Annex to 3.1.1
Description of Existing Wastewater Treatment Plants

Contents

12. MAFRAQ TREATMENT PLANT

The Mafraq Treatment Plant receives the wastewater of the city of Mafraq.

Influent to the plant is screened. The wastewater stabilization pond system of Mafraq consists of two parallel trains of an anaerobic pond, 3 facultative ponds and 2 maturation ponds (see Figure 12). Disinfection of the effluent is possible by a chlorination plant, but was not in operation in March 2000. Drying beds are not available. The ponds are used to a certain extend as holding tanks but not as a treatment system: Water volume in the ponds is used according to requirements of irrigation. For example water level in the anaerobic ponds was more than one meter under design level. This mode of operation does not allow stable biological conditions in the various ponds of the plant. This is certainly one of the reasons, why the treatment efficiency is not satisfactory.

In 1997, the anaerobic ponds were desludged for the first and the only time, since the treatment facilities were put in operation in 1988. Sludge was emptied of the ponds and filled in excavated trenches within the treatment plant area for drying and infiltration.

The 1988 completed plant is meanwhile overloaded by almost 10 % hydraulically. The average BOD_5-strength of about 570 mg/l (influent) is relatively low (in comparison to other plants in Jordan).

The average BOD_5-concentration in the effluent of the plant is unsatisfactory (200 mg/l) and exceeds by far the relevant Jordanian Standards 893/1995 for discharge into wadis and catchment areas.

The natural receiving water of the effluent is the Wadi Ghadeer, which is again a tributary of Wadi Senhan. The main well field of groundwater extraction for drinking water purposes is located in a distance from the treatment plant of some 6 km. To avoid any danger for this well field by pollution from the Wadi Ghadeer, it was decided to use the totality of the plant's effluent for agricultural irrigation.

During summertime the poorly treated wastewater is totally used for agricultural irrigation within the treatment plant area (about 150 donums) in particular for fodder (in particular, barley and corn/maize in winter and alfa-alfa in summer). Even in wintertime the effluent is used for irrigation purposes. However, the quality of the effluent does not meet the biological requirements for the unrestricted reuse of treated wastewater for agricultural irrigation. The fecal coliform counts reach values more than 15,000 per 100 ml minimum. Due to the poorly treated wastewater having still high contents of organic compounds it is not advisable to use the existing chlorination plant for reduction of the bacterial pollution (fecal coliform count).

The farmers have to pay to WAJ 1 JD per year and donum for the lease of agricultural land (in total 150 donum) and the supply of treated wastewater for irrigation within the treatment plant's area.

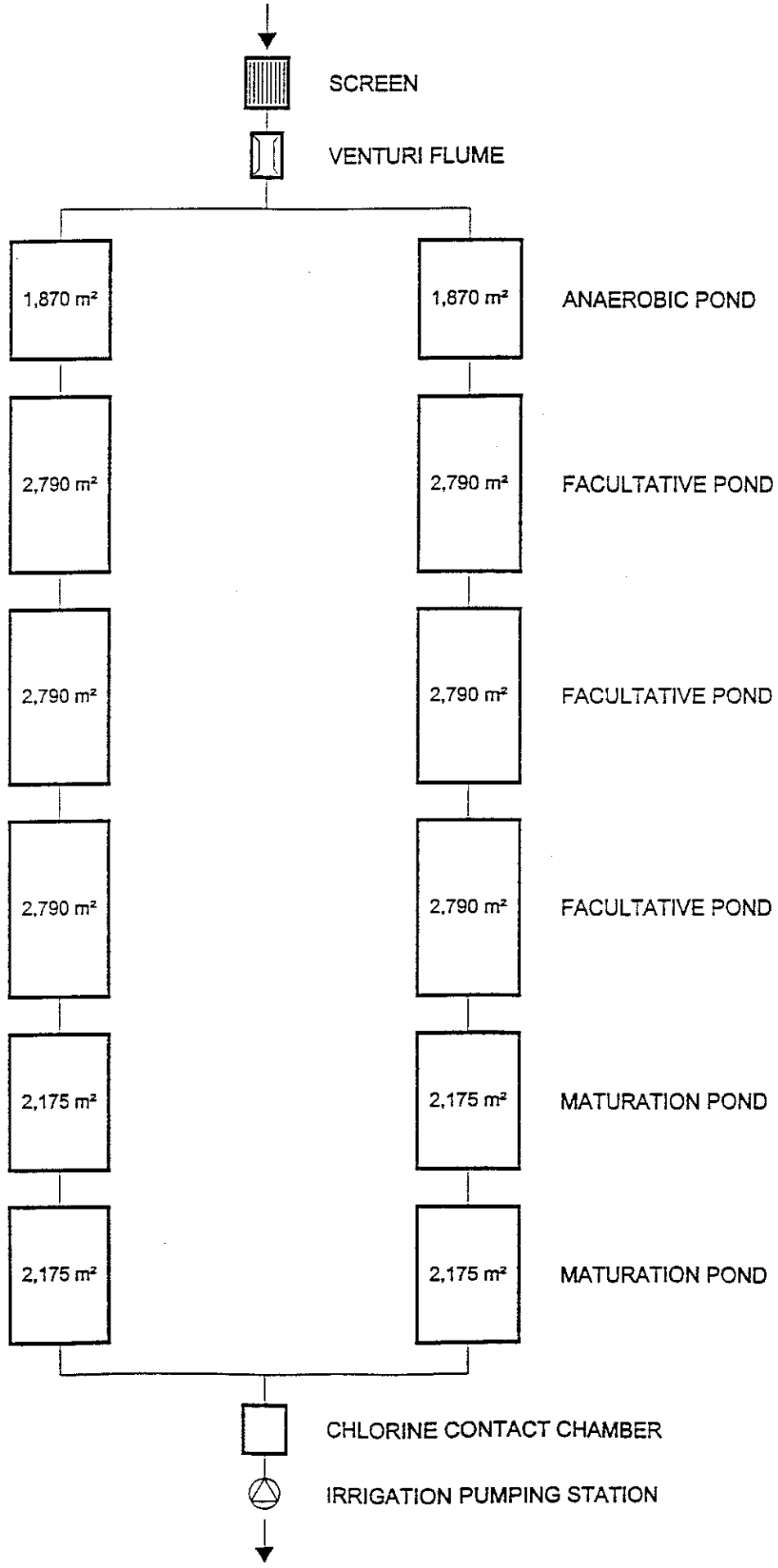

FIGURE 12: Schematic Layout of Wastewater Existing Treatment Plant - MAFRAQ

BASIC DATA OF TREATMENT PLANT:

Mafraq
12

(Data of 1999, if not another year indicated)

Town:	Mafraq
Governorate:	Mafraq
Treatment plant:	Mafraq
Date of visit:	29.3.2000
Responsible engineer:	Ahmed Sartawi
Contacted person:	Ahmed Sartawi
Telephone:	02/6231830 (at WAJ Office, Mafraq)

Population			
	Tot.population living in towns with sewerage:	inhabitants	38.400
	Population growth	%	3,6
Wastewater disposal			
	Public system	%	44
	Cesspools	%	56
	Others	%	0
Wastewater collection			
	Towns/villages connected (the most important)	-	Town of Mafraq only
	Population connected (as coverage treatment)	c	16.800
	Coverage	%	44
	Important industries	-	no important water polluting industries connected
	Number of stormwater overflows works	no.	none
	Length of sewers	km	89,8
	Length per connected capita	m/c	5,3
	House connections	h.c.	2.794
	Capita per house connection	c/h.c.	6,0
	Return factor (acc. to Design Report)	-	0,85
	Monthly peak factor	-	1,25
	Employees for wastewater collection	E	8
	Factor: Sewer length per connected capita/coverage		12,2

BASIC DATA OF TREATMENT PLANT:

Mafraq 12

Wastewater treatment

Wastewater treatment technology		WSP
Wastewater treatment technology		Wastewater stabilisation ponds
In operation since		1988
Composed of treatment facilities		
Facility		Screen
Number of units	-	2 (1manual+1 automatic)
Total dimension		-
Facility		Anaerobic ponds
Number of units	-	2
Total dimension		2 x 2,800 m3
Facility		Facultative ponds
Number of units	-	6
Total dimension		6 x 3,700 m3
Facility		Maturation ponds
Number of units	-	4
Total dimension		4 x 2,600 m3
Facility		Chlorination unit
Number of units	-	1 (not in operation)
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Remarks:		-
		-

Installed capacity	m^3/d	1.800
Population served (assuming 65 g/c/d)	c	16.800
Coverage (assuming 65 g/c/d)	%	44
Inflow treatment plant (average)	m^3/d	1.933
	MCM/a	0,706
Estimated losses by seepage/evaporation	%	25
Estimated effluent of the treatment plant	m^3/d	1.450
	MCM/a	0,529
BOD_5-load influent (according to WAJ data)	mg/l	566
	kg/d	1.094
	t/a	399
BOD_5-load effluent (according to WAJ data)	mg/l	197
	kg/d	286
	t/a	104
		-
Fecal coliforms at effluent (acc.to WAJ data)	1/100 ml	>15,000
Helminth eggs	eggs/l	0
Spec.wastewater generation	l/c/d	115
Spec.BOD_5-load	g/c/d	65
Total dissolved solids (TDS) at effluent	mg/l	1.284
Sludge management		Desludging of anaerobic ponds once in in 12 years (1997) Sludge dried in ditches and covered by earth within the treatment plant area.

BASIC DATA OF TREATMENT PLANT:

Mafraq
12

Cost of wastewater treatment		
Operation and maintenance cost	JD/a	68.396
Operation/maintenance cost related to influent	JD/m^3	0,097
Performance of wastewater collection		
Employees for wastewater collection	E	8
Number of employees per 1,000 house conn.	E/1000 h.c.	2,9
Recommended number of employees	E/1000 h.c.	2 - 4
Number of employees per km sewer	E/10km	0,9
Average number of complaints per month	1/month	?
Average number of complaints per km sewer	1/month/km	#WERT!
Performance of wastewater treatment		
Treatment efficiency (BOD_5 acc.to WAJ data)	%	65
Expected efficiency (acc.to experience)	%	80 - 90
Used treatment capacity (hydraulic)	%	107
Odor problems	-	extremly (particularly in summer)
Specific treatment problems		low treatment efficiency
Power-cuts		no problem
Operation/maintenance arrangement available		?
Employees for wastewater treatment	E	12
Recommended number of employees (WWTP)	E	5
Environmental impacts of effluent		
Discharge of effluent into		hydrographically Wadi Ghadeer to Wadi Senhan
Requirements acc. to JS 893/1995		not respected
(according to WAJ data)		(practically all effluent is stored/infitrated in winter and reused for irrigation in summer)
Reuse of effluent for agricultural irrigation		
Possible reuse (acc. to JS 893/1995)		restricted irrigation only
Practice of restricted irrigation		during whole year: entire effluent is reused
Practice of unrestricted irrigation		for restricted irrigation close and at the plant site
Irrigation near treatment plant	donums	295

Evaporation/infiltration losses of treatment plants:

Wastewater stabilization ponds	WSP
Activated sludge process/Trickling filters	AS/TF
Act.sludge proc./Trickl.filters incl.maturation pond	AS/TF+MP
Aerated ponds incl. maturation ponds	Aer.ponds

13. RAMTHA TREATMENT PLANT

The Ramtha Treatment Plant receives the wastewater of the city of Ramtha only. The main sewer lines in Ramtha are laid in the right and left slope of the Wadi Shomar, which crosses the urban area. During rain this leads very often to important penetration of stormwater into the sewerage system (planed as separate system) due to damaged manholes, opened manhole covers etc.. Stormwater overflow structures are available neither in the collection network nor at the treatment plant. These circumstances lead during rainy season to discharges to the treatment plant up to 4,000 m^3/d (design flow 1,920 m^3/d).

The wastewater stabilization pond system of the treatment plant of Ramtha comprises the following facilities: screens, two trains of anaerobic ponds, facultative ponds and maturation ponds (see Figure 13). Disinfection of the effluent is possible by a chlorination plant, but was not in operation in March 2000. Drying beds are not available. The anaerobic ponds are connected in series, while the facultative ponds and the maturation ponds are operated as two parallel trains. The two trains of the plant are operated alternatively changing every second week the discharge to one or to the other train. This mode of operation does not allow stable biological conditions in the various ponds of the plant. The ponds are used to a certain extend as holding tanks but not as a treatment system. This is certainly one of the reasons, why the treatment efficiency is not satisfactory.

Since the pond system was put in operation in 1988 the anaerobic ponds were desludged only once in 1997. The 6,000 to 7,000 m^3 sludge emptied of the ponds were partly transported by tankers to the dumping ground Al Akeder and partly filled in excavated trenches within the treatment plant area for drying and infiltration. It is reported that in the first anaerobic pond the sludge was 0.5 m below water level.

The 1988 completed plant is meanwhile overloaded by 10 to 20 % hydraulically. The BOD_5-strength was underestimated at design stage having presently an average value of about 1,200 mg/l. The percentage of biological overload is even higher than the hydraulic one. Even the "facultative ponds" work under anaerobic conditions.

The BOD_5-concentration in the effluent of the plant reaches values of more than 240 mg/l and exceeds by far the relevant Jordanian Standards 893/1995 for discharge into wadis and catchment areas. The natural receiving water of the effluent is the Wadi Shomar, which is again a tributary of Yarmouk River. Raw water of Yarmuk deviated to the King Abdullah Canal and is partly used for drinking water purposes. Therefore, it was decided to avoid the discharge of the effluent into the Wadi Shomar. During summertime the poorly treated wastewater is totally used for agricultural irrigation within the treatment plant area (about 70 donums) and outside (about 380 donums) in particular of fodder. Even in wintertime the effluent is used for irrigation purposes. WAJ pays some 440 JD per year to the farmers that they take over the entire effluent quantity of the plant for irrigation during the whole year. However, the quality of the effluent does not meet the biological requirements for the unrestricted reuse of treated wastewater for agricultural irrigation. The fecal coliform counts reach values more than 10,000 per 100 ml minimum. Due to the poorly treated wastewater having still high contents of organic compounds it is not advisable to use the existing chlorination plant for reduction of the bacterial pollution (fecal coliform count).

