Annex to 3.4.1 Description Of Proposed Measures For Wastewater Collection, Treatment And Disposal

Contents

4. BAQA TREATMENT PLANT

Baqa disposes already of a wastewater collection, treatment and disposal system (for details refer to Section 4 of Annex 3.1).

After completion of proposed measures of rehabilitation and extension of the existing Baqa Scheme the following communities will be connected: Baqa Camp, Suwaileh, Ain Albasha, Safout, Abu Nuseir Village, Moobis, Abu Hamad, Umm Dananir and Al Maisah. Figure 4.1 shows the layout of the proposed sewerage system (TYPSA Study).

The project foresees the extension of the existing Baqa Treatment Plant designed for the wastewater production in 2020 (TYPSA Study). The existing treatment process based on trickling filters followed by aerated solids contact tanks will be applied also in future. Slow sand filtration will be added as tertiary treatment. Produced sludge will be treated by gravity thickeners, unheated anaerobic sludge digestion and decanter centrifuges. Figure 4.2 shows the existing and proposed treatment system after extension. The projection of the wastewater production is shown in the following table (acc. to TYPSA Study). Final capacity of the treatment plant will be reached

in 2020: 29,700 m³/d (265,000 connected inhabitants)

Due to missing sufficient areas suitable for agricultural irrigation in the vicinity of the plant it is recommended to discharge the treated effluent via the existing pipeline to the Wadi Rumman. Finally the treated wastewater will flow into the King Talal Dam. From there water will be flow to the Jordan Valley for ultimate reuse.

The investment costs (for future extension measures) based on preliminary design and 1998 prices (TYPSA Study) are:

Treatment plant (primary and secondary treatment)	5.94 million JD
Networks	8.66 million JD
Tertiary treatment and pipeline (reuse system)	3.68 million JD
Dam/storage (pond for reuse)	0 million JD
Total base costs	18.27 million JD
Physical contingencies	1.83 million JD
Engineering	2.01 million JD
Total investment costs	22.11 million JD

According to the TYPSA Study Report proposed extension measures will be implemented between 2008 and 2009 (Phase 1) and between 2013 and 2014 (Phase 2).

Consultant's Study Report:

TYPSA, Symonds Travers Morgan and Universal Engineering Consulting: "Wastewater collection, treatment, disposal and/or reuse systems project for the catchment area of Yarmouk River and Jordan River. Final Report", December 1998

Stanley Consultants: "Upgrading and expansion of the Baqa and Abu Nuseir wastewater treatment plants. Conceptual Report", January 1994

Stanley Consultants: "Upgrading and expansion of the Baqa and Abu Nuseir wastewater treatment plants. Feasibility Report", October 1994

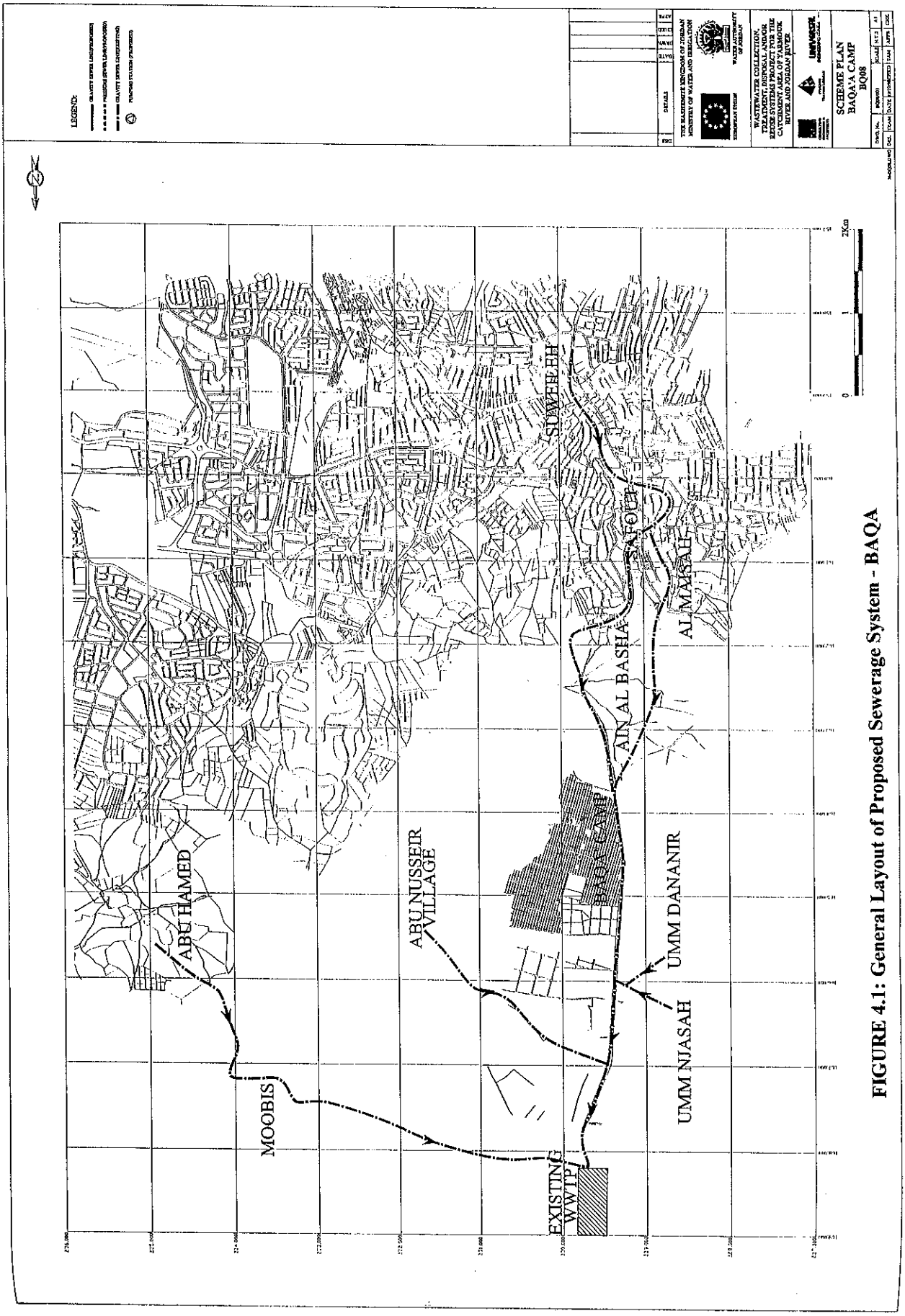

FIGURE 4.1: General Layout of Proposed Sewerage System - BAQA

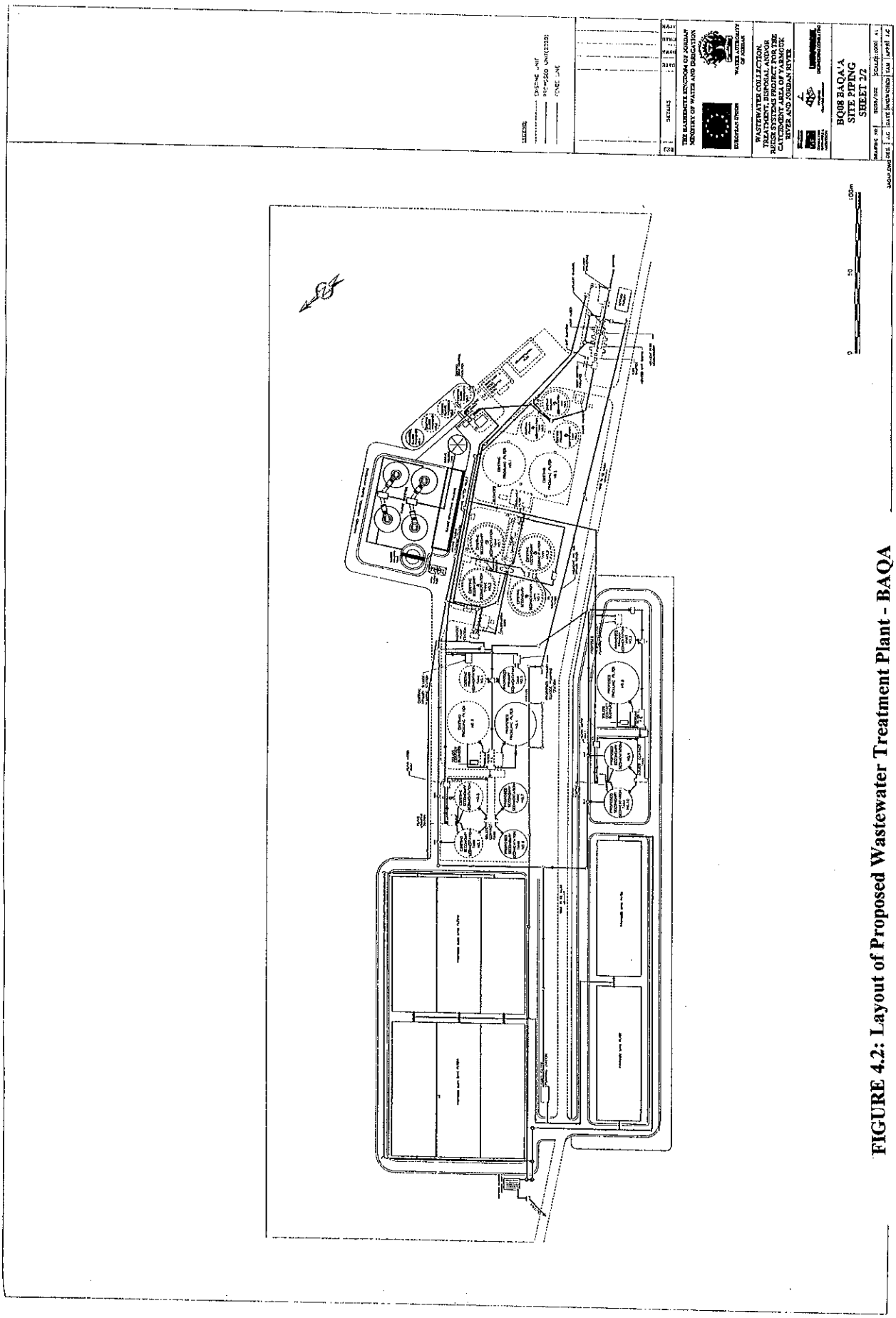

FIGURE 4.2: Layout of Proposed Wastewater Treatment Plant - BAQA

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
4 BAQA

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994: 127.200

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,08	3,08	3,08	3,08	3,08
Spec.water demand	l/c/d	80	100	140	140	140	140
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	80	94	95	95	95	95
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	127.200	152.575	177.547	206.606	240.421	279.771
Connected (sewerage)	c	101.760	143.420	168.669	196.276	228.400	265.782
Not connected (sewerage)	c	25.440	9.154	8.877	10.330	12.021	13.989
Water demand							
Domestic demand	l/c/d	80	100	140	140	140	140
	m³/d	10.176	15.257	24.857	28.925	33.659	39.168
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	10.176	15.257	24.857	28.925	33.659	39.168
Wastewater production							
Return flow (w.demand)	m³/d	6.513	11.474	18.891	21.983	25.581	29.768
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	6.513	11.474	18.891	21.983	25.581	29.768
	m³/month	195.379	344.209	566.729	659.486	767.424	893.029
	m³/a	2.377.114	4.187.875	6.895.209	8.023.749	9.336.998	10.865.186
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5/d$	6.614	9.322	10.964	12.758	14.846	17.276
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load	$kgBOD_5/d$	6.614	9.322	10.964	12.758	14.846	17.276
Reuse of wastwater							
Inflow to the treatment plant	m³/a	2.377.114	4.187.875	6.895.209	8.023.749	9.336.998	10.865.186
Losses in treatment plant	%	0	10	10	5	5	5
(due to infiltr./evap.)	m³/a	0	418.788	689.521	401.187	466.850	543.259
Effluent of treatment plant	m³/a	2.377.114	3.769.088	6.205.688	7.622.562	8.870.148	10.321.927
Net water demand per ha	m³/d/ha	-	-	-	-	-	-
Irrigable reuse area	ha	-	-	-	-	-	-

Water demand for irrigation

5. FUHIS TREATMENT PLANT

Fuhis Wastewater Treatment Plant receives sewage from the towns of Fuhis and Mahis.

Fuhis Wastewater Treatment Plant was completed recently (in 1996). Due to the fact that presently the design capacity of the treatment plant is used to about 40 % only, there are no specific plans for extension (for details of the existing system refer to Section 5 of Annex 3.1).

The projection of the wastewater production shows that the capacity of the plant (2,400 m^3/d) will be reached between 2010 and 2015 (acc. to Consultant's Study Report, see following table).

