figure C-5. Initially, questionnaires were distributed to managers of plants prior to a scheduled visit, but it was found that answers were not forthcoming, except during the interview. The questionnaires became forms for recording basic data and information.

Industrial Survey Interview Procedures

Study team engineers, accompanied by a representative of GOSSD, visited each factory site and interviewed each factory manager. The plant manager's responses to the survey questionnaire were recorded. Usually the technical and bookkeeping staff of the plant assisted the plant manager in providing information.

An important part of the interview consisted of obtaining estimates of annual production and estimates of chemicals and raw materials used each year. Questions were asked regarding the various uses of water, such as process use and cooling use. The average annual pollutional load of a plant could be determined from the responses to such questions. This method provided the most reliable estimates of pollutional loads.

Industrial processes discharging wastewater were studied also. Factory personnel were asked to explain the processes employed in the factory, step by step. Questions were asked to clarify points which were not understood. After the processes had been described, the plant was toured to see the processes in operation.

During the inspection tour, wastewater discharge arrangements were observed and the best location to measure and sample the flow of wastewater was determined. After the initial survey of the factory, data were assembled and reviewed. Potential pollutional loads were calculated. Decision to sample wastewater was made on the basis of the estimated magnitude of pollution potential. Then, where necessary, sampling schedules were developed and samples obtained.

Wastewater Sampling and Analysis

Sampling was undertaken in those cases where pollutional load could not be determined on the basis of raw materials and chemicals used. In particular, mills producing paper pulp, tanneries, and chemical plants were sampled. Sampling was done primarily by technicians from GOSSD under direction of a chemist. Initially an engineer from the study team accompanied the technicians to insure that sampling was done in accordance with established methods. In some cases, sampling was done at the time of initial interview.

Collected samples were taken either to the GOSSD laboratory or to the laboratory of Dr. Fahmy M. El Sharkawi, Professor of Sanitary Engineering at the University of Alexandria, High Institute of Public Health. Samples were subjected to analysis appropriate to the industry being investigated. Both laboratories had limited capacity; only a few samples could be handled each week. The High Institute of Public Health conducted all tests for heavy metals. Analyses were made in accordance with the procedures in Standard Methods for the Examination of Water and Wastewater, Fourteenth Edition, 1975, published by American Public Health Association. Although extensive analysis of industrial wastewater samples could not be made, estimates of pollutional load are considered to be sufficiently accurate for this type of study. Estimates were made on the basis of raw materials and chemical usage. A more accurate determination of pollutional load will require a detailed sampling, measuring, and analysis program of several years. A fully equipped laboratory with several highly trained chemists and a number of technicians skilled in sampling would be required. Such a program should be undertaken in conjunction with operation of the future wastewater system. The results of such an extensive investigation would form the basis of specific recommendations for pre-treatment at each industrial plant, to render its wastes compatible with the public collection and disposal system.

Results of this survey provide a comprehensive view of the industrial wastewater situation in Alexandria. Detail is sufficient to allow investigation of alternative disposal schemes and permit formulation of a responsive master plan.

C.3 Results of the Survey

Figure C-1 indicates the locations of industries in Alexandria which were visited during this survey. Figures C-2, C-3, and C-4 detail the more crowded industrial areas of the city. Individual plant sites are identified by number on these maps and listed in Table C-1, along with name, location, and principal products.

To provide an orderly means to catalog and cross reference questionnaires, computations, figures, and tables, industries were given identity numbers and related industries were grouped according to the following system.

The number of individual plants visited during the survey was distributed over 57 categories and each category given a separate industry identity number.

Type of Industry	Identity Number	Number of Plants
Beverages	1-4	7
Metal Works	6 and 21	2
Chemical Mfg.	7-10	6
Electric and Electronics	11	1
Food	12-20	39
Miscellaneous	22-24	5
Paper	25-26	3
Petroleum Refining	27-28	2
Power Generation	29-30	2
Printing	31-32	2
Plastics, Glass, Rubber	33-36	4
Oil and Soap	37-39	12
Starch and Yeast	40	3
Tanneries	41-43	4
Abattoir	44-45	2
Textiles	46-56	29
Water Treatment Plants	57	6

Information collected during the survey is summarized in three tables. Table C-2, Present Industrial Wastewater Flow Rates, contains water use, wastewater production, and wastewater discharge. The table lists industry number, water use from AWGA and from private sources, total water use, sanitary, process, cooling and total wastewater produced, and wastewater discharged to the sewer system, to the drainage channels, to the canals, and to the sea. Flow rates were calculated from Water Authority records, estimates of pump capacity for private supplies, and actual flow measurements. Water balances were calculated wherever possible to check the information received.

Table C-3, Industrial Wastewater Characteristics, presents analytical results of the wastewaters sampled. The table lists the industry number, pH, total solids, volatile solids, suspended solids, settleable solids, 5-day biochemical oxygen demand, chemical oxygen demand, phosphate, total nitrogen, oil and grease and all special analyses including metals. All results are reported in milligrams per litre except settleable solids which are reported as millimetres per litre and pH which is the negative logarithim of the hydrogen ion activity. The analytical results are from samples collected for this study, from several previous studies done, and from the High Institute of Public Health of Alexandria University. Notes indicate the source of the results, type of sample, sample point, and discharge point. Where analytical results are not available the table has been left blank.

Table C-4, Industrial Pollutant Loads, lists industry number and the mass discharges, expressed in kilograms per day (except for settleable solids which is m^3 per day) of several parameters. These are: total solids, volatile solids, suspended solids, settleable solids, 5-day BOD, COD, phosphate, total nitrogen, and miscellaneous constituents. The quantities presented in this table are the best estimate of the pollution potential of each plant based upon available data and information. In making the

estimates, information was obtained from:

- analytical results from sampling the wastewater from this survey and past reports;
- information concerning the raw materials, chemicals, and processes used;
- comparisons made between Alexandria industries and similar industries surveyed elsewhere.

Results in Table C-4 do not correspond in all cases with the data in Table C-3. The values in Table C-4 reflect the application of information on raw materials, chemicals, and processes used as well as comparisons with similar industries elsewhere. The sums of the columns in Table C-4 represent estimated pollutional load of industries visited, or about 90 percent of the total pollutional load for Alexandria industries. Accordingly, ten percent of the Table C-4 values has been added to obtain estimated total pollution loads.

C.4 Assessment of Industrial Wastes

Present Flow and Loads

Estimates of present industrial water use and wastewater production are shown in Table C-5. The present average daily industrial wastewater flow determined by survey was 795 ML/day which, increased by ten percent, leads to an estimated average daily flow of 870 ML/day. This includes process and sanitary wastewaters and cooling water. About 570 ML/day, 66 percent of this flow, is uncontaminated cooling water which is used once and discharged. Usually the adverse effect of this kind of discharge is a local increase in temperature but in some instances these discharges contain oils. The remaining 300 ML/day of contaminated wastewaters includes 74 ML/day from water treatment plants. Water treatment plant discharges contain spent chemical coagulant, silt, clay, and the bodies of organisms removed from the water in the treatment process. The pollutants in this wastewater are largely inert solids and exert a very low level of stress on the oxidation and stabilization resources available. Therefore, the estimated contaminated industrial wastewater flow is 226 ML/day. This daily flow is made up of about 7 ML/day sanitary wastewaters, 208 ML/day industrial process waters and 11 ML/day of unseparated cooling water. Disposal of these contaminated flows is estimated to be 83 ML/day to area drains, 15 ML/day to the Mahmoudia Canal, 93 ML/day to the public sewerage system and 35 ML/day to the Mediterranean Sea. Cooling water discharges are 203 ML/day to area drains, 307 ML/day to canals, and 60 ML/day to the sea.

The industries surveyed discharge 146 tonnes/day BOD_5 and 288 tonnes/day COD. Application of a ten percent increase to account for industries not surveyed results in an estimated present total pollution load, in terms of broad parameters, of 160 tonnes/day BOD_5 and 315 tonnes/day COD. These loads carried in 226 ML/day wastewater result in an average concentration of 700 mg/L BOD_5 and 1400 mg/L COD in industrial wastewaters. That portion of the industrial wastewaters entering the public sewers at the present time has BOD_5 and COD concentration of 695 mg/L and 1460 mg/L, respectively. Industrial wastewaters entering the drains, canals, and the sea are relatively less concentrated due to dilution with cooling water.

Tables C-6, C-7 and C-8 are summaries of wastewater flow and pollutional load by industrial group. Table C-6 presents water use, wastewater flows, and wastewater discharge points. Table C-7 presents flow, BOD_5 and COD values. Flows include large cooling water discharges. Table C-8 presents flow rates, BOD_5 and COD values for industrial wastewaters excluding large cooling water flows. Industries which contribute a larger pollutional load than average are beverages, food, paper, oil and soap, starch and yeast, tanneries, slaughtering, and textiles. Industries with large cooling flows include oil refining, electric power, and the oil and soap industry. Tables C-9 and C-10 list flow, BOD_5 and COD values for various districts in Alexandria having significant industrial wastes. Industrial wastewater discharged to the sewer system, drains, Canal, and sea are totalled separately. Table C-9 includes all large cooling water flows whereas in Table C-10 cooling water flows have been deducted.

Principal Industrial Wastewater Discharges

Several industrial wastewater discharges create significant pollution problems in Alexandria. A major chemical plant in Dekheila discharged 34 000 m^3/day directly to the sea through a privately owned short outfall. This wastewater contains inorganic chemicals including lime, caustic soda, chlorine, ferric chloride, mercury, and acids. Fish kills resulting from this discharge have been reported. Pretreatment of this wastewater at the plant will be required for any discharge of this wastewater off the premises whether to the sea, to a public sewer, or to a separate industrial wastewater collection and evaporation pond disposal system.

The abattoir-tanning area in Mex is the locale of another significant pollution problem. A large slaughterhouse, a large tannery, and many small tanneries discharge about 1 750 m^3/day of wastewater which carries 4450 kg/day of BOD_5 at an average concentration of more than 2 500 mg/L. These wastewaters, which contain significant quantities of chromium, are collected in public sewers which drain to the sea at the shoreline near the entrance to Western Harbor.

Discharges of wastewaters to the lower reaches of the Mahmoudia Canal, partly by industries in the Karmouz area, have resulted in marked degradation of Canal water quality. The major industrial polluters in the area include a yeast plant at Moharrem Bey, a power plant and edible oil plant at Kafr el Zayat and several salt, soda, and oil and soap plants in Karmouz. The Canal in this area is used as an emergency water supply for the Forn el Garaya water treatment plant.

The water quality characteristics of the Mahmoudia Canal have been studied. Results of analyses prepared by Makkawy Mohamed Akel for his thesis "The Effect of the Different Sources of Pollution on the Water Quality Characteristics of Mahmoudia Canal in Alexandria District and its Public Health Aspects" for the High Institute of Public Health, Environmental Health Department, University of Alexandria, October 1975, follow:

Water Quality, Mahmoudia Canal (in Summer)

	Canal, Upstream	Canal, Near Forn el Garaya
Temperature	$27^{o}C$	$37^{o}C$
Total Solids	450 mg/L	750 mg/L
Volatile Solids	60 mg/L	160 mg/L
Oil and Grease	50 mg/L	150 mg/L
Dissolved Oxygen	4 mg/L	1 mg/L
BOD_5	15 mg/L	175 mg/L
COD	20 mg/L	325 mg/L
Chlorides	100 mg/L	160 mg/L
Coliform	$1X10^4$ MPN/100 mL	$2X10^5$ MPN/100 mL

Industrial wastewaters generated in the highly industrialized Moharrem Bey area are collected at the Industries Pump Station which pumps them to Lake Maryut for discharge without treatment. The present flow amounts to about 31 000 m^3/day and the BOD_5 loading to the lake from this source alone is 18 800 kg/day. The wastewater varies considerably in strength, pH, and flow rate. In the vicinity of the outfall, oxygen depletion is complete and there is strong evidence of toxic conditions.

Significant volumes of industrial wastes are presently being discharged into Abu Kir Drain, and hence into Abu Kir Bay. The two principal dischargers are both paper mills which use up to 83 000 m^3/day of water from Rakta Canal and discharge their entire waste flow to the Abu Kir Drain. In addition, outside the study area, several textile mills discharge wastewaters containing wool-scouring, dyeing wastes, and strong acids to the upstream portions of the Abu Kir Drain.

The estimated flow in Abu Kir Drain lies between 1 and 2 million m^3/day. Analyses[a] of Abu Kir Drain above and below the paper mills follow.

Item	Range of Values[b] Upstream from the Paper Mills	Downstream from the Paper Mills
pH	6.4 - 8.2	8.0
Dissolved Oxygen, mg/L	0.4 - 4.2	0.7
COD, mg/L	400 - 4 000	5 191
BOD, mg/L	200 - 1 000	1 285
Oil and Grease, mg/L	30 - 400	496
Total solids, mg/L	6 000 - 8 400	13 551
Fixed solids, mg/L	3 000 - 4 000	4 457
Volatile solids, mg/L	3 000 - 4 400	9 094
Settleable solids, mg/L	0 - 4	13
Free ammonia, mg/L	0.5 - 4.5	-
Nitrate, (NO_3), mg/L	2.0 - 7.0	-
Chlorides, (Cl), mg/L	1 000 - 3 000	-
Total Alkalinity, mg/L	300 - 600	-
Hydrogen sulphide, mg/L	0.2 - 0.5	-

[a] Furnished by Dr. El Sharkawi

[b] Based on 10 samples.

In addition to the principal discharge locations described above, there are numerous individual points where industrial wastewaters are released without treatment to the canals, drains and open water bodies causing significant pollution and nuisance.

C.5 Projections of Flows and Loads

General

Industrial waste survey information provides a basis for estimating future waste loads for planning purposes. All indications point to a continuation of the rapid growth of Alexandria industry which has occurred in recent years. Each plant manager interviewed in the survey was asked what plans had been formulated for expanding his plant. Replies were variable but good information was obtained for short term (up to five years) expansion plans. Information was also available from the planning and housing departments of the Governorate. This information, along with short term projections of industrial water use, was used to estimate industrial wastewater flows and loads for the next five years. For the longer term, industrial activity and discharges were projected using population and water use forecasts. The population studies, see Chapter 5 and Appendix A of this Report, developed forecasts of numbers of people who will be engaged in industry through the year 2000. In addition, use was made of the estimates of industrial water developed during this study. With this information and assuming a mix of new industries similar to the present mix, industrial flows and loads were estimated for the planning period. By the year 2000, the population, and the industrial activity as well, is expected to double its present level.

Water Use by Industry

A summary of the 1977 industrial water use data and projections of years 1982 and 2000 industrial water uses are contained in Table C-11.

Large scale cooling water use is expected to increase at a fairly constant rate, reaching 1 250 ML/d by the year 2000. Water supplied by the Alexandria Water Authority and from private water supplies is expected to increase rapidly for the next five years and then increase at a slower rate through the year 2000. By the mid-80's and thereafter, overall water use is expected to increase more slowly because of conservation and reuse.

The by-production of contaminated industrial wastewaters is expected to increase from the present level of 226 ML/day to 647 ML/day by the year 2000. The projection indicates an average increase of 30 ML/day each year through 1982 and thereafter, 15 ML/day each year.

Table C-12 presents a summary of industrial wastewater discharges from each district of the city for the years 1977, 1982 and 2000. Large increases are expected to the east in Abu Kir and to the west in Dekheila and Ameria, but increases are also expected in existing industrial areas along the Mahmoudia Canal.

The character of industrial wastes is expected to undergo change in the future. Dilution of industrial wastes entering the sewer system will

probably be reduced but pretreatment of industrial flows will partially counteract this trend. The strength of contaminated wastewater is expected to increase slightly over the next 23-year period.

The projections of future pollutional loads are shown on Table C-13. At the present time about 40 percent of the industrial wastewater is discharged to the Alexandria public sewer system. By the year 2000 the implementation of the Master Plan should result in essentially all of the contaminated industrial wastewater being collected in the public sewer system for disposal. Those industries which generate wastewater streams containing toxic and other materials prohibited in the public sewers will have pretreatment facilities to remove these materials so that the treated wastewater can be discharged to the public sewer. The amount of water and pollutional waste loads removed in pretreatment facilities is expected to be neglible as measured by BOD_5 and COD. Therefore, it is assumed that by the year 2000, all contaminated industrial waste discharges will be collected in the public sewers. The projected contaminated industrial wastewater flows and pollutional loads for Alexandria in the year 2000 are 647 ML/day, 453 tonnes/day, BOD_5 and 970 tonnes/day COD, all to be received in the public sewer system.

C.6 Recommendations for Industrial Wastewaters

1. It is recommended that wherever capacity exists in the public sewerage system or wherever capacity can be provdied at a reasonable cost, industrial wastes should be discharged to the public sewerage system. Such discharges should be regulated by a new sewer ordinance. Where necessary, in order to meet requirements of a new ordinance, industry must provide suitable pretreatment of its wastes prior to discharge.

2. It is recommended that a sewer use law containing the elements of the ordinance in Appendix L be adopted and enforced by government authority. The longer adoption and enforcement are delayed, the more difficult and expensive it will become to implement. Cost for providing wastewater treatment or control in a new factory is a small portion of the construction cost of the factory (usually less than 5 percent in the United States), whereas cost to provide such treatment or control in an existing factory may have much greater adverse economic implications on plant operation and production costs.

3. Government action should be taken to encourage water conservation and reuse by industry. Water should be priced near the cost of production as an incentive. Sewer use charges should be established based on flow rate. Through such charges, industries conserving water would be rewarded, while those wasting water would be penalized.

4. A hazardous material disposal site should be established. High strength, low volume wastes containing toxic metals should be collected and trucked to a disposal area. Final disposal of the liquid portion would be by evaporation. Net evaporation for Alexandria is about 2000 mm per year. Wastewater which could be treated in this manner would include: concentrated chrome tanning solutions, chrome dyeing solutions, iron acid pickling wastes, concentrated wastes from copper refining by electolysis, and metal plating wastes.

5. It is recommended that the following minimum pretreatment requirements and other in-plant operations be imposed on the type of industries listed below:

- Beverages: Concentrated caustic bottle washing solutions should be equalized and/or neutralized before discharge to the sewer system.

- Metal Processing: Acid pickling wastes and wastes from copper refining should not be discharged to the sewer system. These wastes should be recovered for use or trucked to a hazardous material disposal area. Studies are required to develop methods to minimize water use and wastewater production.

- Chemicals: A reduction in water consumption is required. The highest standards of housekeeping are required to avoid contamination of wastewater streams. Suspended solids and pH control will also be necessary if contamination cannot be reduced by in-plant changes.

- Electrical and Electronics: Cooling water use must be controlled. Wastewaters containing fluorides and mercury should be segregated for special treatment.

- Food: Food processing wastes should be fine screened through 3 mm slots. Some plants with high levels of suspended solids may require sedimentation. Oil and floating solid traps should be installed at some plants. Whey recovery is necessary at dairies. In all food plants improved housekeeping can reduce waste loads.

- Paper: Paper mill wastewaters should be fine screened (with less than 0.4 mm slots) and adequately settled. Systems for water re-use should be investigated.

- Petroleum Refining: All wastewaters from refineries should pass through gravity oil separators. Oil spill prevention and cleanup plans should be established. Maintenance and housekeeping should also be improved to reduce leakage and spillage of oil.

- Electric Power Generation: Thermal discharges should be within prescribed limits. Boiler blowdown should not be discharged to the canal and should be within allowable temperature limits before discharge to the sewer system. Leakage or discharge of oil or naphtha should also be prevented.

- Printing: Rinse water from the production of printing plates should not be discharged to the sewer system. Such wastes should be trucked to a hazardous material disposal site. Gasoline or solvents used for cleaning must not be allowed to enter the sewer system. Disposal by incineration is recommended.

- Plastic, Glass and Rubber: Studies should be conducted to reduce water consumption and wastewater production. Glass particles should be caught in trays. Spills of solvents should be prevented. Lead from battery plants should be collected for disposal at the hazardous material disposal site.

- Oil and Soap: Traps for collection of floating solids and oil should be installed and cleaned regularly to limit oils escaping to the sewers. Cooling water use should be studied. Contaminated wastes should be collected and discharged to the sewers. Non-contaminated cooling waters should be excluded from the sewers although, if discharged to the canal, allowable temperature limits should not be exceeded.

- Starch and Yeast: The wastewater from starch units should receive sedimentation to reduce settleable solids. Solids from sedimentation basins must be removed regularly to ensure best operation of the system. Solids should be dewatered and recovered or disposed of appropriately. Contaminated wastes must be segregated from cooling water. Cooling water use should be minimized.

- Tanneries: Chrome tanning solutions and first rinse water should be segregated from the other wastewaters. These chrome tanning solutions must be treated separately prior to discharge to the sewer. All other wastewaters should be fine screened, with screens having 2.0 mm slots, to remove large solids which might block sewers. The bits of flesh and hides may be recovered for use in by-products. Flow equalization will probably be advisable.

- Slaughtering: Wastewater from the abattoir should be fine screened through 2 mm slots to remove large solids. Blood should be collected separately for utilization and not wasted into the sewers. Traps for collection of floating solids and fats should also be installed. Solids and fats can be recovered for rendering.

- Textiles: Textile and dyeing shop wastewaters should receive equalization and/or neutralization before discharge. Dyeing solutions containing heavy metals should be separated for pretreatment prior to discharge. Fine screening with screens having 0.4 mm slots should be used to reduce the amount of fibers discharged to the sewer.

- Water Treatment: Water treatment plants could reduce the volume of their discharge with sedimentation of backwash water with clear overflow being routed back to the plant influent. The bottom flow from the sedimentation tank would be discharged to the sewer or otherwise treated for disposal.

6. Materials removed from wastewater during industrial pretreatment should also be handled properly. Solids in the form of sludges or screenings can easily be handled as solid wastes. There are three basic modes by which the solids from industrial wastewater pretreatment can be handled:

   a. Reprocessing and recovering of valuable by-products.
   b. Burial by landfill.
   c. Incineration.

   All three have some degree of applicability for use in Alexandria.

7. Existing and future pretreatment systems must also be properly operated. To be effective, oil traps must be cleaned regularly. Sedimentation tanks and screens also require regular solids removal and cleaning.

TABLE C-1

LIST OF ALEXANDRIA INDUSTRIES

NO.	NAME	LOCATION	PRODUCT
1	El Nasr Bottling Co.	Galal El Desouki Hadara	Carbonated soft drinks
2-1	Egyptian Bottling Co. - Labban unit	Sherif Street Labban	Carbonated soft drinks
2-2	Egyptian Bottling Co. - Main unit	Ibrahim Sherif St. Mostafa Pasha	Carbonated soft drinks
3-1	Egyptian Vineyards and Distilleries Bolnaki unit	Saraya No. 3 St. Bab Sharky	Brandy and Run
3-2	Egyptian Vineyards and Distilleries Zottos unit	Victoria	Rum
3-3	Egyptian Vineyards and Distilleries Kassimatis unit	Nouzha	Rum
4	Pyramids Brewery	Abdel Moneim Sanad Ibrahimia	Beer
5	Alexandria Portland Cement Co.	El Dekheila St. Mex	Portland Cement
6	Egyptian Copper Works	Mahmoudia Canal St. El Zaheria	Copper, Aluminum, steel products
7	Alexandria Pharmaceutical Co.	Gamila Bohreid St. Siouf	Pharmacueticals rubber gloves and plasters
8-1	Nile Match Co. Manshia unit	Suez Canal St. Manshia	Wooden matches
8-2	Nile Match Co. Moharrem Bey unit	Mahmoudia Canal St. Moharrem Bey	Wooden matches
9-1	Misr Chemical Ind. Caustic & Cl Plant	El Dekheila St. Dekheila	NaOH,Cl, HCl FeCl, H_2SO_4, H_2O_2
9-2	Misr Chemical Ind. Soda Ash Plant	El Dekheila St. Dekheila	Na_2CO_3, Na HCO_3 Na OH, $CaCO_3$

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TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
10-1	Industrial Gases Co. Hadara unit	Mahmoudia Canal St. Hadara	Acetylene Oxygen & nitrogen
11	El Nasr Electric & Electronic Co. (Phillips)	Mahmoudia Canal St. Nouzha	Light bulbs and Fluorescent tubes
12	Alexandria Chocolate & Confectionary Co.	Mahmoudia Canal St. Hadara	Chocolate Candy
13-1	El Nasr Dehydration Co.	Saraya No. 3 St. Hadara	Dried Vegetables
13-2	El Nasr Dehydration Co.	Malik Shaw St. Gabbari	Dried Vegetables
13-3	El Nasr Dehydration Co.	Gabbari Mosque St. Gabbari	Dried Vegetables
13-4	El Nasr Dehydration Co.	Mahmoudia Canal St. Hagar el Nawatia	Dried Vegetables
14-1	Edfina Co. Main plant	Mostafa Kamel St. Ras el Soda	Canned fruits & vegetables, jams and juices
14-2	Edfina Co. Agar unit	Muffatish St. Hadara	Agar
15	Egyptian Food Co. ICA Chocolate factory	Mahattet El Souq Bacos	Chocolate, helawa, chewing gum, candy
16	El Nasr Canned Food Co. (KAHA)	Tabia Abu Kir	Juices, jam, canned fruit and vegetables
17-1	North Alexandria Rice Hulling Co. Moharrem Bey unit	Mahmoudia Canal St. Moharrem Bey	Rice
17-2	North Alexandria Rice Hulling Co. Karmouz unit	(Beside Ragheb Bridge) Gomkouria	Rice
17-3	North Alexandria Rice Hulling Co. Gabbari unit	Malek Shah St. Gabbari	Rice

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TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
17-4	North Alexandria Rice Hulling Co. El Masreya unit	Nouzha Bridge	Rice
17-5	North Alexandria Rice Hulling Co. El Hadissa unit	Nouzha Bridge	Rice
17-6	North Alexandria Rice Hulling Co. El Fatha unit	Hagar el Nawatia	Rice
18	Misr Milk & Food Co. (Siclam Dairy)	Mostafa Kamel St. Ras el Soda	Milk, cheese, yogurt
19-1	South Alexandria Milling Co. Sena'et el Tahn unit	El Rasafa St. Ext. Moharrem Bey	Flour
19-2	South Alexandria MIlling Co. Awad Mohnem Mill	Tewfikia St. Karmouz	Flour
19-3	South Alexandria Milling Co. Nofal Mill	Karmouz St. Karmouz	Flour
19-4	South Alexandria Milling Co. El Anfoushi Mill	Kasr Ras El Tin St. En Anfoushi	Flour
19-5	South Alexandria Milling Co. Hergaret A Gawad Mill	Akhshidi St. Gabbari	Flour
19-6	South Alexandria Milling Co. Wasef Mill	Gabbari Mosque St. Gabbari	Flour
19-7	South Alexandria Milling Co. A Gawad Cylinder Mill	El Aman St. Gabbari	Flour
19-8	South Alexandria Milling Co. El Sowehi Mill	Tshoudi St. Gabbari	Flour
19-9	South Alexandria MIlling Co. A Gawad Son's Mill	El Aman St. Gabbari	Flour

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TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
19-10	South Alexandria Milling Co. Chaff Pressing unit	El Tigara St. Minet el Bassal	Flour
19-11	South Alexandria Milling Co. Ima Macaroni unit	El Rasafa St. Ext. Moharrem Bey	Flour
19-12	South Alexandria Milling Co. Helakhrina unit	Mostafa Kamel St. Ras el Soda	Flour
20-1	North Alexandria Milling Co. Moharrem Bey unit 1	Mahmoudia Canal St. Moharrem Bey	Flour
20-2	North Alexandria Milling Co. Moharrem Bey unit 2	Mahmoudia Canal St. Moharrem Bey	Flour
20-3	North Alexandria Milling Co. Mahmoudia unit	Mahmoudia Canal St. Moharrem Bey	Flour
20-4	North Alexandria Milling Co. Ghali Megale's unit	Moh. Abbas el Mahdi St. Moharrem Bey	Flour
20-5	North Alexandria Milling Do. Sharaf unit	Mostafa Kamel St. Bacos	Flour
20-6	North Alexandria Milling Co. El Shenawi unit	Mohsen Pasha St. Moharrem Bey	Flour
20-7	North Alexandria Milling Co. Farhoud unit	Masged el Hadari St. Moharrem Bey	Flour
20-8	North Alexandria Milling Co. El Mallah unit	Alban St. Karmouz	Flour
20-9	North Alexandria Milling Co. Ibrahim Awed unit	Mahmoudia Canal St. Moharrem Bey	Flour
20-10	North Alexandria Milling Co. Sheta unit	Mahmoudia Canal St. Karmouz	Flour

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TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
20-11	North Alexandria Milling Co. El Keek unit	A. Halim El Sherif Gheit el Enab	Flour
21	El Nasr Cast Iron Co.	Mahmoudia Canal St. Moharrem Bey	Cast Iron Cast Steel
22-1	Alexandria Ice & Refrigeration Co. Mahmoudia unit	Mahmoudia Canal St. Hadara	Ice
22-2	Alexandria Ice & Refrigeration Co. Moharrem Bey unit	Mahmoudia Canal St. Moharrem Bey	Ice
22-3	Alexandria Ice & Refrigeration Co. Labban unit	El Kawkab St. Labban	Ice
22-4	Alexandria Ice & Refrigeration Co. Karmouz unit	Mahmoudia Canal St. Karmouz	Ice
22-5	Alexandria Ice & Refrigeration Co. Athenos unit	Suez Canal St. Moharrem Bey	Cold storage
22-6	Alexandria Ice & Refrigeration Co. Souk el Gomaa unit	El Kobri El Kadima St. Souk el Gomaa	Cold storage
22-7	Alexandria Ice & Refrigeration Co. El Wardian unit	El Mex St. Mex	Cold storage
22-8	Alexandria Ice & Refrigeration Co. El Nouzha unit	Albert I St. Nouzha	Cold storage
23	Egyptian Co. for Baling cotton	Gabbari	Baling and storing cotton
24	West Delta Nile Bus Co.	Victor Emmanuel St. Smouha	Workshop and Garage
25-1	National Paper Co. Moharrem Bey unit	Mahmoudia Canal St. Moharrem Bey	Wrapping paper and Box board
25-2	National Paper Co. Tabia unit	Tabia Abu Kir Bay	Wrapping paper and Box board

TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
26	Racta Paper Co.	Tabia, Abu Kir Bay	Writing Paper and Box board
27	Alexandria Petroleum Co.	Dekheila St. El Mex	Refined Petroleum products
28	El Nasr Petroleum Co.	Cairo-Alex Desert Highway, Ameria	Refined Petroleum products
29	Labban Power Station and Gas Works	Mahmoudia Canal St. Karmouz	Electric Power & Petroleum Gas
30	Siouf Power Station	El Awayed	Electric Power
31	Moharrem Industrial Press	Mahmoudia Canal St. Nouzha	Printed Material packages, gummed paper
32	Conversion of Paper Co. (Verta)	Mahattet El Souq St.	Printed paper, Paper products
33	Egyptian Co. for Refractories	Mahmoudia Canal St. Nouzha	Ceramic Tiles Electric Insulators
34	Egyptian Plastic & Electric Co.	Ibn Akil St. Victoria	Plastic Articles Lead Acid Batteries
35	El Nasr Co. for Glass & Crystal	Mufatish St. Hadara	Glass & Fiber glass
36	Transportation and Engineering Co.	Number 38 St. Smouha	Tires and Inner tubes
37-1	Alexandria Oil & Soap Co., Karmouz unit	Mahmoudia Canal St. Karmouz	Hydrogenated oil
37-2	Alexandria Oil & Soap Co., Kafr el Zayat	Mahmoudia Canal St. Karmouz	Edible oils, soaps & detergent
37-3	Alexandria Oil & Soap Co., Ragheb unit	Mahmoudia Canal St. Moharrem Bey	Extracted cotton see oil
37-4	Alexandria Oil & Soap Co., Nouzha unit	Mahmoudia Canal St. Nouzha	Laundry soap, toilet soap and glycerine
38-1	Egpytian Salt & Soda Co., Karmouz unit	S. Mahmoudia Canal St. Karmouz	Cotton seed oil & laundry soap

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TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
38-2	Egyptian Salt & Soda Co., Moharrem Bey unit	S. Mahmoudia Canal St. Moharrem Bey	Refined oil, candles, floor polish
39-1	Extracted Oils Co. El Haddisa unit	Suez Canal St. Moharrem Bey	Edible oils, laundry soap
39-2	Extracted Oils Co. Oil Refinery	Mahmoudia Canal St. Karmouz	Edible oils
39-3	Extracted Oils Co. Hexane Extn. unit	Mahmoudia Canal St. Moharrem Bey	Extracted oils
39-4	Extracted Oils Co. Toilet Soap unit	Aman St. Gabbari	Toilet soap
39-5	Extracted Oils Co. Laundry Soap unit	El Salam St. Gabbari	Laundry soap
39-6	Extracted Oils Co. Animal Feed plant	Gabbari Mosque St. Gabbari	Cattle feed
40-1	Egyptian Starch & Yeast Co. Siouf plant	Abu Soliman St. Siouf	Rice starch, detergent and Na_2SO_4
40-2	Egyptian Starch & Yeast Co. Starch plant	Suez Canal St. Moharrem Bey	Rice starch Glucose
40-3	Egyptian Starch & Yeast Co. Yeast plant	Mahmoudia Canal St. Moharrem Bey	Baker's yeast
41-1	El Nasr Leather Tanning Co.	El Mex St., at El Kadi Sherif St.	Tanned leather and shoes
41-2	El Nasr Tanning Co. Glue Factory	El Mex St. Mex	Glue
42	Private Tanneries	El Mex St. Mex	Tanned leather
43	Star Glue Works	El Mex St. Wardian	Glue, animal fat, bone meal
44	General Co. for Poultry	Cairo-Alexandria Highway	Slaughtered & processed chickens

TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
45	Slaughterhouse	El Mex St. Mex	Slaughtered animals
46	Arab Rug Co.	Mufattish St. Hadara	Dyed yarn and knitted fabrics
47	Gama Shops	Mufattish St. Hadara	Bleached & dyed cotton fabrics
48	Pyramids Dyeing Co.	Mahmoudia Canal St. Moharrem Bey	Dyed and printed viscose & cotton
49-1	Alexandria Spinning & Weaving Co. Nouzha unit	Mahmoudia Canal St. Nouzha	Cotton yarn
49-2	Alexandria Spinning & Weaving Co. Hadara unit	Mufattish St. Hadara	Dyed thread & ready made clothing
49-3	Alexandria Spinning & Weaving Co. Bacos unit	Mahatet El Souq St. Bacos	Woven cotton fabric
50-1	El Nasr Clothing Co., Main unit	Mahmoudia Canal St. Hadara	Underwear, knit clothing & fabrics
50-2	El Nasr Clothing Co., Hosiery unit	Mufattish St. Hadara	Nylon stockings & cotton socks
51-1	El Nasr Textile Co. STIA, plant no. 1	Prince Ibrahim St. Nouzha	Cotton & viscose fabric
51-2	STIA Plant No. 2	Mufattish St. Hadara	Underwear
51-3	STIA Plant No. 3	Mufattish St. Hadara	Tricot knits, and thread
51-4	STIA Plant No. 4	Mahmoudia Canal St. Hadara	Woolen fabrics
51-5	STIA Plant No. 5 & 6	Mahmoudia Canal St. & Muffatish St.	Woolen blankets
51-6	STIA Plant No. 7	Abu Soliman St. Siouf	Woolen blankets
51-7	STIA Plant No. 8	Gawad Hosni St. Siouf	Blankets

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TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
51-8	STIA Plant No. 9	Zaki Ragab St. Nouzha	Wool & wool synthetic fabrics
52	El Siouf Spinning & Weaving co.	Mahmoudia Canal St. Siouf	Woven cotton fabric & cotton yarn
53-1	Modern Textile Co. Bovara unit	Suez Canal St. Moharrem Bey	Cotton, synthetic & silk fabrics
53-2	Modern Textile Co. Durra unit	Saraya No. 3 St.	Cotton, sythetic & silk fabrics
53-3	Modern Textile Co. Sharawi unit	Mahmoudia Canal St. Moharrem Bey	Cotton, synthetic & silk fabrics
53-4	Modern Textile Co. Culvertex unit	Moh. Bey el Shafee St. Bab Sidra	Bleach,Dyed & printed fabrics
54-1	National Spinning & Weaving Co. Karmouz unit	Mahmoudia Canal St. Karmouz	Cotton yarn
54-2	National Spinning & Weaving Co. Moharrem Bey unit	S. Mahmoudia Canal St. Moharrrem Bey	Woven cotton & silk fabric, terry cloth
55	Oriental Linen & cotton Co.	Mostafa Kamel St. Ras el Soda	Linen & cotton fabric
56-1	Arab & United Spinning & Weaving Co., unit No. 1	Gamila Bohraid St. Siouf	Cotton yarn
56-2	Arab & United Spinning & Weaving Co., unit No. 2	Gamila Bohraid St. Siouf	Cotton yarn and fabric
56-3	Arab & United Spinning & Weaving Co., unit No. 3	Gamila Bohraid St. Siouf	Cotton yarn
56-4	Arab & United Spinning & Weaving Co., unit No. 4	Gamila Bohraid St. Siouf	Finished cotton fabric
56-5	Arab & United Spinning & Weaving Co., unit No. 5	Abu Soliman St. Siouf	Cotton yarn

TABLE C-1
(cont'd)

NO.	NAME	LOCATION	PRODUCT
57-1	AWGA Bab Sharky plant	Midan Babour El Mayya	Water
57-2	AWGA Siouf plant	Mahmoudia Canal St. Siouf	Water
57-3	AWGA Manshia plant	Gabbari Rapid Rond	Water
57-4	AWGA Forn el Garaya plant	Mahmoudia Canal St. Karmouz	Water
57-5	AWGA Maamoura plant	Abu Kir St. Maamoura	Water
57-6	AWGA Maryut plant	Southwest of Alex. in desert	Water

TABLE C-2

PRESENT INDUSTRIAL WASTEWATER FLOW RATES

No.	Water Use, m^3/d			Wastewater Flows, m^3/d				Wastewater Discharges, m^3/d			
	AWGA	Private	Total	Sanitary	Process	Cooling	Total	To Sewer	To Drain	To Canal	To Sea
1	450	-	450	2	400	-	402	402	-	-	-
2-1	187	-	187	2	172	-	174	174	-	-	-
2-2	545	-	545	3	502	-	505	505	-	-	-
3-1	134	-	134	4	130	-	134	134			
3-2											
3-3											
4	1 160	-	1 160	10	820	130	960	960	-	-	-
5	1 200	-	1 200	100	50	-	1 150[a]	-	-	-	1 150
6	12 160	-	12 160	200	1 300	7 500	9 000	9 000	-	-	-
7	264	-	264	5	235	5	245	-	245	-	-
8-1	600	-	600	20	530	-	550	550	-	-	-
8-2	450	-	450	35	365	-	400	400	-	-	-
9-1	4 150	-	4 150	50	3 950	-	4 000	-	-	-	4 000
9-2	12 000	18 000	30 000	50	39 750	-	29 800	-	-	-	29 800
10	311	-	311	3	308	-	311	311	-	-	-
11	540	-	540	20	300	120	440	-	440	-	-
12	223	-	223	10	190	-	200	200	-	-	-
13-1	90	-	90	15	75	-	90	90	-	-	-
13-2	100	-	100	10	90	-	100	100	-	-	-
13-3	100	-	100	10	90	-	100	100	-	-	-

(b) Includes 100 m^3/day of groundwater.

TABLE C-2

PRESENT INDUSTRIAL WASTEWATER FLOW RATES (cont'd)

No.	Water Use, m^3/d			Wastewater Flows, m^3/d				Wastewater Discharges, m^3/d			
	AWGA	Private	Total	Sanitary	Process	Cooling	Total	To Sewer	To Drain	To Canal	To Sea
13-4	60	-	60	5	55	-	60	60	-	-	-
14-1	2 200	500	2 700	10	2 490	-	2 500	-	2 500	-	-
14-2	175	-	175	5	170	-	175	175	-	-	-
15	660	100	760	50	220	280	550	550	-	-	-
16	300	315	615	50	250	300	600	-	600	-	-
17-1	17.3	-	17.3	2	15	-	17	17	-	-	-
17-2	17.2	-	17.2	2	15	-	17	17	-	-	-
17-3	11.5	-	11.5	2	9	-	11	11	-	-	-
17-4	37	-	37	2	35	-	37	37	-	-	-
17-5	54.8	-	54.8	2	52	-	54	-	54	-	-
17-6	52	-	52	2	50	-	52	-	52	-	-
18	642	-	642	97[b]	440	60	500	-	500	-	-
19-1	2	96	98	2	96	-	98	98	-	-	-
19-2	2	70	72	2	70	-	72	72	-	-	-
19-3	2	70	72	2	70	-	72	72	-	-	-
19-4	2	70	72	2	70	-	72	72	-	-	-
19-5	2	65	67	2	65	-	67	67	-	-	-
19-6	2	75	77	2	75	-	75	77	-	-	-
19-7	2	52	54	2	52	-	54	54	-	-	-
19-8	2	160	162	2	160	-	162	162	-	-	-

[b] 100 m^3/day sanitary wastes are discharged to septic tanks

TABLE C-2

PRESENT INDUSTRIAL WASTEWATER FLOW RATES (cont'd)

No.	Water Use, m^3/d			Wastewater Flows, m^3/d				Wastewater Discharges, m^3/d			
	AWGA	Private	Total	Sanitary	Process	Cooling	Total	To Sewer	To Drain	To Canal	To Sea
19-9	2	80	82	2	80	-	82	82	-	-	-
19-10	10	-	10	2	8	-	10	10	-	-	-
19-11	6	-	6	1	-	5	6	6	-	-	-
19-12	9	-	9	1	-	8	9	9	-	-	-
20-1	9	100	109	9	100	-	109	109			
20-2	3	36	39	3	36	-	39	39			
20-3	5	82	87	5	82	-	87	87			
20-4	8	62	70	8	62	-	70	70			
20-5	15	108	123	15	108	-	123	123			
20-6	4	51	55	4	51	-	55	55			
20-7	9	56	65	9	56	-	65	65			
20-8	3	27	30	3	27	-	30	30			
20-9	3	8	11	3	8	-	11	11			
20-10	7	20	27	7	20	-	27	27			
20-11	4	20	24	4	20	-	24	24			
21	240	-	240	80	-	160	240	240			
22-1	760	-	760	-	-	50	50	50			
22-2	210	-	210	-	-	25	25	25			
22-3	83	-	83	-	-	25	25	25			
22-4	3	-	3	-	-	3	3	3			

TABLE C-2

PRESENT INDUSTRIAL WASTEWATER FLOW RATES (cont'd)

No.	Water Use, m^3/d			Wastewater Flows, m^3/d				Wastewater Discharges, m^3/d			
	AWGA	Private	Total	Sanitary	Process	Cooling	Total	To Sewer	To Drain	To Canal	To Sea
22-5	28	-	28	-	-	25	25	25			
22-6	42	-	42	-	-	25	25	25			
22-7	28	-	28	-	-	25	25	25			
22-8	8	-	8	-	-	25	25	25			
23	461	-	461	35	-	400	435	435	-	-	-
24	10	-	10	5	5	-	10	10	-	-	-
25-1	650	2 350	3 000	20	2 980	-	3 000	3 000	-	-	-
25-2	720	43 000	43 720	720	42 680	-	43 400	-	43 400[c]	-	-
26	-	40 000	40 000	300	39 700	-	40 000	-	40 000	-	-
27	1 600	56 400	58 000	20	780	57 200	58 000	-	1 600	-	56 400
28	1 065	171 600	172 656	250	11 350	156 000	167 600	-	167 600[d]	-	-
29	875	121 200	122 075	5	2 070	120 000	122 075	2 075	-	120 000	-
30	432	152 720	153 152	430	1 120	151 600	153 150	-	3 150	150 000	-
31	340	-	340	52	168	100	320	-	320	-	-
32	770	-	770	20	750	-	770	770	-	-	-
33	5	500	505	5	70	250	575[e]	-	575	-	-

(c) 400 m^3/d is sent to El Nasr Canned Food Co.

(d) Discharges to Lake Maryut.

(e) Includes 250 m^3/d of ground water.

TABLE C-2

PRESENT INDUSTRIAL WASTEWATER FLOW RATES (cont'd)

No.	Water Use, m^3/d			Wastewater Flows, m^3/d				Wastewater Discharges, m^3/d			
	AWGA	Private	Total	Sanitary	Process	Cooling	Total	To Sewer	To Drain	To Canal	To Sea
34	1 110	1 200	2 310	10	200	2 000	2 210	2 210	-	-	-
35	96	-	96	4	92	-	96	96	-	-	-
36	2 340	-	2 340	150	1 000	1 100	2 250	2 250	-	-	-
37-1	2 400	2 880	5 250	2	128	5 000	5 130	2 330	-	2 800	-
37-2	950	2 850	3 800	5	285	3 140	3 430	950	-	2 480	-
37-3	345	-	345	3	82	260	345	345	-	-	-
37-4	700	5 300	6 000	2	688	5 300	5 990	2 390	-	3 600	-
38-1	886	-	886	10	370	500	880	-	-	870[f]	-
38-2	710	14 400	15 110	10	840	14 150	15 000	15 000	-	-	-
39-1	870	7 000	7 870	7	793	7 000	7 800	7 800	-	-	-
39-2	267	100	367	2	240	100	342	242	-	100	-
39-3	200	-	200	1	69	-	70	70	-	-	-
39-4	132	-	132	2	108	-	110	110	-	-	-
39-5	80	-	80	2	73	-	75	75	-	-	-
39-6	50	-	50	1	1	-	2	2	-	-	-
40-1	1 284	-	1 284	4	1 250	30	1 284	1 284	-	-	-
40-2	832	-	832	2	830	-	832	832	-	-	-
40-3	3 200	4 800	8 000	4	2 966	5 000	7 970	3 170	-	4 800	0
41-1	880	-	880	20	860	-	880	880	-	-	-

[f] 10 m^3/day discharged to septic tanks and dry well.

TABLE C-2

PRESENT INDUSTRIAL WASTEWATER FLOW RATES (cont'd)

No.	Water Use, m^3/d			Wastewater Flows, m^3/d				Wastewater Discharges, m^3/d			
	AWGA	Private	Total	Sanitary	Process	Cooling	Total	To Sewer	To Drain	To Canal	To Sea
41-2	20	-	20	-	200	-	20	20	-	-	-
42	210	-	210	10	200	-	210	210	-	-	-
43	70	17	87	5	82	-	87	87	-	-	-
44	112	-	112	5	70	37	112	-	112	-	-
45	570	-	570	-	570	-	570	570	-	-	-
46	800	400	1 200	1	1 174	-	1 175	1 175	-	-	-
47	225	-	225	-	225	-	225	225	-	-	-
48	160	-	160	1	159	-	160	160	-	-	-
49-1	180	-	180	150	-	-	150	-	150	-	-
49-2	170	-	170	5	165	-	170	170	-	-	-
49-3	1 150	-	1 150	2	1 100	-	1 102	1 102	-	-	-
50-1	3 000	-	3 000	300	2 500	-	2 800	2 800	-	-	-
50-2	150	-	150	10	110	-	120	120	-	-	-
51-1	1 260	140	1 400	200	1 200	-	1 400	1 400	-	-	-
51-2	14	-	14	14	-	-	14	14	-	-	-
51-3	220	-	220	20	200	-	220	220	-	-	-
51-4	44	-	44	24	20	-	44	44	-	-	-
51-5	1 290	-	1 290	40	1 250	-	1 290	1 290	-	-	-
51-6	520	-	520	20	500	-	520	520	-	-	-

TABLE C-2

PRESENT INDUSTRIAL WASTEWATER FLOW RATES (cont'd)

No.	Water Use, m^3/d			Wastewater Flows, m^3/d				Wastewater Discharges, m^3/d			
	AWGA	Private	Total	Sanitary	Process	Cooling	Total	To Sewer	To Drain	To Canal	To Sea
51-7	76	-	76	26	50	-	76	76	-	-	-
51-8	312	-	312	42	270	-	312	312	-	-	-
52	4 400	-	4 400	100	4 000	-	4 100	-	4 100	-	-
53-1	8	-	8	8	-	-	8	8	-	-	-
53-2	2	-	2	2	-	-	2	2	-	-	-
53-3	2	-	2	2	-	-	2	2	-	-	-
53-4	90	-	90	6	80	-	86	86	-	-	-
54-1	470	-	470	100	-	120	220	220	-	-	-
54-2	4 000	5 500	10 000	50	9 000	-	9 500[g]	9 500	-	-	-
55	2 000	-	2 000	60	1 900	-	1 960	1 960	-	-	-
56-1	100	-	100	100	-	-	100	-	100	-	-
56-2	400	-	400	200	-	-	200	-	200	-	-
56-3	110	-	110	40	-	-	40	-	40	-	-
56-4	1 800	-	1 800	10	1 350	50	1 410	-	1 410	-	-
56-5	30	-	30	10	-	-	10	10	-	-	-
57-1	-	-	-	-	32 600	-	32 600	-	-	32 600	-
57-2	-	-	-	-	16 000	-	16 000	-	-	16 000	-
57-3	-	-	-	-	9 700	-	9 700	-	9 700	-	-
57-4	-	-	-	-	4 800	-	4 800	-	-	4 800	-
57-5	-	-	-	-	2 200	-	2 200	-	2 200	-	-
57-6	-	-	-	-	2 400	-	2 400	-	-	2 400	-

[g] Includes 450 m^3/d of water treatment wastewater.

TABLE C-3

INDUSTRIAL WASTEWATER CHARACTERISTICS

No.[a]		pH	Total Solids mg/l	Volatile Solids mg/l	Suspended Solids mg/l	Settleable Solids ml/l	5-day 20°BOD mg/l	COD mg/l	Phosphate PO_4 mg/l	TKN mg/l	Oil and Grease mg/l	Miscellaneous Constituents mg/l
6	a	4.4	962	298	94	4	301	607	0.5	3.9	16	Fe = 7.8, Mn = 2.56, Zn = 1.24
	b	6.6	764	240	-	1.8	220	260	-	3.7	36.5	Fe = 7.28, Ca = 1.28
	c	6.47	1 030	113	-	6.5	110	120	-	2.6	11	Fe = 10, Ca = 1.85
	d	7.4	402	815	-	0.8	72	114	-	4.53	33.5	Cd = 0.006, Cr = 0.1
	e	7.4	460	103	-	0.4	75	130	-	9.82	49	Cd = 0.008, Cr = 0.1
7	a	5.5	810	260	-	0.1	170	304	-	8.3	9.5	Fe = 2.25, Cu = 0.52
	b	6.8	490	195	-	0.2	360	436	-	8.3	12.0	Fe = 0.53, Cu = 0.44
8-2	a	6.8	504	96	56	0.1	120	188	19.8	19.7	-	Fe = 0.68, Zn = 1.4, Cr = 1.2
	b	7.6	281	-	-	-	126	-	-	-	-	-
9-1	a	12.2	28 442	1 732	14 824	40	-	-	0.4	19.2	-	Cl^- = 8,500
9-2	a	10.1	9 313	683	1 128	7	-	-	6	141.2	-	Cl^- = 4,250
	b	8.4	29 835	4 563	196	0.5	-	-	3.5	58.3	-	Cl^- = 14,600
	c	11.6	73 614	7 163	8 642	40	-	-	0.06	31.3	-	Cl^- = 44,000
	d	12.4	108 932	5 076	19 080	33	-	-	45	17.7	-	Cl^- = 8,500
10	a	12.1	7 960	904	3 190	39	280	576	0.4	72.6	1 067	-
11	a	7.1	639	194	192	0.5	165	196	9	19.4	-	Cr = 0.05, Zn = 1.14, F = 0.76
	b	7.8	266	-	67	0.7	67.3	214	-	-	-	-
12	a	6.3	35 522	-	25 762	40	1 400	2 600	-	-	-	-

(a) Sample

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TABLE C-3

INDUSTRIAL WASTEWATER CHARACTERISTICS

(cont'd)

No.[a]		pH	Total Solids mg/l	Volatile Solids mg/l	Suspended Solids mg/l	Settleable Solids ml/l	5-day 20°BOD mg/l	COD mg/l	Phosphate PO_4 mg/l	TKN mg/l	Oil and Grease mg/l	Miscellaneous Constituents mg/l
14-1	a	4.6	2 215	857	708	40	850	864	3	22.8	778	-
	b	6.9	1 540	1 230	-	3.5	940	1 435	-	5.9	13.5	Cu = 1.7
	c	6.95	990	466	-	3.6	510	560	-	8.5	47.5	-
15	a	5.2	2 479	943	780	9	970	1 300	2.4	2.54	-	-
	b	10.4	11 200	3 130	-	24	2 100	4 200	-	12.5	89	Fe = 0.26, Cu = 0.96
	c	5.8	3 030	480	-	4.5	230	520	-	9.7	51	Fe = 1.48, Cu = 0.52
16	a	6.7	3 110	2 406	630	7	1 710	2 592	18	9.0	2,307	-
	b	7.3	1 382	986	202	5	865	1 056	0.3	9.8	70.4	-
18	a	4.9	1 443	853	504	4	810	1 012	17.5	5.7	-	-
	b	3.9	16 133	6 003	910	2	7 350	10 320	0.9	14.6	-	-
	c	5.1	1 941	901	783	5.5	865	1 760	17.5	7.9	-	-
21	a	7.65	400	83	140	0.1	96	115	0.7	1.4	12.4	-
25-1	a	7.4	1 386	732	-	40	600	1 970	-	-	-	-
26	a	8.5	3 448	1 430	1 240	40	900	1 785		8.2	-	Fe = 3,86, Cr = 0.13, Mn = 0.43
	b	10	3 577	-	1 608	40	800	1 160	-	-	-	-
27	a	7	3 244	471	48	0.2	260	510	2.56	17.1	350	-
28	a	8.05	6 121	462	33	0.1	41.5	-	0.4	1.5	64.4	Phenol = 0.0
	b	7.8	6 571	372	50	0.4	28.5	-	0.46	1.13	80	Phenol = .06

(a) Sample

TABLE C-3

INDUSTRIAL WASTEWATER CHARACTERISTICS

(cont'd)

No.[a]		pH	Total Solids mg/l	Volatile Solids mg/l	Suspended Solids mg/l	Settleable Solids ml/l	5-day 20°BOD mg/l	COD mg/l	Phosphate PO_4 mg/l	TKN mg/l	Oil and Grease mg/l	Miscellaneous Constituents mg/l
	c	7.9	7 909	2 322	121	0.7	31	-	0.76	1.72	50	Phenol = .05
31	a	3.0	1 547	727	124	0.4	600	821	60.5	50.5	-	Cr = 28, Zn = 1.45, Fe = 3.8
32	a	7.45	1 010	636	-	9.1	320	1 140	-	6.0	40	Fe = 0.96, Cu = 0.53
	b	7.80	1 850	1 180	-	2.7	390	1 396	-	1.5	94	Cu = 1.46
33	a	7.8	2 620	-	-	-	150	381	0.7	-	-	-
34	a	6.6	598	320	62	2	350	405	0.7	0.9	20	Fe = 1.42, Cr = 1.1, Pb = 4.2
	b	6.7	14 890	14 605	334	0.1	8 000	12 550	0.5	1.5	9 164	Fe = 1.42, Cr = 1.1, Pb = 4.2
	c	7.9	900	130	-	0.01	220	240	-	6.1	110	Fe = 0.18, Cu = 0.54
	d	6.9	5 070	200	-	0.01	180	200	-	4.6	68	Cu = 2.2
	e	7.4	1 810	210	-	0.7	214	370	-	6.7	116	Cr = 0.19, Cd = 0.04
	f	7.3	1 810	310	-	0.64	205	385	-	12.1	39	Cr = 0.03, Cd = 0.012
36	a	6.6	906	349	62		290	405	0.8	1.4	64.4	-
	b	7.0	530	192	112	0.1	180	212	1.6	2.3	21.6	-
37-1	a	7.3	852	86	196	4	58	156	0.25	11.9	126	Fe = 2.7, Ni = 0.8, Zn = 1.7
	b	12.4	8 790	1 612	808	40	850	1 830	0.6	10.6	154	Fe = 3.0, Ni = 0.9, Zn = 0.6
37-2	a	12.4	85 412	13 315	1 462	40	1 990	-	7.5	31.4	4 065	Fe = 3.5, Ni = 1.0, Zn = 1.45 Pb = 1.4
	b	10.3	3 525	2 350	1 446	1.3	1 970	2 030	0.22	9.8	2 341	Fe = 0.8, Ni = 1.76, Zn = 2.3 Pb = 0.4

[a] Sample

TABLE C-3

INDUSTRIAL WASTEWATER CHARACTERISTICS

(cont'd)

No.[a]	pH	Total Solids mg/l	Volatile Solids mg/l	Suspended Solids mg/l	Settleable Solids ml/l	5-day 20°BOD mg/l	COD mg/l	Phosphate PO_4 mg/l	TKN mg/l	Oil and Grease mg/l	Miscellaneous Constituents mg/l
c	7.9	707	175	-	-	108	203	-	0.34	170	-
d	8.5	700	244	-	-	105	376	-	0.58	280	-
e	9.1	6 520	1 115	-	-	178	2 010	-	1.3	1 120	-
f	8.7	603	170	-	-	115	210	-	1.3	170	-
38-1 a	8.6	3 040	400	-	-	165	410	-	1.1	170	-
b	9.1	1 410	540	-	-	300	670	-	1.1	340	-
c	10.5	2 480	1 020	-	-	200	1 210	-	2.6	1 000	-
d	11	2 950	810	-	-	390	1 040	-	1.1	700	-
e	6.9	1 010	380	-	-	300	450	-	3.2	170	-
f	7.5	900	410	-	-	250	470	-	0.66	310	-
g	6.4	1 460	700	-	-	350	740	-	1.55	410	-
h	-	750	310	-	-	280	330	-	8.1	340	-
38-2 a	7.4	3 590	728	502	-	-	80	-	7.8	-	-
b	7.4	1 880	-	1 090	34.8	575	1 750	-	-	-	Fe = 1.1, Mn = 0.43, Zn = 0.41
c	8.3	10 690	-	107	0.2	-	-	-	-	160	-
39-1 a	8.2	36 480	3 992	692	25	3 000	4 312	1.2	12.3	270	Fe = 0.9, Cu = 0.9, Ni = 0.8 Pb = 1.2
b	9.0	56 830	-	242	-	437.6	-	-	-	-	-

(a) Sample

TABLE C-3

INDUSTRIAL WASTEWATER CHARACTERISTICS

(cont'd)

No.[a]	pH	Total Solids mg/l	Volatile Solids mg/l	Suspended Solids mg/l	Settleable Solids ml/l	5-day 20°BOD mg/l	COD mg/l	Phosphate PO4 mg/l	TKN mg/l	Oil and Grease mg/l	Miscellaneous Constituents mg/l
40-1 a	7.0	4 935	2 190	862	40	970	2 550	12.5	15.8	-	Fe = 1.54, F = 3.95
b	11.3	4 555	-	1 011	-	982.5	-	-	-	-	-
c	5.82	11 500	9 343	-	40	6 400	30 800	-	12.4	-	Fe = 0.56, Cu = 0.52
d	7.25	11 860	9 544	-	40	2 560	8 320	-	9.8	-	Fe = 2.9, Zn = 0.56
e	5.8	7 100	4 160	5 140	56	2 720	5 480	-	14.7	-	Fe = 2.9, Zn = 0.56
f	5.7	9 135	7 800	7 160	92	6 770	8 370	-	18.6	-	Fe = 5.3, Zn = 0.46
40-2 a	8.6	10 220	9 600	10 080	40	3 900	9 370	6	30.6	-	F= 4.3, Fe = 0.43, Zn = 0.4
b	10.9	8 060	-	4 320	-	3 870	-	-	-	-	-
c	4.8	1 350	1 010	750	-	-	775	-	-	-	-
d	7.4	1 380	730	-	39	600	1 970	-	-	-	Fe = 0.54, Zn = 0.48
e	7.8	5 760	-	3 390	97	-	-	-	-	341	-
40-3 a	8.5	3 400	1 390	560	0.4	256	820	1.5	209	-	F = 5.7, Fe = 0.56, Zn = 0.2 Pb = 0.2
b	11	3 270	-	220	-	590	-	-	-	-	-
c	5.3	8 270	2 450	430	-	-	940	-	-	-	-
d	7.4	1 150	580	-	34	490	1 750	-	-	-	Fe = 1.0
e	5.8	2 700	-	350	3	-	-	-	-	40	-
f	7.9	9 850	640	-	-	19	-	-	1.5	19	-

(a) Sample

TABLE C-3

INDUSTRIAL WASTEWATER CHARACTERISTICS

(cont'd)

No.[a]	pH	Total Solids mg/l	Volatile Solids mg/l	Suspended Solids mg/l	Settleable Solids ml/l	5-day 20°BOD mg/l	COD mg/l	Phosphate PO4 mg/l	TKN mg/l	Oil and Grease mg/l	Miscellaneous Constituents mg/l
g	7.9	9 850	640	-	-	19	-	-	1.5	19	-
h	8.4	12 050	980	-	-	48	-	-	0.23	170	-
i	8.3	5 280	490	-	-	54	-	-	0.52	170	-
j	7.9	4 810	330	-	-	33	-	-	-	-	-
41-1a	9.5	10 831	2 520	1 382	40	2 525	3 740	0	164	-	Fe = 3.9, Cr = 79, Zn = 1.75
b	9.5	9 755	-	2 074	40	2 800	6 080	-	-	-	Sulfide = 164
44 a	6.85	1 974	1 368	-	-	1 306	1 581	0.51	32.3	102	Fe = 0.5
b	7.1	1 480	1 082	-	-	1 035	1 286	-	29.2	269	Fe = 0.35
45 a	8	4 997	3 550	1 632	30	2 200	3 800	8.4	6.1	262	Fe = 5.0, Zn = 0.37, Pb = 0.44
b	7.6	2 980	-	700	30	4 720	-	-	-	-	-
c	12.2	25 700	9 827	3 800	6	900	11 036	3	61.5	360	-
50-1a	9.9	94 130	7 400	3 207	0.1	620	10 370	5.6	17.8	1 134	-
b	9.9	2 062	650	280	0.1	680	1 730	0.4	7.0	1 000	-
51-1a	6.5	476	139	72	0.1	90	112	0.04	5.35	-	Cr = 2.8, Fe = 0.54
b	12.1	2 730	-	-	0.3	1 000	1 410	-	-	-	-

[a] Sample

TABLE C-3

INDUSTRIAL WASTEWATER CHARACTERISTICS

(cont'd)

No.[a]	pH	Total Solids mg/l	Volatile Solids mg/l	Suspended Solids mg/l	Settleable Solids ml/l	5-day 20°BOD mg/l	COD mg/l	Phosphate PO_4 mg/l	TKN mg/l	Oil and Grease mg/l	Miscellaneous Constituents mg/l
51-8a	9.5	2 160	237	71	0.1	183	200	8.5	21.7	-	Fe = 0.9
b	9.3	740	-	-	-	467	601	-	-	-	-
52 a	11.2	1 740	785	-	14.5	360	790	-	6.7	73	Cu = 1.04
b	4.45	1 705	670	-	3.5	340	717	-	7.1	91.5	
c	8.23	1 230	380	-	0.7	446	734	-	10.8	120	Zn = 0.73
d	8.1	1 320	580	-	0.8	460	800	-	9.8	25	Zn = 0.55
53-4a	7.8	1 662	234	92	1.4	260	346	0.72	3.7	91.2	-
b	9.8	3 320	1 466	172	3.5	1 100	1 574	6	7.8	1370	-
54-2a	9.25	1 037	192	302	1.2	198	253	2.2	4.1	26.6	-
55 a	9.5	772	405	82	0.7	350	422	9.4	11.2	222	-
b	9.7	5 184	2 936	-	1.7	740	2 300	-	9.2	63	Cu = 0.72, Fe = 0.26
c	10.3	1 906	4 766	-	1.4	370	772	-	8.1	31.5	Cu = 3.56, Fe = 0.66
56-4a	7.3	626	260	-	1.6	240	276	-	6.5	43.5	Fe = 0.26, Cu = 0.54
b	4.05	3 180	520	-	0.5	570	800	-	10.4	72	Fe = 0.1, Cu = 1.04

[a] Sample

Table C-3 Notes

Company Number	Sample Source	Sample Type	Sample Location	Discharge Point
6 a	1	grab	Neutralized Pickling Wastes	Sewer
b	3	grab	Final Effluent	Sewer
c	3	grab	Final Effluent	Sewer
d	3	comp.	Final Effluent	Sewer
e	3	comp.	Final Effluent	Sewer
7 a	3	grab	Final Effluent	Drain
b	3	grab	Final Effluent	Drain
8-2a	1	grab	Final Effluent	Sewer
b	2	grab	Final Effluent	Sewer
9-1a	1	grab	Discharge Pump	Sea
9-2a	1	grab	Discharge Pump 1	Sea
b	1	grab	Discharge Pump 2	Sea
c	1	grab	Discharge Pump 3	Sea
d	1	grab	Discharge Pump 4	Sea
10 a	1	grab	Effluent in Sewer	Sewer
11 a	1	grab	Final Effluent	Drain
b	2	grab	Final Effluent	Drain
12 a	2	grab	Final Effluent	Sewer
14-1a	1	grab	Final Effluent	Drain
b	3	grab	Final Effluent	Drain
c	3	grab	Final Effluent	Drain
15 a	1	grab	Final Effluent	Sewer
b	3	grab	Final Effluent	Sewer
c	3	grab	Final Effluent	Sewer
16 a	1	grab	Effluent Discharge 1	Drain
b	1	grab	Effluent Discharge 2	Drain
18 a	1	grab	Effluent Discharge 1	Drain
b	1	grab	Effluent Discharge 2	Drain
c	1	grab	Effluent Discharge 3	Drain
21 a	1	grab	Final Effluent	Sewer
25-1 a	8	comp	Final Effluent	Sewer
26 a	1	grab	Final Effluent	Drain
b	2	grab	Final Effluent	Drain

Company Number		Sample Source	Sample Type	Sample Location	Discharge Point
27	a	1	grab	Oil Sep. Effluent	Drain (sea)
28	a	1	grab	Influent, Combined	-
	b	1	grab	Effluent, Combined	Drain (lake)
	c	1	grab	Effluent, Combined	Drain (lake)
31	a	1	grab	Zinc Plate Rinse	Drain
32	a	3	grab	Final Effluent	Sewer
	b	3	grab	Final Effluent	Sewer
33	a	2	grab	Final Effluent	Drain
34	a	1	grab	Battery Dept. Drain	Sewer
	b	1	grab	P.V.C. Coating Dept.	Sewer
	c	3	grab	Final Effluent	Sewer
	d	3	grab	Final Effluent	Sewer
	e	3	comp.	Final Effluent	Sewer
	e	3	comp.	Final Effluent	Sewer
36	a	1	grab	Pump Discharge 1	Sewer
	b	1	grab	Pump Discharge 2	Sewer
37-1	a	1	grab	Effluent Manhole	Sewer
	b	1	grab	Effluent Outfall	Canal
37-2	a	1	grab	Effleunt Manhole	Sewer
	b	1	grab	Effluent Outfall	Canal
	c	9	mean grab	Outfall Spring	Canal
	d	9	mean grab	Outfall Summer	Canal
	e	9	mean grab	Outfall Autumn	Canal
	f	9	mean grab	Outfall Winter	Canal
38-1	a	9	mean grab	Outfall 1, Spring	Canal
	b	9	mean grab	Outfall 1, Summer	Canal
	c	9	mean grab	Outfall 1, Autumn	Canal
	d	9	mean grab	Oufall 1, Winter	Canal
	e	9	mean grab	Outfall 2, Spring	Canal
	f	9	mean grab	Outfall 2, Summer	Canal

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Company Number		Sample Source	Sample Type	Sample Location	Discharge Point
	g	9	mean grab	Outfall 2, Autumn	Canal
	h	9	mean grab	Outfall 2, Winter	Canal
38-2	a	4	grab	Final Effluent	Sewer
	b	6	grab	Final Effluent	Sewer
	c	5	grab	Final Effluent	Sewer
39-1	a	1	grab	Soap Plant Eff.	Sewer
	b	2	grab	Soap Plant Eff.	Sewer
40-1	a	1	grab	Final Effluent	Sewer
	b	2	grab	Final Effluent	Sewer
	c	3	grab	Final Effluent	Sewer
	d	3	grab	Final Effluent	Sewer
	e	3	comp.	Final Effluent	Sewer
	f	3	comp.	Final Effluent	Sewer
40-2	a	1	grab	Final Effluent	Sewer
	b	2	grab	Final Effluent	Sewer
	c	4	grab	Final Effluent	Sewer
	d	6	grab	Final Effluent	Sewer
	e	5	grab	F nal Effluent	Sewer
40-3	a	1	grab	Final Effluent	Sewer
	b	2	grab	Final Effluent	Sewer
	c	4	grab	Final Effluent	Sewer
	d	6	grab	Final Effluent	Sewer
	e	5	grab	Final Effluent	Sewer
	f	9	mean grab	Outfall, Spring	Canal
	g	9	mean grab	Outfall, Summer	Canal
	h	9	mean grab	Outfall, Autumn	Canal
	i	9	mean grab	Outfall, Winter	Canal
41-1	a	1	grab	Final Effluent	Sewer
	b	2	grab	Final Effluent	Sewer
44	a	7	mean grab	Final Effluent	Drain
	b	7	mean comp.	Final Effluent	Drain

Company Number		Sample Source	Sample Type	Sample Location	Discharge Point
45	a	1	grab	Final Effluent	Sewer
	b	2	grab	Final Effluent	Sewer
49-3	a	1	grab	Final Effluent	Sewer
50-1	a	1	grab	Conc. Dyeing Wastes	Sewer
	b	1	grab	Conc. Bleaching Wastes	Sewer
51-1	a	1	grab	Final Effluent	Sewer
	b	2	grab	Final Effluent	Sewer
51-8	a	1	grab	Final Effluent	Sewer
	b	2	grab	Final Effluent	Sewer
52	a	3	grab	Final Effluent	Drain
	b	3	grab	Final Effluent	Drain
	c	3	comp.	Final Effluent	Drain
	d	3	comp.	Final Effluent	Drain
53-4	a	1	grab	Bleaching Room Eff.	Sewer
	b	1	grab	Dyeing Room Eff.	Sewer
54-2	a	1	grab	Final Effluent	Sewer
55	a	1	grab	Final Effluent	Sewer
	b	3	grab	Final Effluent	Sewer
	c	3	grab	Final Effluent	Sewer
56-4	a	3	grab	Final Effluent	Drain
	b	3	grab	Final Effluent	Drain

Reference List For Table C-3 Notes

1. Sample collected for this study, Analytical Work by Prof. Fahmy M. El Sharkawi, High Institute of Public Health, Alexandria University.

2. Sample collected for this study, Analytical Work by Dr. Dimian Gad Plant Chemist, East Wastewater Treatment Plant, Alexandria.

3. Results from Thesis work by Narium Moustafa Sohail "Characteristics of Wastewater of Some plants in the Siouf Region". For Prof. Fahmy M. El Sharkawi, High Institute of Public Health, Alexandria University.

4. Results from "Report on Industrial Wastes in Moharrem Bey, 1969." Prof. Fahmy M. El Sharkawi, High Institute of Public Health, Alexandria University.

5. Results from "Report on Industrial Wastes in Moharrem Bey, 1973." Prof. Fahmy M. El Sharkawi, High Institute of Public Health, Alexandria University.

6. Results from "Report on Industrial Wastes in Moharrem Bey, 1976." Prof. Fahmy M. El Sharkawi, High Institute of Public Health, Alexandria University.

7. Results from Report "Water use in Poultry Processing", EPA Project, 1977. Prof. Fahmy M. El Sharkawi, High Institute of Public Health, Alexandria University.

8. From "Report on Pollution From the Paper Industry," by Dr. Fahmy M. El Sharkawi, High Institute of Public Health, Alexandria University. January, 1976.

9. From Ph.D. Thesis by Mekkawy Mohamed Akel "The Effect of the Different Sources of Pollution on the Water Quality Characteristics of the Mahmoudia Canal in Alexandria District and its Public Health Aspects". For the High Institute of Public Health, Environmental Health Department, University of Alexandria, October 1975.

TABLE C-4

INDUSTRIAL POLLUTANT LOADS

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO_4 kg/d	TKN kg/d	Oil and Grease kg/d	Miscellaneous Constituents kg/d
1	-	-	-	-	60	100	-	-	-	-
2-1	-	-	-	-	67.5	112.5	-	-	-	-
2-2	-	-	-	-	26	44	-	-	-	-
3-1	-	-	-	-	8 000	10 000	-	-	-	-
3-2[a]	-	-	-	-	-	-	-	-	-	-
3-3[a]	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	375	560				
5	-	-	-	-	35	70	-	-	-	-
6	5 400	900	540	18	810	1 080	-	36	315	Fe = 72, Cu = 9, Zn = 4.5
7	162	57	-	0.04	66	94	-	2	2.5	Fe = 0.4, Cu = 0.12
8-1	277	53	31	0.05	66	103	11	11	-	Fe = 0.4, Cr = 0.66, Mn = 0.5, Zn = 0.77
8-2	200	38.4	22.4	0.04	48	75	8	8	-	Fe = 0.27, Cr = 0.5, Mn = 0.36, Zn = 0.56
9-1	114 000	-	59 300	160	400	1 250	1.6	77	-	Alk = 76,000
9-2	752 000	-	80 000	320	3 300	10 000	189	3 160	-	Alk = 81,600
10	2 500	280	990	12	87	180	0.12	22.6	332	-
11	280	85.4	84.5	0.22	72.6	86.2	4	8.5	-	Sulfide = 1.2, F = 0.33, Zn = 0.5
12	7 920	-	5 750	9	3 000	6 000	-	-	-	Sulfide = 1.5

[a] No information.

TABLE C-4

INDUSTRIAL POLLUTANT LOADS
(Cont'd)

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO_4 kg/d	TKN kg/d	Oil and Grease kg/d	Miscellaneous Constituents kg/d
13-1	-	-	-	-	20	40	-	-	-	-
13-2	-	-	-	-	20	40	-	-	-	-
13-3	-	-	-	-	20	40	-	-	-	-
13-4	-	-	-	-	20	40	-	-	-	-
14-1	3 850	3 000	2 500	100	2 250	3 000	7.5	37.5	1 000	-
14-2	-	-	-	-	70	105	-	-	-	-
15	3 025	825	430	6.9	605	1 100	1.32	4.4	38.5	Fe = 0.5, Cu = 0.4, S = 0.6
16	1 560	1 250	294	4	875	1 312	7.5	6.3	975	S = 0.9, Cl^- = 106
17-1	-	-	-	-	5	8	-	-	-	-
17-2	-	-	-	-	5	8	-	-	-	-
17-3	-	-	-	-	5	8	-	-	-	-
17-4	-	-	-	-	5	8	-	-	-	-
17-5	-	-	-	-	5	8	-	-	-	-
17-6	-	-	-	-	5	8	-	-	-	-
18	2 500	1 010	225	2	1 165	1 500	5	4	-	Cl^- = 825
19-1	-	-	-	-	10	15	-	-	-	-
19-2	-	-	-	-	10	15	-	-	-	-
19-3	-	-	-	-	10	15	-	-	-	-

TABLE C-4

INDUSTRIAL POLLUTANT LOADS
(Cont'd)

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO_4 kg/d	TKN kg/d	Oil and Grease kg/d	Miscellaneous Constituents kg/d
19-4	-	-	-	-	10	15	-	-	-	-
19-5	-	-	-	-	10	15	-	-	-	-
19-6	-	-	-	-	10	15	-	-	-	-
19-7	-	-	-	-	10	15	-	-	-	-
19-8	-	-	-	-	10	15	-	-	-	-
19-9	-	-	-	-	10	15	-	-	-	-
19-10	-	-	-	-	3	5	-	-	-	-
19-11	-	-	-	-	3	5	-	-	-	-
19-12	-	-	-	-	3	5	-	-	-	-
20-1	-	-	-	-	12	18	-	-	-	-
20-2	-	-	-	-	10	15	-	-	-	-
20-3	-	-	-	-	10	15	-	-	-	-
20-4	-	-	-	-	10	15	-	-	-	-
20-5	-	-	-	-	12	18	-	-	-	-
20-6	-	-	-	-	10	15	-	-	-	-
20-7	-	-	-	-	10	15	-	-	-	-
20-8	-	-	-	-	10	15	-	-	-	-
20-9	-	-	-	-	2	3	-	-	-	-

TABLE C-4

INDUSTRIAL POLLUTANT LOADS
(Cont'd)

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO4 kg/d	TKN kg/d	Oil and Grease kg/d	Miscellaneous Constituents kg/d
20-10	-	-	-	-	5	8	-	-	-	-
20-11	-	-	-	-	5	8	-	-	-	-
21	96	20	33.6	-	23	27.6	0.16	0.34	3	-
22-1	-	-	-	-	.5	1	-	-	-	-
22-2	-	-	-	-	.5	1	-	-	-	-
22-3	-	-	-	-	.5	1	-	-	-	-
22-4	-	-	-	-	.5	1	-	-	-	-
22-5	-	-	-	-	.5	1	-	-	-	-
22-6	-	-	-	-	.5	1	-	-	-	-
22-7	-	-	-	-	.5	1	-	-	-	-
22-8	-	-	-	-	.5	1	-	-	-	-
23	-	-	-	-	10	20	-	-	-	-
24	-	-	-	-	3	6	-	-	-	-
25-1	4 170	2 200	-	120	1 800	6 000	-	-	-	Fe=9, Zn=3, Cu=0.2, Mn=1, Pb=0.3
25-2	86 000	43 000	-	-	12 900	37 250	-	-	-	-
26	140 000	58 000	60 000	-	40 000	72 000	-	240	-	Fe=160, Zn=8, Cu=0.4, Mn=16, Cr=5.2
27	5 200	750	77	.32	420	840	4.2	27	520	Phenol = 8.35
28	310 000	294 000	15 000	-	1 500	3 000	60	42	2 300	-

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TABLE C-4

INDUSTRIAL POLLUTANT LOADS
(Cont'd)

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO_4 kg/d	TKN kg/d	Oil and Grease kg/d	Miscellaneous Constituents kg/d
29	-	-	200	-	200	-	-	-	800	-
30	-	-	210	-	750	1 300	-	-	960	-
31	-	-	-	-	112	320	-	-	-	Cr = 0.16, Fe = 0.02, Zn = 0.01
32	1 100	700	-	4.6	273	975	-	5.4	52	Fe = 0.4, Cu = 1.2
33	1 350	-	-	-	77	196	-	-	-	Sulfides = 1.2
34	5 300	464	-	1.1	453	663	-	15.5	188	Cu = 1.8, Pb = 2.1
35	-	-	96	-	10	15	-	-	-	-
36	1 615	607	200	7.9	530	700	2.7	3.7	100	-
37-1	16 200	2 330	2 580	80	1 360	3 200	3.0	124	644	Fe=16, Mn=1.5, Ni=5, Zn=9, Pb=2.6
37-2	72 000	19 300	5 500	40	8 400	9 000	7.75	58	10 500	Fe=5, Co=0.75, Ni=6, Zn=8.0, Pb=1.5
37-3	-	-	-	-	332	664	-	-	66.4	-
37-4	-	-	-	-	1 575	3 150	-	-	670	-
38-1	-	-	-	-	435	875	-	-	220	-
38-2	28 400	16 500	-	525	8 680	26 400	-	-	3 020	Fe=16.3, Mn=6.5, Zn=6.2, Pb=2.2
39-1	-	-	-	-	3 900	7 800	-	-	2 000	-
39-2	-	-	-	-	340	680	-	-	170	-
39-3	-	-	-	-	24	48	-	-	12	-
39-4	-	-	-	-	110	220	-	-	55	-

TABLE C-4

INDUSTRIAL POLLUTANT LOADS
(Cont'd)

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO_4 kg/d	TKN kg/d	Oil and Grease kg/d	Miscellaneous Constituents kg/d
39-5	-	-	-	-	60	120	-	-	30	-
39-6	-	-	-	-	-	-	-	-	-	-
40-1	11 500	8 500	5 600	95	5 000	11 700	16	18	-	Fe = 3.2, Cu = 0.5, Zn = 0.64
40-2	8 500	8 000	8 400	33	3 250	800	5	25.5	-	-
40-3	7 830	3 132	1 250	1.25	1 100	402.5	4.7	655	-	-
41-1	9 530	2 220	1 215	35	2 220	3 290	-	144	-	Cr = 70, Fe = 3.4, Zn = 1.5
41-2	-	-	-	-	20	40	-	-	-	-
42	-	-	-	-	422	630	-	-	-	Cr = 8.9
43	-	-	-	-	87	174	-	-	-	-
44	193	138	-	-	131	161	.04	3.5	20.8	-
45	2 550	1 983	850	17	1 700	2 270	4.5	3.4	142	-
46	-	-	-	-	480	960	-	-	-	-
47	-	-	-	-	160	320	-	-	-	-
48	-	-	-	-	96	192	-	-	-	-
49-1	-	-	-	-	30	45	-	-	-	-
49-2	-	-	-	-	293	590	-	-	-	-
49-3	-	-	-	-	616	1 230	-	-	-	-
50-1	-	-	-	-	1 800	4 500	-	-	-	-

TABLE C-4

INDUSTRIAL POLLUTANT LOADS
(Cont'd)

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO_4 kg/d	TKN kg/d	Oil and Grease kg/d	Misellaneous Constituents kg/d
50-2	-	-	-	-	616	1,230	-	-	-	-
51-1	-	-	-	-	800	1,600	-	-	-	-
51-2	-	-	-	-	-	-	-	-	-	-
51-3	-	-	-	-	138	276	-	-	-	-
51-4	-	-	-	-	13	26	-	-	-	-
51-5	-	-	-	-	230	460	-	-	-	-
51-6	-	-	-	-	300	600	-	-	-	-
51-7	-	-	-	-	23	46	-	-	-	-
51-8	-	-	-	-	260	520	-	-	-	-
52	5 230	1 970	-	3	1 860	3 150	-	43	295	Fe=1.9, Cu=1.2, Ni=2.9, Zn=2.6, Pb=0.3
53-1	-	-	-	-	-	-	-	-	-	-
53-2	-	-	-	-	-	-	-	-	-	-
53-3	-	-	-	-	-	-	-	-	-	-
53-4	-	-	-	-	120	180	-	-	-	-
54-1	-	-	-	-	20	40	-	-	-	-
54-2	-	-	-	-	3 400	4 400	-	-	-	-
55	9 240	5 400	-	2.6	972	1 700	18	20	210	-
56-1	-	-	-	-	20	30	-	-	-	-

TABLE C-4

INDUSTRIAL POLLUTANT LOADS
(Cont'd)

No.	Total Solids kg/d	Volatile Solids kg/d	Suspended Solids kg/d	Settleable Solids m^3/d	BOD_5 kg/d	COD kg/d	Phosphate PO_4 kg/d	TKN kg/d	Oil and Grease kg/d	Miscellaneous Constituents kg/d
56-2	-	-	-	-	50	100	-	-	-	-
56-3	-	-	-	-	8	12	-	-	-	-
56-4	-	-	-	-	890	1 340	-	-	-	-
56-5	-	-	-	-	-	-	-	-	-	-
57-1	-	-	19 560	-	6 520	9 780	-	-	-	-
57-2	-	-	9 900	-	3 300	4 950	-	-	-	-
57-3	-	-	5 820	-	1 940	2 910	-	-	-	-
57-4	-	-	2 880	-	960	1 440	-	-	-	-
57-5	-	-	1 320	-	440	660	-	-	-	-
57-6	-	-	1 440	-	480	720	-	-	-	-

TABLE C-5

SUMMARY OF INDUSTRIAL WATER USE AND WASTEWATER PRODUCTION - 1977

	IS[a] Survey	TI[b] Total	CF[c] Cooling	NF[d] Net	WT[e] AWA	TC[f] WW
Water Use, ml/d						
AWGA	88.9	97	-	97	-	-
Private	612.6	684	572	112	-	-
TOTAL	701.5	781	572	209	-	-
Waste Discharge, ml/d						
Sanitary	5.9	8	-	8	-	8
Process	251.0	275	-	275	68	207
Cooling	538.1	587	570	17	6	11
TOTAL	795.0	870	570	300	74	226
To:						
Sewers	84.1	92	-	92	3	89
Drains	279.0	306	203	103	15	88
Canals	340.5	377	307	70	56	14
Sea	91.4	95	60	35	-	35
TOTAL	795.0	870	570	300	74	226

(a) Total flow at industries surveyed.