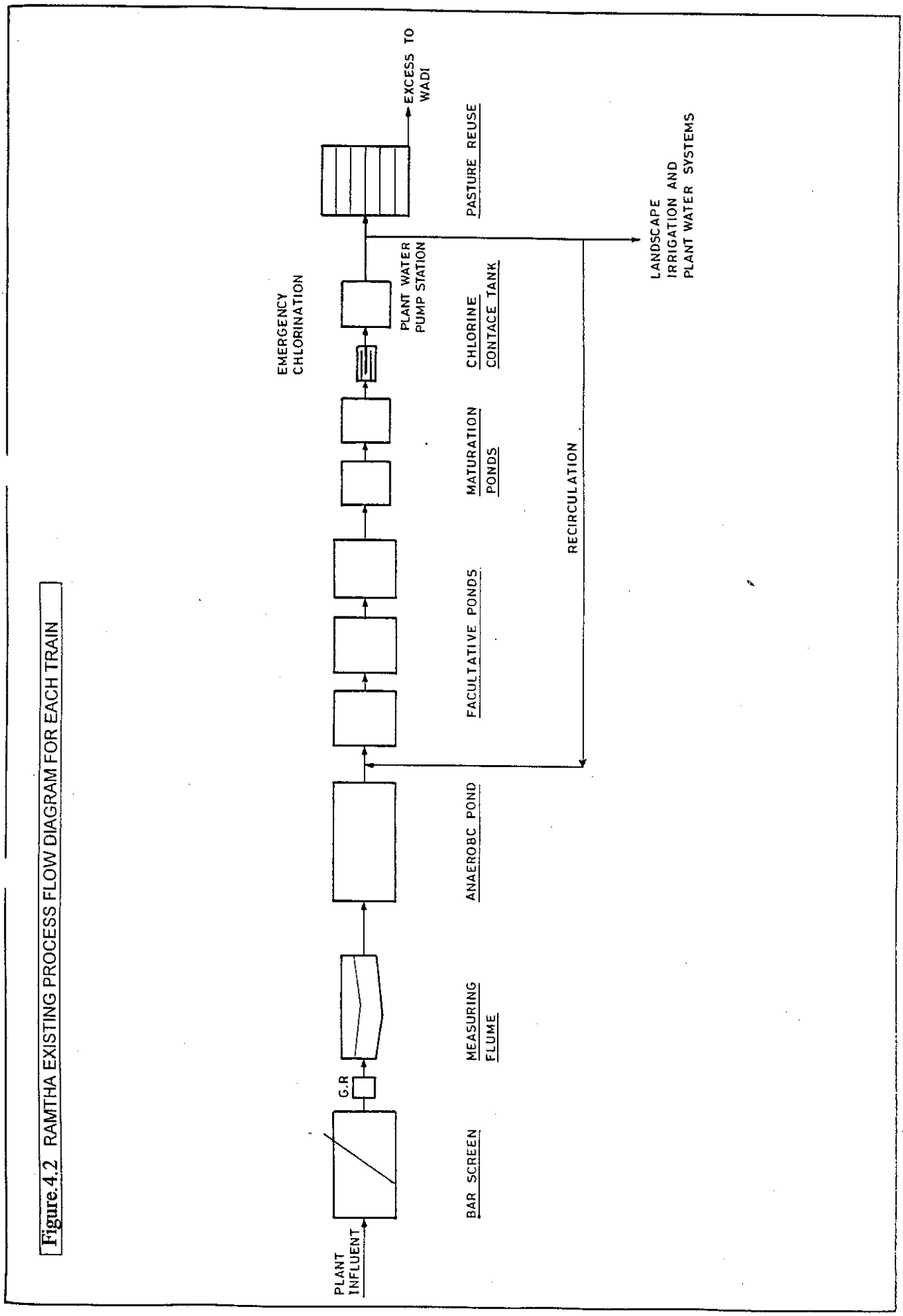

FIGURE 13: Schematic Layout of Existing Wastewater Treatment Plant - RAMTHA

BASIC DATA OF TREATMENT PLANT:

Ramtha
13

(Data of 1999, if not another year indicated)

Town:	Ramtha
Governorate:	Irbid
Treatment plant:	Ramtha
Date of visit:	28.3.2000
Responsible engineer:	Essa Khazaleh
Contacted person:	Essa Khazaleh
Telephone:	02/7382436

Population		
Tot.population living in towns with sewerage:	inhabitants	59.200
Population growth	%	3,6
Wastewater disposal		
Public system	%	67
Cesspools	%	33
Others	%	0
Wastewater collection		
Towns/villages connected (the most important)	-	Ramtha Town only
Population connected (as coverage treatment)	c	39.900
Coverage	%	67
Important industries	-	no important water polluting industries connected
Number of stormwater overflows works	no.	none
Length of sewers	km	134,5
Length per connected capita	m/c	3,4
House connections	h.c.	3.012
Capita per house connection	c/h.c.	13,2
Return factor (acc. to Design Report)	-	0,8
Monthly peak factor	-	1,25
Employees for wastewater collection	E	8
Factor: Sewer length per connected capita/coverage		5,0

BASIC DATA OF TREATMENT PLANT:

Ramtha
13

Wastewater treatment

Wastewater treatment technology		WSP
Wastewater treatment technology		Wastewater stabilisation ponds
In operation since		1988
Composed of treatment facilities		
Facility		Screen
Number of units	-	2 (1manual+1 automatic)
Total dimension		-
Facility		Anaerobic ponds
Number of units	-	2
Total dimension		2 x 9,800 m3
Facility		Facultative ponds
Number of units	-	6
Total dimension		6 x 17,600 m3
Facility		Maturation ponds
Number of units	-	4
Total dimension		6 x 8,200
Facility		Chlorination unit
Number of units	-	1 (not in operation)
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Remarks:		The 2 trains are operated alternatively changing every two weeks.
		-

Installed capacity	m^3/d	1.900
Population served (assuming 65 g/c/d)	c	39.900
Coverage (assuming 65 g/c/d)	%	67
Inflow treatment plant (average)	m^3/d	2.174
	MCM/a	0,794
Estimated losses by seepage/evaporation	%	25
Estimated effluent of the treatment plant	m^3/d	1.631
	MCM/a	0,595
BOD_5-load influent (according to WAJ data)	mg/l	1.194
	kg/d	2.596
	t/a	947
BOD_5-load effluent (according to WAJ data)	mg/l	239
	kg/d	390
	t/a	142
Fecal coliforms at effluent (acc.to WAJ data)	1/100 ml	>15,000
Helminth eggs	eggs/l	0
Spec.wastewater generation	l/c/d	54
Spec.BOD_5-load	g/c/d	65
Total dissolved solids (TDS) at effluent	mg/l	1.546
Sludge management		Desludging of anaerobic ponds once in in 12 years (1997) Sludge transported by tankers to dumping site Al Akeder, partly dried in open ditches

BASIC DATA OF TREATMENT PLANT:

Ramtha
13

Cost of wastewater treatment		
Operation and maintenance cost	JD/a	46.665
Operation/maintenance cost related to influent	JD/m^3	0,059
Performance of wastewater collection		
Employees for wastewater collection	E	8
Number of employees per 1,000 house conn.	E/1000 h.c.	2,7
Recommended number of employees	E/1000 h.c.	2 - 4
Number of employees per km sewer	E/10km	0,6
Average number of complaints per month	1/month	20
Average number of complaints per km sewer	1/month/km	0,1
Performance of wastewater treatment		within the treatment plant area.
Treatment efficiency (BOD_5 acc.to WAJ data)	%	80
Expected efficiency (acc.to experience)	%	80 - 90
Used treatment capacity (hydraulic)	%	114
Odor problems	-	yes (particularly in summer)
Specific treatment problems		high discharges in winter (up to 3 times design cap.)
Power-cuts		no problem
Operation/maintenance arrangement available		no
Employees for wastewater treatment	E	14
Recommended number of employees (WWTP)	E	9
Environmental impacts of effluent		
Discharge of effluent into		hydrographically Wadi Shomar to Yarmouk River
Requirements acc. to JS 893/1995		not respected
(according to WAJ data)		(practically all effluent is reused in summer and in winter for irrigation)
Reuse of effluent for agricultural irrigation		
Possible reuse (acc. to JS 893/1995)		restricted irrigation only
Practice of restricted irrigation		during whole year: entire effluent is reused for restricted irrigation close and at the plant site
Practice of unrestricted irrigation		
Irrigation near treatment plant	donums	520

Evaporation/infiltration losses of treatment plants:

Wastewater stabilization ponds	WSP
Activated sludge process/Trickling filters	AS/TF
Act.sludge proc./Trickl.filters incl.maturation pond	AS/TF+MP
Aerated ponds incl. maturation ponds	Aer.ponds

14. SALT TREATMENT PLANT

The sewage collection, treatment and disposal system of Salt is one of the oldest in Jordan. Wastewater treatment plant receives sewage from the town of Salt and Yaraka only. Even if the sewerage is designed as a separate system, during rainfall the sewers collect stormwater also. The entire sewerage system disposes of only one stormwater overflow located at the treatment plant.

Physical treatment facilities consist of 2 screens (1 automatic and 1 manual) and 2 non-aerated grit chambers plus 2 oil traps. Biological treatment is based on an activated sludge process (extended aeration) comprising activated sludge tanks and secondary settling tanks. Tertiary treatment is provided by maturation ponds (see Figure 14). Treated wastewater may be chlorinated, if required.

The plant was put in operation in 1981 and was extended in 1994 to a capacity of 7,700 m^3/d. Only about 50 % of the design capacity is presently used at the treatment plant. Some changes in the mode of operation are executed recently in order to take better into account this fact.

Excess sludge is thickened by sludge thickeners. During summer time the thickened sludge is dried by the sludge drying beds of the treatment plant, while during winter time the thickened sludge is transported by tankers to Ain Ghazal pretreatment plant and conveyed together with the raw wastewater of Amman to the As Samra treatment plant. Instead of this, it is proposed to use the existing sludge drying beds throughout the year. Dried sludge is stabilized and could be used in the agriculture as fertilizer and soil conditioner. The second option could be its disposal at a sanitary landfill.

Main receiving water is Wadi Shua'ab discharging finally into the Shua'ab Reservoir. The effluent of the plant (< 10 mg BOD_5/l) does meet the requirements according to the related Jordanian Standard 893/1995 for discharge into wadis and catchment areas. Due to the additional treatment of wastewater by two maturation ponds (in series) and chlorination of the effluents, the fecal coliform count could be reduced to less than 1,000 in 100 ml. However, at present the fecal coliform count is still higher than 10,000, because effluent is not chlorinated continuously. Therefore, effluent can be reused for restricted irrigation only.

At present, treated wastewater is partly reused for restricted irrigation purposes downstream of the treatment plant (partly legally, partly illegally), even required standards for unrestricted irrigation could be met by the applied/possible treatment process. Main portion of the effluent is reused only downstream of the Shua'ab Reservoir after dilution with surface water.

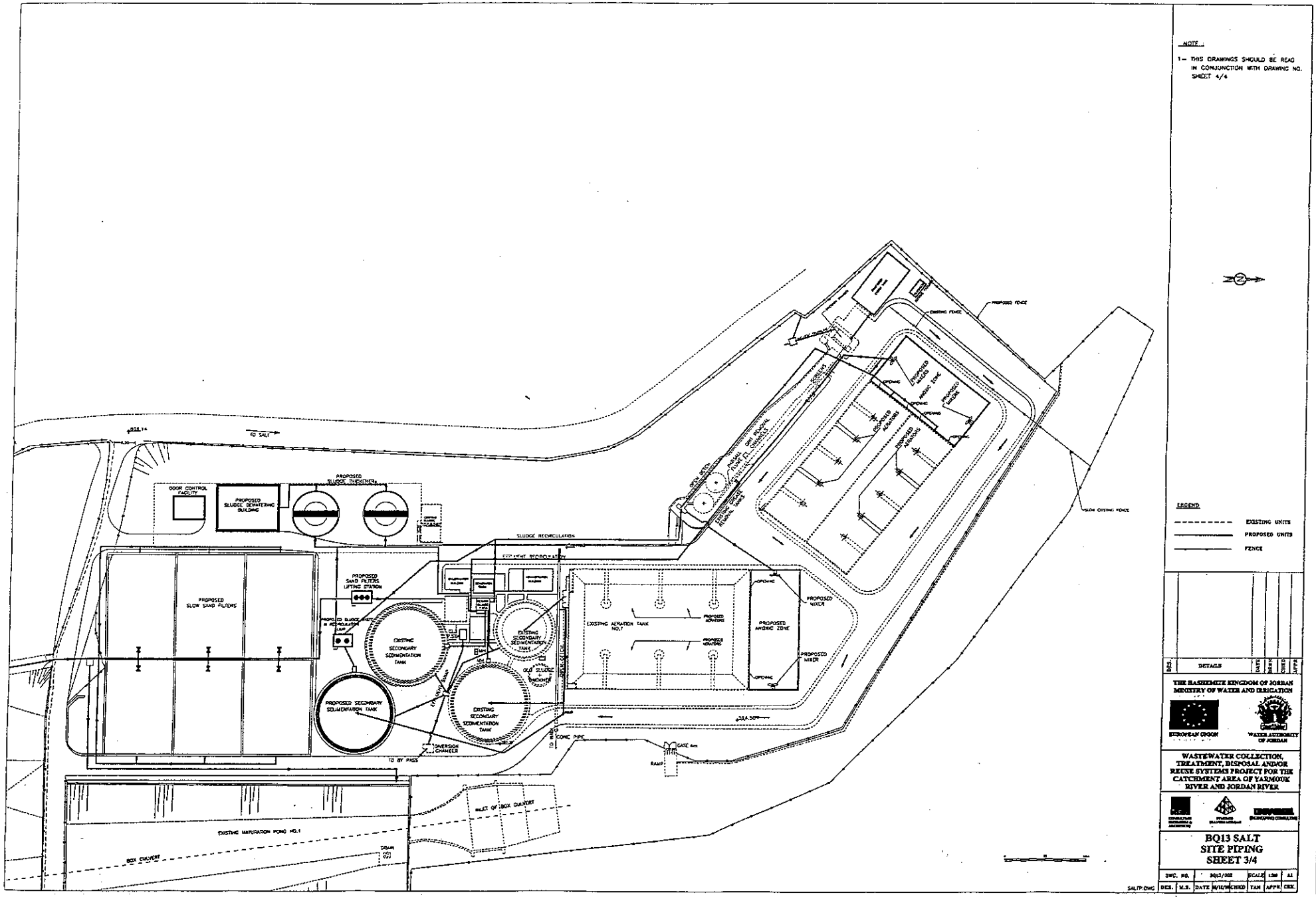

FIGURE 14: Schematic Layout of Existing Wastewater Treatment Plant (including proposed extension measures) - SALT