According to the "Study and design of effluent reuse scheme and arrangement of the structures for Fuhis/Mahis WWTP" prepared by CEC in 1994 plantations of eucalyptus trees for the purpose of commercial wood production is recommended. It is shown that the planting of eucalyptus trees will give best returns. It is anticipated that the reuse of this crop will enhance environmental considerations, maximize the use of the effluent water and minimize the health risk as the crop will be wood and not edible products.

Taking into account the water demand for irrigation of eucalyptus trees an area of 90 ha in 2020 may be irrigated (see following table). Effluent of the plant (excess water) not used for agricultural irrigation (e.g. in times where the irrigation demand is low) will discharges by a gravity pipe to the Wadi Shua'ab adjacent to the plant.

Proposed land (acc. to the above mentioned study) for the reuse scheme is marked in the Figure 5.1. Area A has an approximate area of 42 ha and is the property of the General Mining Company. Area B is about 20 ha and is privately owned plots of land. The topography of the chosen land is ideal for tree plantations using drip irrigation. The quarry land (area A) is a hill surrounded by two wadis converging at the southern end of area B. Area B is mainly a sloping land at the side of a hill.

Capital cost for the reuse scheme is roughly estimated to 215,000 JD (prices of 1994), i.e. for planting of stage I (50,000 JD) and irrigation networks of stage I (165,000 JD).

Presently, no measures of the proposed wastewater reuse scheme are implemented.

Consultant's Study Report:

GKW Consult: "Water reuse study report for Fuhis/Mousa sewage treatment plants", June 1994.

CEC: "Study and design of effluent reuse scheme and new arrangements of structures for Fuhis/Mahis WWTP", December 1994

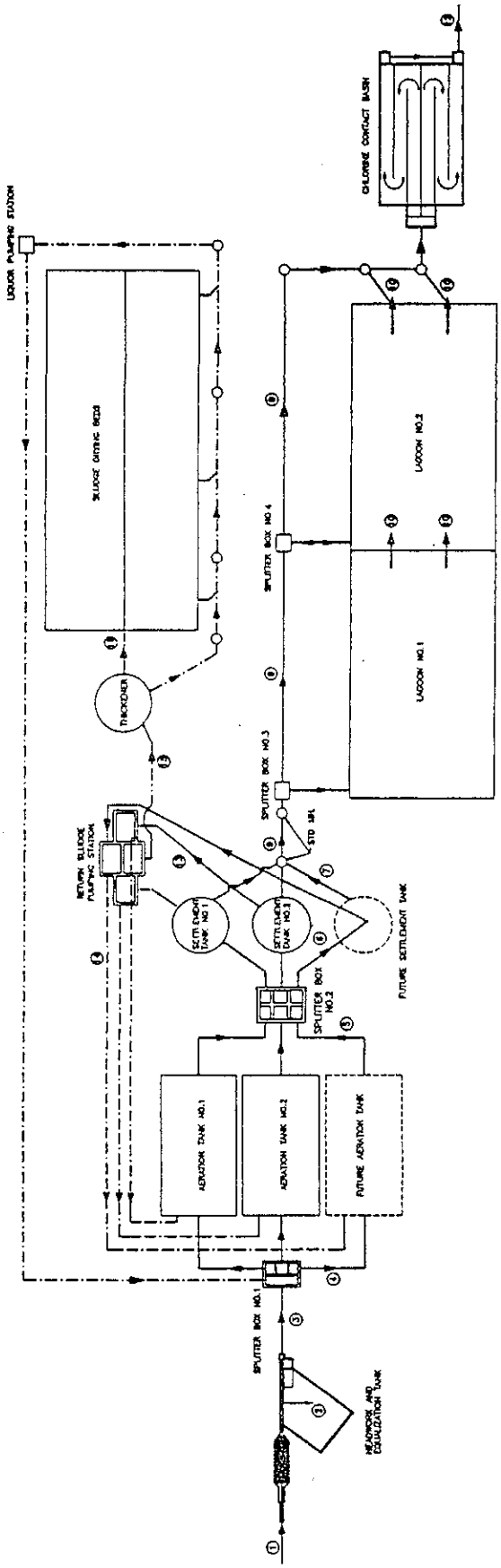

FIGURE 5.2: Layout of Existing and Future Wastewater Treatment Plant - FUHIS

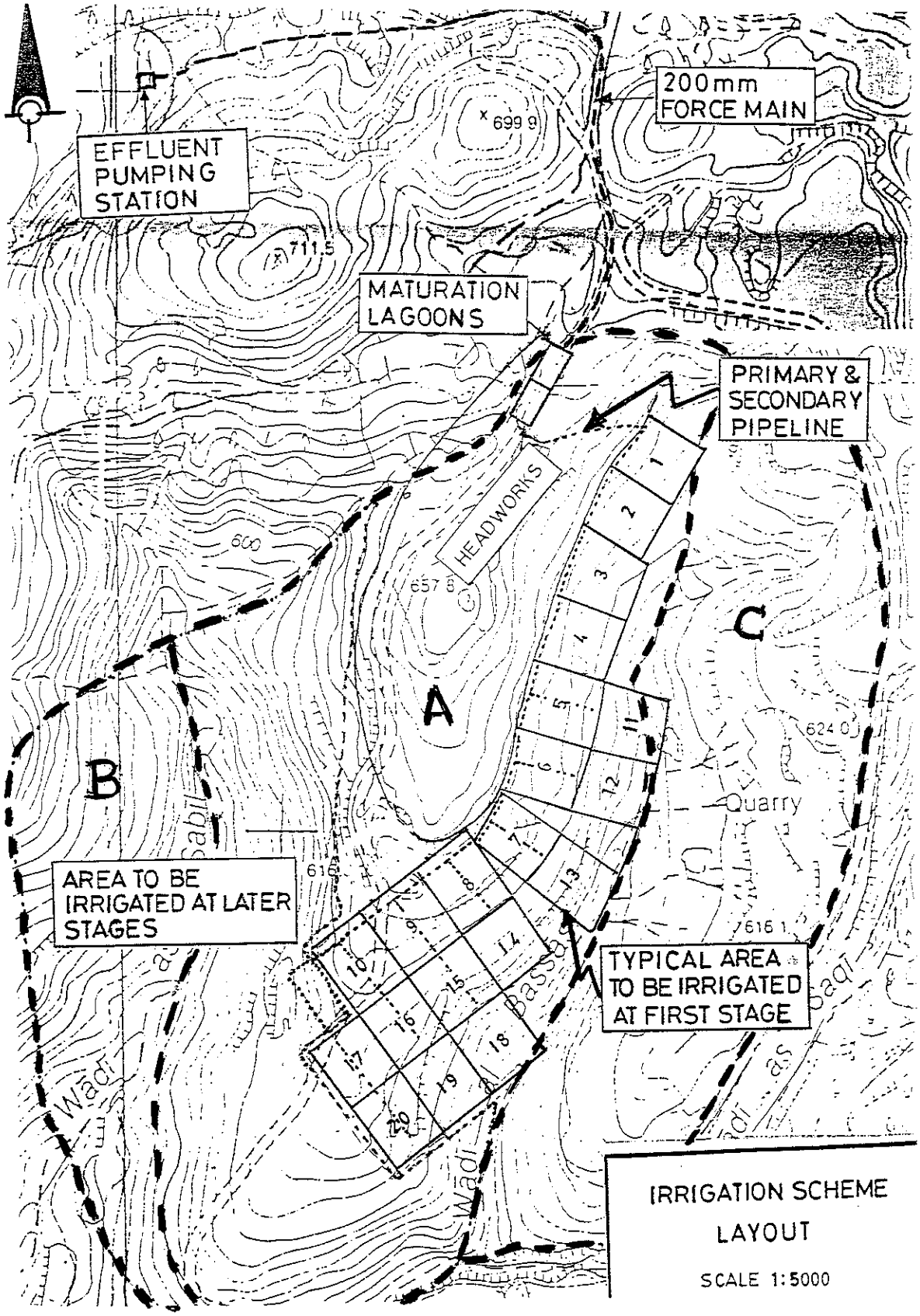

FIGURE 5.3: Potential Reuse Areas - FUHIS

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT: 5 FUHIS

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994 16.723

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,415	3,3	3,3	3,3	3,3
Spec.water demand	l/c/d	94	105	106	112	116	119
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	0	55	85	90	90	90
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	16.723	20.456	23.901	28.114	33.069	38.898
Connected (sewerage)	c	0	11.251	20.316	25.302	29.762	35.008
Not connected (sewerage)	c	16.723	9.205	3.585	2.811	3.307	3.890
Water demand							
Domestic demand	l/c/d	94	105	106	112	116	119
	m³/d	1.572	2.148	2.534	3.149	3.836	4.629
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	1.572	2.148	2.534	3.149	3.836	4.629
Wastewater production							
Return flow (w.demand)	m³/d	0	945	1.723	2.267	2.762	3.333
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	0	945	1.723	2.267	2.762	3.333
	m³/month	0	28.352	51.684	68.013	82.858	99.982
	m³/a	0	344.945	628.819	827.490	1.008.102	1.216.452
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5/d$	0	731	1.321	1.645	1.935	2.276
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load	$kgBOD_5/d$	0	731	1.321	1.645	1.935	2.276
Reuse of wastwater							
Inflow to the treatment plant	m³/a	0	344.945	628.819	827.490	1.008.102	1.216.452
Losses in treatment plant	%	0	10	10	10	10	10
(due to infiltr./evap.)	m³/a	0	34.495	62.882	82.749	100.810	121.645
Effluent of treatment plant	m³/a	0	310.451	565.937	744.741	907.291	1.094.807
Net water demand per ha	m³/d/ha	-	35	35	35	35	35
Irrigable reuse area	ha	-	24	44	58	71	86

Water demand for irrigation Eucalyptus trees 35 m³/d/ha

6. IRBID TREATMENT PLANT (CENTRAL)

1. Long term development in Greater Irbid Area

The long-term strategy for the Greater Irbid Area foresees altogether four wastewater treatment plants:

- Central Irbid Treatment Plant for the drainage area North (existing since 1987)
- Wadi Arab Treatment Plant for the drainage area West (existing since 1999)
- Wadi Hassan Treatment Plant for the villages in the drainage area South (completion in 2000)
- Wadi Shallala Treatment Plant for the drainage area East (under study)

The basic concept of the long-term development for Greater Irbid is shown in the Figure 6.1.

Central Irbid Treatment Plant

This treatment plant serves the center and the North of the town connected to Interceptor B. The flow is expected to exceed the capacity of the existing treatment plant in year 2010. From this year onwards the quantity of sewage exceeding 12,000 m^3/d has to be bypassed and discharged directly to Wadi Arab plant.

Wadi Arab Treatment Plant

The treatment plant is proposed to serve the following communities and areas of Irbid:

- Irbid South
- Irbid West
- Part of Irbid North
- Irbid North East
- Bayt Ras
- Natifa
- Zabdat

Details of Wadi Arab Plant are given under Section 16.

Wadi Hassan Treatment Plant

This treatment plant will serve the following villages in the South of the project area:

- An Nu'ayyma
- Kitm
- Shatana

It is proposed to reuse the effluent of this plant locally. Wadi Hassan Plant is described under Section 18.

Wadi Shallala Treatment Plant

This treatment plant will be constructed to serve the area East. This plant area will serve the following communities:

- Irbid South- East
- Aydun
- Al Husn
- As Sarih
- Huwwara
- Mukh. Al Husn
- Sal

Proposed measures for Wadi Shallala are described under Section 33.

2. Treatment Plant Irbid Central

The existing Wastewater Treatment Plant Irbid Central (for details of the existing system refer to Section 6 of Annex 3.1) is used to about 40 % only, because a big portion of the sewage of Irbid (about 65 %) is discharged since 1999 to the new plant Wadi Arab. There are no plans for future extension of the Treatment Plant Irbid Central. It is even proposed to abandon this plant after its general lifetime is reached (about 2020). All wastewater would then be discharged to Wadi Arab Treatment Plant.

The projection of the wastewater production (acc. to Consultant's Study Report, see following table) shows that the capacity of the plant (about 12,000 m^3/d) will be reached in about 2010. From that time on all wastewater exceeding this flow will be discharged to Wadi Arab Treatment Plant. No extension of the treatment capacity is proposed.

Presently, the effluent of Irbid Central Plant is discharged by a 30 km long pipeline (after 15 km downstream together with the effluent of Wadi Arab Treatment Plant) to the Jordan Valley for irrigation purposes. This long pipeline was constructed to protect the aquifer and groundwater resources located downstream of the plant, which are exploited for municipal water supply.

Due to insufficient suitable land for irrigation no reuse scheme in the upland close to Irbid is recommended. It is proposed to reuse the treated effluent of Irbid Central Plant together with Wadi Arab Plant (compare Section 16) in Jordan Valley to produce mixed crops (see Wadi Arab Irrigation Complex, Figure 6.3).