(b) Estimated total flow for all industries in Alexandria.

(c) Principal flows of cooling water.

(d) Net flow = total flow less cooling water.

(e) Water treatment plant back flows and non-contaminated cooling waters not considered under principal coolant flow (item c).

(f) Contaminated industrial wastewaters = net flow (item d) less backflows, non-contaminated coolant water (item e).

TABLE C-6

1977 WASTEWATER FLOWS BY INDUSTRIAL GROUP

Number	Name	Water Use, m^3/day AWGA	Private	total	Wastewater Flows, m^3/day Sanitary	Process	Cooling	Total	Wastewater Discharges, m^3/day To Sewer	To Drain	To Canal	To Sea
1-4	Beverages	2 476	-	2 476	21	2 026	130	2 175	2 175	-	-	-
6+21	Metal Works	12 400	-	12 400	280	1 300	7 660	9 240	9 240	-	-	
7-10	Chemicals	17 775	18 000	35 775	163	35 138	5	35 306	1 261	245	-	33 800
11	Electronics	540	-	540	20	300	120	440	-	440	-	-
12-20	Food	4 853	2 223	7 076	366	5 562	653	6 484[a]	2 778	3 706	-	-
5, 22-24	Miscellaneous	3 073	-	3 073	140	55	600	1 795[b]	645	-	-	1 150
25 & 26	Paper	1 370	45 350	46 720	1 040	85 360	-	86 400	3 000	83 400	-	-
27 & 28	Petroleum	2 665	228 000	230 665	270	12 130	213 200	225 600	-	169 200	-	56 400
29 & 30	Power	1 307	273 920	275 227	435	3 190	271 600	275 225	2 075	3 150	270 000	-
31 & 32	Printing	1 110	-	1 110	72	918	100	1 090	770	320	-	-
33-36	Plastic, G & R[c]	3 551	1 700	5 251	169	1 362	3 350	5 131[d]	4 556	575	-	-
37-39	Oil & Soap	7 590	32 530	40 120	47	3 677	35 450	39 174	29 314	-	9 850	-
40	Starch & Yeast	5 316	4 800	10 632	10	5 046	5 030	10 086	5 286	-	4 800	-
41-43	Tanneries & Glue	1 180	17	1 197	35	1 162	-	1 197	1 197	-	-	-
44 & 45	Slaughtering	682	-	682	5	640	37	682	570	112	-	-
46 & 56	Textiles	22 983	6 040	29 023	1 543	25 253	170	27 416	21 416	6 000	-	-
57	Water Treatment	-	-	-	-	67 700	-	67 700	-	11 900	55 800	-
TOTAL		88 871	612 580	701 580	4 616	250 819	538 105	795 000	84 150	279 050	340 450	91 350

[a] Excludes 97m^3/day to septic tanks

[b] Includes 1000 m^3/day groundwater

[c] Glass and Rubber

[d] Includes 250 m^3/day groundwater

TABLE C-7

PRESENT FLOWS AND LOADS BY INDUSTRIAL GROUP

Industry	Flow m^3/day	Percent of Total Flow	BOD_5 Kg/day	BOD_5 mg/l	COD Kg/day	COD mg/l
Beverage	2 170	0.27	8 530	3 900	10 820	5 000
Metal Works	9 240	1.16	830	90	1 110	120
Chemicals	35 300	4.44	3 970	112	11 700	330
Elec. & Alectronic	440	0.05	70	159	90	205
Food	6 480	0.82	8 280	1 280	13 520	2 090
Miscellaneous	1 800	0.2	50	28	110	61
Paper	86 400	10.87	54 700	633	115 250	1 330
Oil Refining	225 600	28.38	1 920	9	3 840	17
Elec. Power	275 200	34 62	1 350	5	2 500	9
Printing	1 090	0.14	380	350	1 300	1 190
Plastic, Glass & Rubber	5 130	0.65	1 070	209	1 570	306
Oil & Soap	39 180	4.93	25 220	644	52 150	1 330
Starch & Yeast	10 090	1.27	9 350	927	23 520	2 330
Tanneries	1 200	0.15	2 650	2 210	4 110	3 425
Slaughtering	680	0.09	1 830	2 690	2 430	3 570
Textiles	27 400	3.45	12 600	460	23 470	857
Water Treatment	67 700	8.55	13 640	201	20 460	302
TOTAL	795 000	100.00	146 440		287 960	
Average TOTAL				(184)		(362)

TABLE C-8

NET INDUSTRIAL FLOWS AND POLLUTIONAL LOADS
(Less Large Scale Cooling Water)

Industry	Flow m^3/day	Percent of Total Flow	BOD_3 Kg/day	BOD_3 mg/l	COD Kg/day	COD mg/l
Beverages	2 170	0.70	8 530	3 900	10 820	5 000
Metal Works	9 240	2.97	830	90	1 110	120
Chemicals	35 300	11.35	3 970	112	11 700	330
Elec. & Electronic	440	0.14	70	159	90	205
Food	6 480	2.08	8 280	1 280	13 520	2 090
Miscellaneous	1 600	0.51	50	31	110	69
Paper	86 400	27.79	54 700	633	115 250	1 330
Oil Refining	11 600	3.73	1 200	103	2 400	207
Elec. Power	5 225	1.68	450	86	700	134
Printing	1 090	0.35	380	350	1 300	1 190
Plastic, Glass & Rubber	5 130	1.65	1 070	209	1 570	306
Oil & Soap	39 180	12.60	25 220	644	52 150	1 330
Starch & Yeast	10 090	3.24	9 350	927	23 520	2 330
Tanneries	1 200	0.59	2 650	2 210	4 110	3 425
Slaughtering	680	0.22	1 830	2 690	2 430	3 570
Textiles	27 400	8.81	12 600	460	23 470	857
Water Treatment	67 700	21.77	13 640	201	20 460	302
TOTAL	310 000	100.00	144 820		284 720	
Average TOTAL				(467)		(918)

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TABLE C-9

TOTAL INDUSTRIAL DISCHARGES BY DISTRICT

District	Flow m^3/day	BOD kg/day	BOD mg/l	COD Kg/day	COD mg/l
Mex	1 767	4 449	2 500	6 401	3 622
Gabbari	909	250	275	447	492
Karmouz	6 588	3 342	507	6 254	950
Gheit El Enab	9 719	3 460	356	4 490	462
Moharram Bey	310	116	374	222	716
Industries Pump Sta.	31 166	18 804	603	53 000	1 700
Hadara	11 032	9 004	816	18 693	1 694
Smouha Drain	11 694	1 476	126	2 016	173
East W.W.T.P.	6 049	6 958	1 150	15 685	2 593
Horreya New Collector	536	8 060	15 040	10 100	18 843
Salah El Din	595	198	333	308	518
Bab El Akhdar	-	-	-	-	-
Sporting Pum Sta.	960	375	390	560	583
TOTAL to Sewer	81 055	56 320	695	118 107	1 460
Ameria	167 600	1 500		3 000	
Nouzha	1 539	272		617	
Siouf	6 515	3 166		5 284	
Abu Kir	84 000	53 775		110 562	
Kalaa Drain	12 962	2 821		4 371	
Ras El Soda	6 752	4 827		6 860	
TOTAL to Drain	279 368	66 261	237.5	130 694	468
Karmouz(to Canal)	131 050	8 255		10 935	
Mahmoudia Canal	207 000	10 780		16 650	
Noubaria Canal	2 400	480		720	
TOTAL to Canal	340 450	19 551	59	28 305	85
Dekheila	92 950	4 155		12 160	
TOTAL to Sea	92 950	4 155	44.7	12 160	131
Grand TOTAL	795 000	146 387	184	289 266	364

TABLE C-10

NET INDUSTRIAL DISCHARGES BY DISTRICT
(Less Large Scale Cooling)

District	Flow m^3/day	BOD Kg/day	BOD mg/l	COD Kg/day	COD mg/l
Mex	1 767	4 449	2 500	6 401	3 622
Gabbari	909	250	275	447	492
Karmouz	6 588	3 342	507	6 254	950
Gheit El Enab	9 719	3 460	356	4 490	462
Moharram Bey	310	116	374	222	716
Industries Pump Sta.	31 166	18 804	603	53 000	1 700
Hadara	11 032	9 004	816	18 693	1 694
Smouha Drain	11 694	1 476	126	2 016	173
East W.W.T.P.	6 049	6 958	1 150	15 685	2 593
Horreya New Collector	536	8 060	15 040	10 100	18 843
Salah El Din	595	198	333	308	518
Bab El Akhdar	-	-	-	-	-
Sporting Pump Sta.	960	375	390	560	583
TOTAL to Sewer	81 055	56 320	695	118 107	1 460
Ameria	11 600	1 500		3 000	
Nouzha	1 539	272		617	
Siouf	6 515	3 166		5 284	
Abu Kir	84 000	53 775		110 562	
Kalaa Drain	12 962	2 821		4 371	
Ras El Soda	6 752	4 827		6 860	
TOTAL to Drain	123 370	66 361	538	130 694	1 059
Karmouz(to canal)	11 050	8 255		10 935	
Mahmoudia Canal	57 000	10 780		16 650	
Noubaria Canal	2 400	480		720	
TOTAL to Canal	70 450	19 550	227.5	28 305	402
Dekheila	34 950	4 155	119	12 160	348
TOTAL to Sea	34 950	4 155	119	12 160	348
Grand TOTAL	310 000	146 387	472	289 266	933

TABLE C-11

SUMMARY OF PROJECTED INDUSTRIAL WATER AND WASTEWATER FLOWS

	Industries Total			Cooling Waters & W.T. Backflow[a]			Contaminated Wastewater		
	1977	1982	2000	1977	1982	2000	1977	1982	2000
Water Use, Ml/day									
AWGA	97	170	310	-	-	-	-	-	-
Private	684	945	1800	572	700	1320	-	-	-
TOTAL	781	1082	2110	572	700	1320	-	-	-
Wastewater, Ml/day									
Sanitary	8	10	27	-	-	-	8	10	27
Process	275	455	535	68	123	-	207	332	535
Cooling	587	749	1405	576	710	1320	11	39	85
TOTAL	870	1214	1967	644	833	1320	226	381	647
To:									
Sewer	92	130	-	3	6	-	89	124	-
Drain	306	539	-	218	358	-	88	181	-
Canal	377	411	-	363	403	-	14	8	-
Sea	95	134	-	60	66	-	35	68	-
TOTAL	870	1214	1967	644	833	1320	226	381	647

[a] Cooling waters and water treatment plant washwater (filter backflows)

TABLE C-12

SUMMARY OF CONTAMINATED INDUSTRIAL WASTE DISCHARGES BY DISTRICT

District	1977 Flow m^3/day	1982 Flow m^3/day	2000 Flow m^3/day
Dekheila	35 000	75 500	140 000
Mex	1 770	2 500	4 000
Gabbari	990	1 200	5 000
Karmouz & Gheit El Enab (Mahmoudia West & Gheit El Enab)	7 600	2 700	40 000
Moharram Bey(Mahmoudia East)	500	1 000	3 000
Industrial Pump Station	32 000	40 500	60 000
Hadara	12 000	15 000	27 000
Nouzha	2 000	2 500	20 000
Smouha & Hagar El Nawatia	12 000	18 200	45 000
Bacos, Siouf & Victoria	14 000	22 000	60 000
Abis	3 000	4 000	8 000
Ras El Soda	5 000	8 000	30 000
Mamoura & Sadat City	2 500	7 500	7 500
Abu Kir Bay	84 000	127 000	140 000
Downtown & Western Harbor	600	1 000	2 500
Ibrahimia	1 000	1 500	3 000
Ameria	12 000	26 000	52 000
TOTAL	226 000	381 000	647 000

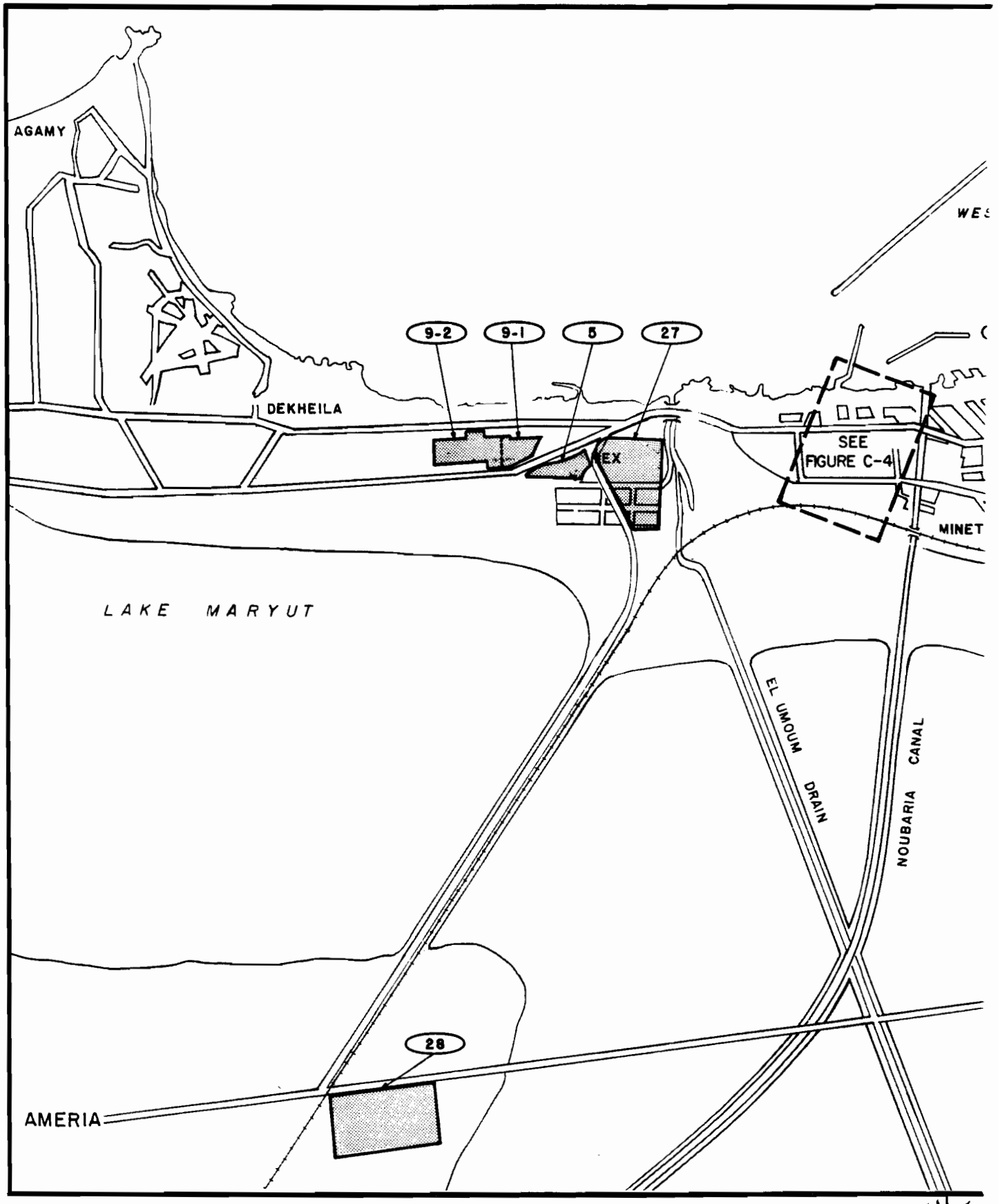
Note: Contaminated wastewater does not include large cooling water or water treatment wastes.

TABLE C-13

PROJECTED INDUSTRIAL POLLUTION LOADS

Description	Flow m^3/day	BOD mg/l	BOD Kg/day	COD mg/l	COD Kg/day
1977					
Flow to Sewer	81 000	700	56 700	1460	118 300
Net Discharge	310 000	475	147 250	933	289 200
Contaminated Discharge	226 000	640	145 000	1240	280 000
1982					
Flow to Sewer	130 000	700	91 000	1460	190 000
Net Discharge	503 000	500	251 500	1050	528 000
Contaminated Discharge	381 000	650	248 000	1400	533 000
2000					
Tributary to Existing Sewer System(1977)	220 000	700	154 000	1500	330 000
Contaminated Discharge	647 000	700	453 000	1500	970 000

BEST AVAILABLE COPY



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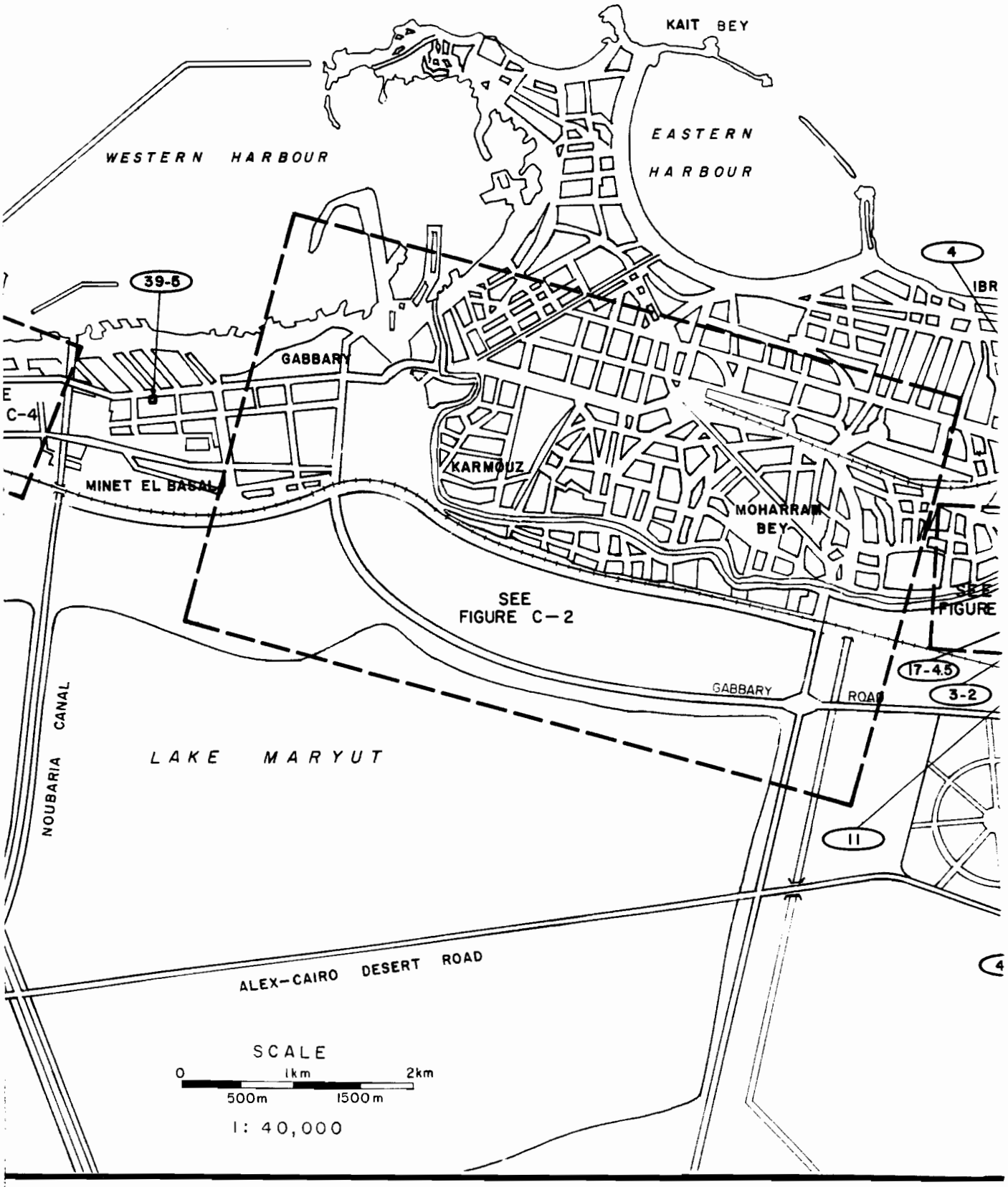

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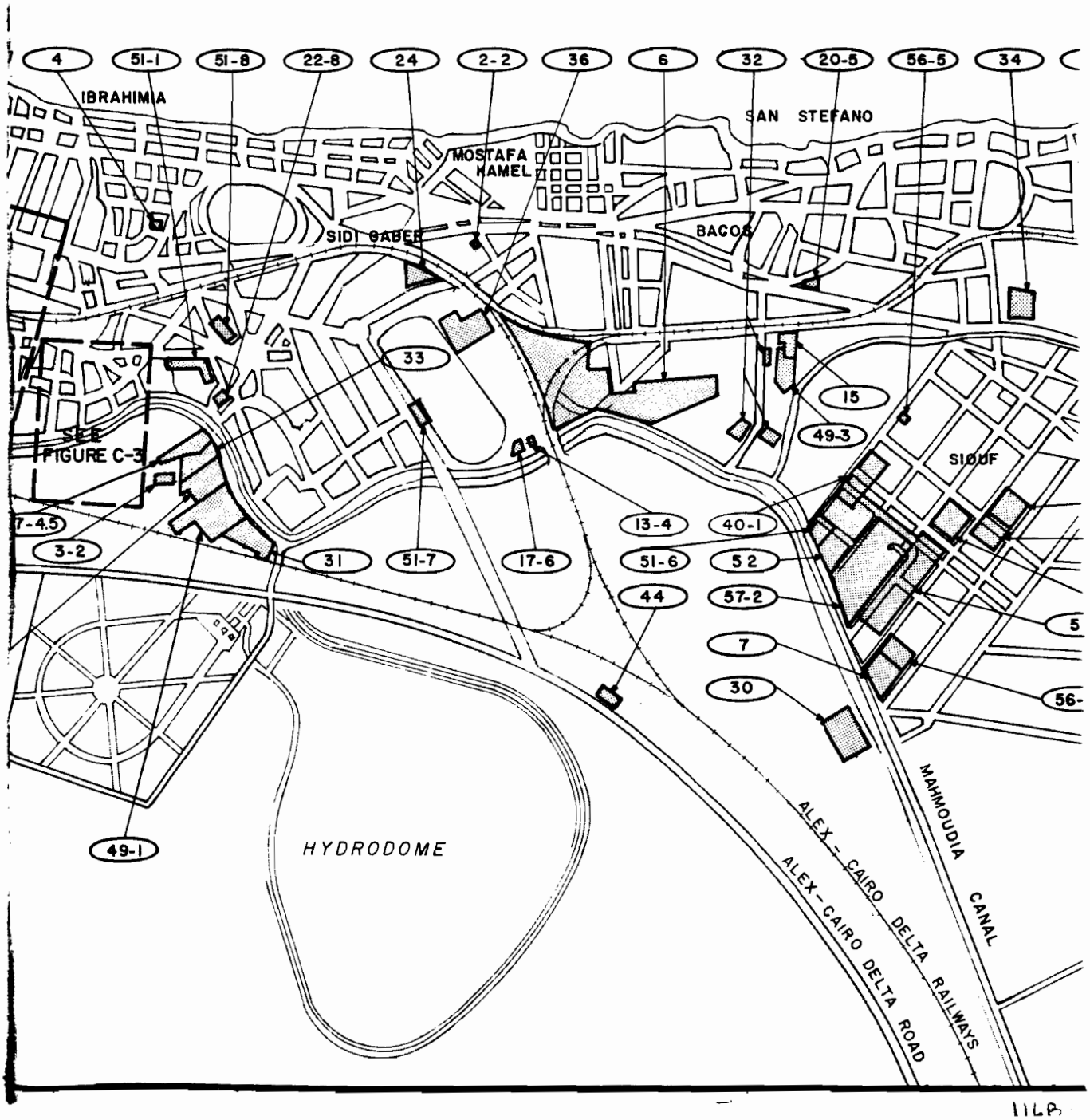

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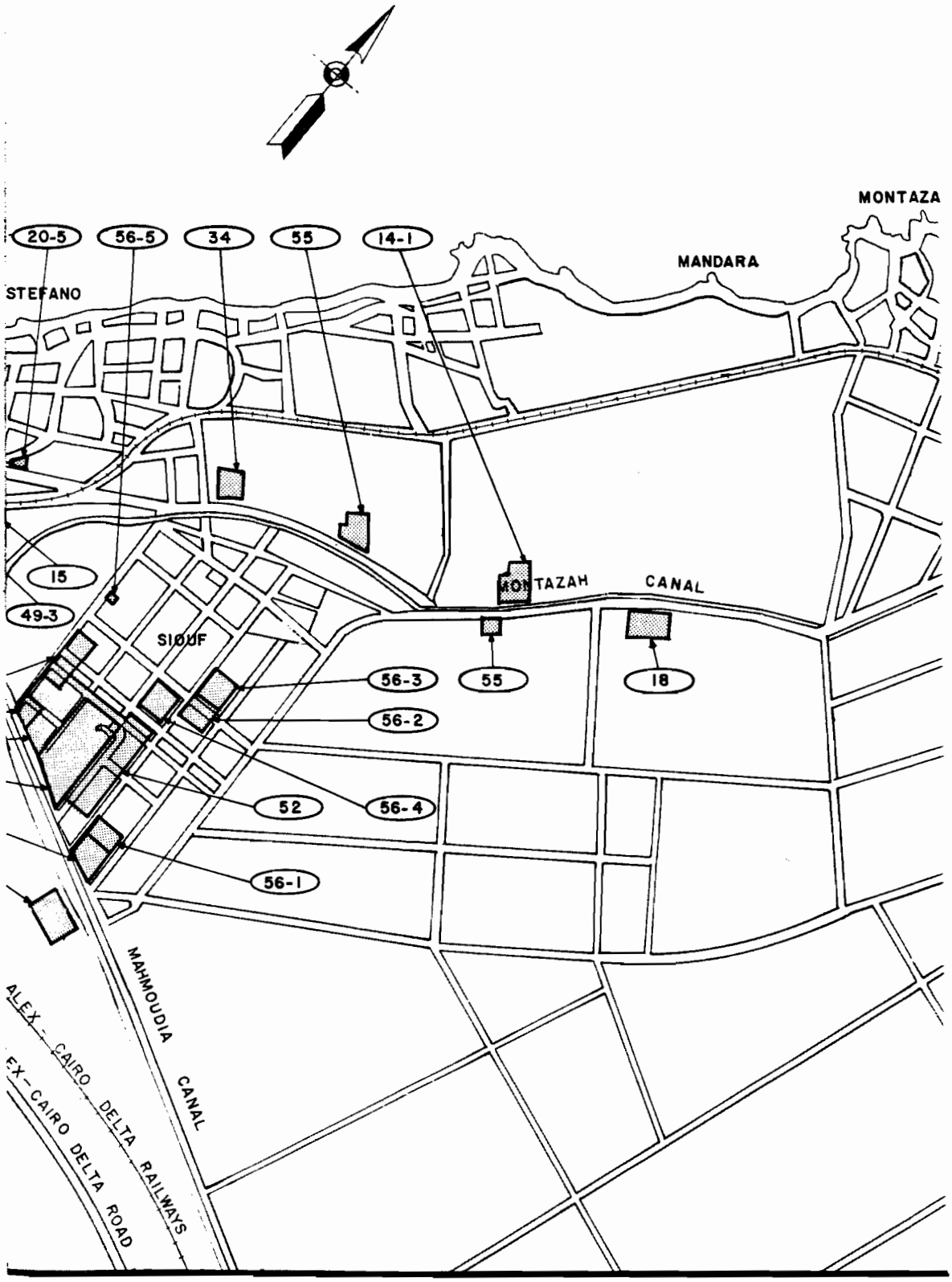

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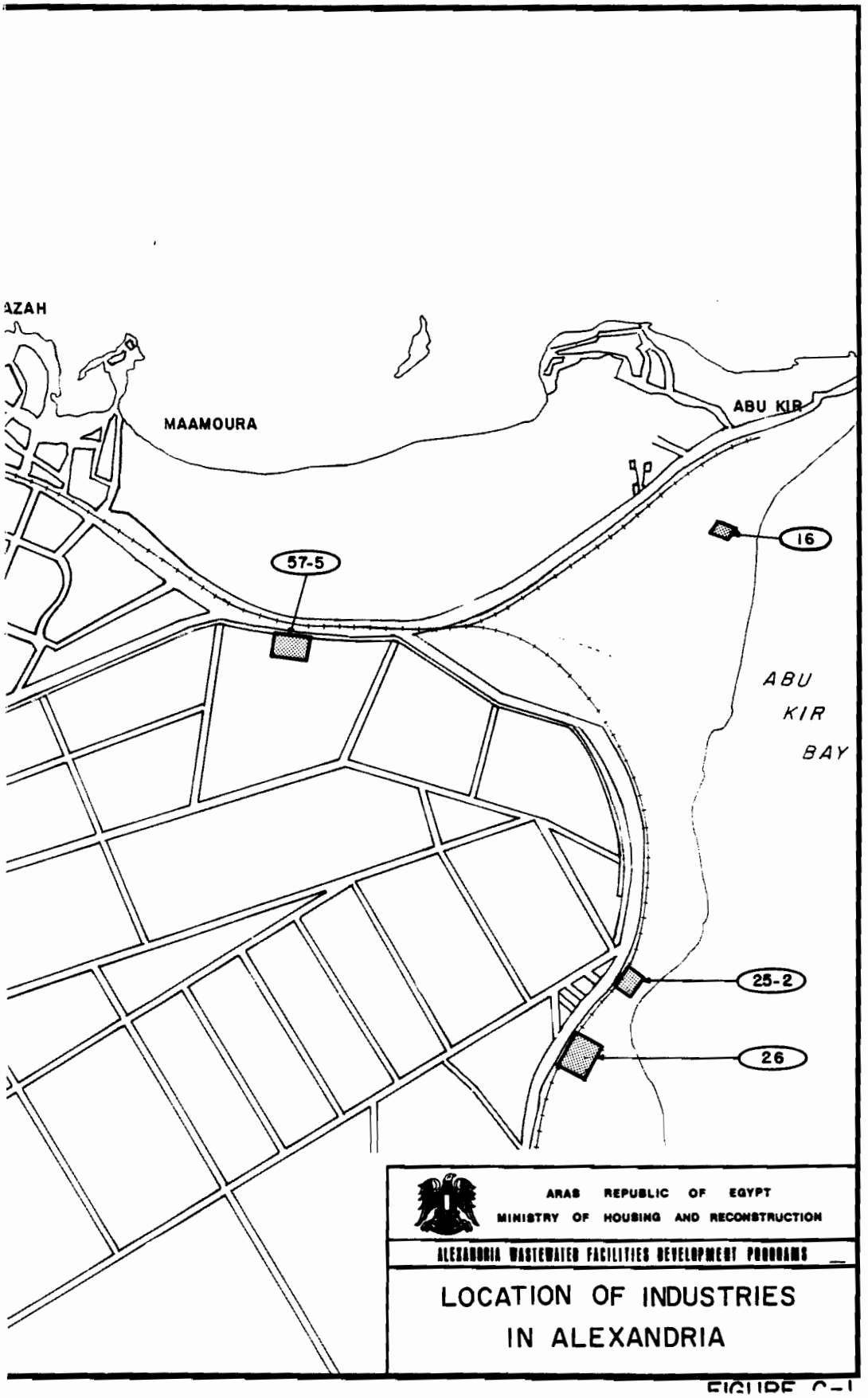

FIGURE C-1

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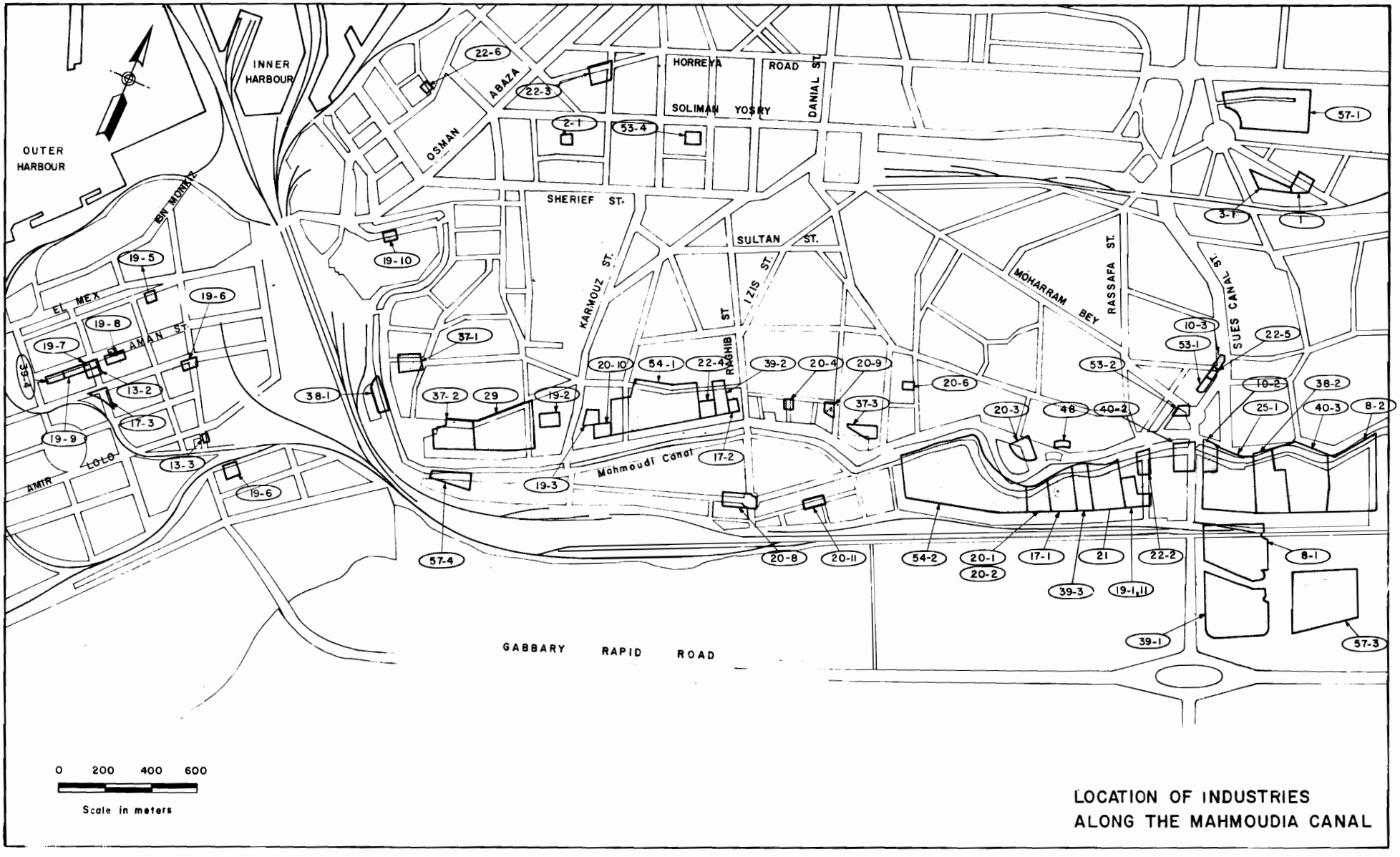

LOCATION OF INDUSTRIES ALONG THE MAHMOUDIA CANAL

FIGURE C-2

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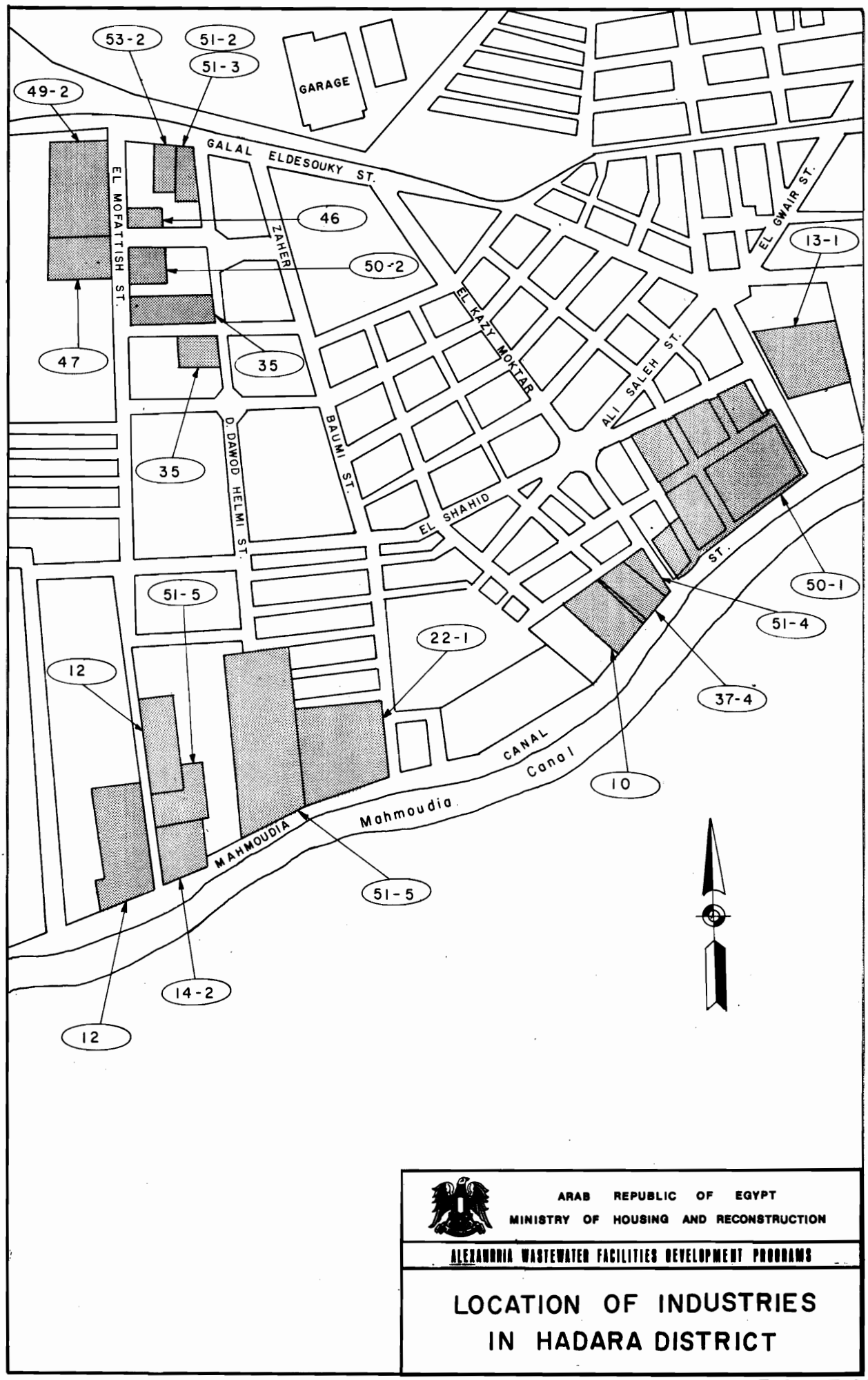

ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION

ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

LOCATION OF INDUSTRIES IN HADARA DISTRICT

FIGURE C-3

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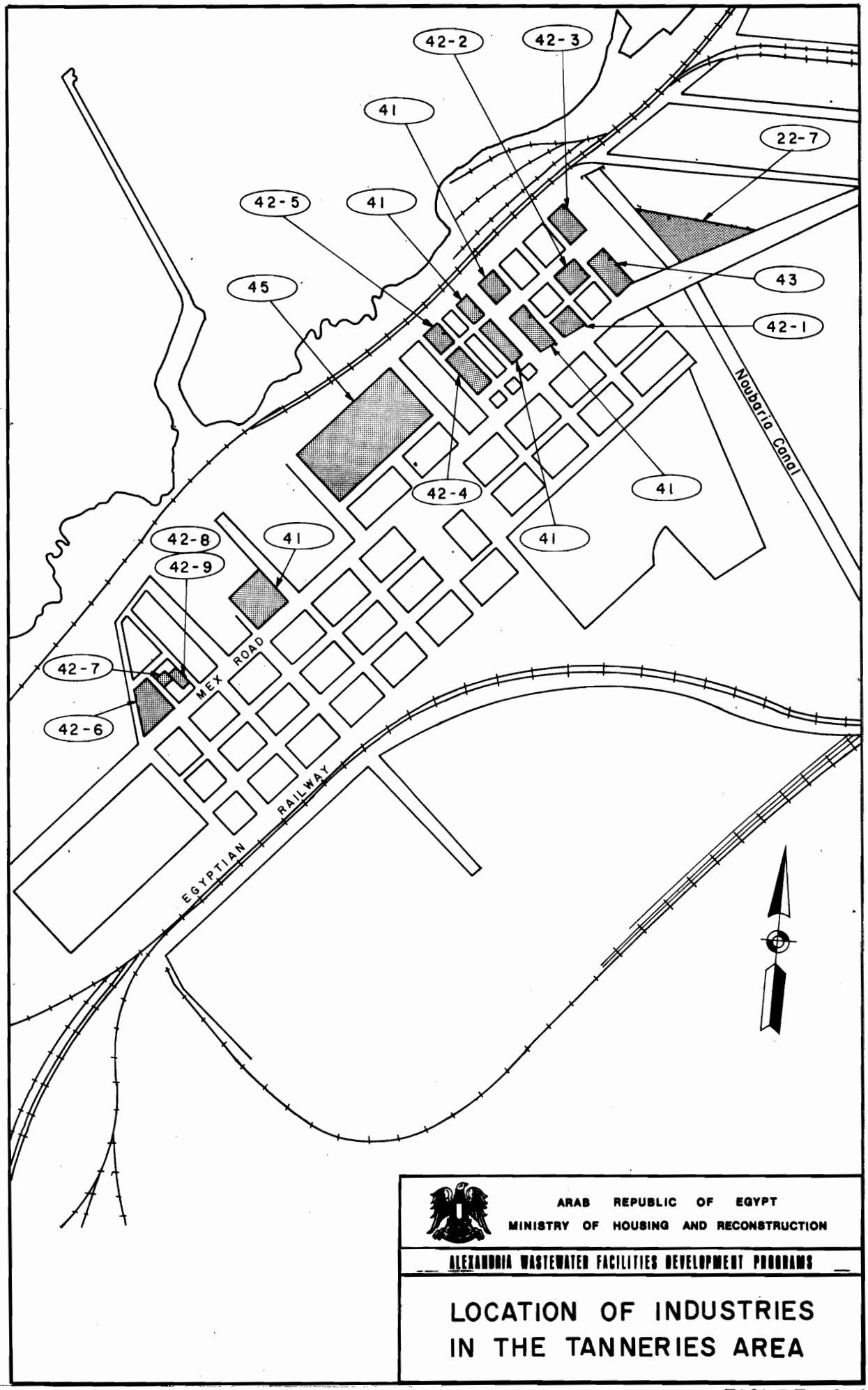

FIGURE C-4

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APPENDIX D

WASTEWATER QUANTITY AND QUALITY

Appendix D covers present and estimated future wastewater flows and loads for various portions of the study area.

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TABLE D-1

SUMMARY OF GAUGED WASTEWATER FLOWS, Litres/sec)

	Date	1000	1030	-AM- 1100	1130	(Noon) 1200	1230	1300	1330	1400	1430	-PM- 1500	1530	1600	1630	1700	1730	1800	1830	1900	1930	2000	2030	2100	2130	2200
East STP	6 June	380	330	230	360	280	280	310	390	330	230	160	-	-	-	-	-	-	-	-	280	280	280	310	280	180
Smouha	6 June	570	660	590	620	620	560	630	590	660	650	680	640	690	680	620	650	650	620	650	610	610	610	610	610	570
Ind. P.S.	13 June	450	-	450	450	450	450	450	-	450	450	-	450	450	450	450	450	450	450	-	450	450	450	-	450	450
Gheit el Enab	3 July	580	610	610	650	630	530	530	580	580	530	530	430	460	480	510	480	510	530	430	460	460	530	630	580	610
Gabbary	20 June	180	210	210	210	210	220	220	220	200	190	140	170	130	170	120	110	90	80	120	130	130	90	160	150	150
Kait Bey	20 June	760	1370	1290	1230	1180	1180	1180	1180	1180	1120	1370	1290	1710	1630	1710	1560	1630	1500	1630	1630	1290	1460	1560	1290	1000

		2300	2330	(Mid-night) 2400	030	100	130	200	230	300	330	-AM- 400	430	500	530	600	630	700	730	800	830	900	930	24-hour Average
East STP	7 June	-	-	280	280	230	230	510	-	-	-	-	-	180	140	390	510	390	450	580	450	510	640	330
Smouha	7 June	530	550	540	520	520	550	480	520	510	500	490	480	440	460	460	460	440	450	480	500	550	590	570
Ind. P.S.	14 June	450	450	-	450	450	450	450	450	450	450	450	450	-	450	450	450	450	-	450	450	450	-	450
Gheit el Enab	4 July	610	610	610	630	610	610	510	480	680	630	480	480	340	430	430	510	410	510	560	650	530	580	540
Gabbary	21 June	140	140	130	120	120	120	110	110	110	110	100	90	100	120	130	140	150	170	170	170	180	200	150
Kait Bey	21 June	630	770	770	770	800	770	770	770	770	770	770	770	770	750	1500	1420	1290	1180	1500	1370	1230	1290	1170
																								TOTAL 3210

(a) Based on hourse when flow passing gauge.

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TABLE D-2

SUMMARY OF SAMPLED WASTEWATERS

	Sample No.	pH	Alkalinity $CaCo_3$ [a]	Total Solids	Total Volatile Solids	Suspended Solids	Volatile Suspended Solids	Ammonia (as N)	Albuminoid Nitrogen	Chloride	Phosphate	Oil & Grease	BOD_5	COD
East Plant	1	7.2	336	1762	548	865	432	31.0	4.0	266	8.2	160	390	800
7 June 1977	2	7.2	317	1812	546	648	314	37.0	8.8	380	4.7	115	530	1350
	3	6.8	300	1978	674	650	502	42.0	1.2	408	14.2	241	600	1500
	4	6.8	424	1848	616	476	446	34.0	4.0	572	9.5	150	470	1600
	Average	7.0	344	1850	596	660	424	36.0	5.0	407	9.0	167	498	1313
Smouha Drain	1	7.0	413	1592	472	306	176	46.0	7.8	421	6.4	185	540	650
7 June 1977	2	7.4	345	1338	340	312	196	18.0	5.0	317	8.9	232	360	100
	3	7.8	348	1142	258	224	134	24.0	0.6	281	7.8	116	270	650
	4	7.8	340	1132	258	284	146	18.0	5.2	249	5.5	117	200	650
	Average	7.5	362	1301	332	282	163	27.0	5.0	317	7.0	163	343	513
Industry P.S.	1	6.8	320	6970	1076	598	454	3.2	3.3	2790	1.1	126	1000	2250
12 June 1977	2	6.8	550	8218	1408	1476	800	16.2	4.0	2800	2.7	1325	1400	3500
	3	6.5	500	7432	1576	1102	786	9.6	3.0	2640	1.8	1991	1200	4000
	4	7.3	395	8408	1680	1252	908	8.1	0.1	3160	0.4	2303	800	3375
	Average	7.0	441	776	1435	1107	737	9.0	3.0	2848	2.0	1436	1100	3281
Gheit el Enab	1	7.2	470	2178	1124	1042	812	26.4	8.4	360	12.0	226	400	1400
4 July 1977	2	7.3	438	1560	688	530	424	33.6	6.5	335	15.0	106	440	800
	3	7.4	468	1256	432	202	178	24.0	6.5	310	9.0	46	320	400
	4	7.3	500	1912	862	640	524	28.8	12.0	460	20.0	302	420	1800
12 June 1977	5	7.0	485	2310	692	812	490	35.6	3.3	475	14.8	249	1100	1885
	Average	7.0	472	1843	760	645	486	30.0	7.0	388	14.0	186	536	1257
Gabbary Drain	1	7.0	450	1886	726	630	502	41.0	12.0	250	17.8	316	520	1000
20 June 1977	2	6.9	430	1630	452	354	284	31.0	12.0	440	9.9	132	460	1000
	3	7.0	420	1448	303	382	156	28.0	11.0	217	8.1	62	420	900
	4	7.0	420	1476	380	280	216	41.0	12.0	190	16.1	102	380	400
	Average	7.0	430	1610	465	412	290	35.0	12.0	274	13.0	153	445	825
Kait Bey	1	6.8	380	1488	660	686	520	41.0	14.5	402	17.8	326	840	1440
20 June 1977	2	7.0	364	1660	394	308	246	31.0	11.0	438	10.4	164	500	700
	3	7.0	348	1080	382	360	282	31.0	8.0	450	8.5	595	580	600
	4	7.2	340	950	306	310	202	34.0	10.0	408	13.0	130	360	400
	Average	7.0	358	1295	436	416	313	34.0	11.0	425	12.0	304	570	785

[a] All values in mg/l except for pH.

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TABLE D-3

PROJECTED WASTEWATER FLOWS BY SEWER AREA - 1980

	Areal Extent ha	Total Pop. thousand	Rate l/c/d	Domestic Average ML/day	Domestic Peak ML/day	Industrial[a] Average ML/day	Industrial[a] Peak ML/day	Infil-tration ML/day	Total Flow Average ML/day	Total Flow Peak ML/day
Sewered Area										
East Zone	2320	1045	120	125	188	43	65	35	203	288
West Zone	745	680	80	55	93	72	108	9	136	210
Central Zone	1250	830	113	94	147	22	33	11	127	191
Unsewered Area										
Nouzha	100	50	70	3	10	13	19	1	17	30
Ras 1 Soda	225	107	85	9	20	7	11	2	18	33
Siouf Keblia	80	80	75	6	14	17	25	1	24	40
Sadat City	0	-	-	-	-	-	-	-	-	-
Abu Kir	200	45	90	4	10	113	169	2	119	181
Mex-Dekheila	90	63	80	5	12	60	90	1	66	103
Ameria	280	60	100	6	14	23	34	3	32	51
To Be Sewered	5290	2960	(150)	307	508	370	555	65	742	1127
To Remain Unsewered	-	80	160	13	22	-	-	-	(13)	(22)
Alexandria - TOTAL	-	3040	(105)	320	530	370	555	65	(755)	(1149)

[a] Industrial flow, includes water treatment plant filter backwash flows.

TABLE D-4

PROJECTED WASTEWATER FLOWS BY SEWER AREA - 1990

	Areal Extent ha	Total Pop. thousand	Rate l/c/d	Domestic Average ML/day	Domestic Peak ML/day	Industrial[a] Average ML/day	Industrial[a] Peak ML/day	Infil-tration ML/day	Total Flow Average ML/day	Total Flow Peak ML/day
Sewered Area										
East Zone	2320	1240	127	158	230	74	111	36	268	377
West Zone	830	730	105	77	122	92	138	9	178	269
Central Zone	1250	885	125	110	169	28	42	12	150	223
Unsewered Area										
Nouzha	150	60	83	5	14	25	38	1	31	53
Ras el Soda	250	224	98	22	42	20	30	2	44	74
Siouf Keblia	120	125	96	12	25	32	48	1	45	74
Sadat City	350	125	215	27	48	4	6	4	35	58
Abu Kir	250	116	112	13	25	132	198	2	147	225
Dekheila	150	115	87	10	22	102	153	1	113	176
Ameria	580	280	132	37	62	43	64	5	85	131
To Be Sewered	6250	3900	(120)	471	759	552	828	73	1096	1659
To Remain Unsewered	-	130	140	18	26	-	-	-	18	(26)
Alexandria - TOTAL	-	4030	(120)	489	785	552	828	73	(1114)	(1687)

[a] Industrial flow includes water treatment plant filter backwash flows.

TABLE D-5

PROJECTED WASTEWATER FLOWS BY SEWER AREA - 2000

	Areal Extent ha	Total Pop. thousand	Rate l/c/d	Domestic Average ML/day	Peak ML/day	Industrial[a] Average ML/day	Industrial[a] Peak ML/day	Infil-ration ML/day	Total Average ML/day	Total Flow Peak ML/day
Sewered Area										
East Zone	2320	1450	130	190	270	104	156	38	332	464
West Zone	920	800	125	100	150	110	165	9	219	324
Central Zone	1250	930	136	127	190	34	51	12	173	253
Unsewered Area										
Nouzha	250	72	100	7	17	36	54	2	45	73
Ras el Soda	350	326	107	35	63	30	45	3	68	111
Siouf Keblia	250	157	108	17	35	47	70	2	66	107
Sadat City	1050	500	108	54	92	8	12	9	71	113
Abu Kir	350	185	108	20	40	150	225	3	173	268
Dekheila-Mex	250	145	103	15	31	144	216	2	161	249
Ameria	860	500	136	68	109	62	93	7	137	209
To Be Sewered	7850	5065	(125)	633	997	725	1087	87	1445	2172
To Remain Unsewered	-	190	130	25	43	-	-	-	(25)	(43)
Alexandria - TOTAL	-	5255	(125)	658	1040	725	1087	87	(1470)	(2215)

[a] Industrial flow includes water treatment plant filter backwash flows.

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TABLE D-6

DETERMINATION OF FUTURE WASTE LOADS

Concentration	1980	1990	2000
Domestic BOD_5, mg/L	500	500	500
COD, mg/L	950	950	950
Industrial BOD_5, mg/L	650	675	700
COD, mg/L	1380	1450	1500
Future Flow, ML/day			
Domestic	320	489	658
Backwash[a]	45	50	70
Industry[b]	325	502	655
Sub-total	690	1041	1383
Infiltration	65	73	87
TOTAL Wastewater	755	1114	1470
Future Load, tonnes/day			
BOD_5			
Domestic & Backwash	183	270	364
Industrial	211	339	459
TOTAL	394	609	823
COD			
Domestic & Backwash	347	512	692
Industrial	449	728	983
TOTAL	796	1240	1675
Per Capita Load, mg/person/day			
BOD_5			
Domestic & Backwash	62	69	72
Industrial	71	87	91
TOTAL	133	156	163
COD			
Domestic & Backwash	117	131	137
Industrial	152	187	194
TOTAL	269	318	331

[a] Water treatment plant filter backwash flows.

[b] Contaminated industrial process wastewater only.

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APPENDIX E

REUSE OF WASTEWATER FOR IRRIGATION

Appendix E contains a summary report on Evaluation of Wastewater Reuse for Crop Irrigation carried out during the first half-year of the Master Plan Study. The appendix covers irrigation water requirements, crop yields, effects of wastewater application and assessment of reuse potential for principal agricultural areas near Alexandria.

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PREFATORY NOTE

This study on wastewater use for irrigation was scheduled and completed in an early phase of the wastewater study program. A basic assumption made for the study was that water use in Alexandria would add an increment of 350 mg/L total dissolved solids (TDS) to the concentration found in the water supply, an incremental value commonly found in wastewater systems elsewhere. Field sampling and analyses showed that the use of water in Alexandria added TDS ranging from 750 to 1450 mg/L and correspondingly greater concentrations of other constituents. Account has been taken of these larger increments in Chapter 6 of the Technical Report (Volume II).

These greater concentrations of TDS in Alexandria wastewater require dilution of effluent with canal water in order not to exceed limits of salinity known to cause reduction in crop productivity. The net result is to increase service area to be supplied by a given amount of wastewater and, hence, increase conveyance and distribution costs.

APPENDIX E

REUSE OF WASTEWATER FOR IRRIGATION

E.1 Introduction

Purpose and Scope of Study

Appendix E describes studies to evaluate the potential reuse of wastewater for irrigation on lands near Alexandria. The general study includes a wide area but is focused on lands nearby probable sewage collection points. These locations are the Abu Kir Drain area, to the north of Mahmoudia Canal between the Montazah Canal and the vicinity of Abu Kir Drain; the Abbis Area, including Abbis Extensions and adjacent areas south of the Drinking Water Canal; parts of Maryut Sector to the southwest of Ameria; and Ameria Northwest. The areas are shown on Figure E-1.

Of these study areas, Abu Kir Drain and the Abbis Area are presently irrigated. Relatively small areas in Maryut Sector and Ameria Northwest are not irrigated. Secondary treatment of Alexandria's wastewaters is considered necessary in order to reduce coliform bacteria and physical-chemical constituents to acceptable levels for widespread application on the crop areas considered. Crops grown for human consumption require a higher level of treatment than can be provided by primary wastewater effluent. Wastewater reuse with lesser treatment is considered feasible only where new crop patterns not directly used for human consumption are to be developed.

Study Method

The general procedure was to inventory land characteristics, and in irrigated areas, existing crop pattern, crop yields, irrigation, and drainage practices. Taking into account salt and nutrient composition of wastewater, the effects upon future crop patterns, yields and management, and the benefits are assessed. Benefits were next compared with the costs of wastewater irrigation, sewage treatment, water service, and land improvement. Costs of land improvement were also included.

To evaluate land characteristics, available maps and reports from the Ministry of Agriculture and the University of Alexandria were reviewed. These provided data on soil characteristics, depth to water table, salinity, productivity classifications, and results of leaching trials, as they affect land reclamation.

Available data on crop patterns, yields and prices were obtained from the Ministry of Agriculture, the government operated Nahda and Maryut Companies, reports by the Ford Foundation and the World Bank. These were checked against data furnished by the USDA Economic Research Service. The income received by the Egyptian Government, in addition to that paid to the farmer for certain crops, was estimated from the World Bank annual review of commodity price forecasts.

Available data on irrigation were obtained from the Ministry of Irrigation, and irrigation requirements were estimated by comparing delivery data with evapotranspiration requirements computed by data from the University of California, Davis, U.S.A., and from the Food and Agricultural Organization, U.N. This comparison has also been used to aid in estimating the amount of leaching achieved with present irrigation practice.

The above data have been supplemented by field inspections, soil borings, water quality sampling and observations of crop growth, irrigation and drainage management. This aided in estimating necessary leaching and irrigation requirements for wastewater, and in estimating potential crop growth and income.

Summary

1. Potential reuse of wastewater for irrigation was studied for lands near probable sewage collection points in Alexandria and Ameria; Abu Kir Drain and Abbis Areas, Maryut Sector, and Ameria Northwest. Available local data were used and supplemented with field observations.

2. The lands occupy portions of the northwest Nile Delta and adjoining delta fringe. Climate is favorable for year long agriculture. Soils range from excellent to poor; cropping includes general field crops, fruit, and vegetables.

3. Irrigation is applied mainly in small checks with some furrows in annual row crops, vines, and trees. Over-irrigation is common and shallow water tables are widespread. Improved systems and management of irrigation and drainage are needed.

4. Potential irrigation sources include treated wastewater and mixtures of wastewater-canal water. Wastewater is slightly saline with enriched nutrient constituents. Wastewater-canal mixtures, to provide ample nutrients and minimize salinity hazards, are recommended where integration of the two sources is practical.

5. Water requirements vary by soil and crops. For planning purposes an annual diversion requirement of 7000 m^3/feddan has been adopted. As the projected monthly distribution of wastewater differs from monthly irrigation demands, various schedules for serving full and mixed (part wastewater-- part canal water) supplies are presented.

6. Subject to needs for effective government management of reclaimed lands and improved irrigation and drainage management, on-farm benefits and long range national benefits are projected. On-farm benefits include a saving in fertilizer cost and, where salinity is not limiting, increased crop yields. National benefits include ultimate increases in water and fertilizer for agriculture.

7. Potential benefits of sewage irrigation are presented for four areas. For Abu Kir Drain and Abbis Areas, mixed wastewater-canal supplies are recommended. For Maryut Sector mixed supplies would result from the proposed means of service. In Ameria Northwest, lands are favorable for a full supply of treated sewage, affording a rare opportunity to increase Egypt's agricultural potential and optimize land use. Zoning to protect this potential would be needed now.

8. Net benefits require accounting for costs of land improvement, wastewater treatment, and conveyance to the land.

9. Benefits are assessed in the perspective of alternate irrigation sources, as, for example, the development of additional Nile River storage.

E.2 General Description of Study Area

General Location

The study areas occupy portions of the northwest Nile Delta and the fringing desert plain. The areas are shown on Figure E-1. The Abu Kir Drain Area southeast of Alexandria is a flat plain of mixed alluvial sediments. The Abbis Areas consist of land reclaimed from Lake Maryut. The Maryut Sector is part of the extensive desert plain to the west of the delta and Ameria Northwest is a high ridge above the plain.

Climate

The climate of the area is very favorable for long-season agriculture. Both winter and summer are relatively mild, with a mean monthly minimum temperature of 9.3°C in January and a mean monthly maximum of 30.6°C in August. Mean monthly relative humidity ranges from 65 to 75 percent throughout the year near Alexandria, but decreases inland. Wind velocities away from the immediate sea coast average less than 3 m/sec year long. The rainfall, occurring almost entirely from October to March, averages 192 mm per year at Alexandria, decreasing inland.

Land

Most of the soils in the Alexandria area are of marine or mixed marine-alluvial origin. To the south, fringing Lake Maryut is an area of flat topography, lying 2 to 4 m below sea level, with predominantly clay surface soils underlain by variably stratified materials. These range from highly permeable sands and shell deposits to tight clays. The underground water table, originally very shallow, now ranges from 50 cm to more than 1 m depth. Salinity, originally more than 8 mmho/cm, is generally less than 4 mmho/cm, due to drainage and reclamation. This area includes the Abbis Area and Abbis Extension.

East of the reclaimed areas and the Mahmoudia Canal is another area of nearly flat topography, ranging from slightly above to slightly below sea level. Near the Montazah Canal are sandy soils underlain by tight clays and water tables at less than 50 cm depth. Further east are clay soils underlain by stratified and medium textured materials with variable shell deposits, and water tables ranging from 80 cm to more than 1 m depth. Salinity ranges generally from 2-4 mmho/cm. This includes the Abu Kir Drain Area.

West of Lake Maryut and south of Ameria is a portion of the desert plain with mainly fine textured soils. In the Maryut Sector, the smooth plain slopes eastward from an elevation of 30 m to about 10 m near the Cairo-Alexandria Desert Road. These soils are mostly clay loam, some to depths of more than 1.5 m, some underlain by lime or gypsum accumulations below 50 cm, and small scattered areas with limestone below 40 cm. The water table, originally near sea level or 10 to 30 m below the ground surface, is now within 1.5 m of surface in most of the area due to over-irrigation. Salinity, originally low, has increased and high accumulations occur in surface soils which are left uncultivated.

The Ameria Northwest area consists of a high ridge with deep clay loam soils on relatively smooth topography, and higher ridges of shallow non-irrigable soils. The eastern part of the area is zoned for industry and housing; the southern lands are occupied by the town of Ikingy Maryut. Other lands have developed dry native grasses with some scattered olive and almond orchards. The lands are just outside the study area, but are called to the attention of MOHR due to the urgency of zoning, if the lands are to be preserved as part of Egypt's future agricultural resource. The potential for using the higher non-irrigable lands for housing with large interspersed areas of green fields, offers an opportunity to better optimize land use and create an aesthetically and environmentally pleasing landscape.

Additional areas not studied in detail include the land northeast of Ameria and areas west of Agamy. The lands northeast of Ameria are zoned for industry or agriculture; the soils west of Agamy are mainly sandy, underlain by shallow limestone deposits. These appear expensive to serve, would have high water requirements, and would be limited to the production of few crops.

Land Ownership. A large part of the lands in the potential service areas are government reclaimed lands, which are still in government ownership or under government control. This includes the lands between the Maamoura and Taufiki Canals, about half of the lands between Maamoura Canal and Abu Kir Drain, most of the land between Abbis Canal and Alexandria, and most of the lands served from the Noubaria Canal, in the Maryut Sector and the North Tahrir and Nahda Company lands. A relatively small part of these lands was formerly in private ownership and has remained so. The size of private holdings was reduced by agrarian reform to a maximum of 50 feddans. The average size is now approximately 25 feddans. Present ownership status of the originally government-owned land is not entirely clear. According to some sources, the lands in the Abbis Area are now privately owned, although the owners continue to pay on a loan for land development costs. Other sources indicate that farmers are still tenants. In Maryut Sector, most of the farmers are tenants, but some have been granted title to the lands.

Cropping. Due to favorable climate, year long cropping occurs in all areas. Most extensive are field crops and vegetables, with fruit in certain areas.

The principal winter crops are berseem, wheat, and in some areas, barley, broad beans, and winter vegetables. Cotton is extensive to the south, but little cotton is grown near Alexandria, due to the high demand for vegetables.

In the Abbis Area, records show that the above described cropping pattern predominates; mostly barley is grown instead of wheat and no fruit is produced. Crop growth varies from excellent to poor. Reported yields are below average.

In the Abu Kir area, a diversified pattern of field crops and vegetables is grown. Fruits account for about 20 percent of production; citrus fruits are grown mostly, but apples and pears are also cultivated. Crop growth ranges from excellent near Abu Kir Drain, to poor in areas near Montazah.

In Maryut Sector, the crop pattern is largely field crops and vegetables, with extensive areas of grapes. Reported yields are below average, largely due to limited water supplies. The better lands should have a potentially high productivity with adequate water and good management.

In Ameria Northwest cropping is limited to a few olive and almond orchards irrigated by windmills.

Land Classification. A 1960 classification of lands according to suitability for irrigation agriculture, prepared by the Soil Survey Division of the Ministry of Irrigation, is shown in Figure E-2, updated to reflect land development in the Abu Kir and Abbis Areas since that time. Similar classifications were not obtained for Maryut Sector and Ameria Northwest area, but relative suitability for irrigation may be inferred from the soil maps shown in Figures E-3 and E-4.

In Figure E-2, the relative suitability of the lands is shown for the Abu Kir Drain and Abbis Area. It is understood that the classification is adapted from that used by the U.S. Bureau of Reclamation, and the classes may be generally defined as follows:

Class 1: Suitable for high yields of any climatically adapted crops with minimum costs of management.

Class 2: Suitable for moderate yields of most crops with moderate costs of management.

Class 3: Suitable for marginal to moderate yields of most crops with high costs of management.

Class 1 lands occur only to the east of Abu Kir Drain. They have finely textured, but well aggregated surface soils underlain by variably stratified materials. They are used for a variety of fruits, vegetables, and field crops. Crop growth is excellent and the field drains are deep and effective.

Class 2 lands are extensive in the Abu Kir Drain area and in parts of the Abbis Area. They have soil profiles that are less permeable than those of Class 1 lands, and drainage is less effective. The growth of field crops and many vegetables is similar to that of Class 1, but tree fruits are less productive due to less effective drainage.

Class 3 includes lands near Montazah and Lake Idku in the Abu Kir Drain area, and much of the reclaimed lands of the Abbis Area. They were originally highly saline and, after many years of farming, are still more saline than Class 2 lands. To some extent their productivity can be improved by deeper drainage, especially where underlain by permeable sands and shell deposits. Improvement will be difficult, however, where underlain by tight marine clays. Class 3 lands are characterized by fair to good growth of most crops, except fruits which are generally poor.

The general maps of Maryut Sector and Ameria Northwest Area show the relative suitability for irrigation, although no official land classification was obtained.

In Maryut Sector, the extensive areas of deep clay loam soils in the western sector are comparable to Class 2. This is also true of the irrigable lands in Ameria Northwest which, lying outside of the principal study area, were not evaluated in detail.

Irrigation Practice

Irrigation water is furnished to the Abu Kir and Abbis Extension areas by branch canals from the Mahmoudia Canal; to the Maryut Sector by the Maryut

Canal, a branch from the Noubaria Canal. Water is released from the Mahmoudia Canal by gravity through headworks, and the flow is controlled by these releases and the water elevation at the drain spillways at the end of the branch canals. During the period that the canals are open, water is released to the farms through slide gates set by the ditch tender, according to water levels, to give the desired flow.

Noubaria Canal water is conveyed through the Maryut Canal by a series of pump lifts, due to rising elevations and thence to other canals serving various parts of the area.

Since the flow in the branch canals is controlled by elevation, accurate measure or control of water releases is difficult, and is further aggravated by problems of gradient, weeds, and structure maintenance. Also, due to water scheduling and uncertain flows, there is a tendency for farmers to take more water than needed when water is available.

Although actual quantities of water delivered are not accurately measured, deliveries are scheduled to provide water on a rotation basis in accordance with crop needs. Service areas from the main canals are divided into two or three blocks in a given area. Branch canals in these blocks then receive water at varying intervals.

For general field crops, the blocks are open five days and closed ten days from September 15 to May 30, while open seven days and closed seven days from June 1 to September 15. For vegetables the schedule is seven days open, seven days closed, throughout the year; for rice, four days open, four days closed through the growing season. An estimated schedule for fruit could not be obtained. The schedules are not followed rigidly and are modified by only partial closures to furnish water for longer periods to vegetables in field crop areas or to meet other needs.

A rigid application of the field crop schedule, i.e., 8 months irrigation one-third of the time at an application of 50 m^3/feddan/day, three-and-one-half months 50 percent of the time at 72 m^3/feddan/day, and one-half month closure for cleaning would amount to 8030 m^3/feddan/year or 1.91 m^3/m^2. Available records indicate that such a schedule is not strictly followed, that deliveries vary more nearly in accordance with crop demand, and that total yearly applications are less than indicated. The rotation under which farmers must complete their irrigations, inadequate functioning of limited water control structures, and further problems in delivery, due to uneven gradients and channel weeds, tend to make farmers take more water than actually needed.

When water is available, according to irrigation officials, farmers over-irrigate, hoping to store excess moisture in the soil. At the same time, according to these officials, the farmers often fail to shut the water off when the irrigation is complete and waste much excess water to the drains.

Another factor affecting irrigation management is the canal design. In many parts of the Abbis and Abu Kir Drain Areas, the canal water surface is below field level and animal-driven water wheels. In some cases, mechanical pumps are used to lift the water for irrigation. According to Ministry of Irrigation representatives, canals are so designed to require farmers to lift the water to encourage more efficient irrigation use. With an average water wheel capacity of 250 m^3/day for a farm of four feddans, the average flow per feddan is 62.5 m^3/day. The peak requirements for evapotranspiration

alone are about 7 mm/day, i.e., (.007) (4200), or 29.4 m^3/day. It is thus evident that during the peak season, irrigations would be needed 50 percent of the time, and there would be little leeway in water elevation for adequate deliveries by the water wheel, or in soil moisture storage.

Canal design may also affect water quality and salinity. Seepage from the canals causes high ground water on adjoining lands in areas where the canal water surface is above field elevation. Where the canal water surface is below field level and only slightly above the water table, seepage is reduced. However, during closures and low flows, ground water may drain into the canal and temporarily increase the salinity.

Irrigations are generally applied to small checks separated by field drains. For grain and berseem the entire check is flooded; for vegetables, fruit, and other row crops,furrows are generally used. Many of the furrows are not well maintained and, together with inadequate leveling, this tends to reduce the uniformity of application.

Drainage

The main drains in the Abbis Extension and Maryut Sector lead to Lake Maryut, conveyed from the field drains through a system of collector drains. The field drains in the Abbis Extension are open drains about 25 m apart and not more than 1 m deep. In the Abu Kir area they are mostly open drains at 25 to 50 m spacing and 1 to 1.5 m deep. Some tile drains have been noted on private lands.

In the Maryut Sector, the field drains are open, generally at 50 m spacing and about 1 m deep.

Need for improved maintenance of open drains has been noted in all areas. Many drains are clogged with earth or weeds and do not function properly. There is also a need to improve maintenance of drainage pumps where the effluent is pumped into the collector systems and the main drains.

In some places there is a need for deeper and more frequent drains, as in the Maryut Sector. In the Abbis Area, deeper drains are needed at about the same spacing. Where feasible, tile drainage should be installed to save land and reduce maintenance costs. Plans for tile drainage have been recommended by FAO in the Maryut Sector and other nearby Noubaria Canal service areas. It is also understood that the Egyptian government plans to install tile drains in the Abbis Area within the next ten years.

E.3 Water Quality for Irrigation

General

The irrigation waters considered in this study are the waters of the Mahmoudia and Noubaria Canals and branches thereof, treated sewage of Alexandria and Ameria, and various mixtures of canal and wastewater. The waters of both the Mahmoudia and Noubaria Canals are from the Nile River. However, different factors affect their quality and they are considered separately.

Mahmoudia Canal and Alexandria Wastewaters

The Mahmoudia Canal provides service for irrigation, municipal and industrial (M & I) use, and navigation to Alexandria and adjoining agricultural lands.

It is the present irrigation supply for the Abu Kir Drain and Abbis areas which might use treated wastewater collected near Alexandria.

Water quality analyses for the Mahmoudia Canal are available from the Alexandria Water Authority for 1973 and from samples taken in 1977 by CDM. The more recent analyses are not materially different from the 1973 data which are used herein. In Table E-1 the mean canal composition of the Mahmoudia water is shown in column 2 and the projected composition of treated wastewater in column 3. The original data were slightly modified by arbitrarily adding sulfates to attain ionic balance, and by assuming that the carbonates, reported with pH 7.2, were actually bicarbonates. As shown, the canal water has a total concentration of 324 mg/L and an electrical conductivity (EC) of 0.39 mmho/cm.

Projected wastewater composition in column 3 was obtained by adding 350 mg/L to the ions of column 2 on a pro rata basis, a total resulting in 674 mg/L. From these data, the EC is estimated as 0.8 mmho/cm, SAR (sodium absorption ratio) is calculated as 2.57, and the adjusted SAR, which reflects the increased tendency for sodium absorption due to bicarbonate precipitation, is 5.04. The computed EC of 0.78 was increased to an estimated 0.9 mmho/cm based on an independent estimate of soluble nitrogen and phosphate, as discussed later.

Projected wastewater quality is slightly saline, with a small tendency to reduce soil permeability by sodium absorption. It would be satisfactory for use on well drained soils, but marginal for use on poorly drained soils, where it would be difficult to obtain the leaching needed for salt sensitive fruits and vegetables, which are important to Alexandria.

An estimate of added nutrients was also made. By relating projected sewage flows to population and applying per capita nitrogen contributions corrected for treatment losses, wastewater was estimated to contain about 23 mg/L of total nitrogen. By a similar process, phosphate, present mostly as orthophosphate, was estimated to be about 6 mg/L, equivalent to 4.4 mg/L of P_2O_5. These values are projected as nitrogen and P_2O_5 composition, independently of the pro rata increase given in Table E-1.

A total N concentration of 23 mg/L and P_2O_5 concentration of 4.4 mg/L applied in typical annual irrigations of 1.67 m^3/m^2, or 7000 m^3/feddan, would represent annual applications of 161 kg per feddan of nitrogen and 30.8 kg per feddan of P_2O_5. This is more than twice the annual consumption of 69.3 kg/feddan of nitrogen and 12.2 kg/feddan P_2O_5 fertilizer quoted for Egypt in 1975. (H.A. El Tobgy, in Contemporary Egyptian Agriculture, Ford Foundation, Cairo, 1976.)

The Mahmoudia Canal water is quite low in salinity and also low in nutrients. Although wastewater would have an EC of about .9 mmho/cm and a slight tendency to increase exchangeable sodium in the soil, its use would annually add more than twice the nitrogen and phosphate typically used in Egypt as well as other vitamins, trace elements, and hormones not quantitatively evaluated. A 50 percent mixture of wastewater and canal waters would have an EC of 0.65, and an adjusted SAR of about 4.0. It would cause no significant leaching difficulties on most soils of the area, and would provide a fertilizer contribution equal to the annual average consumption.

TABLE E-1

COMPOSITION OF ALEXANDRIA WATERS

Ions	Canal Water	Wastewater		
	mg/L	mg/L	me/L	
Ca	32.72	68.08	3.40	
Mg	14.43	30.03	2.50	10.31
Na	48.74	101.42	4.41	
HCO_3	84.84	176.53	2.89	
SO_4	77.72	161.72	3.37	
Cl	49.00	101.96	2.87	10.09
NO_3	4.81	10.07	0.16	
SiO_2	11.58	24.10	0.80	
TOTAL	328.84	673.84		
EC (mmho/cm)	0.39	0.78		
SAR[a]	2.52	2.57		
SAR (Adj.)[b]		5.04		

[a] $SAR = Na/\left(\frac{Ca + Mg}{2}\right).5$; all ions in me/L.

[b] SAR = (Adjusted) = SAR [1 + (8.4 - pH_c)], where 8.4 is pH of water in equilibrium with $CaCO_3$ at 1 Atmosphere; pH_c is (pk_2 - pk_c) + p(Ca + Mg) + pAIK; pk_2 and pk_c are negative logs of 2nd dissociation constant of H_2CO_3 and solubility constant of $CaCO_3$ respectively, p(Ca + Mg) and pAIK are negative logs of molar concentrations of Ca and Mg, and of equivalent concentrations of titratable CO_3 and HCO_3.

Noubaria Canal and Ameria Wastewaters

The Noubaria Canal, through the Maryut Canal, serves the irrigated lands of Maryut Sector, a portion of which is a potential service area for wastewater collected in Ameria. It is also the probable source of M & I water for Ameria, from which sewage water would be derived to serve either a part of Maryut Sector or the undeveloped irrigable lands northwest of Ameria.

The salinity of Noubaria Canal water above Nasser Canal, about 45 km south of Ameria, is similar to that of the Mahmoudia Canal. From this point northward it steadily increases, due to saline return flows. Data obtained for 1976 from FAO indicates that the average TDS near Maryut Canal was 500 mg/L, although it ranged as high as 1000 mg/L during low flows.

Analyses indicate that even in high flow stages it ranges above 750 mg/L. Applying the previously described estimated increase of 350 mg/L in wastewater, the projected effluent would have a TDS of about 1100 mg/L, or an EC of about 1.57 mmho/cm. This would be unsatisfactory except for salt tolerant crops with good drainage and irrigation management.

This may be corrected somewhat by the West Noubaria Main Drain which is presently under construction. Ameria may be provided with a water supply that does not exceed 500 mg/L. If this can be done, the projected sewage supply from Ameria would have 850 TDS, or an EC of 1.2 mmho/cm. This would be acceptable for irrigating salt sensitive crops with good drainage and irrigation management. The nutrient content would presumably be similar to that of Alexandria sewage.

Ameria wastewater might be conveyed to the Maryut Canal at Pumping Plant No. 2 to furnish a mixed supply for about 5000 non-irrigated feddans in Maryut Sector. The quality of Maryut Canal water as well as wastewater is thus of concern.

Data from FAO indicate that in 1976 the TDS in Maryut Canal ranged from 500 at Pumping Plant No. 2 to 1000 mg/L at the highest Pumping Plant (No. 5). Recent analyses indicate that approaching the peak irrigation season, at Pumping Plant No. 2, the EC was 1.1 mmho/cm; about 770 mg/L TDS.

As reported, the salinity increase in Maryut Canal is caused by saline ground water intrusion into the canal at low flow stages in the deeply excavated sections near pump lifts. The high salinity at higher flows may be due to increasing salinity in the Noubaria Canal or other factors not yet determined.

If canal salinity can be reduced by corrective measures, a wastewater-canal water mix would be suitable for high-income salt sensitive vegetables and fruits with good drainage and irrigation management. If uncorrected, the mixed water would only be suitable for lower-income salt tolerant crops.

E.4 Agricultural Water Requirements

General

Water requirements for agricultural crops were determined to aid in estimating monthly and annual sewage quantities that would be needed to supply potential service areas and to aid in estimating the feasibility of meeting leaching requirements of the more saline wastewater. The latter was

important since most of the lands have shallow water tables and sustained cropping requires intensive drainage systems. The general approach compares irrigation delivery records with computed crop use to aid in estimating conveyance and on-farm losses and thus derive a basis for projecting future irrigation requirements.

Definition of Terms

The following terms are used in this report:

1. Diversion: The monthly or annual quantity of water supplied to an area through the branch canals. It includes the farm requirements plus operational spills to drains, evaporation losses, and transpiration by water weeds.

2. Farm Delivery (FD): Generally this is defined as the quantity delivered to the farm-headgate. In areas of shallow water table, it also includes canal seepage losses which move to the water table and supply some of the water to farm crops.

3. Evapotranspiration (ET): The monthly or annual quantity of water used by a crop to complete its growth cycle. It includes crop transpiration, evaporation from the adjacent soil, and water in the harvested crop.

4. Effective Precipitation (EP): The portion of total rain that contributes to crop ET, appreciable quantities will reduce farm delivery requirements; negligable quantities cannot be considered in scheduling irrigations. As most rains occur during winter cropping periods, this is considered partially effective; rains after January are neglected.

5. ET of Applied Water (ETa): That part of ET that must be met by irrigation, determined by deducting EP from ET.

6. Surface Run-off: The water applied to the field that runs off into drain ditches and does not contribute to ET or the leaching requirements. Also included are farm ditch spills to drains.

7. Deep Percolation: Water entering the soil in excess of crop needs which percolates below the root zone. In areas of shallow water table it runs out through drains or raises the water table. That portion percolating and remaining below the root zone is termed the leaching fraction.

8. Irrigation Efficiency (IE): This is the ratio ETa/FD expressed as a percentage, the difference (FD - ETa) is surface run-off and deep percolation.

General Methods of Determination

ET may be measured directly in lysimeters or computed from measurements using climatic data. As no measurements that could be fully interpreted were available for this area, ET was computed by a method developed for FAO by consultant P.E. Rijtema and William O. Pruitt, Irrigation Engineer, University of California, Davis, U.S.A.

From available rainfall records, EP was determined by monthly soil moisture budgets and deducted from computed ET to get ETa.

FD quantities were determined after available 1976 diversion records for Abbis Extension were compared with ET computed from crop records for same year. Diversions greatly exceeded computed ET in October and December and from discussion with Engineer Maher, it was learned that these contained operational spills. The deep percolation and surface run-off were then estimated from general observation of soils and irrigation practice and available data on leaching experience.

Estimated Water Requirements

From discussion with Pruitt in California during 1977 it was learned that the ET for grass 10 cm high in the attached Table E-2 agreed fairly well with lysimeter measurements at Davis, considering climatic differences. This was taken as the reference ET (ETo).

The monthly ET of other crops would be related to ETo by a coefficient KC (ratio ET/ETo) depending on the stage of growth, and ranging from .15 to .45, depending on soil moisture conditions. As growth progresses, it approaches 1.0 and exceeds it for aerodynamically rough crops, decreasing after maturity, depending on crop moisture at harvest. For several major crops, planting and harvest dates were determined as given in Table E-3, and plots were made for KC for the middle of each period as shown on Figures E5-E8. Although these should be curves rather than straight lines, as drawn, no loss in accuracy results. The values obtained were graphically smoothed to reflect the spread in planting and harvest periods, giving an adjusted KC. This was then applied to monthly ETo values to give monthly ET as shown in Table E-4.

Monthly ET values were next adjusted based on further communications with Pruitt. The reference to ETo for the year was 30 percent higher for Alexandria than measured grass ETo at Davis. Also according to Pruitt, the Rijtema method by which the ETo was developed over-predicted the measured grass ET at Davis by 15 to 20 percent. This indicated a possible reduction in the reference data for Alexandria to give values 5 to 10 percent higher than at Davis. Rather than repeat the entire procedure, the ET of individual crops was adjusted to give values 10 percent greater than the measured ET of the same crops at Davis. These were used in deriving other water requirements in Table E-5.

EP and ETa are given in Table E-5. Only the rainfall of January and December were considered to be significant. Soil moisture budgets were run, deducting ET and adding EP and ETa as needed. The sum of EP and ETa in each month equals the ET unless soil moisture changes. The general result is a delay of needed ETa due to winter rainfall; no change occurs for summer crop.

FD was determined by applying a 60 percent irrigation efficiency to the ETa's shown in Tables E-2,3,4 and 5 for all crops except grapes and citrus, where 65 and 70 percent were used. This reflects better management, observed crop growth, and partially an arbitrary adjustment as the computed citrus ETs seemed high.