BASIC DATA OF TREATMENT PLANT:

Salt
14

(Data of 1999, if not another year indicated)

Town:	Salt
Governorate:	Balqa
Treatment plant:	Salt
Date of visit:	19.3.2000
Responsible engineer:	Mohammed Aliwi
Contacted person:	Mohammed Aliwi
Telephone:	05/3555616

Population			
	Tot.population living in towns with sewerage:	inhabitants	67.200
	Population growth	%	3,6
Wastewater disposal			
	Public system	%	61
	Cesspools	%	39
	Others	%	0
Wastewater collection			
	Towns/villages connected (the most important)	-	Salt Town only
	Population connected (as coverage treatment)	c	41.200
	Coverage	%	61
	Important industries	-	detergent, medical, soup factory (total 50-100 m3/d)
	Number of stormwater overflows works	no.	1 (at the treatment plant)
	Length of sewers	km	114,0
	Length per connected capita	m/c	2,8
	House connections	h.c.	2.993
	Capita per house connection	c/h.c.	13,8
	Return factor (acc. to Design Report)	-	0,85
	Monthly peak factor	-	1,20
	Employees for wastewater collection	E	8
	Factor: Sewer length per connected capita/coverage		4,5

BASIC DATA OF TREATMENT PLANT:

Salt 14

Wastewater treatment

Wastewater treatment technology		EA + MP
Wastewater treatment technology		Extended aeration plus maturation ponds
In operation since		1981(ext.94)
Composed of treatment facilities		
Facility		Screens
Number of units	-	2 (1 auto.+1 manual)
Total dimension		
Facility		Grit chamber
Number of units	-	2 (manual)
Total dimension		
Facility		Oil trap
Number of units	-	2 parallel
Total dimension		
Facility		Activated sludge tanks
Number of units	-	3
Total dimension		(8,000 + 4,000 + 4,000) m3
Facility		Secondary settling tanks
Number of units	-	3
Total dimension		(1,000 + 1,000 + 500) m3
Facility		Maturation ponds
Number of units	-	2 (in series)
Total dimension		(15,000 + 45,000) m3
Facility		Chlorination unit
Number of units	-	1
Total dimension		
Facility		Sludge thickener
Number of units	-	1
Total dimension		
Facility		Drying beds
Number of units	-	13
Total dimension		2,080 m2
Facility		
Number of units	-	
Total dimension		
Remarks:		

Installed capacity	m^3/d	7.700
Population served (assuming 65 g/c/d)	c	41.200
Coverage (assuming 65 g/c/d)	%	61
Inflow treatment plant (average)	m^3/d	3.166
	MCM/a	1,156
Estimated losses by seepage/evaporation	%	10
Estimated effluent of the treatment plant	m^3/d	2.849
	MCM/a	1,040
BOD_5-load influent (according to WAJ data)	mg/l	845
	kg/d	2.675
	t/a	976
BOD_5-load effluent (according to WAJ data)	mg/l	11
	kg/d	31
	t/a	11
Fecal coliforms at effluent (acc.to WAJ data)	1/100 ml	>15,000
Helminth eggs	eggs/l	0
Spec.wastewater generation	l/c/d	77
Spec.BOD_5-load	g/c/d	65
Total dissolved solids (TDS) at effluent	mg/l	666

Sludge management

Thickener daily emptied
In winter: sludge by tankers to As Samra TP via Ain Ghaza
Dried sludge to As Samra (no agr.use)
In summer: sludge to drying beds

BASIC DATA OF TREATMENT PLANT:

Salt 14

Cost of wastewater treatment

Operation and maintenance cost	JD/a	150.403
Operation/maintenance cost related to influent	JD/m^3	0,130

Performance of wastewater collection

Employees for wastewater collection	E	8
Number of employees per 1,000 house conn.	E/1000 h.c.	2,7
Recommended number of employees	E/1000 h.c.	2 - 4
Number of employees per km sewer	E/10km	0,7
Average number of complaints per month	1/month	210
Average number of complaints per km sewer	1/month/km	1,8

Performance of wastewater treatment

Treatment efficiency (BOD_5 acc.to WAJ data)	%	99
Expected efficiency (acc.to experience)	%	90 - 98
Used treatment capacity (hydraulic)	%	41
Odor problems	-	not particularly
Specific treatment problems		no
Power-cuts		3 -5 per month, no problem
Operation/maintenance arrangement available		?
Employees for wastewater treatment	E	21
Recommended number of employees (WWTP)	E	8

Environmental impacts of effluent

Discharge of effluent into	Wadi Shua'ab to Shua'ab Reservoir
Requirements acc. to JS 893/1995	respected
(according to WAJ data)	-
	-

Reuse of effluent for agricultural irrigation

Possible reuse (acc. to JS 893/1995)		restricted irrigation only
Practice of restricted irrigation		at plant site and upstream of Shua'ab Dam (legally and illega
Practice of unrestricted irrigation		downstream of Shua'ab Dam (after dilution with freshwater)
Irrigation near treatment plant	donums	15

Evaporation/infiltration losses of treatment plants:

Wastewater stabilization ponds	WSP
Activated sludge process/Trickling filters	AS/TF
Act.sludge proc./Trickl.filters incl.maturation pond	AS/TF+MP
Aerated ponds incl. maturation ponds	Aer.ponds

15. TAFIELAH TREATMENT PLANT

The Tafielah Wastewater Treatment Plant is located in some hundred meters distance to the build-up areas of Tafielah town in a very steep area belonging to the Wadi Al Ghweir. The plant receives sewage from the town of Tafielah. Present inflow has reached only half of the hydraulic capacity of the plant, which is rather low taking into account that the plant was put in operation in 1989. There are two reasons for this: Most probably the Consulting Engineer has overestimated the specific water consumption at the design stage. In addition, the present number of house connection could be increased from 1,200 to 2,000 with respect to the existing collection network.

The incoming flow to the treatment is screened by 2 screens (one automatic and one manual). The downstream located facilities are arranged in two parallel trains: Settling of solid matter of sewage takes place in the Imhoff tanks. Biological treatment is based on trickling filter technology and solid contact channels followed by secondary settling (see Figure 15). Chlorination facilities are located upstream of the maturation pond.

Sludge of the secondary settling tanks is pumped to the Imhoff tanks, where sludge is decomposed in a chamber below the settling volume. From there, excess sludge is discharged to the drying beds. After sun drying during 3 – 6 weeks in winter and 2 – 3 weeks in summer dried sludge is transported by trucks to the solid waste dumping ground Jorf Al Darawesh.

Main receiving water is Wadi Al Ghweir flowing down to the Jordan Valley. The effluent's quality (35 mg BOD_5/l) does meet the requirements according to the relevant Jordanian Standard 893/1995 for discharge into wadis and catchment areas. The fecal coliform count at the outflow of the plant does not allow unrestricted agricultural irrigation.

Presently, treated wastewater is used for restricted irrigation inside the treatment plant only (15 donums) but not downstream of the plant. Due to topographical reasons there are almost no appropriate areas for agricultural irrigation in the valley of Wadi Al Ghweir, which is very steep. However, farmers are asking for treated wastewater for irrigation of their lands upstream of the plant, where other resources than treated wastewater are scarce.

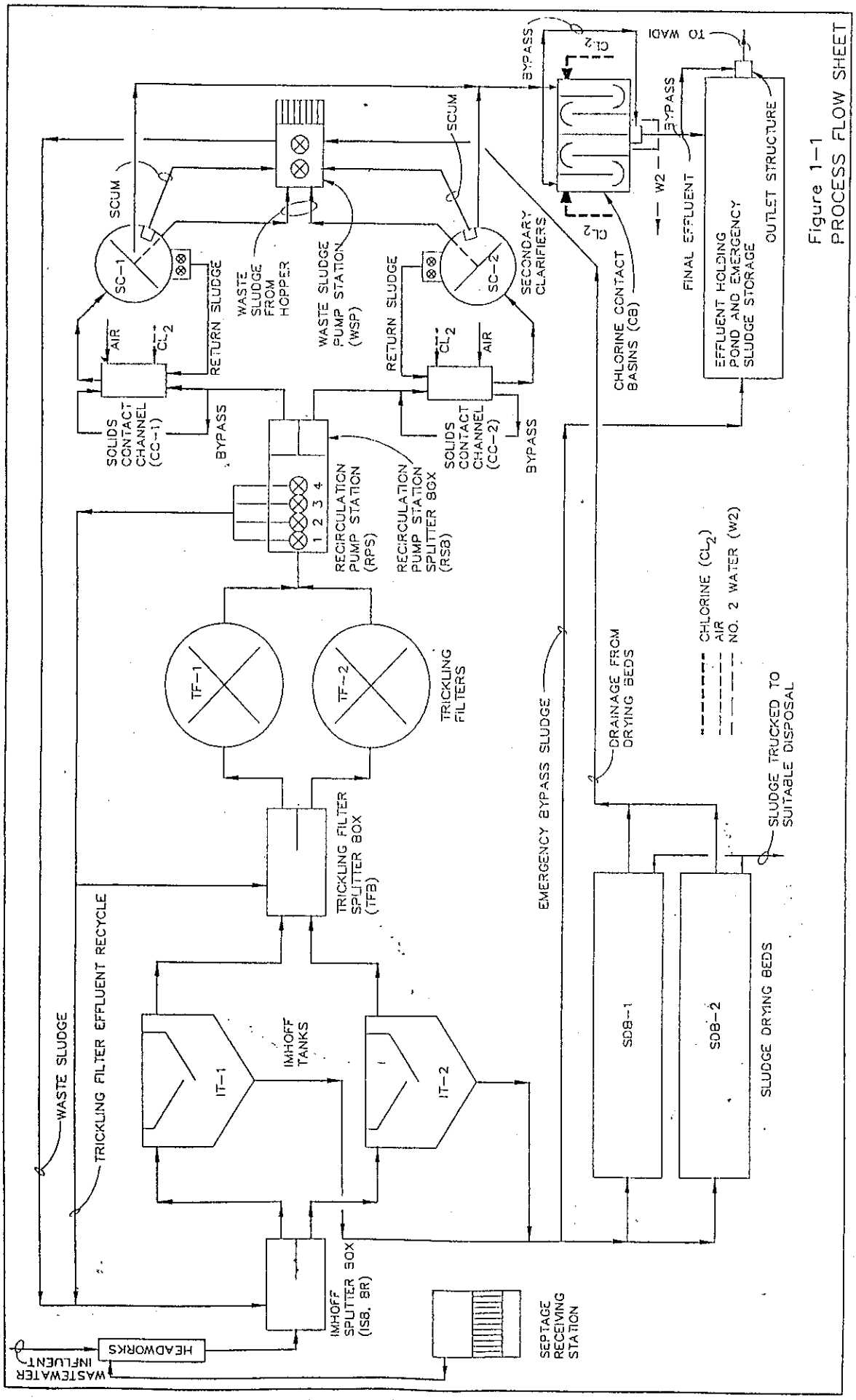

FIGURE 15: Schematic Layout of Existing Wastewater Treatment Plant - TAFIELAH

BASIC DATA OF TREATMENT PLANT:

(Data of 1999, if not another year indicated)

Tafielah
15

Town:	Tafielah
Governorate:	Tafielah
Treatment plant:	Tafielah
Date of visit:	2.4.2000
Responsible engineer:	Kalid Jameel
Contacted person:	Malek Y. Al-Rawashdeh (Dir.of WAJ Tafila)
Telephone:	03/342535

Population			
	Tot.population living in towns with sewerage:	inhabitants	24.900
	Population growth	%	3,6
Wastewater disposal			
	Public system	%	49
	Cesspools	%	51
	Others	%	0
Wastewater collection			
	Towns/villages connected (the most important)	-	Tafila
	Population connected (as coverage treatment)	c	12.300
	Coverage	%	49
	Important industries	-	no important water polluting industries connected
	Number of stormwater overflows works	no.	none
	Length of sewers	km	54,4
	Length per connected capita	m/c	4,4
	House connections	h.c.	1.214
	Capita per house connection	c/h.c.	10,1
	Return factor (acc. to Design Report)	-	0,8
	Monthly peak factor	-	1,25
	Employees for wastewater collection	E	6
	Factor: Sewer length per connected capita/coverage		9,0

BASIC DATA OF TREATMENT PLANT:

Tafielah 15

Wastewater treatment

Wastewater treatment technology		TF + MP
Wastewater treatment technology		Trickling filters plus maturation ponds
In operation since		1989
Composed of treatment facilities		
Facility		Screen
Number of units	-	2 (1 auto.+1 manual)
Total dimension		-
Facility		Imhoff tank
Number of units	-	2
Total dimension		2 x 600 m3
Facility		Trickling filters
Number of units	-	2 parallel
Total dimension		2 x 950 m3
Facility		Solid contact aeration tanks
Number of units	-	2 parallel
Total dimension		2 x 33 m3
Facility		Secondary settling tanks
Number of units	-	2
Total dimension		-
Facility		Chlorination unit
Number of units	-	1
Total dimension		-
Facility		Maturation ponds
Number of units	-	1
Total dimension		2.150
Facility		Drying beds
Number of units	-	21
Total dimension		21 x 120 = 2,500 m2
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-

Remarks: Chlorination facility is located upstream of the maturation pond, but was not in operation in April 2000.