In July 2000 the Ministry of Water and Irrigation prepared Terms of Reference for a study for reuse of treated wastewater for the Greater Irbid Area. It is proposed that the German Development Bank (Kreditanstalt fuer Wiederaufbau, KfW) will finance this study.

Consultant's Study Report:

RRI, DAR and Sigma: "Technical, economical and financial Feasibility Study. Phase B. Feasibility study of preferred alternatives for wastewater collection and treatment systems in the Greater Irbid area.", March 1992

DAR: "Update of the feasibility study. Wastewater collection and treatment systems in the Greater Irbid area. Stage 2. Wadi Shallala." November 1998.

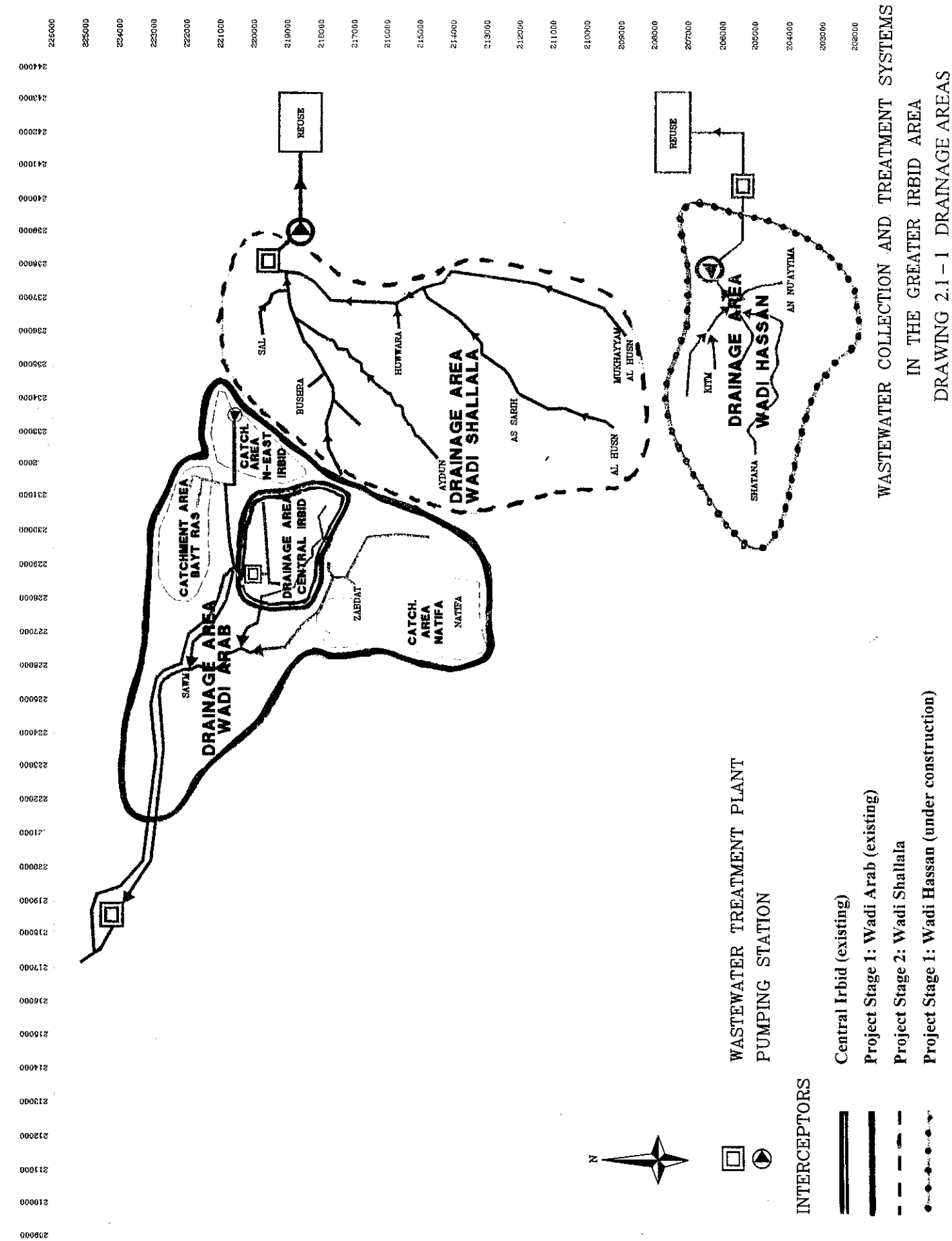

FIGURE 6.1: General Layout of Proposed Sewerage System – GREATER IRBID

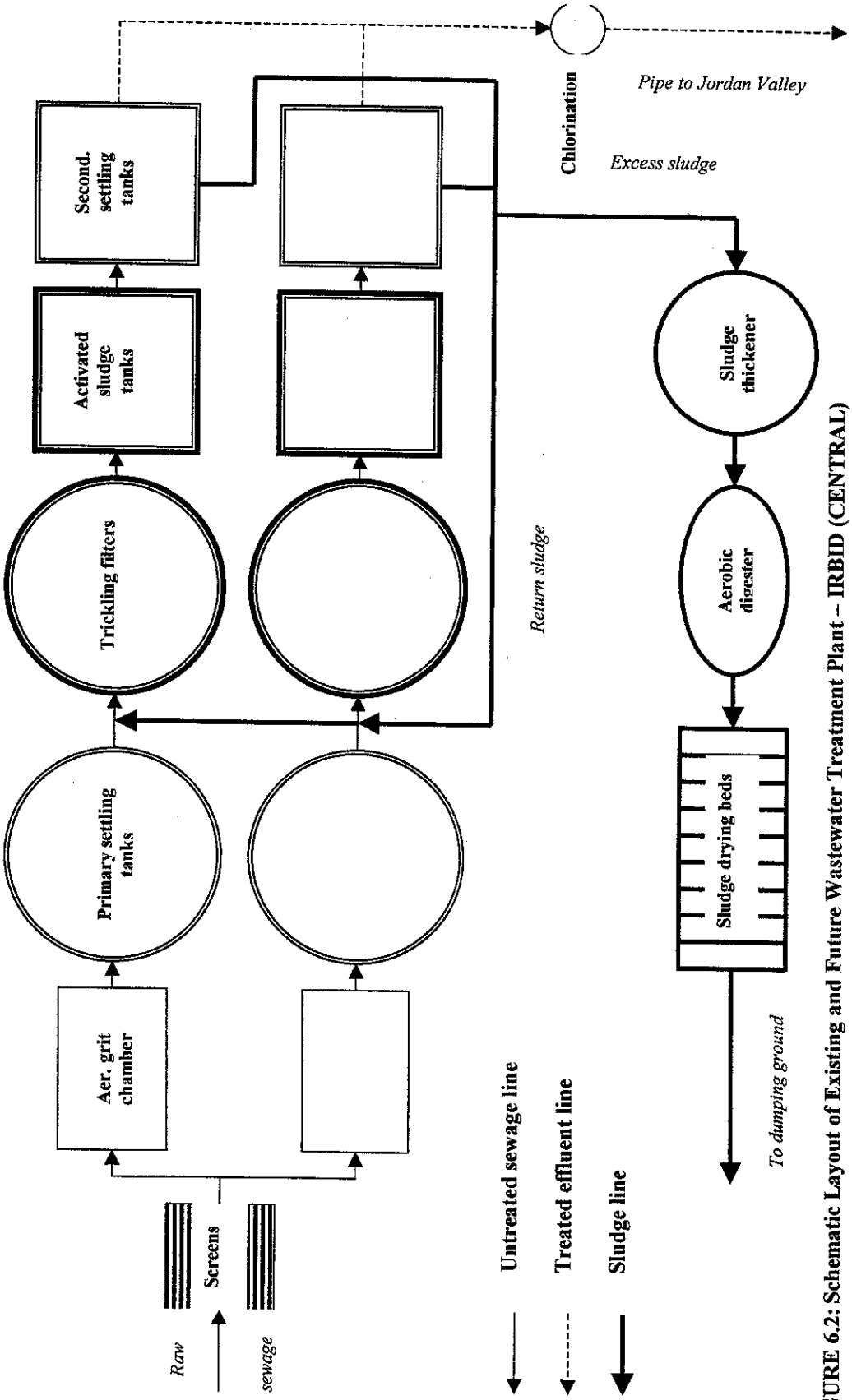

FIGURE 6.2: Schematic Layout of Existing and Future Wastewater Treatment Plant – IRBID (CENTRAL)

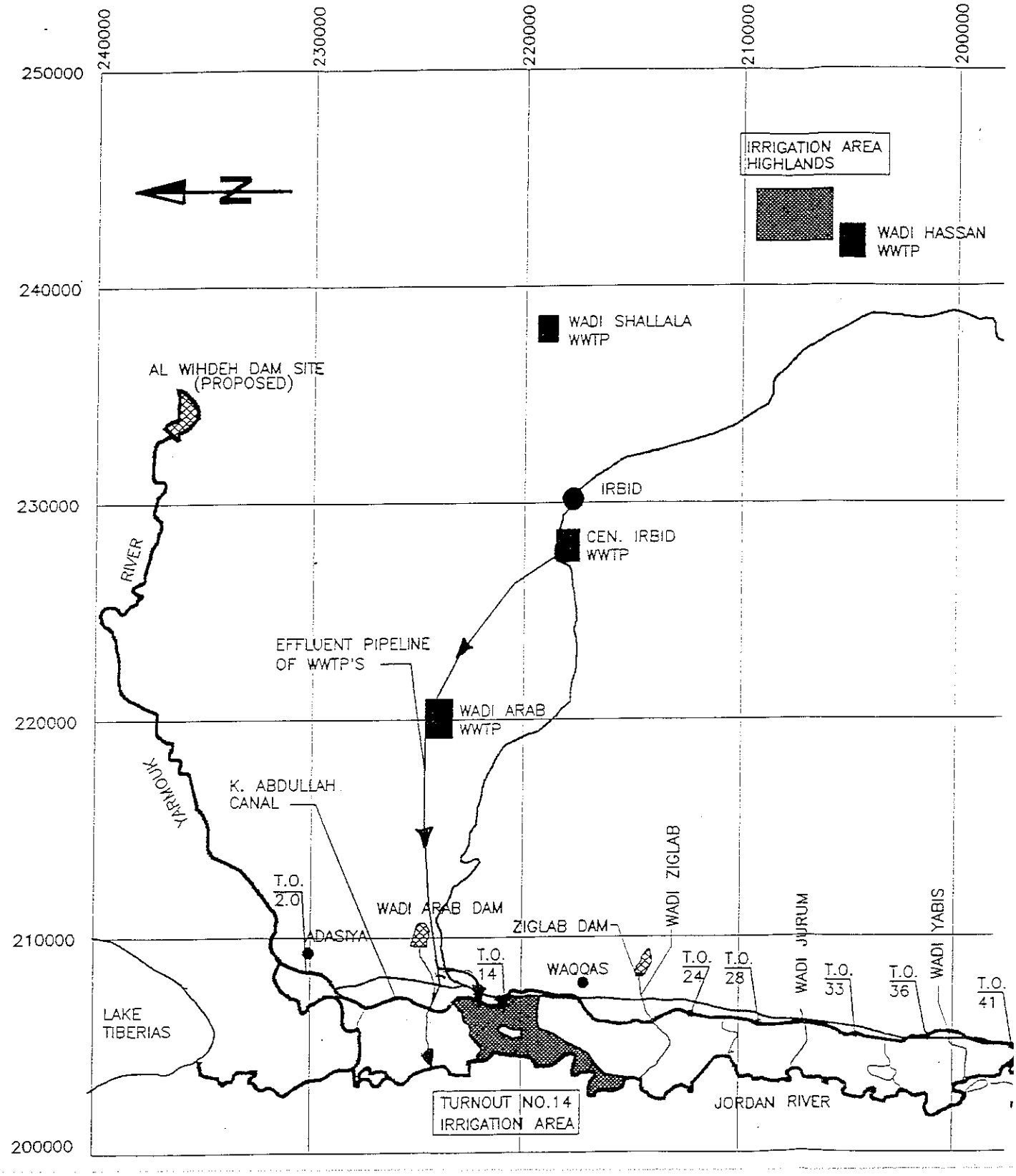

FIGURE 6.3: Potential Reuse Areas – (IRBID CENTRAL)
WADI ARAB IRRIGATION COMPLEX

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
6 IRBID CENTRAL

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994: 77.770 — since 2010 the population remains constant, because add.sewage flows to Wadi Arab