The FD values are summarized in Table E-6, converted from mm depth to m^3/m^2 (a term more widely used in Egypt) and also expressed in the common term m^3/feddan (1 Feddan = 4200 m^2; about 1.04 acres). Water requirements in m^3/feddan were supplied for several crops by the Ministry of Irrigation. These supposedly represent FD, but are less than ETo values at Davis, California, where ETo is less than that for Alexandria. As these differences could not be reconciled, local figures were not used. On an annual

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TABLE E-2

EVAPORATION DEMAND FOR GRASS 10 CM HIGH AT ALEXANDRIA

Month	Evaporation Demand (ET), mm Mean Daily	Monthly
January	2.52	78
February	3.21	90
March	4.29	133
April	5.14	154
May	6.10	189
June	6.73	202
July	7.10	220
August	6.61	205
September	5.82	175
October	4.24	131
November	2.81	84
December	2.19	68
TOTAL		1 729

Source: Crop Water Use, P.E. Ritjema and A. Abou Khaled, Table 20, FAO Cairo Research on Crop Water Use, Salt Affected Soils and Drainage, Arab Republic of Egypt, 1975.

TABLE E-3

MAJOR CROP GROWTH PERIODS[a]

Crop	Plant	Harvest
Barley	15 Nov - 15 Dec	1 May - 31 May
Berseem (long season)	1 Sep - 10 Nov	1 May - 31 May
Broad Beans	15 Oct - 30 Nov	15 Apr - 31 May
Wheat	15 Oct - 1 Dec	1 May - 1 Jun
Winter Lettuce	1 Oct - 1 Dec	15 Feb - 1 Apr
Winter Tomatoes	15 Oct - 15 Dec	1 Feb - 1 Apr
Rice	15 Apr - 15 May	15 Aug - 15 Oct
Corn	1 May - 15 Jun	15 Aug - 30 Sep
Watermelon Seed	15 Apr - 15 Jun	15 Aug - 30 Sep
Potatoes (summer)	1 Feb - 15 Mar	1 Jul - 20 Jul
Tomatoes (late summer)	1 Feb - 1 Mar	1 Jun - 1 Dec
Cotton	5 Mar - 15 Mar	10 Sep - 20 Sep

[a] Used to determine ET

TABLE E-4

CROP COEFFICIENTS AND COMPUTED ET

Crop		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
Grass	Basic Kc	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	
	ET, mm/day	2.81	2.19	2.52	3.21	4.29	5.14	6.10	6.73	7.10	6.61	5.82	4.24	-
Grapes[a]	Basic Kc	.35	-	-	-	.25	.45	.60	.70	.70	.65	.55	.45	
	ET, mm/day	.98	-	-	-	1.07	2.31	3.66	4.71	4.97	4.30	3.20	1.91	
	ET, mm/month	28.8	-	-	-	33.2	69.3	113.5	141.3	154.1	133.3	96.0	59.2	828.7
Citrus[b]	Basic Kc	.67	.67	.63	.63	.67	.67	.67	.72	.72	.72	.72	.72	
	ET, mm/day	1.88	1.47	1.59	2.02	2.87	3.44	4.09	4.85	5.11	4.76	4.19	3.05	
	ET, mm/month	56.5	45.5	49.2	56.6	89.1	103.3	126.7	145.4	158.5	147.5	125.7	94.6	1 198.6
Berseem[c]	Basic Kc	.67	.92	.92	.92	.92	.71	.25	-	-	-	-	.26	
	Adjusted Kc	.72	.86	.92	.92	.90	.63	.22	-	-	-	.10	.30	
	ET, mm/day	2.02	1.88	2.32	2.95	3.86	3.24	1.34	-	-	-	.58	1.27	
	ET, mm/month	60.6	58.3	71.9	82.6	119.7	97.2	41.5	-	-	-	17.4	39.4	588.6
Barley	Basic Kc	-	.45	.58	1.02	1.05	.99	.22	-	-	-	-	-	
	Adjusted Kc	.06	.40	.61	.98	1.05	.90	.27	-	-	-	-	-	
	ET, mm/day	.17	.88	1.54	3.15	4.50	4.65	1.65	-	-	-	-	-	
	ET, mm/month	5.1	26.4	47.7	88.2	139.5	138.9	51.1	-	-	-	-	-	496.9
Wheat	Basic Kc	.30	.52	.97	1.05	1.05	1.05	.75	.11	-	-	-	-	
	Adjusted Kc	.27	.57	.89	1.01	1.05	.75	.65	.34	-	-	-	.06	
	ET, mm/day	.76	1.25	2.24	3.24	4.50	3.86	4.21	2.29	-	-	-	.25	
	ET, mm/month	22.8	38.7	69.5	90.8	139.6	115.6	130.5	68.6	-	-	-	7.90	684.0
Broad Bean	Basic Kc	.30	.56	.99	1.05	1.05	1.01	.24	-	-	-	-	-	
	Adjusted Kc	.29	.61	.93	1.05	1.04	.86	.40	-	-	-	-	.05	
	ET, mm/day	.81	1.34	2.34	3.37	4.46	4.42	2.44	-	-	-	-	.21	
	ET, mm/month	24.3	41.5	72.5	94.4	138.3	132.6	75.6	-	-	-	-	65.1	644.3

TABLE E-4 (cont'd)

CROP COEFFICIENTS AND COMPUTED ET

Crop		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
Rice	Basic Kc	-	-	-	-	-	-	.15	.82	1.10	1.10	1.09	.33	
	Adjusted Kc	-	-	-	-	-	.04(d)	.25	.76	1.10	1.10	1.08	.37	
	ET, mm/day		-	-	-	-	.21	1.52	5.11	7.81	7.27	6.29	1.57	
	ET, mm/month	-	-	-	-	-	6.2	47.3	153.4	242.1	225.4	188.6	48.6	911.6
Corn	Basic Kc	-	-	-	-	-	-	.15	.57	.99	1.05	.32	-	
	Adjusted Kc	-	-	-	-	-	-	.20	.56	.90	.94	.42	-	
	ET, mm/day	-	-	-	-	-	-	1.22	3.77	6.39	6.21	2.44	-	
	ET, mm/month	-	-	-	-	-	-	37.8	113.1	198.1	192.5	73.2	-	614.7
Cotton	Basic Kc	-	-	-	-	.20	.32	.62	.96	1.05	.91	.34	-	
	ET, mm/day	-	-	-	-	.86	1.64	3.78	6.40	7.46	6.01	1.98	-	
	ET, mm/month	-	-	-	-	26.7	49.2	117.2	193.8	231.2	186.2	59.4	-	863.9
Water-melon seed(e)	Basic Kc	-	-	-	-	-	-	.22	.60	.93	.92	.24	-	
	Adjusted Kc	-	-	-	-	-	.06	.21	.64	.84	.75	.33	-	
	ET, mm/day	-	-	-	-	-	.31	1.28	4.31	6.04	4.96	1.92	-	
	ET, mm/month	-	-	-	-	-	9.3	39.7	129.3	187.2	153.8	57.6	-	576.9
Potatoes (summer)	Basic Kc	-	-	-	-	.43	.90	1.05	.95	.40	-	-	-	
	Adjusted Kc	-	-	-	.10	.41	.85	1.03	.85	.41	-	-	-	
	ET, mm/day	-	-	-	.32	1.76	4.37	6.28	5.65	2.91	-	-	-	
	ET, mm/month	-	-	-	9.0	54.6	131.1	194.7	169.5	90.2	-	-	-	649.1
Tomatoes Early summer	Basic Kc	-	.02	.05	.31	.48	.89	1.05	.94	.34	-	-	-	
Late summer	Basic Kc	-	-	-	.05	.13	.40	.65	1.03	1.03	.77	-	-	
Winter	Basic Kc	.45	.82	1.05	1.03	.37	-	-	-	-	-	.05	.22	

TABLE E-4 (cont'd)

CROP COEFFICIENTS AND COMPUTED ET

Crop		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
Tomatoes (cont'd)	Mean Kc	.15	.28	.36	.46	.33	.43	.56	.66	.46	.26	.02	.07	
	ET, mm/day	.42	.61	.91	1.48	1.42	2.21	3.42	4.44	3.27	1.72	.12	.20	
	ET, mm/month	12.6	19.0	28.1	41.3	43.9	66.3	105.9	133.2	101.2	53.3	3.5	9.2	617.5
Winter Carrots	Basic Kc	.55	.94	1.00	.85	-	-	-	-	-	-	-	.21	
	Adjusted Kc	.50	.90	.98	.80	.30	-	-	-	-	-	.10	.30	
	ET, mm/day	1.41	1.97	2.47	2.57	1.29	-	-	-	-	-	.58	1.79	
	ET, mm/month	42.3	61.0	76.6	72.0	40.0	-	-	-	-	-	17.4	55.5	364.8
Winter Lettuce	Basic Kc	.42	.60	.88	.93	-	-	-	-	-	-	-	-	
	Adjusted Kc	.43	.65	.84	.90	.30	-	-	-	-	-	-	.20	
	ET, mm/day	1.20	1.42	2.12	8.89	1.29	-	-	-	-	-	-	.85	
	ET, mm/month	36.0	44.0	65.7	80.9	40.0	-	-	-	-	-	-	26.4	293.0
Composite Vegetables	Adjusted Kc	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	
	ET, mm/day	1.83	1.42	1.64	2.09	2.79	3.34	3.97	4.37	4.62	4.30	3.78	2.76	369.1
	ET, mm/month	54.9	44.0	50.8	58.5	86.5	100.2	123.1	131.1	143.2	133.3	113.4	85.6	1124.6

(a) Values adjusted upward 10% for Ameria area

(b) Half cover crop, half clean cultivated, decreased 5% for smaller trees .

(c) When preceeding cotton values deducted after March

(d) Nursery for 15% of transplanted rice areas

(e) Summer crop for Abbis Extension

TABLE E-5

DERIVATION OF ETa AND FD FOR MAJOR CROPS

Crop		Monthly Water Requirement, m^3/m^2												
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
Grapes	ET	28	-	-	-	33	69	113	141	154	133	96	59	826
	EP	-	56	49	-	-	-	-	-	-	-	-	-	105
	ETa	78	-	-	-	-	102	113	141	-	147	140	-	721
	FD	120	-	-	-	-	157	174	217	-	226	215	-	1109
Citrus	ET	39	32	34	40	62	72	89	101	110	103	88	66	836
	EP	-	56	49	-	-	-	-	-	-	-	-	-	105
	ETa	-	-	-	40	60	90	106	106	110	103	88	28	731
	FD	-	-	-	57	86	128	151	151	157	147	126	40	1043
Vegetables Year Long	ET	47	38	44	51	74	86	106	131	143	133	113	87	1053
	EP	-	56	49	-	-	-	-	-	-	-	-	-	105
	ETa	100	-	-	66	74	86	106	131	143	103	84	55	948
	FD	167	-	-	110	123	143	177	202	220	158	140	92	1532
Berseem (Long Season)	ET	61	58	72	83	120	97	41	-	-	-	17	39	588
	EP	-	56	49	-	-	-	-	-	-	-	-	-	105
	ETa	91	-	-	73	85	63	41	-	-	-	-	130	483
	FD	151	-	-	122	142	105	68	-	-	-	-	217	805
Wheat	ET	20	34	61	79	120	100	56	-	-	-	-	7	477
	EP	-	56	49	-	-	-	-	-	-	-	-	-	105
	ETa	-	-	-	116	120	136	-	-	-	-	-	-	372
	FD	-	-	-	193	200	227	-	-	-	-	-	-	620

TABLE E-5 (cont'd)

DERIVATION OF ETa AND FD FOR MAJOR CROPS

Crop		Monthly Water Requirements, m^3/m^2												
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
Barley	ET	4	22	41	76	121	120	44	-	-	-	-	-	428
	EP	-	56	49	-	-	-	-	-	-	-	-	-	105
	ETa	-	-	-	110	121	92	-	-	-	-	-	-	313
	FD	-	-	-	183	202	153	-	-	-	-	-	-	508
Broad-beans	ET	21	36	63	82	120	116	66	-	-	-	-	56	560
	EP	-	56	49	-	-	-	-	-	-	-	-	-	105
	ETa	140	-	-	117	120	78	-	-	-	-	-	-	455
	FD	233	-	-	195	200	130	-	-	-	-	-	-	758
Rice	ET	-	-	-	-	-	6	47	153	242	225	189	49	911
	ETa	-	-	-	-	-	6	177	153	242	225	108	-	911
	FD	-	-	-	-	-	10	295	235	372	346	180	-	1438
Corn	ET	-	-	-	-	-	-	38	113	198	192	73	-	614
	ETa	-	-	-	-	-	-	75	180	190	169	-	-	614
	FD	-	-	-	-	-	-	125	277	292	260	-	-	954
Water-melon seed	ET	-	-	-	-	-	9	40	129	187	154	58	-	577
	ETa	-	-	-	-	-	-	153	129	160	135	-	-	577
	FD	-	-	-	-	-	-	255	198	246	208	-	-	907
Cotton	ET	-	-	-	-	27	49	117	194	231	186	59	-	863
	ETa	-	-	-	-	55	65	117	194	200	158	74	-	863
	FD	-	-	-	-	92	108	195	298	308	243	123	-	1367

TABLE E-6

FARM DELIVERY REQUIREMENTS OF MAJOR CROPS

Monthly Requirements in m^3/m^2 and m^3/feddan

Crop		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	TOTAL
Grapes	m^3/m^2	.120	-	-	-	-	.157	.174	.217	-	.226	.215	-	1.109
	m^3/feddan	504	-	-	-	-	659	731	911	-	949	903	-	4 657
Citrus	m^3/m^2	-	-	-	.057	.086	.128	.151	.151	.157	.147	.126	.040	1.043
	m^3/feddan	-	-	-	239	361	538	634	634	659	617	529	168	4 379
Vegetables	m^3/m^2	.167	-	-	.110	.123	.143	.177	.202	.220	.158	.140	.92	1.532
	m^3/feddan	701	-	-	462	517	601	743	848	924	664	588	386	6 434
Berseem(long season)	m^3/m^2	.151	-	-	.122	.142	.105	.068	-	-	-	-	.217	0.805
	m^3/feddan	634	-	-	512	596	441	286	-	-	-	-	911	3 380
Wheat	m^3/m^2	-	-	-	.193	.200	.227	-	-	-	-	-	-	0.620
	m^3/feddan	-	-	-	811	840	953	-	-	-	-	-	-	2 604
Barley	m^3/m^2	-	-	-	.183	.202	.153	-	-	-	-	-	-	0.508
	m^3/feddan	-	-	-	769	848	643	-	-	-	-	-	-	2 260
Broadbeans	m^3/m^2	.233	-	-	.195	.200	.130	-	-	-	-	-	-	0.758
	m^3/feddan	979	-	-	819	840	546	-	-	-	-	-	-	3 184
Rice	m^3/m^2	-	-	-	-	-	.010	.295	.235	.372	.346	.180	-	1.438
	m^3/feddan	-	-	-	-	-	42	1239	987	1562	1453	756	-	6 039
Corn	m^3/m^2	-	-	-	-	-	-	.125	.277	.292	.260	-	-	0.954
	m^3/feddan	-	-	-	-	-	-	525	1163	1226	1092	-	-	4 006
Watermelon seed	m^3/m^2	-	-	-	-	-	-	.255	.198	.246	.208	-	-	0.907
	m^3/feddan	-	-	-	-	-	-	1071	832	1033	874	-	-	3 810
Cotton	m^3/m^2	-	-	-	-	.092	.108	.195	.298	.308	.243	.123	-	1.367
	m^3/feddan	-	-	-	-	386	454	819	1252	1294	1021	517	-	5 743

basis, however, the combination of berseem, grain, or broad beans, as winter crops followed by corn, rice, or vegetables as summer crops, ranging from 6600 to 9400 m^3/feddan agree reasonably well with figures commonly quoted in Egypt. Thus, the figures in Table E-6 have been adopted for estimating water demand for wastewater.

Farm delivery demand for major crops was determined, as shown in Table E-6. When applied to present crop patterns as listed in Tables E-11-13, the annual farm delivery was 6357 m^3/feddan for the Abu Kir Drain Area and 6827 m^3/feddan for the Abbis Area. When applied to a projected crop pattern of grapes, vegetables, and field crops in Maryut Sector, the farm delivery was 6580 m^3/feddan.

For practical planning purposes, 7000 m^3/feddan has been adopted as the diversion requirement, which allows for some transpiration by water weeds, evaporation, and unavoidable operational spills. This annual quantity also agrees generally with the average diversion deliveries commonly used by the Egyptian Ministry of Irrigation.

Leaching Requirement

This will vary with soil, irrigation methods, drainage conditions, and many other factors. Estimates may be made from field measurements. Where these are not available the following are used for estimates:

1. Field observation of soils, drainage conditions, and crop growth.

2. Comparison of reported diversions or farm deliveries, and, if available, drainage flows, with computed ET or ETa.

The first method was used for the entire service area; the second could only be applied where records were obtained for Abbis Extensions.

Entire Service Area. The estimated leaching attainable under present management varies from about 0.30 to 0.40 m^3/m^2 per year. For most soils and crops, this is adequate for the EC of the present water supply which is about 0.4 mmho/cm. For wastewaters, EC would be about 0.9 mmho/cm or with a 50 percent mixture of canal water and sewage, about 0.65 mmho/cm. With the increased EC the adequacy of leaching will depend on the salt tolerance of the crops. Most field crops grown are moderately to highly tolerant of salinity while certain vegetables and fruits are very sensitive. Thus, where fruit is grown, or where vegetables are important in the rotation, as in most areas near Alexandria, their tolerance will determine the leaching required.

The leaching requirement is that portion of water entering the soil that must pass below the root zone to maintain salt concentrations that permit a specified crop yield. In the U.S., in estimating leaching requirements, 90 percent optimum yields are considered practical goals, as many factors besides salinity affect yield. In this study area, crop yields much lower than under similar conditions in the U.S. support a subsistance economy due to many agronomic factors besides water quality and leaching. From discussions at the Alexandria Salinity Laboratory, 85 percent of optimum is considered as a practical yield goal for vegetables and fruits. For field crops 90 to 100 percent of optimum may be attainable with respect to salinity restrictions.

The leaching requirement is a function of crop salt tolerance, quality of the water, and the proportion of water applied that must move through the soil to maintain salt tolerance concentration in the main root zone. The leaching requirement is presented in Table E-7.

Salt tolerance values are expressed as ECe, i.e., electrical conductivity of the saturation extract, as EC is proportional to salt concentration. They represent the EC's in the main root zone of crops occurring in soils with the indicated yields. They were determined by lysimeter experiments at the U.S. Salinity Laboratory, Riverside, and in other parts of the world. The data were compiled by the contributors to the 1976 FAO, Rome publication, "Water Quality for Agriculture." The Ministry of Agriculture Salinity Laboratory at Alexandria has also conducted lysimeter experiments and no significant difference in the permissible ECe's in the yield ranges were indicated.

The permissible ECe's in the crop root zone are listed for irrigation waters with EC's of 0.9, the estimated EC of Alexandria sewage water, and 0.65, a 50 percent mixture of sewage and Mahmoudia Canal water. Other EC's may also be considered, but these suffice for estimating the effects on leaching requirements.

The leaching requirements are determined as the average quantity of water, and percentage of water applied to the soil that must percolate below the crop root zone to maintain the indicated ECe at a given soil depth. They are based on the premise that under continuous irrigation a balance is reached between the salts of the irrigation and percolating waters. The salts in the irrigation water, whose removal by plants is negligible, will increase in concentration due to water uptake by plants. At equilibrium, except as modified by mineral weathering and precipitation, the quantity of salts percolating from the root zone will equal that entering the soil in the irrigation water. That is, $C_iD_i = C_dD_d$, where C_i and C_d are the concentrations of the irrigation and percolating waters, and D_i and D_d are the depths of the applied and percolating water. Rearranging terms $C_d = C_i\ (D_i/D_d)$, i.e., the concentration of the drainage or percolating water, is increased over that of the irrigation water by the ratio of the depth of water entering, to that leaving the root zone.

Similarly at salt balance, the concentration of water draining from any depth increases over that of the irrigation water by the ratio of the quantity of water entering the soil to that draining from that depth. Thus, if half the applied water drains from a given depth, the concentration will be twice that of the applied water, and if only 5 percent drains from the bottom of the root zone, the concentration will be twenty times that of the applied water.

Applying this principle, the FAO contributors indicate that under favorable drainage condition the EC of the water draining from the root zone may be much higher than a satisfactory ECe in the main root zone. For poorly drained conditions, however, where capillary rise may return the salts from the bottom to the main root zone, it is necessary to provide more leaching and maintain lower EC's at the bottom of the root zone. Thus, for this study leaching requirements have been computed to provide the ECe for an 85 percent yield near the bottom of the root zone where 90 percent of the applied water has been used by evapotranspiration. By this means a satisfactory ECe can be maintained in the main root zone despite some water table fluctuation and capillary rise.

TABLE E-7

LEACHING REQUIREMENT FOR 85 PERCENT OPTIMUM YIELD

Crop	EC[b]	Leaching Requirement[a] depth, mm EC=0.9	EC=0.65	FD, percent EC=0.9	EC=0.65
Carrots	2.0	640	330	39	25
Onions	2.1	570	300	36	25
Oranges	2.6	380	200	28	17
Lettuce	2.4	440	230	31	19
Other Trees	2.3	480	250	32	20
Grapes	3.0	290	150	22	13
Potatoes	2.9	300	160	23	14
Corn	2.9	300	160	23	14
Broadbeans	3.1	270	140	21	12
Cabbage	3.3	240	120	19	11
Tomatoes	4.0	160	70	14	6
Berseem	4.1	150	70	13	6
Melons	4.3	140	60	12	6
Rice	4.2	150	60	13	6
Wheat	8.1	176	120	15[c]	11[c]
Cotton	10.7	132	92	12[c]	8[c]

[a] With irrigation water EC's of 0.9 and 0.65 mmho/cm.

[b] Electrical conductivity of the saturation extract at 85 percent of optimum yield, mmho/cm.

[c] Would provide 100 percent yield with respect to salinity restrictions.

Applying this principle to compute the leaching requirement, the salt balance is:

ETa (100 + D) EC_i = ETa (10 + D) EC 90, where 100 and 10 are 100% and 10% of the ETa; EC, the EC of irrigation water; EC 90, the EC at the depth, where 90% of ETa has been used; and D is the unknown percentage of ETa to be leached from the root zone bottom. From the above,
EC 90 = EC_i (100 + D/10 + D) and D = (100 EC_i - 10 EC 90) / (EC 90 - EC_i). With ETa in units of depth, (mm, m^3/m^2, etc.), D, a percentage, may be also converted to the same depth unit. The leaching requirement may also be expressed as a percentage of applied water, by LR (leaching requirement) = D (in percent) / 100 + D.

The above computation would be modified under well drained conditions, not only in the depth of the permissible EC_e, but to reflect the fact that the EC of the drainage water can be much higher than that of EC_e (saturation extract) since the draining water is much less than saturation. With a shallow water table, however, the water percolating near the root zone bottom approaches saturation so that EC_e and EC 90 are comparable.

In computing the values shown, the ETa's for oranges and grapes are those given in Table E-5. For other crops grown in yearlong rotation, the ETa for the entire year must be considered. This varies from winter-summer vegetables, 948 mm, to vegetables and berseem, 999 mm, and many other combinations. For purposes of estimating the feasibility of leaching, an average figure of 1000 mm was used.

As previously determined, the amount of leaching required with wastewater at an EC of 0.9 mmhos/cm for the more sensitive vegetables would be as much as 650 mm. This would be difficult to achieve on fine textured soils without good drainage and would necessitate special irrigation, for leaching purposes. It would be further complicated by some HCO_3 precipitation, and consequent increase in SAR and permeability problems which are more acute at low EC's of applied water. Thus, gypsum or other calcium amendments might be needed together with good drainage to achieve the necessary leaching for the more sensitive vegetables and fruits.

The leaching requirements for the other crops appear to be readily attainable, and for cotton or wheat,yields unrestricted by salinity could be achieved with low annual leaching quantities.

For a 50 percent mixture of wastewater and canal water the necessary leaching is attainable with all crops, even though extra quantities might be needed in some impermeable soils not completely leached of salt present before irrigation development.

Abbis Extension. Crop records for winter 1975-1976, and summer 1976 are given in Table E-8. Diversion records for the same period are shown in Table E-9. The ET computed as previously described and plotted in Figure E-9 together with diversions furnished by Engineer Ibrahim Maher, Department of Irrigation, Alexandria, generally follow the ETa, but greatly exceed it in October and December. In January the canal was closed for cleaning, as shown in the graph. Normally this occurs for only 15 days.

The computed ETa of 26.7 million m^3 is about 57 percent of the annual diversion of 46.7 million m^3. However, according to Engineer Maher, excess releases occur from October to December resulting from spills during the

TABLE E-8

ABBIS EXTENSIONS CROP PATTERN 1975-76

Crop	Area, feddans Winter	Summer
Berseem	2051	-
Barley	1584	-
Wheat	375	-
Broadbeans	1327	-
Vegetables	960	1600
Watermelon Seed	-	2089
Corn	-	2012
Rice	-	390
TOTAL	6297	6091

Source: Mr. Gamal Etman, Nahda Co.

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TABLE E-9

ABBIS EXTENSIONS - DIVERSIONS FROM MARYUT CANAL

		Diversion of Water		
		1000 m^3	m^3/feddan	m^3m^2
Nov	1975	3297	523	0.12
Dec	1975	1911	303	0.07
Jan	1976[a]	-	-	-
Feb	1976	2730	433	0.10
Mar	1976	3185	506	0.12
Apr	1976	3640	578	0.14
May	1976	5719	908	0.22
June	1976	5376	854	0.20
July	1976	6160	978	0.23
Aug	1976	6160	978	0.23
Sept	1976	4116	654	0.16
Oct	1976	4368	693	0.17
TOTAL		46662	7410	1.76

Source: Eng. Ibrahim Maher, Dept. of Irrigation, Alexandria; diversions to 6297 net irrigated feddans.

[a] Canal closed for cleaning during entire month.

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rainy season when the Mahmoudia Canal stores water as most gates are closed. Apparently, this cannot be adequately prevented by shutting down the Nile Pump Station. An allowance for these spills was made by assuming an irrigation efficiencey of 63.5 percent from October to December, the same as indicated by data for February through September. In addition, 5 percent of the diversion was assumed to be lost through spills, evaporation, and weed transpiration during the rest of the year. On this basis, farm delivery, and farm losses are estimated as follows:

	1000 m^3	m^3/m^2
Diversion	46 662	1.76
Winter spills	4 495	.17
Other spills, losses by evaporation and weeds	2 333	.18
Farm Delivery	39 834	1.51
Runoff	5 957	.23
Applied to soil	33 859	1.28
Leaching Fraction	7 147	.27
ETa	26 712	1.01

As appreciable surface runoff and farm ditch waste was noted in the area, an allowance of 15 percent was made. Deducting this from the farm delivery of 1.51 m^3/m^2 leaves 1.28 applied to the soil. This less the computed ETa of 1.01 gives 0.27 m^3/m^2 or 21 percent of the applied water available for leaching.

Other factors to consider are soils, drainage conditions, and reported leaching experience. The surface soils are clay, underlain by stratified sands, shell layers or clays. This was noted in the soil borings and from soil boring logs furnished by the Nahda Company who manage the area. A report by Drs. Bakr and El Attar, University of Alexandria, Faculty of Agriculture, 1963, reported leaching as much as 1 m on similar soils a few kilometres south in a month's period. However, observations showed spotty crop growth and surface salt in many areas underlain by tight clays where the reputedly permeable shells do little to improve drainage. Water samples from the Maryut branch canal and the Main Drain from the area indicate a ten fold increase in chlorides. This could represent a salt balance with only 10 percent leaching or drainage flow lines sweeping salty layers. However, as the drains are shallow, and subsurface flows are diluted by surface runoff, it is likely that average leaching is much less then reported by Bakr and El Attar.

Deeper drains should improve this situation; these are planned within the next five years. In view of this and the close drain spacing, leaching attainable would be greater. With adequate drainage, leaching could also be increased by extra applications between crops. Some were noted in the area in May shortly before planting a summer crop, reportedly ponding the water for two or three days. This could also be done in fall or winter and such intermittent leaching would be one of the more effective ways to control salt.

For present conditions an overall irrigation efficiency of about 67 percent was assumed, with an average leaching fraction of about 0.27 m^3/m^2. With improved drainage it is estimated that the leaching fraction might be increased to about 0.40 m^3/m^2.

E.5 Utilization of Wastewater for Irrigation

Full and Partial Supply

The projected monthly supply of wastewater has a much lower peak flow than monthly irrigation demand. This must be considered in planning deliveries to a service area. In Table E-10, the monthly distribution of projected wastewater is compared with the monthly farm delivery demands in m^3/feddan. Distribution is based on projections of population and per capita sewage generation rates. As shown in column 3, supply exceeds water demand from September through January but is less than demand from February through August. The difference in each period is 1770 m3, or 25 percent of annual demand. Various service options to adjust for this difference, discussed in the following paragraphs, are further considered for each potential service area.

Full Supply. To furnish full supply of wastewater for irrigation would require constructing storage for 25 percent of annual flow. It would also mean designing a system to accommodate monthly fluctuations ranging from 100 to more than 1000 m^3/feddan. As previously discussed, full supply of sewage irrigation water is undesirable due to salinity except on well drained soils. Full supply is thus considered only where drainage is known to be satisfactory and it is impractical to integrate wastewater and canal water supplies.

Partial Supply - 75 Percent. A less expensive and more practical alternative is to furnish 75 percent of the supply to an area and utilize canal releases for the remaining 25 percent of demand. Such a program would involve releasing 25 percent of total wastewater volume to Lake Maryut or to the sea in winter, or applied to other areas as partial supply. Canal water thus saved would be released in summer from High Dam Storage. The monthly fluctuations in wastewater flows would range from 550 m^3 to 645 m^3/feddan; an increase of only 17 percent.

Partial Supply - 50 Percent. Wastewater might also be furnished by delivering half of the demand quantities listed in column 2 of Table E-10, with the other half furnished by canal deliveries. Monthly fluctuations would be reduced to a minimum of 250 and a maximum of about 500 m^3/feddan. In addition to provision for monthly fluctuations, this approach presents some difficulty of planning for wastewater deliveries in winter months when larger operational spills are likely to occur. It has the advantage, however, of virtually eliminating salinity hazard and providing benefits to an area twice the size than would utilize the full wastewater supply.

Another means of furnishing 50 percent wastewater supply, shown in column 4 of Table E-10, is at a constant rate from February through August, thus avoiding supply fluctuations and the complication of deliveries during winter months. It also allows flexibility for local irrigation operators to integrate canal deliveries with a constant known quantity. It has the disadvantage, however, of utilizing only half of the sewage supply and providing benefits to an area that could utilize full supply.

Other Partial Supplies. In some cases, as in the Maryut Sector, the full supply of Ameria wastewater in year 2000 could be mixed with the Maryut Canal flow. The resulting mixture can only be roughly estimated from available

TABLE E-10

COMPARISON OF IRRIGATION DEMAND AND WASTEWATER SUPPLY

		Irrigation Demand	Wastewater Supply	Difference[a] 100% Supply	50% Wastewater Supply[b]	Difference 50% Supply
Nov	1975	433	579	146		433
Dec	1975	100	574	474		100
Jan	1976	100	552	452		100
Feb	1976	567	550	(-17)	500	67
Mar	1976	785	552	(-233)	500	285
Apr	1976	648	557	(-91)	500	148
May	1976	904	574	(-330)	500	404
June	1976	948	596	(-352)	500	448
July	1976	1090	620	(-470)	500	590
Aug	1976	921	644	(-277)	500	421
Sept	1976	139	614	475		139
Oct	1976	365	588	233		365
TOTAL		7000	7000	0	3500	3500

[a] Wastewater supply minus irrigation demand.

[b] Sewage is furnished at a constant rate from February through August.

data at about 15 percent sewage water. As mentioned previously and further discussed under potential service to Maryut Sector, the mixture percentage itself is less important than the measures needed to reduce salinity in the Noubaria and Maryut Canals.

E.6 Crop Yields and Farm Income

Present

In Tables E-11-13 crop areas, yields, and income are shown for portions of the Abu Kir Drain and Abbis Areas, and for Maryut Sector. Crop areas are listed in feddans. Yields were obtained from the Ministry of Agriculture, Alexandria. Several years' records were provided, but many discrepancies occurred which could not be resolved, and only the 1975-1976 data were usable. All yields were converted to a common unit of metric tonnes.

As the Ministry furnished no price data, prices were obtained from the Ford Foundation, Cairo for 1970-1974, and modified for 1976 conditions in accordance with IBRD recommendations. These prices were taken as a first approximation. The data were then reviewed by agricultural economists with personal farming experience at FAO, Alexandria and further modified based on data from USDA Economic Research Service.

As data indicate, the major source of income for the three areas is vegetables, where yields and prices associated with them greatly outweigh effects of variations in field crops. To a lesser extent this is also true of fruits. As shown by the tables, farm income is 480 LE/feddan in the Abu Kir Drain Area and 387 LE/feddan in Abbis Canal Area. The low income in the Maryut Sector of 243 LE/feddan is due to large areas of land that now lay idle in summer.

Potential for Increase

To noticeably increase farm income requires adjustments to many complex economic problems including more effective government management of reclaimed lands, and extensive improvements in irrigation and drainage systems as well as education and training programs. It is unrealistic to assume that all of these problems will be resolved in the next 20 years. This is a fact that must be taken into consideration in forecasting benefits from wastewater reuse.

Economic Problems. Many economic problems are involved in increasing crop income. Specified amounts of many crops must be marketed through the government at fixed prices. These include cotton, corn, wheat, rice, broad beans, onions, oranges, watermelons, and grapes at their peak season. The balance of production of these and other crops is sold at uncontrolled and generally higher prices. The farmer's market sells at uncontrolled prices. The Alexandria area farmers generally maximize production of vegetables in order to market them at uncontrolled prices.

Ability to increase the area of high income crops is limited by government requirements that a certain portion of the land be used for basic crops at fixed prices, and by problems inherent in present farming methods. Although there is some mechanization, most of the farm work is done by hand, or by farm animals. To support these animals, large areas are planted with berseem each year, rather than cash crops. Mechanization would allow more land in cash crops, but would increase the present surplus of farm labor

TABLE E-11

CROP AREAS AND INCOME 1975-1976 - ABU KIR DRAIN AREA

Crop	Area, feddans	Yield, tonnes/feddan	/tonne	Income, LE /fed.	Gross
Fruit:					
General[a]	2 648	4.7	50.00	235.00	622 280
Oranges & lemons	960	8.0	33.00	264.00	253 440
Sub-total	3 608	-	-	(242.7)	875 720
Winter Crops:					
Wheat	80	1.2	51.30	61.56	4 925
Barley	1 132	1.0	48.31	46.38	52 502
Green Beans	541	6.2	76.00	471.20	254 919
Berseem	3 499	(4x6.7) = 26.8	4.50	120.60	421 979
Tomatoes	346	5.6	52.30	292.88	101 336
Other vegetables	2 589	8.0	38.00	304.00	787 056
Sub-total	8 187			(198.21)	1 622 717
Summer Crops:					
Potatoes	941	7.0	60.00	420.00	311 220
Corn	691	1.1	50.00	56.00	38 696
Rice	1 794	2.6	52.00	135.20	242 549
Tomatoes	1 498	5.8	52.30	303.34	454 403
Other vegetables	4 219	8.0	38.00	304.00	1 282 576
Sub-total	8 943			(260.48)	2 329 444
TOTAL Crop	20 738			(384.66)	4 827 881
				94.47[b]	
TOTAL Land	12 551			479.13	

[a] Pears assumed to be representative

[b] Animal value taken as 30% of annual crop value.

TABLE E-12

CROP AREAS AND INCOME 1975-76 - ABBIS AREA

Crop	Area, feddans	Yield tonnes/feddan	Income, LE /tonne	/fed.	Gross
Fruit:					
None	-	-	-	-	-
Winter Crops:					
Wheat	415	0.8	51.30	42.07	17 459
Barley	2 069	0.9	48.31	49.55	85 967
Berseem short	30	(3 x 4) = 12.0	4.50	54.00	16 205
Berseem, cont.	4 873	(4 x 5.6) = 22.4	4.50	100.80	491 198
Dry Beans	1 327	0.9	91.00	77.35	102 643
Tomatoes	255	5.6	52.30	292.88	74 684
Other vegetables	1 996	8.0	38.00	304.00	606 784
Sub-total	10 965			(125.88)	1 380 355
Summer Crops:					
Potatoes	374	6.8	60.00	408.00	152 592
Corn	3 788	1.2	50.00	59.50	225 386
Rice	480	1.9	52.00	98.80	47 424
Sunflower	80	0.4	95.00	38.00	3 040
Watermelon Seed	2 243	0.3	350.00	105.00	235 515
Tomatoes	1 455	5.8	52.30	303.34	441 360
Other vegetables	2 781	8.0	38.00	304.00	845 424
Sub-total	11 201			(174.16)	1 950 741
TOTAL Crop	22 166				3 331 096
TOTAL Land	11 201			(297.39)	
				89.21[a]	
			Total	386.60	

[a] Animal value taken as 30% of annual crop value.

TABLE E-13

CROP AREAS AND INCOME 1975-76 - MARYUT SECTOR

Crop	Area, feddans	Yield tonnes/feddan	Income, LE /tonne	/feddan	Gross
Fruit					
General[a]	6 418	3.0	50.00	150.00	962 700
Winter Crops					
Wheat	4 653	1.0	51.30	48.74	226 787
Barley	1 046	0.8	48.31	38.16	39 915
Dry beans	6 273	0.9	91.00	77.35	485 216
Berseem	8 542	(4x5) = 20.0	4.50	90.00	768 780
Tomatoes	307	5.6	52.30	292.88	89 914
Other vegetables	371	8.0	38.00	304.00	112 784
Sub-total	21 192			(81.32)	1 723 296
Summer Crops					
Potatoes	113	7.0	60.00	420.00	47.460
Corn	2 840	1.2	50.00	59.50	168 890
Tomatoes	1 148	5.8	52.30	303.34	348 234
Watermelon	1 939	8.0	33.12	264.96	513 757
Watermelon seed	445	0.2	350.00	52.50	23 362
Other vegetables	1 346	8.0	38.00	304.00	409 184
Sub-total	7 831			(192.94)	1 510 977
TOTAL Crop	29 023[b]				4 197 073
TOTAL Land	21 192			(198.04)	
				45.79[c]	
			Total	243.83	

[a] Grapes assumed to be representative.

[b] 13 361 feddans now estimated to be idle in summer.

[c] Animal value taken as 30% of annual crop value.

which will become more acute as population continues to increase. To offset this, other employment is needed in industry, including agro-industries for processing and grading of crops.

Although a large portion of cropland is devoted to berseem for winter feed and some of it dried for hay, there is a shortage of summer feed which is only partially met by straw, other dry feed, and concentrates. Production of milk and meat is low, and there is a need for fewer animals, improved livestock breeds, better animal husbandry, and better integration of winter and summer feeding to increase production.

Land Ownership and Farm Operations. The problem of improved crop production is also affected by land ownership and size of operation. A large portion of the lands considered for wastewater reuse are government reclaimed lands, which are still in government ownership or under governmental control. There are noticeable differences in management of the originally private lands, the "private" lands of the government projects, and other lands in the government projects. The originally private farms are larger, more efficient operations with better crops, soil, irrigation, and drainage management. The "private" farms in the reclamation projects, although only 3 to 5 feddans in size also have better crops and appear better managed than other government lands. The fact that yield of most crops on government lands is less than the Egyptian average, and much less than under similar climatic conditions in the U.S., is apparently related to ownership and operation, as well as the quality of the land.

Taher S. Khalife, Agricultural Service Expert with United Nations Development Projects, in the report "Abbis Extension Settlement", March, 1973, indicates that the agricultural cooperatives responsible under the Ministry of Agriculture for services to farmers have been deficient in many respects. He indicates that the farmers were furnished only about half of the needed seed and fertilizer and only about 10 percent of the summer concentrate needed for livestock. He also indicated that they had failed to adequately carry out "block farming". This is a system in which several parcels comprising a 3 to 5 feddan farm are assigned to separate large blocks which are farmed as units to provide more efficient operations, especially in mechanization and pesticide control. While the farmer has the disadvantage of travelling to separate blocks in timing his operations, the operations themselves are more efficient.

Khalife indicates a great need for improved extension services to the farmers and better management of the lands in order to increase crop and animal production.

Improved Irrigation and Drainage. Improved irrigation methods such as drip or sprinkler systems are recommended by many Egyptians as a means of increasing farm income and saving irrigation water. These systems are expensive and best adapted to high income fruits and vegetables, not to close-grown clover, grain, and other relatively low income crops, which are now grown in rotation with vegetables. While these systems are being studied in Egypt, there is no indication that they will become widespread in the near future.

Also, while these methods provide a better means of water control, they are no substitute for good management of surface irrigation. Generally, they should be used only where lands are not suited to other methods. Consequently, they are not considered in estimating benefits on the smooth, nearly flat lands, comprising most of the study area.

Some improvement in irrigation methods may be expected in the next 20 years, although it will not change the basic need for improved operation and management of existing irrigation and drainage systems, as the primary and fundamental means of increasing farm income.

E.7 Effects of Wastewater Irrigation on Farm Income

General

Wastewater supply will be more saline and will contain more nitrogen and phosphate than the canal water. The effects of wastewater irrigation on farm income will be determined by the interaction of these constituents. With adequate leaching and drainage, salinity can be controlled and the land can benefit from the increased nitrogen and phosphate. The minimum benefit would be a savings in fertilizer cost; the maximum would also include an increase in crop yields. Where drainage and leaching are inadequate, full supply of wastewater will produce little or no benefit as salinity will limit nutritional gains. Under these conditions a mixed supply of wastewater and canal water would be more beneficial, reducing the salinity hazard, while providing adequate nutritional gains.

Specific On-Farm Benefits

The savings in fertilizer cost consists of saving in fertilizer materials and the labor for application. The saving in fertilizer, with an average application of 400 kg/feddan at 4 LE/100 kg, is estimated as 16 LE/feddan. The labor saved is estimated as 3 man-days/feddan with an average wage of 1 LE/man-day, or 3 LE/feddan. Total estimated savings are 19 LE/feddan. The effect of wastewater on crop yield will vary with land characteristics, crop patterns, and irrigation management. Benefits versus adverse effects are discussed separately for each potential service area in Section E.9.

National Benefits

In addition to on-farm benefits, reuse of wastewater for irrigation can ultimately provide national benefits including the following:

1. Increase of total fertilizer available for agriculture.
2. Increase of total available water supply:
   (a) if utilized on irrigable lands, would increase the nation's potential food and fiber supply for an expanding population;
   (b) would expand potential for municipal and industrial water supply by offsetting a portion of agricultural water supply;
   (c) by exchange would increase the water supply available for navigation.
3. Provides benefit to the nation represented by the difference in price paid to the farmer for governmental regulated crops and the world prices received, by the government. (From available data, it is estimated that this is at least 20 percent of the farm income in the Alexandria area.)
4. Provides social benefit holding people to the land rather than migrating to cities in search of employment.
5. Provides social benefit of increased agricultural employment on farms and in processing agricultural products.
6. In areas such as Ameria Northwest, the creation of green tracts among the industrial and residential developments would be environmentally and aesthetically desirable. This type of development

would permit location of agricultural processing plants close to the labor supply.

Net Benefit

Net benefit to the farmer and the nation is determined by difference between the above mentioned benefits and the costs of development. The latter include costs of sewage treatment attributable to irrigation use, costs of conveying water to the land, and costs of land improvement attributable to irrigation with wastewater. To assess the net benefit of wastewater reuse also requires comparison with alternative irrigation sources, as discussed in the following section.

E.8 Alternative Sources of Irrigation Supply

Alternatives

The following two alternatives are means of utilizing additional Nile River water. They would not provide the fertilizer benefits of wastewater, but their relatively low cost in comparison with the expense of sewage treatment and conveyance for irrigation justifies consideration in the near future.

Additional Storage. The cost of developing further Nile River storage may be roughly estimated from available cost information on the Aswan High Dam. According to information received from the Beheria Governorate at Damanhur, Egypt's share of the additional storage at the High Dam was 7.5 billion m^3 at a capital cost of LE 100 million, or .0133 LE/m^3. With an annual cost of 10 percent for interest, operation, maintenance and replacement, this amounts to 1.3 mms/m^3 (.0013 LE/m^3).

Water Salvage from Present Irrigation Systems. As previously discussed, there is a tendency for wasteful irrigation practice in existing irrigation systems. Farmer irrigation practice cannot readily be corrected in the short term. However, improvements in system operation could save a significant amount of water and facilitate more efficient farm uses.

According to representations of the Ministry of Irrigation, about 10 to 15 percent of the irrigation water annually diverted to branch canals is lost by operational spills to drains. This is largely due to inadequate maintenance of existing structures. With better water control, these losses could be reduced and more efficient farm deliveries could be made.

Thus, 10 percent of the annual diversions to 10 feddans would meet the diversion requirement for 1 feddan. According to some irrigation officials, this saving could be accomplished by rehabilitation of existing structures at a cost of about 1 LE per irrigated feddan. With an average diversion of 7000 m^3/feddan, 700 m^3 could be saved for a cost of 1 LE, which amounts to 1.4 mms/m^3 (.0014 LE/m^3).

E.9 Areas with Potential for Wastewater Irrigation

General

In the following subsections, potential for wastewater irrigation is discussed for four major areas. In the Abu Kir Drain and Abbis Areas, mixed supplies of wastewater and canal water appear to be more beneficial

than a full supply. In Maryut Sector the proposed method of service would necessarily involve a mixture of wastewater and canal water. In Ameria Northwest, soil and drainage conditions are favorable for a full supply of wastewater.

In the Abu Kir Drain and Abbis Areas, which now have ample water supplies, the immediate benefits are the fertilizer contributions of wastewater. In Maryut Sector and Ameria Northwest where irrigation supplies are inadequate or lacking altogether, the benefits are attributable to both water supply and fertilizer contributions.

Irrigation of either Maryut Sector or Ameria Northwest could utilize most of the projected Ameria wastewater supply to the year 2000.

I. Abu Kir Drain Area

Location and Size. As shown in Figure E-2, this area lies to the right of the Mahmoudia Canal extending from Montazah Canal to the vicinity of Lake Idku. Most of the land is drained to the Mediterranean through Abu Kir Drain. The El Teraa Canal and Difshu Drain North were arbitrarily selected as the eastern limits of probable economic service.

Potential Service Areas. Depending on the type of service, the areas that could utilize wastewater supplies are determined as follows:

		Potential Reuse Area, feddans		
	Supply	Full Service	Partial Service	
Year	ML/day	(100%)	(75%)	(50%)[a]
1980	53	2 740	3 650	5 480
1990	124	6 470	8 625	12 940
2000	241	12 540	16 720	25 080

[a] 50% supply fluctuating with demand; area receiving 50% supply at constant rate from February to August is the same as that which could utilize full supply.

As indicated, wastewater supply in 1980 would be sufficient to furnish a full supply or a 50 percent supply at constant rate to 2740 feddans. It could also provide a 50 percent mixed supply at fluctuating rate to 5480 feddans. This would comprise about half the area between Montazah Canal and Abu Kir Drain, the area nearest to the probable point of sewage collection. This, however, is largely less productive Class 3 land, much of which may be converted to urban development. If service were provided farther east, more productive lands would receive an irrigation supply.

By year 2000, the entire area of 12 540 feddans between Montazah Canal and Lake Idku could receive a 50 percent supply at constant rate and most of the study area could be served with a mixed supply at fluctuating rate. Thus, as shown in Figure E-2, there is opportunity to serve a large area of Class 1 land and maximize possible benefit.

Land and Crops. These are mainly clay soils underlain by stratified soils of variable texture. Water tables range from less than 50 cm to more than 1.0 m depth, as salinity is low to moderate. As shown in Figure E-2, areas of Class 3 land occur near Montazah, and areas of Class 2 east of Taufiki Canal. Class 1 areas, comprising the best lands, occur east of Abu Kir Drain.

Drains are generally 50 m apart, ranging from less than 1 m depth in the west to about 1.5 m depth in eastern lands. Open drains predominate, but tile drains were observed on some private farms. Crops include tree fruits, which are mainly citrus, vegetables, and field crops. Crop growth varies from fair on Class 3 lands near Montazah to excellent on Class 1 lands near Abu Kir Drain. For the area as a whole, yields are below the Egyptian average.

Potential Effects of Wastewater Irrigation. As salt sensitive fruits and vegetables are important in the area, it would be difficult to meet the leaching required to maintain productivity with a full supply of wastewater. A mixed supply of canal-wastewater would reduce the salinity hazard and provide adequate nutrients.

Benefits. Full supply of wastewater would produce no immediate on-farm benefits, as the salinity would nullify the nutrient gain. A 50 percent mixture of canal-wastewater would produce a fertilizer saving benefit of 19 LE/feddan. In addition, an estimated crop yield increase would produce an incremental net income of 10 percent of the amount shown in Table E-11, or 48 LE/feddan. The total annual benefit would be 67 LE/feddan. For 20 080 feddans that could receive a mixed supply in year 2000, this would amount to LE 1 680 000. In 1977 the present worth at 10 percent discount rate is LE 1.9 million.

The difference between on-farm benefits and development costs becomes the net benefit. Costs include land improvement, sewage treatment attributable to irrigation, and conveyance and distribution of treated wastewater.

With mixed supply no land improvement or special management is needed. Drains are deep and effective in the eastern part of the area. In the western lands, with shallow clay soils of Class 3, deepening the drains would have little effect. Adequate leaching for adapted crops could be carried out with the existing drains. Sewage treatment and conveyance costs are determined in Chapter 7 of the Technical Report. The following general observation can be made. If wastewater disposal through sea outfalls is least costly, then the cost of secondary treatment is attributable to irrigation. Assuming wastewaters were to be collected near Montazah Canal, conveyance and delivery to the irrigation system in the western part of the area would have the least cost. As better lands lie east of the Taufiki Canal, greater benefits will be realized if the supply can be transported to these areas.

Quantitative analysis of net benefit for reuse of wastewater on area croplands is presented as part of a benefits/cost evaluation made in comparing regional alternatives in Chapter 7 of Volume II.

Alternatives to Wastewater Irrigation. As these lands now have adequate water supply from Mahmoudia Canal, there is little defined need to develop additional supplies. Sewage could primarily provide fertilizer benefits. If canal water is limited in the future, lower cost alternatives that would initially be considered involve development of additional storage or salvage of operational spills.

II. Abbis Area

Location and Size. This includes lands south and east of the hydrodrome, bounded on the north by the Mahmoudia Canal, on the southeast by the Deshoudi Outfall Drain, and to the southwest by the El Umoum Drain.

It includes the lands served by the Maryut, Beida, and Abbis Canals. The total area, shown on Figure E-2, comprises 24 000 feddans.

The Deshoudi Outfall Drain was arbitrarily selected as the eastern limit of probable economic service. As the lands southeast of Deshoudi Drain are similar to those within the delineated area, benefits per feddan should be the same.

Within the area the portion known as Abbis Extension was studied in greater detail. It lies immediately south of the Drinking Water Canal and El Kalaa Drain leading to Lake Maryut and is served by the Maryut Canal. A full or partial wastewater supply could be furnished readily to the land by an intake structure near Kalaa Pump Station. The location of Abbis Extensions is shown on Figures E-1 and E-2. It comprises an irrigated area of 6 300 feddans.

Potential Service Areas. Depending on the type of service, areas that could utilize the projected sewage supplies are determined as follows:

		Potential Reuse Area, feddans		
Year	Supply, ML/day	Full Service	75% Service	50% Service[a]
1980	167.2	23 885	32 720	47 770
1990	193.4	27 630	27 850	55 260
2000	204.9	29 270	40 100	58 540

[a] 50% supply fluctuating with demand, area receiving 50% supply at constant rate from February - August is same as that which could utilize full supply.

The above data are derived from sewage supply estimates and concepts discussed in Section R-5.

As indicated, the projected wastewater supply would be sufficient to provide a full supply, or a 50 percent supply at a constant rate, to 23 885 feddans (nearly the entire study area of 24 000 feddans) by 1980. By 1990 and thereafter, this supply would exceed the demand of the entire area. In all years supplies are more than sufficient to provide partial service mixtures indicated for the area.

Land and Crops. The irrigated lands have been reclaimed from Lake Maryut. They lie 2 and 4 m below sea level and are smooth, with nearly flat topography. The surface soils are clay, underlain by variably stratified sediments. These range from tight clays to permeable sands and shell deposits. The water table, originally very shallow, is from 50 cm to 1 m below the ground surface. Soil salinity, originally more than 8 mmho/cm, is generally less than 4 mmho/cm.

The lands are predominantly Class 3. Open field drains less than 1 m deep are spaced 50 m apart. Field crops and vegetables are grown; crop growth is fair, but yields are below average for Egypt.

Potential Effects of Wastewater Irrigation. As salt sensitive vegetables are important to the economy of this area, it would be difficult to meet the leaching required to maintain productivity. Deeper drains are needed and according to local sources, deeper tile drains are planned for

the Abbis Area within the next ten years. With adequate drainage and a mixed canal-wastewater irrigation supply, the leaching needed for even salt sensitive crops could be achieved.

Benefits. Full wastewater supply would produce no on-farm benefits, as salinity would offset the increased nutrients. A mixed supply would provide a fertilizer saving of LE 19 per feddan, and an income increase of 10 percent of the amount shown in Table E-12, or LE 39 per feddan. The total annual benefit would be LE 58 per feddan. For 23 885 feddans that would receive a 50 percent mixed supply in 1980 this would be LE 1 385 000 in 1977, the present worth of which at 10 percent discount rate is LE 10.4 million.

The difference between the on-farm benefits and development costs is net benefit. The costs would include land improvement, secondary sewage treatment attributable to irrigation, and the conveyance and distribution of irrigation water. An improved drainage system would be required to realize the benefits indicated. Since improved drainage is planned by the Egyptian Government, the cost should not be attributable to wastewater reuse. The conveyance costs to reach the main canals, including Abbis, in order to serve the entire area have been determined. These costs are relatively low and if secondary treatment is required for Maryut discharge, then the net benefit should be positive.

Quantitative analysis of net benefit for reuse of wastewater on area croplands is presented as part of a benefits/cost evaluation made in comparing regional alternatives in Chapter 7 of Volume II.

Alternatives to Wastewater Irrigation. As the lands now have an adequate water supply from Mahmoudia Canal, there is no immediate need to develop additional irrigation supplies. Wastewater would primarily provide fertilizer benefits. If canal water is limited in the future, the lower cost alternatives, such as developing additional storage and salvage of operational spills, should first be considered.

III. Maryut Sector

Location and Size. Maryut Sector lies south of Ameria and west of the Cairo-Alexandria Desert Road as shown on Figures E-1 and E-3. It is irrigated from Maryut Canal, a major branch from Noubaria Canal, which traverses the center of the Sector from east to west, and through a series of five pump lifts, conveys the water to an elevation 30 m above sea level. From there it branches into a canal serving the southwest sector and into Bahig Canal which serves the northwest sector and continues many kilometres west to serve Maryut Extension.

The total area is 41 000 feddans, of which only 22 000 feddans are irrigated. Due to water shortages, large areas are idle in the summer.

Potential Service Areas. Wastewater could be transported from Ameria at an elevation of about 12 m to Pumping Plant No. 2 at the intersection of the Desert Road and Maryut Canal at an elevation of 14 m. The distance is 8 km. At Pumping Plant No. 2 it would be mixed with Maryut Canal waters to serve the areas selected.

As shown on Figure E-3, extensive areas of deep soil occur in the Western Sector, and these are relatively free of drainage or salinity problems and are comparable in quality to Class 2 lands.

The mixed canal-wastewater supply could be used to serve presently non-irrigated lands of this area. Comparison of preliminary cost estimates with benefit estimates indicate that about 5 000 feddans would be necessary to yield a positive net benefit. As the projected sewage supplies would be inadequate to serve so large an area before year 2000, only that year is considered for evaluation.

The total annual quantity of sewage water by year 2000 of 34.2 million m^3 would irrigate about 4 890 feddans, if the supply conformed to irrigation demand. However, there would be a wastewater excess of 1 770 m^3/feddan or 25 percent of the total in winter, with a corresponding deficit in summer. Only 75 percent of the supply would be furnished to the 4 890 feddans and 25 percent would be supplied to other presently irrigated lands. The summer deficit on the 4 890 feddans could be met by High Dam storage releases of canal water replaced by the winter excess wastewater. The wastewater would actually be part of a mixed supply, but for benefit evaluation it may be considered as the equivalent of a new supply for 4 890 feddans.

According to Mr. Fouad Taha of the Maryut Company, the supply could be used immediately and the Maryut Canal and pump stations could accommodate an additional 500 ML/day. As the estimated peak sewage flow is about 9 percent of 34.2 million m^3, or about 100 Ml/day, the peak flow would be well within canal capacity.

Land and Crops. The lands for which benefits are evaluated would be selected from the non-irrigated lands of Class 2 quality in the Western Sector. These are smooth gently sloping lands, having deep soils of clay or clay loam texture. They are free of salt or only slightly saline, calcareous, and water tables are now more than 1.25 m deep. Field drains are open, about 1 m deep, and about 50 to 100 m apart.

The lands are not presently cropped, but similar lands in the Sector produce grapes, almonds, vegetables, and general field crops.

Potential Effect of Wastewater Irrigation. Wastewater would necessarily be mixed with Maryut Canal water to furnish a mixed supply. As discussed in Section E-3, the waters of the Noubaria and Maryut Canals have TDS ranges of 750 to 1 000 mg/L and what can or cannot be done to reduce this will markedly affect the salinity of Ameria's wastewater, the Maryut Canal, and the resultant mixed supply.

With 22 000 feddans irrigated in Maryut Sector and 12 000 in Maryut Extensions, average canal flow would be 7.5 m^3/sec to meet an annual demand of 7 000 m^3/feddan. Average flow of wastewater would be 1.04 m^3/sec.

Assuming that the West Noubaria Main Drain and corrective measures in the Maryut Canal can reduce the salinity to about 600 mg/L TDS, and that the sewage water will have about 850 mg/L TDS, the resulting mixture would have about 630 mg/L, or an EC of about 1 mmho/cm.

With salinity reduced to this level, and some nutrient increase, the leaching requirements for all field crops, grapes, olives, or almonds could be met, and good yields obtained. This would bring an estimated gross income of LE 345 per feddan. Based on information from the Ford Foundation, Cairo, the net value added to the land would be about LE 200 per feddan.

Benefits. The estimated net income of 200 LE/feddans for an irrigated area of 4 890 feddans is LE 978 000 starting in the year 2000. The 1977 present worth at 10 percent discount rate is LE 1.1 million.

Costs necessary to achieve the above benefit are land improvement, sewage treatment attributable to irrigation, and capital expense and annual operation of a system to convey the sewage from Ameria to Pumping Plant No. 2. These costs, on a present worth basis, must be deducted from the benefit to obtain the net benefit.

The land improvements which are needed include drainage and some leveling. As these improvements would be necessary regardless of irrigation source, they are not chargeable to sewage irrigation in comparison with other alternatives.

The alternate location for disposal of sewage would be to the sea via the lower reaches of the West Noubaria Main Drain where treatment by waste stabilization ponds would be required. Thus, only part of treatment cost would be chargeable to sewage for irrigation.

Quantitative analysis of net benefit for reuse of wastewater on area croplands is presented as part of a benefits/cost evaluation made in comparing regional alternatives in Chapter 7 of Volume II.

Alternative Irrigation Sources. While sewage irrigation, starting in the year 2000, may show a favorable benefit cost ratio, it is unsatisfactory to wait 23 years to bring irrigable land of good potential into production. High priority should be given to other supply sources, such as increased storage on the Nile River and salvaging irrigation water wasted to drains.

IV. Ameria Northwest

Location and Size. This area extends from the Cairo-Alexandria Desert Road, north of Ameria, which is the eastern boundary, about 9 km to the west. It is bounded on the north by steep non-irrigable lands sloping toward Lake Maryut and on the south by the Ameria-Mersa Matruh Railroad. To the west, near the irrigated lands of Maryut Extensions, the irrigable lands become a narrow strip, for which irrigation with Ameria sewage is not considered feasible. The total extent of the area is about 4 975 feddans, as shown in Figure E-4.

Potential Service Areas. The lands are mostly irrigable except for scattered non-irrigable areas of shallow soil on the higher ridges. The percent land use consists of extensive areas of dry land, with scattered irrigated olive and almond orchards, and existing residential lands in and near the community of Ikingy Maryut. Additionally, a large tract in the eastern area has been zoned for future residential and industrial use. The distribution of the existing and proposed land uses, and the irrigable and non-irrigable lands shown on Figure E-4 are summarized as follows:

	Area, feddans		
Land Use	Irrigable	Non-irrigable	Total
Existing Residential	640	212	852
Future Residential and Industrial	1 442	320	1 762
Other (dry land)	2,180	180	2,360
TOTAL	4,262	712	4 974

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There are 2 180 feddans of irrigable land available for commercial agriculture with no known land use restrictions. Additionally, the area zoned for future residential and industrial use includes 1 762 feddans, of which 1 442 are irrigable and have high potential productivity. Maximizing the utilization of these irrigable lands for agriculture, with housing confined insofar as practicable to the higher non-irrigable lands would be a highly desirable land use.

To utilize the non-irrigable lands for housing or industry with large interspersed areas of green field provides a rare opportunity to optimize land use and concurrently provide an aesthetic and environmentally pleasing landscape. While these lands are not within the principal study area, they are called to the attention of MOHR, because of the urgency of zoning now to preserve the irrigable lands as part of Egypt's future agricultural resource.

In addition to these lands, there is a potential for wastewater irrigation of home gardens and orchards in the existing residential areas. It is understood that these areas are zoned for low density residential development, with not more than 15 percent to be occupied by housing and buildings. Sewage, after suitable secondary and polishing treatment, might be furnished to an estimated 70 percent of the residential lands.

Assuming irrigation of irrigable lands not specifically designated for other uses, the irrigable portions of the area zoned for future housing and industry, and 70 percent of the existing residential areas, the total irrigated area would be 4 020 feddans. The diversion requirements, at an average of 7 000 m^3/feddan, are compared with the projected wastewater supplies as follows:

	Quantity, 1000 m^3/year			
Land Use	Diversion Requirement	Wastewater Supply		
		1980	1990	2000
Existing Residential	3 100			
Future Housing and Industrial	10 100			
Other (dry land)	15 300			
TOTAL	28 500	2 500	10 700	34 200

Only a small part of the area could be served in 1980, less than half in 1990, and all by year 2000.

It is possible that wastewater could be supplied through the Bahig Canal which serves Maryut Extensions. The general land gradient, however, slopes upward to the east and this possibility does not appear promising. It is thus likely that storage of winter excess supplies comprising 25 percent of the annual demand would be needed to utilize the full supply of wastewater.

Land and Crops. The major part of Ameria Northwest is a broad ridge whose major axis is from northeast to southwest. It ranges in elevation from 35 to 45 m above sea level, and approximately 28 m above Ameria. The general relief is smooth to gently undulating with higher ridges of non-irrigable shallow soils. The southeast portion north of the railroad is a smooth plain ranging as high as 30 m above sea level.

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The soils are predominantly clay loams,with no obvious stratification or barriers to drainage,of depths of 2 to 3 m or more. Drainage should not be difficult on the higher lands but should be allowed for in the absence of deep borings to determine stratigraphy, and past drainage problems on similar lands to the south. The presence of windmills suggests that water aquifiers occur within depths of 10 to 15 m; possibly pumping would aid in drainage control.

The land should be highly productive, and with adequate drainage, moderately salt tolerant fruits and vegetables and all field crops could be grown with a full supply of treated wastewater.

Potential Effect of Wastewater. As the lands would be irrigated entirely by wastewater, the estimated TDS would be 850 mg/L; an EC of about 1.3 mmho/cm. The water would also contain nutrients amounting to more than twice the Egyptian average annual consumption of nitrogen and phosphate fertilizer. Adequate leaching and drainage would be necessary to control salinity and provide for attaining the fertilizer benefits.

As there is no present shallow water table or obvious drainage barrier to a depth of 2 to 3 m, adequate drainage should be achieved by a drain 1.5 m deep at a spacing of 50 m. With adequate drainage the needed leaching could be achieved for moderately salt tolerant crops, such as grapes, olives, almonds, figs, most vegetables except carrots, spinach, or potatoes, and all field crops. Crop yields should be above the Egyptian average as the high position of the lands, favorable air, drainage, and fertilizer content of the sewage would all contribute to high productivity. Also in developing the new lands, there is an opportunity to develop improved irrigation methods and management.

Benefits. The estimated gross income from the above cropping pattern is LE 350 per feddan. The net income, allowing for a fertilizer saving of LE 19 per feddan,is estimated as LE 220 per feddan.

In 1990, the water supply of 10.7 million m^3 would meet the diversion requirement for 1 528 feddans. At LE 220 per feddan, the total benefit would be LE 336 000. The present worth in 1977 at 10 percent discount rate is LE 1.0 million.

For the additional 2 492 feddans that would be irrigated in 2000, the benefit at LE 220 per feddan would be LE 548 000. Assuming this started in year 2000, the present worth in 1977 is LE 0.6 million.

Costs necessary to achieve the above benefits are land improvement, sewage treatment chargeable to irrigation, and the capital and operating expense of a system to store and convey irrigation water for the area.

Land improvement would include a distribution system at an estimated cost of LE 200 per feddan, and a drainage system at an estimated cost of LE 100 per feddan.

Quantitative analysis of net benefit for reuse of wastewater on area croplands is presented as part of a benefits/cost evaluation made in comparing regional alternatives in Chapter 7 of the Technical Report.

Alternative Irrigation Sources. It is possible that water might be conveyed to the area through Bahig Canal, but this would probably require enlargement

of the canal or an additional facility to furnish the necessary capacity. Also, until the salinity of the Maryut and Bahig Canals is reduced, the water quality would probably be no more favorable than that of Ameria wastewater.

By a system similar to that needed for Ameria, additional supplies from Nile River storage or salvage of operational losses might also be conveyed to the area. This would provide the necessary water supply, but would not provide the fertilizer benefit afforded by reuse of wastewaters.

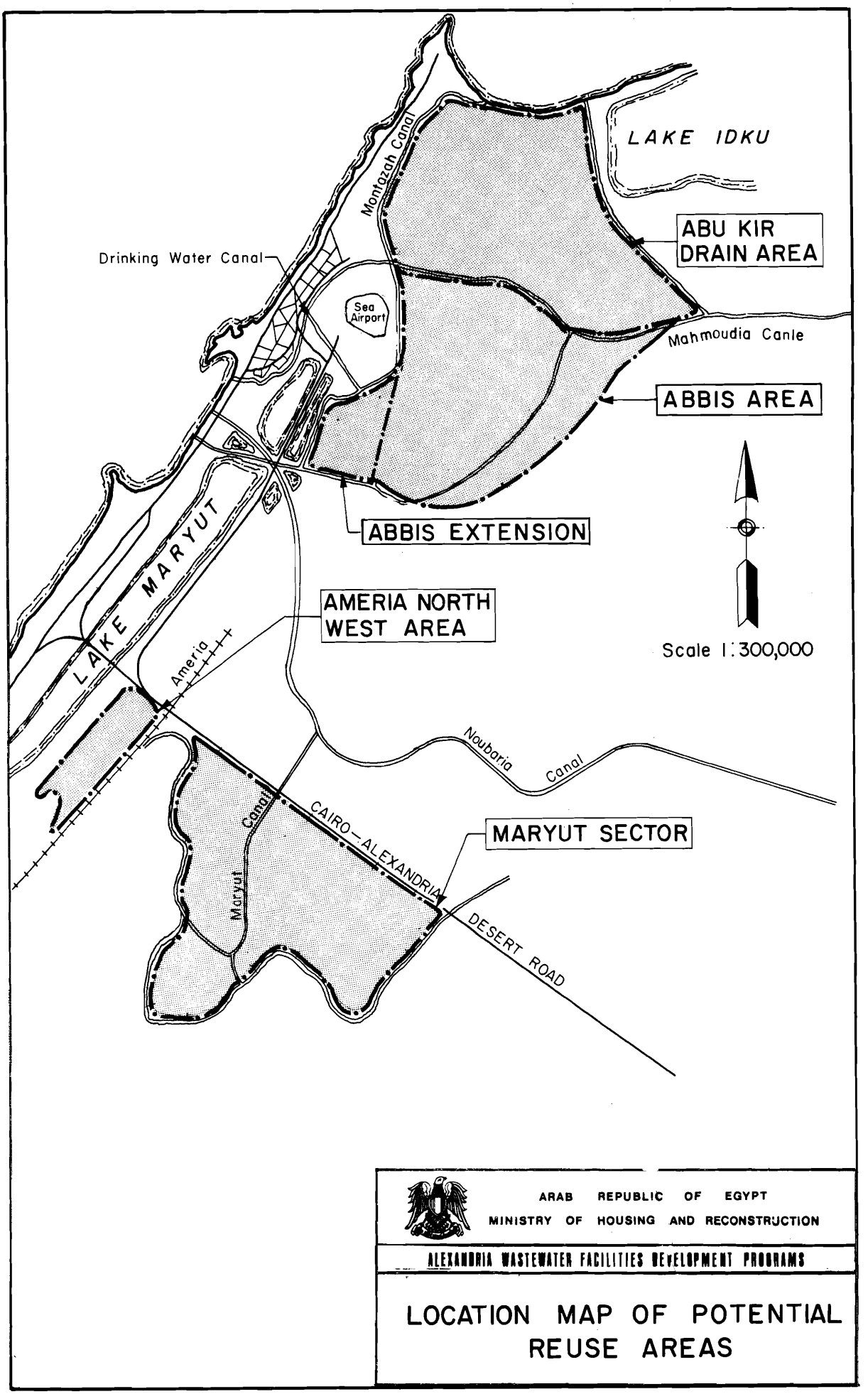
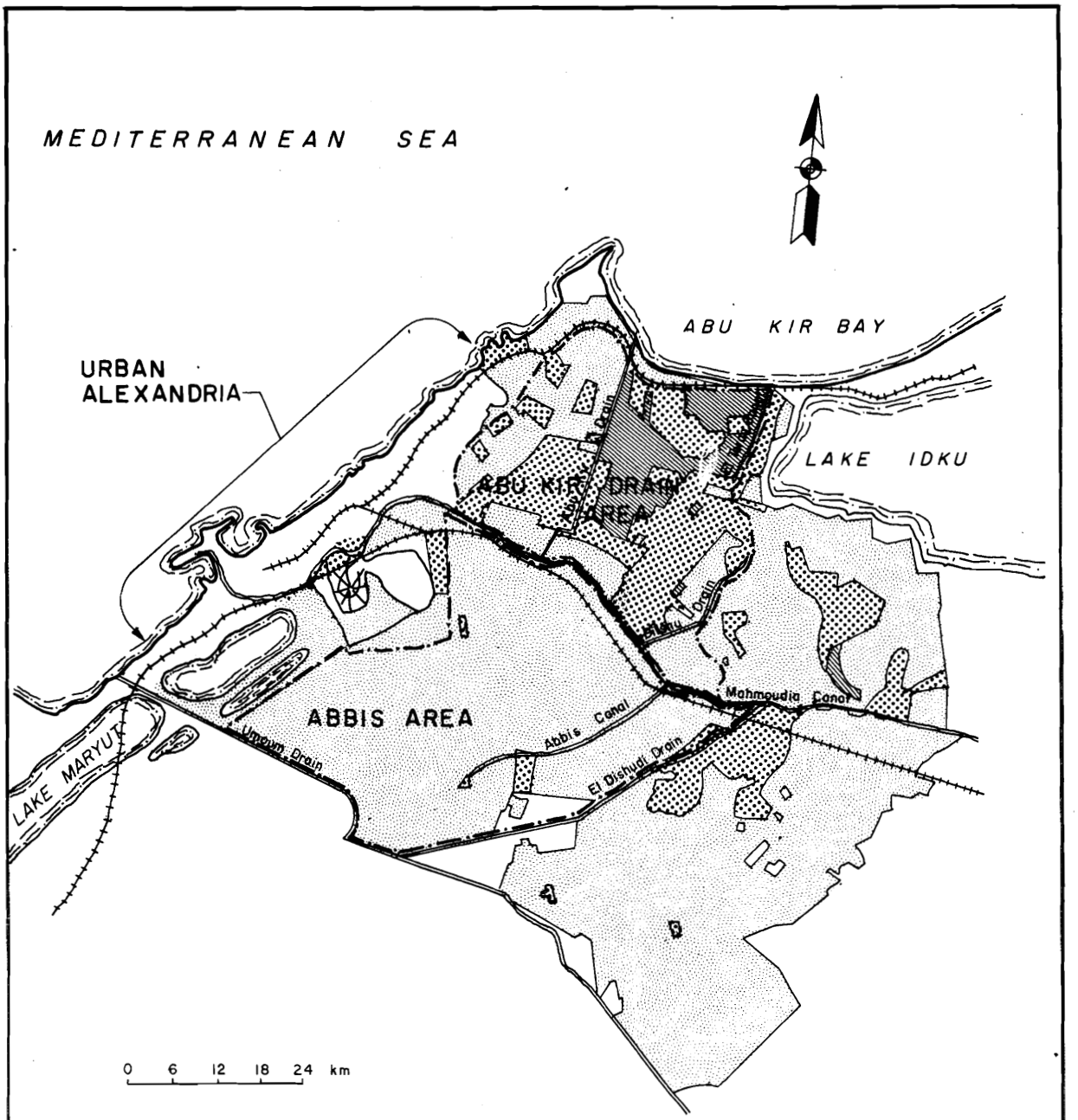

LAKE IDKU
Montazah Canal
ABU KIR DRAIN AREA
Drinking Water Canal
Sea Airport
Mahmoudia Canle
ABBIS AREA
ABBIS EXTENSION
LAKE MARYUT
AMERIA NORTH WEST AREA
Scale 1:300,000
Ameria
Noubaria Canal
Canal
CAIRO-ALEXANDRIA
MARYUT SECTOR
Maryut
DESERT ROAD
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
LOCATION MAP OF POTENTIAL REUSE AREAS

FIGURE E-1



LEGEND

- CLASS 1 - High Crop Yield
- CLASS 2 - Moderate Crop Yield
- CLASS 3 - Marginal Crop Yield

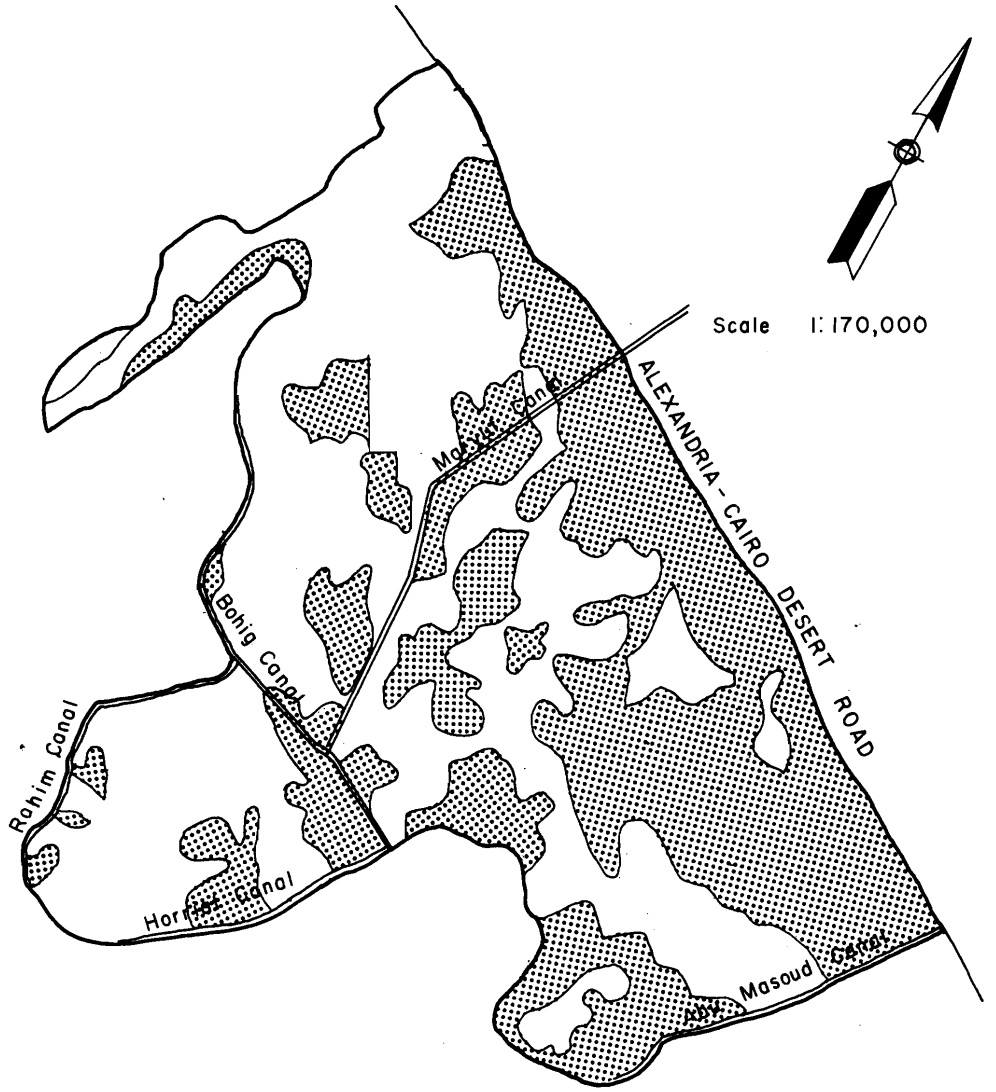
Scale 1: 300,000

ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION

ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

SOIL MAP OF ABU KIR DRAIN AND ABBIS AREAS

FIGURE E-2



LEGEND

DEEP, FINE TEXTURED, CALCAREOUS SOILS

FINE TEXTURED, CALCAREOUS SOILS, UNDERLAIN BY DENSE ACCUMULATIONS OF LIME, GYPSUM, OR LIMESTONE

ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION

ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

SOIL MAP OF MARYUT SECTOR

FIGURE E-3

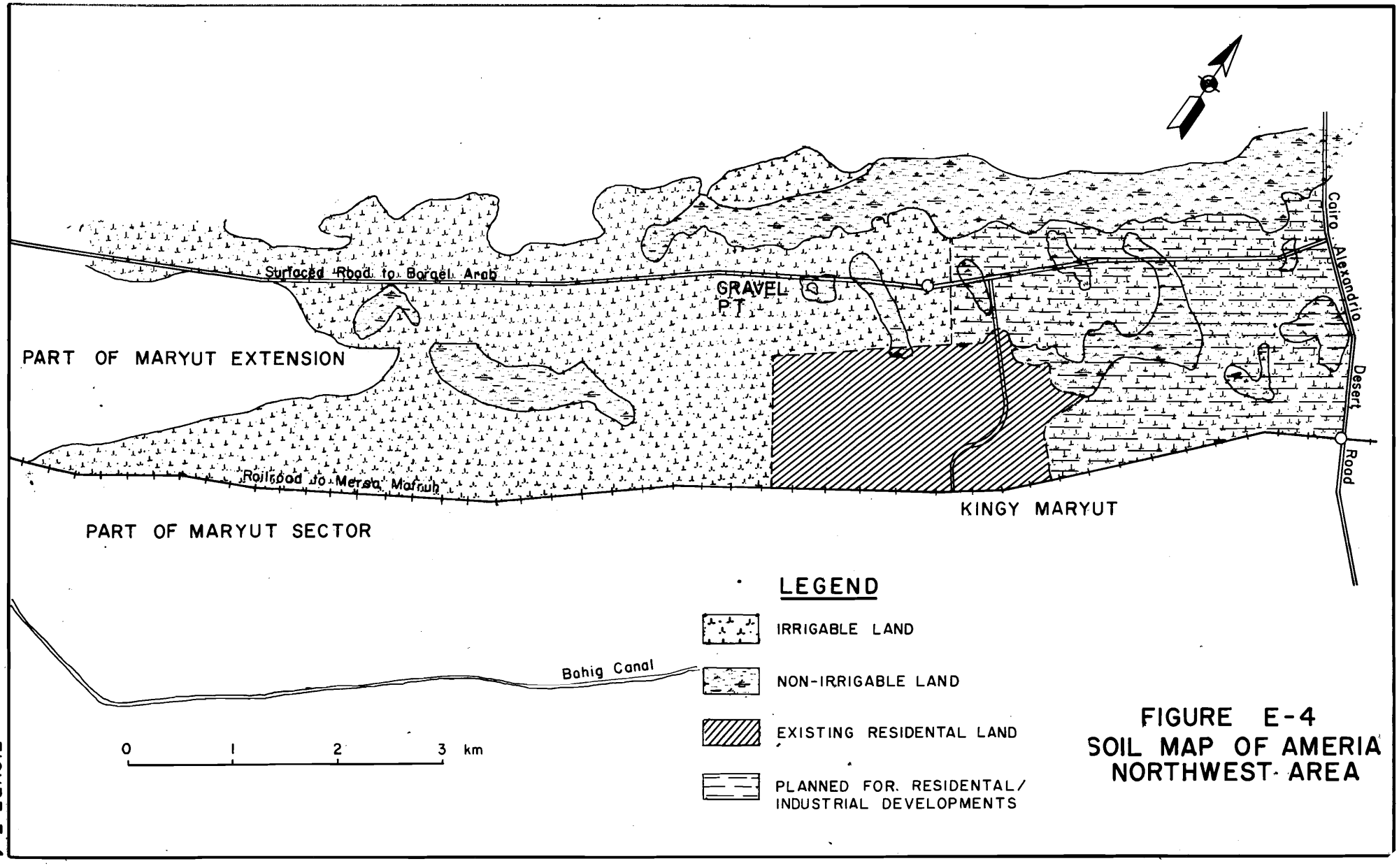


FIGURE E-4
SOIL MAP OF AMERIA NORTHWEST AREA

FIGURE E-4

APPENDIX E

SUPPORTING DATA

Certain Data obtained from various Egyptian governmental agencies contributed to the preparation of this Appendix. The following are in the files of the CDM Alexandria Office.

Maps

Prepared by the Soil Survey Division, Ministry of Agriculture, 1960, for areas near Alexandria.

Scale 1:100 000

1. Soil Productivity Classification
2. Soil Groups
3. Soil Salinity Classification
4. Depth to Water Table
5. Soil Alkalinity
6. Soil Organic Matter Content
7. Soil Soluble Phosphoric Acid Classification

Scale 1:300 000

1. Soil Salinity
2. Depth to Water Table
3. Soil Groups

Prepared by the Land and Water Department, Maryut Agricultural Society, 1976-77.

Scale 1:25 000

1. Soil Map of Maryut Sector
2. Distribution of Soil Salinity (Surface Soil) Maryut Sector

Reports

1. Crop areas (feddan), and average yields for Abu Kir Drain Area, Abbis Area, and Maryut Sector, 1975-76 (Arabic Original and English translation) furnished by Ministry of Agriculture, Alexandria.
2. Reclamation of Saline Alkali Soils by Leaching Abbis Area, Hatim El-Attar and Helmy M.A. Bakr, Dissertation at College of Agriculture, University of Alexandria, June 1963.
3. Abbis Extension Settlement, Taher S. Khalife, Agricultural Services Expert, UNDP, March, 1973.
4. Preliminary Report on Orabi Pilot Farm, Taher S. Khalife, Agricultural Services Expert, UNDP, June 1972.
5. Feasibility Study on the Establishment of Agro-Industries in the Newly Reclaimed Sectors of Northwest Delta, Maryut and North Tahreer, UNDP, June, 1972.
6. Staff Project Report, a Fruit and Vegetables Development Project, Arab Republic of Egypt, World Bank, May 12, 1976.