Installed capacity	m^3/d	1.600
Population served (assuming 65 g/c/d)	c	12.300
Coverage (assuming 65 g/c/d)	%	49
Inflow treatment plant (average)	m^3/d	851
	MCM/a	0,311
Estimated losses by seepage/evaporation	%	10
Estimated effluent of the treatment plant	m^3/d	766
	MCM/a	0,280
BOD_5-load influent (according to WAJ data)	mg/l	942
	kg/d	802
	t/a	293
BOD_5-load effluent (according to WAJ data)	mg/l	35
	kg/d	27
	t/a	10
Fecal coliforms at effluent (acc.to WAJ data)	1/100 ml	no information
Helminth eggs	eggs/l	0
Spec.wastewater generation	l/c/d	69
Spec.BOD_5-load	g/c/d	65
Total dissolved solids (TDS) at effluent	mg/l	798

Sludge management: Sludge from the Imhoff tanks is discharged to the drying bed Sludge is dried 3-6 weeks (winter) and 2-3 weeks (summer) and then it is brought by trucks to the dumping ground Jorf Al Darawesh.

BASIC DATA OF TREATMENT PLANT:

Tafielah 15

Cost of wastewater treatment		
Operation and maintenance cost	JD/a	74.368
Operation/maintenance cost related to influent	JD/m^3	0,239
Performance of wastewater collection		
Employees for wastewater collection	E	6
Number of employees per 1,000 house conn.	E/1000 h.c.	4,9
Recommended number of employees	E/1000 h.c.	2 - 4
Number of employees per km sewer	E/10km	1,1
Average number of complaints per month	1/month	20
Average number of complaints per km sewer	1/month/km	0,4
Performance of wastewater treatment		
Treatment efficiency (BOD_5 acc.to WAJ data)	%	96
Expected efficiency (acc.to experience)	%	90 - 95
Used treatment capacity (hydraulic)	%	53
Odor problems	-	not particularly
Specific treatment problems		no
Power-cuts		2 per month (5 - 20 min.), generator available
Operation/maintenance arrangement available		basic
Employees for wastewater treatment	E	20
Recommended number of employees (WWTP)	E	5
Environmental impacts of effluent		
Discharge of effluent into		Wadi Al Gheir
Requirements acc. to JS 893/1995		respected
(according to WAJ data)		
Reuse of effluent for agricultural irrigation		
Possible reuse (acc. to JS 893/1995)		restricted irrigation only
Practice of restricted irrigation		very limited
Practice of unrestricted irrigation		not
Irrigation near treatment plant	donums	15

Evaporation/infiltration losses of treatment plants:

Wastewater stabilization ponds	WSP
Activated sludge process/Trickling filters	AS/TF
Act.sludge proc./Trickl.filters incl.maturation pond	AS/TF+MP
Aerated ponds incl. maturation ponds	Aer.ponds

16. WADI ARAB TREATMENT PLANT

About 65 % of the wastewater collected in Irbid is discharged to the Wadi Arab Treatment Plant (approx. 15 km west of Irbid), since this plant was put in operation in May 1999. A 15 km long main conveys sewage from the sewered areas (presently Irbid South, Irbid West, part of Irbid North) to the plant. Even if the sewerage is designed as a separate system, during rainfall the sewers collect stormwater also. The entire sewerage system disposes of only one stormwater overflow located at the treatment plant.

Physical treatment facilities consist of 2 automatic screens and 2 aerated grit chambers. Biological treatment is based on an activated sludge process (extended aeration) comprising activated sludge tanks and secondary settling tanks (see Figure 16). Treated wastewater is chlorinated. The arrangement of the treatment facilities is quite particular, insofar as these are located in the rather narrow of Wadi Arab. The distance between the facilities at the extremities is almost 3 km.

Presently, only about one third of the design capacity of the treatment plant (21,000 m^3/d) is used. Therefore, only three of the six trains are in operation.

Excess sludge is treated by sludge thickeners and then pumped to sludge holding tanks. Thickened sludge is dried by the sludge drying beds of the treatment plant. Trucks transport the dried and stabilized sludge to the dumping ground Al Akeder about 50 km distant from the treatment plant. It is not used in the agriculture as fertilizer and soil conditioner.

The effluent is discharged by a 15 km long pipeline (together with the effluent of Central Treatment Plant of Irbid) 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. The effluent of the plant (< 10 mg BOD_5/l) does meet the requirements according to the related Jordanian Standard 893/1995 for discharge into wadis and catchment areas or for reuse for unrestricted agricultural irrigation. Due to the chlorination of the effluents, the fecal coliform count is reduced to less than 1,000 in 100 ml. However, because the effluent of this plant is mixed with effluent of the Central Plant having worse water quality in the conveyor to the Jordan River the fecal coliform count is still too high to reuse this mixed treated wastewater for unrestricted agricultural irrigation.

Along the narrow valley of Wadi Arab there are no important areas suitable for irrigation present. Nevertheless, in the Jordan Valley treated wastewater may be reused for restricted irrigation purposes.

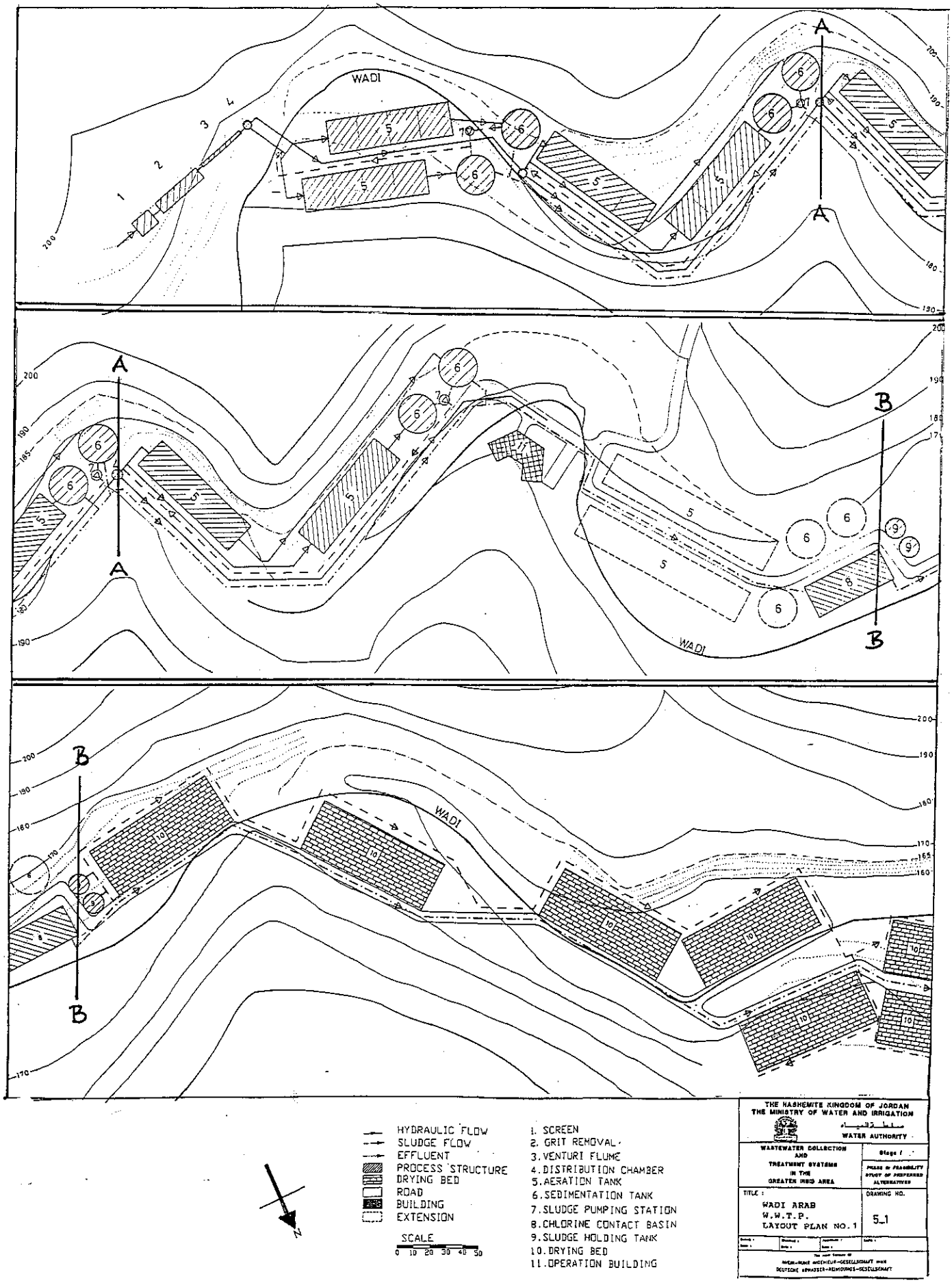

FIGURE 16: Schematic Layout of Existing Wastewater Treatment Plant - WADI ARAB

BASIC DATA OF TREATMENT PLANT:

(Data of 1999, if not another year indicated)

Wadi Arab
16

Town:	Irbid
Governorate:	Irbid
Treatment plant:	Wadi Arab
Date of visit:	26.3.2000
Responsible engineer:	Yousef Hajjat
Contacted person:	Yousef Hajjat
Telephone:	02/7517101

Population			
	Tot.population living in towns with sewerage:	inhabitants	171.000
	Population growth	%	3,6
Wastewater disposal			
	Public system	%	50
	Cesspools	%	50
	Others	%	0
Wastewater collection			
	Towns/villages connected (the most important)	-	Irbid South, Irbid West parts of Irbid North
	Population connected (as coverage treatment)	c	86.320
	Coverage	%	50
	Important industries	-	no important water polluting industries connected
	Number of stormwater overflows works	no.	1 (at the treatment plant)
	Length of sewers	km	201,5
	Length per connected capita	m/c	2,3
	House connections	h.c.	8.970
	Capita per house connection	c/h.c.	9,6
	Return factor (acc. to Design Report)	-	0,8
	Monthly peak factor	-	-
	Employees for wastewater collection	E	Together with Irbid Central
	Factor: Sewer length per connected capita/coverage		4,6

BASIC DATA OF TREATMENT PLANT:

Wadi Arab 16

Wastewater treatment

Wastewater treatment technology		EA 1)
Wastewater treatment technology		Extended aeration
In operation since		1999
Composed of treatment facilities		
Facility		Screens
Number of units	-	2 (1 auto.+1 manual)
Total dimension		
Facility		Aerated grit chamber
Number of units	-	2
Total dimension		
Facility		Activated sludge tanks
Number of units	-	6
Total dimension		6 x 9,350 m3
Facility		Secondary settling tanks
Number of units	-	6
Total dimension		6 x 2,500 m3
Facility		Chlorination unit
Number of units	-	1 (in operation)
Total dimension		
Facility		Sludge thickener/holding tanks
Number of units	-	2
Total dimension		(560 + 300)m3
Facility		Drying beds
Number of units	-	
Total dimension		11,250 m2
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Remarks:		Only 3 of 6 trains in operation

Installed capacity	m^3/d	21.000
Population served (assuming 65 g/c/d)	c	86.320
Coverage (assuming 65 g/c/d)	%	50
Inflow treatment plant (average)	m^3/d	5.993
	MCM/a	2,187
Estimated losses by seepage/evaporation	%	5
Estimated effluent of the treatment plant	m^3/d	5.693
	MCM/a	2,078
BOD_5-load influent (according to WAJ data)	mg/l	811
	kg/d	4.860
	t/a	1.774
BOD_5-load effluent (according to WAJ data)	mg/l	10
	kg/d	57
	t/a	21
Fecal coliforms at effluent (acc.to WAJ data)	1/100 ml	1,000
Helminth eggs	eggs/l	0
Spec.wastewater generation	l/c/d	69
Spec.BOD_5-load	g/c/d	56
Total dissolved solids (TDS) at effluent	mg/l	no information
Sludge management		Sludge is dried in drying beds, dried sludge is transported by trucks to the dumping ground "Al Akeder (50 km distant)"

BASIC DATA OF TREATMENT PLANT:

Wadi Arab
16

Cost of wastewater treatment		
Operation and maintenance cost	JD/a	202.736
Operation/maintenance cost related to influent	JD/m³	0,093
Performance of wastewater collection		
Employees for wastewater collection	E	9,75
Number of employees per 1,000 house conn.	E/1000 h.c.	1,1
Recommended number of employees	E/1000 h.c.	2 - 4
Number of employees per km sewer	E/10km	0,5
Average number of complaints per month	1/month	104
Average number of complaints per km sewer	1/month/km	0,5
Performance of wastewater treatment		
Treatment efficiency (BOD_5 acc.to WAJ data)	%	99
Expected efficiency (acc.to experience)	%	85 - 95
Used treatment capacity (hydraulic)	%	29
Odor problems	-	not particularly
Specific treatment problems		no
Power-cuts		1 per week (up to 3 h), no problem
Operation/maintenance arrangement available		yes
Employees for wastewater treatment	E	61
Recommended number of employees (WWTP)	E	12
Environmental impacts of effluent		
Discharge of effluent into		hydrographically Wadi Arab (15 km pipe to Jordan Valley)
Requirements acc. to JS 893/1995 (according to WAJ data)		respected
Reuse of effluent for agricultural irrigation		
Possible reuse (acc. to JS 893/1995)		unrestricted irrigation after chlorination
Practice of restricted irrigation		no
Practice of unrestricted irrigation		no
Irrigation near treatment plant	donums	0

Evaporation/infiltration losses of treatment plants:

Wastewater stabilization ponds	WSP
Activated sludge process/Trickling filters	AS/TF
Act.sludge proc./Trickl.filters incl.maturation pond	AS/TF+MP
Aerated ponds incl. maturation ponds	Aer.ponds

17. WADI ESSIR TREATMENT PLANT

Wadi Essir Treatment Plant receives sewage from the town Wadi Essir only. However, only about 10 % of the Town drain to the Wadi Essir Treatment Plant, while the other 90 % discharge their sewage to Amman (As Samra). The plant is located some 16 km downstream of the town in the steep valley of Wadi Essir. The Town area belongs administratively to Greater Amman, whereby only less than 1 % of the wastewater of Greater Amman is discharged to Wadi Essir plant. Remaining wastewater of Amman is treated in As Samra and Abu Nuseir treatment plant, whereby the treatment plant As Samra receives about 99 % of sewage generated in Amman area.