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,00	2,91	2,91	2,91	2,91
Spec.water demand	l/c/d	115	120	128	130	130	130
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	90	50	70	90	90	90
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	77.770	92.861	107.177	123.706	142.783	164.803
Connected (sewerage)	c	69.993	46.431	75.024	111.335	128.505	148.323
Not connected (sewerage)	c	7.777	46.431	32.153	12.371	14.278	16.480
Water demand							
Domestic demand	l/c/d	115	120	128	130	130	130
	m³/d	8.944	11.143	13.719	16.082	18.562	21.424
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	8.944	11.143	13.719	16.082	18.562	21.424
Wastewater production		To Wadi Arab:		0	0	1.365	3.426
Return flow (w.demand)	m³/d	6.439	4.457	7.682	11.579	13.365	15.426
Losses/inflow	m³/d	0	0	0	0		0
Total (to Irbid Central)	m³/d	6.439	4.457	7.682	11.579	12.000	12.000
	m³/month	193.181	133.720	230.474	347.366	360.000	360.000
	m³/a	2.350.365	1.626.933	2.804.097	4.226.286	4.380.000	4.380.000
Pollutional load		To Wadi Arab:		0	0	853	2.141
Poll. load (dom.demand)	$kgBOD_5/d$	4.550	3.018	4.877	7.237	8.353	9.641
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load (to Irbid central)	$kgBOD_5/d$	4.550	3.018	4.877	7.237	7.500	7.500
Reuse of wastwater							
Inflow to the treatment plant	m³/a	2.350.365	1.626.933	2.804.097	4.226.286	4.380.000	4.380.000
Losses in treatment plant	%	5	5	5	5	5	5
(due to infiltr./evap.)	m³/a	117.518	81.347	140.205	211.314	219.000	219.000
Effluent of treatment plant	m³/a	2.232.847	1.545.586	2.663.893	4.014.971	4.161.000	4.161.000
Net water demand per ha	m³/d/ha		22	22	22	22	22
Irrigable reuse area	ha	0	192	332	500	518	518

Treated effluents discharged together with the one of Treatment Plant Wadi Arab into Jordan Valley and reused by common reuse areas

Water demand for irrigation Mixed crop pattern 22 m³/d/ha
(demand as for "North Jordan Valley", no.29 reuse areas)

7. JERASH (EAST) TREATMENT PLANT

1. Long term development in Jerash Area

According to the Consultants Study Report the long-term strategy for the Jerash Area including surrounding communities foresees two independent sewerage schemes and two wastewater treatment plants:

- *Jerash East Treatment Plant (existing Jerash Treatment Plant)*

  This treatment plant will serve in future the Jerash Town, Soof, Soof Camp and Dair Laiyat (acc. to information got from M. Mansour, MOWI).

- *Jerash West Treatment Plant (construction of a new plant along Wadi Al Wadana, which is a tributary of Wadi Zarqa)*

  The following communities will be connected to the proposed scheme: Jerash Camp, Sakep, Reimoon, Ketteh, Nahla, Dhaher Es Saru and Amamah (acc. to information got from M. Mansour, MOWI).

Details of Jerash West System are given under Section 24.

2. Existing Jerash East Treatment Plant

Due to the limited space at the existing treatment plant of Jerash East (for details of the existing system refer to Section 7 of Annex 3.1) there is no possibility to expand the existing facilities to meet the required capacity of both Jerash East and West. Therefore the existing Jerash East Treatment Plant will serve in future Jerash Town, Soof, Soof camp and Dair Laiyat. Figure 7.1 shows the existing sewerage system of Jerash East.

The plant was put in operation in 1983 and was extended in 1990 to a capacity of 3,500 m^3/d. Presently only less than half of this capacity is used.

Preliminary treatment facilities consist of screens and grit chambers. Biological treatment is based on an activated sludge process (extended aeration). Maturation ponds in series provide tertiary treatment. Treated wastewater is disinfected by chlorination. Excess sludge is treated in sludge thickeners/holding tanks and dewatered in drying beds (for details of the existing system see Section 7 of Annex 3.1). Figure 7.2 shows the existing and future treatment system. The projection of the wastewater production is shown in the following table. The plant will be reach its final capacity

after 2005: 3,500 m³/d (30,000 connected inhabitants)

An extension is required before 2010 for the projected wastewater to be collected

in 2020: 8,500 m³/d (74,000 connected inhabitants)

The investment costs based on 1998 prices are:

Treatment plant (primary and secondary treatment)	3.44 million JD
Networks	5.13 million JD
Total base costs	8.57 million JD
Physical contingencies an d engineering (about 20 %)	1.71 million JD
Total investment costs	10.28 million JD

There is almost no suitable land for irrigation close to the proposed treatment plant site. Therefore, it is recommended that the treated effluent from the plant will be discharged into the Wadi Al Wadana, which is a tributary of Wadi Zarqa. Finally, Wadi Zarqa mouths into King Talal Reservoir. From there water will flow to the Jordan Valley for ultimate reuse.

Consultant's Study Report:

TYPSA, Symonds Travers Morgan and Universal Engineering Consulting: "Wastewater collection, treatment, disposal and/or reuse systems project for the catchment area of Yarmouk River and Jordan River. Interim Report", July 1998

GWE: "Expansion and upgrading of the wastewater treatment plant at Jerash. Design Report", 1991

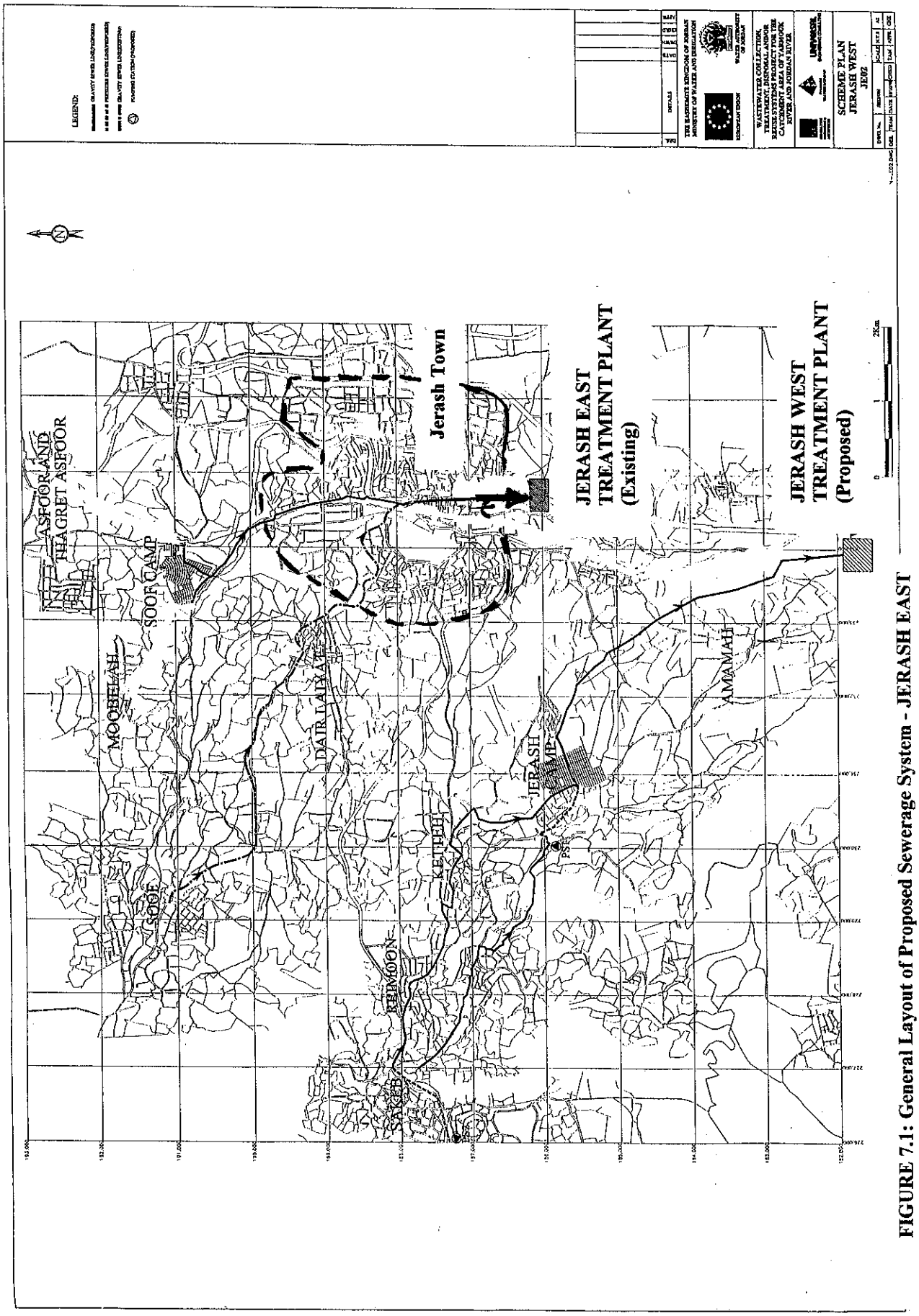

FIGURE 7.1: General Layout of Proposed Sewerage System - JERASH EAST

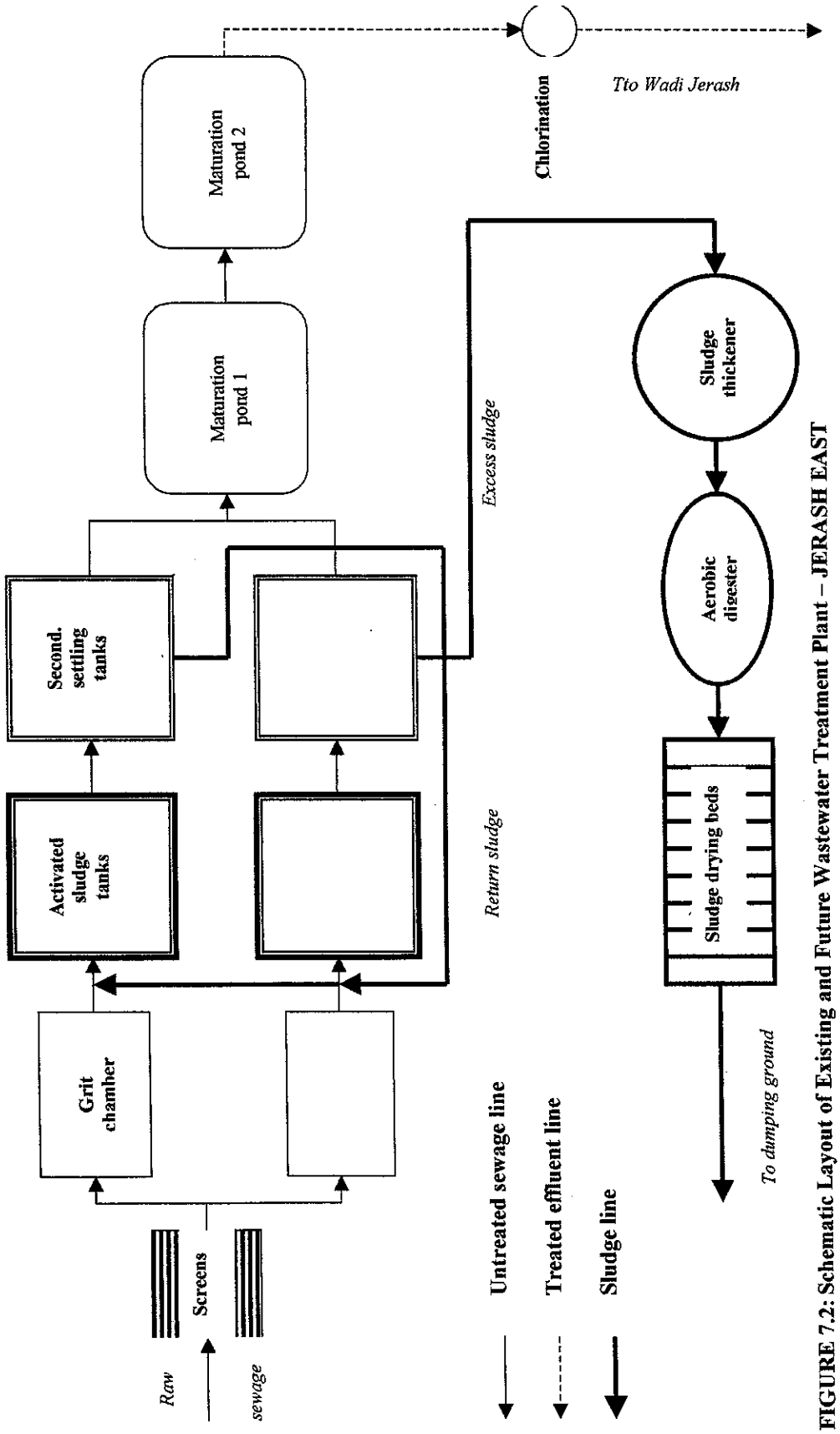

FIGURE 7.2: Schematic Layout of Existing and Future Wastewater Treatment Plant – JERASH EAST