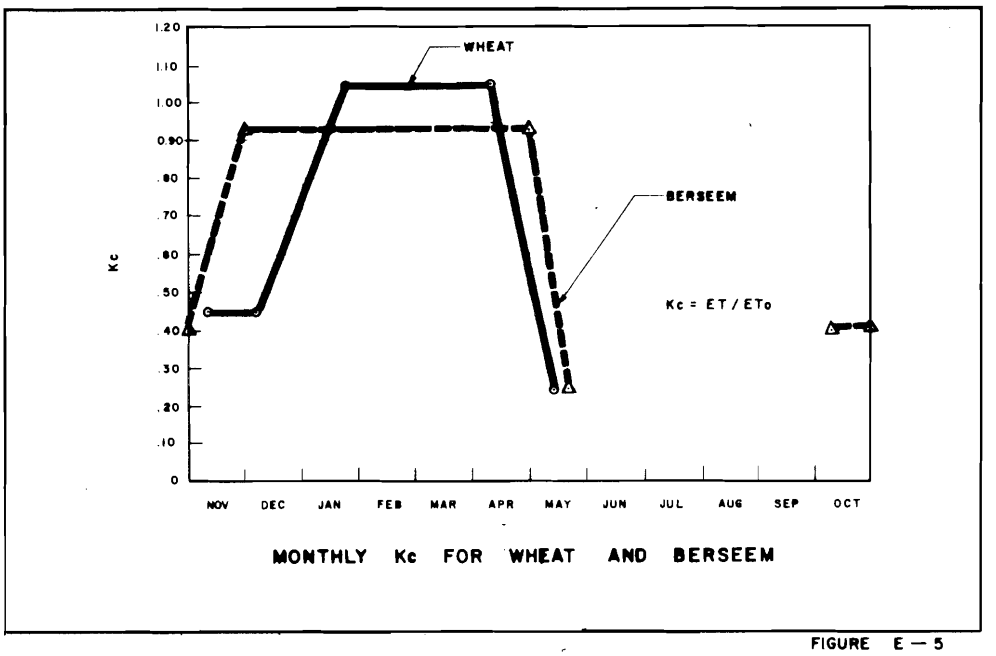


FIGURE E — 5

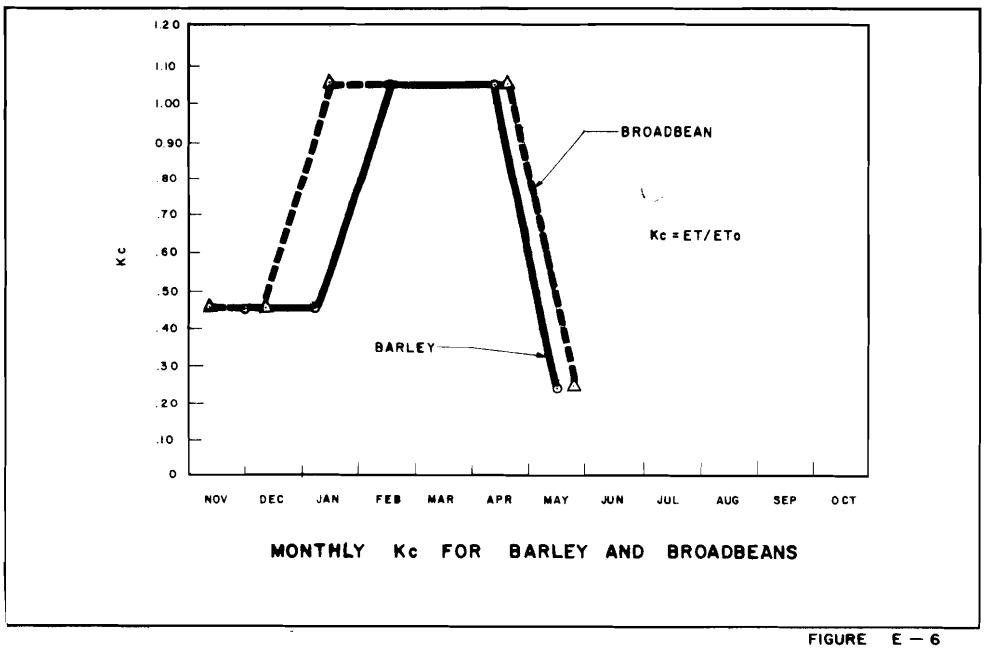


FIGURE E — 6

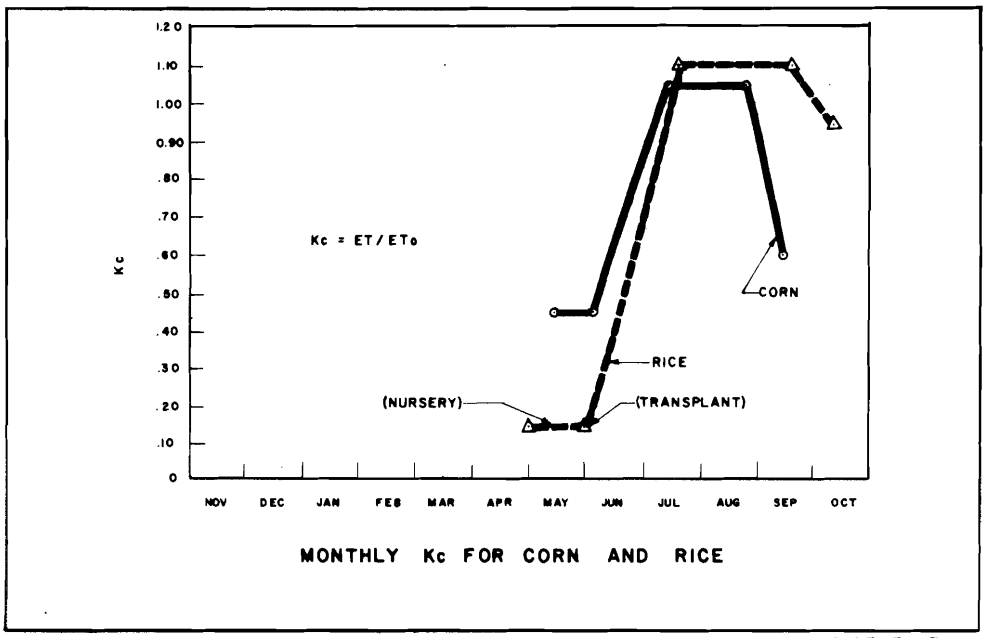


FIGURE E – 7

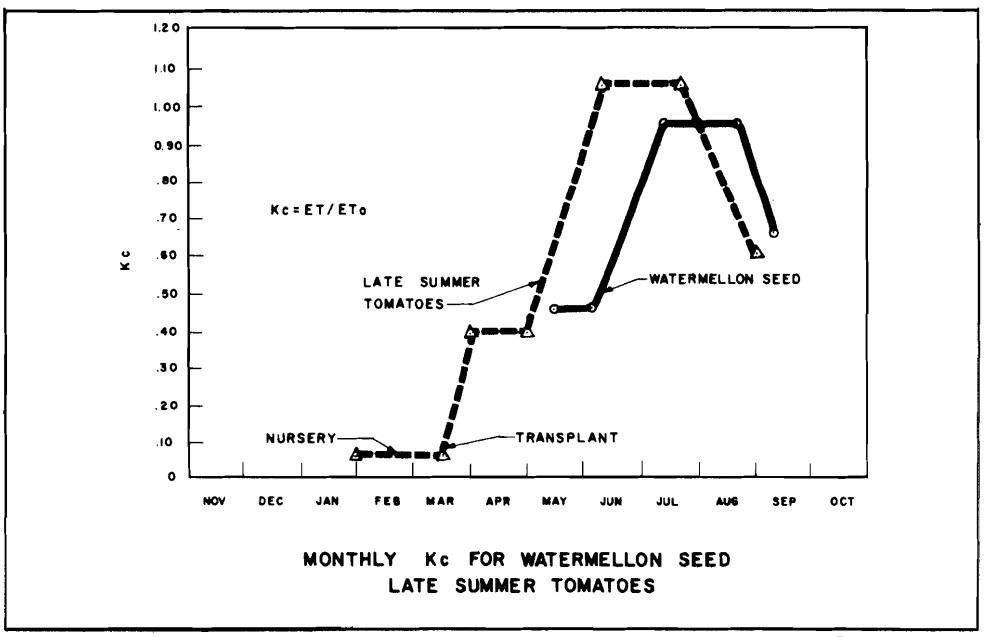
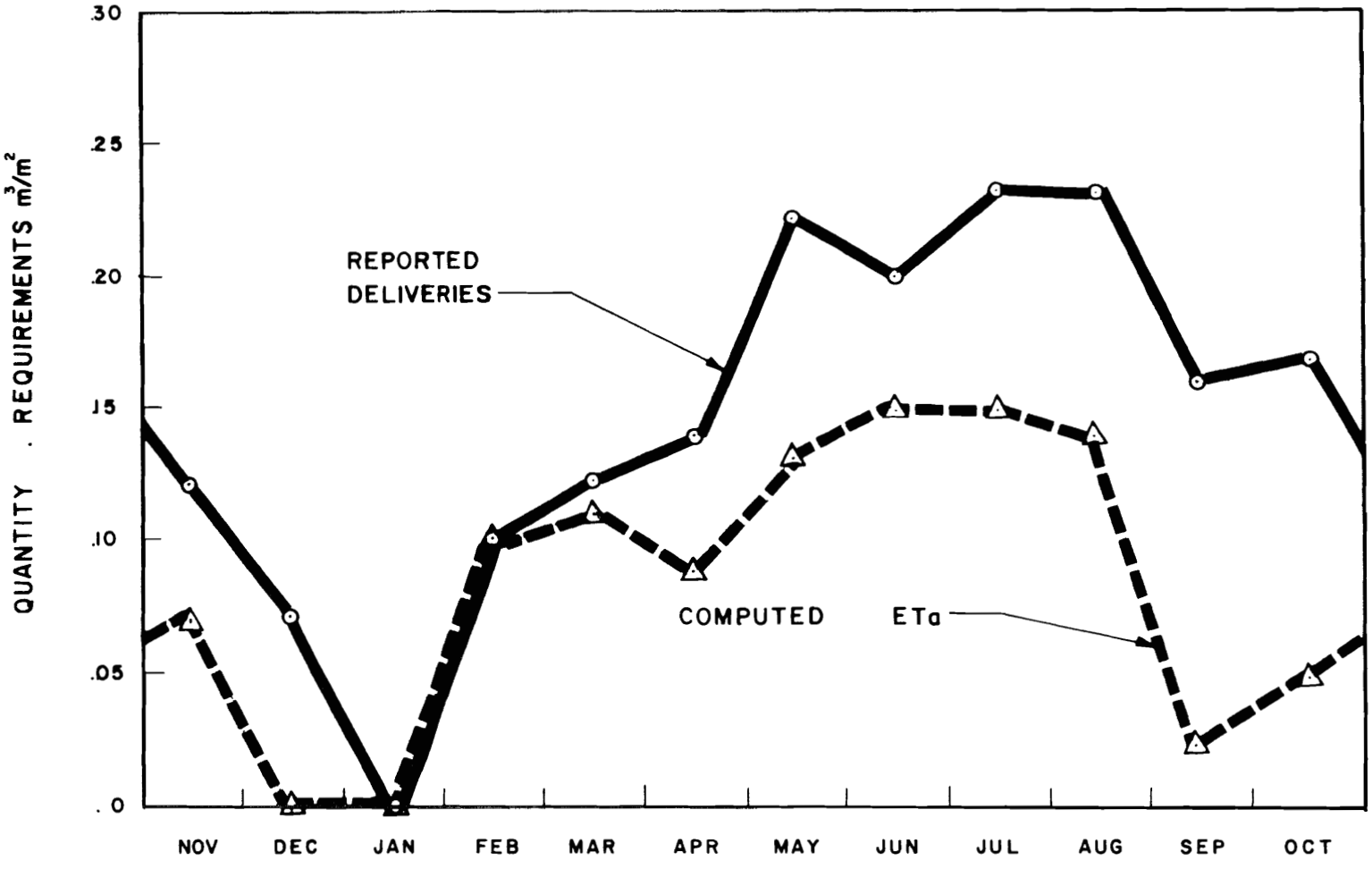


FIGURE E – 8



ABIS EXTENSIONS
COMPARISON OF REPORTED DELIVERIES
AND COMPUTED ETa, 1975-1976

FIGURE E-9

APPENDIX F

FUNCTIONAL DESIGN CRITERIA

Appendix F sets forth the functional planning and design criteria used for assessment of existing wastewater facilities and formulation of all proposed facilities of the recommended master plan.

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F-1 Peak Factor Curve

APPENDIX F

FUNCTIONAL DESIGN CRITERIA

F.1 Introduction

Design and planning criteria used in the analysis of existing facilities and in the preparation of outline designs for proposed facilities are set forth in this Appendix. In selection of these criteria, account has been taken of local water use and wastewater generation found in this study. Account has also been taken of modern practices elsewhere in the world with particular reference to conditions found in the Middle East. Criteria for planning of future facilities have been developed by extrapolating, where appropriate, present criteria values based upon historical trends and upon experience gained in a world-wide practice.

F.2 Wastewater Flows and Characteristics

The present operation of large portions of the sewerage system in a surcharged condition limits considerably the observation and measurement of wastewater flow rates and quality. A limited number of measurements were made at points of discharge of sewers serving significant areas. Data from these observations served as a check for flow rates developed from the analysis of water use records made available by the Alexandria Water General Authority (AWGA). Design considerations related to the quality of local wastewaters have been based upon the results of analysis of composite samples taken in the local systems.

Flow data are developed from a basic per capita daily wastewater use plus industrial flow plus an allowance for infiltration according to the formula:

$$Q_a = \frac{1}{86400}(P_a q F_a + 1.5 I_a + 8640 H_a) \qquad \text{Eq. 1}$$

Q_a = the rate of flow at point A in the system, litres/sec.

P_a = the tributary population upstream of point A.

q = the per capita daily rate of domestic wastewater generation in litres/day.

F_a = a peaking factor, dependent upon population upstream of point A.

I_a = the estimated industrial flow tributary to point A, in litres/day.

H_a = the tributary area upstream of point A, in hectares.

The peaking factor, F, is a function of average rate of wastewater flow with values as given in Figure F-1. The 1.5 multiplier for industrial flows allows for variations in industrial discharges. Values of industrial flow, I, were developed for all areas of the city and were projected for estimates

of future flows. The infiltration allowance is 0.1 litre/sec per hectare of tributary area.

Values of average per capita flow, q, were developed from water use information. The value of q = 100 litres/capita/day was used for the year 1977 wastewater flows. This value was increased on a straight line basis to 125 litres/capita/day in the year 2000 for estimating flows in the intervening years.

Wastewater strength, based upon composite sampling and reasonable projections, is given (in mg/L) as follows:

	Year			
	1977	1980	1990	2000
BOD_5	640	650	675	700
COD	1240	1380	1450	1500

F.3 Sewer Design

Design Period. For laterals and sub-mains, and for trunk mains where paralleling sewers cannot be built economically in the future, pipelines shall be designed to handle the flows from the fully developed tributary area. For trunk mains where a paralleling pipeline can be built in the future, the design period shall be 20 years.

Pipe Size. Pipelines shall be designed to convey the peak flows developed by Equation 1, while flowing full and without surcharge. Minimum diameter for sewers shall be 200 mm and for house connections, 150 mm.

Pipe Slope. Pipelines shall be designed for a minimum slope that will provide a flowing-full velocity of 0.6 metres/sec. The slope of laterals serving less than 100 property connections shall be 0.006 minimum.

Pipe Depth. Minimum cover shall be 1.0 m over the crown of the pipe. Services below the level required for gravity collection shall be provided with pumps. Sub-main and trunk sewers shall be designed with depth for gravity flow from smaller branch sewers.

Pipe Joints. Pipe joints shall be tongue and groove or bell and spigot with rubber or neoprene rings to form resilient, water-tight joints.

Pipeline Design. Hydraulic design of pipelines shall be made using the Manning Formula.

$$V = M R^{2/3} S^{1/2} \qquad \text{Eq. 2}$$

where V = velocity in metres per second

$M = \frac{25.8}{\sqrt[6]{k}}$

k = roughness, 0.0015 m for concrete and vitrified clay pipe

R = hydraulic radius, metres

S = slope

Pipeline Construction. Pipelines constructed in clay soils shall be pile supported, if necessary, and shall be bedded on 150 mm coarse sand.

Pipeline Transition. Design shall provide a smooth energy gradient. At changes in size, the crowns of upstream and downstream sewers shall be matched. Transitions shall be gradual to minimize turbulence and deposition of solids.

Manhole Location. Manholes shall be constructed at all sewer junctions and at all changes in sewer size, gradient and direction.

Manhole Spacing. Manhole spacing shall be as follows:

Pipe Size, mm	Maximum Spacing, m
Less than 200	30
200-250	40
251-450	50
451-600	60
601-1200	100
Larger than 1200	150 (special structure)

Manholes shall be a minimum diameter of 1200 mm with 600 mm clear openings for entry. Manholes shall be water-tight with joints between precast sections, if used, adequately water-proofed by the use of water stop materials or of tongue and groove design and fitted with a rubber or neoprene gasket. Manhole steps shall be of cast iron cast in the manhole barrel during manufacture of the barrel. Manhole frames and covers shall be of cast iron with covers designed for locking. Covers shall have adequate holes for sewer ventilation.

Force Mains. Pipeline size shall result in flow velocities between 0.6 m/sec and 3.5 m/sec when any combination of pumps in the station is in use. Velocities shall be computed using the Manning formula, Eq. 2, and $k = 0.0015$ m for cement-lined cast iron and cement-lined steel pipe, 0.002 m for unlined cast iron and steel pipe and 0.0012 m for asbestos-cement pipe.

Pipeline alignment shall be selected to minimize the total pumping head and as much as possible on an up-grade. High points in the line shall be provided with air release valves, and low points shall have blow off provisions. Pipelines shall be provided with restraining type joints as required to eliminate the need for thrust blocks. Surge suppression shall be assumed necessary and provided for in preliminary designs.

Siphons. Inverted siphons or depressed sewers shall be used only where necessary. The design shall provide for multiple barrels as needed to convey peak flows. The primary barrel shall be sized to provide a velocity of 0.6 m/sec at minimum flow and a velocity of 1.0 m/sec at least once each day. Terminal structures shall be designed to facilitate pipeline cleaning.

F.4 Pump Stations

Capacity. Pump stations shall be capable of handling peak instantaneous flows.

Screening. Each pump station shall be provided with a manually cleaned bar screen or trash rack.

Pumps. Pumps shall be electric motor driven centrifugal type designed especially for pumping screened raw sewage. The pump sizes selected shall be such that taking into account the operating volume of the wetwell and the variation of the incoming flow, no pump will be required to start more frequently than once in twelve minutes. The number and size of pumps shall be such that peak instantaneous flow can be discharged with one of the largest pumps on standby. Pump suction and discharge openings shall be at least 100 mm in diameter. Consideration shall be given to providing pumps designed for two speeds of operation under favorable conditions of flow variability.

Motors. Electric motors shall be selected with suitable service factor for continuous or intermittant operation and shall be of such design that starting current does not overload the electric supply system, and if appropriate, the auxiliary power system.

Auxiliary Power. Auxiliary power shall be provided either by self-contained diesel engine driven generators sized adequately for handling station needs or alternatively, a dual power source by connections to two independent power sources. Automatic transfer switches shall be provided.

Metering. The station discharge header shall contain a suitable meter for measuring, indicating, recording and totalizing the station discharges.

Station Structure. The station design shall provide a drywell for housing the pumps and a two-compartment, interconnected wetwell. The wetwell design operating capacity shall be consistent with the size selection of the pumps to meet the requirements of pump operation, without surcharging incoming pipelines. Adequate provision for cleaning the wetwells shall be included. Superstructure buildings shall be architecturally compatible to the surroundings. The building shall provide, in addition to space for mechanical and electrical equipment, adequate ventilation and light and such operator amenities as toilet and shower.

F.5 Treatment Plants

General. Treatment levels for the Master Plan study are limited to preliminary, primary and secondary treatment with unit processes as follows:

- Preliminary: screening, grit removal, flotable removal.
- Primary: screening, plain settling, sludge treatment, disinfection.
- Secondary (activated sludge process alternative): screening, preaeration (optional), grit removal, plain settling, aeration, final settling, disinfection, sludge treatment:
- Secondary (waste stabilization pond alternative): screening, anaerobic lagoon, aerobic lagoon, recirculation system, disinfection.

Treatment plants shall be stage-designed for not less than ten years per stage. Initial land procurement shall provide the area needed for the full future development of the plant site consistent with the Master Plan, including the necessary buffer zones as specified below. Early stage plant designs shall

provide for later stage construction to optimize the cost of extensions and to minimize operational problems during construction and start-up of extensions, and subsequently . The design shall provide for construction of extensions without interruption to flow in existing plant units and the placing of the extension plant on line with a minimum interruption to plant service.

Hydraulic design shall accommodate peak instantaneous flows to the plant. For plants receiving flow entirely from pump stations, the hydraulic capacity shall be the sum of the peak pump station flows or alternatively, a holding tank for balancing peak flows shall be provided. Bypass facilities shall be provided so that the plant, or any unit of the plant, can be taken out of service.

Standby power shall be provided to be able to handle the peak plant flows. Standby power will not be provided to operate treatment units such as aerators, settling tanks and sludge treatment facilities. Standby power as needed for operating disinfection facilities during a power outage shall be provided.

Metering shall be provided in the plant inlet flow stream. The metering system shall consist of a primary element and secondary instrument(s) for totalizing, indicating and recording flow. Preference shall be given to open channel metering.

Multiple plant units, where appropriate, shall be provided so that one unit of a type can be withdrawn from service for maintenance without interrupting plant flow. Hydraulic connections and flow control devices shall be provided to facilitate maintenance of plant units.

For activated sludge treatment plants smaller than 40 000 m^3/day, the process units shall be designed for 1.15 times average daily flow and loadings. Plants larger than 40 000 m^3/day shall be designed for average daily loadings for purposes of planning estimates.

A buffer zone not less than 500 m wide shall be provided on all sides of a treatment works, including oxidation ponds. This land should be controlled by GOSSD. Building on this land should be restricted to prevent construction of housing, factories and commercial buildings. Farming can be permitted. Exception to this requirement for buffer zones may be taken in the case of preliminary or primary treatment plants associated with submarine outfall disposal where plants must be built in waterfront or developed areas. When this is the case, plant units shall be covered and provided with odor control facilities. The plant structures shall be architecturally designed to blend into the locale, if appropriate.

F.6 Preliminary Treatment

Preliminary treatment is defined as the set of unit processes which:

- screen the raw sewage to remove solids that may cause clogging or malfunction of downstream unit processes or facilities;
- remove sand and other gritty materials;
- remove floating solids such as garbage, bits of paper and plastic, grease, oil and material brought to the surface in the process.

Preliminary treatment shall be employed only for effluents to be discharged to the sea through long outfalls.

Screens. Shall be mechanically cleaned bar racks having a clear opening not greater than 20 mm. The screen mechanism shall be designed to operate continuously to rake and elevate the material intercepted on the screen and discharge it into wheeled containers. The wheeled containers shall allow drainage to the floor of any water accumulating in the container. The screen shall be the first unit in the process chain.

Screen Chamber(s). Shall provide smooth hydraulic conveyance of incoming wastewater and shall have hydraulic cross section large enough so that the velocity through the bar rack at peak flow will not exceed 1.0 m/sec. The velocity distribution in the channel immediately upstream of the screen shall be uniform.

Screening disposal is to be by truck-hauling the drained screenings to a suitable remote landfill site.

Grit removal shall be accomplished in an aerated grit chamber located downstream of the screens but ahead of the flotation unit. The design shall be such that inorganic particles greater than 0.2 mm in diameter are deposited on the bottom of the chamber. Deposited grit shall be removed from the chamber during its continued operation by mechanical means. The grit shall be elevated and washed for discharge to a truck or wheeled container for transport and disposal. Grit shall be washed by the effluent wastewater which shall be returned to the grit unit inlet.

Design of grit chambers shall provide rectangular units about 4 m deep, length to width ratio about 3, and a hydraulic detention period at peak flows not greater than five minutes. Air supply shall be 0.02 m^3 per m^3 of wastewater, manually adjustable.

Flotable removal shall employ plain-air aeration, i.e., air injected at atmospheric pressure, as contrasted with dissolved air pressure or vacuum flotation. The objective is to remove flotable materials while removing a minimum of suspended material having a specific gravity slightly greater than 1.0, i.e., sludge. Floating materials shall be skimmed from the tank for draining and disposal by trucking to a sanitary landfill. The grit removal and flotable removal unit processes may be combined in a single concrete structure if desired.

F.7 Primary Treatment

Primary Treatment is defined as the set of unit processes which:

- screen the raw sewage to remove solids that may cause clogging or malfunction of the downstream unit processes or facilities;
- remove sand and other gritty materials;
- remove settleable solids by plain sedimentation;
- treat the resulting sludge;
- disinfect the settled effluent prior to discharge.

Screens and grit removal shall be as described above for Preliminary Treatment.

Plain sedimentation shall be carried out in a rectangular tank(s) having a length to width ratio of at least three. The flow shall be distributed over the vertical cross section of the tank at the inlet end and removed over a

system of weirs at the effluent end. The tank shall be equipped with mechanical sludge scrapers and skimmers to collect the sludge in hoppers at the inlet end and the scum in a scum trough near the outlet end. The mechanism shall be electric motor driven.

The tank structure shall be designed to provide a surface loading rate of 25 m/day and a detention period of 2.5 hours at design rates of flow. Weir design shall provide weir loading rates not to exceed 620 m^3/day per metre length of weir. The hoppers shall have side slopes of not less than 60° from horizontal, or 1.73 vertical to 1.0 horizontal.

Sludge and scum shall be withdrawn by gravity or hydrostatic head to adjacent sludge and/or scum holding sumps. Conveyance of these materials for treatment or disposal shall be by pumping and piping systems. Individual valved pipelines shall be provided for each sludge hopper.

For primary treatment plants associated with sea outfall disposal, sludge shall be conveyed by pumping and pressure pipe system to the existing East Treatment Plant site for treatment. Sludge treatment shall consist of dewatering on existing sand beds or by centrifuge (or filter press or vacuum filter) for disposal. Provision shall be made for addition of lime and polymer coagulant aids to optimize dewatering. Disposal will be by hauling away by farmers for use on land. For other means of disposal, the sludge treatment facilities shall be located at the plant site.

Sludge pumps shall be non-clog, centrifugal type with fully recessed impeller. Sludge conveyance pipelines shall be designed for a flow velocity of 1.6 to 2.0 m/sec and a friction factor eight times that for water for a given type of pipe. Pipe for sludge conveyance shall be cement-lined cast iron or asbestos-cement. Long sludge conveyance pipelines shall be designed with cleanout fittings at intervals of 300 m.

Disinfection shall be by addition of a chlorine solution to the effluent. Chlorine supply shall be by ton chlorine cylinders and plant facilities shall be provided to handle and store these containers in covered storage. Chlorine feed machines shall be sized to feed up to 20 mg/L at all rates of plant flow. Chlorine feed shall be manually adjustable but the amount fed shall be automatically metered in proportion to the measured plant flow. Chlorine solution shall be diffused into the effluent at a point where downstream aeration is minimal.

For inland disposal of effluent, a chlorine contact period not less than 15 minutes at peak flow rates shall be provided in a contact tank. Where disposal is by means of an outfall offering more than 15 minutes flow time before discharge at peak flow rates, no contact tank will be needed.

F.8 Secondary Treatment - Activated Sludge Process

Secondary Treatment - Activated Sludge Process is defined as the set of unit processes which:

- screen the raw sewage to remove solids that may cause clogging or malfunction of the downstream unit processes or facilities;
- remove sand and other gritty materials;
- remove raw sewage settleable solids and scum by plain sedimentation;

- treat the settled effluent in an aeration tank reactor, using the conventional activated sludge process, for removal and oxidation of organic pollutants not removed by primary settling;
- separate the effluent and activated sludge by secondary settling and return of a portion of the sludge to the reactor;
- disinfect the settled effluent prior to discharge;
- treat the primary and waste activated sludge.

Screening, grit removal and primary settling shall be as required for primary treatment.

Aeration tank reactors shall be rectangular in plan and 4.5 to 5 m deep. The tank shall be sized to provide six hours detention for twice the average daily flow rate (affords up to one hundred percent return activated sludge). Aerators shall be mechanical surface type designed to diffuse 1.0 kg oxygen per kWh into the mixed liquor. Aerators shall be driven by two-speed electric motors through gear boxes designed with adequate service factor for continuous and intermittant duty. The number of aerators, their size and shape of the tank shall be selected to provide adequate mixing and circulation in the reactor at minimum overall cost.

Secondary settling tanks shall be rectangular in plan and sized to provide a surface loading rate of 25 m/day based upon sewage flow (not mixed liquor rate of flow) or a solids loading rate of 3.4 kg dry solids per m^2 of tank surface area per hour, whichever gives the larger area. The detention period based upon average daily sewage flow shall be 2.0 hours. The tank shall be designed with the sludge hoppers near the effluent end of the tank to derive maximum benefit from density currents. Multiple effluent weirs shall provide a loading rate not to exceed 370 m^3/day/m. The tank shall be equipped with travelling bridge or chain-and-flight sludge scraper mechanism, electric motor driven.

The return activated sludge system shall consist of pumps and piping sized to handle a flow equal to the average daily sewage flow. Pumps may be centrifugal type electric motor driven with variable speed capability, but consideration shall be given to air lift and Archimedes screw pumps if secondary tank bottom-flow is lifted prior to separation of waste activated sludge and return activated sludge.

Disinfection shall be as given under Sec. F.7, Primary Treatment, above. No less chlorinator capacity shall be allowed for secondary treated effluent to provide for the event of plant bypass or malfunction.

Waste activated sludge shall be returned to the inlet channels of the primary settling tanks where it shall be mixed with incoming sewage.

Sludge, primary settling tank bottom flow, shall be treated by dewatering, adding lime, coagulant and/or polymer filter aids. Dewatering shall be by centrifuge, filter press or vacuum filter as dictated by sludge characteristics and economics. Dewatered sludge shall be truck-hauled to storage sites where farmers can haul it away for their use or alternatively, composted with other solid wastes for agricultural use.

F.9 Secondary Treatment - Waste Stabilization Ponds

Waste stabilization by anaerobic-aerobic lagoons is defined as the set of unit processes which:

- provide initial settling of the wastewater and anaerobic digestion of the settled solids, all in compartmentalized lagoons;
- treat the settled effluent in aerobic lagoons with provision for recirculation of aerobic lagoon effluent to the lagoon inlet.

The anaerobic lagoons which receive the raw wastewater shall be 4 to 5 m deep and provide a detention period of three days based upon design average daily flow. The design shall provide at least two compartments for parallel operation so that one unit may be taken out of service for consolidation and removal of digested sludge. Inlet structures shall provide for loading the lagoon near its center. Outlet structures shall be located near the periphery of the lagoon. They shall be designed to allow withdrawal at selected levels of the lagoon for best quality effluent.

Aerobic lagoons shall be designed to operate between 1.0 and 1.8 m depth, with design flows being computed on the basis of 1.5 m depth. The lagoon area (total) shall be designed on the basis of BOD_5 loading of 300 kg/ha per day assuming that 35 percent of the raw sewage BOD_5 is removed in the anaerobic lagoon. A detention period of at least 30 days shall be provided. Inlet and outlet structures shall be located to minimize short-circuiting. The outlet structure shall be designed to allow effluent withdrawal at or below the water surface, at the operator's option, for optimum effluent quality. The outlet structure shall be designed to be able to drain the lagoon by lowering the pond level at a rate of 0.3 m per week while receiving its normal load.

Lagoons shall be designed with earth dykes on a slope not to exceed 1 vertical to 3 horizontal. Freeboard shall be not less than 0.7 m at maximum operating depth except that ponds greater than three hectares in area shall have 1.0 m freeboard. Dykes shall be not less than 3 m wide at the top and prepared for vehicle travel. A 4m wide roadway or top of dyke shall be provided to and around the anaerobic pond, properly prepared to handle heavy equipment. The lagoon bottom shall be nearly level, graded slightly to allow drainage of the pond. The soil, if not relatively impervious, shall be prepared by compaction and, if necessary, the placing of a sandy clay lining, adequately compacted. Dyke areas above the water line should be seeded with grass to reduce wind and wave erosion. Surface runoff from areas adjacent to lagoons shall be directed away from the lagoons.

Facilities for return of aerobic pond effluent to the inlet of the aerobic pond shall be provided. The total capacity of this system shall be equivalent to twenty percent of the plant flow. The recirculated flow shall be mixed with the incoming wastewater flow (anaerobic pond effluent) before discharging from the aerobic pond inlet structure.

F.10 Submarine Outfalls

Preliminary design criteria, based on incomplete information of the sea floor, currents, density gradients and bathymetry, to be used in developing outline designs for estimating comparative costs are given below. Final design shall be based upon criteria established when this information is available from

detailed marine studies.

The outfall pipeline shall be placed in a trench with not less than 2 m backfill cover over the top of the pipe at the shoreline, through the surf zone and to a depth of 15 m. The backfill cover shall be adequately protected against wave erosion. At depths greater than 15 m, the pipeline shall be placed in a trench the depth of which is at least half the diameter of the pipe and shall be protected by rock backfill. In the diffuser section, the trench shall be one-fourth the diameter of the pipe or less.

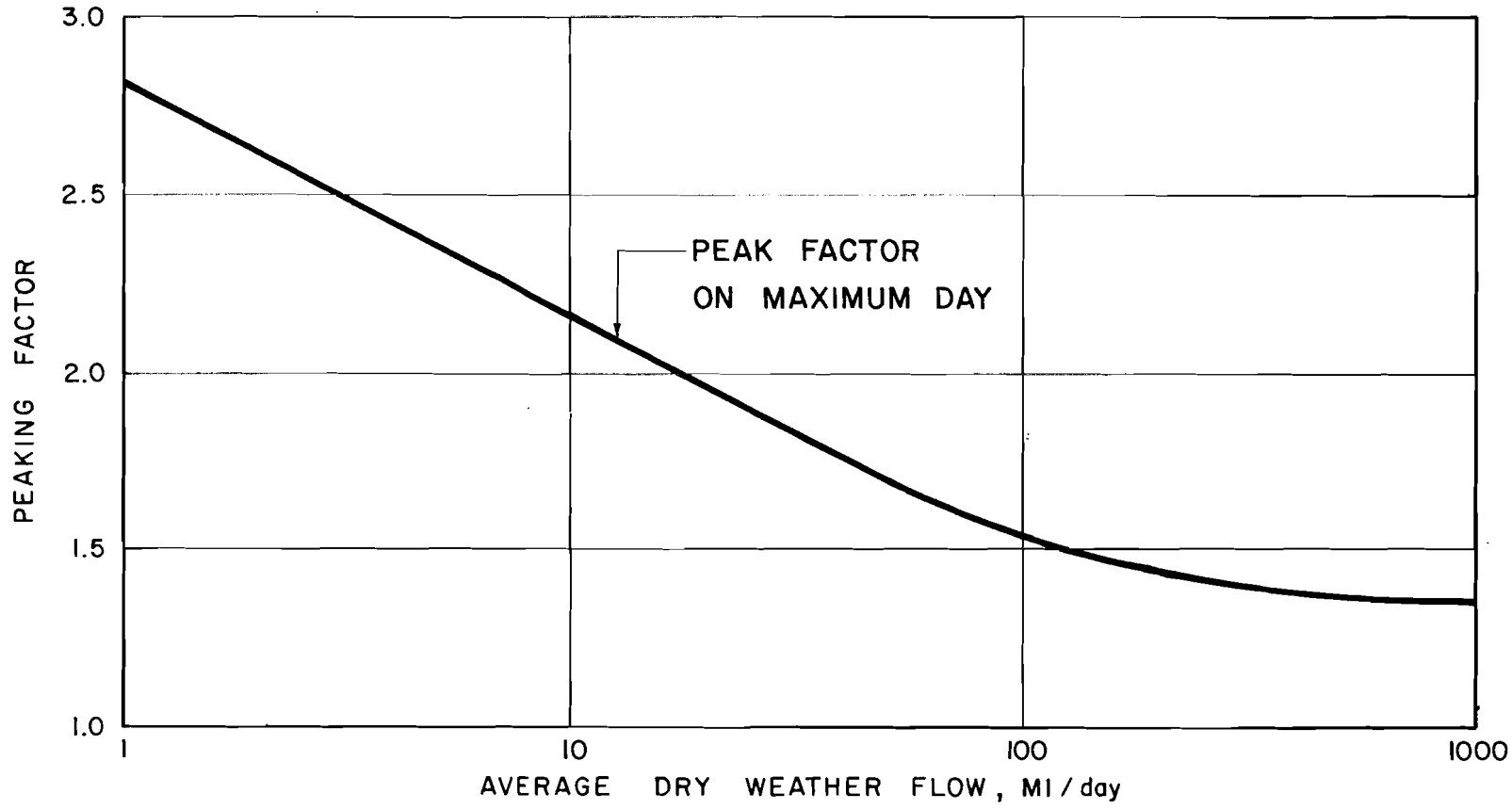
The pipeline shall be sized so that at average design dry weather flow the mean velocity in the pipe is 0.75 m/sec. The pipeline shall be of uniform diameter throughout its length and shall be fitted with a gate structure at the end to facilitate cleaning and/or flushing. The length of the diffuser section shall be estimated on the basis of 1.2 m length per 1000 m^3 of wastewater per day. The length of the outfall shall place the diffuser section in 50 m depth of water to afford an initial dilution in the range of 500-1000 to 1.

The pipelines shall be of reinforced concrete or concrete lined and coated steel with double gasketed joints to allow for pressure testing each joint after placement of the pipe.

F.11 General Requirements

Sewerage and sewage treatment facilities are usually funded over long periods or have long repayment periods over which replacement costs should not be required and maintenance costs should be minimized. Therefore designs shall feature, as much as is practical, facilities having long life and minimum maintenance. Design shall be such that routine and preventive maintenance are made easy. Capital programs shall provide the hoists, carriers, tools and shops necessary to carry out normal maintenance. Additionally, designs shall specify quality materials and workmanship as well as mechanical equipment known to have long service life and to be adequately backed by a good factory service organization.

Treatment plant service buildings shall be provided to the extent and quality consistent with the proposed plant process units. Permanent buildings shall be provided for long term treatment plants to house control features, office, laboratory and general service functions such as stores, shops, garage, locker room, toilets, showers, tool rooms, and a communications system. For interim plants, such as waste stabilization pond installations, buildings may be of a temporary nature but shall be servicable and relatively maintenance free for the expected service life of the plant. Adequate space shall be provided to house control features, office, laboratory and the same general service amenities as for permanent buildings.



ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION

ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

PEAK FACTOR CURVE

FIGURE F-1

APPENDIX G

BASIS OF COST FOR ESTIMATING

Appendix G presents costs for local building materials, labor and proposed construction items found in Alexandria.

LIST OF TABLES

		Page
G-1	Average Daily Wages of Workers in Construction Industry - Public Sector	G-1
G-2	Unit Prices of Building Materials - Open Market	G-2
G-3	Unit Costs of Principal Construction Items	G-3

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TABLE G-1

AVERAGE DAILY WAGES OF WORKERS IN CONSTRUCTION INDUSTRY
PUBLIC SECTOR

Type	Rate, LE
Unskilled:	
Earthwork	1.25[a]
Watchman	1.25
Water Sprinkling	1.50
Materials Carrier	1.75
Mortar Mixer	1.75
Concrete Pourer, Mixer	2.00
Semi-skilled:	
Foreman	2.50
Manual Vibration Work	2.50
Reinforcement Work	3.25
Rough Carpentry Work	3.25
Stone Facing Work	3.25
Mechanic	3.25
Skilled:	
Electrician	4.00
Carpenter	4.00
Concrete Facing Work	4.00
Flooring Builder	4.00
Formwork Carpenter	4.25
Plasterer	4.25
Mason	4.50
Plumber	4.50

[a] All values expressed as of July, 1977. Alexandria prices including Social Security. Based on figures from Ministry of Housing and Reconstruction.

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TABLE G-2

UNIT PRICES OF BUILDING MATERIALS

OPEN MARKET

Type	Price, LE	Unit
Stone, second class	8[a]	m^3
Stone, screened for bedding	10	m^3
Gravel, for concrete mix	11	m^3
Gravel, fine	4	m^3
Sand, fill	3	m^3
Brick, first quality	60 (25)[b]	per 1000
Portland Cement	60 (18)	tonne
Wood Planks, rough	110	m^3
Lumber, plywood	200 (160)	m^3
Reinforcing bars, plain	170 (152)	tonne
Reinforcing bars, deformed	210	tonne

[a] July 1977 Alexandria prices exclusive of on-site delivery cost.

[b] Values in parentheses are official government subsidy prices at which major contractors for public works are required to bid. Supplies at these prices are not always available.

TABLE G-3

UNIT COSTS OF PRINCIPAL CONSTRUCTION ITEMS

	Cost, LE[a]	Unit
Earth Excavation:		
Foundations, less than 2 m deep	3	m^3
Foundations, greater than 2 m deep	7	m^3
Within Caissons	20	m^3
Trenches less than 2 m deep	1-2	m^3
Trenches 2-5 m deep	2-8	m^3
Trenches 2-8 m deep	8-12	m^3
Truck Hauling	0.3	m^3/km
Backfill		
Native material	0.5	m^3
Hauled granular fill	3	m^3
Lateral Trench Support[b]		
Install and remove wood sheeting	2	m^2
Structural		
Masonry, Brick or Stone	25	m^3
Plaster (1.5 cm thick)	3	m^2
Lean Concrete	11-15	m^3
Plain Structural Concrete	15-25	m^3
Reinforced Concrete		
Foundation slabs	75	m^3
Beams and floor slabs	100	m^3
Columns and pillars	120	m^3
Gravity Pipe (Flexible water-tight joints)[c]		
150 mm vitrified clay	3	m
300 mm " "	8	m
600 mm " "	25	m
1000 mm reinforced concrete	75	m
2000 mm " "	200	m
Pressure Pipe (Ductile iron w/rubber joint)[c]		
250 mm	20	m
600 mm	70	m
1000 mm	220	m
Pavement Removal and Restoration	4-12	m^2

[a] July, 1977 Alexandria prices inclusive of contractor overhead and profit.

[b] Per square metre of trench wall.

[c] Delivered on site but not including installation cost.

APPENDIX H

SEWER DESIGNS

Appendix H includes functional design layout drawings (initial) for typical sewer appurtances and principal conveyance structures (gravity collectors and force mains) proposed in the recommended facilities master plan.

LIST OF FIGURES

H-1	Typical Trench Section for Gravity Sewer
H-2	Typical Trench Section for Force Main
H-3	Typical Overflow-Diversion Structure
H-4	Lateral Bracing for Various Trench Depths
H-5	Typical Joints for Gravity Sewers
H-6	Typical Manhole for Gravity Sewers
H-7	Typical Layout of Property Connections (as constructed in Alexandria)
H-8	Hagar el Nawatia Diversion Structure
H-9	Mohamed Aly Collector
H-10	New P.S. No.5 - East Collector
H-11	Sidi Bishr Collector
H-12	Ras el Soda Collector
H-13	Main Siouf Keblia Collector
H-14	Siouf Keblia Collector - North Branch
H-15	Siouf Keblia Collector - South Branch
H-16	Sadat City Collector
H-17	Abu Kir Collector
H-18	Nouzha Main Collector
H-19	West Zone Collector - 1
H-20	West Zone Collector - 2
H-21	Mex-Dekheila Collector
H-22	Dekheila Industries Collector
H-23	Sidi Bishr Outfall-Land Portion

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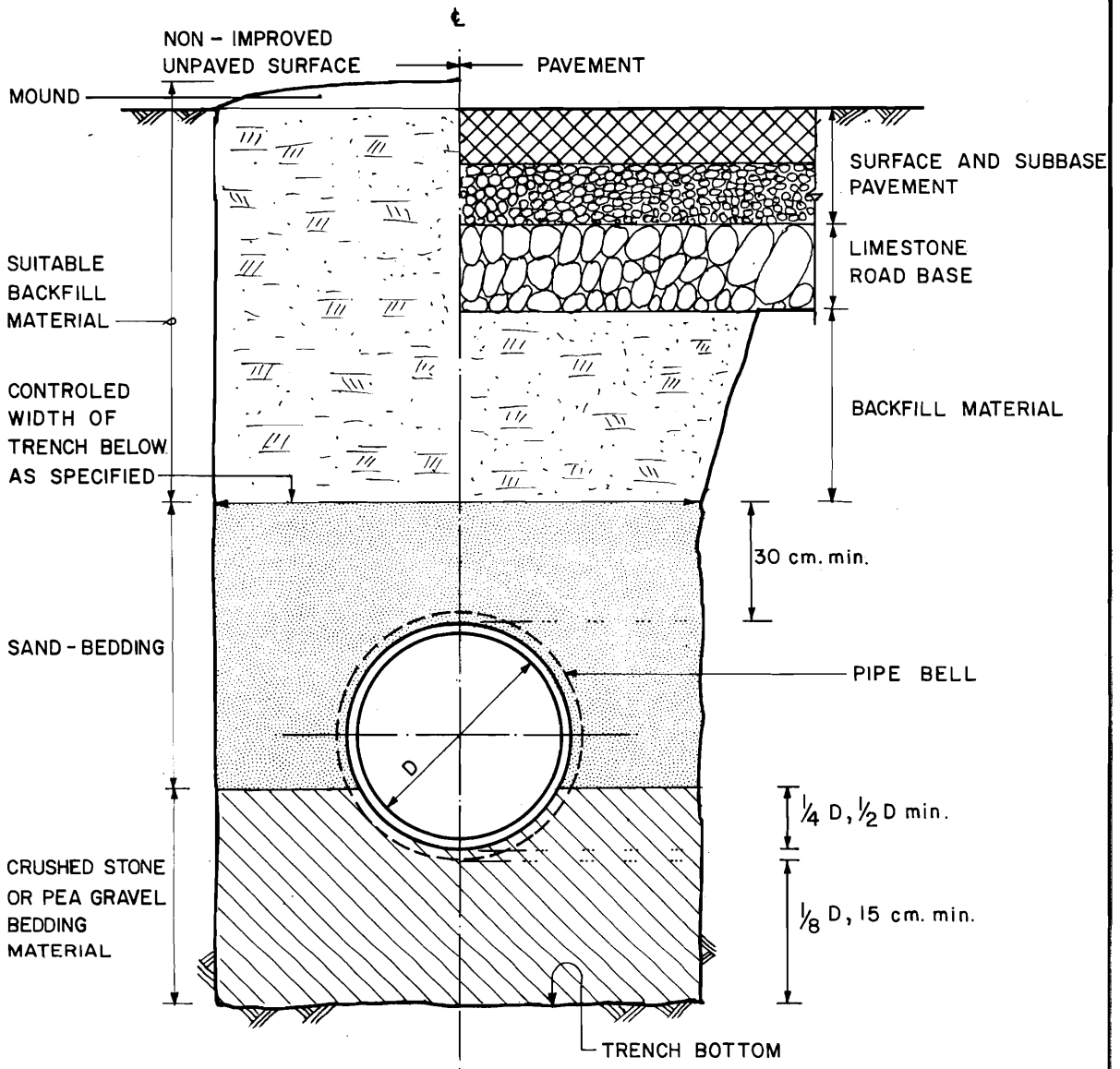
NOTE:
FOR SIDEWALKS SURFACING
TO BE AS SPECIFIED



TYPES AND DEGREES OF
COMPACTION FOR BACKFILL AND
BEDDING MATERIALS
AS SPECIFIED

SPECIAL PIPE BEDDING NOT SHOWN
TRENCH BRACING NOT SHOWN

NOT TO SCALE

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ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

TYPICAL TRENCH SECTION FOR GRAVITY SEWER

FIGURE H-1

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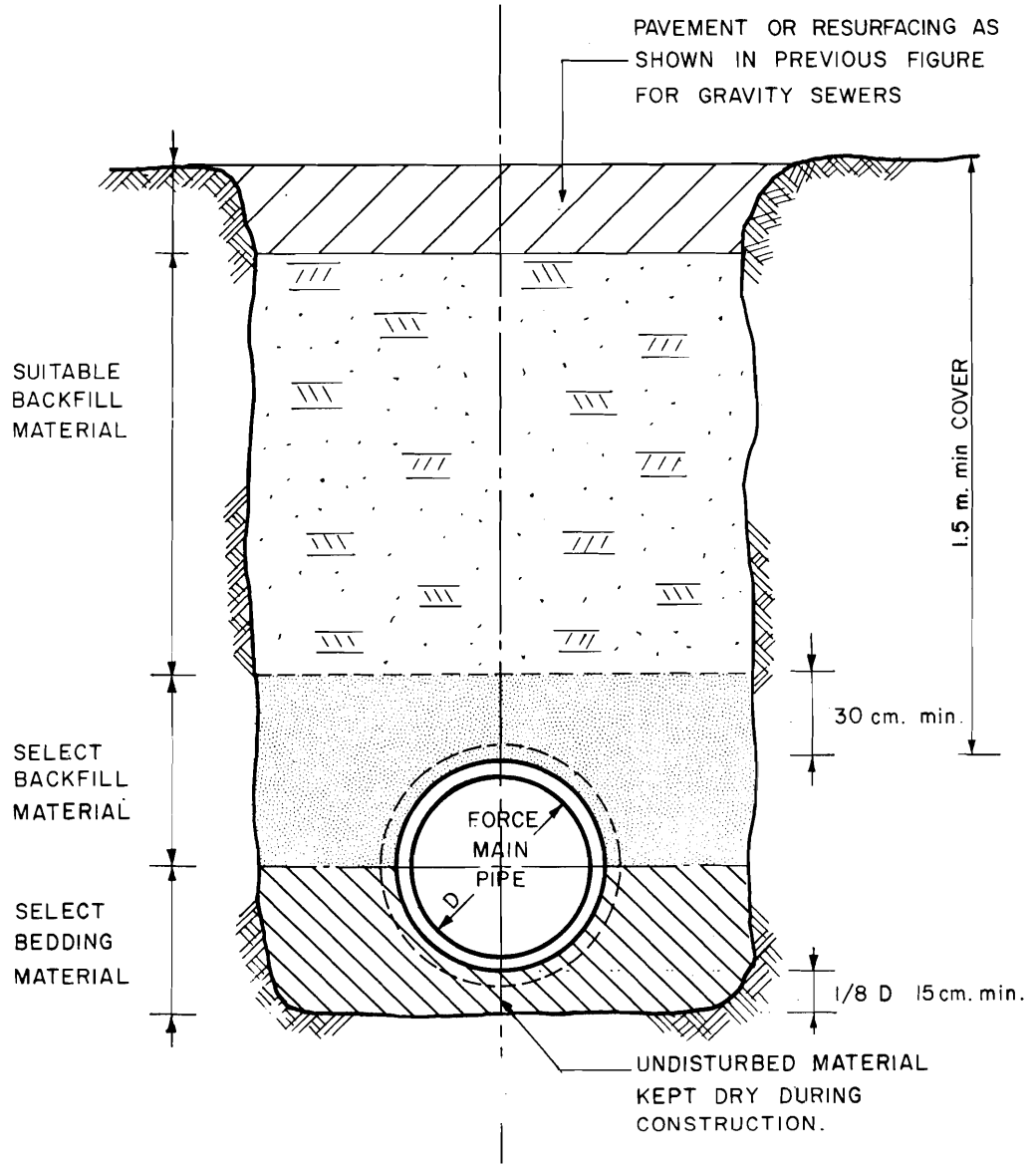

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TYPICAL TRENCH SECTION FOR FORCE MAIN

TRENCH BRACING NOT SHOWN
NOT TO SCALE

FIGURE H-2

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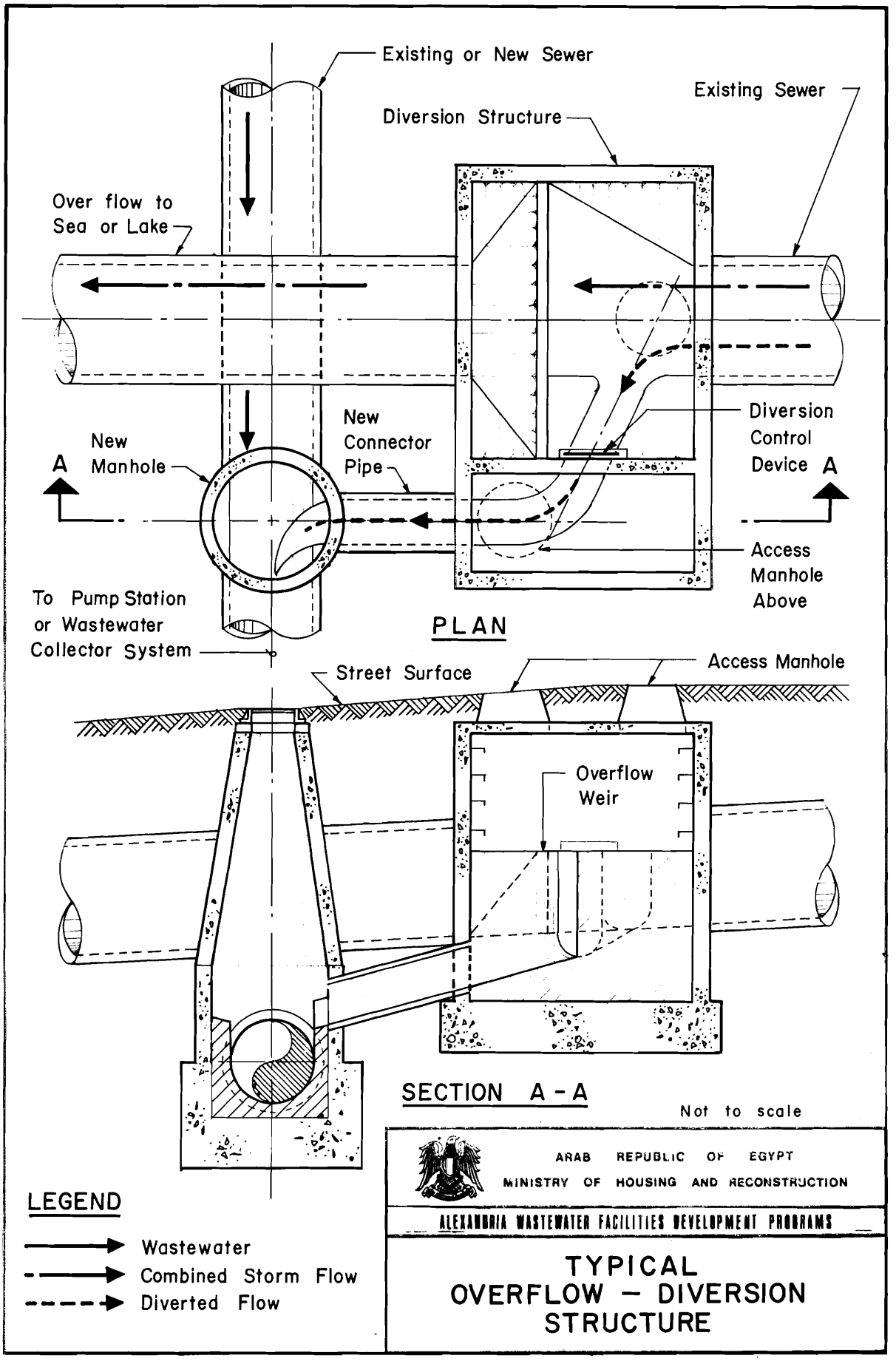
Existing or New Sewer
Existing Sewer
Diversion Structure
Over flow to
Sea or Lake
New
Manhole
A
New
Connector
Pipe
Diversion
Control
Device
A
Access
Manhole
Above
To Pump Station
or Wastewater
Collector System
PLAN
Street Surface
Access Manhole
Overflow
Weir
SECTION A - A
Not to scale
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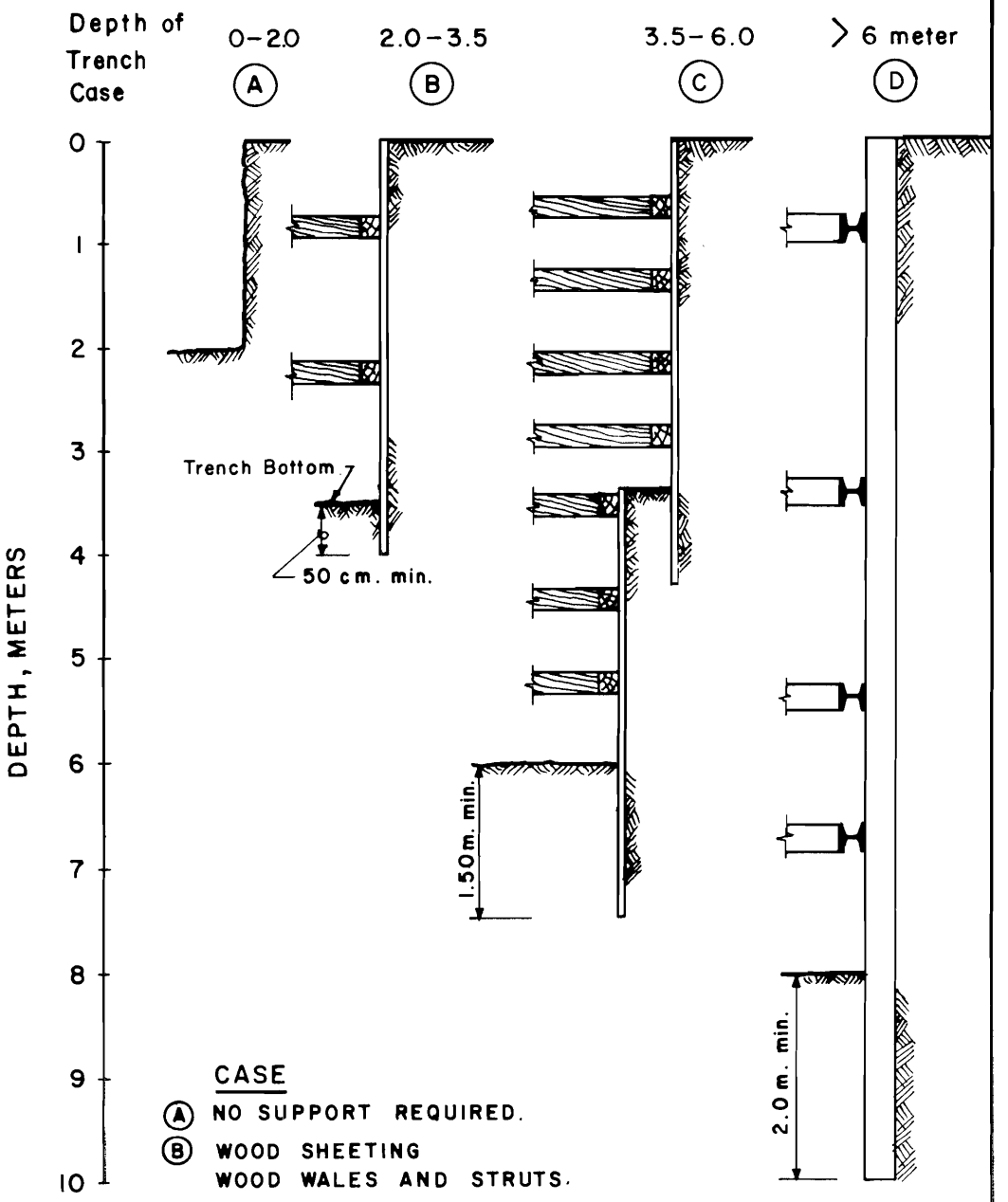
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
LEGEND
Wastewater
Combined Storm Flow
Diverted Flow
TYPICAL
OVERFLOW – DIVERSION
STRUCTURE

FIGURE H-3



CASE

(A) NO SUPPORT REQUIRED.

(B) WOOD SHEETING
WOOD WALES AND STRUTS.

(C) DOUBLE TIERED
WOOD SHEETING
WOOD WALES AND STRUTS.

(D) INTER LOCKING STEEL SHEET
PILING WITH STEEL WALES AND STRUTS.

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ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

LATERAL BRACING FOR VARIOUS TRENCH DEPTHS

FIGURE H-4

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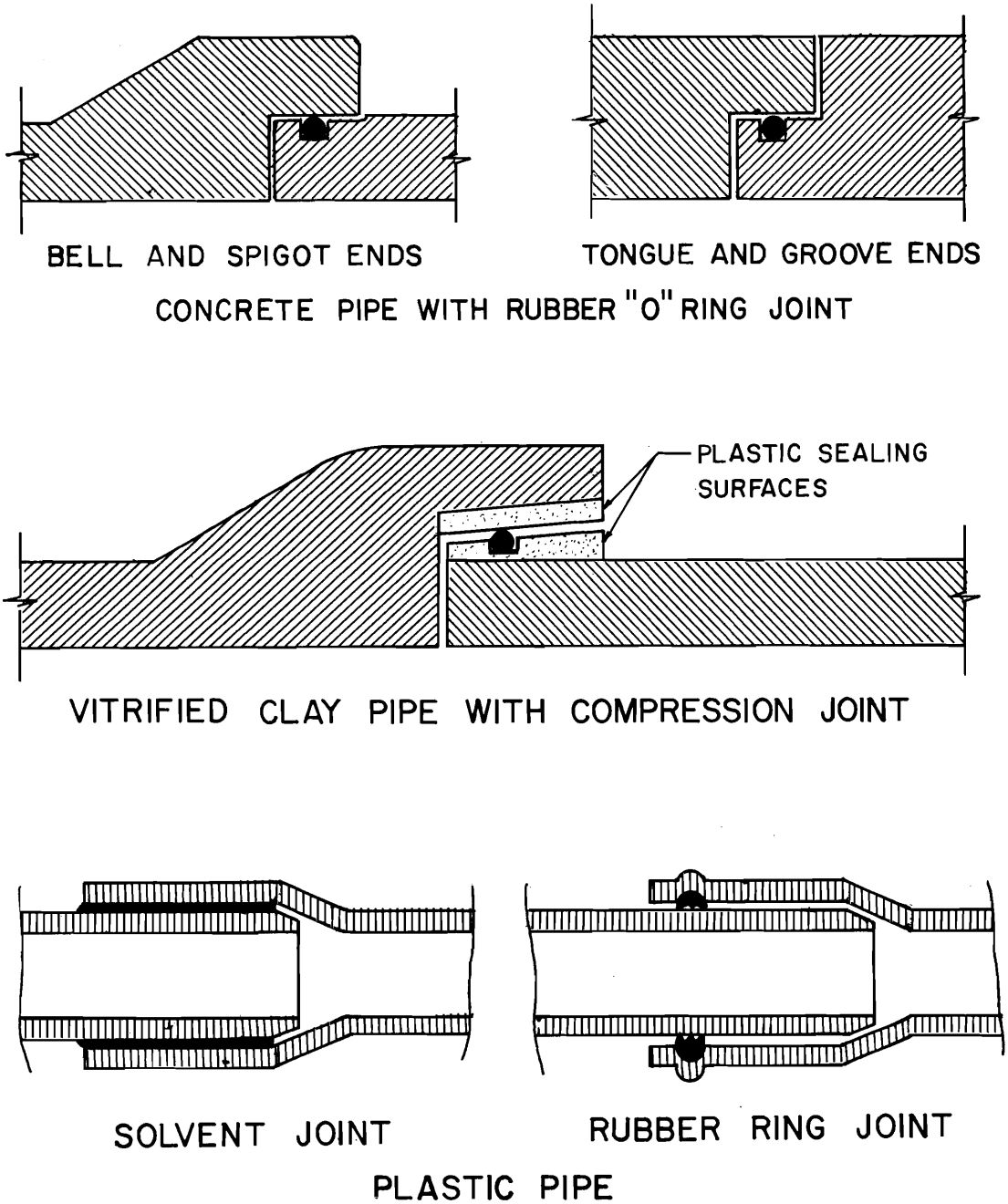

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ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

TYPICAL JOINTS FOR GRAVITY SEWERS

Not to scale

FIGURE H-5

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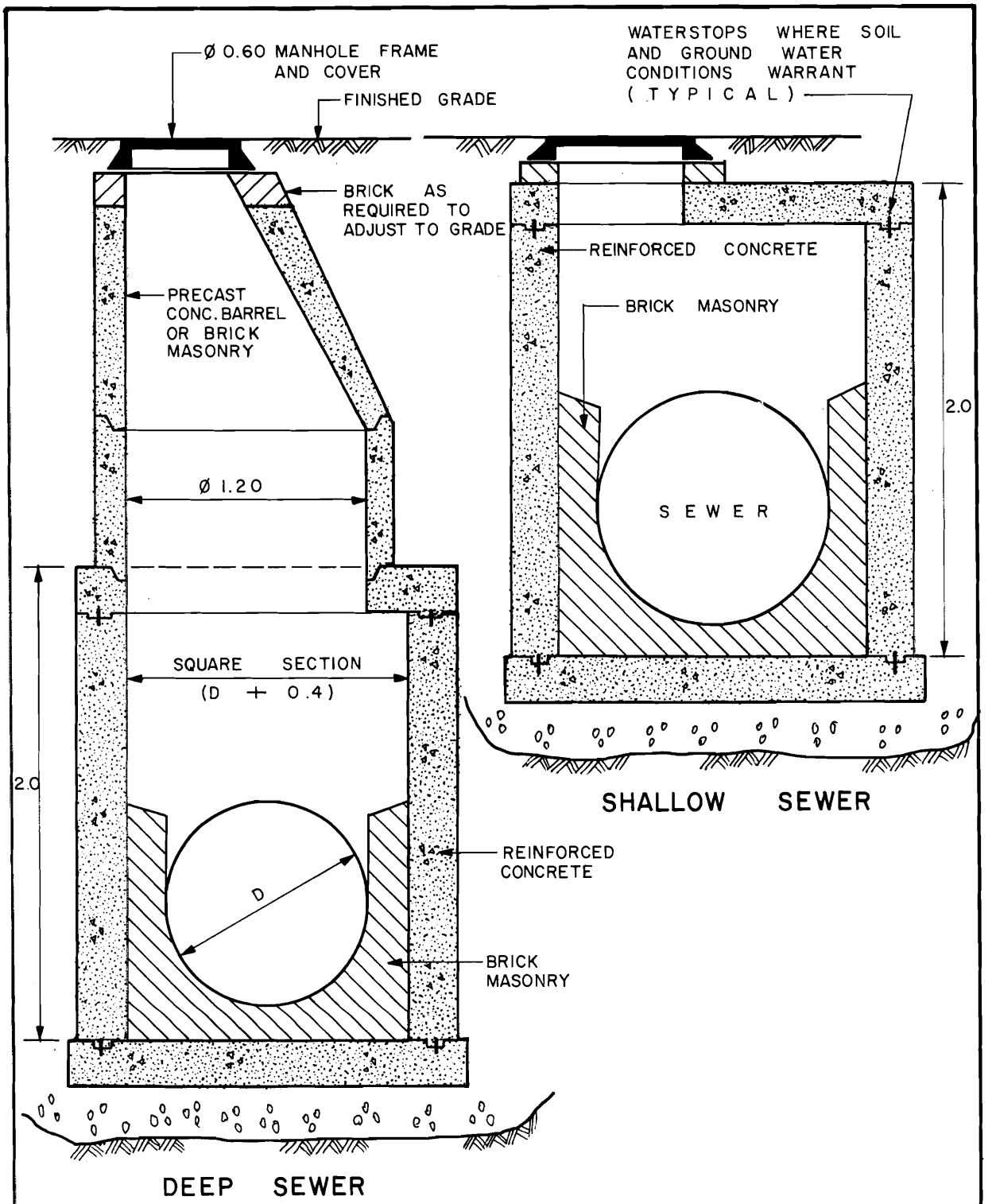

FOR SEWER SIZES GREATER THAN Ø 800 mm

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ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

TYPICAL MANHOLE FOR GRAVITY SEWERS

DIMENSIONS IN METERS

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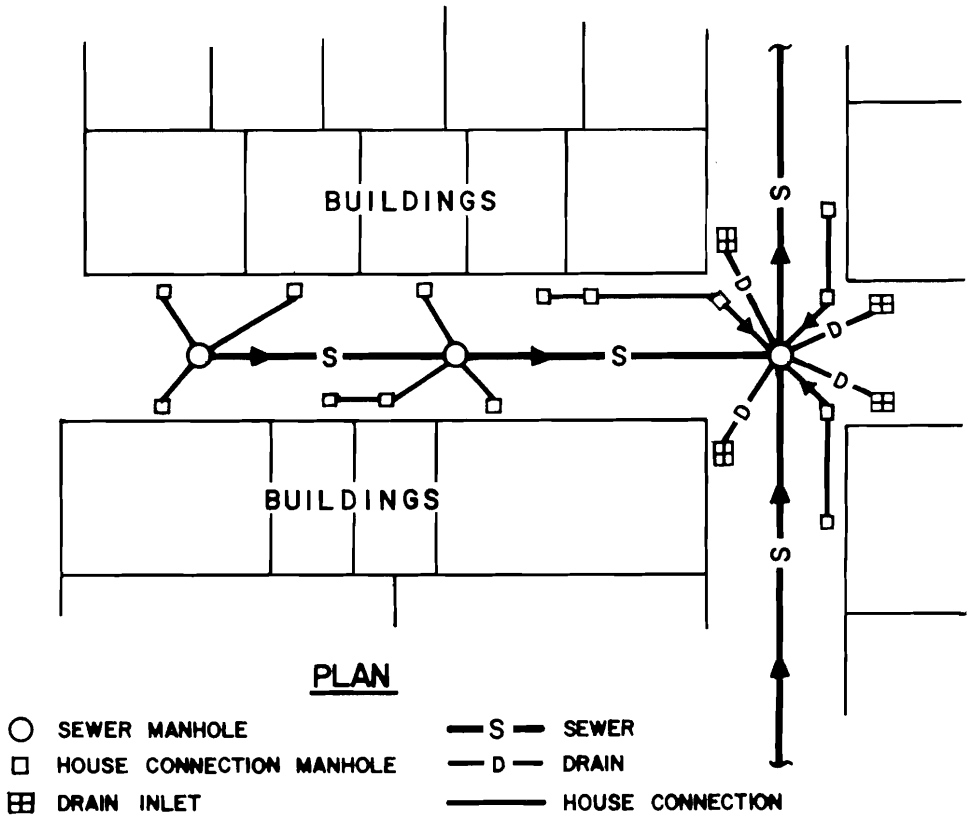
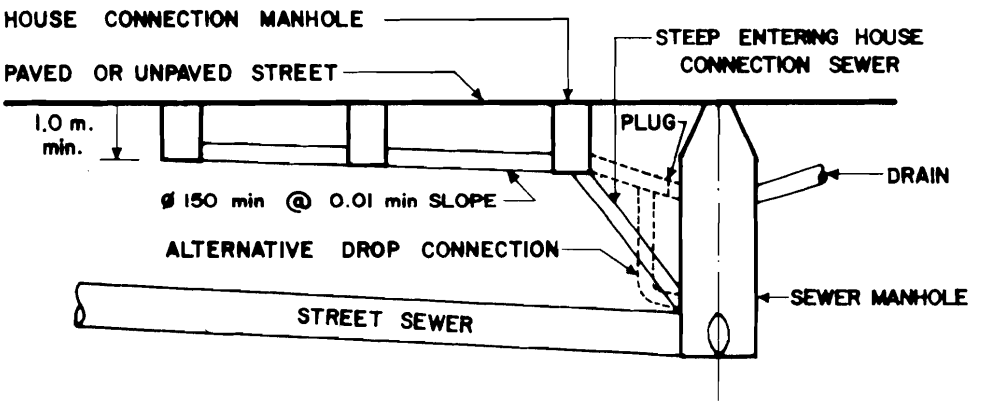
FIGURE H-6





SCHEMATIC PROFILE

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ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

TYPICAL LAYOUT OF PROPERTY CONNECTIONS (AS CONSTRUCTED IN ALEXANDRIA)