Physical treatment facilities consist of 2 screens (1 mechanic and 1 manual) only, without grit chambers. Biological wastewater treatment is done in two trains of 2 anaerobic ponds (parallel), 2 aerated ponds (parallel) and 4 maturation ponds (2 parallel and 2 in series). A schemaic layout of the plant is shown in Figure 17. Presently, only one anaerobic pond is in operation. Aeration of the aerobic ponds is done by submersible pumps lifting water and jetting it back to the water surface. Treated wastewater may be chlorinated, if required. The design capacity of the treatment plant (put in operation end 1996) is 4,000 m^3/d, of which presently a quarter is used only.

Up to now the ponds did not need desludging because of the operation time of three years only and because of the low present load (25 % of installed capacity). For future sludge emptying of the operated anaerobic pond it is proposed to use the second anaerobic pond (presently out of operation) as sludge drying bed. Separate drying beds do not exist. Dried sludge shall be used within the treatment area as fertilizer and soil conditioner or supplied to the farmers for the same purposes, if possible.

In February 1997 a landslide occurred at the uphill side of one of the anaerobic pond and, consequently, the affected pond was put out of operation. WAJ decided to stabilize the slope by construction of several series of gabions. However, the slide could not be stopped by these measures. The National Committee for Dams has inspected the site in June 1999 to prepare a technical report. Further action will be undertaken accordingly.

Receiving water is the Wadi Essir downstream of its confluent with the Wadi El Bakhath discharging finally into the Kafrein Reservoir. The effluent of the plant (<50 mg BOD_5/l) does meet the requirements according to the relevant Jordanian Standard 893/1995 for discharge into wadis and catchment areas. Without chlorination of the effluents of the plant the fecal coliform count is was found as 1,600 in 100 ml in 1999. The effluent could be reused for unrestricted irrigation, if safety chlorination would be provided.

The treatment plant of Wadi Essir is operated by the consortium of Suez Lyonnaise des Eaux - Montgomery Watson Arabtech Jardaneh. Related contract comprises wastewater collection for the Greater Amman area and operation of wastewater treatment plant Wadi Essir. The consortium has started work in 1999. The treatment plant disposes of a small laboratory for routine wastewater analysis. The efficiency of the treatment process is controlled by the central laboratory of WAJ taking samples

and analyzing the effluent water of the treatment plant monthly (pH, BOD_5, COD, TSS, TDS, total coliforms, fecal coliforms) and each forth month (heavy metals).

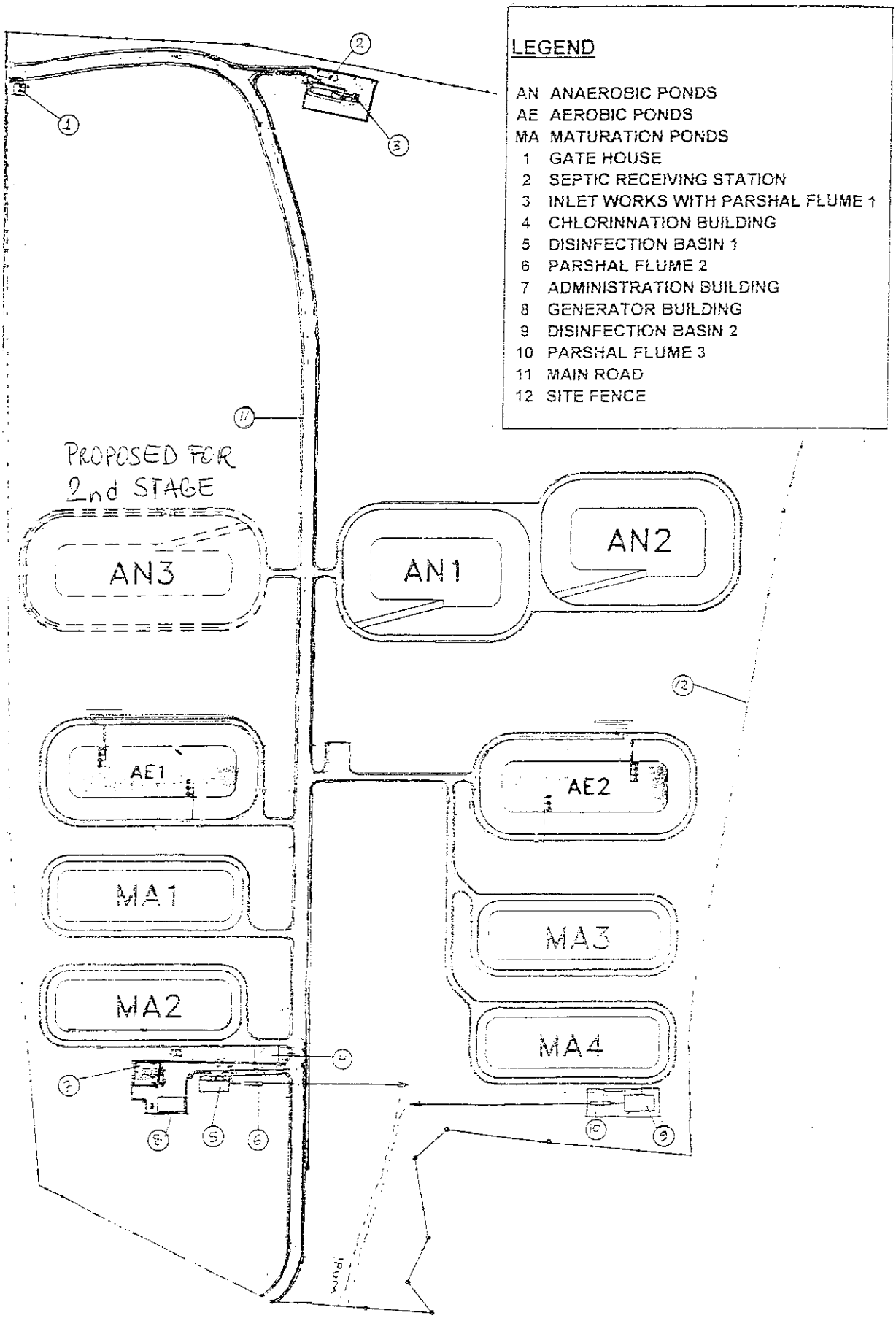

FIGURE 17: Schematic Layout of Existing Wastewater Treatment Plant - WADI ESSIR

BASIC DATA OF TREATMENT PLANT:

(Data of 1999, if not another year indicated)

Wadi Essir
17

Town:	Wadi Essir
Governorate:	Amman
Treatment plant:	Wadi Essir
Date of visit:	23.3.2000
Responsible engineer:	M.Hisham,EMA
Contacted person:	M.Hisham,EMA
Telephone:	079/635575(TP), 065651052 (priv)

Population		
Tot.population living in towns with sewerage:	inhabitants	11.000
Population growth	%	3,6
Wastewater disposal		
Public system	%	79
Cesspools	%	21
Others	%	0
Wastewater collection		
Towns/villages connected (the most important)	-	Wadi Essir
Population connected (as coverage treatment)	c	8.700
Coverage	%	79
Important industries	-	no important water polluting industries connected
Number of stormwater overflows works	no.	1 (at the treatment plant)
Length of sewers	km	20,0
Length per connected capita	m/c	2,3
House connections	h.c.	1.860
Capita per house connection	c/h.c.	4,7
Return factor (acc. to Design Report)	-	0,8
Monthly peak factor	-	1,20
Employees for wastewater collection	E	together with As Samra
Factor: Sewer length per connected capita/coverage		2,9

BASIC DATA OF TREATMENT PLANT:

Wadi Essir
17

Wastewater treatment

Wastewater treatment technology		AP
Wastewater treatment technology		Aerated ponds
In operation since		1996
Composed of treatment facilities		
Facility		Screens
Number of units	-	2 (1 auto.+1 manual)
Total dimension		-
Facility		Anaerobic ponds
Number of units	-	2
Total dimension		2 x 19,000 m3
Facility		Aerated ponds
Number of units	-	2
Total dimension		2 x 10,800 m3
Facility		Maturation ponds
Number of units	-	4
Total dimension		4 x 4,700 m3
Facility		Chlorination unit
Number of units	-	1 (only in operation, if needed)
Total dimension		
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Remarks:		-
		-

Installed capacity	m^3/d	4.000
Population served (assuming 65 g/c/d)	c	8.700
Coverage (assuming 65 g/c/d)	%	79
Inflow treatment plant (average)	m^3/d	914
	MCM/a	0,334
Estimated losses by seepage/evaporation	%	20
Estimated effluent of the treatment plant	m^3/d	731
	MCM/a	0,267
BOD_5-load influent (according to WAJ data)	mg/l	622
	kg/d	569
	t/a	208
BOD_5-load effluent (according to WAJ data)	mg/l	50
	kg/d	37
	t/a	13
Fecal coliforms at effluent (acc.to WAJ data)	1/100 ml	1,600
Helminth eggs	eggs/l	0
Spec.wastewater generation	l/c/d	105
Spec.BOD_5-load	g/c/d	65
Total dissolved solids (TDS) at effluent	mg/l	1.084
Sludge management		Anaer.ponds not yet desludged, sludge shall be dried in the 2nd anaerobic pond.

BASIC DATA OF TREATMENT PLANT:

Wadi Essir
17

Cost of wastewater treatment		
Operation and maintenance cost	JD/a	72.327
Operation/maintenance cost related to influent	JD/m^3	0,217
Performance of wastewater collection		
Employees for wastewater collection	E	together with As Samra
Number of employees per 1,000 house conn.	E/1000 h.c.	1,3
Recommended number of employees	E/1000 h.c.	2 - 4
Number of employees per km sewer	E/10km	0,9
Average number of complaints per month	1/month	?
Average number of complaints per km sewer	1/month/km	#WERT!
Performance of wastewater treatment		
Treatment efficiency (BOD_5 acc.to WAJ data)	%	92
Expected efficiency (acc.to experience)	%	80 - 90
Used treatment capacity (hydraulic)	%	23
Odor problems	-	not particularly
Specific treatment problems		landslides within the treatment plant area
Power-cuts		no problem
Operation/maintenance arrangement available		yes
Employees for wastewater treatment	E	13
Recommended number of employees (WWTP)	E	5
Environmental impacts of effluent		
Discharge of effluent into		Wadi Essir/Wadi El Bukhath to Kafrein Reservoir
Requirements acc. to JS 893/1995 (according to WAJ data)		respected
Reuse of effluent for agricultural irrigation		
Possible reuse (acc. to JS 893/1995)		unrestricted irrigation after chlorination
Practice of restricted irrigation		some farmers reuse illegally the treated sewage
Practice of unrestricted irrigation		downstream of Kafreen Dam (after dilution)
Irrigation near treatment plant	donums	50
		Irrigation of treatment plant area

Evaporation/infiltration losses of treatment plants:

Wastewater stabilization ponds	WSP
Activated sludge process/Trickling filters	AS/TF
Act.sludge proc./Trickl.filters incl.maturation pond	AS/TF+MP
Aerated ponds incl. maturation ponds	Aer.ponds

18. WADI HASSAN TREATMENT PLANT (under construction)

The Wadi Hassan sewerage system was in March 2000 still under construction. The villages of An Nuayyima, Shatana and Kitm will be sewered by the future system. There are no specific industries that could be a significant source of pollution. In a pump station (1 + 1 pump and 300 m^3 pump sump) wastewater will be pumped to the treatment plant. A force main connects the station with the plant having a length of 4,500 m.

Mechanical treatment facilities consist of 2 automatic screens and 2 aerated grit chambers. Biological treatment is based on extended aeration process comprising activated sludge tanks (mammoth rotors) and secondary settling tanks. Tertiary treatment is provided by maturation ponds (see Figure 18). Treated wastewater may be chlorinated, if required.

Excess sludge will be treated by sludge thickeners/sludge holding tanks. Thickened sludge will be dried by the sludge drying beds of the treatment plant.

The effluent standards to be achieved are :

- BOD_5 = 30 mg/l
- COD = 100 mg/l
- NH_3 = 2.5 mg/l
- SS = 30 mg/l

The microbiological quality of the effluent for wastewater reuse has to fulfill the following requirements:

- Feacal coliforms = 100/100ml
- Nematodes = 1/liter

Proposed measures of sewage collection, treatment and disposal will serve in particular the protection of the groundwater aquifer.

Completion of the sewerage system and treatment plant will be not before early 2001.