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
7 JERASH EAST

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994: 42.787

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,02	3,02	3,02	3,02	3,02
Spec.water demand	l/c/d	120,00	130	143	143	143	143
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	30	30	50	60	70	80
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	42.787	51.149	59.354	68.874	79.922	92.741
Connected (sewerage)	c	12.836	15.345	29.677	41.325	55.945	74.193
Not connected (sewerage)	c	29.951	35.805	29.677	27.550	23.976	18.548
Water demand							
Domestic demand	l/c/d	120	130	143	143	143	143
	m³/d	5.134	6.649	8.488	9.849	11.429	13.262
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	5.134	6.649	8.488	9.849	11.429	13.262
Wastewater production							
Return flow (w.demand)	m³/d	1.232	1.596	3.395	4.728	6.400	8.488
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	1.232	1.596	3.395	4.728	6.400	8.488
	m³/month	36.968	47.876	101.851	141.826	192.004	254.630
	m³/a	449.777	582.490	1.239.190	1.725.547	2.336.045	3.097.996
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5/d$	834	997	1.929	2.686	3.636	4.823
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load	$kgBOD_5/d$	834	997	1.929	2.686	3.636	4.823
Reuse of wastewater							
Inflow to the treatment plant	m³/a	449.777	582.490	1.239.190	1.725.547	2.336.045	3.097.996
Losses in treatment plant	%	10	10	10	10	10	10
(due to infiltr./evap.)	m³/a	44.978	58.249	123.919	172.555	233.605	309.800
Effluent of treatment plant	m³/a	404.799	524.241	1.115.271	1.552.992	2.102.441	2.788.197
Net water demand per ha	m³/d/ha	-	-	-	-	-	-
Irrigable reuse area	ha	-	-	-	-	-	-

Water demand for irrigation

8. KARAK TREATMENT PLANT

Karak disposes already of a wastewater collection, treatment and disposal system (for details refer to Section 8 of Annex 3.1).

After completion of proposed measures of rehabilitation and extension of the existing Karak Scheme the following communities will be connected: Karak, Shehabiyyeh, Salhiyyeh and Azesieh. Figure 8.1 shows the layout of the sewerage system.

The project foresees the rehabilitation and extension of the existing Karak Treatment Plant designed for the wastewater production in 2020 (DAR Study). The existing treatment process based on two-staged trickling filters will be applied also in future. A maturation pond will be added as tertiary treatment. Produced sludge will be treated by Imhoff tanks, sludge lagoons and drying beds. Figure 8.2 shows the existing and proposed treatment system. The projection of the wastewater production is shown in the following table (acc. to DAR Study). Final capacity of the treatment plant will be reached

in 2020: 4,300 m³/d (36,000 connected inhabitants)

At present, the treated effluent is discharged into Wadi Karak via a pipeline of 5 km. An extension of further 3 km conducts the effluent to the agricultural reuse areas. This reuse shall be managed in a co-operation with the Ministry of Agriculture. Related project is called "Water sector intervention – Karak water supply and effluent reuse", which will be funded by the European Community. The farmers created a co-operation for distribution and reuse of the effluent. The water is mainly used for irrigation of trees.

The effluents may supply irrigation water (by gravity) for an area of about 60 ha in 2020 taking into account the demand for irrigation of eucalyptus and olive trees (see following table). Proposed wastewater reuse areas are presented in the Figure 8.3.

The investment costs (for future extension measures) based on rough cost estimation and 1999 prices (DAR Report) are:

Rehabilitation of existing treatment plant	0.30 million JD
Extension of existing treatment plant	1.70 million JD
Extension of collection network	1.70 million JD
Total base costs	3.70 million JD
Physical contingencies and engineering	0.80 million JD
Total investment costs	4.50 million JD

A Feasibility Study on the "Rehabilitation and Extension of Wastewater Treatment Plants in Karak and Kufranja" will be prepared in 2001. In June 2000 offers for consultancy services were presented to WAJ. The study will be financed by the Kreditanstalt fuer Wiederaufbau, KfW (German Bank for Reconstruction and Development). The proposed project includes the rehabilitation and extension of the existing treatment plant of Karak as well as the extension of the existing sewerage network.

Consultant's Study Report:

DAR: "Report on the rehabilitation and extension of the wastewater treatment plants Karak, Kufranja, Ma'an, Mafraq", July 1999

J.M.Montgomery: "Municipal water distribution improvements and sewerage and stormwater drainage systems in Karak. Feasibility Study Report", March 1983