NOT TO SCALE

FIGURE H-7

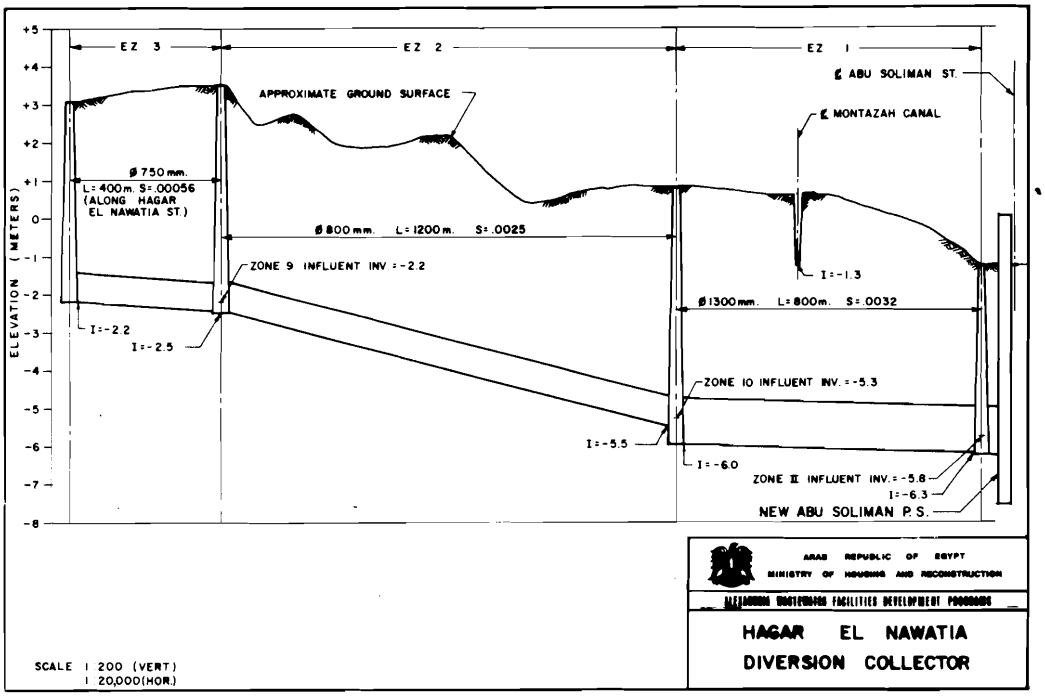

FIGURE H-8

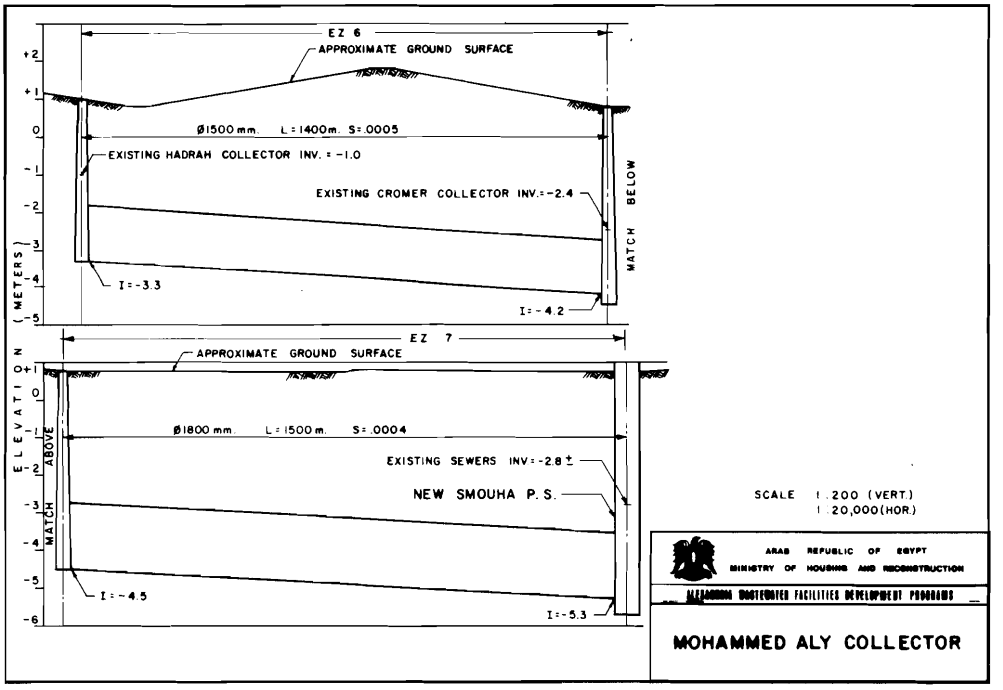

FIGURE H-9

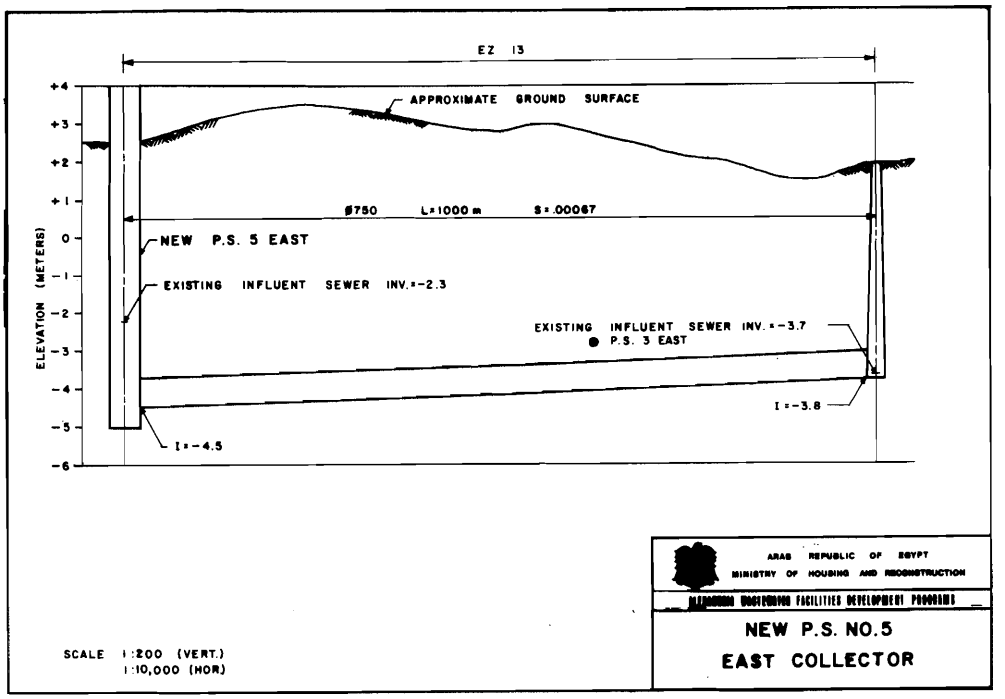

FIGURE H-10

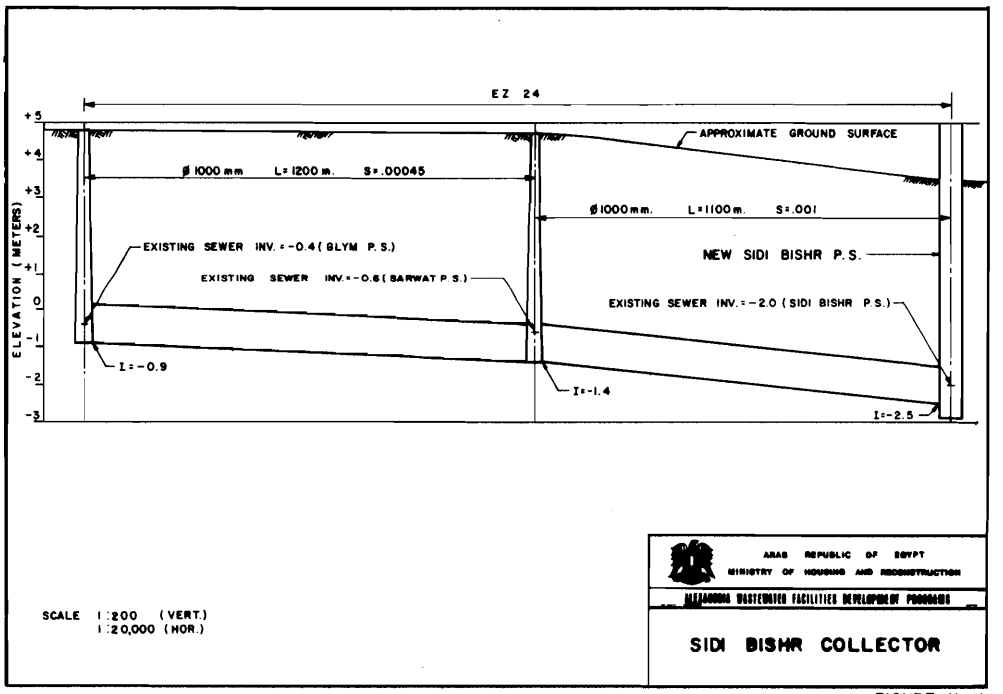

FIGURE H-11

FIGURES H-10 & H-11

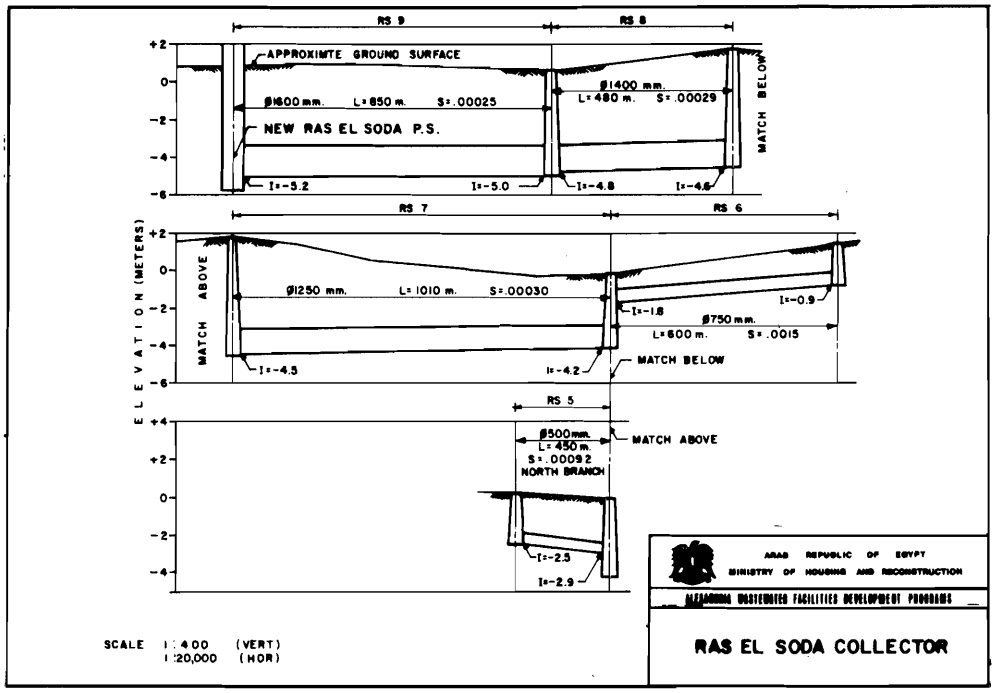

FIGURE H-12

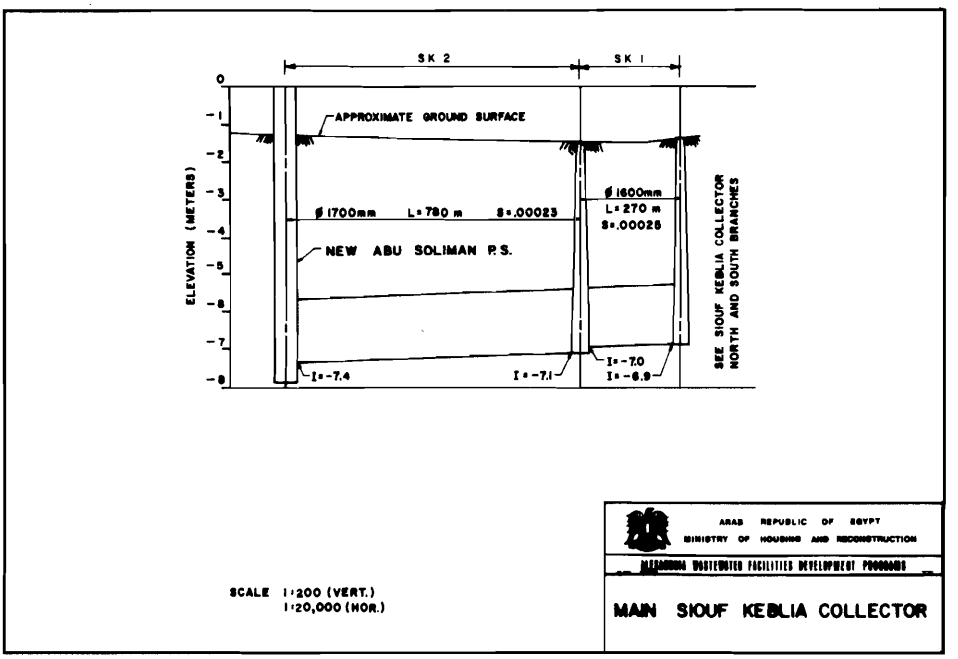

FIGURE H-13

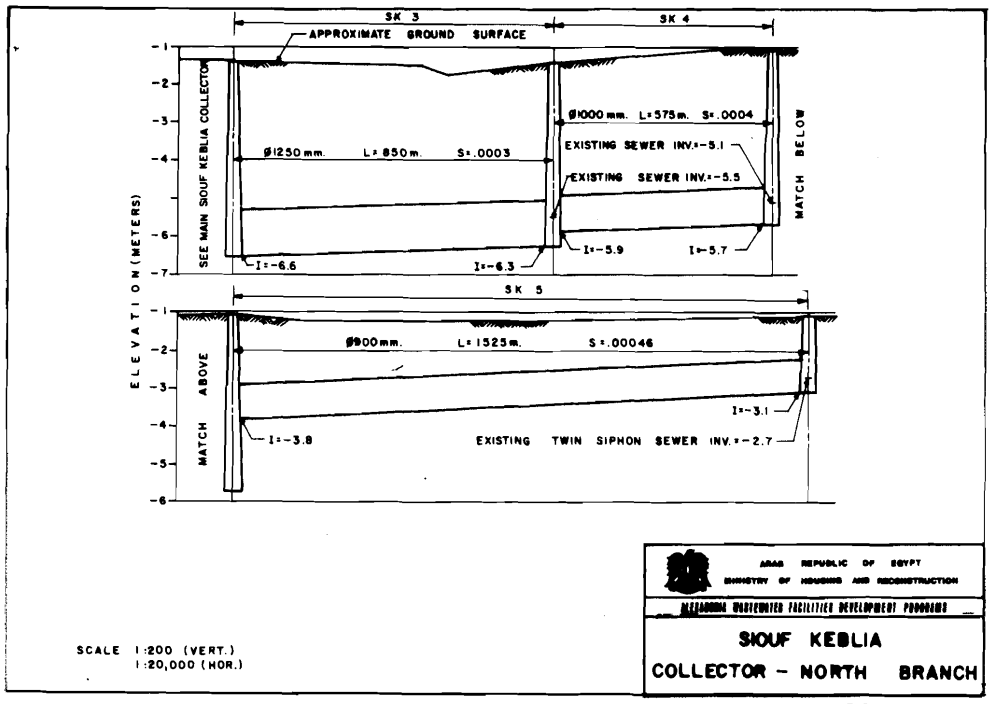

FIGURE H-14

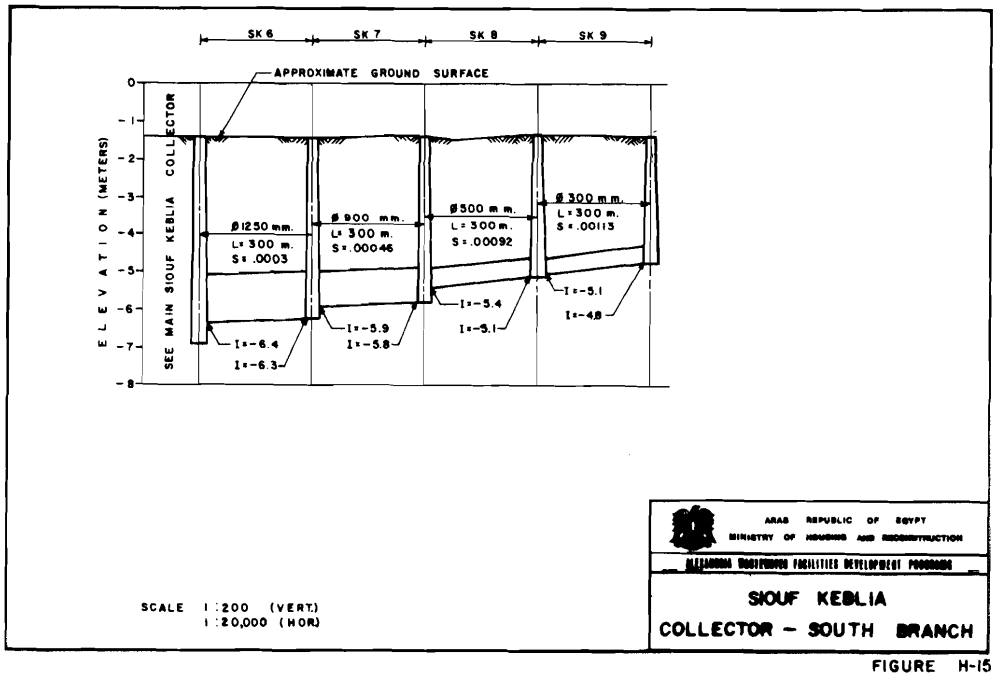

FIGURE H-15

FIGURES H-14 & H-15

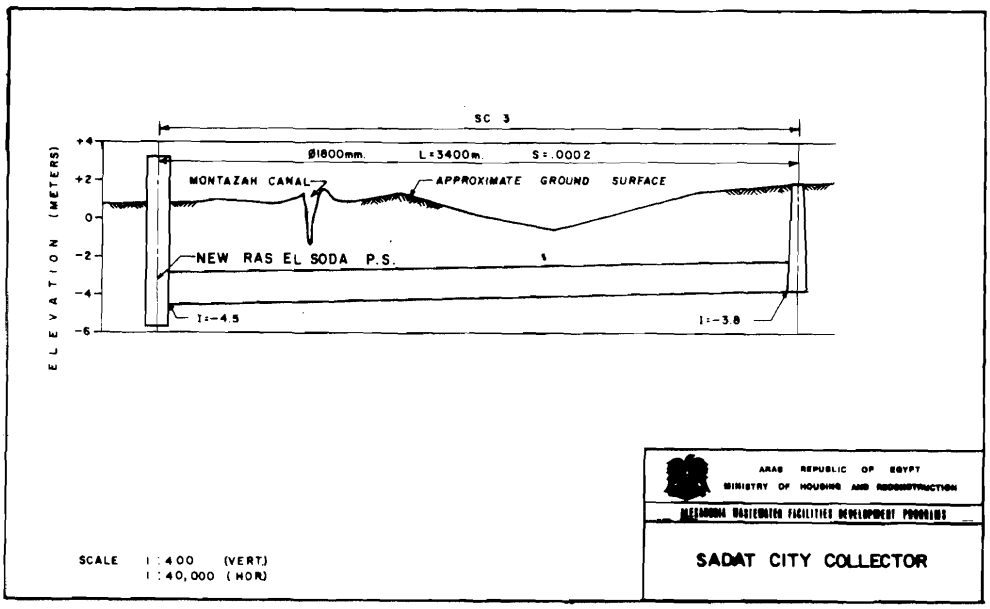

FIGURE H-16

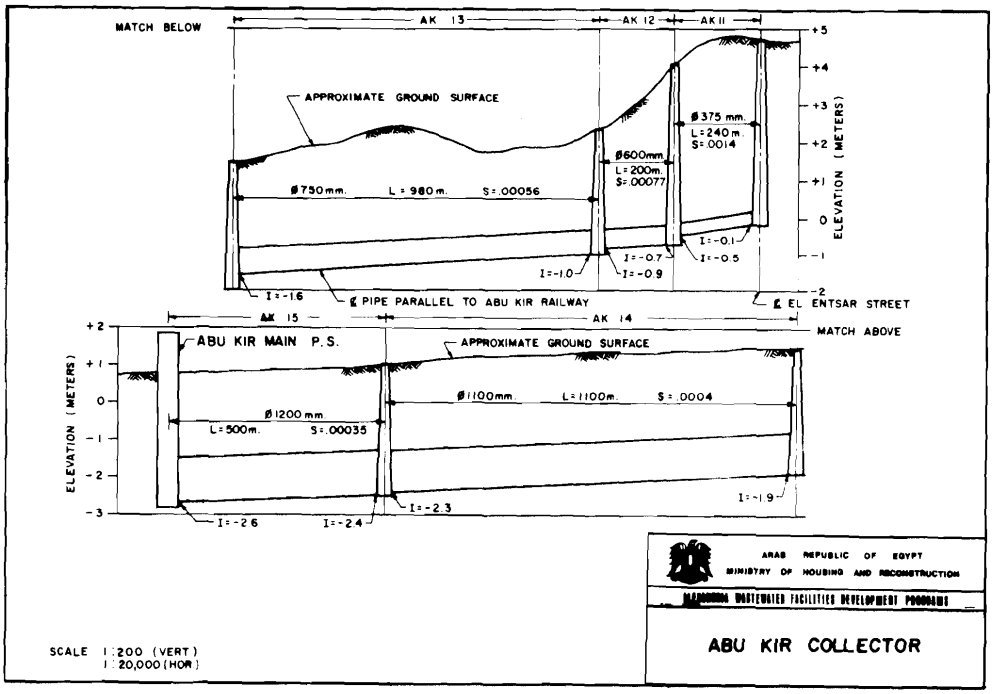

FIGURE H-17

FIGURES H-16 & H-17

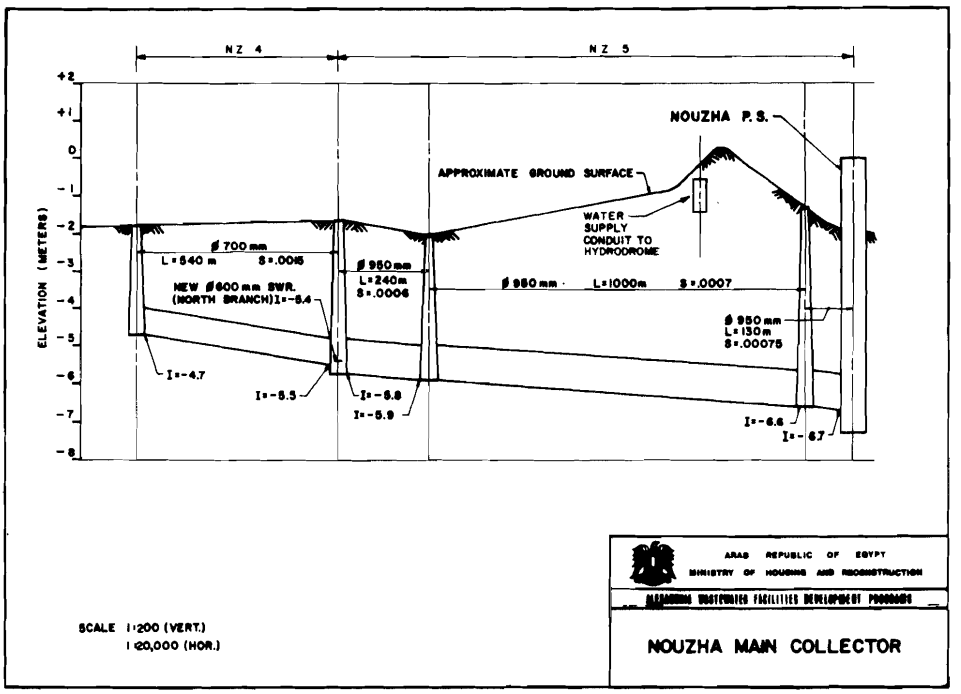

FIGURE H-18

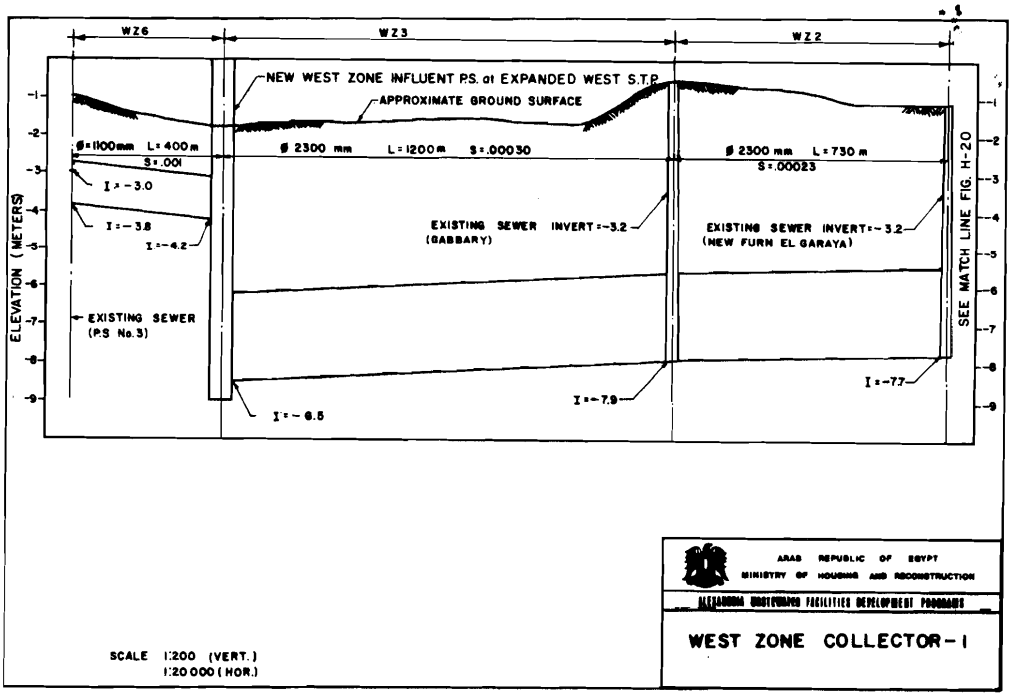

FIGURE H-19

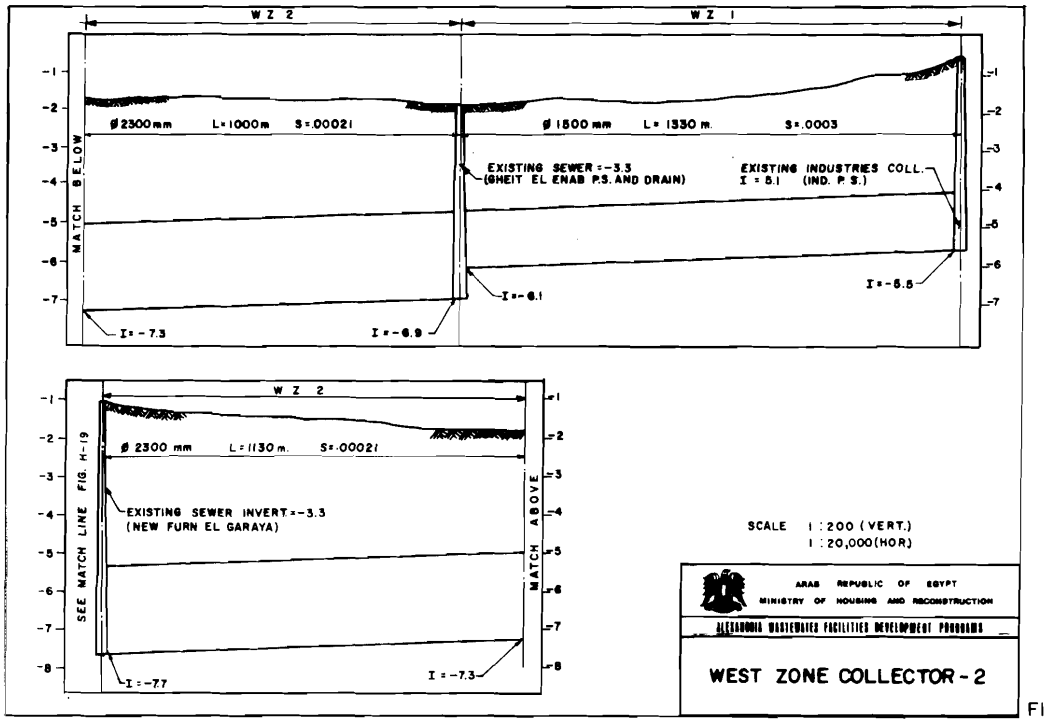

FIGURE H-20

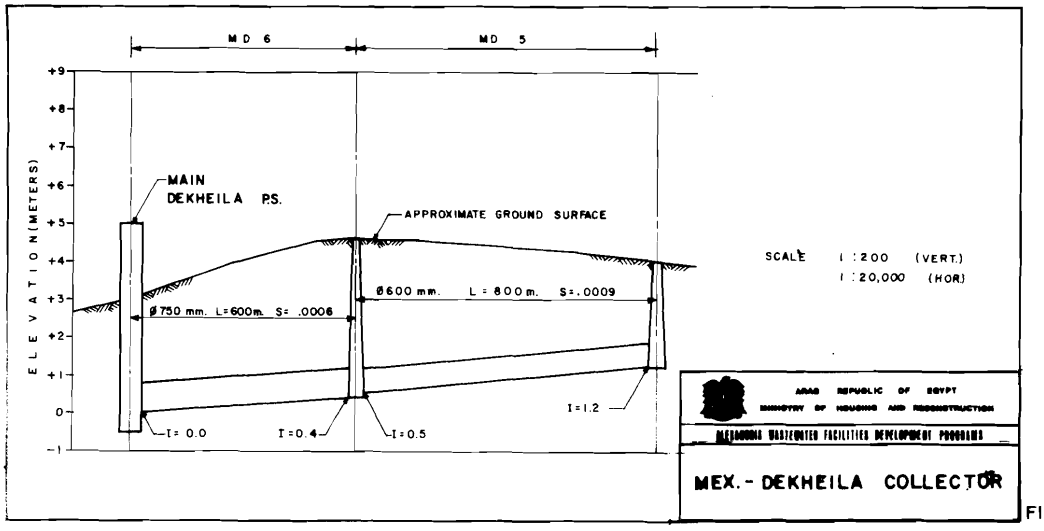

FIGURE H-21

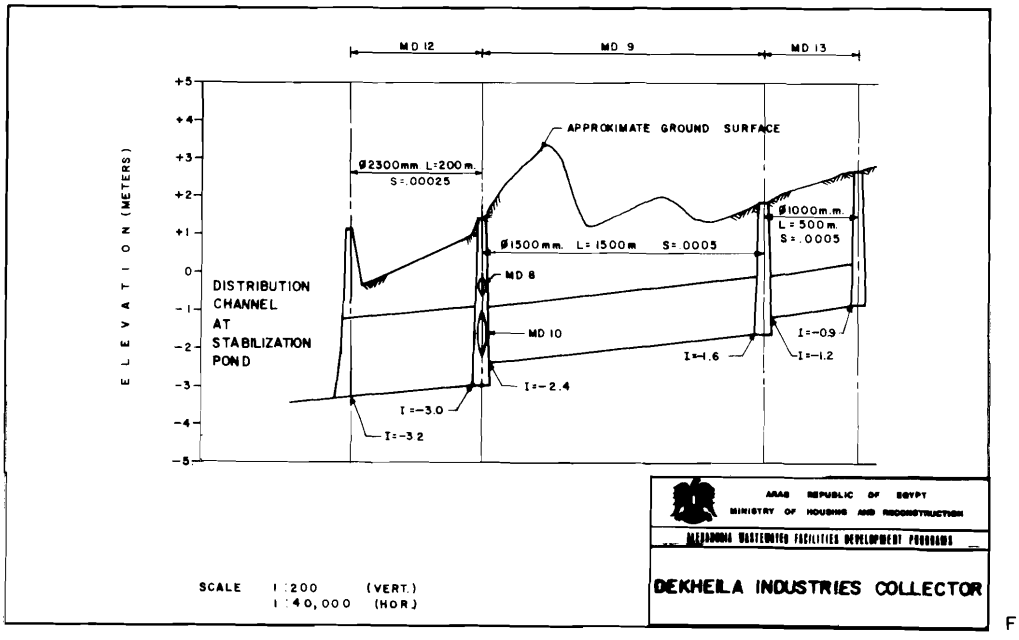

FIGURE H-22

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FIGURES H-20, H-21 & H-22

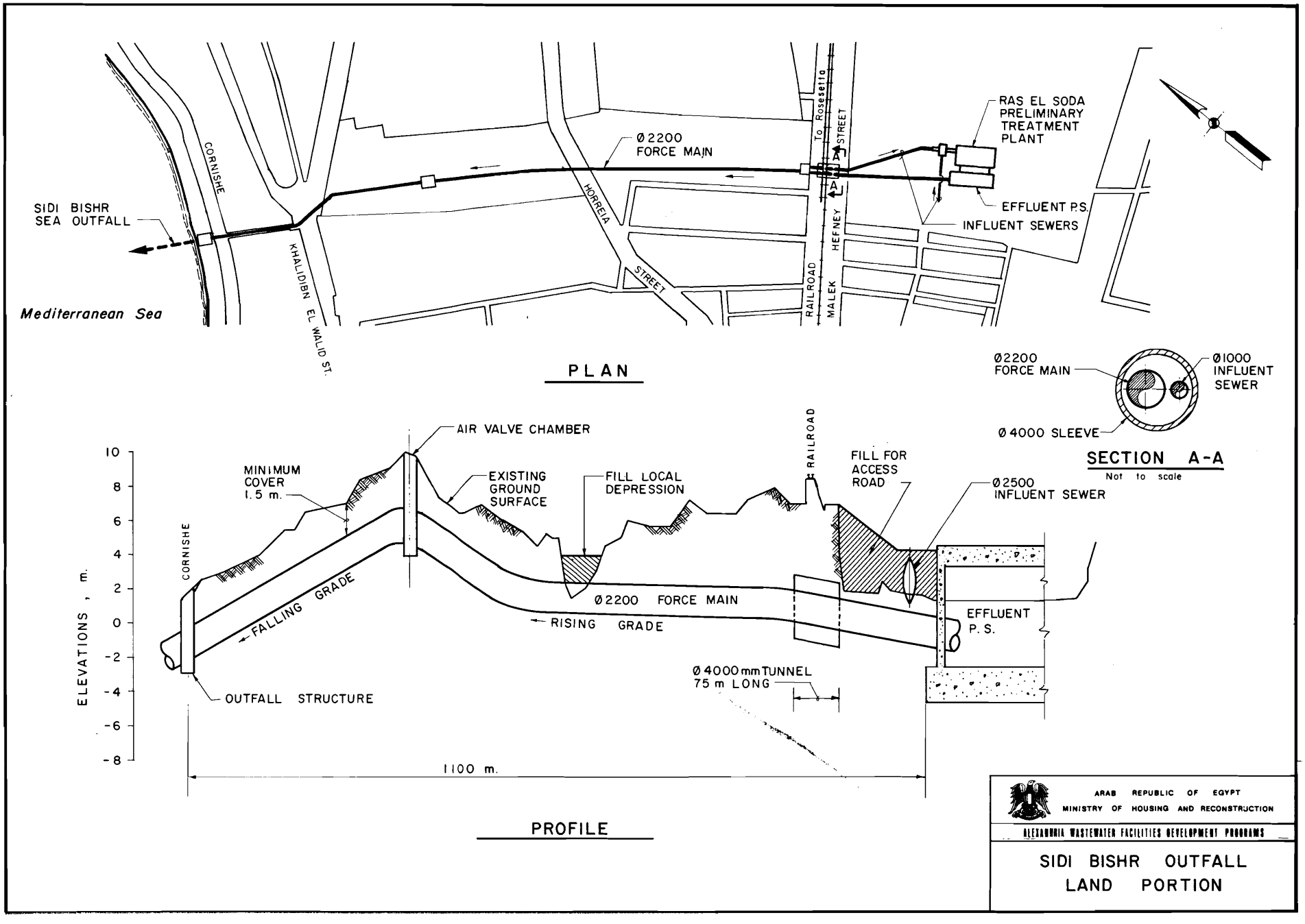

FIGURE H-23

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APPENDIX I

PUMP STATION AND TREATMENT PLANT DESIGN

Appendix I includes functional design layout drawings (preliminary) for the pump stations and treatment facilities proposed in the recommended master plan.

LIST OF FIGURES

I-1	Typical Pump Station to 100 ML/day Capacity
I-2	Typical Pump Station Greater Than ML/day Capacity
I-3	Ras el Soda Preliminary Treatment and Pumping Facilities
I-4	Kait Bey Preliminary Treatment and Pumping Facilities
I-5	Preliminary Treatment Works - General Plan
I-6	Preliminary Treatment Plant - Section Drawings
I-7	West Sewage Treatment Plant Modifications
I-8	West Treatment Plant Section Drawing
I-9	Mex-Dekheila Waste Stabilization Pond
I-10	Mex-Dekheila Waste Stabilization Pond (Plan A & B)
I-11	Ameria Waste Stabilization Pond
I-12	Abu Kir Bay Evaporation Pond

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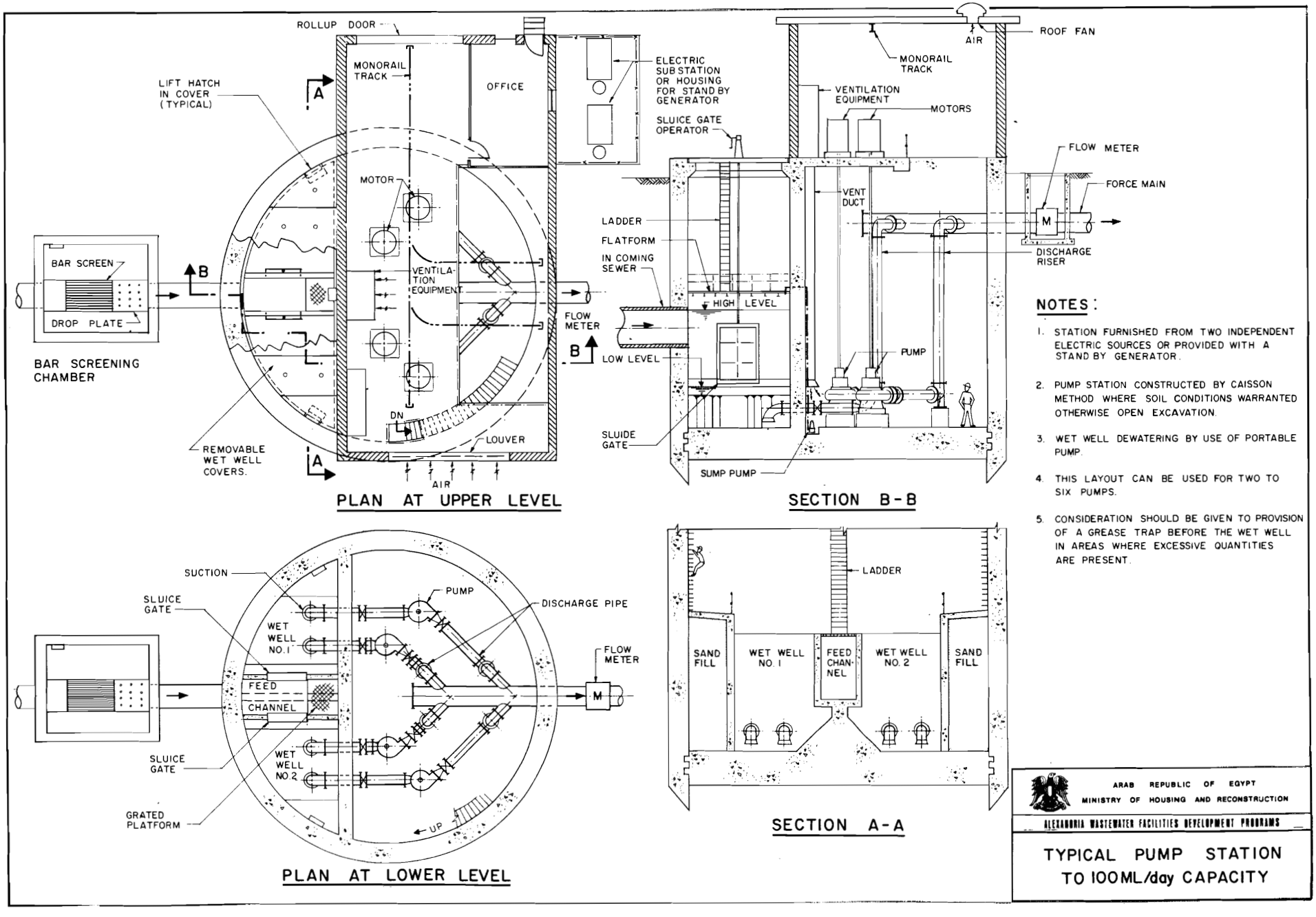
ROLLUP DOOR
MONORAIL TRACK
OFFICE
ELECTRIC SUBSTATION OR HOUSING FOR STAND BY GENERATOR
LIFT HATCH IN COVER (TYPICAL)
A
MOTOR
BAR SCREEN
DROP PLATE
BAR SCREENING CHAMBER
B
VENTILATION EQUIPMENT
FLOW METER
DN
LOUVER
REMOVABLE WET WELL COVERS.
AIR
PLAN AT UPPER LEVEL
AIR
ROOF FAN
MONORAIL TRACK
VENTILATION EQUIPMENT
MOTORS
SLUICE GATE OPERATOR
FLOW METER
FORCE MAIN
VENT DUCT
LADDER
FLATFORM
IN COMING SEWER
HIGH LEVEL
LOW LEVEL
PUMP
DISCHARGE RISER
SLUIDE GATE
SUMP PUMP
SECTION B-B
SUCTION
SLUICE GATE
PUMP
DISCHARGE PIPE
WET WELL NO.1
FLOW METER
FEED CHANNEL
SLUICE GATE
WET WELL NO.2
GRATED PLATFORM
UP
PLAN AT LOWER LEVEL
LADDER
SAND FILL
WET WELL NO. 1
FEED CHANNEL
WET WELL NO. 2
SAND FILL
SECTION A-A
NOTES:
1. STATION FURNISHED FROM TWO INDEPENDENT ELECTRIC SOURCES OR PROVIDED WITH A STAND BY GENERATOR.
2. PUMP STATION CONSTRUCTED BY CAISSON METHOD WHERE SOIL CONDITIONS WARRANTED OTHERWISE OPEN EXCAVATION.
3. WET WELL DEWATERING BY USE OF PORTABLE PUMP.
4. THIS LAYOUT CAN BE USED FOR TWO TO SIX PUMPS.
5. CONSIDERATION SHOULD BE GIVEN TO PROVISION OF A GREASE TRAP BEFORE THE WET WELL IN AREAS WHERE EXCESSIVE QUANTITIES ARE PRESENT.
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MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
TYPICAL PUMP STATION TO 100ML/day CAPACITY

FIGURE I-1

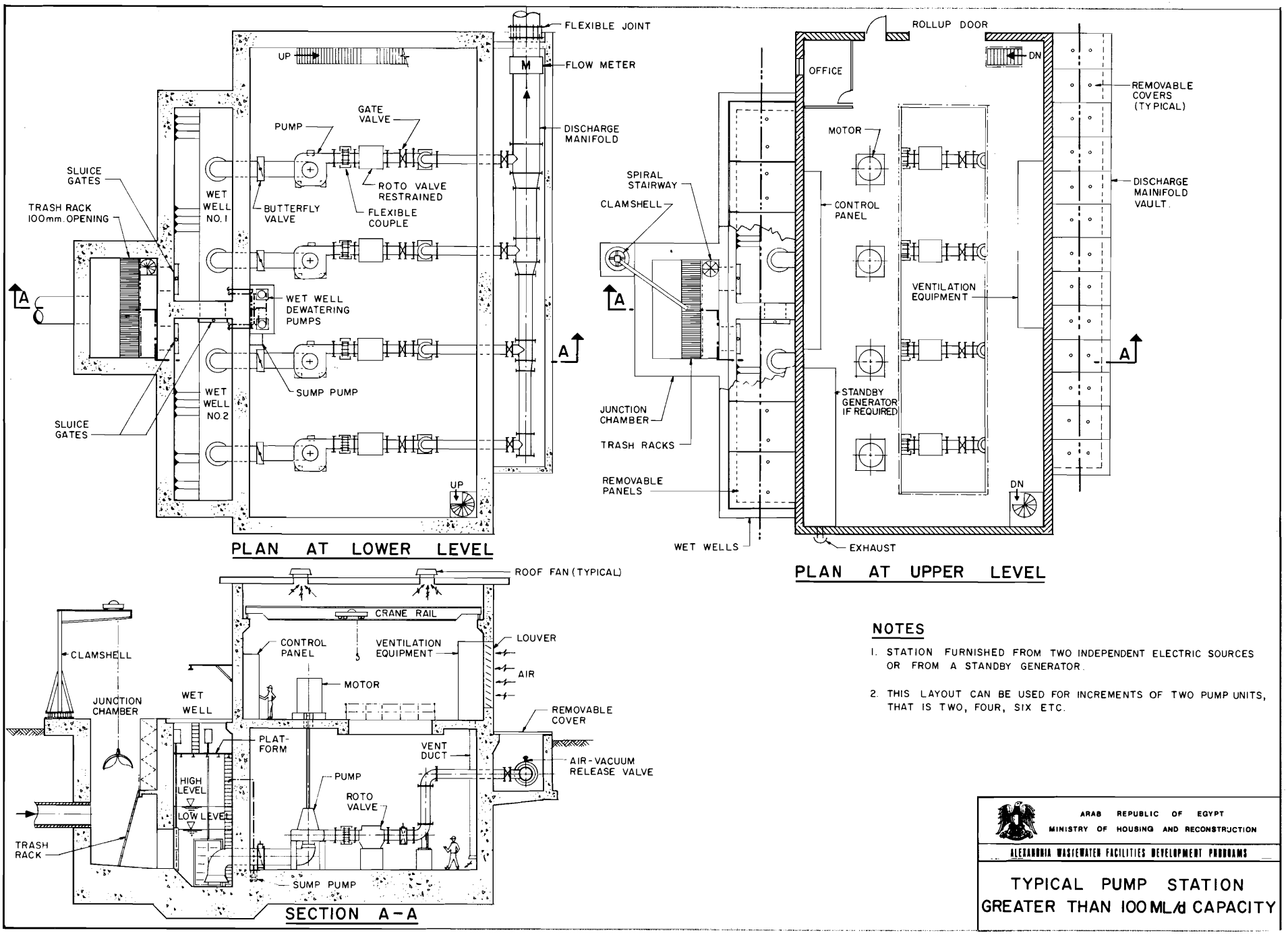
FLEXIBLE JOINT
FLOW METER
UP
PUMP
GATE VALVE
DISCHARGE MANIFOLD
SLUICE GATES
TRASH RACK 100mm. OPENING
WET WELL NO. 1
BUTTERFLY VALVE
ROTO VALVE RESTRAINED
FLEXIBLE COUPLE
WET WELL DEWATERING PUMPS
SUMP PUMP
WET WELL NO. 2
SLUICE GATES
A
PLAN AT LOWER LEVEL
ROLLUP DOOR
OFFICE
DN
REMOVABLE COVERS (TYPICAL)
MOTOR
SPIRAL STAIRWAY
CLAMSHELL
CONTROL PANEL
DISCHARGE MAINIFOLD VAULT.
VENTILATION EQUIPMENT
STANDBY GENERATOR IF REQUIRED
JUNCTION CHAMBER
TRASH RACKS
REMOVABLE PANELS
WET WELLS
EXHAUST
PLAN AT UPPER LEVEL
ROOF FAN (TYPICAL)
CRANE RAIL
CLAMSHELL
CONTROL PANEL
VENTILATION EQUIPMENT
LOUVER
AIR
MOTOR
JUNCTION CHAMBER
WET WELL
REMOVABLE COVER
PLAT-FORM
VENT DUCT
AIR-VACUUM RELEASE VALVE
PUMP
HIGH LEVEL
ROTO VALVE
LOW LEVEL
TRASH RACK
SUMP PUMP
SECTION A-A
NOTES
1. STATION FURNISHED FROM TWO INDEPENDENT ELECTRIC SOURCES OR FROM A STANDBY GENERATOR.
2. THIS LAYOUT CAN BE USED FOR INCREMENTS OF TWO PUMP UNITS, THAT IS TWO, FOUR, SIX ETC.
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
TYPICAL PUMP STATION
GREATER THAN 100 ML/d CAPACITY

FIGURE I-2

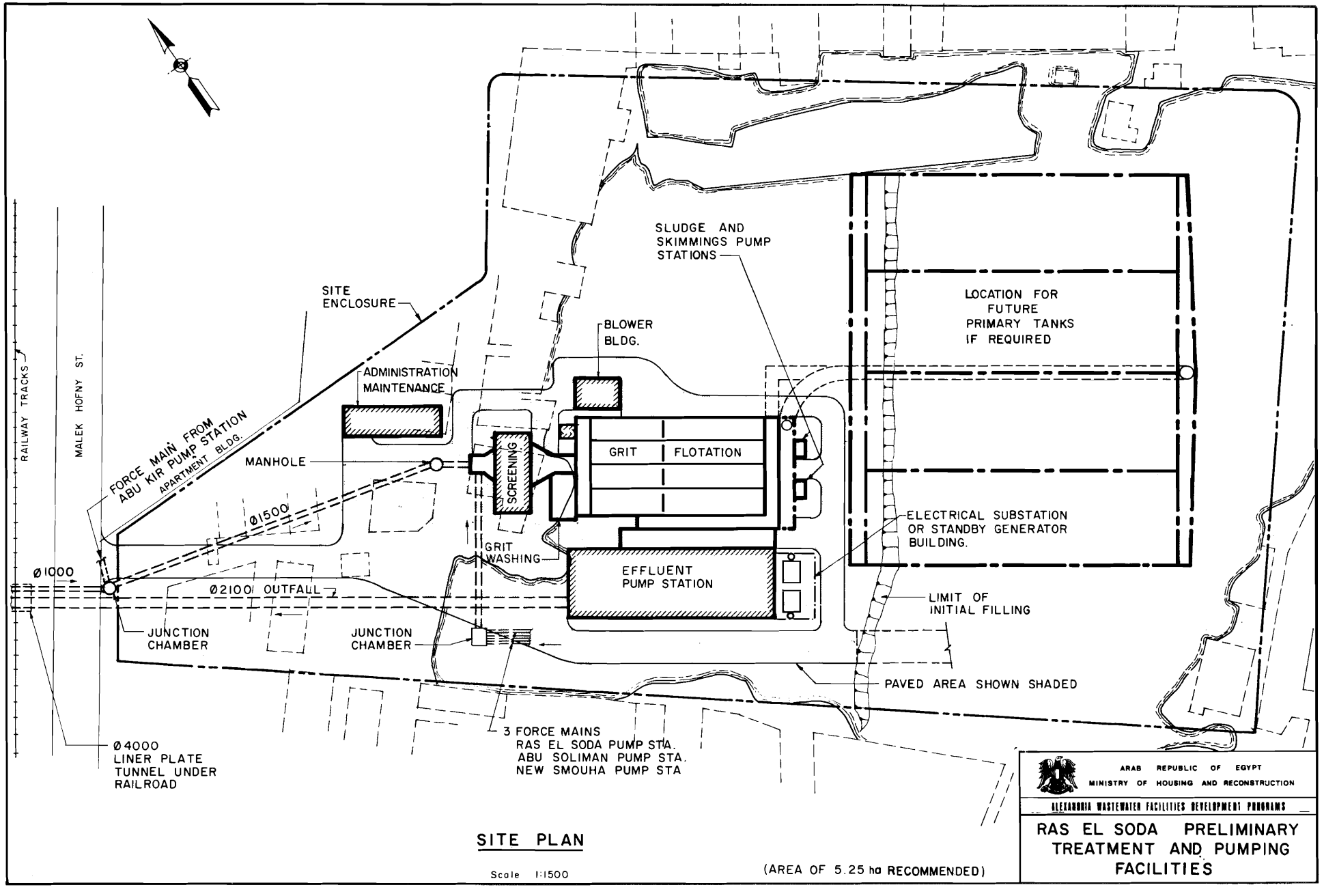

FIGURE I-3

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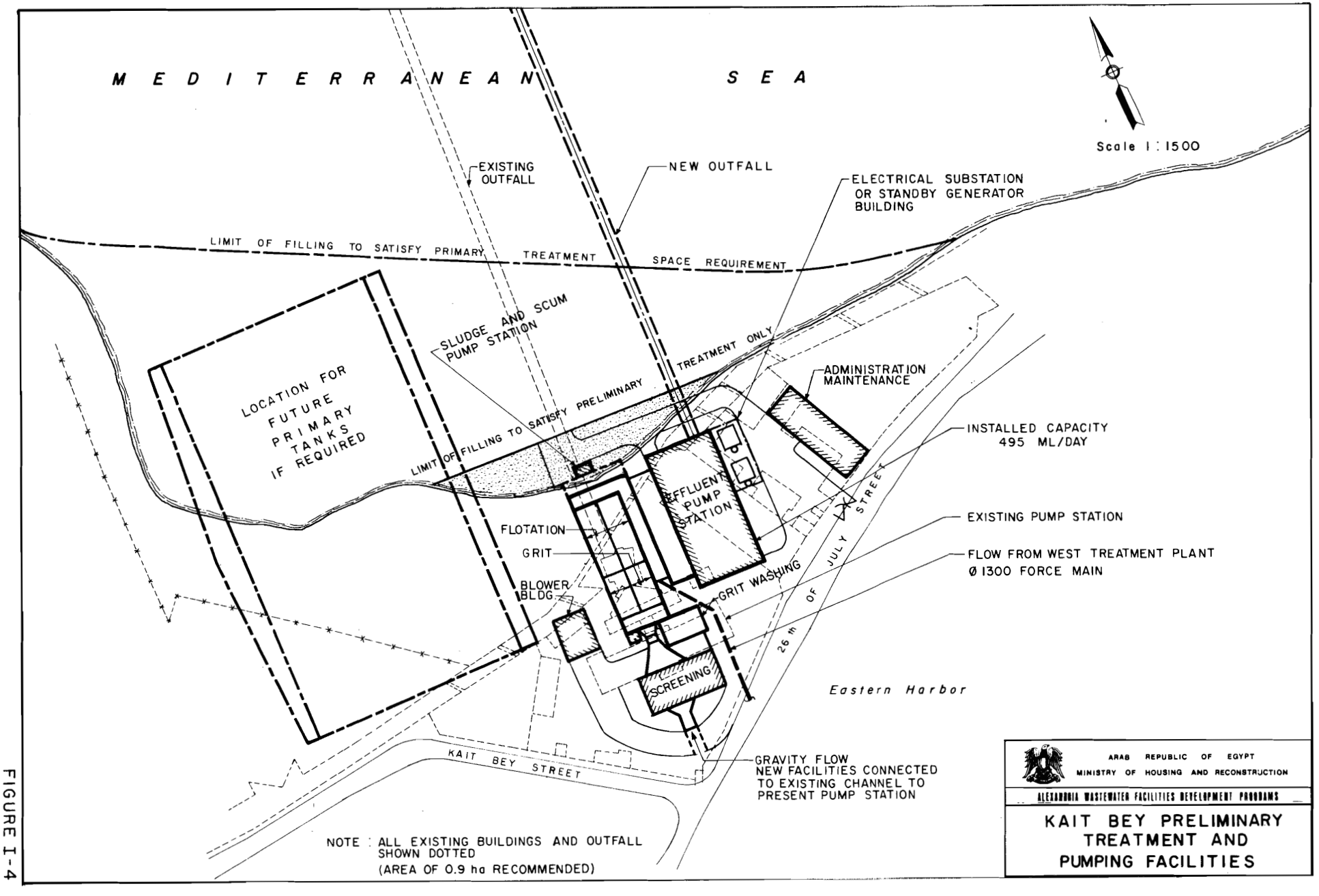
MEDITERRANEAN SEA
Scale 1 : 1500
EXISTING OUTFALL
NEW OUTFALL
ELECTRICAL SUBSTATION OR STANDBY GENERATOR BUILDING
LIMIT OF FILLING TO SATISFY PRIMARY TREATMENT SPACE REQUIREMENT
SLUDGE AND SCUM PUMP STATION
LOCATION FOR FUTURE PRIMARY TANKS IF REQUIRED
LIMIT OF FILLING TO SATISFY PRELIMINARY TREATMENT ONLY
ADMINISTRATION MAINTENANCE
INSTALLED CAPACITY 495 ML/DAY
EFFLUENT PUMP STATION
EXISTING PUMP STATION
FLOW FROM WEST TREATMENT PLANT Ø 1300 FORCE MAIN
FLOTATION
GRIT
BLOWER BLDG
GRIT WASHING
SCREENING
26 m OF JULY STREET
Eastern Harbor
KAIT BEY STREET
GRAVITY FLOW NEW FACILITIES CONNECTED TO EXISTING CHANNEL TO PRESENT PUMP STATION
NOTE : ALL EXISTING BUILDINGS AND OUTFALL SHOWN DOTTED
(AREA OF 0.9 ha RECOMMENDED)
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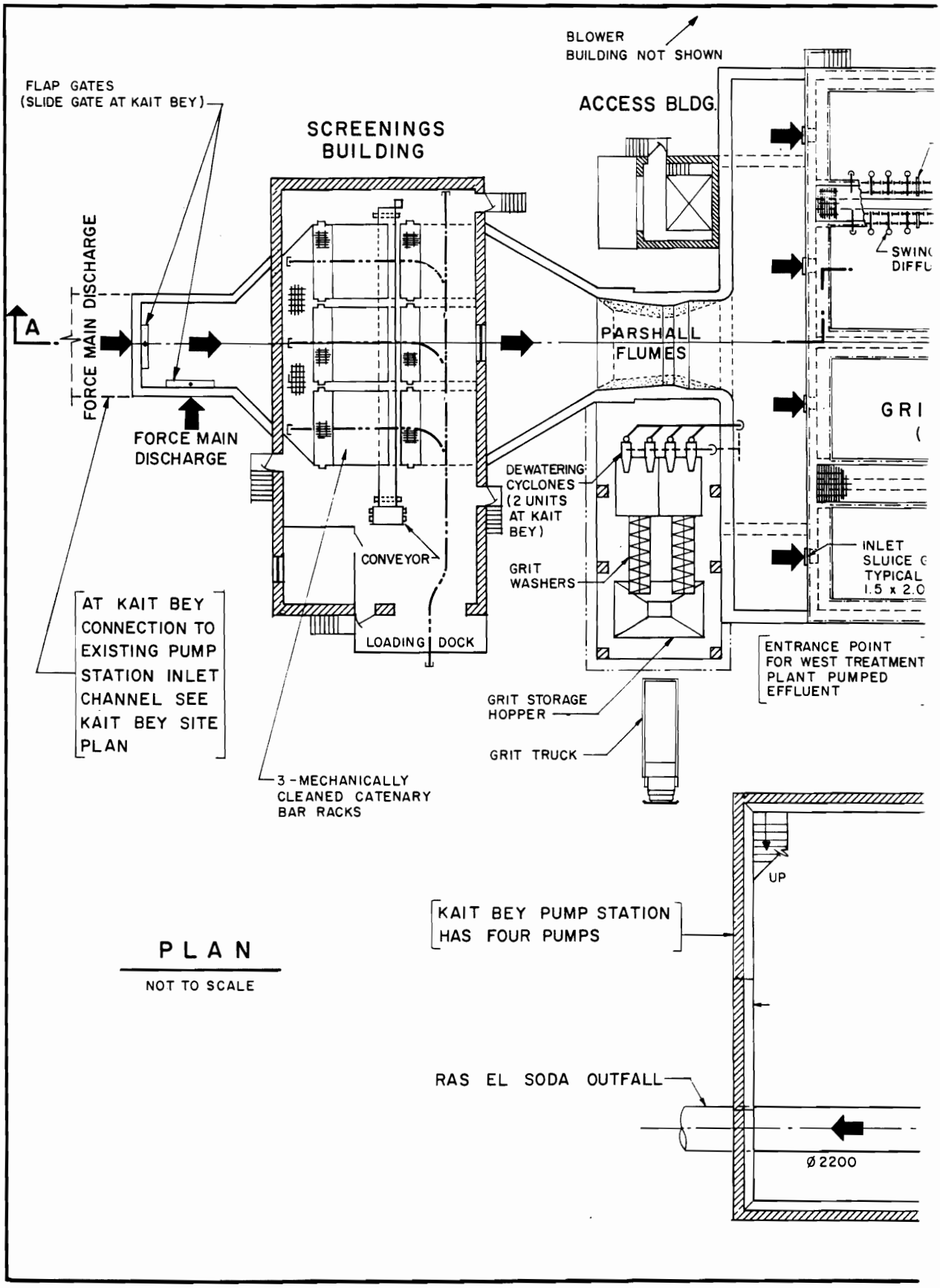
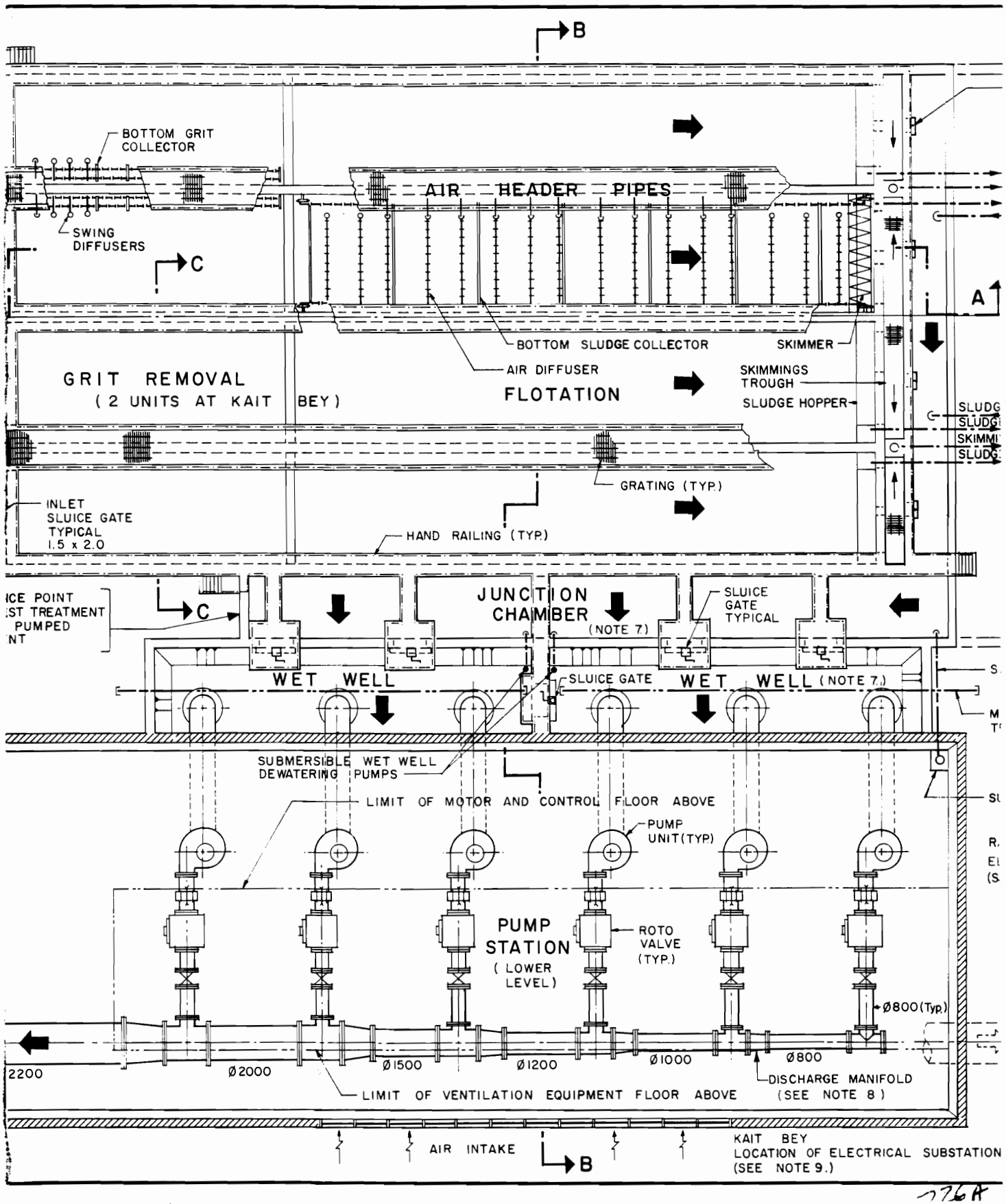
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
KAIT BEY PRELIMINARY TREATMENT AND PUMPING FACILITIES

FIGURE I-4

BEST AVAILABLE COPY

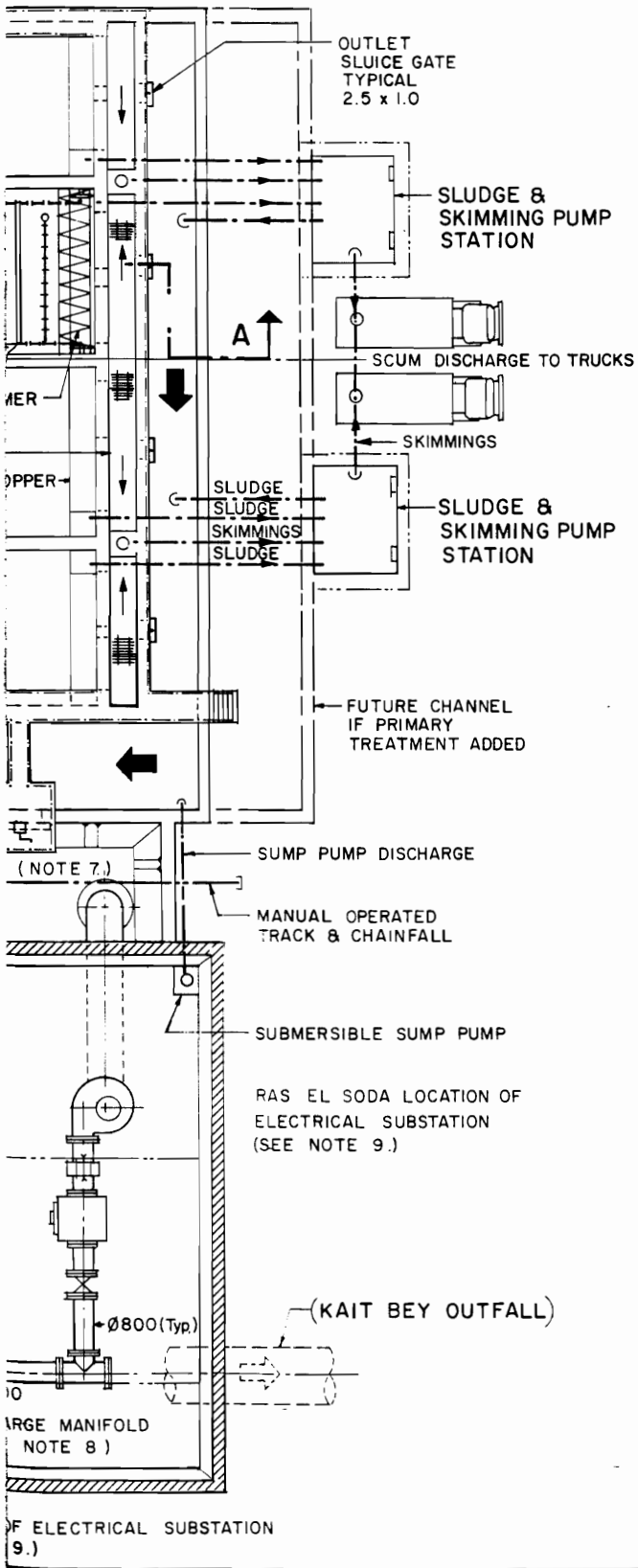


BEST AVAILABLE COPY



176A

BEST AVAILABLE COPY



NOTES :

1. LAYOUT AS SHOWN IS FOR RAS EL SODA THE KAIT BEY IS SIMILAR AS NOTED ON THIS PLAN
2. PUMP UNITS FOR RAS EL SODA
   5 AT 175 ML/Day
   1 STANDBY
3. PUMP UNITS FOR KAIT BEY
   3 AT 175 ML/Day
   1 STANDBY
4. SCREENINGS, GRIT, AND SKIMMINGS ARE REMOVED BY TRUCKING OFFSITE
5. SLUDGE FROM FLOTATION TANKS PUMPED INTO EFFLUENT CHANNEL
6. BOTH RAS EL SODA AND KAIT BEY PLANTS TO BE PROVIDED WITH LIGHTWEIGHT COVERS OVER GRIT AND FLOTATION TANKS
7. PUMP STATION WET WELLS AND JUNCTION CHAMBERS TO HAVE REMOVABLE PANEL—COVERS.
8. DISCHARGE MANIFOLD SHOWN INSIDE PUMP STATION. OPTIONAL LAYOUT POSSIBLE WITH MANIFOLD OUTSIDE PUMP STRUCTURE.
9. STANDBY POWER PROVIDED BY CONNECTION TO DUAL POWEN SOURCE. IF NO DUAL POWER SOURCE AVAILABLE STANDBY DIESEL GENERATOR TO BE INCLUDED.

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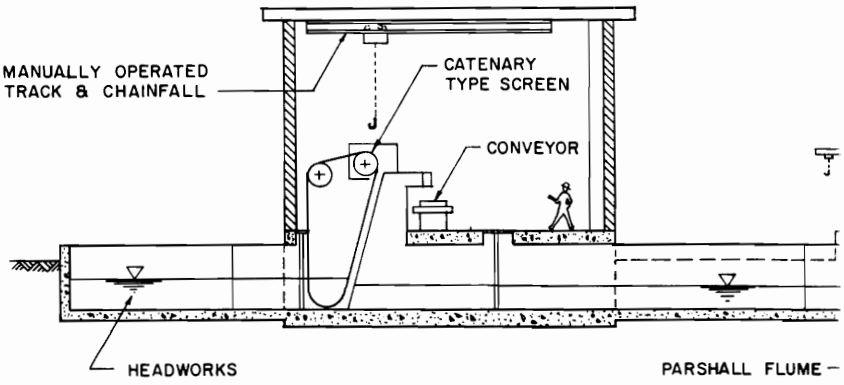
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

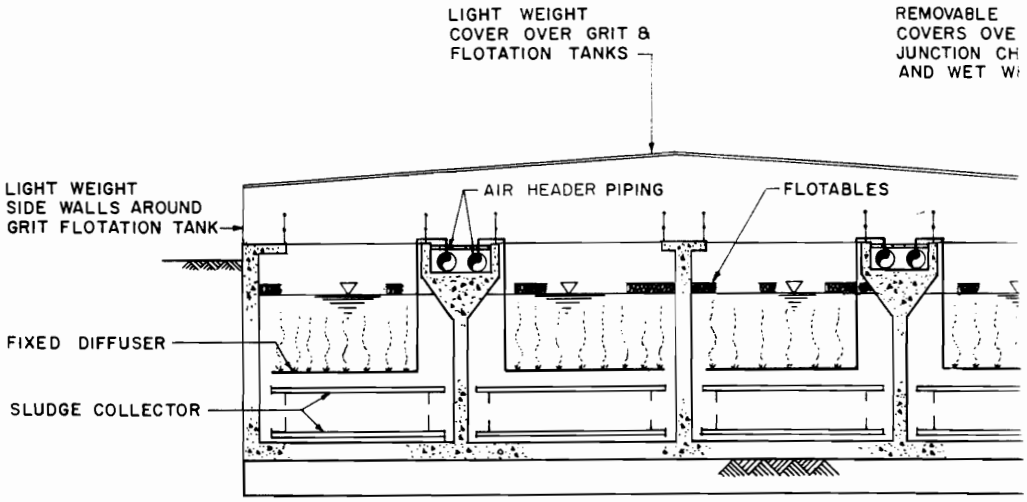
PRELIMINARY TREATMENT WORKS GENERAL PLAN

FIGURE T—5

BEST AVAILABLE COPY

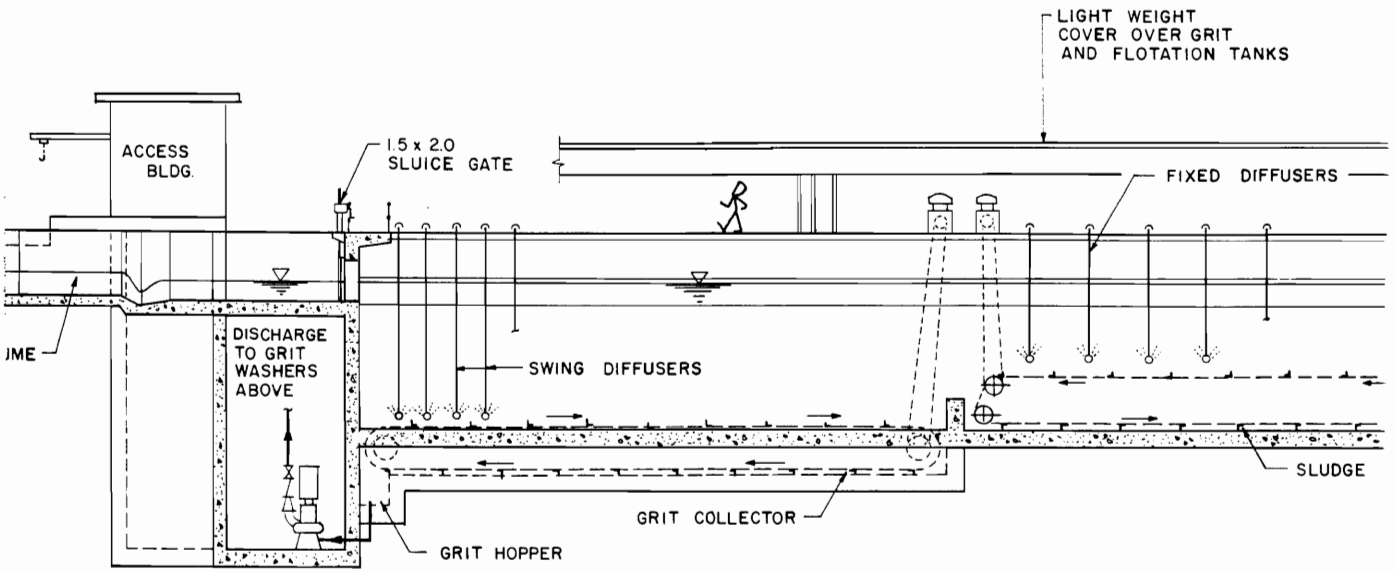


SCREENINGS BLDG.



FLOTATION

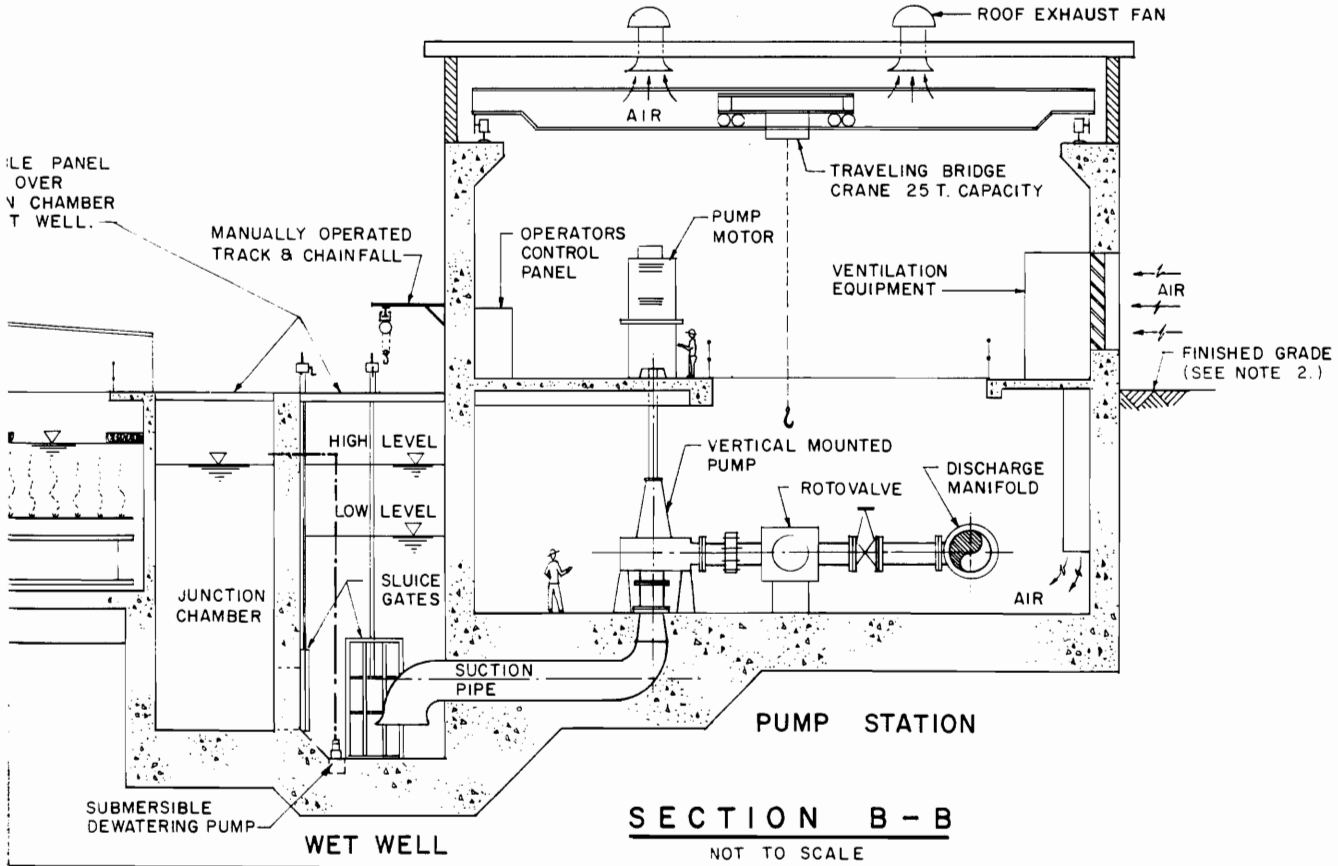
BEST AVAILABLE COPY



GRIT PUMP STATION GRIT REMOVAL

SECTION A-A

NOT TO SCALE



PUMP STATION

WET WELL

SECTION B-B

NOT TO SCALE

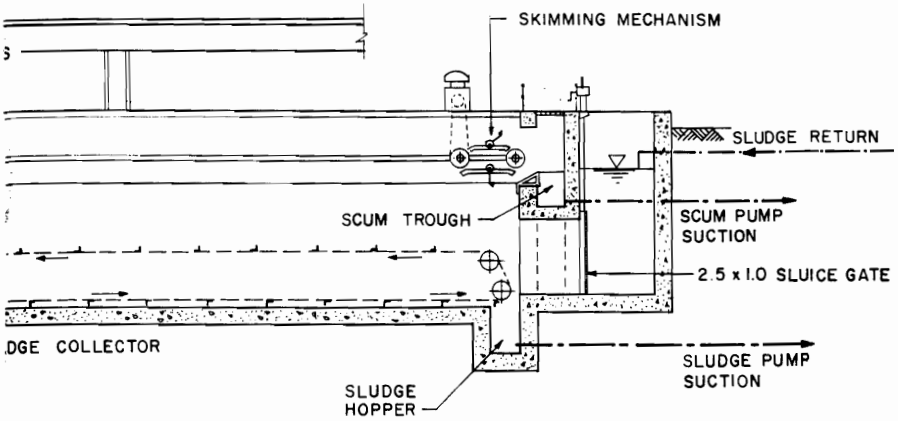
227A.

BEST AVAILABLE COPY

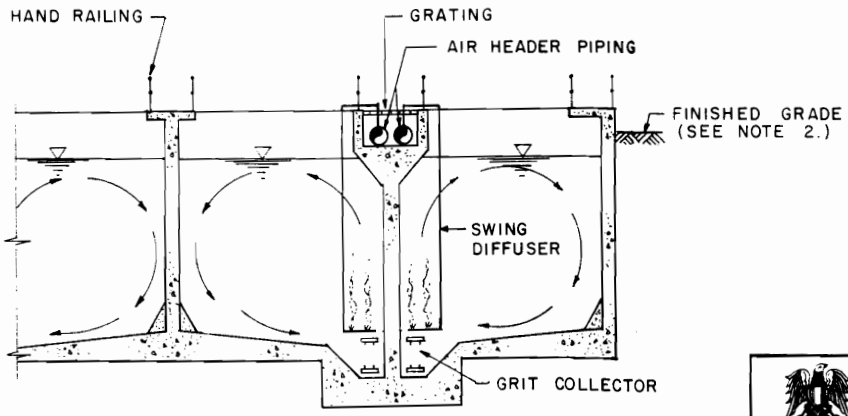
NOTES:

1- LAYOUT AS SHOWN IS FOR RAS EL SODA. KAIT BEY IS SIMILAR AS NOTED

2- KAIT BEY PLANT SET AT A LOWER ELEVATION. THE PERIPHERAL WALLS OF THE CHANNELS AND BASINS ARE 2.0 METRES HIGHER THAN SHOWN HERE.
THE PUMP STATION SUB STRUCTURE WILL BE 2.0 METRES DEEPER



FLOTATION



GRIT REMOVAL

SECTION C-C

NOT TO SCALE

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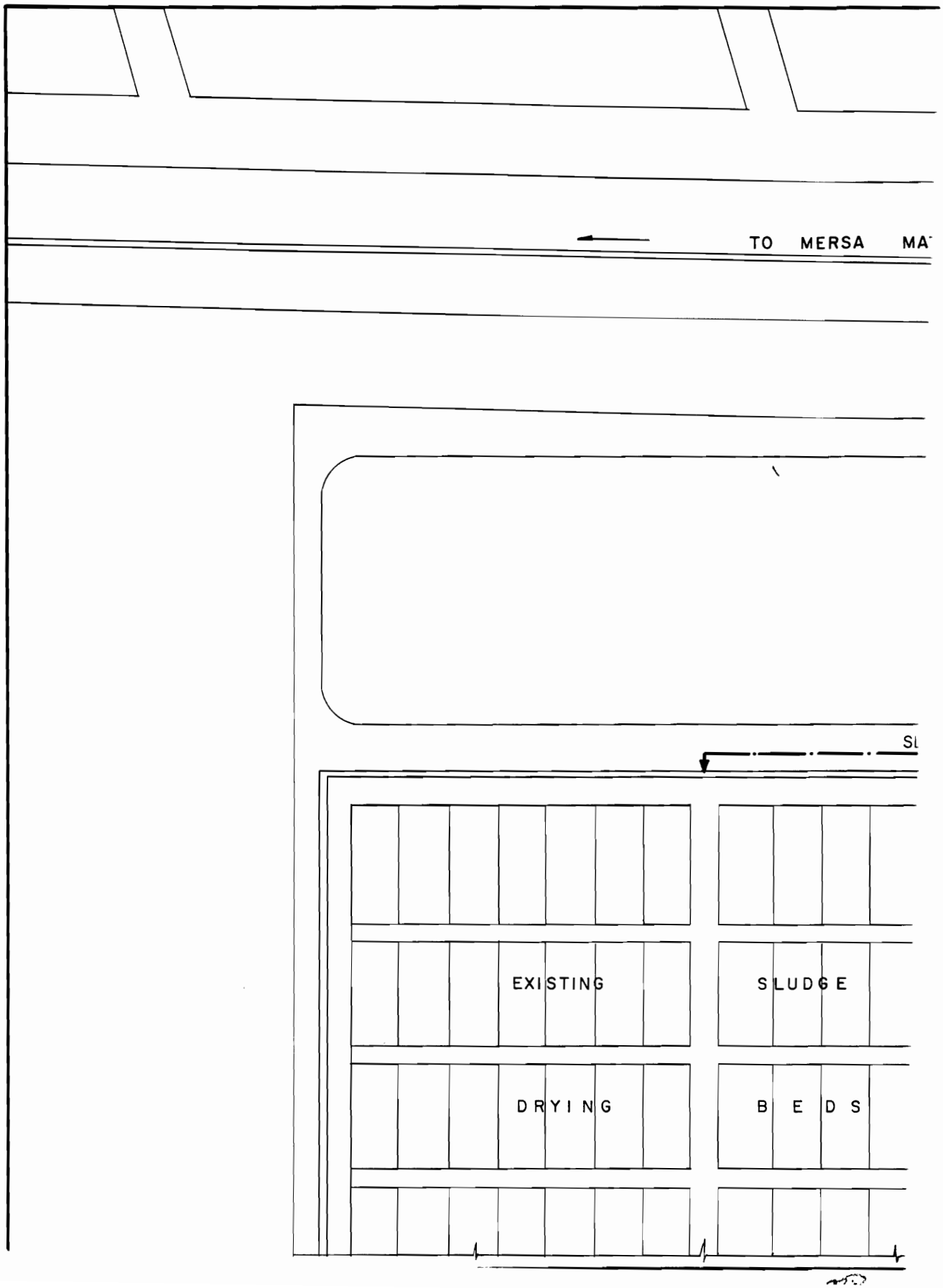
MINISTRY OF HOUSING AND RECONSTRUCTION

ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

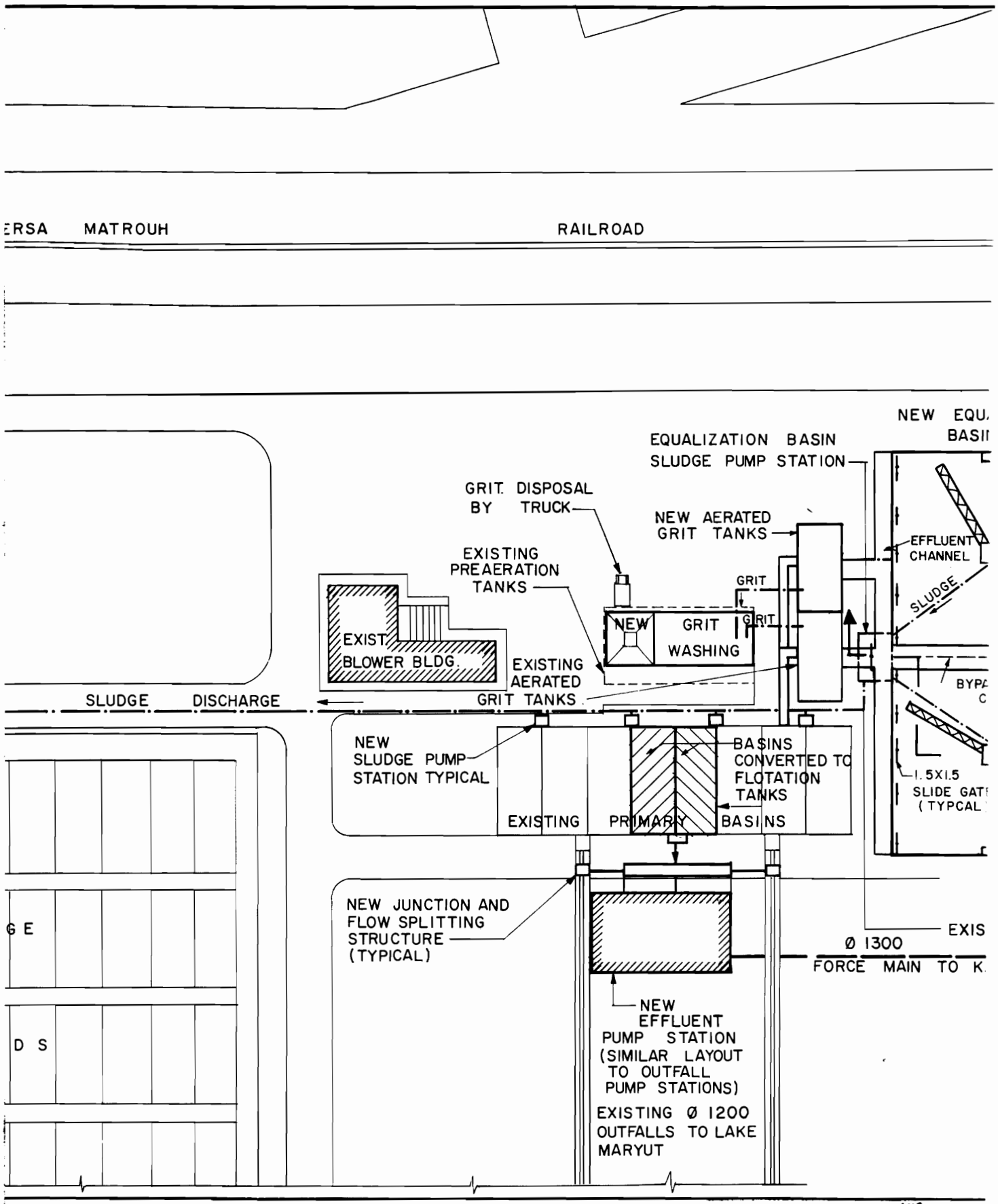
PRELIMINARY TREATMENT PLANT - SECTIONS

FIGURE I-6

BEST AVAILABLE COPY

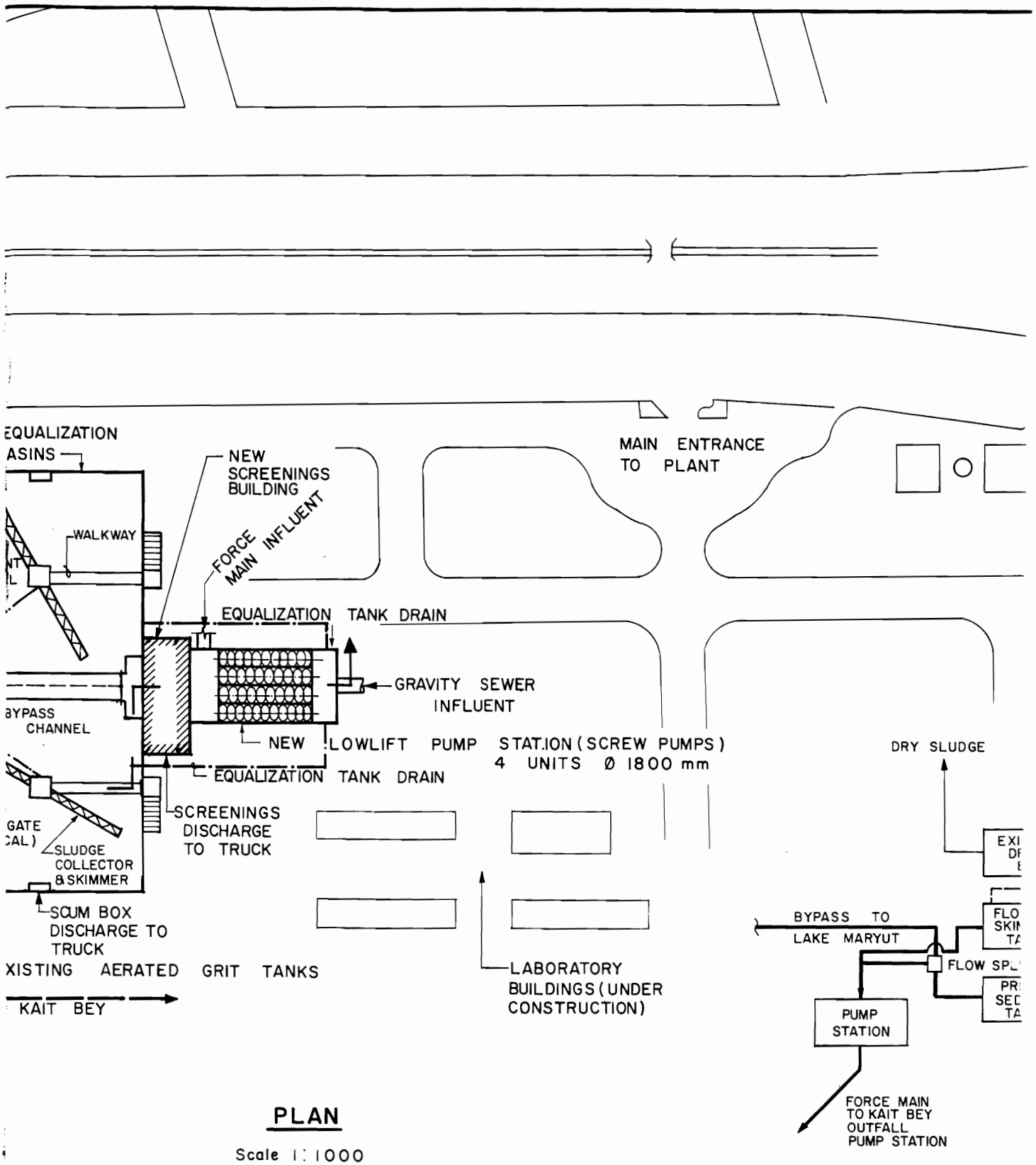


BEST AVAILABLE COPY



228A

BEST AVAILABLE COPY



PLAN

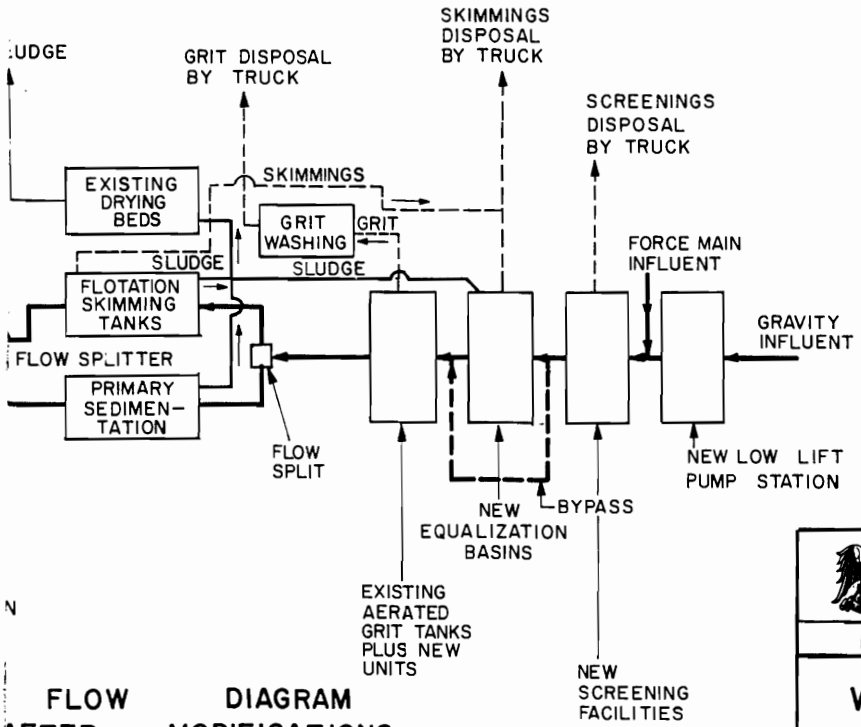
Scale 1 : 1000

FLOV
AFTER

BEST AVAILABLE COPY

LIST OF MODIFICATIONS

1. CONSTRUCT LOW LIFT PUMP STATION FOR GRAVITY INFLOW
2. CONNECT FORCE MAIN INFLOW TO JUNCTION AT TOP OF LOW LIFT PUMP STATION
3. CONSTRUCT SCREENINGS FACILITY
4. CONSTRUCT EQUALIZATION BASINS
5. CONSTRUCT NEW AERATED GRIT TANKS (EQUAL TO EXISTING)
6. CONSTRUCT GRIT WASHING FACILITY AT EXISTING PREAERATION UNIT. (ABANDON PREAERATION UNITS)
7. INSTALL SLUDGE PUMPING FOR EXISTING PRIMARY TANKS AND NEW EQUALIZATION BASINS
8. INSTALL NEW SLUDGE COLLECTOR AND SKIMMING MECHANISMS IN SIX EXISTING CLARIFIERS.
9. CONVERT TWO EXISTING CLARIFIERS TO FLOTATION UNITS
10. CONSTRUCT FLOW SPLITTING STRUCTURES AT EFFLUENT END OF PRIMARY TANKS
11. CONSTRUCT EFFLUENT PUMP STATION
12. CONSTRUCT EFFLUENT FORCE MAIN TO KAIT BEY OUTFALL PUMP STATION
13. ALL NECSSARY CHANNELS, PIPING, DIVERSION STRUCTURES TO CONNECT ADDED FACILITIES TO EXISTING FACILITIES.