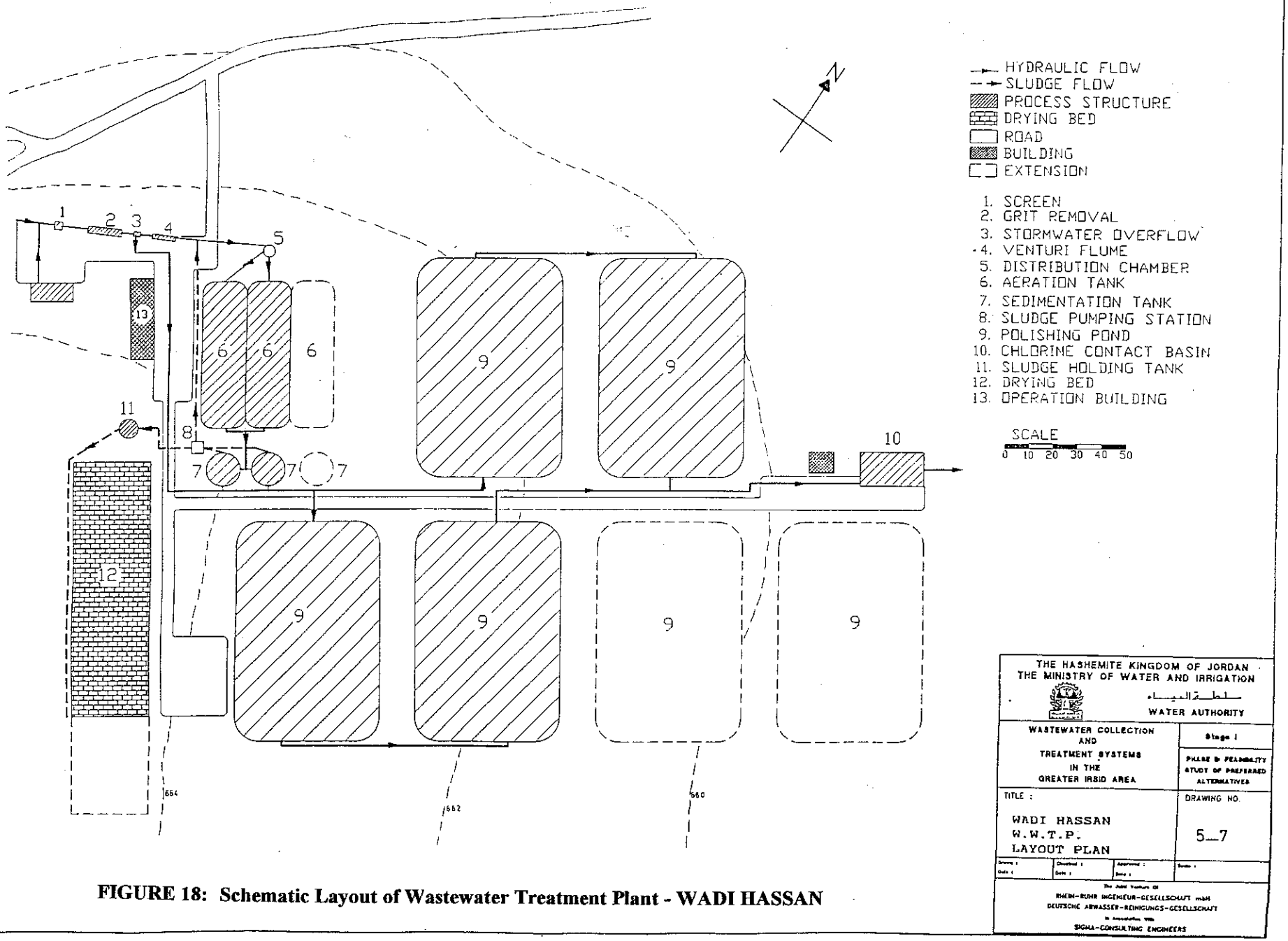

FIGURE 18: Schematic Layout of Wastewater Treatment Plant - WADI HASSAN

BASIC DATA OF TREATMENT PLANT:

Wadi Hassan
18

(Data of 1999, if not another year indicated)

Town:	An Nuayyima, Shatana, Kitm
Governorate:	Irbid
Treatment plant:	Wadi Hassan
Date of visit:	26.3.2000
Responsible engineer:	Mr.Boehm
Contacted person:	Mr.Boehm
Telephone:	02/7057011

Population			
	Tot.population living in towns with sewerage:	inhabitants	22,000 *)
	Population growth	%	
Wastewater disposal			
	Public system	%	#WERT!
	Cesspools	%	#WERT!
	Others	%	0
Wastewater collection			
	Towns/villages connected (the most important)	-	An Nuayyima, Shatana, Kitm
	Population connected (as coverage treatment)	c	n.a.
	Coverage	%	#WERT!
	Important industries	-	no important water polluting industries connected
	Number of stormwater overflows works	no.	1 (at the treatment plant)
	Length of sewers	km	n.a.
	Length per connected capita	m/c	n.a.
	House connections	h.c.	n.a.
	Capita per house connection	c/h.c.	#WERT!
	Return factor (acc. to Design Report)	-	0,8
	Monthly peak factor	-	
	Employees for wastewater collection	E	n.a.

Factor: Sewer length per connected capita/coverage

BASIC DATA OF TREATMENT PLANT:

Wadi Hassan
18

Wastewater treatment

Wastewater treatment technology		EA+MP
Wastewater treatment technology		Extended aeration plus maturation ponds
In operation since		expected in 2000
Composed of treatment facilities		
Facility		Screens
Number of units	-	2 (automatic)
Total dimension		-
Facility		Aerated grit chamber
Number of units	-	2
Total dimension		
Facility		Activated sludge tanks (mamout rotors)
Number of units	-	2
Total dimension		2 x 3,600 m3
Facility		Secondary settling tanks
Number of units	-	2
Total dimension		2 x 830
Facility		Maturation ponds
Number of units	-	4 (2 in series and 2 in parallel)
Total dimension		4 x 1,700 m3
Facility		Chlorination unit
Number of units	-	1
Total dimension		
Facility		Sludge thickener/holding tank
Number of units	-	1
Total dimension		300 m3
Facility		Drying beds
Number of units	-	
Total dimension		3,000 m2
Facility		-
Number of units	-	-
Total dimension		-
Facility		-
Number of units	-	-
Total dimension		-
Remarks:		The construction of the treatment plant will be most propably completed in July 2000

Installed capacity	m^3/d	1.600
Population served (assuming 65 g/c/d)	c	not applicable
Coverage (assuming 65 g/c/d)	%	not applicable
Inflow treatment plant (average)	m^3/d	not applicable
	MCM/a	not applicable
Estimated losses by seepage/evaporation	%	10
Estimated effluent of the treatment plant	m^3/d	not applicable
	MCM/a	not applicable
BOD_5-load influent (according to WAJ data)	mg/l	not applicable
	kg/d	not applicable
	t/a	not applicable
BOD_5-load effluent (according to WAJ data)	mg/l	30 (acc.to design)
	kg/d	not applicable
	t/a	not applicable
Fecal coliforms at effluent (acc.to WAJ data)	1/100 ml	100 (acc.to design)
Helminth eggs	eggs/l	not applicable
Spec.wastewater generation	l/c/d	not applicable
Spec.BOD_5-load	g/c/d	not applicable
Total dissolved solids (TDS) at effluent	mg/l	not applicable
Sludge management		Sludge will be thickened in the thickener and then dried by in the sludge drying beds.

BASIC DATA OF TREATMENT PLANT:

Wadi Hassan
18

Cost of wastewater treatment

Operation and maintenance cost	JD/a	n.a.
Operation/maintenance cost related to influent	JD/m³	n.a.

Performance of wastewater collection

Employees for wastewater collection	E	n.a.
Number of employees per 1,000 house conn.	E/1000 h.c.	n.a.
Recommended number of employees	E/1000 h.c.	n.a.
Number of employees per km sewer	E/10km	n.a.
Average number of complaints per month	1/month	n.a.
Average number of complaints per km sewer	1/month/km	n.a.

Performance of wastewater treatment

Treatment efficiency (BOD_5 acc.to WAJ data)	%	n.a.
Expected efficiency (acc.to experience)	%	90 - 98
Used treatment capacity (hydraulic)	%	n.a.
Odor problems	-	n.a.
Specific treatment problems		n.a.
Power-cuts		n.a.
Operation/maintenance arrangement available		n.a.
Employees for wastewater treatment	E	n.a.
Recommended number of employees (WWTP)	E	n.a.

Environmental impacts of effluent

Discharge of effluent into		Wadi Hassan
Requirements acc. to JS 893/1995 (according to WAJ data)		n.a.

Reuse of effluent for agricultural irrigation

Possible reuse (acc. to JS 893/1995)		n.a.
Practice of restricted irrigation		n.a.
Practice of unrestricted irrigation		n.a.
Irrigation near treatment plant	donums	n.a.
		Some research is carried out by the Jordan University for Science and Technology (JUST) about the reuse of treated sewage if the plant.

Evaporation/infiltration losses of treatment plants:

Wastewater stabilization ponds	WSP
Activated sludge process/Trickling filters	AS/TF
Act.sludge proc./Trickl.filters incl.maturation pond	AS/TF+MP
Aerated ponds incl. maturation ponds	Aer.ponds

ANNEX to 3.1.2

Monthly Influent to the Treatment Plants in 1997, 1998 and 1999

Table 1: Monthly influent to treatment plants (1997)

(in m3/d)

	Plant	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total MCM/a
1	Abu Nuseir	1.548	1.526	1.545	1.468	1.420	1.403	1.467	1.544	1.470	1.460	1.462	1.516	1.486	0,542
2	Aqaba	6.444	6.484	7.015	7.121	8.211	8.160	8.552	8.395	7.300	7.276	6.775	6.356	7.341	2,679
3	As-Samra	141.581	148.639	156.779	148.559	155.155	154.942	158.499	157.916	154.277	164.079	163.690	176.840	156.746	57,212
4	Baqa	7.255	7.674	7.136	7.157	7.173	7.169	7.132	7.230	7.256	7.340	7.467	7.622	7.301	2,665
5	Fuhis							190	205	393	511	472	686	410	0,149
6	Irbid	7.720	8.211	8.462	9.263	9.603	9.989	9.962	10.050	9.828	10.203	9.288	8.859	9.287	3,390
7	Jerash	1.723	1.611	1.725	1.660	1.480	1.447	1.350	1.544	1.463	1.512	1.531	1.616	1.555	0,568
8	Karak	1.226	1.385	1.216	1.135	1.137	1.259	1.241	1.284	1.071	997	1.007	1.011	1.164	0,425
9	Kufranja [1)]	1.153	1.814	2.598	2.358	1.597	1.235	1.458	1.548	1.429	1.238	1.462	1.900	1.649	0,602
10	Ma'an	1.488	1.471	1.582	1.677	1.708	2.762	1.935	1.889	1.667	2.000	1.833	1.613	1.802	0,658
11	Madaba	3.149	3.372	3.785	2.844	3.029	3.605	3.722	3.720	3.501	2.892	3.033	3.054	3.309	1,208
12	Mafraq	2.362	2.655	2.497	2.711	2.813	2.850	3.073	3.228	2.178	2.174	2.580	2.535	2.638	0,963
13	Ramtha	1.962	1.713	1.943	1.895	2.073	1.505	1.602	1.563	1.438	1.497	1.501	1.413	1.675	0,612
14	Salt	3.910	3.811	3.865	4.172	4.305	4.480	4.532	4.395	4.288	4.137	3.637	3.390	4.077	1,488
15	Tafila	937	827	792	792	575	670	693	644	678	721	718	919	747	0,273
16	Wadi Arab													0	0,000
17	Wadi Al Seer	205	778	2.183	890	524	499	604	785	858	978	952	1.017	856	0,312
	Total m3/d	182.663	191.971	203.123	193.702	200.803	201.975	206.012	205.940	199.095	209.015	207.408	220.347	202.043	73,746

1) The high discharge figures in some months are due to non-opreational flowmeter in the treatment plant.

Table 2: Monthly influent to treatment plants (1998)

(in m3/d)

	Plant	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total MCM/a
1	Abu Nuseir	1.667	1.580	1.668	1.613	1.525	1.562	1.431	1.483	1.392	1.371	1.359	1.347	1.500	0,547
2	Aqaba	6.400	6.975	7.034	8.510	9.053	8.949	8.552	9.027	9.252	8.660	8.353	7.816	8.215	2,999
3	As-Samra	172.283	164.481	170.798	165.200	178.826	181.538	175.769	166.971	161.637	165.956	160.077	162.195	168.811	61,616
4	Baqa	8.122	7.920	7.543	8.041	8.547	8.762	8.929	9.272	9.520	9.645	9.541	9.498	8.778	3,204
5	Fuhis	915	799	1.047	878	852	921	898	765	715	737	793	841	847	0,309
6	Irbid (Central)	8.401	7.396	7.634	7.916	8.612	9.098	9.120	9.313	8.883	8.873	8.586	7.858	8.474	3,093
7	Jerash	2.160	2.021	2.128	2.224	2.104	1.740	1.566	1.499	1.416	1.477	1.589	1.783	1.809	0,660
8	Karak	1.028	1.076	1.082	1.043	1.113	1.121	1.217	1.210	1.225	1.119	1.135	1.089	1.122	0,409
9	Kufranja	2.223	1.829	3.240	4.071	2.491	2.055	2.043	1.909	1.825	1.694	1.780	1.723	2.240	0,818
10	Ma'an	2.000	1.786	1.613	2.000	2.000	2.500	2.000	2.000	2.000	2.000	1.833	1.350	1.924	0,702
11	Madaba	3.097	3.073	3.071	3.184	3.276	3.323	3.438	3.516	3.410	3.190	3.059	2.982	3.218	1,175
12	Mafraq	2.674	2.595	2.770	2.543	2.405	2.447	2.816	2.915	1.968	1.552	1.427	1.451	2.297	0,838
13	Ramtha	1.556	1.428	1.358	1.463	1.423	1.293	1.532	1.513	1.488	2.154	2.000	2.174	1.615	0,590
14	Salt	3.150	2.885	3.443	3.850	4.488	4.665	4.655	4.319	4.000	3.600	3.191	3.250	3.791	1,384
15	Tafila	984	905	1.060	907	840	735	692	667	805	867	945	937	862	0,315
16	Wadi Arab													0	0,000
17	Wadi Essir	1.034	867	1.040	757	740	820	880	702	756	741	707	779	819	0,299
	Total m3/d	217.694	207.616	216.529	214.200	228.295	231.529	225.538	217.081	210.292	213.636	206.375	207.073	216.322	78,957

Table 3: Monthly influent to treatment plants (1999)

(in m3/d)