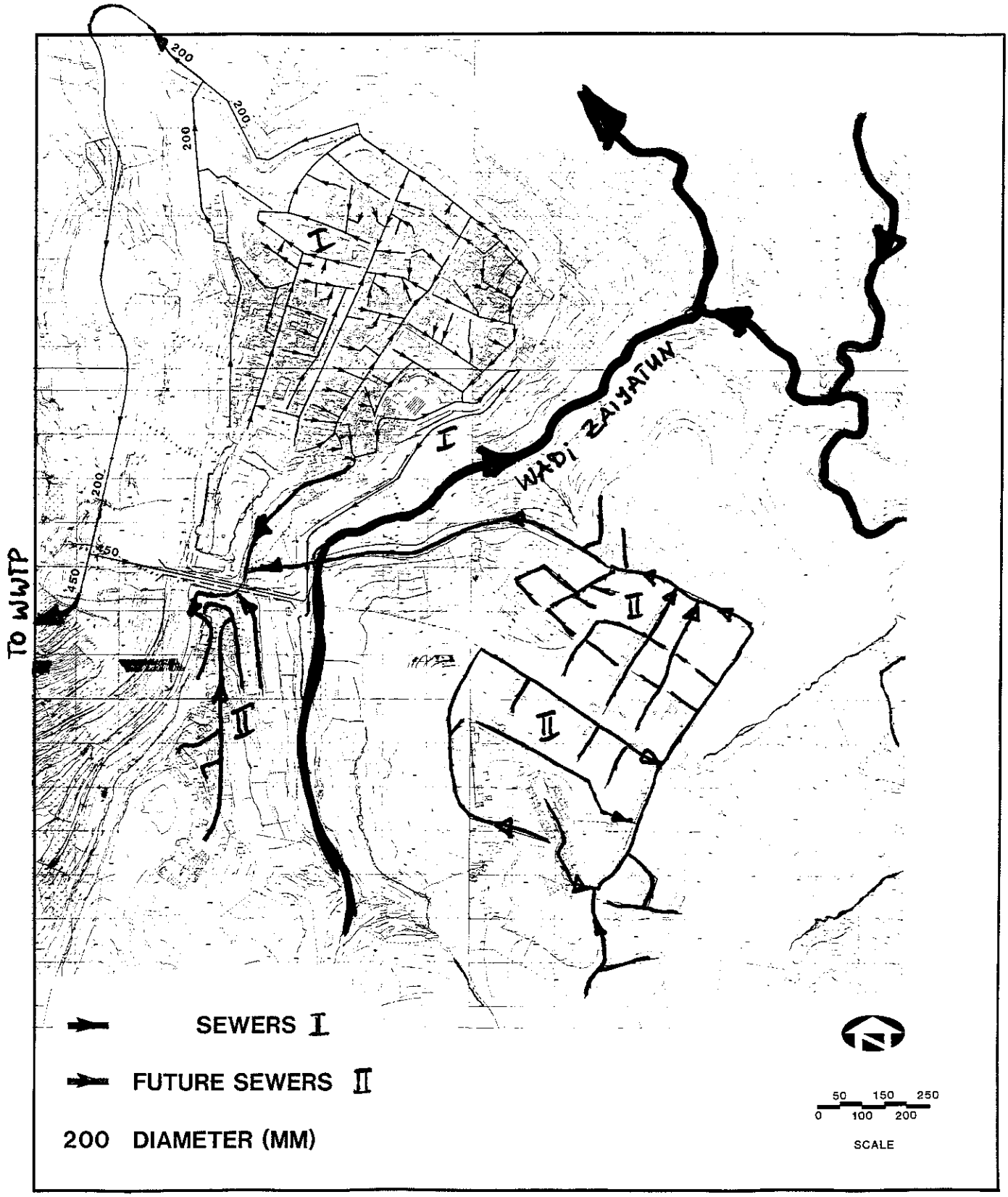

FIGURE 8.1: General Layout of Proposed Sewerage System - KARAK

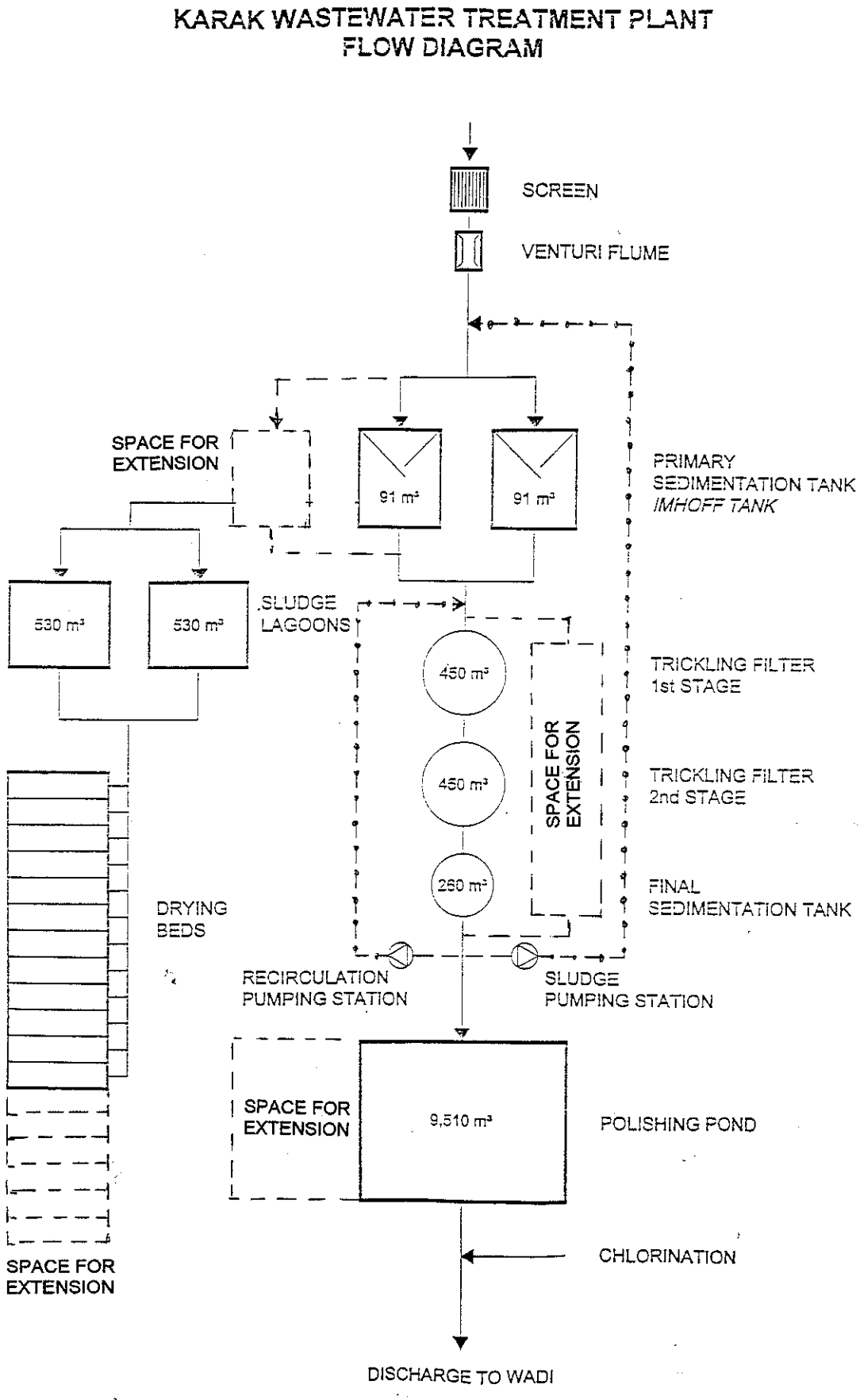

FIGURE 8.2: Layout of Proposed Wastewater Treatment Plant - KARAK

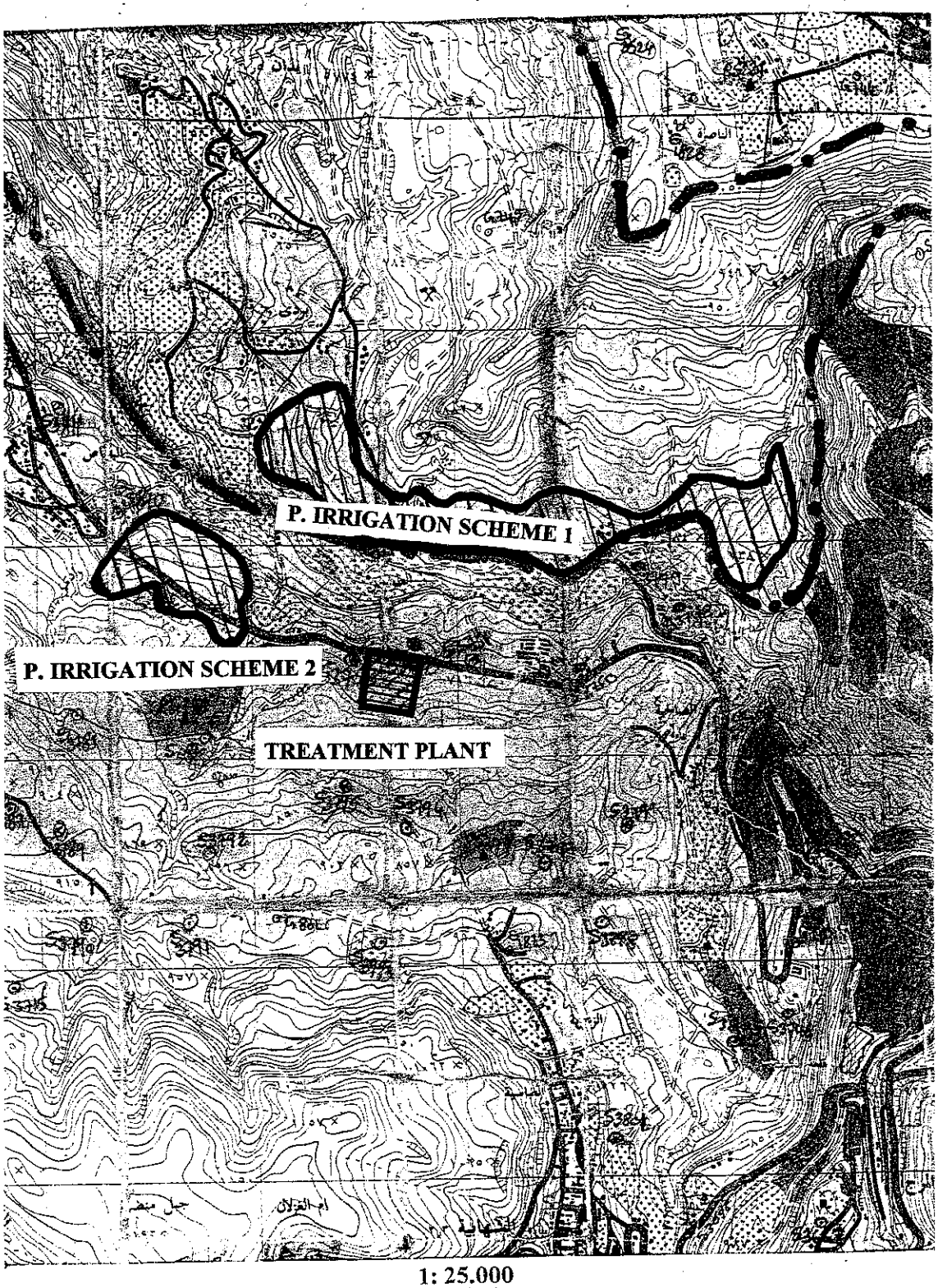

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FIGURE 8.3: Potential Reuse Areas - KARAK

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
8 KARAK

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994: 18.633 (Karak only) 2005: 31.559 (including Shehabiyye, Salhiyyeh, Azesieh)

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,30	3,30	3,30	3,30	3,30
Spec.water demand	l/c/d	110	110	130	150	150	150
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	58	58	65	65	70	70
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5$/c/d	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	18.633	22.640	31.559	37.121	43.664	51.360
Connected (sewerage)	c	10.807	13.131	20.513	24.129	30.565	35.952
Not connected (sewerage)	c	7.826	9.509	11.046	12.992	13.099	15.408
Water demand							
Domestic demand	l/c/d	110	110	130	150	150	150
	m³/d	2.050	2.490	4.103	5.568	6.550	7.704
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	2.050	2.490	4.103	5.568	6.550	7.704
Wastewater production							
Return flow (w.demand)	m³/d	951	1.156	2.133	2.895	3.668	4.314
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	951	1.156	2.133	2.895	3.668	4.314
	m³/month	28.531	34.667	64.002	86.864	110.034	129.428
	m³/a	347.125	421.782	778.685	1.056.845	1.338.744	1.574.705
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5$/d	702	854	1.333	1.568	1.987	2.337
Poll. load (com.demand)	$kgBOD_5$/d						
Poll. load (small ind.)	$kgBOD_5$/d						
Others	$kgBOD_5$/d						
Total load	$kgBOD_5$/d	702	854	1.333	1.568	1.987	2.337
Reuse of wastewater							
Inflow to the treatment plant	m³/a	347.125	421.782	778.685	1.056.845	1.338.744	1.574.705
Losses in treatment plant	%	10	10	10	10	10	10
(due to infiltr./evap.)	m³/a	34.713	42.178	77.869	105.685	133.874	157.471
Effluent of treatment plant	m³/a	312.413	379.604	700.817	951.161	1.204.870	1.417.235
Net water demand per ha	m³/d/ha		62	62	62	62	62
Irrigable reuse area	ha	0	17	31	42	53	63

Water demand for irrigation Eucalyptus trees/olives 62 m³/d/ha (during peak period)

9. KUFRANJA TREATMENT PLANT

Kufranja disposes already of a wastewater collection, treatment and disposal system. (for details refer to Section 9 of Annex 3.1).

After completion of proposed measures of rehabilitation and extension of the existing Kufranja Scheme the following communities will be connected: Kufranja, Anjara, Ain Janna and Ajlun. Figure 9.1 shows the layout of the proposed sewerage system (TYPSA Study).

The project foresees the rehabilitation and extension of the existing Kufranja Treatment Plant designed for the wastewater production in 2020 (DAR Study). The existing treatment process based on two-staged trickling filters will be applied also in future. Slow sand filtration will be added as tertiary treatment. Produced sludge will be treated by Imhoff tanks and drying beds. Figure 9.2 shows the proposed treatment system after extension. The projection of the wastewater production is shown in the following table (acc. to DAR Study). Final capacity of the treatment plant will be reached

in 2020: 9,900 m³/d (88,500 connected inhabitants)

The effluents may supply irrigation water for an area of about 300 ha in 2020 taking into account the demand for barley and eucalyptus/olive trees (see following table). Treated wastewater will be discharged by gravity to the potential reuse areas in the valley of Wadi Kufranja. Proposed wastewater reuse areas are presented in the Figure 9.3.

The investment costs (for future extension measures) based on rough cost estimation and 1999 prices (DAR Report) are:

Rehabilitation of existing treatment plant	0.70 million JD
Extension of existing treatment plant	4,20 million JD
Extension of collection network	8.20 million JD
Total base costs	13.10 million JD
Physical contingencies and engineering	2.60 million JD
Total investment costs	15.70 million JD

According to the TYPSA Study Report implementation of proposed construction measures were foreseen until end of 2001. However, this implementation schedule is not anymore valid. It is more realistic that the measures will be implemented between 2002 and 2004.

A Feasibility Study on the "Rehabilitation and Extension of Wastewater Treatment Plants in Karak and Kufranja" will be prepared in 2001. In June 2000 offers for consultancy services were presented to WAJ. The study will be financed by the Kreditanstalt fuer Wiederaufbau, KfW (German Bank for Reconstruction and Development). The proposed project includes the rehabilitation and extension of the existing treatment plant of Kufranja as well as the extension of the existing sewerage network.

Consultant's Study Report:

TYPSA, Symonds Travers Morgan and Universal Engineering Consulting: "Wastewater collection, treatment, disposal and/or reuse systems project for the catchment area of Yarmouk River and Jordan River. Final Report", December 1998

DAR: "Report on the rehabilitation and extension of the wastewater treatment plants Karak, Kufranja, Ma'an, Mafraq", July 1999