FLOW DIAGRAM AFTER MODIFICATIONS

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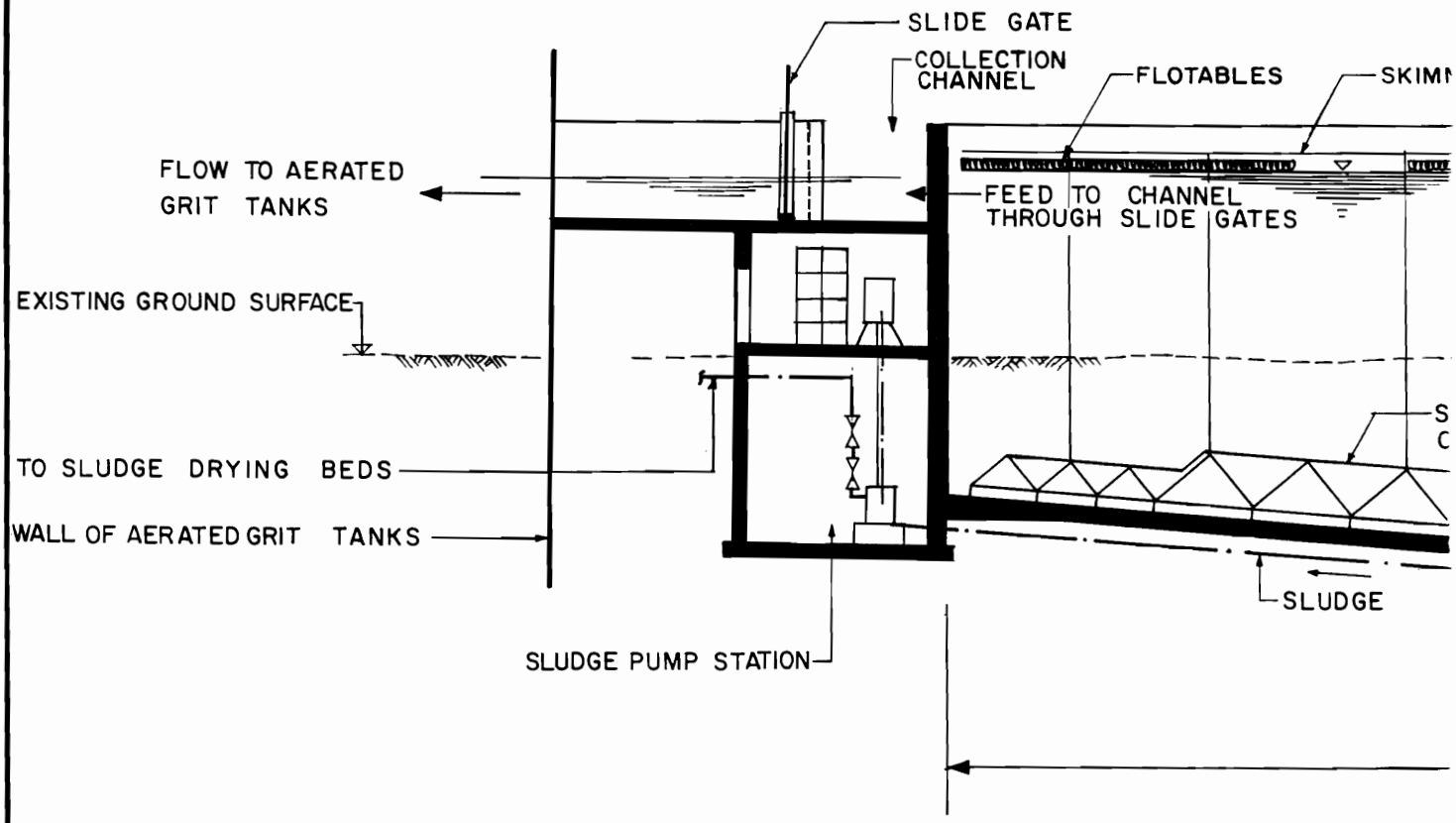
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

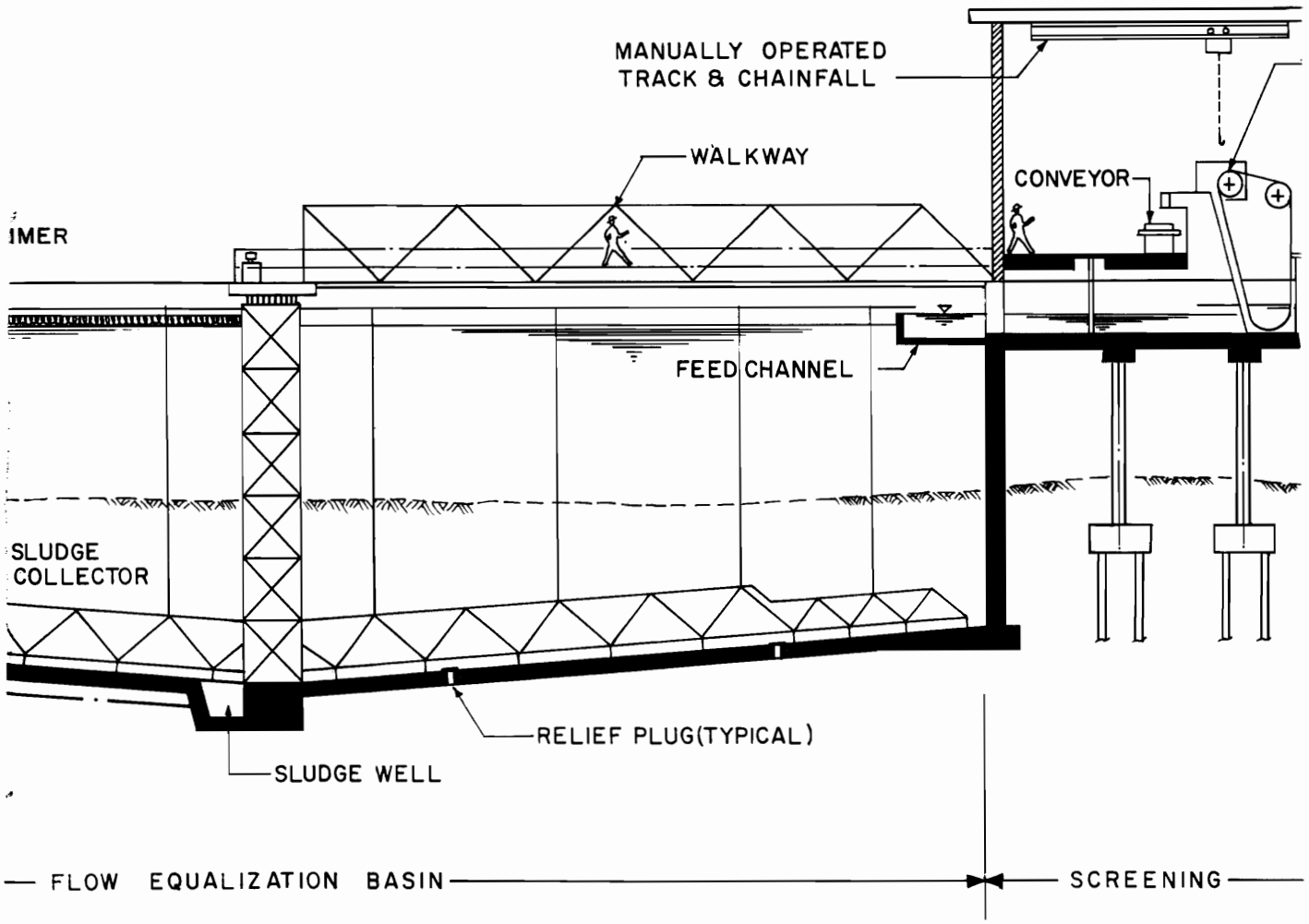
WEST SEWAGE TREATMENT PLANT MODIFICATIONS

FIGURE T-23

BEST AVAILABLE COPY

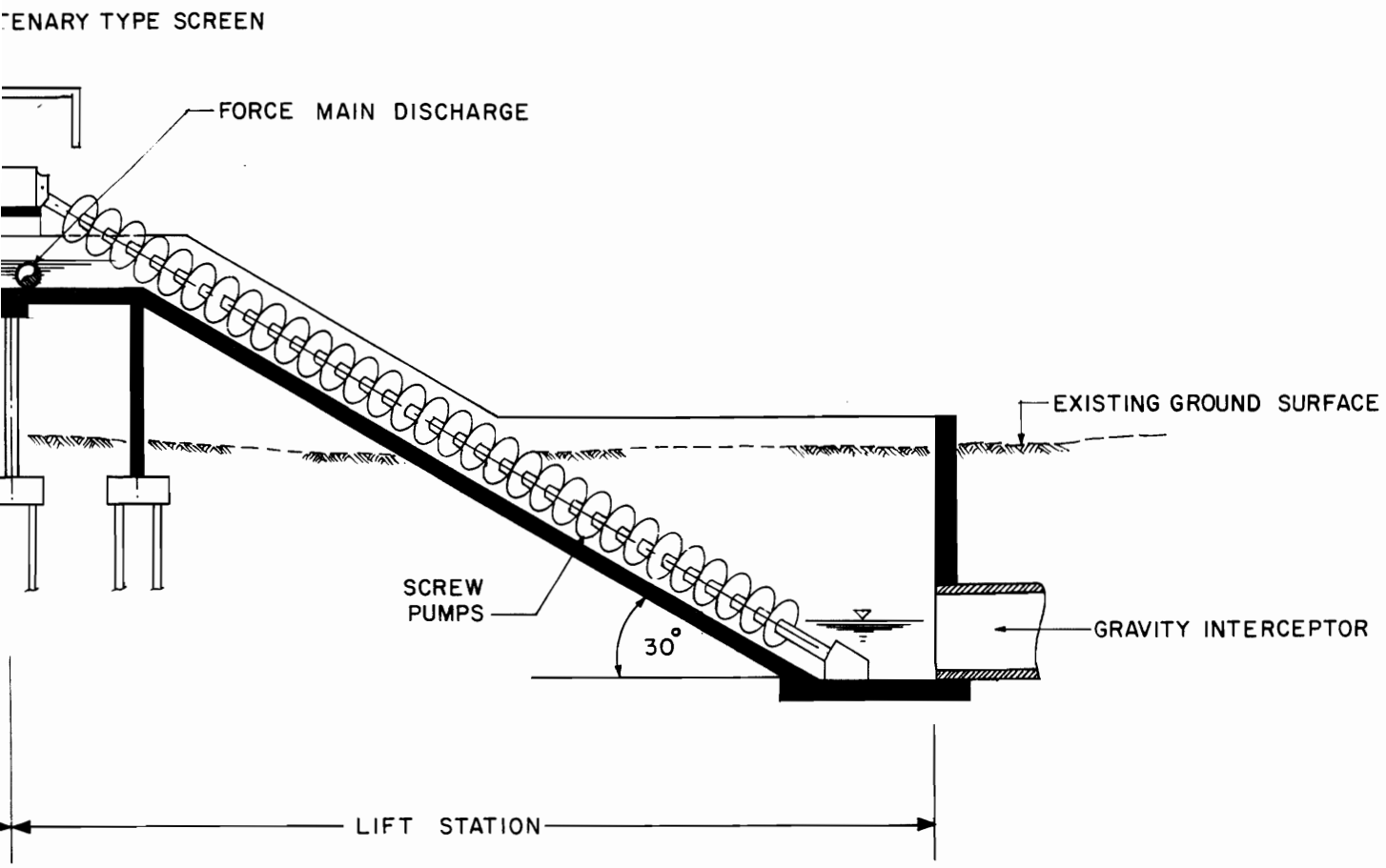


BEST AVAILABLE COPY



SECTION
NOT TO SCALE

BEST AVAILABLE COPY



NOTES:

1. BASED ON AVAILABLE SOILS DATA ALL NEW STRUCTURES WILL REQUIRE PILE FOUNDATIONS.

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ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

WEST TREATMENT PLANT
SECTION DRAWING

FIGURE I-8

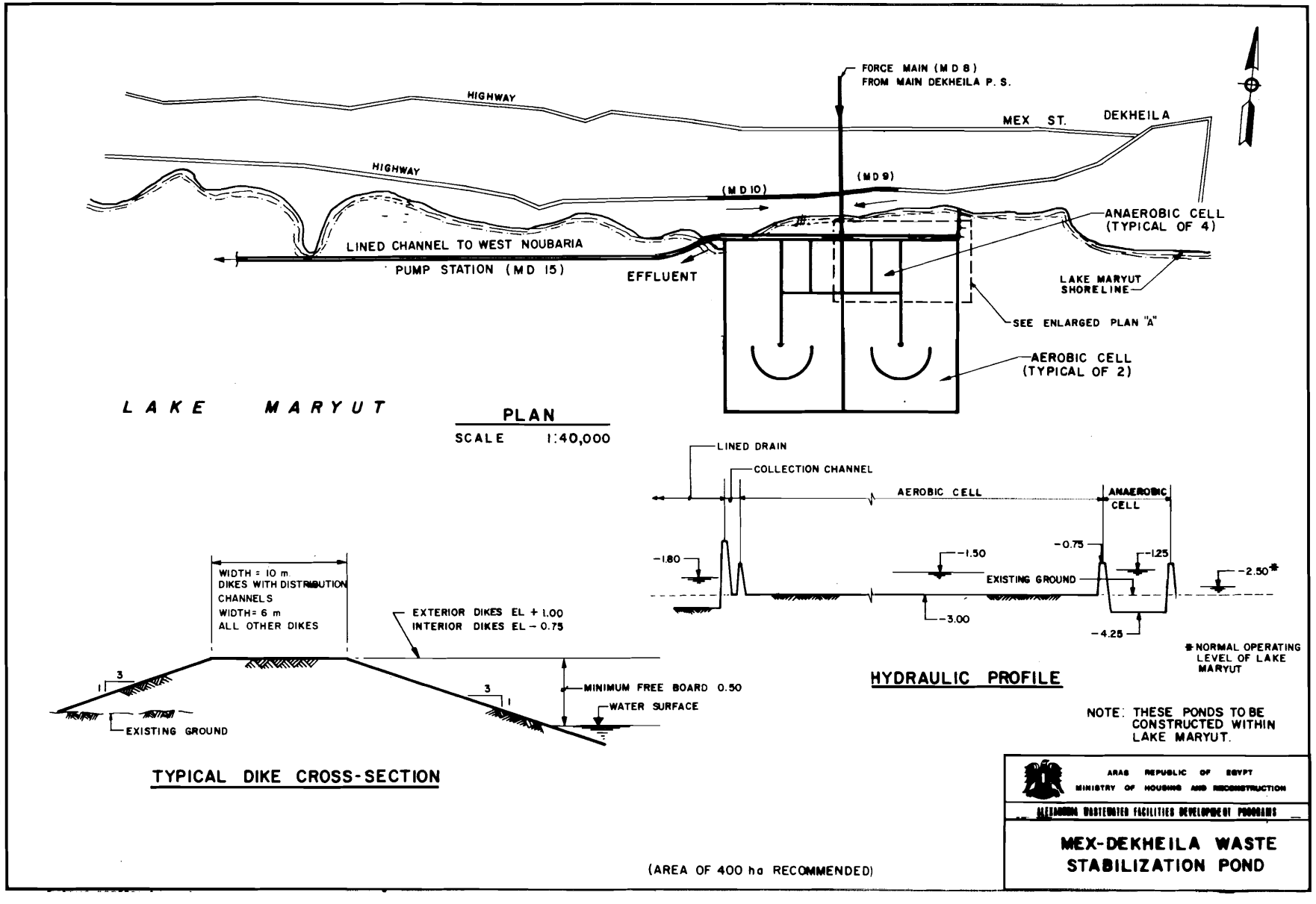

FORCE MAIN (M D 8)
FROM MAIN DEKHEILA P. S.
HIGHWAY
MEX ST.
DEKHEILA
HIGHWAY
(M D 10)
(M D 9)
ANAEROBIC CELL
(TYPICAL OF 4)
LINED CHANNEL TO WEST NOUBARIA
PUMP STATION (M D 15)
EFFLUENT
LAKE MARYUT
SHORELINE
SEE ENLARGED PLAN "A"
AEROBIC CELL
(TYPICAL OF 2)
LAKE MARYUT
PLAN
SCALE 1:40,000
LINED DRAIN
COLLECTION CHANNEL
AEROBIC CELL
ANAEROBIC
CELL
-1.80
-1.50
-0.75
-1.25
-2.50*
EXISTING GROUND
-3.00
-4.25
* NORMAL OPERATING
LEVEL OF LAKE
MARYUT
HYDRAULIC PROFILE
WIDTH = 10 m.
DIKES WITH DISTRIBUTION
CHANNELS
WIDTH= 6 m
ALL OTHER DIKES
EXTERIOR DIKES EL + 1.00
INTERIOR DIKES EL − 0.75
3
1
MINIMUM FREE BOARD 0.50
WATER SURFACE
EXISTING GROUND
TYPICAL DIKE CROSS-SECTION
NOTE: THESE PONDS TO BE
CONSTRUCTED WITHIN
LAKE MARYUT.
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
MEX-DEKHEILA WASTE
STABILIZATION POND
(AREA OF 400 ha RECOMMENDED)

FIGURE I-9

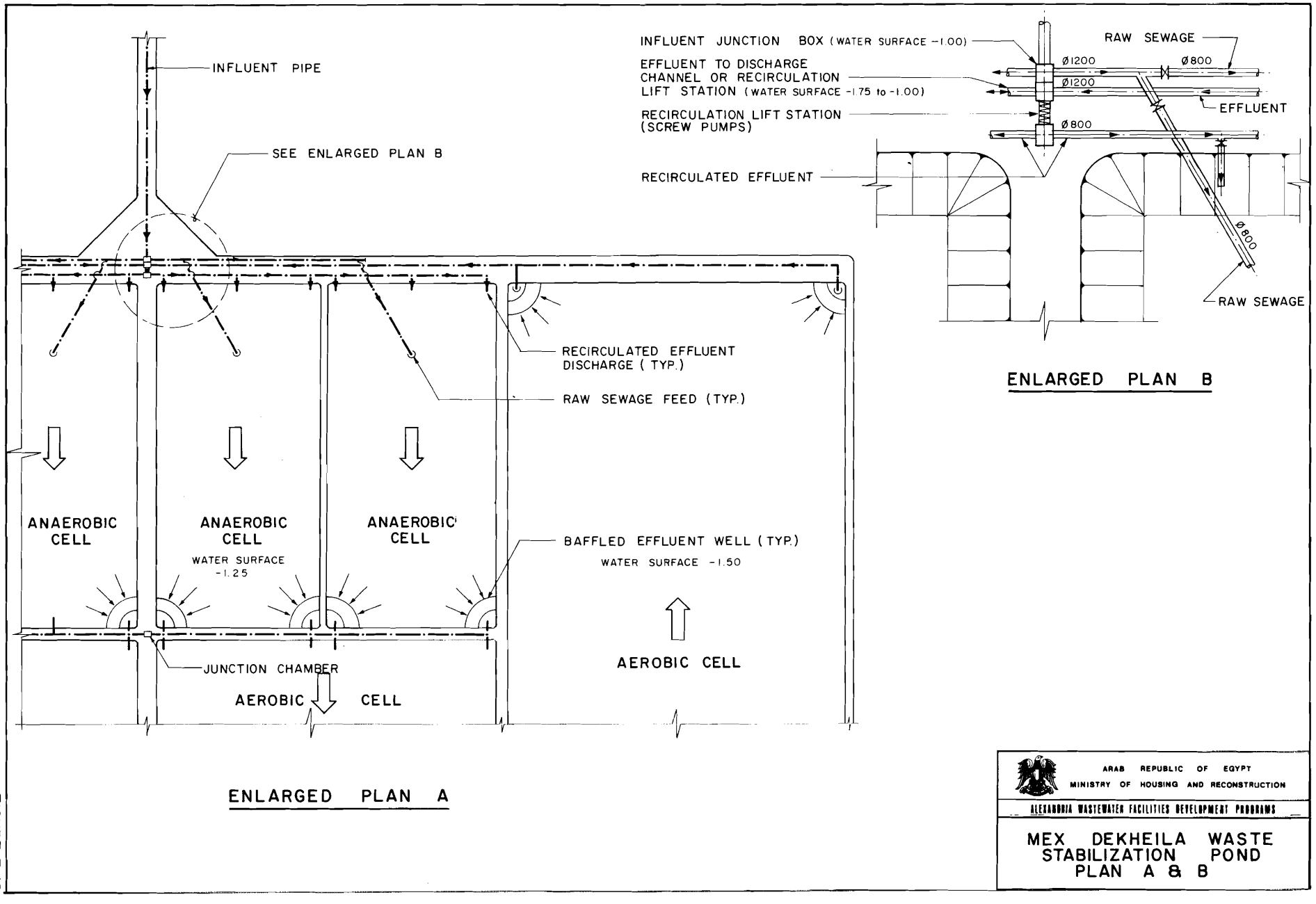

INFLUENT PIPE
SEE ENLARGED PLAN B
RECIRCULATED EFFLUENT DISCHARGE (TYP.)
RAW SEWAGE FEED (TYP.)
ANAEROBIC CELL
ANAEROBIC CELL
WATER SURFACE -1.25
ANAEROBIC CELL
BAFFLED EFFLUENT WELL (TYP.)
WATER SURFACE -1.50
AEROBIC CELL
JUNCTION CHAMBER
AEROBIC CELL
ENLARGED PLAN A
INFLUENT JUNCTION BOX (WATER SURFACE -1.00)
EFFLUENT TO DISCHARGE CHANNEL OR RECIRCULATION LIFT STATION (WATER SURFACE -1.75 to -1.00)
RECIRCULATION LIFT STATION (SCREW PUMPS)
RECIRCULATED EFFLUENT
RAW SEWAGE
Ø1200
Ø800
Ø1200
EFFLUENT
Ø800
Ø800
RAW SEWAGE
ENLARGED PLAN B
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
MEX DEKHEILA WASTE STABILIZATION POND PLAN A & B

FIGURE I-10

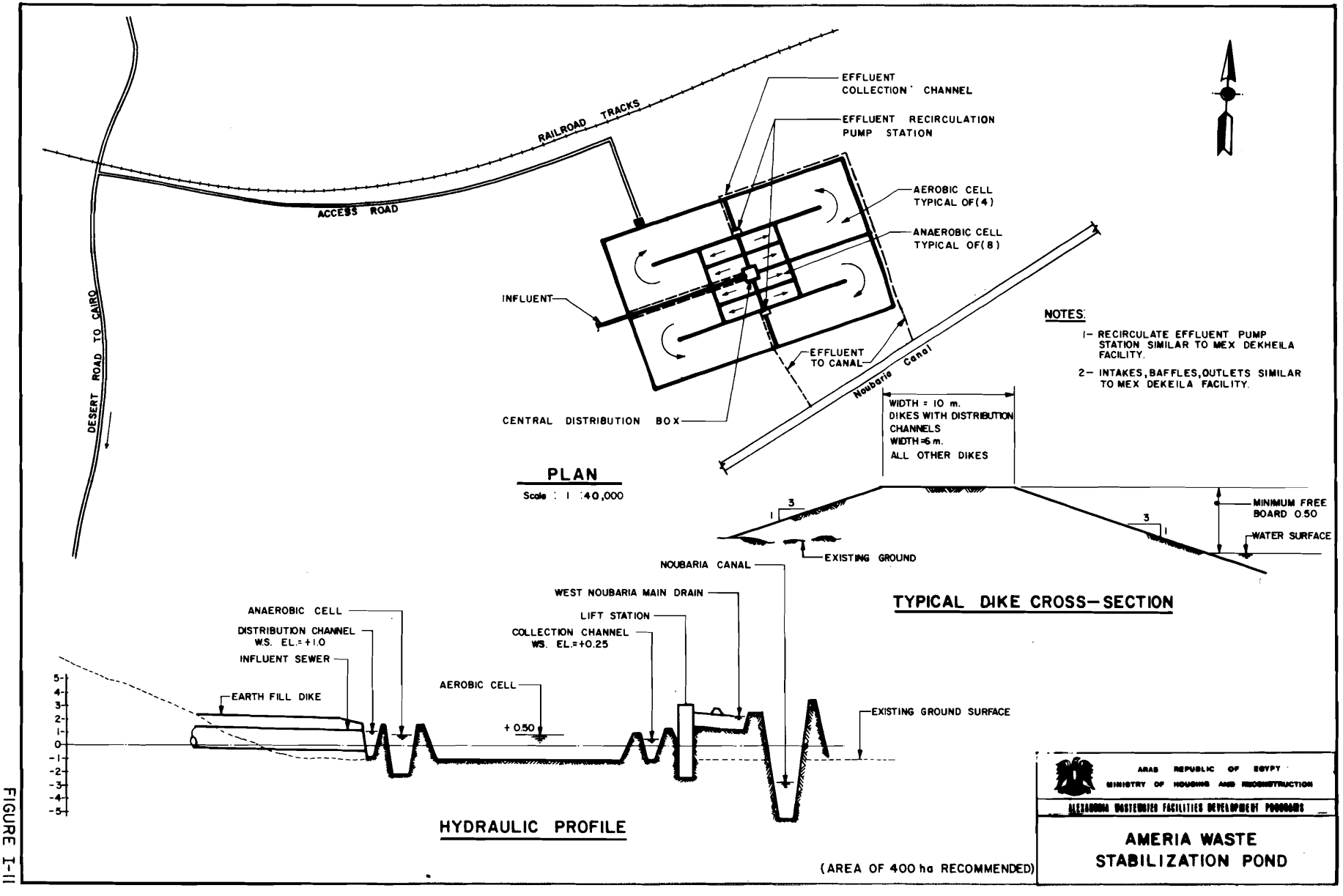
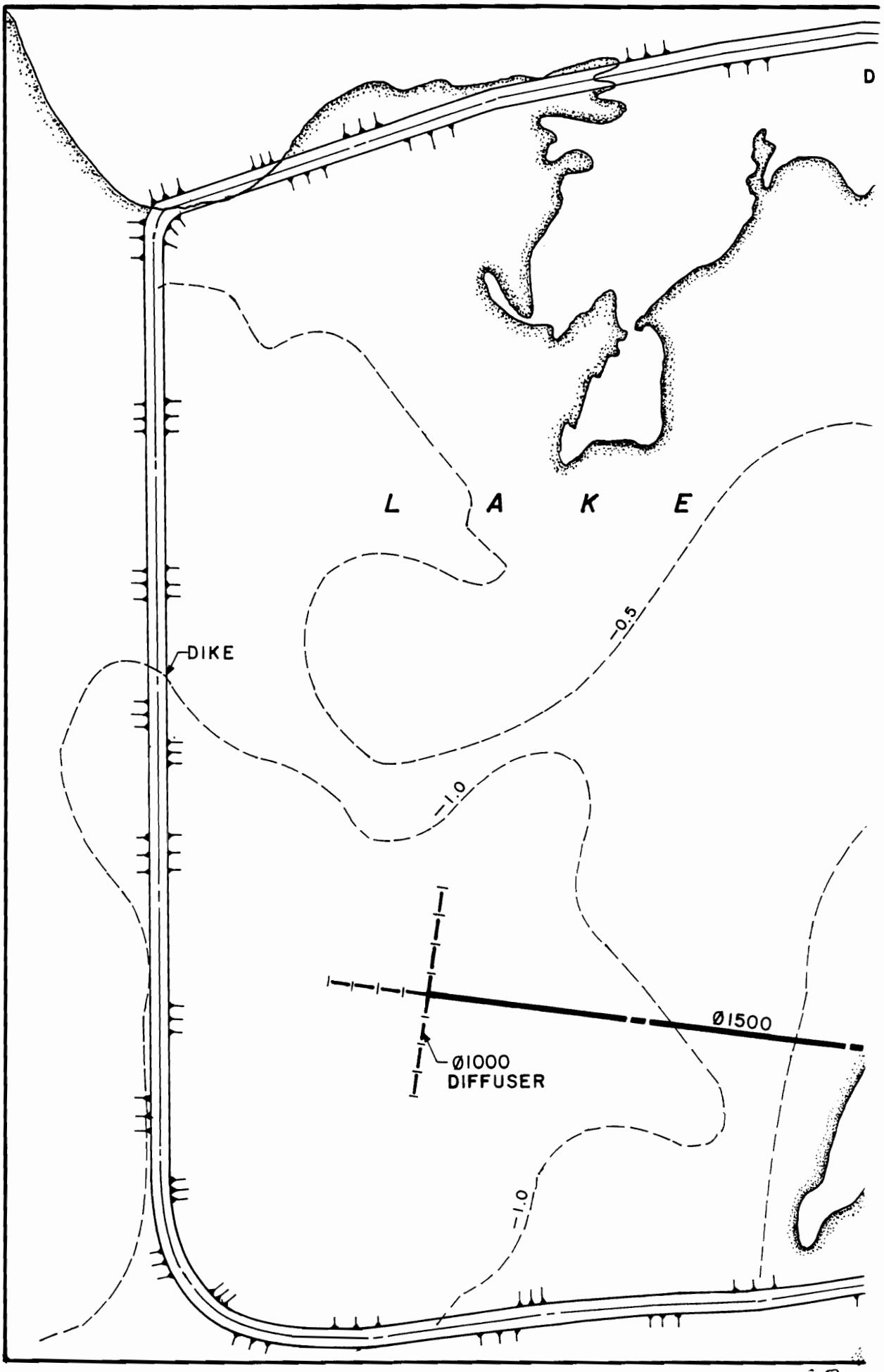

RAILROAD TRACKS
ACCESS ROAD
DESERT ROAD TO CAIRO
EFFLUENT COLLECTION CHANNEL
EFFLUENT RECIRCULATION PUMP STATION
AEROBIC CELL TYPICAL OF(4)
ANAEROBIC CELL TYPICAL OF(8)
INFLUENT
EFFLUENT TO CANAL
Noubaria Canal
CENTRAL DISTRIBUTION BOX
PLAN
Scale : 1 :40,000
NOTES:
1- RECIRCULATE EFFLUENT PUMP STATION SIMILAR TO MEX DEKHEILA FACILITY.
2- INTAKES, BAFFLES, OUTLETS SIMILAR TO MEX DEKEILA FACILITY.
WIDTH = 10 m.
DIKES WITH DISTRIBUTION CHANNELS
WIDTH=6 m.
ALL OTHER DIKES
MINIMUM FREE BOARD 0.50
WATER SURFACE
EXISTING GROUND
TYPICAL DIKE CROSS-SECTION
NOUBARIA CANAL
WEST NOUBARIA MAIN DRAIN
LIFT STATION
ANAEROBIC CELL
DISTRIBUTION CHANNEL W.S. EL.=+1.0
INFLUENT SEWER
COLLECTION CHANNEL W.S. EL.=+0.25
AEROBIC CELL
EARTH FILL DIKE
+0.50
EXISTING GROUND SURFACE
HYDRAULIC PROFILE
(AREA OF 400 ha RECOMMENDED)
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMME
AMERIA WASTE STABILIZATION POND

FIGURE I-11

BEST AVAILABLE COPY



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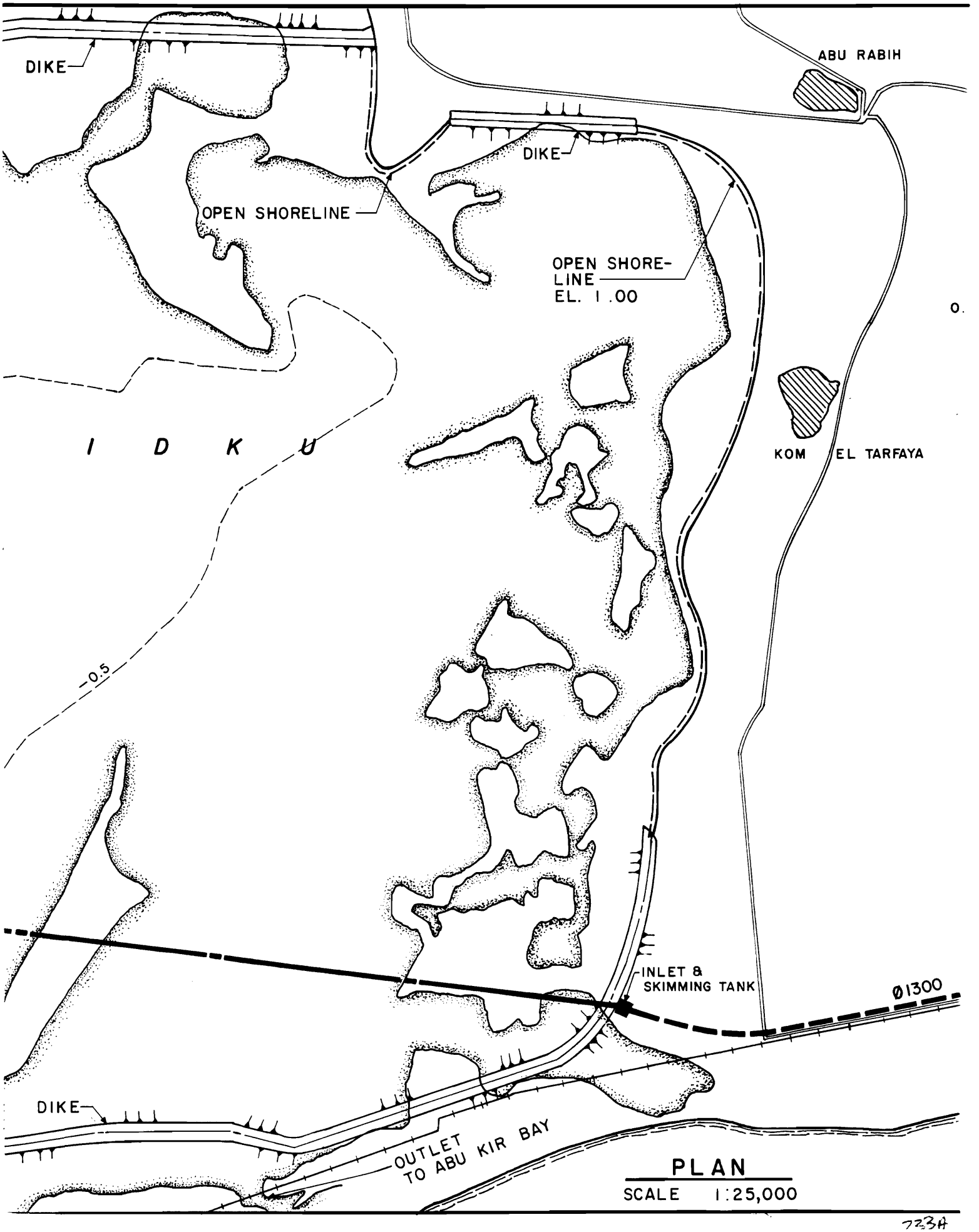

PLAN

SCALE 1:25,000

723A

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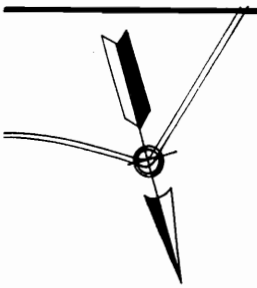
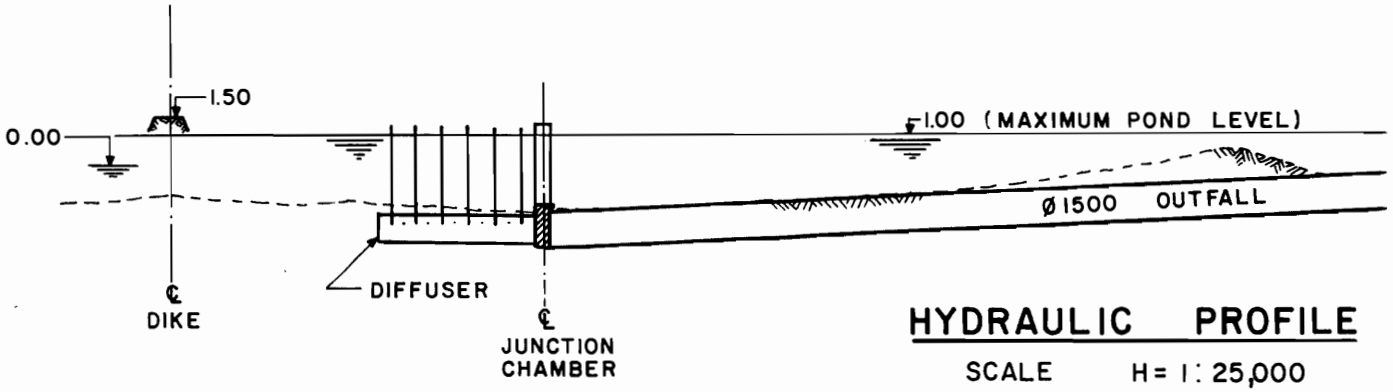
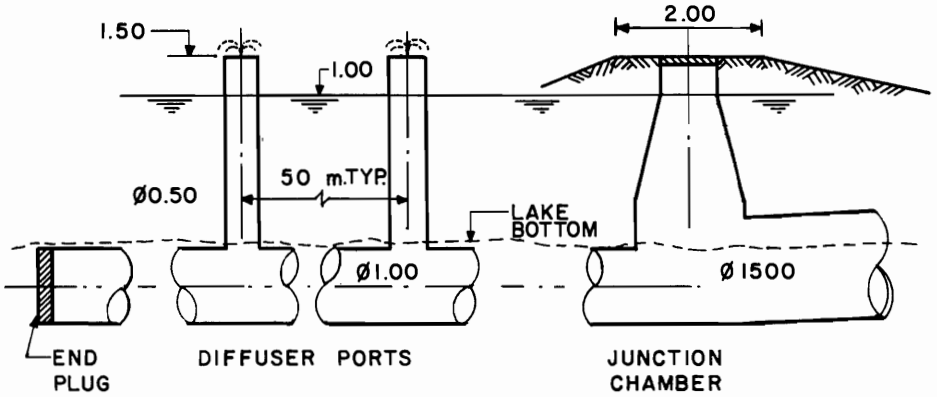




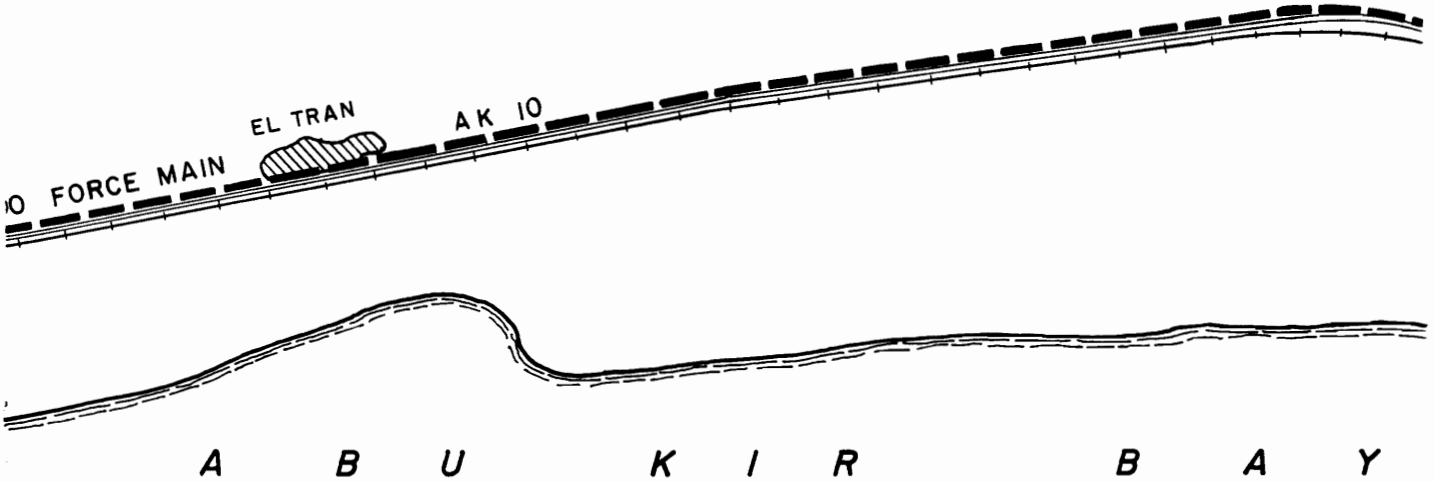
HYDRAULIC PROFILE

SCALE H = 1 : 25,000
V = 1 : 250



DIFFUSER DETAILS

SCALE 1 : 100



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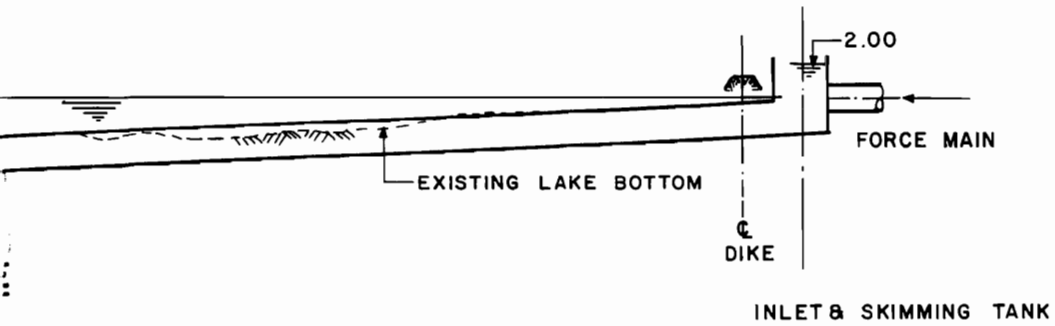
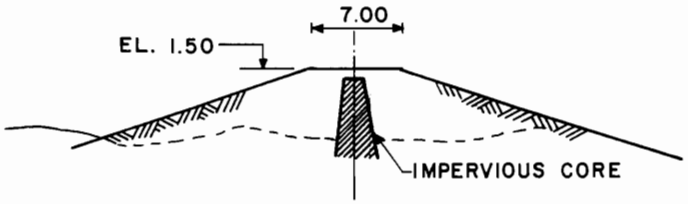
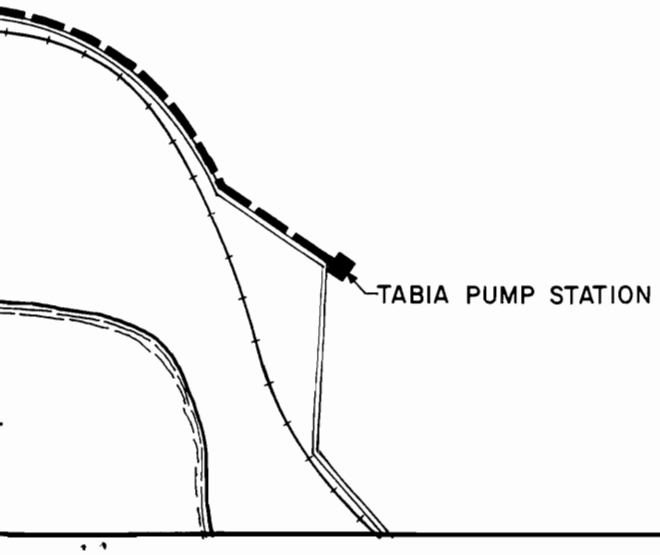




DIKE CROSS SECTION

SCALE 1:50

NOTE: PROVIDE TURN AROUNDS
AT THREE KILOMETRE INTERVALS.



(AREA OF 4000 ha RECOMMENDED)

ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION

ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

ABU KIR BAY EVAPORATION POND

FIGURE 23

APPENDIX J

ELEMENT COSTS OF PRINCIPAL ALTERNATIVE PLANS

Appendix J covers capital cost estimates made for the principal alternative plans evaluated in establishing the recommended facilities plan.

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J-5 West/Central Zones Plan 2 - Reuse

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J-8 Outer West/Ameria Zones Plan 2 - Central Lagoons

J-9 Toxic Industrial Wastewater Collection System Alternative

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TABLE J-1

CONVEYANCE COSTS (INTEGRATED SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
EZ 1	East	Hagar el Nawatia	-	1 300	800	1 510	-
EZ 2		Diversion Sewer	-	800	1 200	1 810	-
EZ 3			-	750	400	510	-
EZ 4		Abu Soliman P.S.	258	-	-	2 370	79.0
EZ 5		Abu Soliman F.M.	-	1 350	3 100	1 660	-
EZ 6		Mohammed Aly Coll.	-	1 800	1 500	3 230	-
EZ 7			-	1 500	1 400	2 830	-
EZ 8		New Smouha P.S.	208	-	-	2 130	102.0
EZ 9		New Smouha F.M.	-	1 200	3 900	1 680	-
EZ 10		Maamoura P.S.	21	-	-	-	7.4
EZ 11		Maamoura F.M.	-	450	4 400	700	-
EZ 12		P.S. No. 1	21	-	-	440	7.1
EZ 13		P.S. No. 3 Sewer	-	750	1 000	330	-
EZ 14		P.S. No. 5	49	-	-	790	14.0
EZ 15		P.S. No. 5 F.M.	-	550	500	100	-
EZ 16		P.S. No. 2	42	-	-	710	12.3
EZ 17		P.S. No. 2 F.M.	-	550	1 250	240	-
EZ 18		P.S. No. 4	17	-	-	-	6.7
EZ 19		P.S. No. 4 F.M.	-	650	1 300	290	-
EZ 20		P.S. No. 6	14	-	-	-	4.7
EZ 21		P.S. No. 6 F.M.	-	450	500	80	-
EZ 22		Sidi Bishr P.S.	67	-	-	950	17.5
EZ 23		Sidi Bishr F.M.	-	750	1 700	420	-
EZ 24		Sidi Bishr Sewer	-	1 000	2 300	1 120	-
	East -	TOTAL				23 900	250.7

TABLE J-1

CONVEYANCE COSTS (INTEGRATED SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
RS 1	Ras el Soda	Hospital's P.S.	17	-	-	390	4.3
RS 2		Hospital's F.M.	-	350	1 150	180	-
RS 3		Ras el Soda P.S.	224	-	-	2 250	30.0
RS 4		Ras el Soda F.M.	-	1 300	800	390	-
RS 5		Ras el Soda Coll.	-	500	450	400	-
RS 6		Ras el Soda Coll.	-	750	600	580	-
RS 7		Ras el Soda Coll.	-	1 250	1 010	1 560	-
RS 8		Ras el Soda Coll.	-	1 400	480	930	-
RS 9		Ras el Soda Coll.	-	1 600	850	1 800	-
	Ras el Soda -	TOTAL				8 480	34.3
SK 1	Siouf	Main Collector	-	1 600	270	570	-
SK 2	Keblia	Main Collector	-	1 700	780	1 690	-
SK 3		North Branch	-	1 250	850	1 380	-
SK 4		North Branch	-	1 000	575	820	-
SK 5		North Branch	-	900	1 525	1 620	-
SK 6		South Branch	-	1 250	300	490	-
SK 7		South Branch	-	900	300	430	-
SK 8		South Branch	-	500	300	310	-
SK 9		South Branch	-	450	300	290	-
SK 10		South Branch	-	250	250	210	-
SK 11		South Branch	-	200	200	160	-
	Siouf Keblia -	TOTAL				7 970	-

TABLE J-1

CONVEYANCE COSTS (INTEGRATED SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
AK 1	Abu Kir	Pump Station 'A'	5	-	-	170	3.2
AK 2		Force Main 'A'	-	250	240	30	-
AK 3		Pump Station 'B'	6	-	-	190	3.2
AK 4		Force Main 'B'	-	250	400	50	-
AK 5		Pump Station 'C'	21	-	-	450	6.4
AK 6		Force Main 'C'	-	400	1 000	140	-
AK 7		Main Pump Station	52	-	-	800	13.7
AK 8		Main Force Main	-	650	8 000	1 770	-
AK 9		Tabia Pump Station	225	-	-	2 250	109.0
AK 10		Tabia Force Main	-	1 300	8 000	3 540	-
AK 11		Abu Kir Collector	-	375	235	40	-
AK 12		Abu Kir Collector	-	600	200	50	-
AK 13		Abu Kir Collector	-	750	975	240	-
AK 14		Abu Kir Collector	-	1 100	1 100	430	-
AK 15		Abu Kir Collector	-	1 200	500	220	-
AK 16		Tabia Collector	-	1 400	2 000	1 370	-
	Abu Kir -	TOTAL				11 740	135.5
WZ 1	West	West Zone Coll.	-	1 200	1 500	1 750	-
WZ 2		West Zone Coll.	-	1 400	4 250	6 860	-
WZ 4		West Zone P.S.	-	324	-	2 840	117.0
WZ 5		West Zone F.M.	-	1 600	5 200	3 270	-
WZ 6		Pump Station No. 2	-	32	-	260	9.3
WZ 7		P.S. No. 2 F.M.	-	500	1 150	240	-
	West -	TOTAL				15 220	126.3

TABLE J-1

CONVEYANCE COSTS (INTEGRATED SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
SC 1	Sadat City	Main Pump Station	-	113	-	1 420	17.5
SC 2		Main Force Main	-	900	2 600	860	-
SC 3		Gravity Sewer	-	1 800	3 400	7 320	-
	Sadat City	TOTAL				9 600	17.5
	Central	No Facilities					

TABLE J-2

CONVEYANCE COSTS (INTEGRATED SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
EZ 1	East	Maamoura F.M.	-	450	4 600	730	-
EZ 2		P.S. No. 1	21	-	-	440	7.1
EZ 3		P.S. No. 2	21	-	-	440	9.2
EZ 4		P.S. No. 2 F.M.	-	400	700	110	-
EZ 5		Gravity Sewer P.S. No. 3 to 5	-	750	1 000	330	-
EZ 6		P.S. No. 4	17	-	-	-	6.0
EZ 7		P.S. No. 5	49	-	-	790	14.0
EZ 8		P.S. No. 6	27	-	-	-	10.8
EZ 9		Sidi Bishr P.S.	6	-	-	190	3.0
EZ 10		Sidi Bishr F.M.	-	250	1 200	150	-
EZ 11		Glym P.S.	57	-	-	880	15.4
EZ 12		Glym F.M.	-	650	1 100	240	-
EZ 13		Glym-Sarwat Swr.	-	900	1 200	470	-
EZ 14		Hagar el Nawatia	-	1 100	700	340	-
EZ 15		Hagar el Nawatia	-	750	400	510	-
EZ 16		Hagar el Nawatia	-	800	1 200	1 810	-
EZ 17		Hagar el Nawatia	-	1 300	800	1 510	-
EZ 18		Hagar el Nawatia	-	2 000	1 000	2 210	-
EZ 19		Abu Soliman Relief	-	1 200	1 300	2 230	-
EZ 20		Mohammed Aly Coll.	-	1 500	1 400	2 830	-
EZ 21		Mohammed Aly Coll.	-	1 800	1 500	3 230	-
EZ 22		Smouha P.S.	249	-	-	2 370	137.0
EZ 23		Smouha F.M.	-	1 400	10 500	5 050	-
	East	TOTAL				26 860	202.5

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TABLE J-2

CONVEYANCE COSTS (INTEGRATED SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

(cont'd)

Item	Zone	Facility	Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
RS 1	Ras el Soda	Hospital's P.S.	17	-	-	390	4.3
RS 2		Hospital's F.M.	-	350	1 150	180	-
RS 3		Ras el Soda Int.	-	1 400	800	1 480	-
RS 4		Ras el Soda Int.	-	1 500	800	1 520	-
RS 5		Ras el Soda Int.	-	1 700	800	1 660	-
RS 6		Africa St. Coll.	-	900	600	230	-
RS 7		Africa St. Coll.	-	1 000	1 300	2 020	-
	Ras el Soda - TOTAL					7 480	4.3
SK 1	Siouf Keblia	Siouf Keblia Int.	-	2 000	2 800	6 250	-
SK 2		Siouf Keblia Int.	-	2 400	1 000	2 520	-
SK 3		Siouf Keblia P.S.	-	540	-	3 900	125.0
SK 4		Siouf Keblia F.M.	-	2 000	8 500	6 270	-
	Siouf Keblia - TOTAL					18 940	125.0
AK 1	Abu Kir	Pump Station 'A'	5	-	-	170	3.2
AK 2		Force Main 'A'	-	250	240	30	-
AK 3		Pump Station 'B'	6	-	-	190	3.2
AK 4		Force Main 'B'	-	250	400	50	-
AK 5		Pump Station 'C'	21	-	-	450	6.4
AK 6		Force Main 'C'	-	400	1 000	140	-
AK 7		Main Pump Station	52	-	-	800	10.8
AK 8		Main Force Main	-	650	5 500	1 220	-
AK 9		Tabia Pump Station	225	-	-	2 250	109.0

TABLE J-2

CONVEYANCE COSTS (INTEGRATED SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

(cont'd)

Item	Zone	Facility	Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
AK 10		Tabia Force Main	-	1 300	8 000	3 540	-
AK 11		Abu Kir Collector	-	375	235	40	-
AK 12		Abu Kir Collector	-	600	200	50	-
AK 13		Abu Kir Collector	-	750	975	240	-
AK 14		Abu Kir Collector	-	1 100	1 100	430	-
AK 15		Abu Kir Collector	-	1 200	500	220	-
AK 16		Tabia Collector	-	1 400	2 000	1 370	-
	Abu Kir -	TOTAL				11 190	132.6
CZ 1	Central	Kait Bey P.S.	253	-	-	2 370	95.0
CZ 2		Kait Bey F.M.	-	1 400	6 600	3 150	-
	Central -	TOTAL				5 520	95.0
WZ 1	West	West Zone Int.	-	1 500	1 330	2 530	-
WZ 2		West Zone Int.	-	2 300	2 860	7 100	-
WZ 3		West Zone Int.	-	2 300	1 200	2 980	-
WZ 4		P.S. No. 2 Eqp. Rpl.	-	32	-	260	9.3
WZ 5		P.S. No. 2 F.M.	-	500	1 150	240	-
WZ 6		West Zone Int.	-	1 100	400	650	-
	West -	TOTAL				13 760	9.3
	Sadat City	Same as Table J-1				9 600	17.5

TABLE J-3

CONVEYANCE COSTS (SEPARATE SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

Item	Zone	Facility	Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
EZ 1	East	Hagar el Nawatia	-	1 100	800	1 380	-
EZ 2		Diversion Sewer	-	750	1 200	1 760	-
EZ 3		Diversion Sewer	-	500	400	460	-
EZ 4		Abu Soliman P.S.	194	-	-	2 010	65.0
EZ 5		Abu Soliman F.M.	-	1 200	3 100	1 360	-
EZ 6		Mohammed Aly Coll.	-	1 700	1 500	3 200	-
EZ 7		Mohammed Aly Coll.	-	1 500	1 400	2 830	-
EZ 8		New Smouha P.S.	163	-	-	1 770	71.0
EZ 9		New Smouha F.M.	-	1 200	3 900	1 680	-
EZ 10		Maamoura P.S.	21	-	-	-	7.4
EZ 11		Maamoura F.M.	-	450	4 400	700	-
EZ 12		P.S. No. 1	21	-	-	440	7.1
EZ 13		P.S. No. 3 Sewer	-	750	1 000	330	-
EZ 14		P.S. No. 5	49	-	-	790	14.0
EZ 15		P.S. No. 5 F.M.	-	550	500	100	-
EZ 16		P.S. No. 2	42	-	-	710	12.3
EZ 17		P.S. No. 2 F.M.	-	550	1 250	240	-
EZ 18		P.S. No. 4	17	-	-	-	6.7
EZ 19		P.S. No. 4 F.M.	-	650	1 300	290	-
EZ 20		P.S. No. 6	14	-	-	-	4.7
EZ 21		P.S. No. 6 F.M.	-	450	500	80	-
EZ 22		Sidi Bishr P.S.	67	-	-	950	17.5
EZ 23		Sidi Bishr F.M.	-	750	1 700	420	-
EZ 24		Sidi Bishr Sewer	-	1 000	2 300	1 120	-
	East -	TOTAL				22 620	205.7

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TABLE J-3

CONVEYANCE COSTS (SEPARATE SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
RS 1	Ras el Soda	Hospital's P.S.	17	-	-	390	4.3
RS 2		Hospital's F.M.	-	350	1 150	180	-
RS 3		Ras el Soda P.S.	204	-	-	2 130	27.0
RS 4		Ras el Soda F.M.	-	1 200	800	360	-
RS 5		Ras el Soda Coll.	-	500	450	400	-
RS 6		Ras el Soda Coll.	-	750	600	580	-
RS 7		Ras el Soda Coll.	-	1 100	1 010	1 520	-
RS 8		Ras el Soda Coll.	-	1 250	480	900	-
RS 9		Ras el Soda Coll.	-	1 400	850	1 700	-
	Ras el Soda -	TOTAL				8 160	31.3
SK 1	Siouf Keblia	Main Collector	-	1 500	1 050	2 120	-
SK 2		North Branch	-	1 000	850	1 230	-
SK 3		North Branch	-	900	575	790	-
SK 4		North Branch	-	750	1 525	1 530	-
SK 5		South Branch	-	1 250	300	490	-
SK 6		South Branch	-	900	300	430	-
SK 7		South Branch	-	500	300	310	-
SK 8		South Branch	-	450	300	290	-
SK 9		South Branch	-	250	250	210	-
SK 10		South Branch	-	200	200	160	-
	Siouf Keblia -	TOTAL				7 560	-

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TABLE J-3

CONVEYANCE COSTS (SEPARATE SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
WZ 1	West	West Zone Coll.	-	1 200	1 500	1 750	-
WZ 2		West Zone Coll.	-	1 400	2 920	4 720	-
WZ 3		West Zone Coll.	-	1 000	1 330	1 950	-
WZ 5		West Zone P.S.	240	-	-	2 250	98.0
WZ 6		West Zone F.M.	-	1 350	5 200	2 690	-
WZ 7		P.S. No. 2	32	-	-	260	9.3
WZ 8		P.S. No. 2 F.M.	-	500	1 150	240	-
	West -	TOTAL				13 860	107.3
MD 1	Mex-	Tanneries P.S.	10	-	-	270	4.0
MD 2	Dekh.	Tanneries F.M.	-	300	1 600	210	-
MD 3		Valley of Moon P.S.	6	-	-	200	3.2
MD 4		Valley of Moon F.M.	-	250	1 200	150	-
MD 5		Mex-Dekh. Collector	-	600	2 500	690	-
MD 6		Mex-Dekh. Collector	-	750	600	190	-
MD 7		Main Dekheila P.S.	32	-	-	590	5.6
MD 8		Main Dekheila F.M.	-	500	1 100	210	-
MD 9		Industries Coll.	-	2 000	2 000	1 840	-
MD 10		Industries Coll.	-	2 100	1 100	1 100	-
		West Ind. P.S.	249	-	-	1 400	70.2
		P.S. Force Main	-	1 400	100	50	-
	Mex-Dekh. -	TOTAL				6 900	83.0

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TABLE J-3

CONVEYANCE COSTS (SEPARATE SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
NZ 1	Nouzha	Nouzha Collector	-	500	850	1 060	-
NZ 2		Fisherman Village P.S.	16	-	-	380	5.7
NZ 3		Fisherman Village F.M.	-	350	1 700	280	-
NZ 4		Nouzha Collector	-	700	540	600	-
NZ 5		Nouzha Collector	-	950	1 370	2 230	-
NZ 6		Nouzha Collector	-	700	500	560	-
NZ 7		Nouzha Collector	-	600	425	440	-
NZ 8		Nouzha P.S.	63	-	-	920	17.5
NZ 9		Nouzha F.M.	-	700	925	220	-
	Nouzha - TOTAL					6 690	23.2
	Sadat City - Same as Table J-1					9 600	17.5
	Abu Kir- Same as Table J-1					11 740	135.5
	Central- No Facilities						
	Ameria - Same as Table J-4					11 080	16.0

TABLE J-4

CONVEYANCE COSTS (SEPARATE SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
EZ 1	East	Maamoura F.M.	-	450	4 600	730	-
EZ 2		P.S. No. 1	21	-	-	440	7.1
EZ 3		P.S. No. 2	21	-	-	440	9.2
EZ 4		P.S. No. 2 F.M.	-	400	700	110	-
EZ 5		Gravity Sewer P.S. No. 3 to 5	-	750	1 000	330	-
EZ 6		P.S. No. 4	17	-	-	-	6.0
EZ 7		P.S. No. 5	49	-	-	790	14.0
EZ 8		P.S. No. 6	27	-	-	-	10.8
EZ 9		Sidi Bishr P.S.	6	-	-	190	3.0
EZ 10		Sidi Bishr F.M.	-	250	1 200	150	-
EZ 11		Glym P.S.	57	-	-	880	15.4
EZ 12		Glym F.M.	-	650	1 100	240	-
EZ 13		Glym-Sarwat Swr.	-	900	1 200	470	-
EZ 14		Hagar el Nawatia	-	500	400	460	-
EZ 15		Hagar el Nawatia	-	1 100	700	340	-
EZ 16		Hagar el Nawatia	-	750	1 200	1 760	-
EZ 17		Hagar el Nawatia	-	1 100	800	1 380	-
EZ 18		Hagar el Nawatia	-	1 800	1 000	2 120	-
EZ 19		Abu Soliman Relief	-	1 200	1 300	2 230	-
EZ 20		Mohammed Aly Coll.	-	1 500	1 400	2 830	-
EZ 21		Mohammed Aly Coll.	-	1 700	1 500	3 200	-
EZ 22		Smouha P.S.	215	-	-	2 130	134.0
EZ 23		Smouha F.M.	-	1 300	10 500	4 730	-
	East -	TOTAL				25 950	199.5

TABLE J-4

CONVEYANCE COSTS (SEPARATE SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
RS 1	Ras el	Hospital's P.S.	17	-	-	390	4.3
RS 2	Soda	Hospital's F.M.	-	350	1 150	180	-
RS 3		Ras el Soda Int.	-	1 400	1 600	2 960	-
RS 4		Ras el Soda Int.	-	1 500	800	1 520	-
RS 5		Africa St. Coll.	-	900	600	230	-
RS 6		Africa St. Coll.	-	1 000	1 300	2 020	-
	Ras el Soda -	TOTAL				7 300	4.3
SK 1	Siouf	Siouf Keblia Int.	-	1 800	2 300	4 910	-
SK 2	Keblia	Siouf Keblia Int.	-	2 000	500	1 160	-
SK 3		Siouf Keblia Int.	-	2 300	1 000	2 510	-
SK 4		Siouf Keblia P.S.	447	-	-	3 430	103.0
SK 5		Siouf Keblia F.M.	-	1 800	8 500	5 610	-
	Siouf Keblia-	TOTAL				17 620	103.0
CZ 1	Central	Kait Bey P.S.	246	-	-	2 370	95
CZ 2		Kait Bey F.M.	-	1 400	6 600	3 150	-
	Central -	TOTAL				5 520	95
WZ 1	West	West Zone Int.	-	1 200	1 330	2 280	-
WZ 2		West Zone Int.	-	2 000	2 860	6 310	-
WZ 3		West Zone Int.	-	2 000	1 200	2 650	-
WZ 4		P.S. No. 2 Eq. Rpl.	-	-	-	260	9.3
WZ 5		P.S. No. 2 F.M.	-	500	1 150	240	-
WZ 6		West Zone Int.	-	1 100	400	650	-
	West -	TOTAL				12 390	9.3

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TABLE J-4

CONVEYANCE COSTS (SEPARATE SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
AM 1	Ameria	Maryut Ind. Coll.	-	750	10 000	2 910	-
AM 2		Free Zone Coll.	-	900	1 250	410	-
AM 3			-	1 200	1 750	780	-
AM 4		Ameria Coll.	-	900	3 100	1 020	-
AM 5			-	1 200	3 250	1 450	-
AM 6			-	600	1 750	410	-
AM 7			-	850	1 625	490	-
AM 8			-	600	4 625	1 080	-
AM 9			-	850	1 875	570	-
AM 10		Industrial P.S.	-	83	-	410	16.0
AM 11		Ind. P.S, F.M.	-	400	2 000	310	-
AM 12		Ameria Coll.	-	750	4 375	1 240	-
	Ameria - TOTAL					11 080	16.0
	Sadat City	Same as Table J-1 or J-2				9 600	17.5
	Abu Kir	Same as Table J-2				11 190	132.6
	Mex-Dekh.	Same as Table J-3				6 900	83.0
	Nouzha	Same as Table J-3				6 690	23.2

TABLE J-5

TREATMENT/DISPOSAL COSTS (INTEGRATED SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

Item	Zone	Facility	Capacity/Pipe Size/Land ML/day	mm	ha	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
	East	Ras el Soda (Prelim) Plant	560	-	-	-	23 900	592
		Sidi Bishr Outfall	-	2 200	-	10 000	55 600	450
		Land	-	-	5	-	2 840	-
	Central	Kait Bey (Prelim) Plant	173	-	-	-	9 500	230
		Kait Bey Outfall	-	1 900	-	10 000	38 075	262
		Land	-	-	4	-	1 200	-
	West	West Plant (Prelim) Conv.	219	-	-	-	7 700	500
		Effluent P.S.	250	-	-	-	1 540	139
		Effluent F.M.	-	1 300	-	5 600	2 970	-
		Land	-	-	0	-	-	-

TABLE J-6

TREATMENT/DISPOSAL COSTS (INTEGRATED SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

Item	Zone	Facility	Capacity/Pipe Size/Land ML/day	mm	ha	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
	East	(Sec.) Plant	560	-	-	-	95 940	2 231
		Effluent P.S.	700	-	-	-	4 430	666
		Effluent F.M. (Crop Reuse)	-	2 400	-	34 000	18 625	-
		Land	-	-	144	-	540	-
	West/ Central	West (Sec.) Plant	392	-	-	-	74 705	2 135
		Effluent P.S.	550	-	-	-	2 720	517
		Effluent F.M. (Crop Reuse)	-	2 000	-	24 000	16 765	-
		Land	-	-	105	-	385	-

TABLE J-7

TREATMENT/DISPOSAL COSTS (SEPARATE SYSTEM) SEA DISPOSAL/SUBMARINE OUTFALL ALTERNATIVE

Item	Zone	Facility	Capacity/Pipe Size/Land ML/day	mm	ha	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
	East	Ras el Soda (Prelim) Plant	475	-	-	-	21 530	503
		Sidi Bishr Outfall	-	1 900	-	10 000	53 590	175
		Land	-	-	5	-	2 835	-
	Central	Kait Bey (Prelim) Plant	165	-	-	-	8 100	200
		Kait Bey Outfall	-	1 700	-	10 000	36 380	240
		Land	-	-	4	-	1 200	-
	West	West Plant (Prelim) Conv.	195	-	-	-	6 900	450
		Effluent P.S.	225	-	-	-	1 350	125
		Effluent F.M.	-	1 200	-	5 600	2 525	-
		Land	-	-	0	-	-	-

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TABLE J-8

TREATMENT/DISPOSAL COSTS (SEPARATE SYSTEM) SECONDARY TREATMENT/REUSE ALTERNATIVE

Item	Zone	Facility	Capacity/Pipe Size/Land ML/day	mm	ha	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
	East	East (Sec.) Plant	475	-	-	-	91 250	2 005
		Effluent P.S.	670	-	-	-	4 105	650
		Effluent F.M.	-	2 100	-	34 000	17 225	-
		Land	-	-	135	-	530	-
	West/ Central	West (Sec.) Plant	360	-	-	-	72 220	1 970
		Effluent P.S.	520	-	-	-	2 500	495
		Effluent F.M.	-	1 900	-	24 000	15 775	-
		Land	-	-	100	-	380	-

TABLE J-9

CONVEYANCE FACILITIES - LOCAL SYSTEMS ALTERNATIVES

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length Metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
AM 1	Ameria	Maryut Ind.Coll.	-	750	10 000	2 910	-
AM 2		Free Zone Coll.	-	900	1 250	410	-
AM 3		Free Zone Coll.	-	1 200	1 750	780	-
AM 4		Ameria Coll.	-	900	3 100	1 020	-
AM 5		Ameria Coll.	-	1 200	3 250	1 450	-
AM 6		Ameria Coll.	-	600	1 750	410	-
AM 7		Ameria Coll.	-	850	1 650	490	-
AM 8		Ameria Coll.	-	600	4 650	1 080	-
AM 9		Ameria Coll.	-	850	1 900	570	-
AM 10		Ameria Coll.	-	1 400	4 400	2 210	-
AM 11		Industrial P.S	83	-	-	1 120	66.0
AM 12		Industrial P.S. F.M.	-	400	2 000	500	-
	TOTAL Conveyance					12 950	66.0
		An/Aer.Lagoons	137	-		8 610	48.0
		Land 315 ha	-			1 180	-
MD 1	Mex-Dekeila	Tanneries P.S.	10	-	-	270	4.0
MD 2		Tanneries F.M.	-	300	2 500	330	
MD 3		Valley of Moon P.S	6	-	-	190	3.2
MD 4		Valley of Moon F.M.	-	250	600	70	-
MD 5		Mex-Dekheila Coll.	-	600	800	220	-
MD 6		Mex-Dekheila Coll.	-	750	600	190	-
MD 7		Main Dekheila P.S.	32	-	-	360	4.8
MD 8		Main Dekheila F.M.	-	500	1 100	140	-

TABLE J-9

CONVEYANCE FACILITIES - LOCAL SYSTEMS ALTERNATIVES

(cont'd)

Item	Zone	Facilities	Pump Capacity ML/day	Pipe Size mm	Pipeline Length Metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
MD 9		Industries Coll.	-	2 000	1 500	1 025	-
MD 10		Industries Coll.	-	2 100	1 100	1 100	-
MD 11		West Indust. P.S.	249	-	-	2 370	77.7
MD 12		West Indust. F.M.	-	1 400	12 000	5 590	-
MD 13		Industries Coll.	-	1 000	500	225	-
TOTAL Conveyance						12 080	99.7
		An/Aer Lagoons	161	-	-	10 800	51.0
		Effluent Channel	(7.0m x 1.6m)	-	6 500	2 105	-
		Effluent P.S.	200	-	-	1 535	85.1
		Land 370 ha	-	-	-	1 385	-
NZ 1	Nouzha	Nouzha Collector	-	500	850	1 060	-
NZ 2		Fisherman Village P.S.	16	-	-	380	5.7
NZ 3		Fisherman Village F.M.	-	350	1 700	280	-
NZ 4		Nouzha Collector	-	700	540	600	-
NZ 5		Nouzha Collector	-	950	1 370	2 230	-
NZ 6		Nouzha Collector	-	700	500	560	-
NZ 7		Nouzha Collector	-	600	425	440	-
NZ 8		Nouzha P.S.	74	-	-	1 060	17.9
NZ 9		Nouzha F.M.	-	750	925	265	-
TOTAL Conveyance						6 857	23.6
		East Plant (Conversion)	45	-	-	150	500

TABLE J-10

CONVEYANCE/TREATMENT/DISPOSAL COSTS (SEPARATE INDUSTRIAL TOXIC WASTE SYSTEM)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
I 26	Ras el Soda	Ras el Soda Coll. 1	-	450	1 500	1 530	-
I 27	"	Ras el Soda Coll. 2	-	600	1 500	1 660	-
I 28	East	East Coll. 1	-	450	1 500	1 530	-
I 29	East	East Coll. 2	-	750	1 500	1 740	-
I 30	Siouf	Siouf Coll.	-	750	2 800	3 200	-
I 31	East	East Coll. 2	-	900	2 000	2 490	-
I 32	Nouzha	Nouzha Coll. 1	-	375	500	570	-
I 33	Nouzha	Nouzha Coll. 2	-	375	1 000	1 140	-
I 34	Central	Central Coll.	-	375	2 800	3 180	-
I 35	West	Karmouz Coll.	-	750	1 400	1 820	-
I 36	West	Karmouz Central Coll.1	-	750	600	830	-
I 37	West	Karmouz Central Coll.2	-	900	1 500	2 090	-
I 38	Mex	Gabbary Coll.	-	300	2 000	300	-
	Collectors -	TOTAL				22 080	
I 10	Ras el Soda	Ras el Soda F.M.	-	400	5 400	920	-
I 11	Siouf	Siouf F.M.	-	750	30	5	-
I 12	Siouf	Siouf Main F.M.	-	900	1 600	530	-
I 13	East	East F.M.	-	600	30	5	-
I 14	East	East Main F.M.	-	900	2 900	930	-
I 15	Nouzha	Nouzha F.M.	-	300	200	30	-
I 16	Nouzha	Nouzha Main F.M.	-	900	3 100	960	-
I 17	West	Industries F.M.	-	750	30	5	-
I 18	West	Industries Main F.M.	-	1 200	7 000	3 060	-

TABLE J-10

CONVEYANCE/TREATMENT/DISPOSAL COSTS (SEPARATE INDUSTRIAL TOXIC WASTE SYSTEM)

(cont'd)

Item	Zone	Facility	Pump Capacity ML/day	Pipe Size mm	Pipeline Length metres	Total Capital Cost LE thousand	Annual Operation and Maintenance Cost LE thousand
I 19	Mex	Gabbary F.M.	-	250	30	5	-
I 20	Mex	Gabbary Main F.M.	-	1 200	8 500	3 740	-
I 25	Dekheila	Dekh. Main F.M.	-	2 100	10 800	8 000	-
	Force Mains-	TOTAL				18 190	
I 1	Ras el Soda	Ras el Soda P.S.	18	-	-	400	110.9
I 2	Siouf	Siouf P.S.	59	-	-	860	247.2
I 3	East	East P.S.	50	-	-	800	201.4
I 4	Nouzha	Nouzha P.S.	11	-	-	280	39.9
I 5	West	Industries P.S.	87	-	-	1 150	218.1
I 6	Mex	Gabbary P.S.	4	-	-	140	7.4
I 7	Dekheila	Dekh. Booster P.S.	478	-	-	3 550	396.6
	Pump Stations -	TOTAL				7 180	1 221.5

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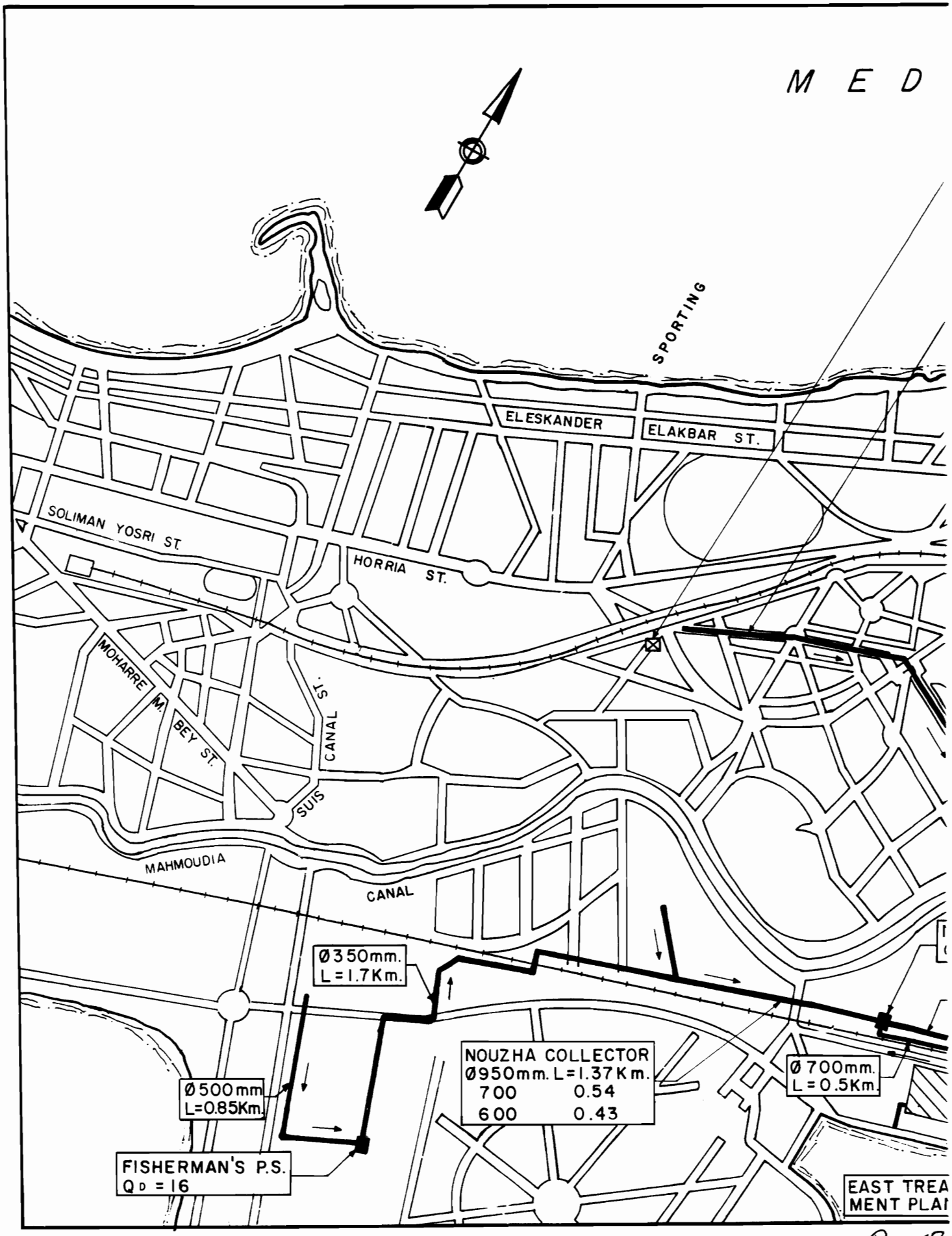

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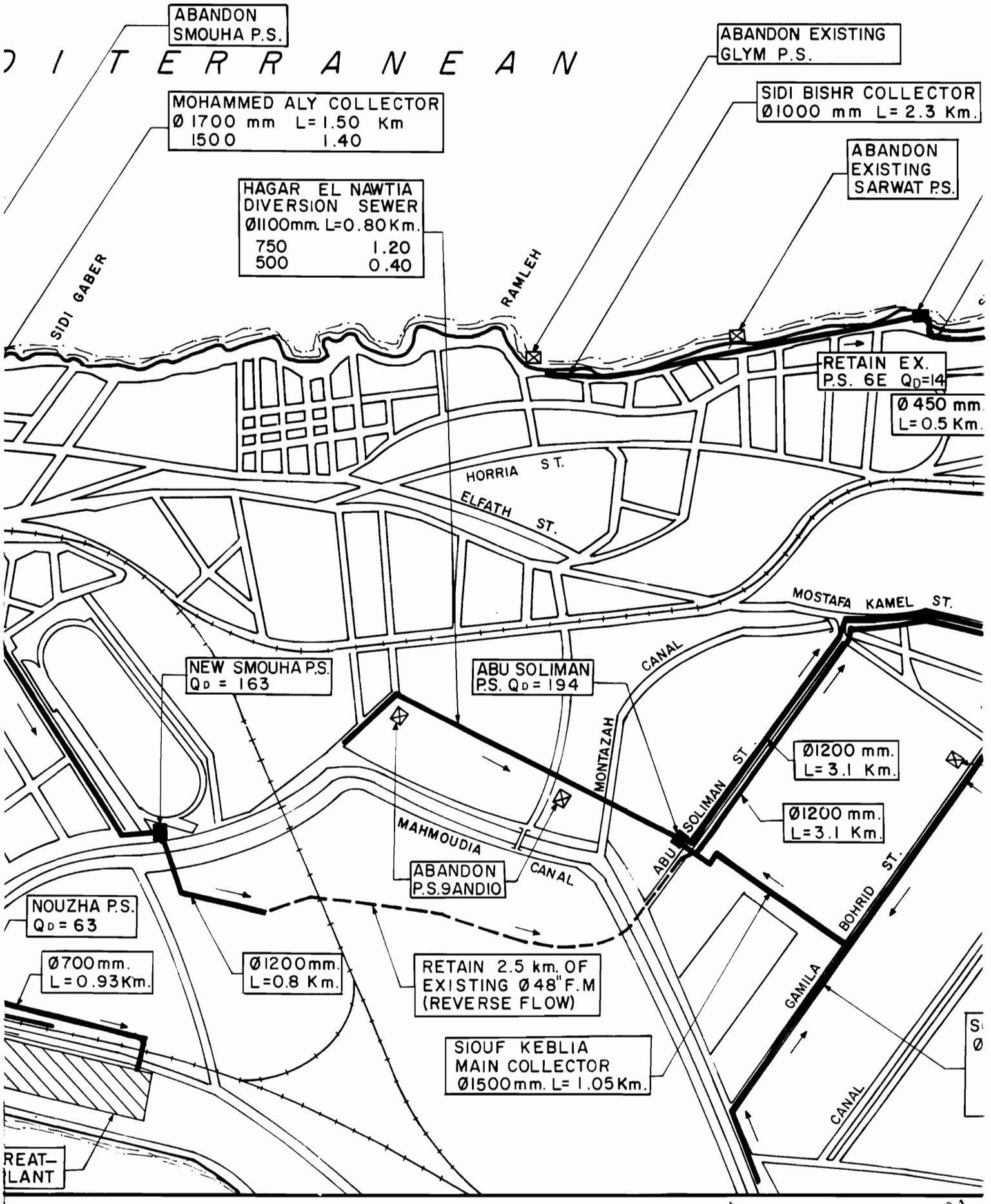

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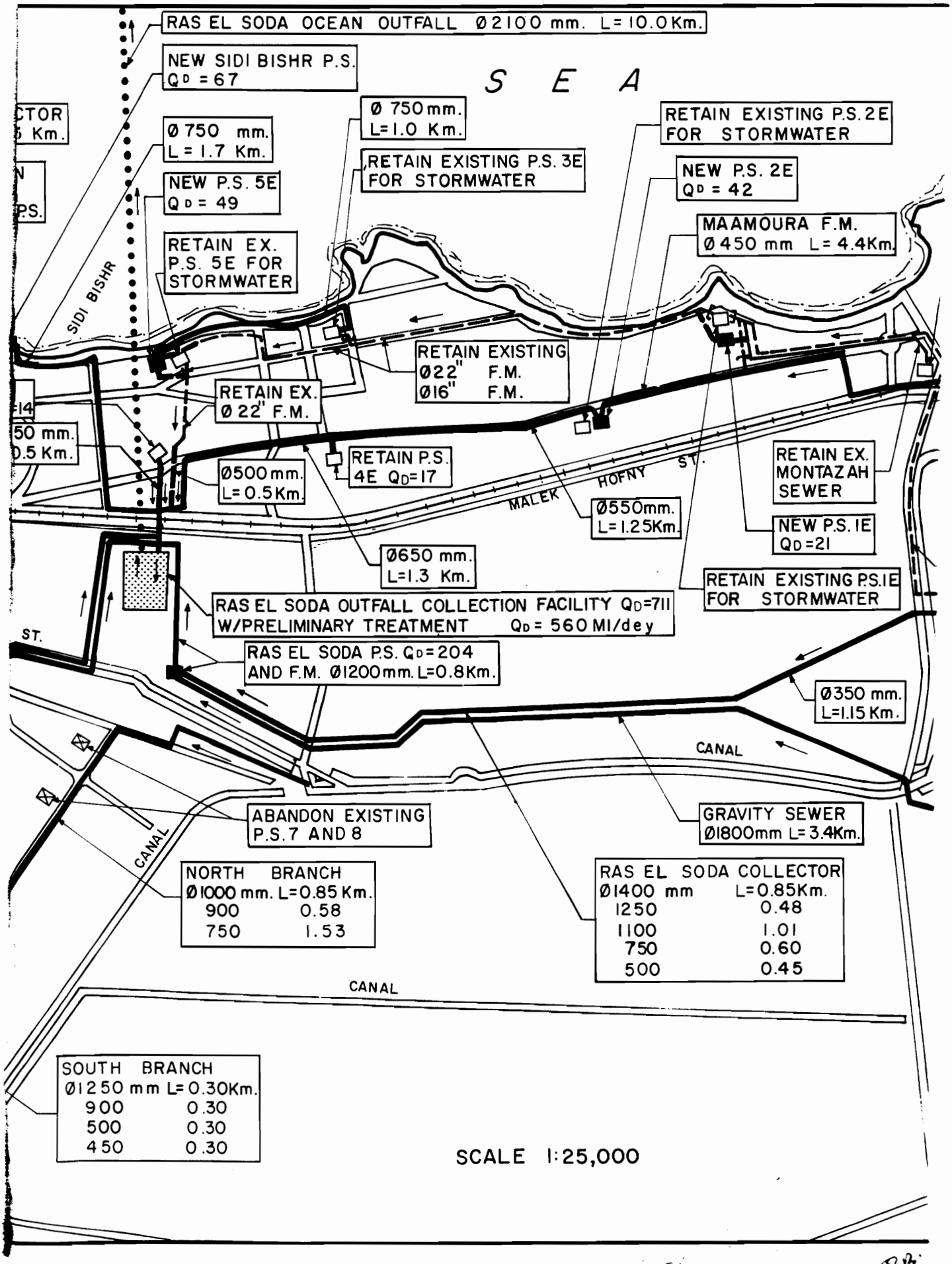