	Plant	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total MCM/a
1	Abu Nuseir	1.356	1.436	1.466	1.412	1.513	1.512	1.506	1.612	1.206	1.275	1.255	1.379	1.411	0,515
2	Aqaba	7.784	7.764	8.633	8.925	9.246	9.314	9.051	9.339	9.642	9.313	8.461	7.814	8.774	3,202
3	As-Samra	168.101	170.012	170.000	168.534	165.000	161.991	169.738	176.536	170.275	162.196	158.317	161.426	166.844	60,898
4	Baqa	9.711	10.127	9.803	10.001	10.278	10.336	10.549	10.382	10.638	10.488	10.633	10.466	10.284	3,754
5	Fuhis	894	1.079	1.001	948	920	994	1.087	1.129	1.093	1.073	1.012	1.000	1.019	0,372
6	Irbid (Central)	8.069	8.107	7.222	6.253	3.834	4.120	4.063	2.158	2.185	3.023	2.922	3.382	4.612	1,683
7	Jerash	1.975	1.979	1.901	1.676	1.588	1.348	1.448	1.332	1.318	1.358	1.665	1.653	1.603	0,585
8	Karak	1.237	1.197	1.075	1.010	1.007	1.080	1.127	1.128	1.068	1.019	1.181	1.627	1.146	0,418
9	Kufranja	2.072	2.033	1.761	1.645	1.400	1.327	1.526	1.383	1.455	1.545	3.171	1.493	1.734	0,633
10	Ma'an	1.350	1.283	1.300	1.733	1.804	2.039	1.763	2.008	2.096	1.700	1.816	1.967	1.738	0,634
11	Madaba	3.148	3.088	3.007	3.153	3.315	3.884	4.013	3.968	3.977	3.929	3.910	3.910	3.609	1,317
12	Mafraq	1.906	1.643	1.921	2.232	2.644	2.545	2.139	2.186	1.481	1.291	1.679	1.522	1.932	0,705
13	Ramtha	2.463	2.695	2.441	2.190	2.290	2.339	2.051	1.743	1.973	1.889	1.982	2.030	2.174	0,793
14	Salt	2.800	2.100	2.784	2.970	3.850	3.700	3.553	3.356	3.366	3.666	2.886	2.955	3.166	1,155
15	Tafila	1.045	1.132	960	850	817	806	800	615	689	804	801	896	851	0,311
16	Wadi Arab					5.759	7.342	8.042	6.229	5.686	4.473	4.888	5.523	5.993	2,187
17	Wadi Essir	838	825	1.013	828	805	833	897	984	1.025	981	927	1.010	914	0,334
	Total m3/d	214.749	216.500	216.288	214.360	216.070	215.510	223.353	226.088	219.173	210.023	207.506	210.053	217.804	79,498

ANNEX to 3.1.3.1

Water Quality Data of Raw Sewage and Treated Sewage of Existing Treatment Plants in 1997, 1998 and 1999

Table 1: Water quality of influent and effluent (averages) of wastewater treatment plants (1997)

Plant	BOD_5 inf	BOD_5 eff	COD inf	COD eff	TSS in	TSS eff	TN inf	TN eff	TP inf	TP eff	pH inf	NH_4-N inf	T °C inf	ABS inf	ABS eff	Cl inf	Cl eff	SAR eff	B eff	TDS inf	TDS eff	Ca eff	F.C eff	Hel. Eggs eff
Abu Nuseir	884	45	1390	107	717	41					8		15							1.380	857			
Aqaba	327	71	833	476	231	424					6.4		22							744	819		>2,400	
As Samra	565	196	1,234	460	501	146	118	91	13.6	18	7.2	74	19	18,3	18,3	311	330	6	5,3	1,125	1249		>120,000	0
Baqa	1,022	131	2,408	326	1,526	132														1,257	1,150			
Fuhis	775	5	1,325	37	674	23					7.1	88								872	837			
Irbid (centr.)	1,145	42	2,703	202	1,293	87					7.4													
Jerash	1,136	26	1,980	105	1,074	83					7									1,327	1,018		>1,600	
Karak	652	37	1,365	148	625	61						65								1,019	889		>1,600	
Kufranja	820	28	1,595	169							7.4	41	21							887	981			
Ma'an	725	187	2,272	613	947	886					7				19					948	947			
Madaba	1,051	342	2,107	691	1,095	214						80		27	21					1,438	1,318			
Mafraq	564	200	1151	595	577	234								16						951	1,171			
Ramtha	1,223	225	2,518	630	1,390	232					7.6									1,317	1,262		>24,000	
Salt	1,143	34	1,646	156	730	33					7.3		16							823	748			
Trafila	1,143	34	1,646	156	730	33					7.3	39	16		22					823	748			
Wadi Arab																								
Wadi Essir	476	54	936	226	614	138					7.6	60		11	4					990	860			

Note:
All results are expressed in mg/l except for pH, SAR, FC, and helminth eggs.
inf: Influent
eff: Effluent
FC is expressed in MPN/ 100 ml
Helminth eggs were expressed in eggs/l

BOD_5: Biol. oxygene demand
COD: Chem.oxygen demand
TSS: Tot. suspended solids
TN: T. Kj. nitrogen
TP: Total phosphorus

ABS: Alkali-Benceno-Sulphate
SAR: Sodium adsorption ratio
TDS: Total dissolved solids
FC: Fecal coliforms
B: Boron

Table 2: Water quality of influent and effluent (averages) of wastewater treatment plants (1998)

Plant	BOD_5 inf	BOD_5 eff	COD inf	COD eff	TSS in	TSS eff	TN inf	TN eff	TP inf	TP eff	pH inf	NH_4-N inf	T °C inf	ABS inf	ABS eff	Cl inf	Cl eff	SAR eff	B eff	TDS inf	TDS eff	Ca eff	F.C eff	Hel. Eggs eff
Abu Nuseir	588	17	1,378	90	556	33					7	68	16							1,060	1,079			>1
Aqaba	408	123	889	499	445	223					7	62	21							730	881		4,698	0
As Samra	634	130	1,403	416	457	108	103	107	15	14	7	73	22	28	25	368	392	6,5	0,74	1,184	1,134	75	140,000	0
Baqa	1,038	104	2,442	377	1231	119						98								1,219	1,322			0
Fuhis	533	8	1,425	55	565	19			30	17	7,2	104								1,013	1,037			0
Irbid (centr.)	1,128	54	2,771	241	1,100	92					7,5	60	21											>1
Jerash	1,090	27	2,307	120	994	69		55			7	68			1,1				27,4	1,177	1,015			0
Karak	687	29	1,432	157	698	75				48	8	64			304					1,050	869			0
Kufranja	1,071	56	1,300	207	932	144					7,5	76	23							966	849			0
Ma'an	701	178	2,293	670	983	443				74	7	128			9					1,254	1,495			0
Madaba	918	299	2,340	726	956	234			70	64		128		26	23,8					1,355	1,251			0
Mafraq	714	250	1,110	575	452	210				79		140	15							1,036	1,294			0
Ramtha	1,390	310	3,124	725	965	518					7,5	105								1,342	1,328			0
Salt	767	14	1,295	47	781	19						120	24							892	691			0
Trafila	1,090	34	1,576	140	638	23					7	70	18		2					976	739			0
Wadi Arab																								
Wadi Essir	586	58	1,287	212	457	116					8	80								1,205	1,035			0

Note:

All results are expressed in mg/l except for pH, SAR, FC, and helminth eggs.

inf: Influent

eff: Effluent

FC is expressed in MPN/ 100 ml

Helminth eggs were expressed in eggs/l

BOD_5: Biol. oxygene demand

COD: Chem.oxy gen demand

TSS: Tot. suspended solids

TN: T. Kj. nitrogen

TP: Total phosphorus

ABS: Alkali-Benceno-Sulphate

SAR: Sodium adsorption ratio

TDS: Total dissolved solids

FC: Fecal coliforms

B: Boron

Table 3: Water quality of influent and effluent (averages) of wastewater treatment plants (1999)

Plant	BOD_5 inf	BOD_5 eff	COD inf	COD eff	TSS in	TSS eff	TN inf	TN eff	TP inf	TP eff	pH inf	NH4-N inf	T °C inf	ABS inf	ABS eff	Cl inf	Cl eff	SAR eff	B eff	TDS inf	TDS eff	Ca eff	F.C eff
Abu Nuseir	634	17	1,233	79	601	29					7,3									1,095	823		<1,000
Aqaba	353	111	903	407	266	384						63								764	879		5,000
As Samra	760	118	1,864	494	545	113			16	26	7	76	23	34	13	326	377	6	1	1,271	1,258	98	140,000
Baqa	1,434	80	3,922	348	1,720	115											43			1,380	1,093		25,00
Fuhis	677	11	1,552	72	720	21					7,6									845	669		15,000
Irbid (centr.)	1,179	47	2,848	211	1,139	76					7,4												2,000
Jerash	1,119	33	2,523	123	943	68					7									1,127	1,132		
Karak	729	46	1,912	225	697	82					8									1,093	896		>1,600
Kufranja	1,331	65	1,649	209	1,023	143					7,9		23							1,234	935		
Ma'an	549	118	1,582	418	715	213					7	96			15					954	945		$16x10^6$
Madaba	1,382	282	5,107	784	1,657	239					8	110		30	21					1,584	1439		>15,000
Mafraq	566	198	1,358	525	424	249						111								1,083	1,284		>15,000
Ramtha	1,194	239	2,285	540	964	361					7									1,630	1,546		>15,000
Salt	845	11	1,454	75	828	13							15							823	666		>15,000
Tafila	942	35	1,538	138	700	47		27			7		16							976	798		
Wadi Arab	811	10	1,063	55		19					8												1,000
Wadi Essir	622	50	1,469	205	565	107					8	166								1,231	1,084		1,600

Note:
All results are expressed in mg/l except for pH, SAR, FC, and helminth eggs.
inf: Influent
eff: Effluent
FC is expressed in MPN/ 100 ml
Helminth eggs were expressed in eggs/l

BOD_5: Biol. oxygene demand
COD: Chem.oxygen demand
TSS: Tot. suspended solids
TN: T. Kj. nitrogen
TP: Total phosphorus

ABS: Alkali-Benceno-Sulphate
SAR: Sodium adsorption ratio
TDS: Total dissolved solids
FC: Fecal coliforms
B: Boron

ANNEX to 3.1.3.2

Water Quality Data of Industrial Effluent (1995 – 2000)

Water Quality Data for Industrial Effluent (1995-2000 by WAJ Lab)

No	Factory	Location	Quantity (m^3/day)	Destination of Discharge	Parameter	TSS	pH	BOD_5	TDS	COD	TOC	B	Br	Cl	NH_4	NO_3	OIL	PO_4	SO_4
					Unit	*mg/l*	-	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/L*
1	Agricultural Mafraq Co.	Al Za'atary, Mafraq	40	Dumping by vacuum tank	Count	13	12	6	13	13	0	0	0	0	12	0	0	11	0
					Maximum	168	8.1	632	2342	1652	0	0	0	0	43	0	0	26	0
					Minimum	17	5.5	31	1018	51	0	0	0	0	0.81	0	0	0.12	0
					Average	79.15	7.06	257.83	1392.62	406.08					17.30			5.97	
2	Al-Kawthar Dairy Co.	Al Khaldiah Mafraq	12	Dumping by vacuum tank	Count	19	18	16	19	19	0	1	0	1	11	0	0	12	1
					Maximum	40135	7.7	7366	30404	47664	0	0.6	0	2438	290.6	0	0	390	3000
					Minimum	88	4.3	424	678	335	0	0.6	0	2438	3.8	0	0	9.2	3000
					Average	3200.00	5.86	2529.50	4361.32	9751.58		0.60		2438.00	48.14			112.31	3000.00
3	Al-Mosely Factory For Ceramic	Sahab, Amman	80	Recycling	Count	16	14	4	13	15	0	2	0	0	5	1	0	9	0
					Maximum	35400	8.7	37	2424	1538	0	0.54	0	0	3.3	30	0	27.2	0
					Minimum	20	6.9	5	552	18	0	0.2	0	0	0.13	30	0	0.32	0
					Average	2479.50	7.59	15.25	1013.23	234.13		0.37			1.16	30.00		10.03	
4	Aread Co. For Oil & Detergent	Sahab, Amman	30	Dumping by vacuum tank	Count	21	19	13	20	21	0	5	0	0	12	0	1	10	0
					Maximum	16828	12.5	44320	29492	211299	0	1.3	0	0	218.9	0	3701	179.5	0
					Minimum	242	7.3	136	2116	331	0	0	0	0	0.65	0	3701	1.26	0
					Average	1910.90	10.85	7624.38	10225.60	34256.05		0.55			61.63		3701.00	96.23	
5	Dar Al-Dawa'	Naur, Amman	200	Gardening	Count	42	41	37	39	45	0	5	0	2	34	3	1	25	2
					Maximum	1088	10.2	2989	3614	5639	0	1.16	0	533	246	13	18	301	60
					Minimum	19	5.5	7	554	79	0	0.3	0	533	0	0.1	18	0.1	36
					Average	131.40	7.27	542.11	1515.08	1070.42		0.51		533.00	18.77	4.43	18.00	20.90	48.00
6	Deluxe Pants Factory /Qastal	Al Qastal, Amman	2	Dumping by vacuum tank	Count	22	22	9	21	23	0	1	0	3	10	2	0	10	2
					Maximum	4153	9.2	2585	15312	25423	0	1.69	0	142	224	0.6	0	118	2280
					Minimum	24	6.4	471	2333	1548	0	1.69	0	115.3	7.5	0.06	0	0	1764
					Average	331.36	7.73	1099.67	4793.67	5029.52		1.69		133.10	32.39	0.33		14.59	2022.00
7	Disinfection & Detergent Fact.	Salt	5	Dumping by vacuum tank	Count	17	18	13	18	18	0	5	0	0	6	0	0	7	0
					Maximum	4280	9.4	5377	14576	12422	0	1.4	0	0	284	0	0	160	0
					Minimum	90	5.8	0	404	280	0	0.8	0	0	9.6	0	0	0.22	0
					Average	537.35	7.32	2269.54	3387.89	5295.94		1.18			72.90			32.43	