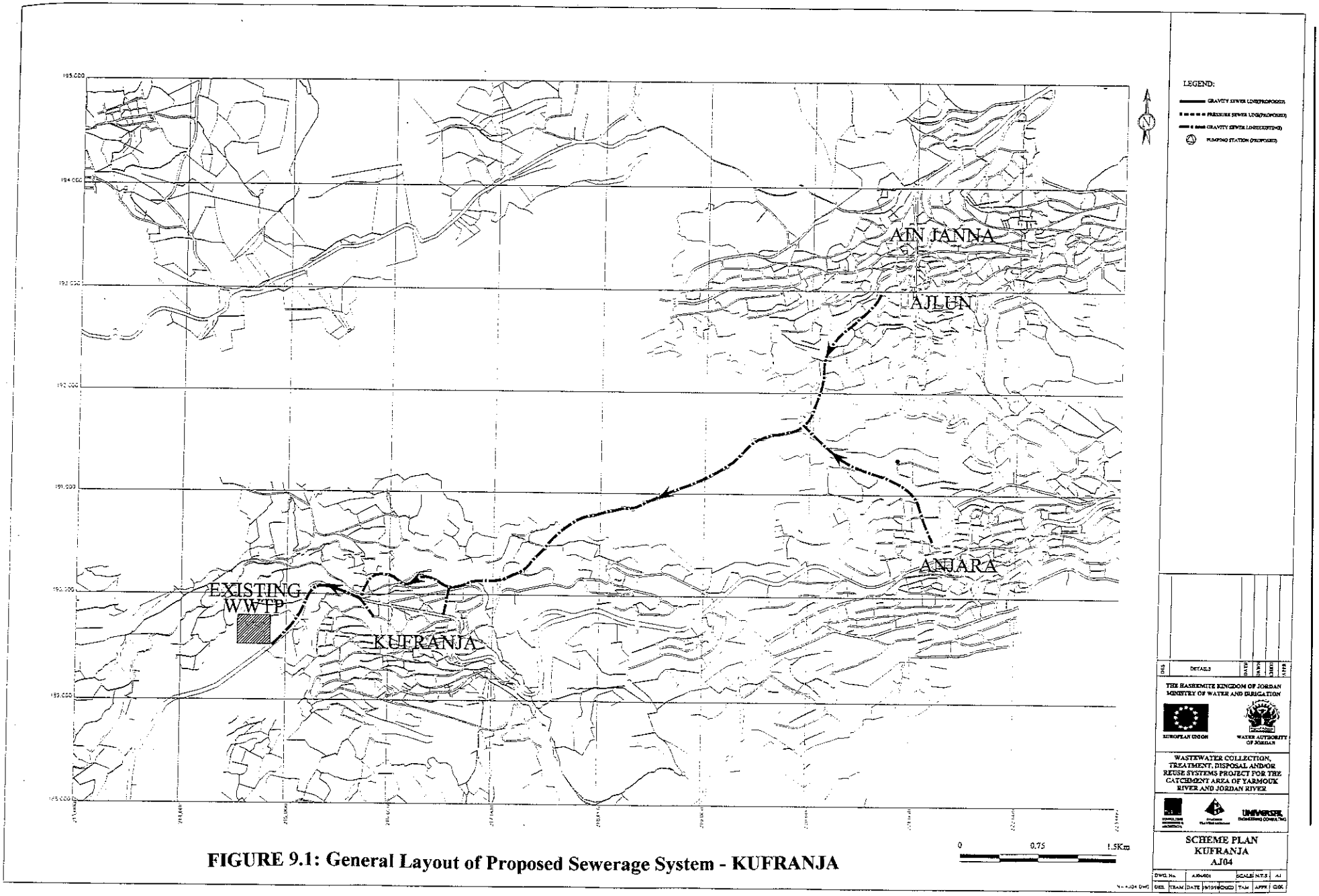

FIGURE 9.1: General Layout of Proposed Sewerage System - KUFRANJA

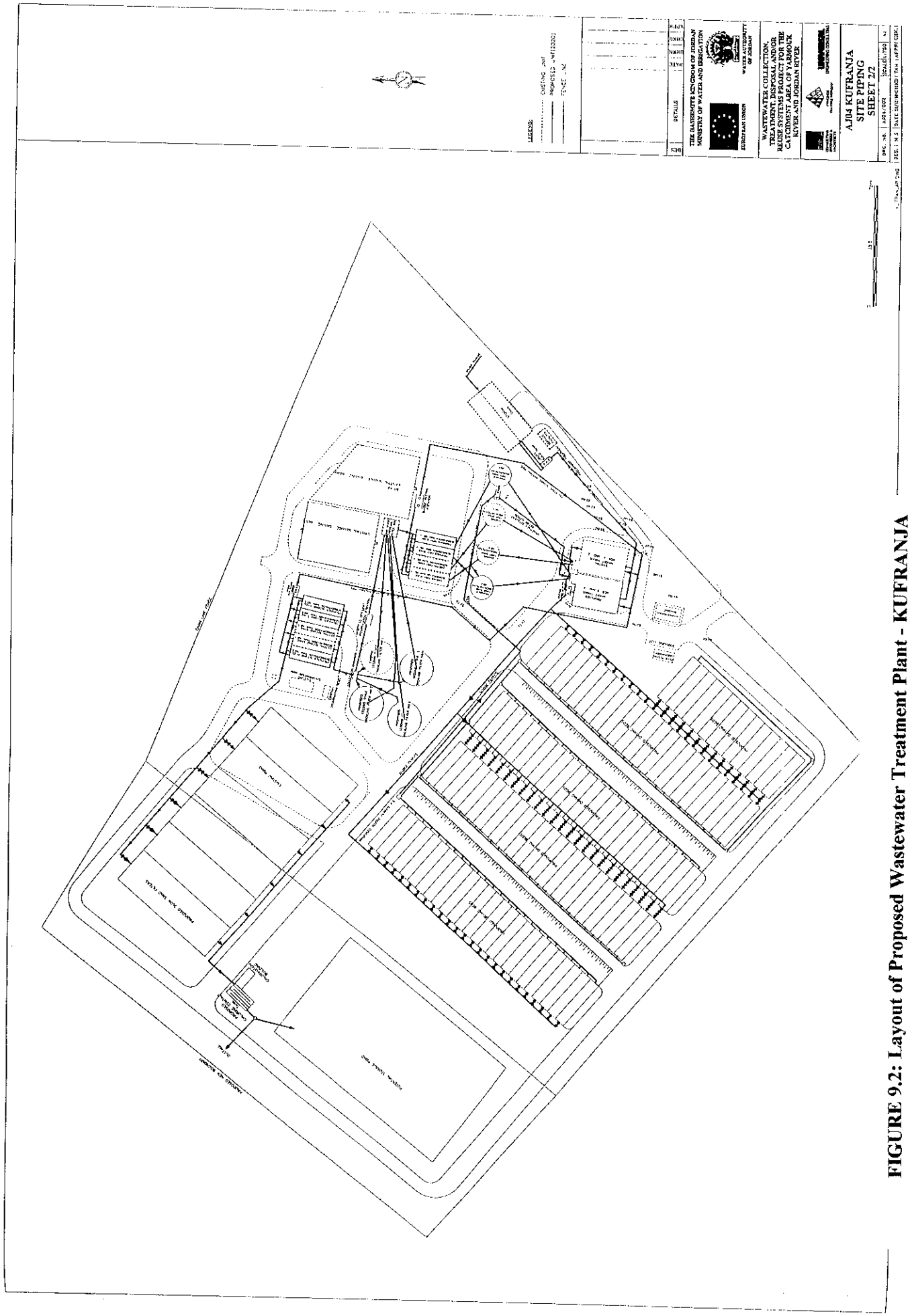

FIGURE 9.2: Layout of Proposed Wastewater Treatment Plant - KUFRANJA

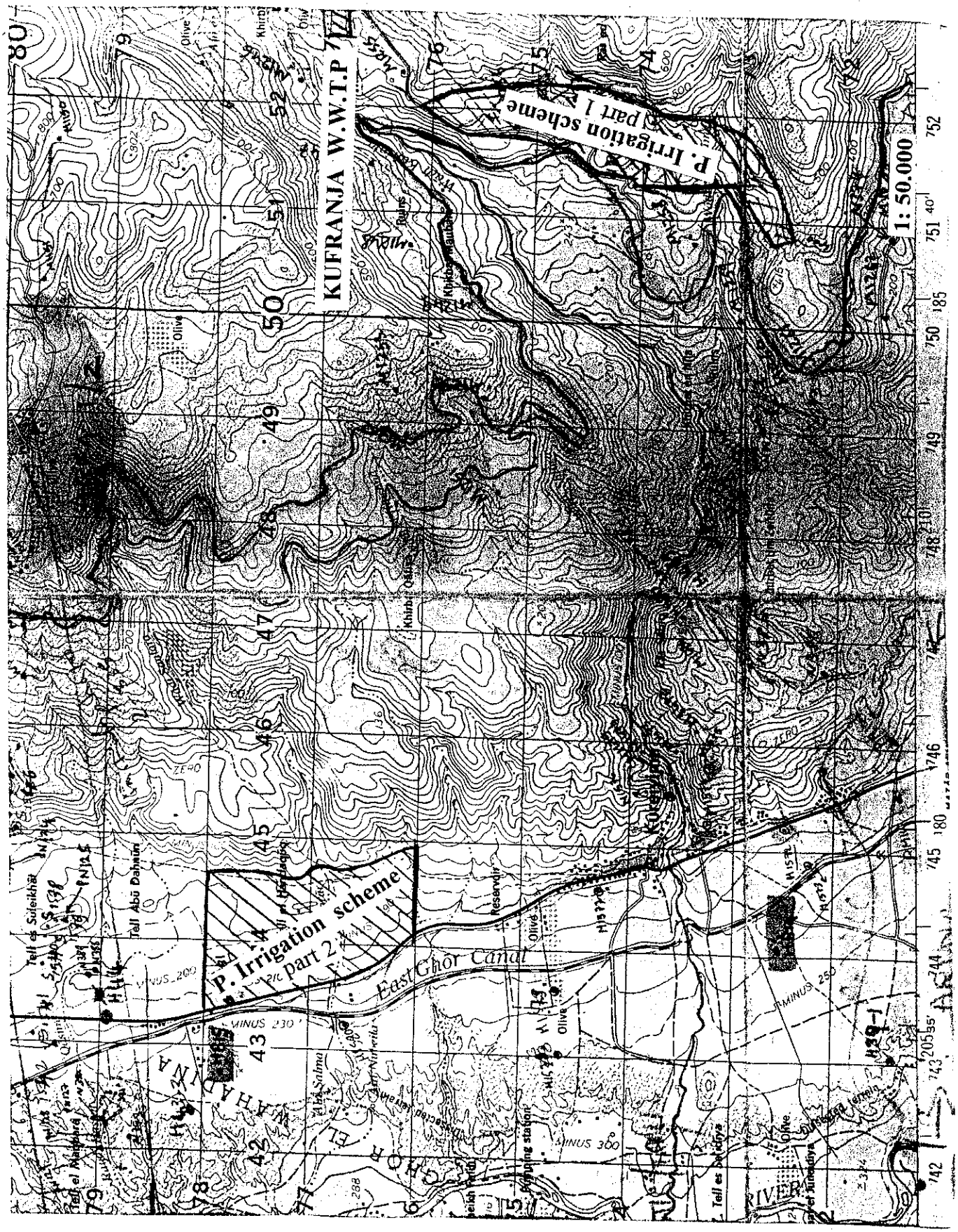

FIGURE 9.3: Potential Reuse Areas - KUFRANJA

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:
9 KUFRANJA

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report, DAR)

Basic data:

Population in 1994: 44.800

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,30	3,30	3,30	3,30	3,30
Spec.water demand	l/c/d	50	80	100	120	130	140
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	40	65	70	80	85	85
Return factor	-	0,8	0,8	0,8	0,8	0,8	0,8
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5/c/d$	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	44.800	54.435	64.030	75.315	88.590	104.204
Connected (sewerage)	c	17.920	35.383	44.821	60.252	75.302	88.574
Not connected (sewerage)	c	26.880	19.052	19.209	15.063	13.289	15.631
Water demand							
Domestic demand	l/c/d	50	80	100	120	130	140
	m³/d	2.240	4.355	6.403	9.038	11.517	14.589
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	2.240	4.355	6.403	9.038	11.517	14.589
Wastewater production							
Return flow (w.demand)	m³/d	717	2.265	3.586	5.784	7.831	9.920
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	717	2.265	3.586	5.784	7.831	9.920
	m³/month	21.504	67.935	107.570	173.526	234.941	297.608
	m³/a	261.632	826.544	1.308.767	2.111.238	2.858.445	3.620.897
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5/d$	1.165	2.300	2.913	3.916	4.895	5.757
Poll. load (com.demand)	$kgBOD_5/d$						
Poll. load (small ind.)	$kgBOD_5/d$						
Others	$kgBOD_5/d$						
Total load	$kgBOD_5/d$	1.165	2.300	2.913	3.916	4.895	5.757
Reuse of wastewater							
Inflow to the treatment plant	m³/a	261.632	826.544	1.308.767	2.111.238	2.858.445	3.620.897
Losses in treatment plant	%	0	5	5	5	5	5
(due to infiltr./evap.)	m³/a	0	41.327	65.438	105.562	142.922	181.045
Effluent of treatment plant	m³/a	261.632	785.217	1.243.329	2.005.676	2.715.523	3.439.852
Net water demand per ha	m³/d/ha		30	30	30	30	30
Irrigable reuse area	ha	0	72	114	183	248	314

Water demand for irrigation Barley, eucalyptus, olives 30 m³/d/ha

10. MA'AN TREATMENT PLANT

Ma'an Treatment Plant receives its wastewater from the sewerage system of the town of Ma'an only (for details of the existing system refer to Section 10 of Annex 3.1). The sewer network needs expansion according to the development of the town. The sewered area is shown in Figure 10.1.

Ma'an's existing Wastewater Treatment Plant is overloaded by about 10 %. According to the Consultant's Study Report it is proposed to rehabilitate and extend the existing treatment system. The treatment facilities will consist of (as presently) anaerobic ponds, facultative ponds and maturation pond (see Figure 10.2).

Land within the treatment plant area is sufficient to extend the plant by 3 more facultative ponds and a maturation pond.

The projection of the wastewater production is shown in the following table. Final capacity of the treatment plant will be reached

in 2020: 5,100 m³/d (48,000 connected inhabitants)

The effluents could supply irrigation water for an area of about 95 ha in 2020 taking into account the demand for alfalfa and barley irrigation (see following table). A pumping station and a transmission line to the potential reuse areas will discharge treated wastewater. Presently, the farmers operate this infrastructure for irrigation (including the distribution system). Reuse areas will be extended in future due to increasing effluent. Proposed wastewater reuse areas are presented in the Figure 10.3.

The investment costs (for future extension and rehabilitation measures) based on rough cost estimations and 1999 prices (DAR Study) are:

Rehabilitation of existing treatment plant	0.50 million JD
Extension of existing treatment plant	1.30 million JD
Extension of collection network	3.00 million JD
Total base costs	4.80 million JD
Physical contingencies and engineering	1.30 million JD
Total investment costs	6.10 million JD

No implementation schedule for proposed construction measures are foreseen. Even no Feasibility Study and/or Final Design is done or planned presently.