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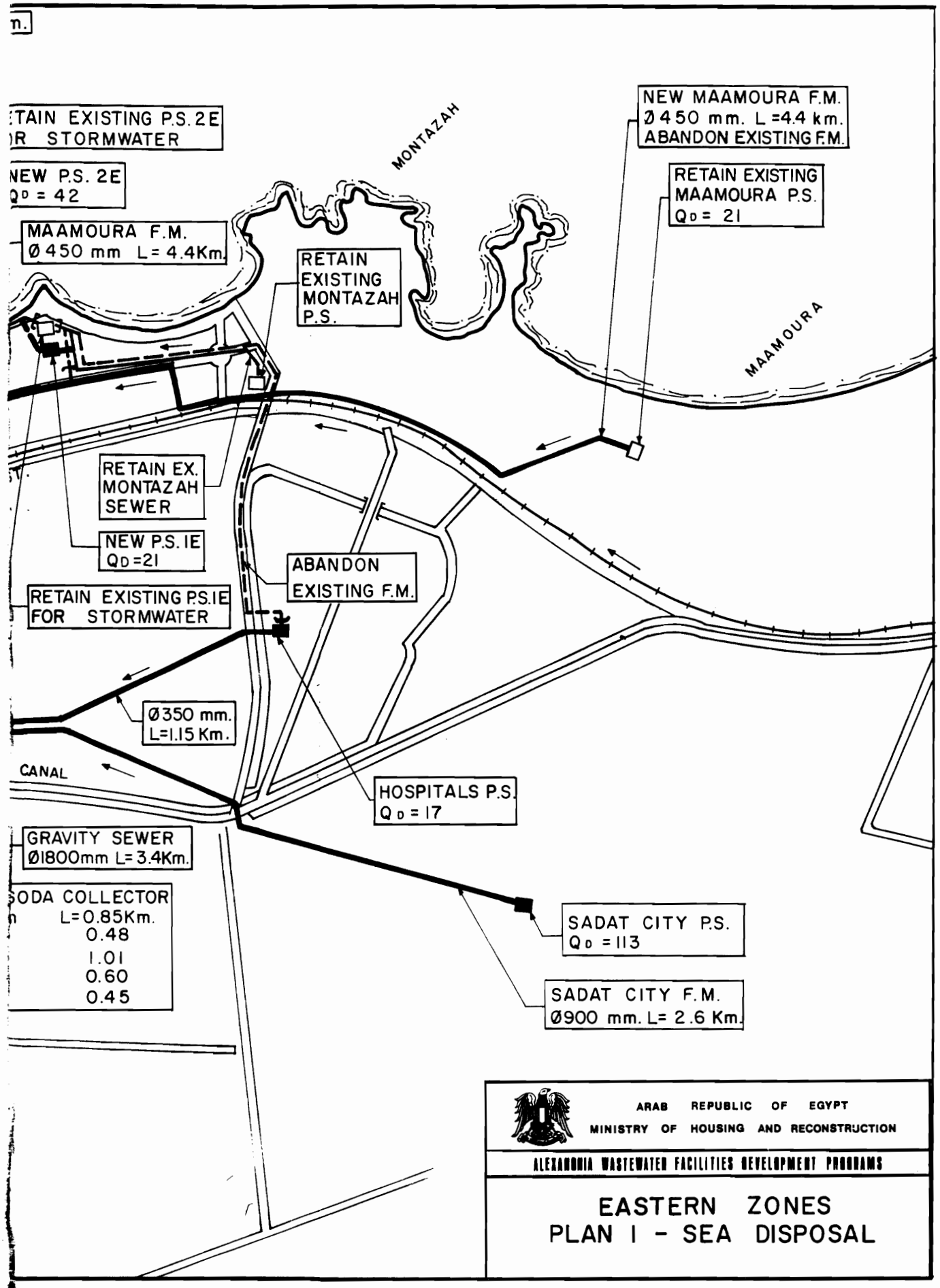

FIGURE J-1

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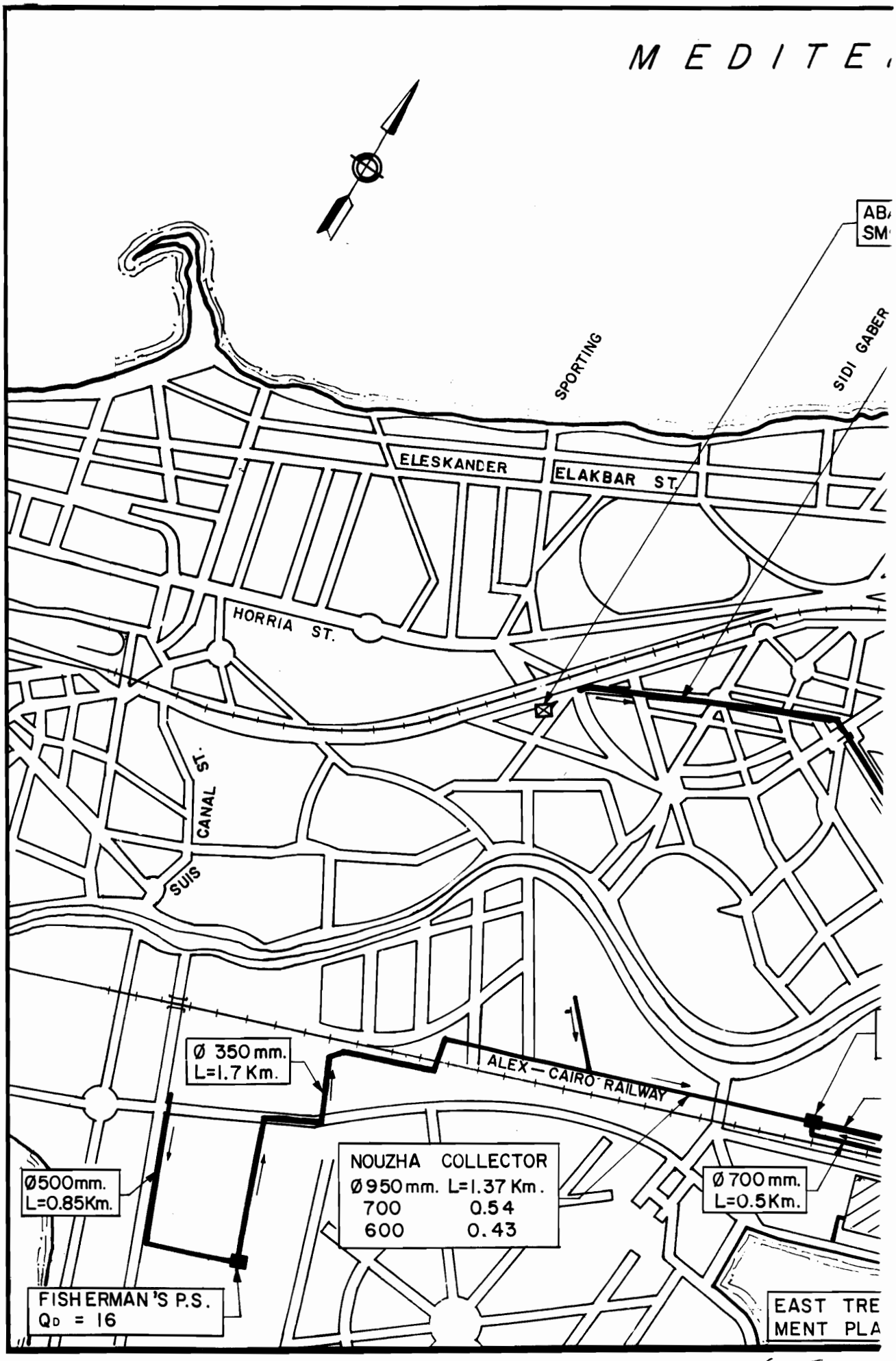

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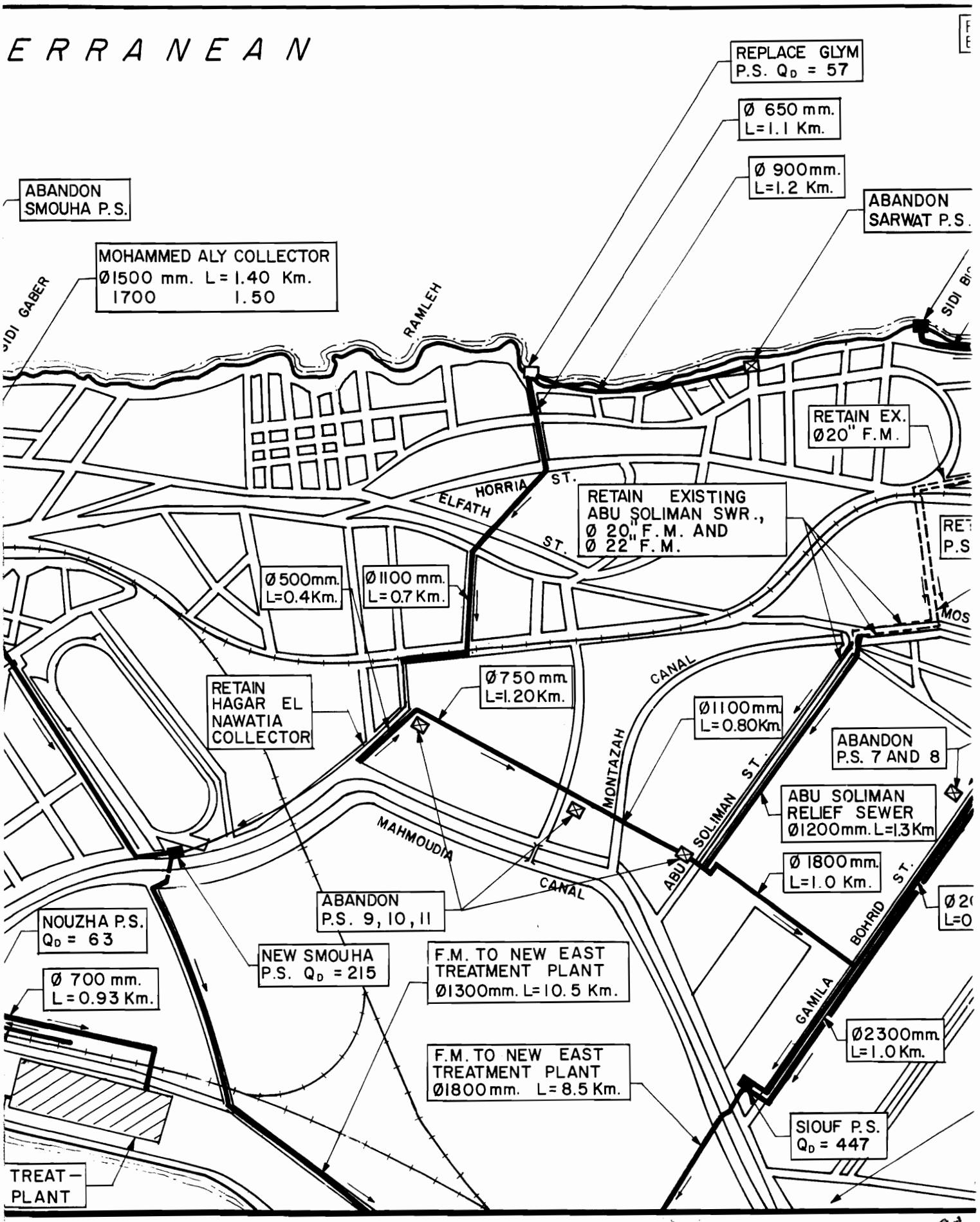

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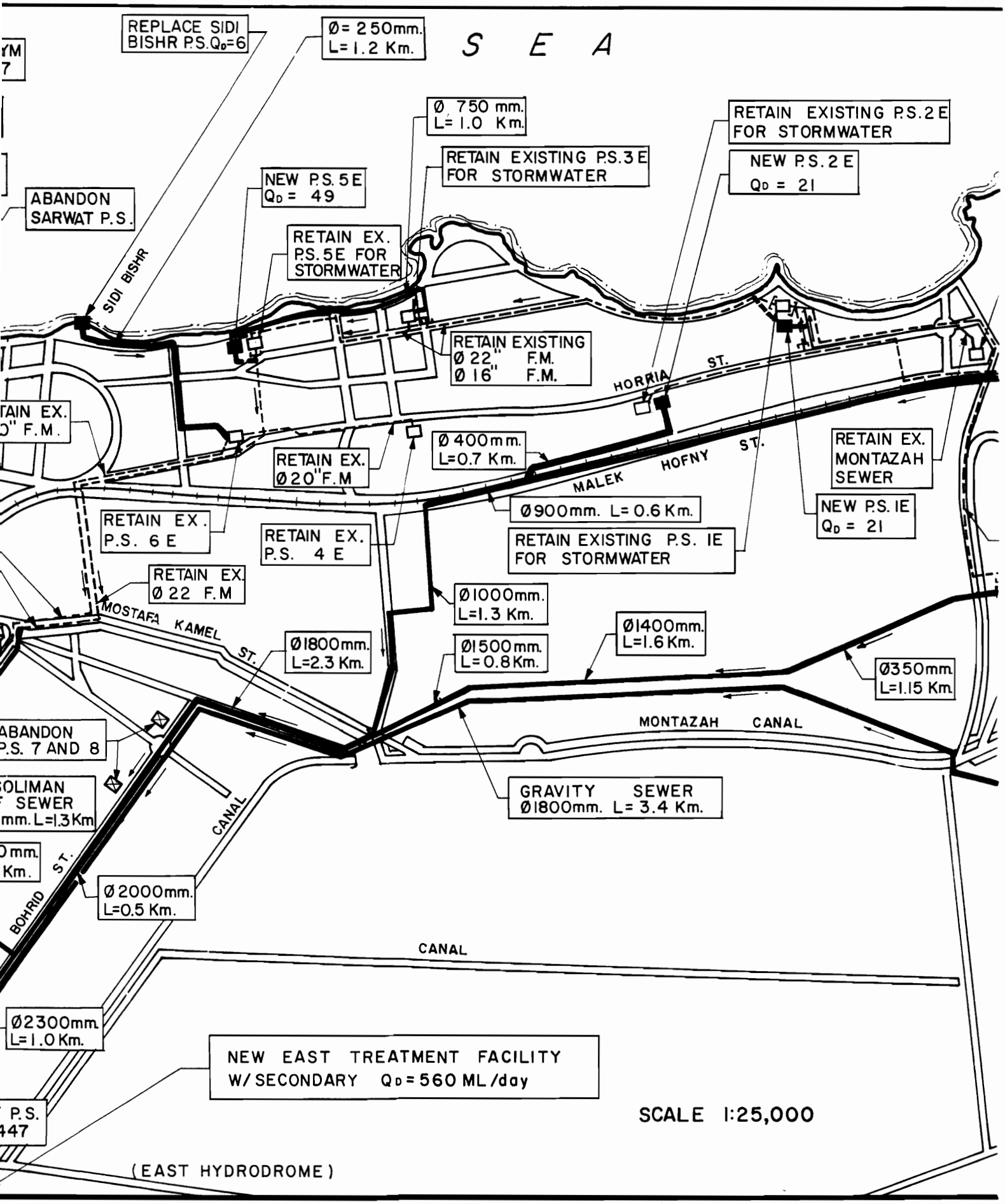

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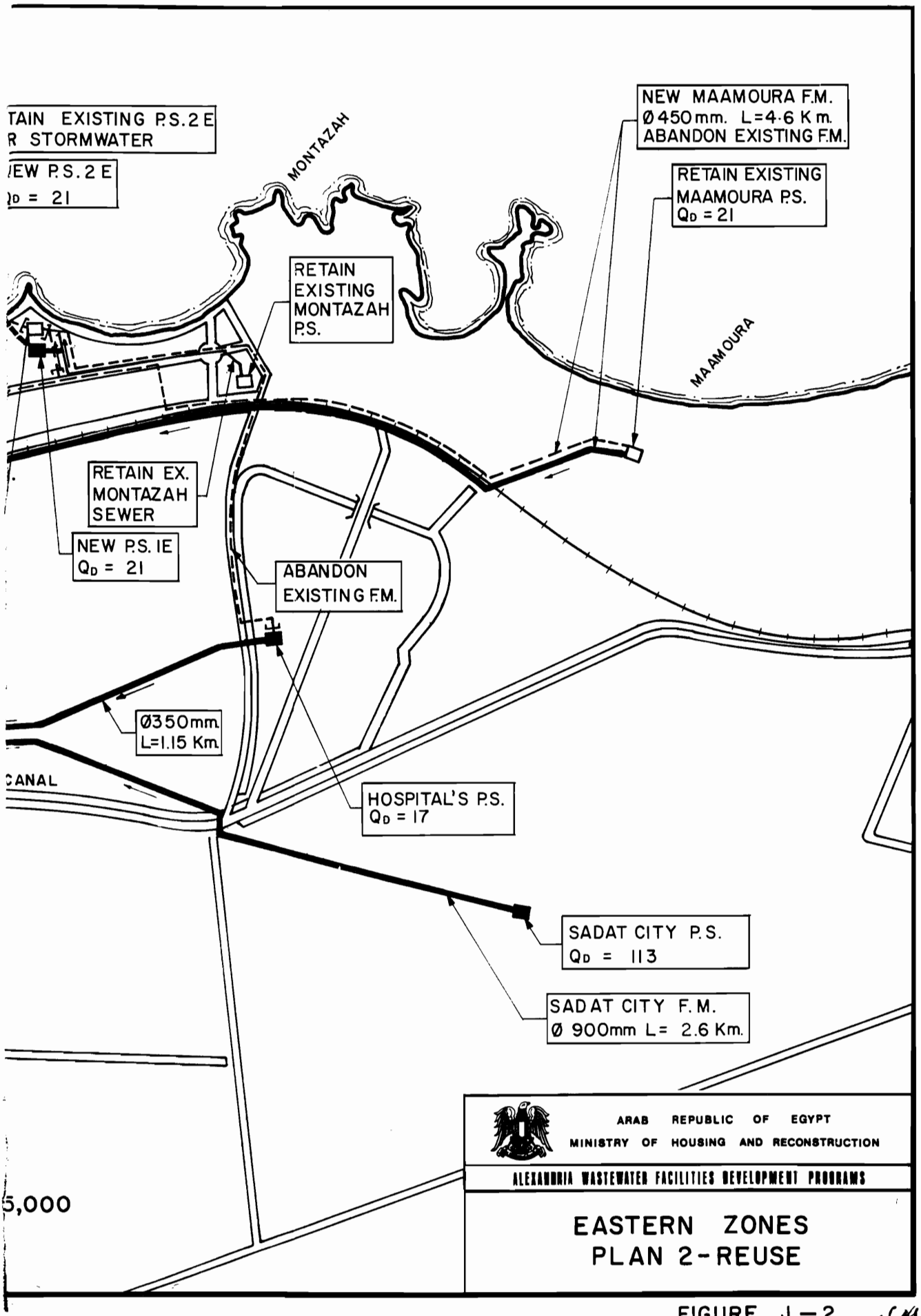


FIGURE J – 2

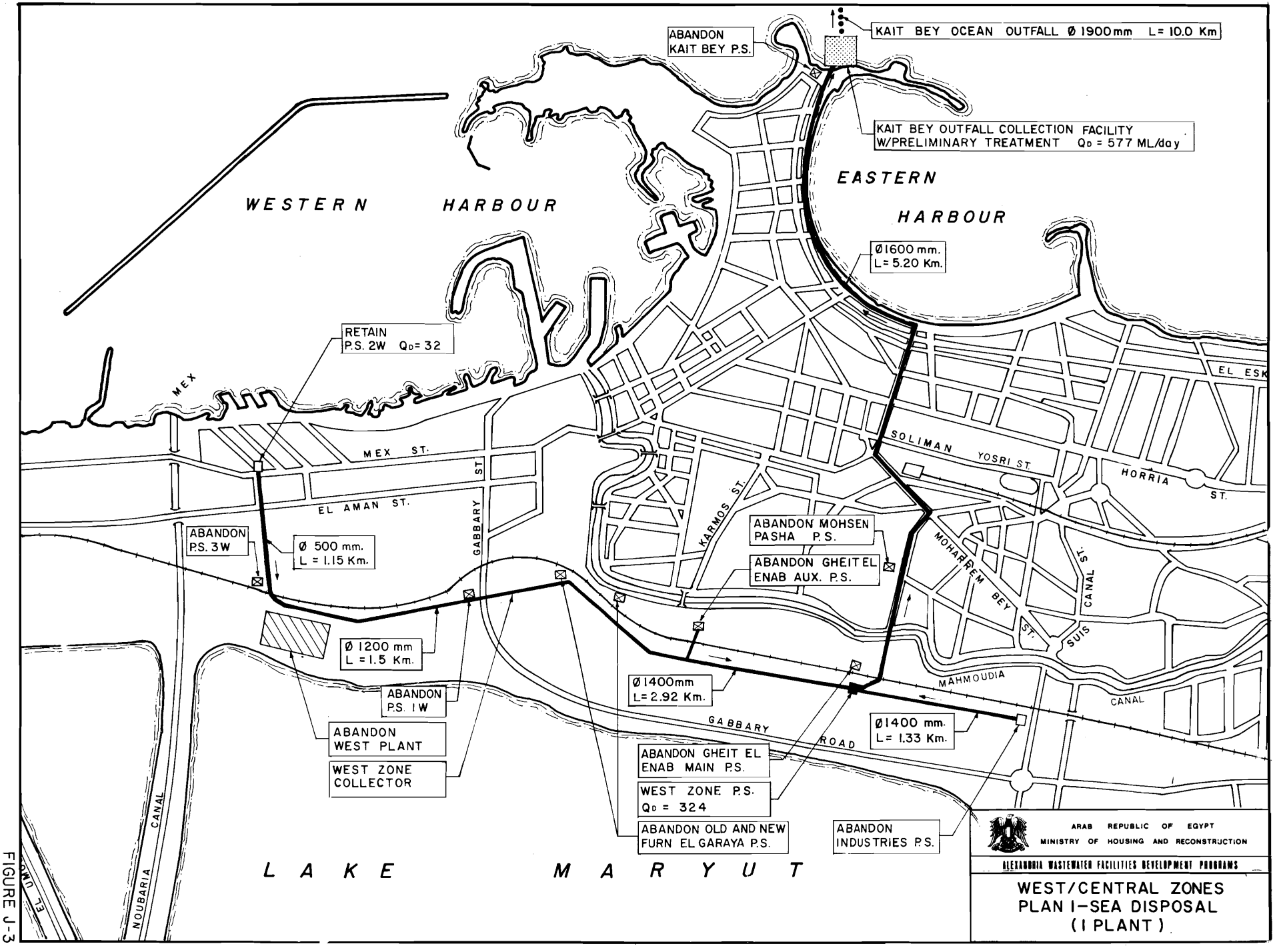

KAIT BEY OCEAN OUTFALL Ø 1900mm L= 10.0 Km
ABANDON KAIT BEY P.S.
KAIT BEY OUTFALL COLLECTION FACILITY W/PRELIMINARY TREATMENT QD = 577 ML/day
EASTERN HARBOUR
WESTERN HARBOUR
Ø1600 mm. L= 5.20 Km.
RETAIN P.S. 2W QD= 32
MEX
MEX ST.
EL AMAN ST.
GABBARY ST.
ABANDON P.S. 3W
Ø 500 mm. L = 1.15 Km.
Ø 1200 mm L = 1.5 Km.
ABANDON P.S. 1W
ABANDON WEST PLANT
WEST ZONE COLLECTOR
KARMOS ST.
ABANDON MOHSEN PASHA P.S.
ABANDON GHEIT EL ENAB AUX. P.S.
SOLIMAN YOSRI ST.
HORRIA ST.
EL ESK
MOHARREM BEY ST.
CANAL ST.
SUIS
MAHMOUDIA
CANAL
Ø1400mm L= 2.92 Km.
Ø1400 mm. L= 1.33 Km.
GABBARY ROAD
ABANDON GHEIT EL ENAB MAIN P.S.
WEST ZONE P.S. QD = 324
ABANDON OLD AND NEW FURN EL GARAYA P.S.
ABANDON INDUSTRIES P.S.
NOUBARIA CANAL
EL UMOM
LAKE MARYUT
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
WEST/CENTRAL ZONES
PLAN I-SEA DISPOSAL
(I PLANT)

FIGURE J-3

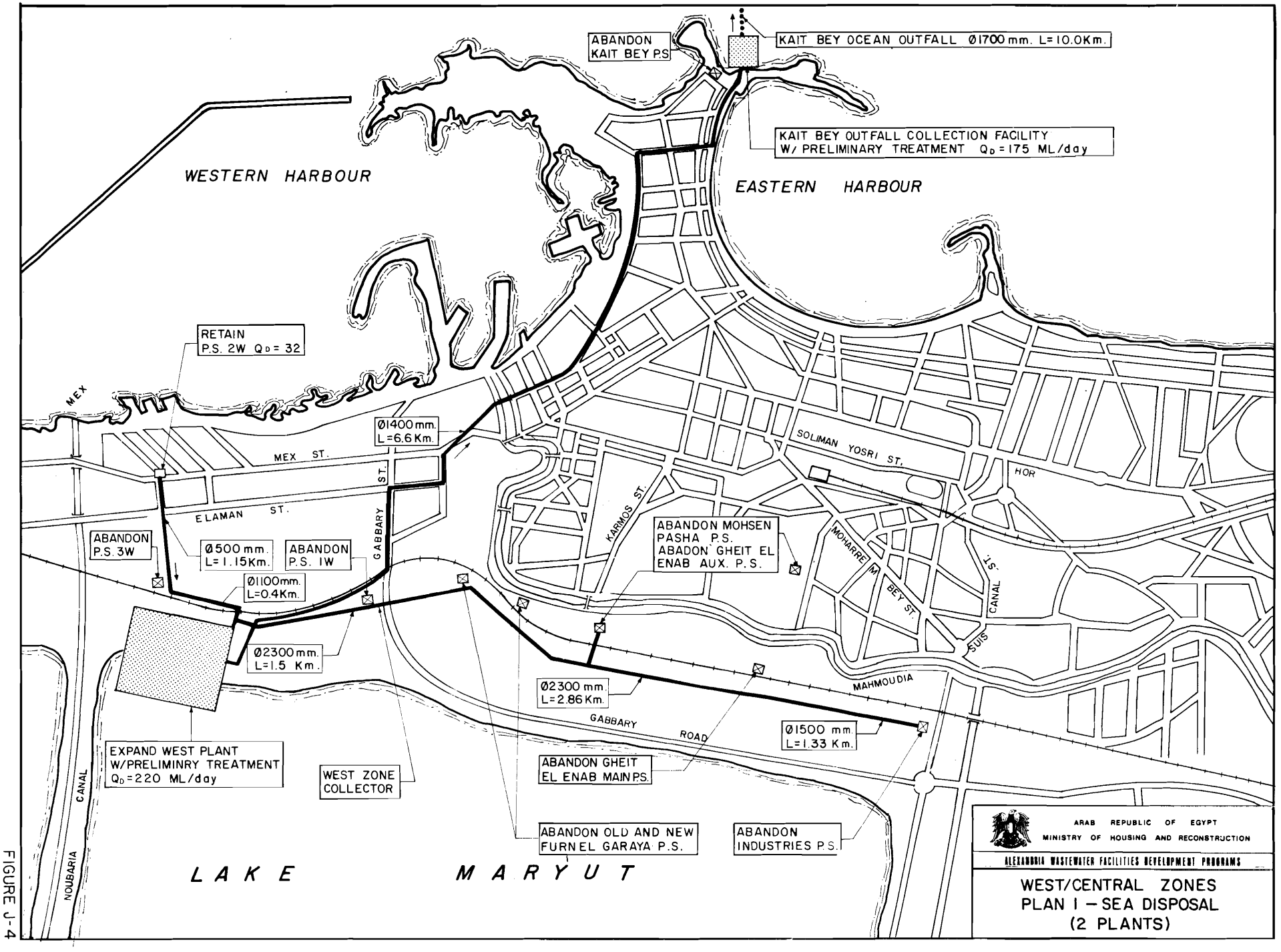

ABANDON KAIT BEY P.S
KAIT BEY OCEAN OUTFALL Ø1700 mm. L=10.0Km.
KAIT BEY OUTFALL COLLECTION FACILITY W/ PRELIMINARY TREATMENT Q_D=175 ML/day
WESTERN HARBOUR
EASTERN HARBOUR
RETAIN P.S. 2W Q_D= 32
MEX
Ø1400 mm. L=6.6 Km.
MEX ST.
ELAMAN ST.
GABBARY ST.
SOLIMAN YOSRI ST.
HOR
KARMOS ST.
ABANDON MOHSEN PASHA P.S. ABADON GHEIT EL ENAB AUX. P.S.
MOHARREM BEY ST.
SUIS CANAL ST.
ABANDON P.S. 3W
Ø500 mm. L=1.15Km.
ABANDON P.S. 1W
Ø1100mm. L=0.4Km.
Ø2300 mm. L=1.5 Km.
Ø2300 mm. L=2.86 Km.
MAHMOUDIA
GABBARY ROAD
Ø1500 mm. L=1.33 Km.
EXPAND WEST PLANT W/PRELIMINRY TREATMENT Q_D=220 ML/day
WEST ZONE COLLECTOR
ABANDON GHEIT EL ENAB MAIN P.S.
ABANDON OLD AND NEW FURN EL GARAYA P.S.
ABANDON INDUSTRIES P.S.
NOUBARIA CANAL
LAKE MARYUT
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
WEST/CENTRAL ZONES
PLAN I – SEA DISPOSAL
(2 PLANTS)

FIGURE J-4

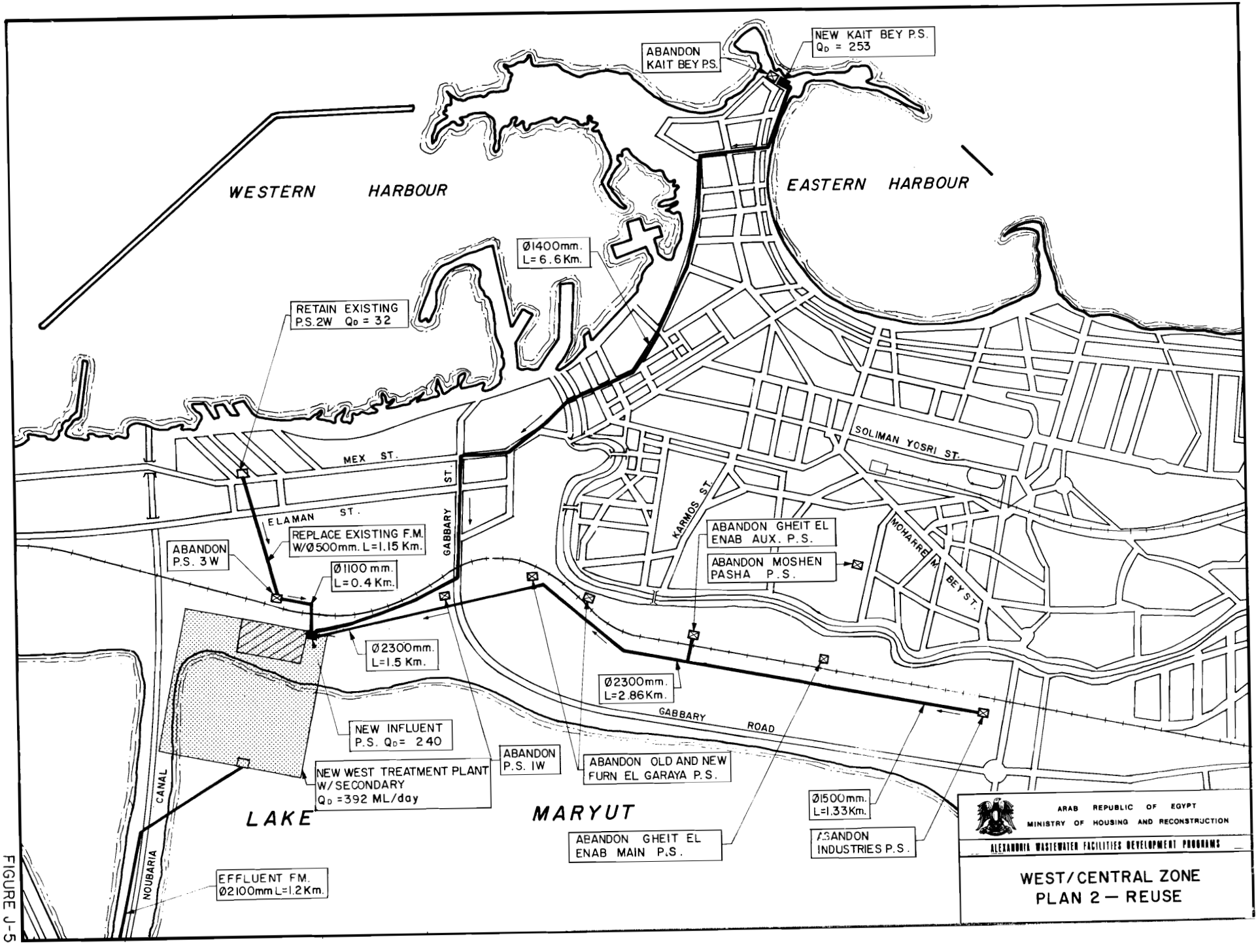

WESTERN HARBOUR
EASTERN HARBOUR
ABANDON KAIT BEY P.S.
NEW KAIT BEY P.S. Q_D = 253
Ø1400mm. L=6.6Km.
RETAIN EXISTING P.S.2W Q_D = 32
MEX ST.
ELAMAN ST.
GABBARY ST.
SOLIMAN YOSRI ST.
KARMOS ST.
MOHARREM BEY ST.
ABANDON P.S. 3W
REPLACE EXISTING F.M. W/Ø500mm. L=1.15 Km.
Ø1100 mm. L=0.4 Km.
ABANDON GHEIT EL ENAB AUX. P.S.
ABANDON MOSHEN PASHA P.S.
Ø2300mm. L=1.5 Km.
Ø2300mm. L=2.86Km.
GABBARY ROAD
NEW INFLUENT P.S. Q_D= 240
ABANDON P.S. 1W
ABANDON OLD AND NEW FURN EL GARAYA P.S.
NEW WEST TREATMENT PLANT W/SECONDARY Q_D =392 ML/day
LAKE MARYUT
Ø1500mm. L=1.33Km.
ABANDON GHEIT EL ENAB MAIN P.S.
ABANDON INDUSTRIES P.S.
NOUBARIA CANAL
EFFLUENT F.M. Ø2100mm L=1.2Km.
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
WEST/CENTRAL ZONE
PLAN 2 — REUSE

FIGURE J-5

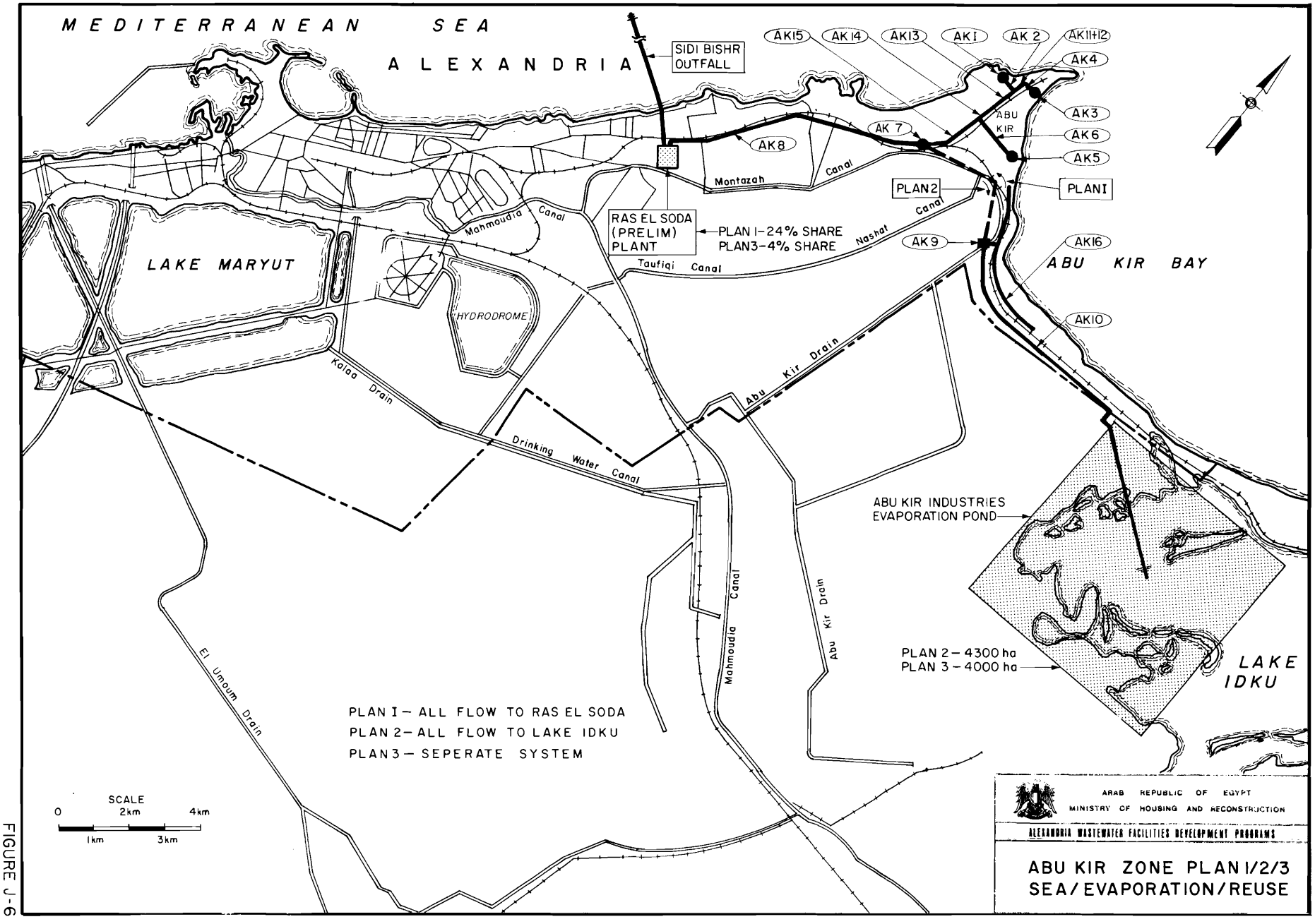

MEDITERRANEAN SEA
ALEXANDRIA
SIDI BISHR OUTFALL
AK15
AK14
AK13
AK1
AK 2
AK11+12
AK4
AK3
AK6
AK5
ABU KIR
AK 7
AK8
Montazah
Canal
PLAN2
PLAN1
RAS EL SODA (PRELIM) PLANT
PLAN 1-24% SHARE
PLAN3-4% SHARE
Mahmoudia Canal
Nashat Canal
AK9
AK16
ABU KIR BAY
Taufiqi Canal
LAKE MARYUT
HYDRODROME
AK10
Kalaa Drain
Abu Kir Drain
Drinking Water Canal
ABU KIR INDUSTRIES EVAPORATION POND
Mahmoudia Canal
Abu Kir Drain
PLAN 2 - 4300 ha
PLAN 3 - 4000 ha
LAKE IDKU
El Umoum Drain
PLAN 1 - ALL FLOW TO RAS EL SODA
PLAN 2 - ALL FLOW TO LAKE IDKU
PLAN 3 - SEPERATE SYSTEM
SCALE
0 2km 4km
1km 3km
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
ABU KIR ZONE PLAN 1/2/3
SEA/EVAPORATION/REUSE

FIGURE J-6

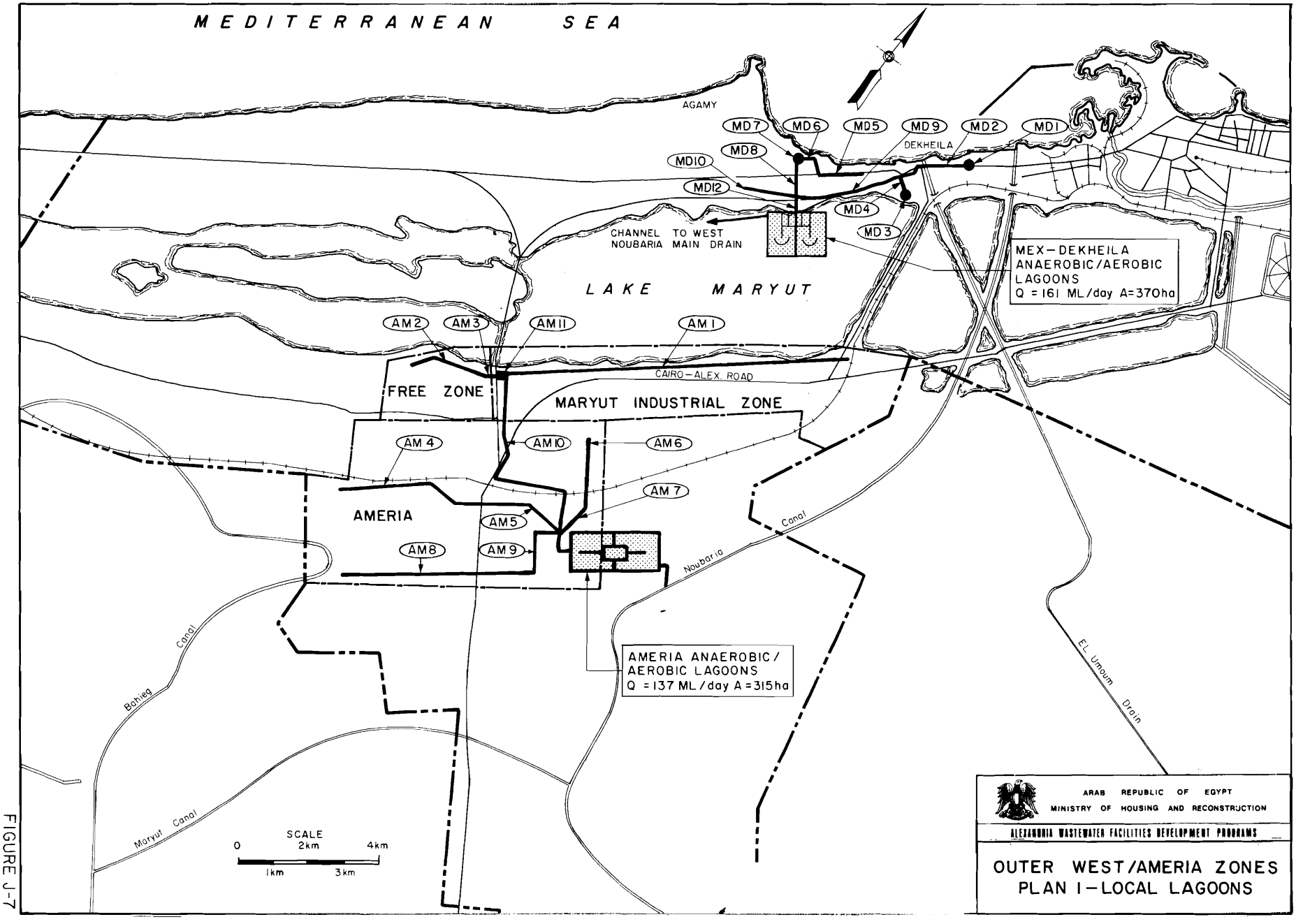

MEDITERRANEAN SEA
AGAMY
MD7
MD6
MD5
MD9
MD2
MD1
DEKHEILA
MD8
MD10
MD12
MD4
MD3
CHANNEL TO WEST NOUBARIA MAIN DRAIN
MEX-DEKHEILA ANAEROBIC/AEROBIC LAGOONS Q = 161 ML/day A=370ha
LAKE MARYUT
AM2
AM3
AM11
AM1
CAIRO-ALEX. ROAD
FREE ZONE
MARYUT INDUSTRIAL ZONE
AM4
AM10
AM6
AM7
AMERIA
AM5
AM8
AM9
Noubaria Canal
Bahieg Canal
Maryut Canal
EL Umoum Drain
AMERIA ANAEROBIC/ AEROBIC LAGOONS Q = 137 ML/day A = 315ha
SCALE
0
2km
4km
1km
3km
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
OUTER WEST/AMERIA ZONES
PLAN I-LOCAL LAGOONS

FIGURE J-7

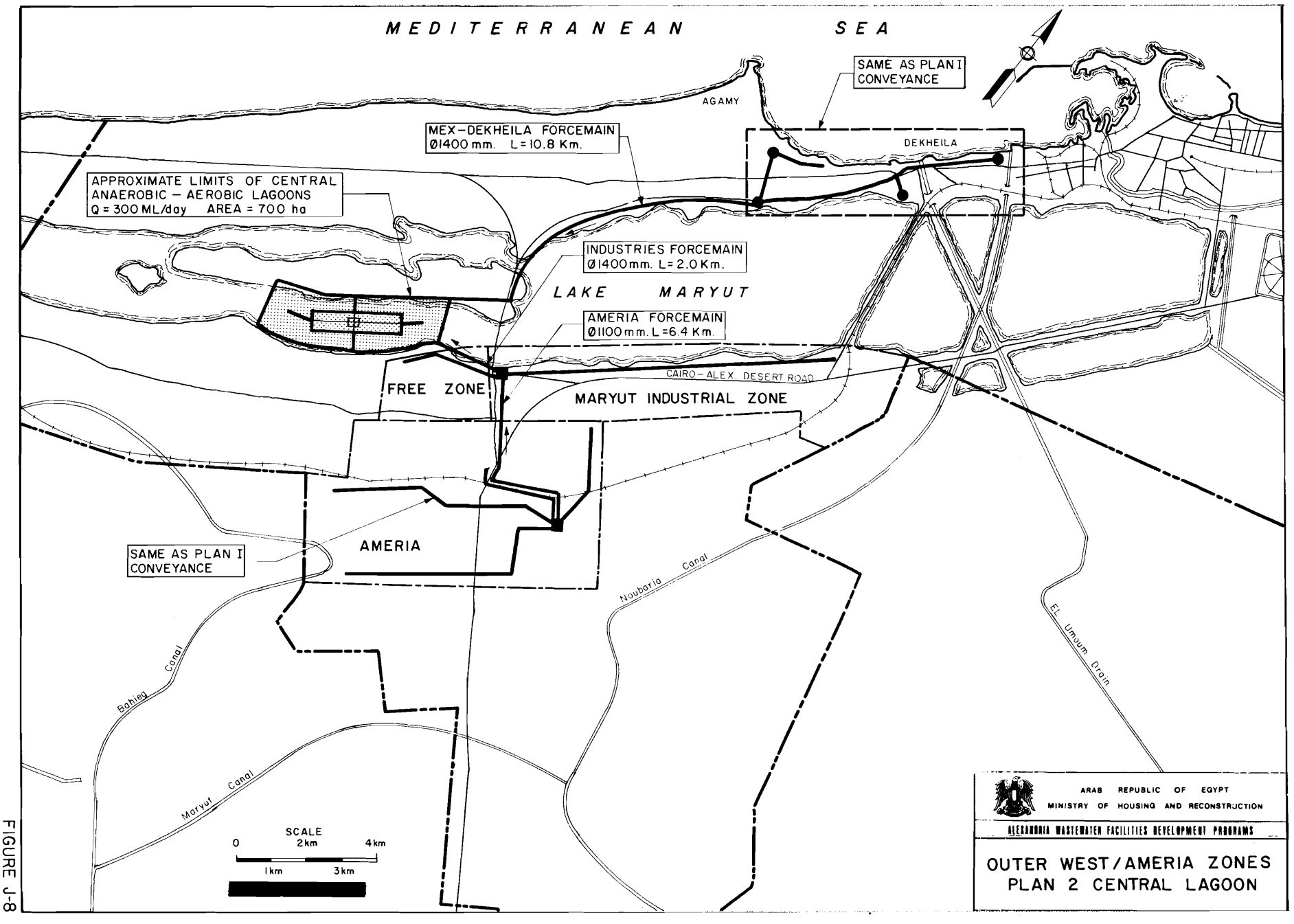
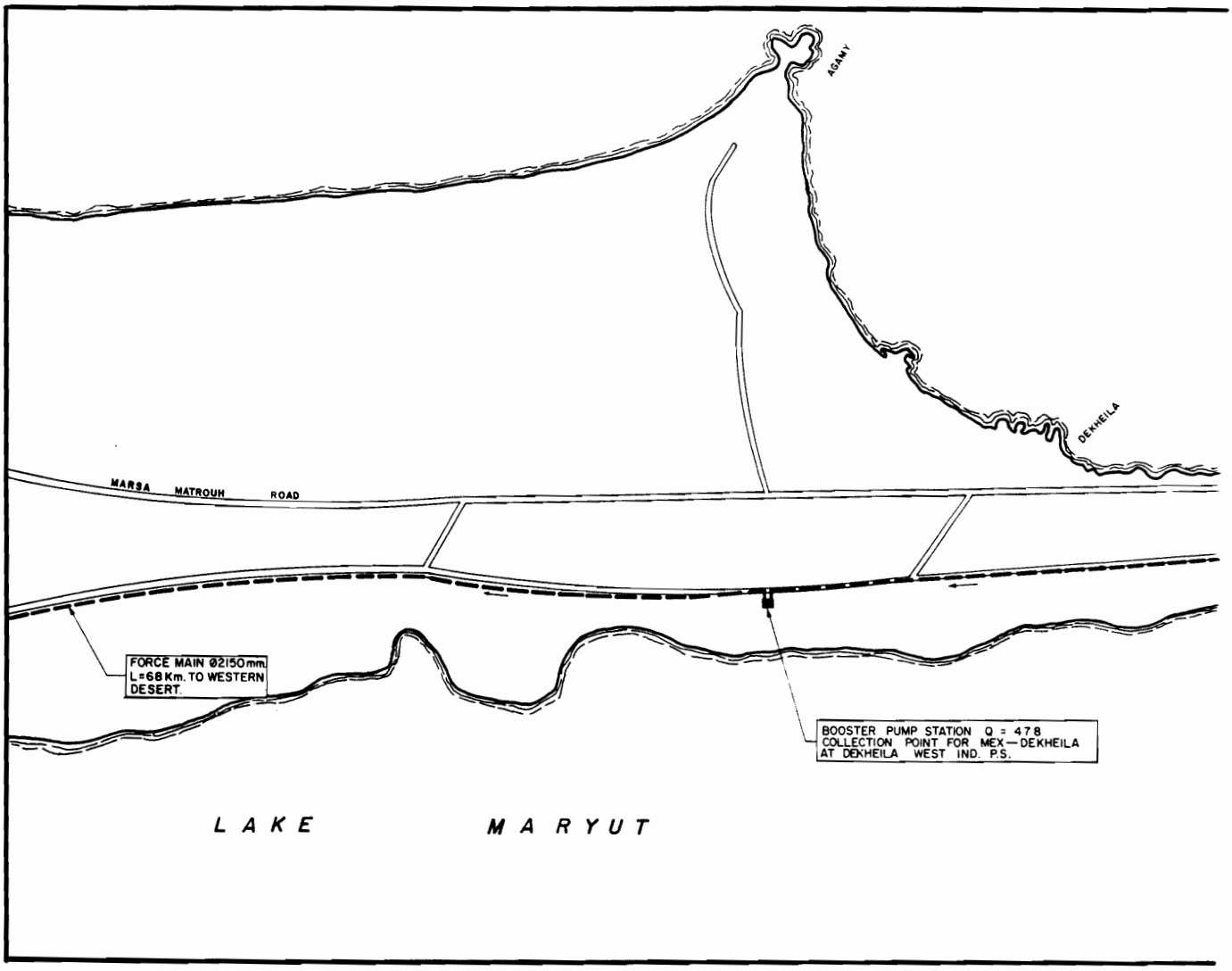

MEDITERRANEAN SEA
SAME AS PLAN I CONVEYANCE
AGAMY
DEKHEILA
MEX-DEKHEILA FORCEMAIN
Ø1400 mm. L=10.8 Km.
APPROXIMATE LIMITS OF CENTRAL ANAEROBIC - AEROBIC LAGOONS
Q = 300 ML/day AREA = 700 ha
INDUSTRIES FORCEMAIN
Ø1400mm. L=2.0 Km.
LAKE MARYUT
AMERIA FORCEMAIN
Ø1100mm. L=6.4 Km.
CAIRO-ALEX. DESERT ROAD
FREE ZONE
MARYUT INDUSTRIAL ZONE
AMERIA
SAME AS PLAN I CONVEYANCE
Noubaria Canal
El Umoum Drain
Bahieg Canal
Maryut Canal
SCALE
0 2km 4km
1km 3km
ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION
ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS
OUTER WEST/AMERIA ZONES
PLAN 2 CENTRAL LAGOON

FIGURE J-8



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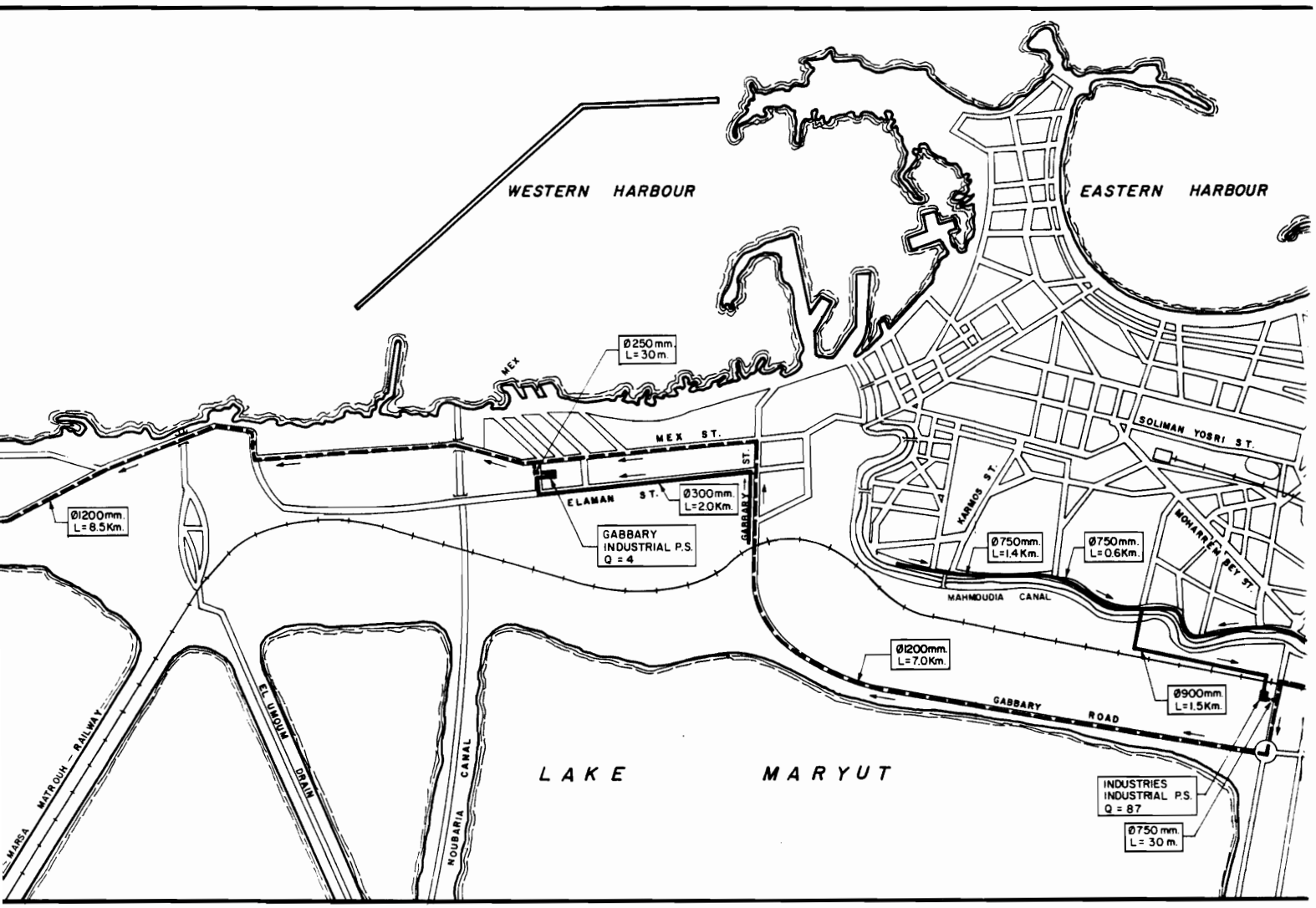

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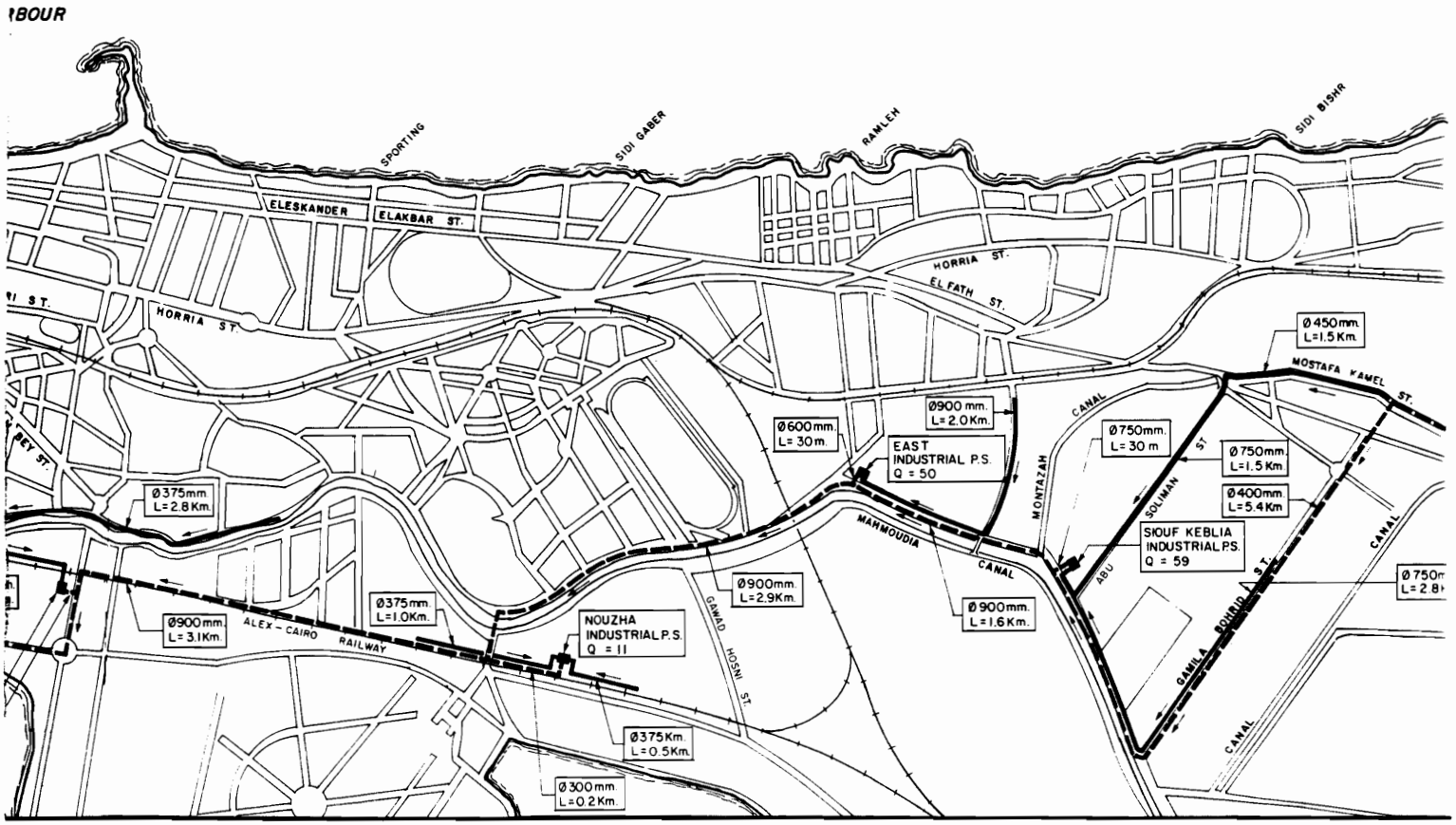
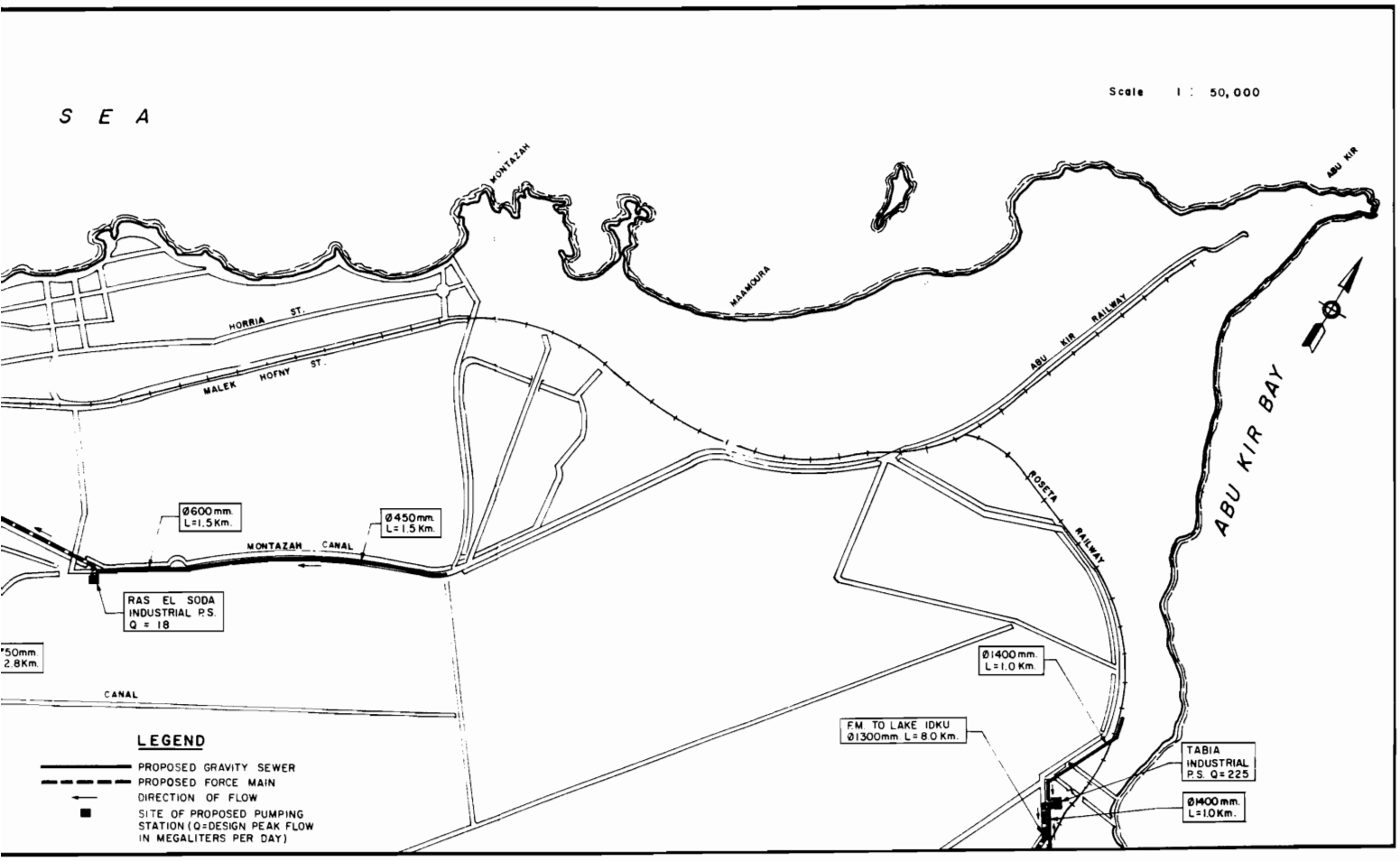
M E D I T E R R A N E A N



BEST AVAILABLE COPY

266B



ARAB REPUBLIC OF EGYPT
MINISTRY OF HOUSING AND RECONSTRUCTION

ALEXANDRIA WASTEWATER FACILITIES DEVELOPMENT PROGRAMS

TOXIC INDUSTRIAL WASTEWATER COLLECTION SYSTEM ALTERNATIVE

FIGURE J-9

BEST AVAILABLE COPY

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APPENDIX K

ECONOMIC EVALUATIONS

Appendix K presents the basis of economic analysis (benefits and costs) for the recommended plan.

LIST OF TABLES

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TABLE K-1

SUMMARY OF BENEFITS, LE thousand

Year	New User A	Current User B	Land Value C	Industry D	Recreation E	Health F	TOTAL
1978	246	-	15 470	-	-	-	15 716
1979	258	-	15 470	-	-	-	15 728
1980	282	-	15 470	-	7 368	-	23 120
1981	312	-	15 470	-	7 623	1 716	25 121
1982	342	255	15 470	778	7 874	1 808	26 532
1983	348	263	15 470	816	8 134	3 865	28 896
1984	840	286	15 470	854	8 390	3 968	29 808
1985	1104	311	15 470	894	8 645	4 158	30 582
1986	1212	327	11 750	935	8 901	4 344	27 469
1987	1224	354	11 750	979	9 156	5 899	29 362
1988	1224	380	11 750	1 025	9 412	6 160	29 951
1989	554	389	11 750	1 073	9 667	6 436	29 869
1990	553	398	11 750	1 111	9 923	7 743	31 478
1991	554	406	11 750	1 144	10 268	8 080	32 202
1992	553	415	11 750	1 200	10 613	8 425	32 956
1993	554	423	11 750	1 230	10 958	8 778	33 693
1994	553	433	11 750	1 261	11 303	9 147	34 447
1995	534	441	11 750	1 291	11 648	9 514	35 178
1996	534	450	11 750	1 321	11 994	9 907	35 956
1997	534	458	11 750	1 126	12 339	10 300	36 507
1998	534	467	11 750	1 381	12 684	10 720	37 536
1999	534	475	11 750	1 412	13 029	11 138	38 338
2000	534	484	11 750	1 443	13 374	11 575	39 160
2001	534	484	-	1 443	13 374	11 575	27 410
2002	534	484	-	1 443	13 374	11 575	27 410
2003	534	484	-	1 443	13 374	11 575	27 410
2004	534	484	-	1 443	13 374	11 575	27 410
2005	534	484	-	1 443	13 374	11 575	27 410
2006	534	484	-	1 443	13 374	11 575	27 410
2007	534	484	-	1 443	13 374	11 575	27 410
2008	534	484	-	1 443	13 374	11 575	27 410
2009	534	484	-	1 443	13 374	11 575	27 410
2010	534	484	-	1 443	13 374	11 575	27 410
TOTAL	19 257	12 255	300 010	35 704	347 050	259 431	973 707

Present Worth Values(LE): 316 526 000 at 8%

259 379 000 at 10%

168 075 000 at 15%

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TABLE K-2

SUMMARY OF COSTS, LE thousand

Year	Capital	O & M	TOTAL
1978	3 927	2 822	6 749
1979	15 243	3 360	18 603
1980	23 356	3 661	27 017
1981	44 587	1 527	46 114
1982	30 850	1 702	32 552
1983	31 323	1 795	33 118
1984	49 628	1 901	51 529
1985	53 368	1 964	55 332
1986	48 645	2 024	50 669
1987	40 988	2 139	43 127
1988	35 487	2 250	37 737
1989	6 773	2 300	9 073
1990	6 773	2 350	9 123
1991	6 773	2 400	9 173
1992	6 773	2 450	9 223
1993	6 773	2 500	9 273
1994	6 773	2 560	9 333
1995	6 742	2 585	9 327
1996	6 742	2 610	9 352
1997	6 742	2 635	9 377
1998	6 742	2 660	9 402
1999	6 742	2 685	9 427
2000	6 742	2 710	9 452
2001	-	2 710	2 710
2002	-	2 710	2 710
2003	-	2 710	2 710
2004	-	2 710	2 710
2005	-	2 710	2 710
2006	-	2 710	2 710
2007	-	2 710	2 710
2008	-	2 710	2 710
2009	-	2 710	2 710
2010	-	2 710	2 710
TOTAL	458 492	82 690	541 182

Present Worth Values: 275 072 - 3 584 = 271 488 (8%)

239 775 - 1 957 = 237 818 (10%)

176 513 - 451 = 176 062 (15%)

Assumptions and Methodology:

1. Capital costs include the Top Priority Program and the Master Plan.

TABLE K-3

SUMMARY OF COST OF RECOVERY ITEMS, LE thousand

Year	Structures 40 Years	Equipment 20 Years	Value of Structures in 2011	Value of Equipment in 2011
1978				
1979				
1980				
1981				
1982	135	125		
1983	2 610	2 410		
1984	7 214	6 660		
1985				
1986	14 502	1 468		
1987	8 187	7 557		
1988	3 916	3 614		
1989	17 829	5 647		
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999				
2000				
2001				
2002		125		
2003		2 410		
2004		6 660		
2005				
2006		1 468		
2007		7 557		
2008		3 614		
2009		5 647		
2010				
2011			22 925	22 519

Assumptions and Methodology:

1. Assume a life of 40 years for structures and 20 years for equipment. Assume replacement, if necessary, at 1977 costs.

2. Assume no recovery for sewers, force mains, gravity sewers, and outfalls.

3. Take straight line depreciation, so that the recovery in 20 years on an item with a 40-year life would be 50 percent.

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TABLE K-4

ESTIMATED BENEFITS OF A
WASTEWATER SYSTEM TO THE NEW USER

Year	New Users	Connection Cost, LE	Annual Benefit, LE
1978	1 640	150	246 000
1979	1 720	150	258 000
1980	1 880	150	282 000
1981	2 180	150	312 000
1982	2 280	150	342 000
1983	2 320	150	348 000
1984	5 600	150	840 000
1985	7 360	150	1 104 000
1986	8 080	150	1 212 000
1987	8 160	150	1 224 000
1988	8 160	150	1 224 000
1989	3 690	150	553 500
1990	3 690	150	553 500
1991	3 690	150	553 500
1992	3 690	150	553 500
1993	3 690	150	553 500
1994	3 690	150	553 500
1995	3 560	150	534 000
1996	3 560	150	534 000
1997	3 560	150	534 000
1998	3 560	150	534 000
1999	3 560	150	534 000
2000	3 560	150	534 000
2001	3 560	150	534 000
2002	3 560	150	534 000
2003	3 560	150	534 000
2004	3 560	150	534 000
2005	3 560	150	534 000
2006	3 560	150	534 000
2007	3 560	150	534 000
2008	3 560	150	534 000
2009	3 560	150	534 000
2010	3 560	150	534 000
TOTAL			19 257 000

Assumptions and Methodology:

1. Value to connections is that charged by GOSSD in 1977 (LE 150).

2. New connections as estimated in Recommended Facilities Plan.

3. Commence in 1978 with Top Priority Projects (TPP).

TABLE K-5

ESTIMATED BENEFITS OF IMPROVED

WASTEWATER SYSTEM MAINTENANCE TO CURRENT USERS

Year	GOSSD Sewer Maintenance Costs, LE	Multiplier	Annual Benefit, LE
1978			
1979			
1980			
1981			
1982	511 000	0.5	255 500
1983	525 000	0.5	262 500
1984	571 000	0.5	285 500
1985	622 000	0.5	311 000
1986	654 000	0.5	327 000
1987	708 000	0.5	354 000
1988	761 000	0.5	380 500
1989	778 000	0.5	389 000
1990	796 000	0.5	398 000
1991	812 000	0.5	406 000
1992	830 000	0.5	415 000
1993	846 000	0.5	423 000
1994	865 000	0.5	432 500
1995	882 000	0.5	441 000
1996	900 000	0.5	450 000
1997	916 000	0.5	458 000
1998	934 000	0.5	467 000
1999	950 000	0.5	475 000
2000	968 000	0.5	484 000
2001	968 000	0.5	484 000
2002	968 000	0.5	484 000
2003	968 000	0.5	484 000
2004	968 000	0.5	484 000
2005	968 000	0.5	484 000
2006	968 000	0.5	484 000
2007	968 000	0.5	484 000
2008	968 000	0.5	484 000
2009	968 000	0.5	484 000
2010	968 000	0.5	484 000
TOTAL			12 254 500

Assumptions and Methodology:

1. Currently, over one-half of the GOSSD sewer maintenance budget is spent in responding to emergencies brought about by stoppages due, primarily, to excessive solids/greases in pipes--use .5.

2. Assume elimination of all but excess over 50% when TPP completed.

3. Costs as provided in the recommended Master Plan.

TABLE K-6

BENEFITS TO OVERALL LAND VALUES

Year	New Sewered Areas Inner City ha	New Sewered Areas Outer City ha	Increase in Values, LE thousand Inner City 15%	Increase in Values, LE thousand Outer City 25%	Annual Benefit
1978	22.5	180.0	4220	11 250	15 470
1979	22.5	180.0	4220	11 250	15 470
1980	22.5	180.0	4220	11 250	15 470
1981	22.5	180.0	4220	11 250	15 470
1982	22.5	180.0	4220	11 250	15 470
1983	22.5	180.0	4220	11 250	15 470
1984	22.5	180.0	4220	11 250	15 470
1985	22.5	180.0	4220	11 250	15 470
1986	12.0	152.0	2250	9 500	11 750
1987	12.0	152.0	2250	9 500	11 750
1988	12.0	152.0	2250	9 500	11 750
1989	12.0	152.0	2250	9 500	11 750
1990	12.0	152.0	2250	9 500	11 750
1991	12.0	152.0	2250	9 500	11 750
1992	12.0	152.0	2250	9 500	11 750
1993	12.0	152.0	2250	9 500	11 750
1994	12.0	152.0	2250	9 500	11 750
1995	12.0	152.0	2250	9 500	11 750
1996	12.0	152.0	2250	9 500	11 750
1997	12.0	152.0	2250	9 500	11 750
1998	12.0	152.0	2250	9 500	11 750
1999	12.0	152.0	2250	9 500	11 750
2000	12.0	152.0	2250	9 500	11 750
TOTAL					300 010

Present Worth Values(LE): 143 237 000 at 8%

125 920 000 at 10%

91 879 000 at 15%

Assumptions and Methodology

1. An average cost of LE 125 per m^2 of land in the city and LE 25 per m^2 outside of the city was used, based on present land value .
2. Assumed value increases in property of 15% (inner) and 25% (outer) present increased attractiveness of areas for residency or commercial and industrial development.

TABLE K-7

ESTIMATED BENEFITS OF A
WASTEWATER SYSTEM TO INDUSTRY

Year	Industrial Water Usage m^3/day	Days per Year	Charge/m^3 .0061 LE	Annual Benefit, LE
1982	349 000	365	.0061	778 270
1983	365 800	365	.0061	815 734
1984	382 900	365	.0061	853 867
1985	400 800	365	.0061	893 784
1986	419 500	365	.0061	935 485
1987	439 100	365	.0061	979 193
1988	459 600	365	.0061	1 024 908
1989	481 100	365	.0061	1 072 353
1990	498 000	365	.0061	1 110 540
1991	512 900	365	.0061	1 143 767
1992	538 500	365	.0061	1 200 855
1993	552 000	365	.0061	1 230 960
1994	565 500	365	.0061	1 261 065
1995	579 000	365	.0061	1 291 170
1996	592 500	365	.0061	1 321 275
1997	606 000	365	.0061	1 126 150
1998	619 500	365	.0061	1 381 485
1999	633 000	365	.0061	1 411 590
2000	647 000	365	.0061	1 442 810
2001	647 000	365	.0061	1 442 810
2002	647 000	365	.0061	1 442 810
2003	647 000	365	.0061	1 442 810
2004	647 000	365	.0061	1 442 810
2005	647 000	365	.0061	1 442 810
2006	647 000	365	.0061	1 442 810
2007	647 000	365	.0061	1 442 810
2008	647 000	365	.0061	1 442 810
2009	647 000	365	.0061	1 442 810
2010	647 000	365	.0061	1 442 810
TOTAL				35 703 861

Assumptions and Methodology:

1. GOSSD 1961 charge of LE .003 per m^3 to industrial users is assumed to reflect the benefit to users of a public sewerage system. The charge has been raised to LE .0061 per m^3 to reflect inflation since 1961 and estimated inflation until 1982.

2. Benefits commence in 1982 after TPP completion.

3. Usage is equal to contaminated wastewater flow.

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TABLE K-8

ESTIMATED BENEFITS OF AN
EXPANDED WASTEWATER SYSTEM TO RECREATION

Year	Recreational Benefit, LE thousand	Multiplier[a]	Annual Benefit, LE thousand
1980	29 470	.25	7 368
1981	30 492	.25	7 623
1982	31 514	.25	7 879
1983	32 536	.25	8 134
1984	33 558	.25	8 390
1985	34 580	.25	8 645
1986	35 603	.25	8 901
1987	36 625	.25	9 156
1988	37 647	.25	9 412
1989	38 669	.25	9 667
1990	39 691	.25	9 923
1991	41 072	.25	10 268
1992	42 452	.25	10 613
1993	43 833	.25	10 958
1994	45 213	.25	11 303
1995	46 594	.25	11 648
1996	47 975	.25	11 994
1997	49 355	.25	12 339
1998	50 736	.25	12 684
1999	52 116	.25	13 029
2000	53 497	.25	13 374
2001	53 497	.25	13 374
2002	53 497	.25	13 374
2003	53 497	.25	13 374
2004	53 497	.25	13 374
2005	53 497	.25	13 374
2006	53 497	.25	13 374
2007	53 497	.25	13 374
2008	53 497	.25	13 374
2009	53 497	.25	13 374
2010	53 497	.25	13 374
TOTAL			347 050

Present Worth Values(LE): 95 639 000 at 8%
74 864 000 at 10%
44 878 000 at 15%

Note: refer to following pages for assumptions and methodology.

[a] Amount dependent on elimination of beach pollution.

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Assumptions and Methodology for Table K-8:

1. Basis of Calculation

   A. Assumes that tourism and use of beaches will increase with reduction/elimination of beach pollution, and that the result will be increased spending in the Alexandria area by European and regional tourists, and increased beach use by local residents.

   B. Benefits based on number of tourist days and the average expenditures for European and regional tourists, and on average expenditures of bathers.

2. Calculations

   A. Estimated number of leisure-oriented tourists to Alexandria and Western Desert beaches (from Vol. II Regional Plan for the Coastal Zone):

Source of Tourists	Number of Tourist Days, thousand 1980	1990	2000
Regional	1 950	2 496	3 198
European	1 113	4 526	11 788
TOTAL	3 063	7 022	14 986

   B. Assumed, on a conservative basis, that 10% of the regional (Arab) tourists and 5% of other international visitors use Alexandria beaches if aesthetic and health qualities are improved; number of beach-using tourist days are estimated as follows:

Source of Tourists	Number of Tourist Days, thousand 1980	1990	2000
Regional	195	250	320
European	56	230	590
Egyptian	11 004	14 646	19 418
TOTAL[a]	11 255	15 126	20 328

[a] Based on ten million visitor days in 1976, escalated at 3 percent per year, the Egyptian total represents the difference between the total and that of international visitors.

3. Calculation of Benefits

A. For all tourist visitors, using the average individual daily expenditures from the Regional Plan, deducting the equivalent of transportation and accomodations between Cairo and Alexandria (80 percent), and including only 70 percent of Egyptian visitors (to exclude Alexandria residents), local expenditures are calculated as follows:

Factor	Source of Tourists	LE/day	Expenditure, LE thousand 1980	1990	2000
0.2	Regional (Arab)	12.0	468	600	768
0.2	European	15.0	168	690	1 770
0.7	Egyptian	3.5	26 960	35 883	47 574
TOTAL			27 596	37 173	50 112

B. For those actually using the beaches (one out of each three visitors), the costs of a beach table and umbrella (LE 0.20 per day), and concession consumables at LE 0.30 per day for a total of LE 0.17 per tourist per day.

On-Beach Expenditure, LE thousand

1980	1990	2000
1874	2518	3385

TABLE K-9

PROJECTED HEALTH BENEFITS
OF AN EXPANDED WASTEWATER SYSTEM

Year	Cost of Work Absences Due to Wastewater Related Illnesses, LE	Estimates of Decreases in Wastewater Related Illnesses	Benefit per Labor Force Member	Total Labor Force (thousand)	Benefit to Total Labor Force (LE thousand)
1976	8.77				
1977	8.95				
1978	9.13				
1979	9.31				
1980	9.50				
1981	9.69	.25	2.41	712	1 716
1982	9.88	.25	2.47	732	1 808
1983	10.08	.50	5.04	752	3 865
1984	10.28	.50	5.14	772	3 968
1985	10.49	.50	5.25	792	4 158
1986	10.70	.50	5.35	812	4 344
1987	10.91	.65	7.09	832	5 899
1988	11.13	.65	7.23	852	6 160
1989	11.35	.65	7.38	872	6 435
1990	11.58	.75	8.68	892	7 743
1991	11.81	.75	8.86	912	8 080
1992	12.05	.75	9.04	932	8 425
1993	12.29	.75	9.22	952	8 777
1994	12.54	.75	9.41	972	9 147
1995	12.79	.75	9.59	992	9 513
1996	13.05	.75	9.79	1 012	9 907
1997	13.31	.75	9.98	1 032	10 299
1998	13.58	.75	10.19	1 052	10 720
1999	13.85	.75	10.39	1 072	11 138
2000	14.13	.75	10.60	1 092	11 575
2001	14.13	.75	10.60	1 092	11 575
2002	14.13	.75	10.60	1 092	11 575
2003	14.13	.75	10.60	1 092	11 575
2004	14.13	.75	10.60	1 092	11 575
2005	14.13	.75	10.60	1 092	11 575
2006	14.13	.75	10.60	1 092	11 575
2007	14.13	.75	10.60	1 092	11 575
2008	14.13	.75	10.60	1 092	11 575
2009	14.13	.75	10.60	1 092	11 575
2010	14.13	.75	10.60	1 092	11 575
TOTAL					259 431

Present Worth Values: 59 144 000 at 8%
43 800 000 at 10%
22 823 000 at 15%

Note : refer to following page for assumptions and methodology.

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Assumptions and Methodology for Table K-9:

1. Assumes the loss of five working days per year by a labor force member due to wastewater-related illness.

2. Assumes that the average mean urban household income of LE 500 in 1977 will increase in real terms, e.g., as a result of increases in productivity, at a rate of 2 percent annually. This is below the MOHR/USAID estimated increase, thus offsetting the effect on household income of increased female participation in the labor force.

   Source: Urban Land Use in Egypt, Table 4, MOHR/USAID, August 1977.

3. Assumes that the effect of the wastewater system project will be to reduce, but not eliminate, wastewater-related diseases.

4. The estimate of labor force size was derived from a 1969 survey; the labor force assumed to remain in a constant relationship to population (to 1976) and was adjusted upward to reflect increased female participation in the labor force. The average annual increase (20 000 per year) was assumed to hold constant through the year 2000. This estimate is somewhat below those estimates which might be derived from holding labor force in a fixed relationship to the estimated population.

5. No attempt has been made to estimate medical costs as these are largely subsidized by the national government.

APPENDIX L

RECOMMENDED SEWER USE ORDINANCE

Appendix L presents a model sewer use ordinance which is recommended for implementation as part of the master plan program.

APPENDIX L

RECOMMENDED SEWER USE ORDINANCE

Introduction

Discharge of large quantities of solids such as trash, garbage, street sweepings, oils, manure, and septage (semi-liquid waste pumped from septic tanks) into the sewerage system of Alexandria causes serious operational problems. Problems are compounded by operation of the system in a surcharged condition. As a result, velocity of flow is decreased so that solids are not carried through the system. The discharge of certain liquids, such as used oil, mazout residue, toxic industrial wastes, liquids having a high or low pH, and inflammable liquids to the sewers causes structural damage to the collection system and treatment works, upset of treatment process, and unacceptable damage to receiving waters. Oils, tars, and other inflammable liquids pose a fire and explosion hazard at pump stations, treatment works, and within the sewers.

Proper operation and maintenance of the wastewater system in an economical manner requires prevention of all such harmful discharges. Enactment and enforcement of an effective sewer use ordinance is the usual way of achieving proper functioning of a wastewater collection system.

An ordinance provides a full range of regulatory procedures, such as those needed in application for connections, design of connections, payment for services, permits for building sewers, sewer materials, flow sampling, and measurement of discharges. The ordinance contains specific penalties such as heavy fines and incarceration, for non-compliance with its provisions. An effective ordinance gives an operating agency necessary legal authority to control use of the sewerage system. It is designed to protect considerable public investment, insure proper operation, and minimize additional expenditure for system maintenance and replacement.