Consultant's Study Report:

DAR: "Report on the rehabilitation and extension of the wastewater treatment plants Karak, Kufranja, Ma'an, Mafraq", July 1999

J.M.Montgomery: "Municipal water distribution improvements and sewerage and stormwater drainage systems in Ma'an. Feasibility Study Report", March 1983

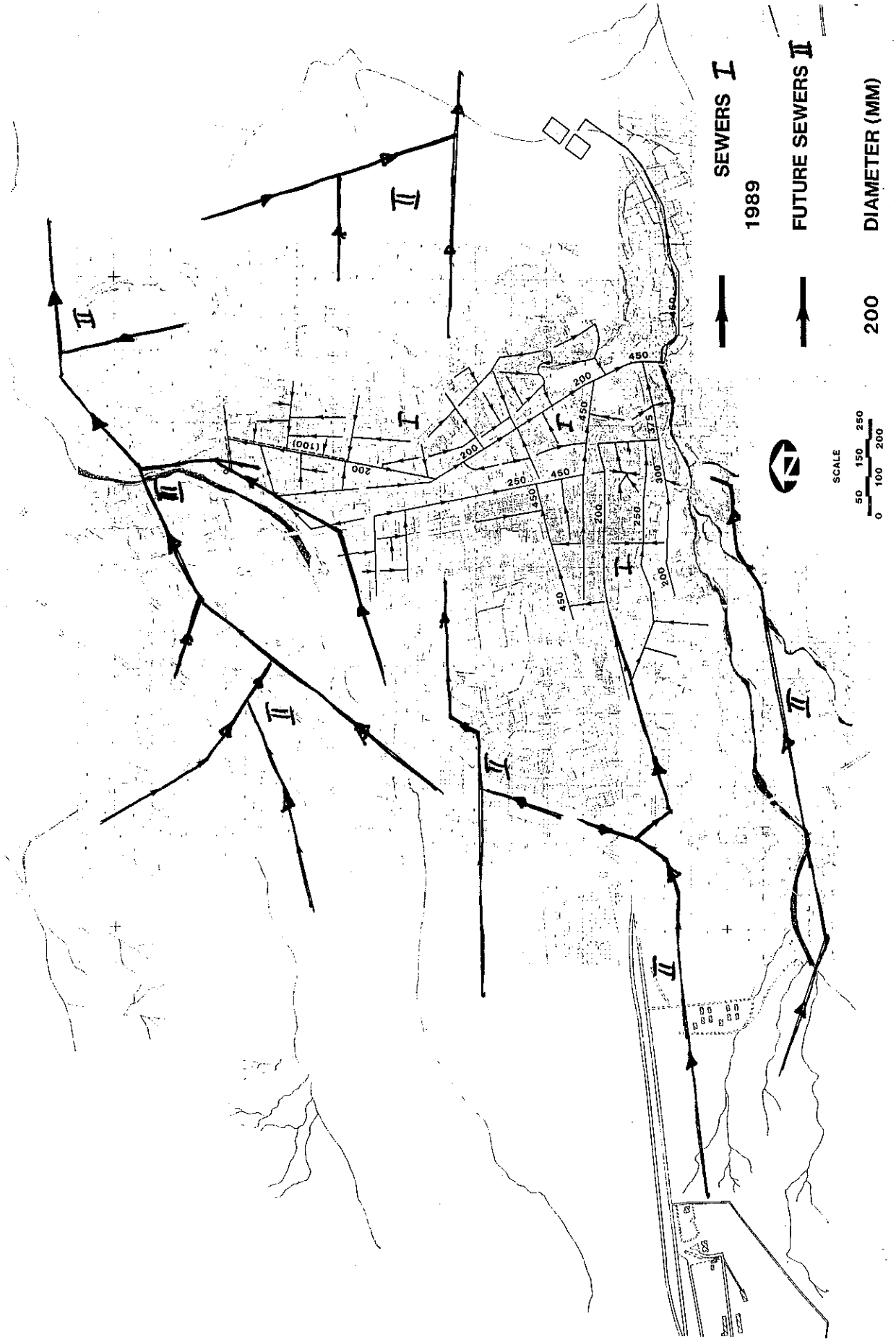

FIGURE 10.1: General Layout of Proposed Sewerage System - MA'AN

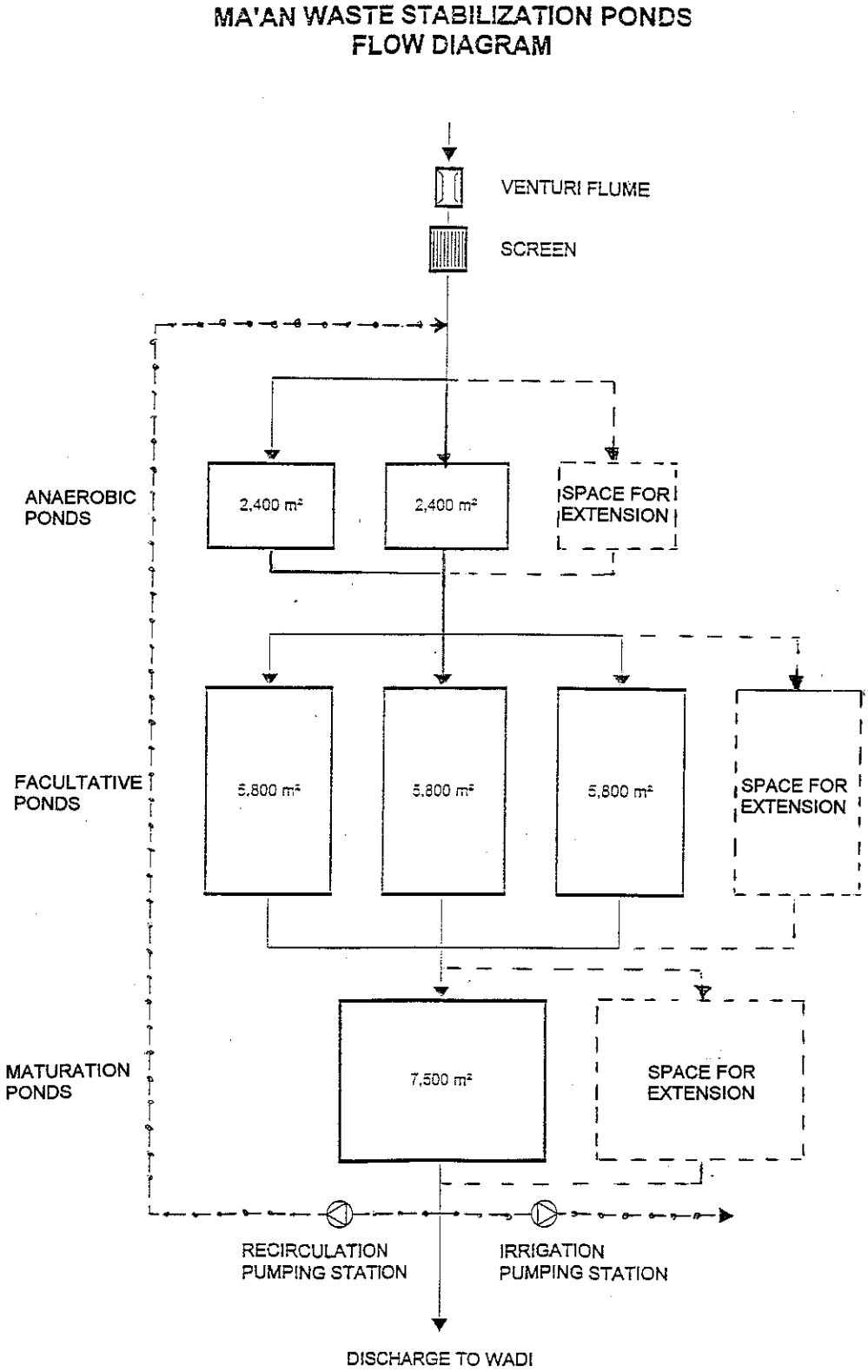

FIGURE 10.2: Layout of Wastewater Existing and Future Treatment Plant - MA'AN

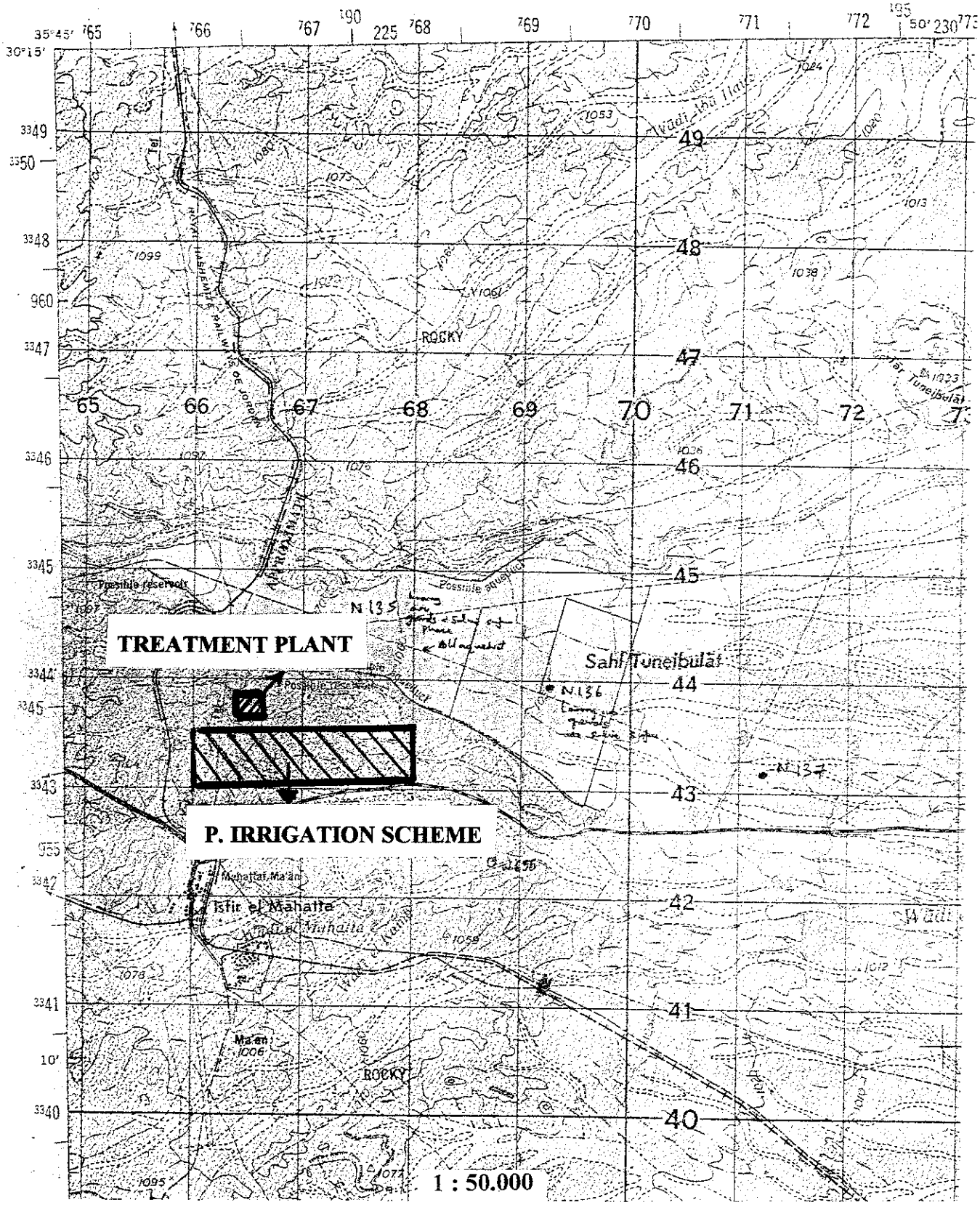

FIGURE 10.3: Potential Reuse Areas - MA'AN

PROJECTION OF WASTEWATER PRODUCTION OF TREATMENT PLANT:

10 MA'AN

SCENARIO 0 "Consultants' Study" (acc. to Consultant's Study Report)

Basic data:

Population in 1994 22.989

	Unit	1994	2000	2005	2010	2015	2020
Growth rate (previous period)	%	-	3,3	3,3	3,3	3,3	3,3
Spec.water demand	l/c/d	110	120	120	120	125	125
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Coverage	%	60	60	60	70	80	90
Return factor	-	0,85	0,85	0,85	0,85	0,85	0,85
Losses/inflow	%	0	0	0	0	0	0
Specific pollutional load	$gBOD_5$/c/d	65	65	65	65	65	65

	Unit	1994	2000	2005	2010	2015	2020
Population	c	22.989	27.933	32.857	38.648	45.460	53.472
Connected (sewerage)	c	13.793	16.760	19.714	27.053	36.368	48.125
Not connected (sewerage)	c	9.196	11.173	13.143	11.594	9.092	5.347
Water demand							
Domestic demand	l/c/d	110	120	120	120	125	125
	m³/d	2.529	3.352	3.943	4.638	5.682	6.684
Commercial demand	m³/d						
Small industrial demand	m³/d						
Pastoral demand	m³/d						
Total	m³/d	2.529	3.352	3.943	4.638	5.682	6.684
Wastewater production							
Return flow (w.demand)	m³/d	1.290	1.710	2.011	2.759	3.864	5.113
Losses/inflow	m³/d	0	0	0	0	0	0
Total	m³/d	1.290	1.710	2.011	2.759	3.864	5.113
	m³/month	38.690	51.286	60.325	82.784	115.922	153.399
	m³/a	470.734	623.974	733.952	1.007.201	1.410.388	1.866.349
Pollutional load							
Poll. load (dom.demand)	$kgBOD_5$/d	897	1.089	1.281	1.758	2.364	3.128
Poll. load (com.demand)	$kgBOD_5$/d						
Poll. load (small ind.)	$kgBOD_5$/d						
Others	$kgBOD_5$/d						
Total load	$kgBOD_5$/d	897	1.089	1.281	1.758	2.364	3.128
Reuse of wastwater							
Inflow to the treatment plant	m³/a	470.734	623.974	733.952	1.007.201	1.410.388	1.866.349
Losses in treatment plant	%	25	25	25	25	25	25
(due to infiltr./evap.)	m³/a	117.684	155.993	183.488	251.800	352.597	466.587
Effluent of treatment plant	m³/a	353.051	467.980	550.464	755.401	1.057.791	1.399.761
Net water demand per ha	m³/d/ha		40	40	40	40	40
Irrigable reuse area	ha	0	32	38	52	72	96

Water demand for irrigation Alfalfa, barley 40 m³/d/ha