Present Sewer Use Law

Current Egyptian law which regulates the discharge of wastewaters is law 93-1962, Decision of the President of the UAR, Concerning the Discharge of Wastewaters. This law consists of four chapters:

Chapter I	The Public Sewer and Discharges to It
Chapter II	Water Courses and Discharging into Them
Chapter III	General Laws
Chapter IV	Penalties and Final Laws.

The law establishes general principles regulating construction of, connection to, and discharge into public sewers, as well as discharge of wastewaters into various types of public watercourses. It also contains controls for various discharges and penalties for violations. While the law provides basic controls, it is too general to afford the kind of regulation needed for economical operation of the sewerage system and adequate protection to receiving waters.

Another document having legal status is Decision No. 649 in the Executive Program of the Law No. 93 for 1962 by the Ministry of Housing and

Reconstruction. The document consists of five chapters and appendices explaining the law in detail, as follows:

Chapter I	Applications
Chapter II	Manholes and Chambers for Isolating Pollutants
Chapter III	Substances Harmful to Sewer System
Chapter IV	Extensions of Sewer System, Connections, and Costs
Chapter V	General Laws
Chapter VI	Quality Standards for Wastewater Disposal
Chapter VII	Sampling and Analysis

Chapter VII contains quality standards for discharges of liquid wastes to public sewers, wastewater disposal to waterways, disposal to the River Nile and its branches, wastewater disposal to canals, and disposal of wastewater by irrigation on agricultural land. A limited number of specific criteria are established which limit effluent quality, but these are too few to provide the protection needed. They are also out-of-date in view of present technology.

Recommended Sewer Use Ordinance

The need for a stronger sewer use law and its enforcement has been expressed throughout the Facilities Master Plan Study. Provision for implementation and enforcement of such a law has been included in the immediate phase work (Top Priority Projects) of the Master Plan Program. The following is a recommended sewer use ordinance which, if adopted, will provide needed strength and modernization to the present law. It is recognized that the proposed model ordinance will require some modification to adapt its provisions to Egyptian legal terms and procedures but technical aspects should not need much alteration for adaption.

The new ordinance does not contain regulations for control of wastewater discharges to watercourses as covered by Chapter II of the existing law 93-1962. Discharge of wastewater to watercourses is a separate subject which should be addressed by a separate law or by retaining the provisions of Law 93-1962.

ORDINANCE REGULATING SEWER CONSTRUCTION, SEWER USE AND INDUSTRIAL WASTE DISCHARGE

ARTICLE 1

General Provisions

Section 1.01 Purposes. This is an ordinance regulating the use of public and private sewers and drains, private wastewater disposal, the installation and connection of building sewers, discharge of wastewaters and wastes into the public sewer system, and providing penalties thereof; for the Alexandria Governorate, Arab Republic of Egypt.

Section 1.02 Definitions.

.01 "Agency" shall mean the governmental authority having jurisdiction over the operation and maintenance of the sewerage system in Alexandria, currently the General Organization for Sewerage and Sanitary Drainage--Alexandria.

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.02 "Approved" shall mean approval by the Director of the Agency or his authorized representative.

.03 "Biochemical Oxygen Demand", (BOD_5), shall mean the quantity of oxygen utilized in the biochemical oxidation of organic matter under standard laboratory procedure in five (5) days at 20°C, expressed in milligrams per litre (mg/L).

.04 "Building Drain" shall mean that part of the lowest horizontal piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer, beginning one and one-half (1.5) metres outside the inner face of the building wall.

.05 "Building Sewer" shall mean an extension from the building drain to the public sewer or other place of disposal; also called "property connection".

.06 "Combined Sewer" shall mean a sewer intended to receive both wastewater and storm or surface water.

.07 "Commercial Wastewater" shall mean water-carried wastes and wastewater from commercial and business establishments.

.08 "Discharger" shall mean any person, company, business or organization that discharges or causes a discharge to a public sewer.

.09 "Domestic Wastewater" shall mean the water-carried wastes produced from non-commercial or non-industrial activities and which result from normal human living processes.

.10 "Easement" shall mean an acquired legal right for specific use of land owned by others.

.11 "Floatable Oil" is oils, fats or grease in a physical state such that they can be easily separated by gravity from wastewater prior to sewer discharge in an approved pretreatment facility.

.12 "Garbage" shall mean animal and vegetable waste resulting from the handling, preparation, cooking, and serving of foods.

.13 "Industrial Connection Sewer" shall mean the sewer connecting the building sewer or building waste drainage system of the public sewer for the purpose of conveying industrial wastewater.

.14 "Industrial Wastes" or "Industrial Wastewater" shall mean all water-carried wastes and wastewater, excluding domestic wastewater and uncontaminated water, and shall include all wastewater from any producing, manufacturing, processing, institutional, agricultural or other operation where the wastewater discharged includes significant quantities of wastes of non-human origin.

.15 "May" and "Shall", may is permissive, shall is mandatory.

.16 "Natural Outlet" shall mean any outlet, including storm sewers and combined sewer overflows, into a watercourse, pond, ditch, lake, or body of surface or groundwater.

.17 "pH" shall mean the logarithm of the reciprocal of the hydrogen ion concentration. The concentration is the weight of hydrogen ions, in grams, per litre of solution. Neutral water, for example, has a pH value of 7 and a hydrogen ion concentration of 10^{-7}.

.18 "Properly Shredded Garbage" shall mean the wastes from the preparation, cooking, and dispensing of food that have been shredded to such a degree that all particles will be carried freely under the flow conditions normally prevailing in public sewers, with no particles greater than 10 mm in any dimension.

.19 "Property Connection" refer to .05 above.

.20 "Public Sewer" shall mean a common sewer controlled by a governmental agency or public utility.

.21 "Radioactive Material" shall mean material containing chemical elements that spontaneously change their atomic structure by emitting particles, rays or energy forms.

.22 "Sanitary Sewer" shall mean a sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions together with minor quantities of ground, storm, and surface waters that are not admitted intentionally.

.23 "Sewage" is the spent or used water of community. The term is synonymous with "wastewater".

.24 "Sewer" shall mean a pipe or conduit that carries wastewater.

.25 "Sewerage System" shall mean the network of wastewater collection, conveyance, treatment and disposal facilities interconnected by sewers and owned by the Agency.

.26 "Slug" shall mean any discharge of water or wastewater which, in concentration of any given constituent or in quantity of flow exceeds for any period of duration longer than fifteen(15) minutes more than five (5) times the average twenty-four (24) hour concentration or flows during normal operation and shall adversely affect the collection system and/or performance of wastewater treatment works.

.27 "Solid Wastes" shall mean the non-liquid carried wastes of a community not suitable for disposal by discharge into the sewerage system or plumbing facilities. The term includes garbage, trash, debris, street sweepings, waste building materials, and animal manures.

.28 "Standard Methods" shall mean "Standard Methods for the Examination of Water and Wastewater", the most recent edition published by the American Public Health Association.

.29 "Storm Drain" (sometimes termed"Storm Sewer") shall mean a drain or sewer for conveying water, groundwater, subsurface water, or unpolluted water from any source.

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.30 "Suspended Solids" shall mean total suspended matter that either floats on the surface of, or is in suspension in, water, wastewater, or other liquids, and that is removable by laboratory filtering as prescribed in "Standard Methods" and referred to as nonfilterable residue.

.31 "Uncontaminated Water" shall mean any water flowing from an individual property, commercial establishment or industry not contaminated or polluted with wastes and which is suitable for discharge into a storm drain or to a natural outlet.

.32 "User" is synonymous with"discharger".

.33 "Wastewater" is synonymous with "sewage"(refer to .23)

ARTICLE 2

Use of Public Sewers Required

Section 2.01. It shall be unlawful for any person to place, deposit, or permit to be deposited in any unsanitary manner on public or private property within Alexandria Governorate any human or animal excrement, garbage, or objectionable waste except in officially designated places established specifically for deposit of these wastes.

Section 2.02. It shall be unlawful to discharge to any natural outlet or storm drain within Alexandria Governorate any wastewater or other polluted waters except where suitable treatment has been provided in accordance with all provisions of this ordinance.

Section 2.03. Except as hereinafter provided, it shall be unlawful to construct or maintain any privy, privy vault, septic tank, cesspool, or other facility intended or used for the disposal of wastewaters.

Section 2.04. The owners of all houses, buildings, or properties used for human occupancy, employment, recreation, or other purposes, situated in Alexandria Governorate and abutting on any street, or right-of-way in which there is now located or may in the future be located a public or combined sewer of the Agency, is required at the owner's expense to install suitable toilet facilities therein and connect such facilities to the proper public sewer in accordance with provisions of this ordinance, within ninety (90) days after date of official notice to do so, provided that said public sewer is within 30 metres of the property line.

ARTICLE 3

Private Wastewater Disposal

Section 3.01. Where a public sanitary or combined sewer is not available under the provisions of Section 2.04, the building sewer shall be connected to a private wastewater disposal system complying with the provisions of this Article.

Section 3.02. Before beginning construction of private wastewater disposal system the owner shall first obtain an official written permit from the Agency. The application for such a permit shall be made on a form furnished

by the Agency which the applicant shall supplement by plans, specifications and other information required by the Agency. A permit fee (of LE_____) shall be paid at the time the application is accepted by the Agency.

Section 3.03. A permit for a private wastewater disposal system shall not become effective until the installation is completed and is approved by the Agency. An authorized representative of the Agency shall be allowed to inspect the installation at any stage of the construction and the applicant shall notify the Agency when the work is ready for final inspection and before any underground portions are covered. The inspection shall be made within forty-eight (48) hours after receipt by the Agency of notice to inspect from the applicant.

Section 3.04. The design of a private wastewater system shall comply with the standards of the Agency as regards type, location, and layout of the system. No permit shall be issued for any private wastewater system employing subsurface soil absorption where the area of the property is less than fifteen hundred (1500) square metres. No septic tank or cesspool shall be permitted to discharge to any natural outlet or storm drain.

Section 3.05. At such time as a public sewer becomes available to a property served by a private wastewater disposal system, as provided in Section 2.04, a direct connection shall be made to the public sewer within sixty (60) days in compliance with this ordinance and any septic tanks, cesspools and similar private wastewater disposal facilities shall be cleaned of sludge and filled with suitable material as approved by the Agency.

Section 3.06. The owners shall operate and maintain private wastewater disposal facilities in a sanitary manner at all times. The cleaning out or pumping of sludge from septic tanks and cesspools shall be done by the Agency's maintenance crews or by a private contractor licensed by the Agency.

ARTICLE 4

Building Sewers - Construction and Connection

Section 4.01. No person shall uncover, make any connections with or opening into, use, alter, or disturb any public sewer or appurtenance thereof without first obtaining a written permit to do so from the Agency.

Section 4.02. There shall be two classes of building sewer permits; (1) residential, commercial and institutional, and (2) industrial. For either class the owner or his authorized representaive shall make an application for a building sewer and/or connection on an official application form furnished by the Agency. The permit application shall be accompanied by plans, specifications and other information required by the Agency. A permit/inspection fee (of LE _____) will be charged for a residential commercial and institutional permit and (LE _____) for an industrial permit. The fee shall be paid to the Agency at the time the application is submitted.

Section 4.03. All costs and expenses for the installation and connection of the building sewer(s) shall be borne by the owner. The owner shall indemnify the Agency from any loss or damage that may directly or indirectly result by the installation of the building sewer(s).

Section 4.04. A separate and independent building sewer shall be provided for every building; except where one building stands at the rear of another on an interior lot and no private sewer is available or can be constructed to the rear building through an adjoining alley, court, yard, or driveway. In this latter case, the building sewer at the front building may be extended to the rear building and the whole considered as one building sewer, but the Agency does not and will not assume any obligation or responsibility for damage caused by or resulting from any such single connection and the operation thereof.

Section 4.05. Old building sewers may be used in connection with new buildings only when they are found, on examination and test by the Agency, to meet all requirements of this ordinance.

Section 4.06. The size, slope, alignment, materials of construction of a building sewer, and the methods to be used in excavating, placing of pipe, jointing, testing, and backfilling the trench, shall all conform to the requirements of the building and plumbing code or other applicable rules and regulations of the Agency.

Section 4.07. Whenever possible, the building sewer shall be brought to the building at an elevation below the basement floor. In all buildings in which any building drain is too low to permit gravity flow to the public sewer, sanitary sewage carried by such building drain shall be pumped or otherwise lifted by a means approved by the Agency and discharged to the building sewer.

Section 4.08. No person(s) shall make connection of roof downspouts, foundation drains, areaway drains, or other sources of surface runoff or groundwater to a building sewer or building drain which in turn is connected directly or indirectly to a public sanitary sewer unless such connection is approved by the Agency for purposes of disposal of polluted surface drainage.

Section 4.09. The connection of the building sewer into the public sewer shall conform to the requirements of the building and plumbing code or other applicable rules and regulations of the Agency. All such connections shall be made gastight and watertight and verified by proper testing. Any deviation from the prescribed procedures and materials must be approved by the Agency before installation.

Section 4.10. An applicant for the building sewer permit shall notify the Agency when the building sewer is ready for inspection and connection to the public sewer. The connection and testing shall be made under the supervision of the Agency or its representatives.

Section 4.11. All excavations for building sewer installation shall be adequately guarded with barricades and lights so as to protect the public from hazard. Streets, sidewalks, parkways, and other public property disturbed in the course of the work shall be restored in a manner satisfactory to the Agency.

Section 4.12. There shall be no discharge of industrial wastewaters directly or indirectly to the sewerage system of the Agency without having first obtained a permit from the Agency in accordance with this ordinance. Such a permit shall be in two parts; (1) for the construction of the building sewer and its connection to the public sewer, as set forth in Sections 4.01 through 4.11 above and as required hereinafter in Sections

4.13 through 4.21; and (2) for the control of wastewater discharges. The permit shall restrict the quality and quantity characteristics of the discharge as set forth in Article 5 of this ordinance and in addition, may require pretreatment of the industrial wastewaters, restriction of peak rates of discharge, the discharge of certain wastewater only to specified sewers or drains, relocation of a point of discharge, prohibition of certain wastewater components not included in Article 5, restriction of discharge to certain hours of the day and any other conditions as may be rquired to carry out the purpose of this ordinance. All costs of construction, operation and maintenance of any pretreatment works at the industrial plant shall be borne by the owner.

Section 4.13. The permit issued by the Agency for an industrial wastewater discharge shall contain restrictions and conditions as provided for in Section 4.12. For a discharge occuring at the time of enactment of this ordinance, a discharger shall be allowed one hundred-twenty (120) days to comply with permit conditions. For a new discharge, compliance shall begin immediately. The permit conditions shall be for the control of the rate of discharge and/or the control of discharge quality. If for any reason the discharge quantity and/or quality is to be changed because of increase in plant production, installation of new or different processes or change in product, application for a new or amended permit shall be made through regular procedures described above. A new or amended permit shall be required for an increase in average daily flow of fifteen (15) percent or more.

Section 4.14. The Agency may suspend a permit for industrial wastewater discharge for a period not to exceed forty-five (45) day when such suspension is necessary to stop a discharge which presents an imminent hazard to public health, safety, or welfare, to the local environment or to the Agency's facilities. Any discharger notified in writing of a suspension of his permit shall immediately comply with the order to suspend discharge. In the event of failure of the discharger to comply voluntarily with the suspension order, the Agency shall take such legal steps as are necessary to insure compliance. After suspension of a permit, the Agency may reinstate the permit or require an amended permit as appropriate for the purposes of this ordinance.

Section 4.15. The Agency may revoke a permit for industrial wastewater discharge upon finding that the conditions of the permit or any provision of this ordinance have been violated. Revocation shall be ordered only after a hearing on the question has been held by the Agency. At this hearing the discharger may appear personally or through counsel, cross examine witnesses and present evidence in his own behalf. Notice of the hearing shall be given to the discharger at least fifteen (15) days prior to the date of the hearing. Any discharger whose permit has been revoked shall stop immediately all discharge of industrial wastewaters to the public sewers(s). The Agency may disconnect or permanently block from the public sewer the building sewer of any discharger whose permit has been revoked if such action is needed to insure compliance with the order of revocation.

Section 4.16. All domestic or sanitary wastewaters from toilets, showers, drinking fountains, etc. in an industrial plant, shall be kept separate from all industrial wastewaters until the industrial wastewaters have passed through the control manhole described in Section 4.17.

Section 4.17 A control manhole of a design approved by the Agency shall be constructed by the discharger, if required, as a condition of the permit.

The control manhole shall facilitate inspection, sampling, and flow measurement by personnel of the Agency. The control manhole shall be located outside the plant fence or, if within the plant fence, access at all times to the manhole by Agency personnel shall be guaranteed by the discharger. The control manhole may be used as a junction manhole for domestic sewage and industrial wastes provided the junction occurs downstream of the sampling and measuring point.

Section 4.18. Periodic measurements of flow rates and volumes shall be made and sampling of the industrial wastewaters shall be carried out by all industrial wastewater dischargers unless specifically exempted by the conditions of the permit. The frequency of such measurements and sampling, and the scope thereof shall be specified in the permit. All sampling analyses and flow measurements shall be performed by a laboratory selected by the discharger and approved by the Agency. The results of the measurements and analyses shall be verified by a responsible administrative official of the industrial discharger under penalty of perjury and submitted to the Agency as specified in the permit. All wastewater analyses shall be in accordance with the procedures contained in "Standard Methods".

Section 4.19. All dischargers required by the conditions of the permit to make periodic measurements of flow shall furnish and install at the control manhole or other appropriate location a calibrated flume, weir or flow meter of similar device approved by the Agency suitable to measure the industrial wastewater flow rate and total volume. A flow indicating, totaling, and recording register may be required by the Agency. In lieu of flow measurements the Agency may accept records of water usage and adjust the flow volumes by suitable factors to determine peak and average flow rates for the specific discharge. The discharger shall submit to the Agency the results of all measurements and analyses as soon as they are available but not less frequently than once monthly or in accordance with the terms of the permit.

Section 4.20. Measurements to verify the wastewater flows and quantities of waste constituents reported by the industrial dischargers will be conducted on a random basis by personnel of the Agency. Should measurements or other investigations reveal that the industrial discharger is discharging a flow rate, or quantity of flow, or quantities of constituents significantly in excess of that stated on the permit, or in excess of the quantities reported to the Agency by the discharger, the discharger shall be required to apply for an amended industrial wastewater permit. If such verifying measurements and analyses indicate violation of the prohibitions on discharges as set forth in Article 5, the discharger shall be required to stop the discharge of wastewaters within twenty-four (24) hours of notice, shall correct the condition causing the violation in a manner approved by the Agency, and make a new application for an industrial wastewater discharge permit. The discharger shall also pay any penalties imposed under provisions of this ordinance prior to application for a new permit.

Section 4.21. Designs of pretreatment works shall be approved by the Agency prior to beginning construction. The Agency shall be allowed access to the site at any time during construction of the pretreatment works for the purposes of inspection.

Section 4.22. Sample Private Waste Disposal Application for Permit.

PRIVATE WASTE DISPOSAL APPLICATION

to the (Agency) .....:

The undersigned, being the .....of the
(owner, owner's agent)
property located at.....
(number) (street)
does hereby request a permit to install sanitary sewage disposal facilities to serve the .....at the location.
(residence, commercial building, etc.)

1. The proposed facilities include: .....
.....
to be constructed in complete accordance with the plans and specifications attached hereunto as Exhibit "A".

2. The area of the property is.....square metres.

3. The name and address of the person or firm who will perform the work is:.....

4. The maximum number of persons to be served by the proposed facilities is:.....

5. The locations and nature of all sources of private or public water supply within thirty (30) metres of any boundary of said property are shown on the plat (map) attached hereunto as Exhibit "B".

In consideration of the granting of this permit, the undersigned agrees:

1. To furnish any additional information relating to the proposed work that shall be requested by the (Agency).

2. To accept and abide by all provisions of Ordinance No..... of the (Agency) of....., and of all other pertinent ordinances or regulations that may be adopted in the future.

3. To operate and maintain the wastewater disposal facilities covered by this application in a sanitary manner at all times, in compliance with all requirements of the (health officer), and at no expense to the (Agency).

4. To notify the (Agency) at least twenty-four (24) hours prior to commencement of the work proposed, and again at least twenty-four (24) hours prior to the covering of any underground portions of the installation.

Date:..... Signed.....
(applicant)
.....
(address of applicant)

LE.....inspection fee paid. .....
Application approved and permit issued: (certification of (Agency) treasurer)

Date..... Signed.....
(for the Agency)

Section 4.23. Sample Application for Residential and Commercial Sewer Connection permit.

RESIDENTIAL OR COMMERCIAL BUILDING

SEWER CONNECTION APPLICATION

To the (Agency).....:
The undersigned, being the..... of the
(owner, owner's agent)
property located at.....does
(number) (street)
hereby request a permit to install and connect a building sewer to serve the
.....at said location.
(residence, commercial building, etc.)

1. The following indicated fixtures will be connected to the proposed building sewer:

Number	Fixture	Number	Fixture
.....	Kitchen sinks	.....	Water closets
.....	Lavatory Sinks	.....	Bathtubs
.....	Laundry tubs	.....	Showers
.....	Urinals	.....	Bidets

Specify other fixtures .....
2. The maximum number of persons who will use the above fixtures is.....
3. The name and address of the person or firm who will perform the proposed work is .....
4. Plans and specifications for the proposed building sewer are attached hereunto as Exhibit "A".

In consideration of the granting of this permit, the undersigned agrees:

1. To accept and abide by all provisions of Ordinance No. ..... of the (Agency)....., and of all other pertinent ordinances or regulations that may be adopted in the future.
2. To maintain the building sewer at no expense to the (Agency).
3. To notify the (Agency) when the building sewer is ready for inspection and connection to the public sewer, but before any portion of the work is covered.

Date: ..... Signed .....
(applicant)
.....
LE.....inspection fee paid. (address of applicant)
Application approved and permit .....
issued: (certification by (Agency) treasurer)
Date: ..... Signed .....
(for the Agency)

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Section 4.24. Sample Application for Industrial Sewer Connection Permit.

INDUSTRIAL SEWER CONNECTION APPLICATION

To the (Agency) .....:

The undersigned being the.....of the
(owner, lessee, tenant, etc.)
property located at .....
.....
does hereby request a permit to.....an industrial
(install, use)
sewer connection serving the ....., which company
(name of company)
is engaged in .....
.....
at said location.

1. A plan of the property showing accurately all sewers and drains now existing is attached hereunto as Exhibit "A".
2. Plans and specifications covering any work proposed to be performed under this permit is attached hereunto as Exhibit "B".
3. A complete schedule of all process waters and industrial wastes produced or expected to be produced at said property, including a description of the character of each waste, the daily volume and maximum rates of discharge, and representative analyses, is attached hereunto as Exhibit "C".
4. The name and address of the person or firm who will perform the work covered by this permit is .....
.....

In consideration of the granting of this permit the undersigned agrees:

1. To furnish any additional information relating to the installation or use of the industrial sewer for which this permit is sought as may be requested by the (Agency).
2. To accept and abide by all provisions of Ordinance No. ..... of the (Agency)....., and of all other pertinent ordinances or regulations that may be adopted in the future.
3. To operate and maintain any waste pretreatment facilities, as may be required as a condition of the acceptance into the public sewer of the industrial wastes involved, in an efficient manner at all times, and at no expense to the (Agency).
4. To cooperate at all times with the (Agency) and its representatives in their inspecting, sampling, and study of the industrial wastes, and any facilities provided for pretreatment.
5. To notify the (Agency) immediately in the event of any accident, negligence, or other occurrence that occasions discharge to the public sewers of any wastes or process waters not covered by this permit.

Date .....

Signed .....
(applicant)

.....
(address of applicant)

LE.....inspection fee paid

Application approved and permit granted:

.....
(certification by (Agency) treasurer)

Date: .....

Signed .....
(for the Agency)

ARTICLE 5

Use of the Public Sewers

Section 5.01 Prohibitions on Discharges. No discharger shall discharge wastes to a public sewer which cause, threaten to cause, or are capable of causing either alone or by interaction with other substances:

(a) a fire or explosion;
(b) obstruction of flow or injury to the treatment works; objectionable substances include but are not limited to asphalt, dead animals, offal, ashes, sand, mud, straw, mazout residue, industrial process shavings, metal, glass, rags, feathers, tar, wood, whole blood, paunch manure, bones, hair, fleshings, and paper products either whole or ground.
(c) danger to life or safety of personnel;
(d) a strong offensive odor or prevention of the effective maintenance or operation of the treatment works.
(e) air pollution by the release of toxic or malodorous gases or malodorous gas-producing substances;
(f) interference with wastewater treatment processes;
(g) the Agency's effluent or any other product of a treatment process, residues, sludges, or scums, to be unsuitable for reclamation and reuse or to interfere with the reclamation process;
(h) a detrimental environmental impact or a nuisance in the waters into which the Agency discharges wastewaters, or a condition unacceptable to any public agency having regulatory jurisdiction over the Agency;
(i) discoloration or any other condition in the quality of the Agency's treatment works effluent such that receiving water quality requirements established by law cannot be met;
(j) conditions at or near the Agency's treatment works which violate any statute or any rule, regulation, or ordinance of any public agency or regulatory body;
(k) the Agency's treatment works to be overloaded or cause excessive Agency collection or treatment costs.

Section 5.02 Prohibitions on Storm Drainage and Ground Water. Stormwater, groundwater, rainwater, street drainage, subsurface drainage or yard drainage shall not be discharged through direct or indirect connections to a public sewer unless a permit is issued by the Agency. The Agency may approve the discharge of such water only when no reasonable alternative method of disposal is available. If a permit is granted for the discharge of such water into a community sewer, the user shall pay the applicable charges and fees and meet such other conditions as required by the Agency.

Section 5.03 Prohibition on Unpolluted Water. Unpolluted water, including, but not limited to cooling water, process water or blow-down from cooling towers or evaporative coolers shall not be discharged through direct or indirect connection to a public sewer unless a permit is issued by the Agency. The Agency may approve the discharge of such water only when no reasonable alternative method of disposal is available. If a permit is granted for the discharge of such water into a community sewer, the user shall pay the applicable charges and fees and shall meet such other conditions as required by the Agency.

Section 5.04 Limitations on Radioactive Wastes. No person shall discharge or cause to be discharged, any radioactive waste into a public sewer except:

(a) when the person is authorized to use radioactive materials by the governmental agency empowered to regulate the use of radioactive materials, and
(b) when the waste is discharged in strict conformity with current regulations and recommendations for safe disposal, and
(c) when the person is in compliance with all rules and regulations of all other applicable regulatory agencies.

Section 5.05 Limitations on the Use of Garbage Grinders. Waste from garbage grinders shall not be discharged into a public sewer except:

(a) wastes generated in preparation of food normally consumed on the premises, and
(b) where the user has obtained a permit for that specific use from the Agency.

Such grinders must shred the waste to a degree that all particles will be carried freely under normal flow conditions prevailing in the public sewer. Garbage grinders shall not be used for grinding plastic, paper products, inert materials, or garden refuse.

Section 5.06 Limitations on Point of Discharge. No person shall discharge any substances directly into a manhole or other opening in a public sewer other than through an approved building sewer, unless he has been issued a permit by the Agency. If a permit is issued for such direct discharge the user shall pay the applicable charges and fees and shall meet such other conditions as required by the Agency.

Section 5.07 Holding Tank Waste. No person shall discharge any holding tank waste into a public sewer unless he has been issued a permit by the Agency. Unless otherwise allowed by the Agency under the terms and conditions of the permit, a separate permit must be secured for each separate discharge. This permit will state the specific location of discharge, the time of day the discharge is to occur, the volume of the discharge and the wastewater constituents and characteristics. If a permit is granted for discharge of such waste into a public sewer, the user shall pay the applicable charges and fees and shall meet such other conditions as required by the Agency.

Section 5.08 Limitations on Wastewater Strength.

.01 No person shall discharge wastewater containing in excess of:

0.1 mg/L arsenic
0.2 mg/L cadmium
2.0 mg/L copper
1.0 mg/L cyanide
1.0 mg/L lead
0.01 mg/L mercury
1.0 mg/L nickel
0.2 mg/L silver
0.5 mg/L total chromium
3.0 mg/L zinc

Adding water for the purpose of diluting wastes which would otherwise exceed maximum concentration limitations shall be unlawful.

.02 No person shall discharge any wastewater:

(a) Having a temperature higher than 65 °C.
(b) Containing more than 300 mg/L of Oil or Grease of animal or vegetable origin.
(c) Containing more than 100 mg/L of Oil or Grease of mineral or petroleum origin.
(d) Having a pH lower than 6.0.

.03 Pretreatment Effluent
When pretreatment of industrial wastewater is required as a condition of the permit, see Section 4.12 of this ordinance, the permit shall specify the pretreatment plant effluent quality required.

ARTICLE 6

Malicious Damage

Section 6.01. No person(s) shall maliciously, willfully, or negligently break, damage, destroy, uncover, deface or tamper with any structure, appurtenance or item of equipment which is a part of the sewerage system. Any persons(s) violating this provision shall be subject to immediate arrest under charge of (equivalent of disorderly conduct).

ARTICLE 7

Penalties

Section 7.01. Penalties for violation of this ordinance shall be imposed upon violators as hereinafter provided. Upon detection of a violation the Agency shall notify the owner within twenty-four (24) hours, in writing, of the violation. The notification of the violation shall contain a revocation of any valid permit. To reinstate a permit revoked for violation, the owner shall make a new application for permit. A condition for reissue of a permit by the Agency shall be full payment of all penalties imposed as result of the violation. If the violation is connection to and use of the public sewers without a valid permit, a condition for issue of a permit shall be full payment of all penalties imposed as result of the violation. Penalties shall be imposed each calendar day of the violation, each new day in which there is violation being considered as a new violation.

Section 7.02. Penalties for violation shall be as follows:

(a)	No valid residential and commercial permit		
	for private wastewater disposal	LE	(1.0) per day
	for connection to and use of public sewers	LE	(1.0) per day
(b)	No valid industrial permit		
	for private wastewater disposal	LE	(500.0) per day
	for connection to and use of public sewers	LE	(500.0) per day
(c)	Violation of Article 5, by residential and commercial holder of valid permit	LE	(20.0) per day
(d)	Violation of Article 5, by industrial holder of permit	LE	(5000.0) per day
(e)	Penalties for having no valid permit and violation of Article shall be additive.		

Notes:

1. The penalty fines in parentheses are only suggested levels.
2. The recommended ordinance has no provision for charges by the Agency on industrial discharges. The trend in some industrialized countries is to require industrial dischargers to bear the costs of industrial wastewater treatment by charging rates which are dependent on the volume and strength of the wastewater and which are consistent with the costs to treat the wastewaters in the Agency's treatment works. It is not economically justifiable or realistic at this time to develop a rational formula for charging industries based on their wastewater discharges.

APPENDIX M

RECOMMENDED PLAN COSTS AND FINANCE

Appendix M covers recommended plan costs by item, element, and area as well as financial statements for the proposed master plan program.

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TABLE M-1

COST OF PRINCIPAL COLLECTORS

Identification	Ident. No.	Design Flow Ml/d	Depth m	Conditions Soil Type	Length m	Size mm	Capital Cost LE thousand
EASTERN							
Inner East							
Hagar el Nawatia	EZ 1	65	6	U	800	1300	1440
" "	EZ 2	52	6	U	1200	800	1380
" "	EZ 3	21	5	U	400	750	375
Mohamed Aly	EZ 7	164	6	U	1500	1800	2700
" "	EZ 6	93-140	6	U	1400	1500	2015
New P.S.5 East	EZ 13	17	6	S	1000	750	505
Sidi Bishr	EZ 24	40-62	6	S	2300	1000	1545
							9960
Outer East							
Ras el Soda	RS 5	38	3	U	450	500	70
" "	RS 6	53	3	U	600	750	195
" "	RS 7	61	5	U	1010	1250	600
" "	RS 8	74	6	U	480	1400	370
" "	RS 9	101	6	U	850	1600	1580
							2815
Siouf Keblia							
Main	SK 1	100	6	U	270	1600	630
Main	SK 2	112	6	U	780	1700	1965
North Branch	SK 3	52	5	U	850	1250	1095
" "	SK 4	39	5	U	575	1000	600
" "	SK 5	30	3	U	1525	900	915
South Branch	SK 6	45	5	U	300	1250	405
" "	SK 7	35	5	U	300	900	290
" "	SK 8	9	4	U	300	500	160
" "	SK 9	7	4	U	300	450	135
							6195
Sadat City	SC 3	80-113	6	U	3400	1800	3050
Abu Kir Peninsula	AK 11	5	5	S	235	375	45
	AK 12	11	4	S	200	600	55
	AK 13	17	4	S	975	750	365
	AK 14	47	4	S	1100	1100	580
	AK 15	52	4	S	500	1200	290
							1335
							23355

COST OF PRINCIPAL COLLECTORS (cont.)

Identification	Ident. No.	Design Flow Ml/d	Depth m	Conditions Soil Type	Length m	Size mm	Capital Cost LE thousand
NOUZHA	NZ 1	13	6	U	850	500	225
	NZ 4	23	4	U	540	700	160
	NZ 5	43	5	U	1370	950	595
	NZ 6	22	4	U	500	700	150
	NZ 7	18	4	U	425	600	100
							1230
WEST/CENTRAL							
Central							
Silsila Collector	CZ 1*	70-160	4	S	1500	1100-1750	1825
Western Harbor							
North Port*	CZ	4	4	S	1530	300	125
South Port*	CZ	5	3	S	700	450	175
Bab el Akhdar*	CZ	73	3	S	125	1000	55
							2180
Inner West							
West Zone	WZ 1	99	6	U	1330	1500	1915
" "	WZ 2	256	7	U	2860	2300	7720
" "	WZ 3	280	7	U	1200	2300	3745
" "	WZ 6	62	7	U	400	1100	745
Gheit el Enab Aux.P.S.Coll.	WZ 10	8	5	U	300	500	300
Gheit el Enab Main P.S.Coll.	WZ	--	-	-	--	--	250
Industries P.S.	WZ	--	-	-	--	--	175
							14850
ABU KIR BAY INDUSTRY	AK 16	113	6	U	2000	1400	1260
OUTER WEST							
Mex-Dekheila	MD 5	10	5	S	800	600	315
" "	MD 6	16	5	S	600	750	290
Industries	MD 9	90-130	5	S	1000	1500	975
"	MD 10	80-100	5	S	1600	1400	1235
"	MD 13	40 -50	4	S	500	1000	290
Influent Sewer	MD 12	250	5	U	800	2300	2580
							5685
							25205

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COST OF PRINCIPAL COLLECTORS (cont.)

Identification	Ident. No.	Design Flow Ml/d	Depth m	Conditions Soil Type	Length m	Size mm	Capital Cost LE thousand
AMERIA							
Industrial	AM 1	18	3	S	10000	750	3370
Free Zone	AM 2	32	3	S	1250	900	470
Free Zone	AM 3	65	4	S	1750	1200	1050
Ameria	AM 4	34	3	S	3100	900	920
"	AM 5	68	5	S	3250	1200	1820
"	AM 6	14	3	S	1750	600	405
"	AM 7	29	3	S	1625	850	480
"	AM 8	14	4	S	4625	600	1220
"	AM 9	29	4	S	1875	850	625
"	AM 10	103	4	S	4375	1500	2900
							13260
							61820

* Under Top Priority Projects

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TABLE M-2

COST OF FORCE MAINS

Identification	Ident. No.	Design Flow Ml/d	Length m	Size mm	Capital Cost LE thousand
EASTERN					
Inner East					
Abu Soliman	EZ 5	258	3100	1350	3500
New Smouha	EZ 9	208	3900	1200	3900
Maamoura	EZ 11	21	4400	450	605
P.S. No. 5E	EZ 15	49	500	550	105
P.S. No. 2E	EZ 17	42	1250	550	270
P.S. No. 4E	EZ 19	17	1300	650	320
P.S. No. 6E	EZ 21	14	500	455	80
Sidi Bishr	EZ 23	67	1700	750	560
					9340
Outer East					
Hospitals	RS 2*	17	1150	350	105
Ras el Soda	RS 4	224	800	1300	375
Sadat City	SC 2	113	2600	900	640
Abu Kir Peninsula					
Pump Station A	AK 2	5	240	250	15
B	AK 4	6	400	250	25
C	AK 6	21	1000	400	105
Main P.S.	AK 8	52	8000	650	1480
					2745
NOUZHA					
Fisherman	NZ 3	16	1700	350	225
Nouzha	NZ 9	74	925	750	260
					485
WEST / CENTRAL					
Inner West					
P.S. No. 2W	WZ 5	32	1150	500	250
Central					
Sporting	CZ 2*	40	500	600	140
Western Harbor	CZ 12	85	2000	750	335
					725

TABLE M-2

COST OF FORCE MAINS (cont.)

Identification	Ident. No.	Design Flow Ml/d	Length m	Size mm	Capital Cost LE thousand
OUTER WEST					
Mex-Dekheila					
Tanneries	MD 2	10	2500	300	365
Valley of Moon	MD 4	6	600	250	50
Main	MD 8	16	1100	350	145
					560
AMERIA					
Industrial	AM 12	85	2000	750	335
ABU KIR BAY INDUSTRY					
Tabia P.S.	AK 10	225	8000	1300	3590
					4485
					17780

*Under Top Priority Projects

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TABLE M-3

COST OF PUMP STATIONS

Identification	Ident. No.	Design Flow, ML/day	Total Dynamic Head,m	Capital Cost LE thousand
EASTERN				
Inner West				
Abu Soliman P.S.	EZ 4	258	23	2370
Smouha P.S.	EZ 8	208	39	2130
P.S. No.1	EZ 12	21	38	440
P.S. No.5	EZ 14	49	32	790
P.S. No.2	EZ 16	42	37	710
Sidi Bishr P.S.	EZ 22	67	21	950
Outer East				
Hospital's P.S.	RS 1	17	27	390
Ras el Soda P.S.	RS 3	224	14	2130
Sadat City P.S.	SC 1	113	22	1420
Abu Kir				
P.S. A	AK 1	5	9	170
P.S. B	AK 3	6	12	190
P.S. C	AK 5	21	20	450
Main P.S.	AK 7	52	67	800
Tabia P.S.	AK 9	225	37	2250
NOUZHA				
Fisherman's Village	NZ 2	16	31	380
Nouzha P.S.	NZ 8	74	16	1060
WEST/CENTRAL				
P.S. No.2	WZ 4	32	20	260[a]
West Plant P.S.	WZ 7	324	15	2720
OUTER WEST				
Tanneries P.S.	MD 1	10	41	270
Valley of Moon P.S.	MD 3	6	15	190
Main P.S.	MD 7	16	24	360
AMERIA				
Industrial P.S.	AM 11	85	48	1120

[a] Equipment replacement and station modifications only.

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TABLE M-4(A)

COST OF TREATMENT FACILITIES

Location	Design Flow ML/day	Processes or (level)	Capital Cost, LE thousand
Ras el Soda	560	(Preliminary)	13 875
Kait Bey	175	(Preliminary)	12 440
West Plant	145[a]	(Preliminary)	11 000
Mex-Dekheila	160	Anaerobic/Aerobic Lagoons	10 810
Lake Idku(Abu Kir Bay)	150	Evaporation Pond	6 840
East Plant (Nouzha)	45	--	150[b]
Ameria	140	Anaerobic/Aerobic Lagoons	4 870
		TOTAL	59 985

[a] Total capacity to be 220 ML/day; 75 ML/day of which now being constructed as a primary plant.

[b] Upgrading of existing plant for conversion to Nouzha flows.

TABLE M-4(B)

COST OF EFFLUENT CONVEYANCE FACILITIES

Identification	Ident. No.	Design Flow ML/d	Length m	Size mm	Capital Cost LE thousand
West Plant	WZ 9	241	6 900	1300	3 250
Sidi Bishr Outfall Land Portion	EZ 25	838	1 100	2200	1 210
Mex-Dekheila Lined Channel	MD 15	175	6 000	7m x 1.6m	1 950
Kait Bey Outfall	--	495	10 000	1700	38 000
Sidi Bishr Outfall	--	838	10 000	2200	46 000
					90 410
West Effluent P.S.	WZ 8	241	-	-	1 540
Mex - Dekheila Lift	MD 15	192	-	-	805
Ameria Lift	AM 15	168	-	-	750

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TABLE M-5

COST OF LAND ACQUISITION

Location	Area ha	Percent Purchased	Unit Cost LE/m^3	Cost, LE thousand
Ras el Soda	6	100	50.0	3 000
Kait Bey	2	100	65.0	1 300
Mex-Dekheila[a]	500	30	0.4	600
Ameria	400	100	0.4	1 600
Lake Idku[b]	4000	30	0.4	4 800
			TOTAL	11 300

[a] Salt bed lands along shoreline of western Lake Maryut.

[b] Marsh land at southwest end of Lake Idku for Abu Kir Industries evaporation pond.

TABLE M-6

COST BREAKDOWN FOR TOP PRIORITY PROJECTS

		1978	1979	1980	1981	TOTAL
Category I (1-4)						
	FEC	145	450	435	115	1 145
	Local	60	320	255	-	635
	TOTAL	205	770	690	115	1 780
Category II (1-15)						
	FEC	540	1 690	1 900	1 045	5 175
	Local	1 330	5 225	6 335	4 145	17 035
	TOTAL	1 870	6 915	8 235	5 190	22 210
Category III (1-4)						
	FEC	45	450	750	795	2 040
	Local	135	1 415	2 420	2 580	6 550
	TOTAL	180	1 865	3 170	3 375	8 590
Category IV (Design)						
	FEC	-	400	-	-	400
	Local	-	220	-	-	220
	TOTAL	-	620	-	-	620
TOTAL	FEC	730	2 990	3 085	1 955	8 700
	Local	1 525	7 180	9 010	6 725	24 500
	TOTAL	2 255	10 170	12 095	8 680	33 200

TABLE M-7

MASTER PLAN COSTS BREAKDOWN - EASTERN AREAS
(LE thousand)

East		Stage I 1979	1980	1981	1982	1983	Stage II 1984	1985	1986	1987	1988	Stage III (89-94)	Stage IV (95-00)	TOTAL
Street Sewers	DFEC	-	-	-	-	-	-	-	-	-	-	-	-	-
	IFEC	30	30	30	768	931	1 679	1 679	1 679	1 679	1 679	6 158	6 158	22 497
	Local	70	70	70	1 792	2 174	3 916	3 916	3 916	3 916	3 916	14 367	14 367	52 493
	TOTAL	100	100	100	2 560	3 105	5 595	5 595	5 595	5 595	5 595	20 525	20 525	74 990
Gravity Collectors	DFEC		25	-	111	111	-	-	-	-	-			247
	IFEC	-	-	158	222	223	989	1 841	1 232	824	439			5 928
	Local	-	57	370	767	772	2 312	4 303	2 878	1 925	1 026			14 410
	TOTAL		82	528	1 100	1 106	3 301	6 144	4 110	2 749	1 465	-	-	20 585
Force Mains	DFEC	-	21	367	844	1 117	1 127	1 833	1 756	477	982			8 574
	IFEC	-	-	11	25	34	35	58	55	15	31			264
	Local		60	178	478	611	548	915	853	232	477			4 352
	TOTAL		81	556	1 347	1 762[a]	1 710	2 856	2 664	724	1 490	-	-	13 190
Pump Stations	DFEC	58	435	1 076	1 028	87	510	895	741	720	725			6 275
	IFEC	-	103	293	257	-	139	244	202	196	198			1 632
	Local	37	318	801	757	56	380	666	552	536	540			4 643
	TOTAL	95	856	2 170	2 042	143	1 029	1 805	1 495	1 452	1 463	-	-	12 550
Treatment Plants	DFEC	159	160	2 042	2 089	2 348								6 798
	IFEC	-	-	743	761	855								2 359
	Local	104	104	1 422	1 454	1 634								4 718
	TOTAL	263	264	4 207	4 304	4 837	-	-	-	-	-	-	-	13 875
Outfalls	DFEC	345	345	11 025	11 392	11 393								34 500
	IFEC	-	-	300	310	310								920
	Local	92	92	3 390	3 503	3 503								10 580
	TOTAL	437	437	14 715	15 205	15 206	-	-	-	-	-	-	-	46 000
Connections	IFEC	62	68	74	75	77	149	149	149	149	149	480	453	2 034
	Local	143	157	171	175	178	346	346	346	346	346	1 120	1 057	4 731
	TOTAL	205	225	245	250	255	495	495	495	495	495	1 600	1 510	6 765
Land Acquisition:	Local	1 500	1 500	-	-	-	-	-	-	-	-	-	-	3 000

(a) Includes Effluent FM (EZ 25)

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TABLE M-8

MASTER PLAN COSTS BREAKDOWN - WEST/CENTRAL AREA
(LE thousand)

		Stage I					Stage II					Stage III	Stage IV	
		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	(89-94)	(95-00)	TOTAL
Street Sewers	DFEC	-	-	-	-	-	-	-	-	-	-	-	-	-
	IFEC	60	120	120	255	317	329	329	329	329	329	1 124	1 124	4 765
	Local	140	280	280	595	738	766	766	766	766	766	2 621	2 621	11 105
	TOTAL	200	400	400	850	1 055	1 095	1 095	1 095	1 095	1 095	3 745	3 745	15 870
Gravity Collectors	DFEC	9	-	-	82	82	-	-	-	-	-	-	-	173
	IFEC	-	-	215	-	-	556	556	642	1 368	818	-	-	4 155
	Local	20	-	501	185	185	1 299	1 299	1 501	3 196	1 911			10 097
	TOTAL	29		716	267	267	1 855	1 855	2 143	4 564	2 729	-	-	14 425
Force Mains[a]	DFEC	2	161	-	-	20				998	1 095	-	-	2 276
	IFEC	-	5	-	-	-				31	34			70
	Local	4	78	-	-	55				485	532			1 154
	TOTAL	6	244	-	-	75	-	-	-	1 514	1 661	-	-	3 500
Pump Stations	DFEC	6	124	-										130
	IFEC	-	34	-										34
	Local	4	92	-										96
	TOTAL	10	250	-	-	-	-	-	-	-	-	-	-	260
Treatment Plants	DFEC	-	-	-	270	270	1 971	1 971	3 269	1 868	1 868			11 487
	IFEC	-	-	-	-	-	717	717	1 190	680	680			3 984
	Local	-	-	-	175	175	1 372	1 372	2 275	1 300	1 300			7 969
	TOTAL	-	-	-	445	445	4 060	4 060	6 734	3 848	3 848	-	-	23 440
Outfall	DFEC				300	300	10 437	10 290	8 673					30 000
	IFEC				-	-	284	280	236					800
	Local				80	80	3 209	3 164	2 667					9 200
	TOTAL				380	380	13 930	13 734	11 576	-	-	-	-	40 000
Connections	IFEC	3	3	3	3	3	6	6	6	6	6	21	21	87
	Local	7	7	7	7	7	14	14	14	14	14	49	49	203
	TOTAL	10	10	10	10	10	20	20	20	20	20	70	70	290
Land Acquisition:	Local	-	650	650	-	-	-	-	-	-	-	-	-	1 300

[a] Includes Effluent FM(WZ9)

TABLE M-9

MASTER PLAN COSTS BREAKDOWN - OUTER WEST (MEX-DEKHEILA)

(LE thousand)

		Stage I					Stage II					Stage III	Stage IV	
		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	(89-94)	(95-00)	TOTAL
Street Sewers	DFEC	-	-	-	-	-	-	-	-	-	-	-	-	-
	IFEC	-	-	128	202	225	225	225	225	225	225	300	300	2 280
	Local	-	-	297	473	525	525	525	525	525	525	700	700	5 320
	TOTAL			425	675	750	750	750	750	750	750	1 000	1 000	7 600
Gravity Collectors	DFEC	-	-	-	34	34	-	-	-	-	-	-	-	68
	IFEC				-	-	862	775						1 637
	Local				77	77	2 016	1 810						3 980
	TOTAL	-	-	-	111	111	2 878	2 585	-	-	-	-	-	5 685
Force Mains	DFEC					3	267	94						364
	IFEC					-	8	3						11
	Local					10	130	45						185
	TOTAL	-	-	-	-	13	405	142	-	-	-	-	-	560
Pump Stations[a]	DFEC					37	410	362						810
	IFEC					-	112	99						211
	Local					24	305	270						599
	TOTAL	-	-	-	-	61	827	731	-	-	-	-	-	1 620
Lagoons	DFEC				22	22	32	32						108
	IFEC				-	-	3 838	3 838						7 676
	Local				81	81	1 432	1 432						3 026
	TOTAL				103	103	5 302	5 302	-	-	-	-	-	10 810
Effluent Ditch	DFEC					8	6	6						20
	IFEC						692	692						1 384
	Local					30	258	258						546
	TOTAL					38	956	956						1 950
Connections	IFEC	-	-	1	1	1	32	32	32	32	32	9	9	181
	Local	-	-	4	4	4	73	73	73	73	73	21	21	419
	TOTAL	-	-	5	5	5	105	105	105	105	105	30	30	600
Land Acquisition:	Local	-	300	300	-	-	-	-	-	-	-	-	-	600

[a] Includes Effluent P.S. (MD 15)

TABLE M-10

MASTER PLAN COSTS BREAKDOWN - NOUZHA AREA
(LE thousand)

		Stage I					Stage II					Stage III	Stage IV	
		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	(89-94)	(95-00)	TOTAL
Street Sewers	DFEC			-	-	-	-	-	-	-	-	-	-	-
	IFEC			68	188	263	263	263	263	263	263	105	105	2 044
	Local			157	437	612	612	612	612	612	612	245	245	4 756
	TOTAL			225	625	875	875	875	875	875	875	350	350	6 800
Gravity Collectors	DFEC				9	6	-	-						15
	IFEC				-	-	209	145						354
	Local				19	14	488	340						861
	TOTAL				28	20	697	485						1 230
Force Mains	DFEC				1	2	145	167						315
	IFEC				-	-	5	5						10
	Local				4	4	70	82						160
	TOTAL				5	6	220	254						485
Pump Stations	DFEC				21	12	434	253						720
	IFEC				-	-	118	69						187
	Local				14	8	323	183						533
	TOTAL				35	20	875	510						1 440
Treatment Plants	DFEC					3	-	71						74
	IFEC					-	-	26						26
	Local					2	-	48						50
	TOTAL					5	-	145						150
Connections	IFEC				6	6	24	24	24	24	24	9	9	150
	Local				14	14	56	56	56	56	56	21	21	350
	TOTAL				20	20	80	80	80	80	80	30	30	500

TABLE M-11

MASTER PLAN COSTS BREAKDOWN - ABU KIR BAY INDUSTRIES
(LE thousand)

		Stage I					Stage II					Stage III	Stage IV	
		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	(89-94)	(95-00)	TOTAL
Street Sewers	DFEC	-	-	-	-	-	-	-	-	-	-	-	-	-
	IFEC						54	54	54	54	54	150	150	570
	Local						126	126	126	126	126	350	350	1 330
	TOTAL						180	180	180	180	180	500	500	1 900
Gravity Collectors	DFEC				8	8	-	-	-	-	-	-	-	16
	IFEC				-	-	-	-	181	181	-	-	-	362
	Local				17	17	-	-	424	424	-	-	-	882
	TOTAL				25	25	-	-	605	605	-	-	-	1 260
Force Mains	DFEC				7	14			770	770	773			2 334
	IFEC				-	-			24	24	24			72
	Local				20	40			374	374	376			1 184
	TOTAL				27	54			1 168	1 168	1 173			3 590
Pump Stations	DFEC				26	26	-	-	-	537	537			1 126
	IFEC				-	-	-	-	-	146	146			292
	Local				17	17	-	-	-	399	399			832
	TOTAL				43	43				1 082	1 082			2 250
Evaporation Pond	DFEC					27	-	-	12	17	12			68
	IFEC					-			1 440	2 016	1 469			4 925
	Local					103			510	714	520			1 847
	TOTAL					130			1 962	2 747	2 001			6 840
Connections	IFEC						-	3	3	6	6	8	5	31
	Local						-	7	7	14	14	17	10	59
	TOTAL						-	10	10	20	20	25	15	90
Land Acquisition:	Local	-	2 400	2 400	-	-	-	-	-	-	-	-	-	4 800

TABLE M-12

MASTER PLAN COSTS BREAKDOWN - AMERIA
(LE thousand)

		Stage I					Stage II					Stage III	Stage IV	
		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	(89-94)	(95-00)	TOTAL
Street Sewers	DFEC						-	-	-	-	-	-	-	-
	IFEC						708	708	708	708	708	3 450	3 450	10 440
	Local						1 652	1 652	1 652	1 652	1 652	8 050	8 050	24 360
	TOTAL						2 360	2 360	2 360	2 360	2 360	11 500	11 500	34 800
Gravity Collectors	DFEC				79	80			-	-	-			159
	IFEC				-	-			1 287	1 620	912			3 819
	Local				179	179			3 008	3 786	2 130			9 282
	TOTAL				258	259	-	-	4 295	5 406	3 042	-	-	13 260
Force Mains	DFEC					2					215			217
	IFEC					-					7			7
	Local					6					105			111
	TOTAL					8					327	-	-	335
Pump Stations[a]	DFEC				21	21				415	453			910
	IFEC				-	-				113	124			237
	Local				13	14				309	337			673
	TOTAL				34	35				837	914	-	-	1 820
Lagoons	DFEC				10	9				15	15			49
	IFEC				-	-				1 729	1 729			3 458
	Local				36	37				645	645			1 363
	TOTAL				46	46				2 389	2 389			4 870
Connections	IFEC						-	63	90	90	90	305	305	943
	Local						-	142	210	210	210	710	710	2 197
	TOTAL						-	210	300	300	300	1 015	1 015	3 140
Land Acquisition: Local		-	800	800	-	-	-	-	-	-	-	-	-	1 600

[a] Includes Effluent lift (AM 15)

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TABLE M-13

MASTER PLAN COSTS SUMMARY
(LE thousand)

		Stage I					Stage II					Stage III	Stage IV	
		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	(89-94)	(95-00)	TOTAL
East	DFEC	562	986	14 510	15 464	15 056	1 637	2 778	2 497	1 197	1 707	-	-	56 394
	IFEC	92	201	1 609	2 418	2 430	2 991	3 971	3 317	2 863	2 496	6 638	6 611	35 637
	Local	1 946	2 358	6 402	8 926	8 928	7 502	10 146	8 545	6 955	6 305	15 487	15 424	98 924
	TOTAL	2 600	3 545	22 521	26 808	26 414	12 130	16 895	14 359	11 015	10 508	22 125	22 035	190 955
West/Central	DFEC	17	285	-	652	672	12 408	12 261	11 942	2 866	2 963	-	-	44 066
	IFEC	63	162	338	258	320	1 892	1 888	2 403	2 414	1 867	1 145	1 145	13 895
	Local	175	1 107	1 438	1 042	1 240	6 660	6 615	7 223	5 761	4 523	2 670	2 670	41 124
	TOTAL	255	1 554	1 776	1 952	2 232	20 960	20 764	21 568	11 041	9 353	3 815	3 815	99 085
Nouzha	DFEC	-	-	-	31	23	579	491	-	-	-	-	-	1 124
	IFEC	-	-	68	194	269	619	532	287	287	287	114	114	2 771
	Local	-	-	157	488	654	1 549	1 326	668	668	668	266	266	6 710
	TOTAL	-	-	225	713	946	2 747	2 349	955	955	955	380	380	10 605
Outer West	DFEC	-	-	-	56	104	715	495	-	-	-	-	-	1 370
	IFEC	-	-	129	203	226	5 769	5 664	257	257	257	309	309	13 380
	Local	-	300	601	635	751	4 739	4 413	598	598	598	721	721	14 675
	TOTAL	-	300	730	894	1 081	11 223	10 572	855	855	855	1 030	1 030	29 425
Abu Kir Bay	DFEC	-	-	-	41	75	-	-	782	1 324	1 322	-	-	3 544
	IFEC	-	-	-	-	-	54	57	1 702	2 427	1 699	158	155	6 252
	Local	-	2 400	2 400	54	177	126	133	1 441	2 051	1 435	367	360	10 934
	TOTAL	-	2 400	2 400	95	252	180	190	3 925	5 802	4 456	525	515	20 730
Ameria	DFEC	-	-	-	110	112	-	-	-	430	683	-	-	1 335
	IFEC	-	-	-	-	-	708	771	2 085	4 260	3 570	3 755	3 755	18 904
	Local	-	800	800	228	236	1 652	1 799	4 870	6 602	5 079	8 760	8 760	39 586
	TOTAL	-	800	800	338	348	2 360	2 570	6 955	11 292	9 332	12 515	12 515	59 825
TOTAL	DFEC	579	1 271	14 510	16 354	16 042	15 339	16 025	15 221	5 817	6 675	-	-	107 833
	IFEC	155	363	2 144	3 073	3 245	12 033	12 883	10 051	12 508	10 176	12 119	12 089	90 839
	Local	2 121	6 965	11 798	11 373	11 986	22 228	24 432	23 345	22 635	18 608	28 271	28 201	211 953
TOTAL		2 855	8 599	28 452	30 800	31 273	49 600	53 340	48 617	40 960	35 459	40 390	40 290	410 625
				101 979					227 976					

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APPENDIX M

FINANCE

M.1 Recent Financial Performance

Introduction

Financial records of GOSSD from 1973 to date were analyzed to determine magnitude of various costs of items which constitute annual expenditures and those factors which affect year-to-year expenditure levels. An inventory and a valuation of current assets were also developed with assistance from GOSSD-Alexandria.

The assembled financial information summarizes GOSSD-Alexandria's recent performance and provides a basis for projecting its future financial condition. While most data required for analysis were available in existing reports and records, GOSSD officials provided the necessary estimates where data were not recorded.

Operating Costs

Table M-14 summarizes historical operating costs of GOSSD-Alexandria in seven major categories. Description of each category is as folows:

> Salaries and Allowances includes salaries for permanent and temporary employees and local consultants, together with allowances which are incremental wage and salary payments made to field workers to compensate for hazardous working conditions and to professionals to discourage them from seeking second jobs or outside private consulting work.
> Employee benefits includes costs of food, clothing, and social services; insurance for health, work accidents, old age or death; and cost-of-living compensation.
> Fuel includes costs for benzene, diesel fuel, oil and other lubricants. In addition, minor expenditures for coal, butane, and kerosene are also included.
> Utilities includes payments for water, gas and electricity. About 90 percent of annual expenditures for power are for pump station and treatment plant energy requirements.
> Spare Parts and Materials includes expenditures for repair and replacement of sewers, vehicles, and equipment.
> Major Repairs includes unanticipated expenditures for materials or contractual services for major repair of mechanical equipment and vehicles, or repairs of buildings, roads, bridges, canal banks and office equipment outside the scope of normal maintenance.
> Other Expenditures includes charge for services provided to GOSSD by other organizations such as the Ministries of Finance and Interior, and the Fire Department; travel expenses; publications, printing and office supply expenses; a research and development allowance; and miscellaneous office administration expenses.

Current accounting procedures do not provide detailed summary reports on the allocation of these costs to the various branches of GOSSD. A summary with this detail would provide management with a tool for evaluating the cost-effectiveness of each branch. The contribution of each branch to

TABLE M-14

GOSSD-ALEXANDRIA FIVE-YEAR FINANCIAL SUMMARY, 1973-1977

Annual Expenditures, LE	1973	1974	1975	1976	1977[a]
Operating Costs					
Salaries and Allowances	398 482	437 150	497 074	544 442	549 984
Employee Benefits	68 618	73 822	97 921	141 640	165 800
Fuel	24 215	23 413	24 024	25 412	33 900
Utilities	33 485	34 266	30 683	84 755	89 050
Spare Parts and Materials	67 495	63 898	50 253	58 277	100 000
Major Repairs	15 499	16 241	13 088	13 647	24 400
Other Expenditures	23 049	26 725	28 437	29 734	32 510
TOTAL	630 843	675 515	741 480	897 907	995 644
Capital Costs					
Master Plan Sewers	111 155	163 763	99 248	484 903	600 000
Master Plan Pump Stations	48 041	40 105	34 036	-	300 000
Master Plan Treatment Facilities	203 859	175 270	303 423	399 940	500 000
Other Projects	181 795	120 862	100 951	144 809	200 000
TOTAL	544 850	500 000	537 658	1 029 652	1 600 000
Debt Payments	-	-	9 312	3 508	3 508
Total Annual Expenditures	1 175 693	1 175 515	1 288 450	1 931 067	2 599 152
Revenues					
Service charges, fees[b]	87 870	127 015	79 262	96 993	not available
Government contribution	1 087 823	1 048 500	1 209 188	1 834 074	not available

Source: Financial records of the Budget and Finance Department, GOSSD-Alexandria.

[a] Operating costs based on budget approved by GOSSD-Cairo. Capital costs based on annual needs estimated by the Project Execution Department on 1 July 1977. Debt Payments based on information from Budget and Finance Department on existing commitments.

[b] Customer contributions for extensions and connections.

the organization and its efficiency could be measured from year to year, allowing the development of budgets which maximize the productive use of funds.

Table M-15 presents an allocation of costs among the various branches based on the available financial data for 1976. In constructing this table, costs allocable to more than one branch, such as general administrative and office expenses, were distributed on a basis of the number of employees in each branch.

Increases in salaries and in the expenses and amounts of materials result in increased operation and maintenance from year to year. During the period from 1973 through 1976, operation and maintenance costs for GOSSD-Alexandria increased an average of 12.6 percent annually. The cost increase in 1976 was 21.1 percent.

Capital Costs and Debt Payments

Table M-14 summarizes over a five-year period expenditures of GOSSD-Alexandria on capital improvements. Major master plan projects are listed according to category; (i.e. sewers,pump stations, or treatment facility). In addition, there have been a variety of other capital needs for which expenditures are made periodically. Because expenditures in "Other Projects" account vary considerably from year to year, no single year's expenditures can be considered representative. Also included are occasional minor debt payments. These are to reimburse contractors for project cost over-runs during the previous year.

Capital improvement for the Alexandria wastewater system has been limited in recent years by national economic conditions. Funds available for capital investment have been distributed annually by the Ministry of Planning to sectors according to national priority. The 1961-1965 GOSSD-Alexandria capital improvement program was the last five-year program which received sufficient funding to be completed on schedule.

Capital funding for the Alexandria wastewater system remained relatively stable in the 1973-1975 period. A 92 percent increase in capital funding occurred in 1976. Currently the Ministry of Planning review capital budgets semi-annually so that additional funds are provided as they become available. The approved 1977 budget for Alexandria was LE 777 000 at the beginning of the year. A preliminary estimate of the revised 1977 budget request, after the semi-annual review, was LE 1,600,000. The recently published Ministry of Planning Five-Year Plan (1978-1982) provides an estimated LE 17.0 million (domestic funds) for capital investment over the coming five-year period or about LE 3.4 million annually.

Locally-Generated Funds

Locally-generated funds for GOSSD-Alexandria, summarized in Table M-14 represent payments made by new wastewater system customers or developers for the actual cost of providing sewer extensions and connections. The remaining funds required for operations, capital improvements and debt payments are provided by the Ministry of Finance.

Before 1962, GOSSD-Alexandria generated revenues through a sewer service charge to industrial customers. The charge was 0.003 LE/m^3 of wastewater discharge based on metered water use. There was adjustment for industries

TABLE M-15

ALLOCATION OF 1976 GOSSD-ALEXANDRIA OPERATION AND MAINTENANCE COSTS[a]

(LE thousand)

Item	Executive[b]	Administrative[c]	Project Development[d]	Operation and Maintenance: Wastewater Treatment	Operation and Maintenance: Sewer Maint.	Operation and Maintenance: Pump Stations	Vehicle Maint.
Salaries and Allowances	2 700	35 000	19 700	36 300	216 000	132 400	104 400
Employee Benefits	700	9 100	5 100	9 500	56 200	34 400	26 600
Fuel	-	-	-	-	200	2 400	22 800
Utilities	100	800	500	25 700	1 000	54 800	1 900
Spare Parts and Materials	-	-	-	10 200	12 500	5 200	30 400
Major Repairs	100	1 000	600	1 000	3 800	4 700	2 400
Other Expenditures	800	9 700	4 500	500	11 200	1 700	1 300
	4 400	55 600	30 400	83 200	300 900	235 600	187 800

(a) Cost allocated to various functions and departments based on financial records of 1976 expenditures rounded to nearest hundred LE; costs allocable to more than one function are allocated on a basis of the number of employees.

(b) Includes General Director's Office

(c) Includes Personnel, Budget and Finance, Legal and Public Services Departments.

(d) Includes Design and Project Execution Departments.

that did not return all water to the sewer due to evaporation or use in production. Problems occurred in revenue collection due to inaccurate documentation by industries of the amount of metered water not returned to the sewers and inability to measure wastewater discharge resulting from the use of ground waters. The industrial wastewater service charge was abandoned in 1963 when the government nationalized industry.

Sewer connection fees are received from two different types of new customers. Those customers who specifically request a sewer connection must pay the estimated cost of making the connection in advance; the fee is then adjusted in accordance with the actual cost incurred by GOSSD-Alexandria. About 150 such connections per year have been made since 1973. The average cost has risen from LE 43 per connection in 1973 to LE 102 per connection in 1976. About ten percent of the annual amount collected was paid by GOSSD-Alexandria as a subsidy for new customers in low-rent housing.

The GOSSD capital improvement program for sewer extensions includes routine construction of all sewer connections for newly-sewered streets. This creates a second category of new customers-- those who are connected to the system without requesting a connection. These connections have averaged about 725 a year during the last two years. The connection fee has averaged about LE 150 per customer. About 50 percent of these fees have been collected in the same year that the connection fee was levied, however, the unpaid balance of these fees as of the end of 1975 was LE 261 387. This total balance was reduced, due to improved collections, to LE 195 763 by the end of the year.

Existing Fixed Assets and Depreciation Expenses.
Accounts of GOSSD-Alexandria do not include records of fixed assets and depreciation expense. Since this information is essential in evaluating the financial condition of the operation, a survey was conducted of existing assets to estimate their July, 1977 value. Principal components of the survey are as follows:

1. Sewers were valued at present-day construction cost, less accumulated depreciation, based on a useful life of 50 years. Of the 1500 km of existing sewers, an estimated 18 percent have been in service for at least 50 years and an additional 20 percent will reach their 50th year in service by the year 1990. While many of these older sewers are subject to collapse and will require replacement, many are still intact and will be in service well beyond an assumed 50-year life. For this analysis, 50 percent of the sewers over 50 years old were given no value, and the remaining 50 percent of these sewers were assumed to have useful lives continuing through 1990. The inventory of sewers valued also included 750 km of building connections, and 31 000 drain inlets.
2. Structures were valued at present-day replacement cost for pump station structures, less accumulated depreciation, based on a 40-year useful life. GOSSD-Alexandria provided estimates of current value of administration and field office buildings and structures at the East Treatment Plant, which were depreciated on the same basis.
3. Equipment was valued at estimated present-day replacement cost, less accumulated depreciation, based on a useful life of 20 years. No value was given to equipment in service for longer than 20 years. Included in this inventory were mechanical and electrical equipment for pump stations and treatment facilities, and office equipment for administrative and field operations.

4. Vehicles were valued at present-day replacement cost, less accumulated depreciation, based on a useful life of 10 years. More than 40 percent of the current fleet has been in service for longer than 10 years; these vehicles were assumed to be in service until 1980 by which time an upgraded vehicle replacement program should be in effect.
5. Land was valued at the current cost of land as estimated by GOSSD-Alexandria; no depreciation is applied to land values. Estimated average land values used were LE 150/m^2 for administrative and field office locations, LE 116/m^2 for pumping station yards, and LE 5/m^2 for the East Treatment Plant site.

Results of this survey are shown in Table M-16.

M.2 Project Segmenting

As discussed in Chapter 9, segmenting of the Wastewater Master Plan construction program may be a viable financing approach if capital development funds are delayed or insufficient. One segment of the Master Plan might consider wastewater system extensions and improvements in only the presently developed areas of the East and West/Central districts of Alexandria. The tables which follow present a modified set of financial statements for GOSSD-Alexandria assuming segmenting resulted in implementation of the program in these principal districts. This exercise provides guidance for future analyses of alternative Master Plan segments should such an approach be taken. A summary of the tables which follow includes:

Table	Title
M-17	Projected Income Statement
M-18	Projected Cash Flow Statement
M-19	Projected Balance Sheet
M-20	Schedule of Capital Assets
M-21	Schedule of Depreciation Expenses.

TABLE M-16

CURRENT VALUE OF GOSSD-ALEXANDRIA FIXED ASSETS AND DEPRECIATION EXPENSE
(LE thousand)

Assets[a] (Useful Life)	Book Value at Current Replacement Cost[b]	Accumulated Depreciation	Net Current Value of Assets	Annual Depreciation Expense
Sewers (50 years)				
Collection and Transmission	96,166	51,618	44,548	1,923
Building Connections	12,675	6,337	6,338	253
Drain Inlets	4,030	2,015	2,015	81
Sub-total	112,871	59,970	52,901	2,257
Structures (40 years)				
Field and Main Office[c]	626	313	313	16
Pump Stations	2,400	905	1,495	60
Treatment Facilities[c]	2,000	650	1,350	50
Sub-total	5,026	1,868	3,158	126
Equipment (20 years)				
Office Equipment[c]	50	25	25	3
Sewer Cleaning Equipment	25	13	12	1
Pump Stations	12,650	6,505	6,145	632
Treatment Facilities[c]	2,000	1,000	1,000	100
Sub-total	14,725	7,543	7,182	736
Vehicles (10 years)	1,252	749	503	125
Land[c]	5,898	-	5,898	-
TOTAL	139,772	70,130	69,642	3,244

[a] Based on survey of existing assets as of July 1, 1977.

[b] Replacement cost estimates based on current day construction or replacement costs as developed by CDM.

[c] Current value based on GOSSD-Alexandria estimates.

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TABLE M-17

MASTER PLAN FOR EAST, WEST AND CENTRAL SYSTEMS
PROJECTED INCOME STATEMENT
(LE thousand)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1994	2000
REVENUES													
Service Charges[a]	--	--	--	3 625	5 447	6 538	7 536	8 293	8 924	9 769	10 717	17 438	26 716
Less Provision for Uncollectables [b]	--	--	--	173	259	311	359	395	425	465	510	830	1 272
TOTAL	--	--	--	3 452	5 188	6 227	7 177	7 898	8 499	9 304	10 207	16 608	25 444
Operating Costs[c]	3 008	3 866	4 607	3 059	4 715	5 679	6 573	7 249	7 789	8 525	9 348	15 211	23 304
Income Before Depreciation	(3 008)	(3 866)	(4 607)	393	473	548	604	649	710	779	859	1 397	2 140
Depreciation[d]	3 254	3 359	3 618	3 917	4 495	5 648	7 569	7 958	8 388	11 080	11 589	19 486	23 022
Net Income	(6 262)	(7 225)	(8 225)	(3 524)	(4 022)	(5 100)	(6 965)	(7 309)	(7 678)	(10 301)	(10 730)	(18 089)	(20 882)

[a] Service charge was designed to recover annual operating costs, plus a reserve to provide working capital equal to one month of operating costs in the following year, plus a provision for uncollectable revenues. Service charge is assumed to be instituted in 1981.

[b] Estimated to be 5 percent of Total Revenues.

[c] Estimated operation and maintenance costs for wastewater facilitites in the Eastern, Western and Central districts are based on operation and maintenance costs for the recommended plan reduced in proportion to the number of connections to be served in these districts only.

[d] Based on Table M-21, Schedule of Depreciation Expenses.

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TABLE M-13

MASTER PLAN FOR EAST, WEST AND CENTRAL SYSTEMS
PROJECTED CASH FLOW STATEMENT
(LE thousand - escalated)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1994	2000
SOURCES OF FUNDS												
Net Income[a]	(6 262)	(7 225)	(3 225)	(3 524)	(4 022)	(5 100)	(6 965)	(7 309)	(7 678)	(10 301)	(10 730)	(18 089)	(20 882)
Depreciation[b]	3 254	3 359	3 618	3 917	4 495	5 648	7 569	7 958	8 388	11 080	11 589	19 486	23 022
Increase in Current Liabilities(c)	--	1 767	1 197	4 910	1 408	1 675	149	6 198	4 892	--	2 178	--	--
Decrease in Current Assets (Excluding Cash)(d)	--	--	--	--	--	--	--	--	--	--	--	--	--
Capital Contributions from Customers[e]	121	214	277	479	1 392	523	3 399	3 980	4 376	4 730	5 061	4 096	6 038
Capital Contributions from Government[f]	7 911	18 803	28 342	48 222	48 002	55 206	73 366	84 899	86 557	72 166	55 534	20 181	30 080
TOTAL	5 024	16 918	25 209	54 004	51 275	57 952	77 518	95 726	96 535	77 675	63 632	25 674	38 258
USES OF FUNDS													
Investment in Utility Plant (g)	3 927	16 236	22 659	53 532	50 201	55 958	75 271	95 160	98 478	71 856	67 642	25 616	38 258
Decrease in Current Liabilities[h]	--	--	--	--	--	--	--	--	--	5 669	--	--	--
Increase in Current Assets (Excluding Cash)[i]	--	85	106	612	514	310	533	244	215	332	239	--	--
TOTAL	3 927	16 321	22 765	54 144	50 715	56 268	75 804	95 404	98 693	77 857	67 881	25 616	38 258
NET OF SOURCES LESS USES	1 097	597	2 444	(140)	560	1 684	1 714	322	(2 158)	(182)	(4 249)	58	0
CASH AT BEGINNING OF PERIOD (j)	578	1 675	2 272	4 716	4 576	5 136	6 820	8 534	8 856	6 698	6 516	3 402	5 130
CASH AT END OF PERIOD[k]	1 675	2 272	4 716	4 576	5 163	6,820	8 534	8 856	6 698	6 516	2 267	3 460	5 130

(a) Taken from Income Statements for East, West and Central Systems.

(b) Taken from Schedule of Depreciation Expenses for East, West and Central Systems.

(c)(d) Changes as shown in Projected Balance Sheets for East, West and Central Systems.

(e) Includes contributions from sewer connection charges and benefit charges to beneficiary developers. One-third of each year's connection charge billings is assumed to be collected in the following year; five percent of all connection charges are assumed to be uncollectable.

(f) Includes government funding required to supplement customer contributions to ensure a sound financial posture throughout the period of study and maintain a sufficient level of working capital for sound financial management.

(g) Estimated capital expenditures for East, West and Central Systems are shown in Table 9-11.

(h)(i) Taken from Projected Balance Sheets for East, West and Central Systems.

(j)(k) Based on cash required to finance one month of operating costs. Income Statement plus one month of the capital expenditures.

TABLE M-19

MASTER PLAN FOR EAST, WEST AND CENTRAL SYSTEMS
PROJECTED BALANCE SHEET
(LE thousand - escalated)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1994	2000
ASSETS													
Fixed Assets													
Utility Plant in Service[a]	139 871	143 553	154 986	169 506	191 556	227 525	327 114	346 535	368 059	497 373	522 815	853 984	1 030 573
Less Accumulated Depreciation[b]	73 333	76 499	79 917	83 782	88 214	93 794	101 323	109 238	117 582	128 617	140 158	250 327	387 997
Net Fixed Assets in Service	66 538	67 054	75 069	85 724	103 342	133 731	225 731	237 297	250 477	368 756	382 657	603 657	642 576
Work in Progress[c]	3 777	16 138	27 164	66 124	94 212	114 133	89 775	165 471	242 381	184 878	227 030	20 816	31 144
TOTAL	70 315	83 192	102 233	151 848	197 554	247 364	315 566	402 768	492 858	553 634	609 687	624 473	673 720
Current Assets													
Cash(d)	1 675	2 272	4 716	4 576	5 136	6 820	8 534	8 856	6 698	6 516	2 267	3 460	5 130
Accounts Receivable-Service Charges (e)	--	--	--	302	454	545	628	691	744	814	893	1 453	2 226
Less Uncollectable Service Charges (f)	--	--	--	173	259	311	359	395	425	465	510	830	1 272
Accounts Receivable - Capital Contributions(g)	61	77	100	129	156	183	407	454	500	541	578	500	713
Less Uncollectable Capital Contributions (h)	9	12	15	19	23	28	61	68	75	81	87	75	107
Inventories (i)	220	286	366	470	715	850	995	1 086	1 165	1 340	1 412	2 324	3 526
TOTAL	1 965	2 647	5 197	5 669	6 743	8 737	10 984	11 550	9 607	9 757	5 747	8 642	12 974
Total Assets	72 280	85 839	107 430	157 517	204 297	256 601	326 550	414 318	502 465	563 391	615 434	633 115	686 694
LIABILITIES													
Equity													
Capital Contributions[j]	77 988	97 005	125 624	174 325	223 719	279 448	356 213	445 092	536 025	612 921	673 516	796 913	967 225
Retained Earnings(Losses)[k]	(5 262)	(13 487)	(21 712)	(25 236)	(29 258)	(34 358)	(41 323)	(48 632)	(56 310)	(66 611)	(77 341)	(163 798)	(280 531)
TOTAL	71 726	83 518	103 912	149 089	194 461	245 090	314 890	396 460	479 715	546 310	596 175	633 115	686 694
Current Liabilities													
Accounts Payable[l]	327	1 353	1 888	4 461	4 183	4 663	6 273	7 930	8 207	5 988	5 637	10 455	15 615
Deposits[m]	227	968	1 630	3 967	5 653	6 848	5 387	9 928	14 543	11 093	13 622	1 249	1 869
TOTAL	554	2 321	3 518	8 428	9 836	11 511	11 660	17 858	22 750	17 081	19 259	11 704	17 484
Total Liabilities	72 280	85 839	107 430	157 517	204 297	256 601	326 550	414 318	502 465	563 391	615 434	633 115	686 694

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NOTES TO ACCOMPANY TABLE M-19

RECOMMENDED MASTER PLAN PROJECTED BALANCE SHEET

a. Utility Plant In Service is the sum of Depreciable Values plus Land appearing on Table M-20 Schedule of Capital Assets.

b. Accumulated Depreciation is taken from Table M-21 of Depreciation Expenses

c. Work In Progress is taken from Table M-20 Schedule of Capital Assets.

d. Cash balance on December 31 is taken from Table M-18 Cash Flow Statement . This end of year balance is sufficient to finance one month of operating costs (Table M-17 Projected Income Statement) plus one month of capital expenditures.

e. Accounts receivable are estimated to equal one month of service charge billings for each year as shown in Table M-17 Projected Income Statement .

f. Taken from Table M-17 Projected Income Statement.

g. Accounts receivable are estimated to equal one-third of the sewer connection charges in each year.

h. Estimated to be 5 percent of connection charge billings.

i. Inventory for 1978 based on end of year balance from 1976 GOSSD-Alexandria financial records; inventories in succeeding years assumed to increase with increased expenditures for materials and supplies operating costs.

j. Capital Contributions are the cumulative sum of the annual Capital Contributions of Customers and Government as shown on Table M-18 Cash Flow Statement . The initial balance for 31 December 1978 was established as the difference between total Equity and Retained losses in 1978. This approach was necessary because a balance sheet displaying Retained Earning and Capital Contributions was not available.

k. Retained Earnings (Losses) are the cumulative earnings or losses appearing on Table M-17 Projected Income Statement as Net Operating Income. Under the proposed revenue program Operating Income after depreciation will result in operating losses during the entire period 1978-2000 which will require an operating subsidy from government.

l. Accounts payable are equal to one month of capital costs.

m. Deposits include contractor deposits of 5 percent and contractor insurance of 1 percent based on the amount of work in process for each year.

TABLE M-20

MASTER PLAN FOR EAST, WEST AND CENTRAL SYSTEM
SCHEDULE OF CAPITAL ASSETS
(LE thousand)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1994	2000
ASSETS ADDED DURING THE YEAR													
Sewers	--	3 308	11 042	14 420	17 276	7 681	96 035	19 416	21 519	108 393	25 437	20 816	31 144
Structures	--	--	--	--	189	16 670	--	--	--	20 916	--	--	--
Equipment	--	--	--	--	4 578	11 611	--	--	--	--	--	--	--
Vehicles	150	567	591	152	70	75	45	48	49	50	53	94	86
Land	--	--	--	--	--	--	3 549	--	--	--	--	--	--
TOTAL	150	3 875	11 633	14 572	22 113	36 037	99 629	19 464	21 568	129 359	25 490	20 910	31 230
ASSETS RETIRED													
Vehicles	51	193	200	52	63	68	40	43	44	45	48	85	77
DEPRECIABLE VALUES													
Sewers	112 871	116 179	127 221	141 641	158 917	166 598	262 633	282 049	303 568	411 961	437 398	703 944	880 481
Structures	5 026	5 026	5 026	5 026	5 215	21 885	21 885	21 885	21 885	42 801	42 801	62 436	62 436
Equipment	14 725	14 725	14 725	14 725	19 303	30 914	30 914	30 914	30 914	30 914	30 914	72 296	72 296
Vehicles	1 351	1 725	2 116	2 216	2 223	2 230	2 235	2 240	2 245	2 250	2 255	2 312	2 364
TOTAL	133 973	137 655	149 088	163 608	185 658	221 627	317 667	337 088	358 612	487 926	513 368	840 988	1 017 577
WORK IN PROGRESS													
Sewers	3 308	11 612	15 818	42 129	63 115	100 811	69 093	131 013	186 986	135 864	162 464	20 816	31 144
Structures	--	239	1 241	6 405	12 388	1 181	6 854	14 017	24 905	11 548	19 635	--	--
Equipment	469	2 157	4 320	10 492	11 611	5 043	10 279	16 892	26 941	33 917	41 382	--	--
Land	--	2 130	5 785	7 098	7 098	7 098	3 549	3 549	3 549	3 549	3 549	--	--
TOTAL	3 777	16 138	27 164	66 124	94 212	114 133	89 775	165 471	242 381	184 878	227 030	20 816	31 144
LAND	5 898	5 898	5 898	5 898	5 898	5 898	9 447	9 447	9 447	9 447	9 447	12 996	12 996
BOOK VALUE OF CAPITAL ASSETS	143 648	159 691	182 150	235 630	285 768	341 658	416 889	512 006	610 440	682 251	749 354	874 800	1 061 717

TABLE M-21

MASTER PLAN FOR EAST, WEST AND CENTRAL SYSTEMS
SCHEDULE OF DEPRECIATION EXPENSES
(LE thousand)

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1994	2000
ANNUAL DEPRECIATION EXPENSES														
Sewers	2%	2 257	2 324	2 544	2 833	3 178	3 332	5 253	5 641	6 071	8 239	8 748	14 079	17 610
Structures	2.5%	126	126	126	126	130	547	547	547	547	1 070	1 070	1 561	1 561
Equipment	5%	736	736	736	736	965	1 546	1 546	1 546	1 546	1 546	1 546	3 615	3 615
Vehicles	10%	135	173	212	222	222	223	223	224	224	225	225	231	236
TOTAL		3 254	3 359	3 618	3 917	4 495	5 648	7 569	7 958	8 388	11 080	11 589	19 436	23 022
BOOK VALUE OF ASSETS RETIRED														
Vehicles		51	193	200	52	63	68	40	43	44	45	48	85	77
ACCUMULATED DEPRECIATION (NET OF RETIREMENTS)														
Sewers		62 227	64 551	67 095	69 928	73 106	76 438	81 691	87 832	93 403	101 642	110 390	188 627	294 287
Structures		1 994	2 120	2 246	2 372	2 502	3 049	3 596	4 143	4 690	5 760	6 830	16 196	25 562
Equipment		8 279	9 015	9 751	10 487	11 452	12 998	14 544	16 090	17 636	19 182	20 728	42 418	64 108
Vehicles		833	813	825	995	1 154	1 309	1 492	1 673	1 853	2 033	2 210	3 086	4 040
TOTAL		73 333	76 499	79 917	83 782	88 214	93 794	101 323	109 238	117 582	128 617	140 158	250 327	387 997
NET CAPITAL ASSET VALUES		70 315	33 192	102 233	151 848	197 554	247 964	315 566	402 768	492 858	553 634	609 696	624 523	673 720

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