No	Factory	Location	Quantity (m^3/day)	Destination of Discharge	Parameter	TSS	pH	BOD_5	TDS	COD	TOC	B	Br	Cl	NH_4	NO_3	OIL	PO_4	SO_4
					Unit	*mg/l*	-	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/L*
8	Eagle Distilleries Co.	Old Zarqa	150	Public sewer	Count	79	79	52	79	79	0	2	0	2	49	1	2	22	1
					Maximum	21906	9.9	9469	37316	432610	0	0.78	0	2848	2560	0.3	18	28	222
					Minimum	8	3	2	622	10	0	0.34	0	382	0	0.3	7	0.2	222
					Average	399.53	7.51	938.67	3189.90	8550.72		0.56		1615.00	108.29	0.30	12.50	6.07	222.00
9	Hadeal Factory For Juice	Ain Al Basha, Salt	0.2	Public sewer	Count	16	16	13	15	16	0	0	0	0	11	0	0	12	0
					Maximum	20114	9.5	12144	49490	46796	0	0	0	0	143	0	0	50	0
					Minimum	12	3.8	11	506	24	0	0	0	0	0.84	0	0	0	0
					Average	2233.56	6.69	4706.31	5314.80	11183.50					48.24			9.59	
10	Hussein Steel Factory	Al Ish Valley, Zarqa	40	Recycling	Count	55	53	26	52	54	0	0	0	4	31	4	1	6	0
					Maximum	901	9.5	510	10740	11400	0	0	0	1944	7.8	45	148.2	15	0
					Minimum	19	4.8	4	7.9	28	0	0	0	35.5	0.14	16	148.2	0.44	0
					Average	129.45	7.86	35.08	3509.33	336.63				997.38	1.45	24.43	148.20	3.15	
11	ICA Company Ltd.	Rusaifah, Zarqa	110	Public sewer	Count	91	89	62	93	94	0	10	0	2	47	6	1	20	7
					Maximum	7112	11.2	4635	10982	11106	0	1.1	0	442	66	20	169.8	38	310
					Minimum	14	4.6	4	213	9	0	0	0	137	0.13	0	169.8	0.3	40
					Average	241.25	7.52	326.89	2167.58	814.88		0.68		289.50	5.44	9.05	169.80	5.59	128.26
12	Intermediate Petrochemicals Indy	Al Ish Valley, Zarqa	11	Dumping by vacuum tank	Count	54	51	30	50	52	0	1	0	0	28	1	2	6	1
					Maximum	28657	12.9	103188	71960	1500000	0	0.9	0	0	87	1.15	340533	3.8	414
					Minimum	2	2.2	55	18	129	0	0.9	0	0	0.78	1.15	1536	0.45	414
					Average	2004.09	8.46	15807.90	9331.90	67075.21		0.90			22.08	1.15	171034.50	1.92	414.00
13	J. Petroleum Refinery/Domastic	Al Hashemiah, Zarqa	800	Gardening	Count	28	27	26	28	28	0	10	0	7	21	11	0	18	7
					Maximum	596	9.5	1809	3346	2876	0	1.89	0	1130	63.5	16.6	0	49	366
					Minimum	16	6.5	4	716	33	0	0	0	67	0.3	0	0	0.2	157.6
					Average	100.71	7.72	101.16	1842.71	230.25		1.03		521.37	22.21	7.77		19.07	238.44
14	Jordan Tanning Co. Ltd.	Zarqa	300	Public sewer	Count	81	79	62	80	81	0	6	0	0	57	1	3	26	0
					Maximum	3132	11.2	1164	19592	7028	0	1.4	0	0	429.4	11	78873	92	0
					Minimum	17	5.7	10	758	60	0	0.4	0	0	1.8	11	22	0.1	0
					Average	277.79	7.36	88.89	11810.95	466.15		0.93			105.85	11.00	26311.67	16.06	
15	Jordan Yeast Co.	Al Rusaifah, Zarqa	500	Gardening	Count	59	58	54	57	58	0	8	1	2	47	2	6	23	2
					Maximum	3972	8.6	69000	34742	89237	0	6	10	852	699	40.6	126.2	217	778
					Minimum	54	5	229	146	374	0	0	10	796	6.85	17.7	3	0	770
					Average	1081.69	6.34	9785.93	10863.86	22435.95		1.56	10.00	824.00	297.86	29.15	24.82	30.60	774.00

No	Factory	Location	Quantity (m^3/day)	Destination of Discharge	Parameter	TSS	pH	BOD_5	TDS	COD	TOC	B	Br	Cl	NH_4	NO_3	OIL	PO_4	SO_4
					Unit	*mg/l*	-	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/L*
16	Jordanian dairy Co. Ltd.	Awjan St, Zarqa	170	Public sewer	Count	86	86	63	85	85	0	0	0	0	59	2	0	13	0
					Maximum	2000	12	6186	30226	32060	0	0	0	0	75.5	0.6	0	83	0
					Minimum	3	3.9	2	482	8	0	0	0	0	0	0	0	1.42	0
					Average	164.77	7.53	414.13	2028.54	1023.48					6.02	0.30		14.13	
17	Kamel Azar For Soap Factory	Irbid	Stopped now	-	Count	4	4	3	3	4	0	1	0	0	1	0	1	1	1
					Maximum	103832	11.8	63708	2168	191233	0	1.2	0	0	479	0	1574	0	41.8
					Minimum	5090	1.5	19793	624	18342	0	1.2	0	0	479	0	1574	0	41.8
					Average	31082.75	8.70	49037.67	1411.33	104270.50		1.20			479.00		1574.00	0.00	41.80
18	Masoud Dairy Co.	Al Hashemiah, Zarqa	12	Gardening	Count	66	65	59	64	66	0	0	0	0	51	4	1	12	0
					Maximum	689	12.3	1781	5428	7479	0	0	0	0	86	0.1	210	27.5	0
					Minimum	2	3.2	2	528	11	0	0	0	0	0	0	210	0.08	0
					Average	162.29	7.88	298.35	1249.97	794.55					6.93	0.07	210.00	8.26	
19	Medmak Factory for Vet. Medecine	Al Ramtha, Irbid	0.1	Dumping by vacuum tank	Count	1	1	0	1	1	0	0	0	0	0	0	0	0	0
					Maximum	1012	7.8	0	2700	9892	0	0	0	0	0	0	0	0	0
					Minimum	1012	7.8	0	2700	9892	0	0	0	0	0	0	0	0	0
					Average	1012.00	7.80		2700.00	9892.00									
20	Middle East Co. For Food Mfg.	Al Jeazah, Amman	50	Gardening	Count	25	25	20	24	25	0	1	0	1	21	3	0	18	1
					Maximum	904	10	1694	4402	2718	0	1.36	0	1356	54.8	0.9	0	303	482
					Minimum	22	6.6	2	720	49	0	1.36	0	1356	0.7	0.1	0	1.3	482
					Average	147.60	7.92	194.70	2522.21	440.08		1.36		1356.00	6.52	0.60		40.07	482.00
21	Middle East For Textile Co.	Al Ish Valley, Zarqa	60	Used by Al Gasel and Wasege Co.	Count	67	60	51	64	66	0	9	0	1	31	2	0	17	1
					Maximum	842	9.5	1680	8442	5011	0	2.7	0	5325	292	31	0	602	1196
					Minimum	2	3.4	5	698	26	0	0.4	0	5325	1.69	0.8	0	0.17	1196
					Average	155.93	6.67	272.20	2586.67	977.58		1.15		5325.00	74.49	15.90		56.73	1196.00
22	Miller Beer Co.	Al Jeazah, Amman	800	Gardening	Count	14	14	5	14	14	0	5	0	4	4	6	2	1	4
					Maximum	1417	10.9	1081	1902	8839	0	1.89	0	263	64.6	2.85	14	0.17	540
					Minimum	15	3	108	360	187	0	0.7	0	63.9	2.7	0	10.5	0.17	55
					Average	234.36	6.21	541.20	884.43	2306.43		1.19		168.75	18.84	0.96	12.25	0.17	191.00
23	National Iron &Steel Co.	Zarqa	0	Recycling	Count	4	4	1	4	4	0	0	0	0	2	0	0	1	0
					Maximum	106	8	30	1872	108	0	0	0	0	1.1	0	0	0.3	0
					Minimum	14	7.3	30	926	29	0	0	0	0	0.59	0	0	0.3	0
					Average	56.75	7.70	30.00	1397.00	76.25					0.85			0.30	

No	Factory	Location	Quantity (m^3/day)	Destination of Discharge	Parameter	TSS	pH	BOD_5	TDS	COD	TOC	B	Br	Cl	NH_4	NO_3	OIL	PO_4	SO_4
					Unit	*mg/l*	-	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/L*
24	Pepsi Cola Co./Irbid	Al Ramtha, Irbid	50	Gardening	Count	27	27	26	28	28	0	7	0	0	14	8	0	12	1
					Maximum	588	11	264	5529	893	0	0.7	0	0	18	10	0	60	147.5
					Minimum	24	1.6	6	1186	54	0	0	0	0	0.5	0	0	6.2	147.5
					Average	141.44	7.59	66.88	2681.86	233.25		0.42			4.80	2.54		24.93	147.50
25	Poultry Slaughter-House	Al Dhlail, Zarqa	200	Gardening	Count	60	60	53	60	60	0	2	0	1	46	4	3	15	1
					Maximum	3992	8.2	2788	2820	14896	0	0.9	0	711	127	1.6	433	63	277
					Minimum	9	5.2	7	570	25	0	0.59	0	711	0.13	0.13	19	6.6	277
					Average	338.41	7.05	154.30	1270.42	641.40		0.75		711.00	22.34	0.62	260.00	32.25	277.00
26	Selpho chemicals Co.	Al Ish Valley, Zarqa	10	Dumping by vacuum tank	Count	97	91	73	95	97	1	25	0	2	67	9	2	47	1
					Maximum	76888	12.6	84110	111117	450000	2.21	14.65	0	4615	163	18	121125	494	31400
					Minimum	28	2.2	3	11.2	17	2.21	0.15	0	458	0.29	0	1927	0.5	31400
					Average	2439.94	8.63	5110.68	19038.45	20750.32	2.21	2.06		2536.50	17.70	5.12	61526.00	40.60	31400.00
27	Tomato Juice Factory / Arda	Der Ala, Al Ghore	2200 (in summer)	Gardening	Count	24	23	24	23	24	0	1	0	2	18	2	0	19	1
					Maximum	1950	8.6	1157	5504	2024	0	0.5	0	498	30	10.5	0	30	150
					Minimum	35	4.3	1	660	13	0	0.5	0	193.4	0.25	0	0	0.2	150
					Average	231.67	6.98	263.28	1648.00	505.67		0.50		345.70	5.22	5.25		5.80	150.00
28	United Co. for Chem. & Oil Ind.	Al Jeazah, Amman	30	Dumping by vacuum tank	Count	4	4	0	4	5	0	1	0	0	2	0	0	2	0
					Maximum	21488	10.2	0	39694	202958	0	3.29	0	0	28.2	0	0	105	0
					Minimum	13	6.1	0	480	890	0	3.29	0	0	7.4	0	0	0.26	0
					Average	6892.50	8.10		15875.00	60224.40		3.29			17.80			52.63	
29	Unium Co.	Urainbah, Amman	40	Gardening	Count	8	8	6	8	7	0	2	0	0	5	2	0	4	0
					Maximum	3870	8.8	64	1816	10672	0	0.62	0	0	15.5	30	0	30.2	0
					Minimum	9	7.5	4	514	21	0	0.4	0	0	0.64	1.91	0	7.6	0
					Average	506.00	8.19	26.83	1195.75	1574.29		0.51			4.30	15.96		16.93	

Water Quality Data for Industrial Effluent (1995-2000 by WAJ Lab.)

Factory	Date	Fe *mg/l*	Mn *mg/l*	Cu *mg/l*	Zn *mg/l*	Cd *mg/l*	Cr *mg/l*	Ni *mg/l*	Pb *mg/l*
Unium Co.	14. Mrz 99	0,28	0,06	0,08	0,25		0,04	0,05	0,15
Tomato Paste Factory	19. Sep 96	2	0,05	0,1	0		0,12	0,28	0,02
Disinfection & Detergent Fact.	20. Apr 96	1,78	0,02	0,15	0,65		0	0	0,19
	24. Feb 97	1,31	0,05	0,09	2,53		0,24	0,37	0,2
	30. Nov 97	0,23	0	0,11	0,41		0,11	0,05	0,43
	24. Mrz 99	0,42	0,86	0,34	0,73		0,12	0,05	0,03
United Co. for Chem. & Oil Ind.	30. Aug 99	0,7	0,06	0,22	0,51		0,86	0,31	0,09
Miller Beer Co.	07. Aug 99	0,09	0,02	0,06	1,18		0,03	0,09	0,04
	26. Sep 99	0,54	0,13	0,06	1,47		0,08	0,12	0,05
	12. Nov 99	0,16	0,01	0,01	0,08		0,09	0,05	0,04
	26. Feb 00	0,04	0,01	0,01	0,35		0,01	0,03	0,042
	02. Mrz 00	0,15	0,01	0,01	0,51		0,01	0,12	0,04
	01. Jul 00	0,43	0,06	0,01	1,13		0,02	0,06	0,15
Dar Al-Dawa'	20. Jun 95		0	0	0,03		0,07	0,13	0
	26. Jul 95		1,09	0	0		0	0	0
	27. Mai 96	0,44	0,06	0	0,15		0	0,03	0,02
	25. Okt 97			0	0,4				0,42
	18. Apr 98	0,19	0	0	13		0,18	0,07	0
	13. Mrz 99	0,17	0,05	0,14	0,35		0,07	0,02	0
	21. Mrz 99	0,19	32	0,22	0,86		0,15	1,1	0,04
	12. Apr 99	0,37	0,06	0,02	0,33		0,09	0,2	0,028
	11. Mai 99	0,17	0,01	0,06	0,18		0,19	0,23	0,045
	26. Jan 00	0,28	0,21	0,01	1,6		0,01	0,11	0,1
	25. Apr 00	0,71	0,23	0,01	0,55		0,04	0,12	0,01
Middle East Co. for Food Mfg.	14. Sep 96	0,27	0,09	0,27	0,67		0,27	0,33	0,27
	18. Mai 98						0,01	0,4	
	26. Mai 98			0,19	0,26			0,29	
Deluxe Pants Factory /Qastal	03. Jun 96	0,95	0	0	0		0	0	0,32
	07. Apr 97	0	0,01	0	0,3		0,04	0,28	0,01
	17. Mai 97	0,56	0,04	0	0,65		0	0,17	
	01. Feb 98	0,11	0,04	0,09	0,55		0	0,15	0,06
	17. Mrz 98	1,24	0,12	0,02	0,22		0,18	0,21	0,16
	07. Feb 99	1,42	0,29	0	0,2		1,33	0,7	2,5
	30. Aug 99	0,13	0,11	0,06	0,7		0,17	0,45	1,36
	26. Sep 99	1,34	1,24	0,1	1,95		0,3	0,23	0,3
	08. Nov 99	0,31	0,04	0,07	0,7		0,07	0,07	0,04
	02. Mrz 00	0,66	0,01	0,01	0,66		0,03	0,43	0,06
Al-Mosely Factory for Ceramic	09. Okt 95	0,03	0	0,02	0,03		0,02	0	0
	01. Dez 96	0,07							
	30. Dez 96	0,65	0,8	0,35					
	29. Sep 97	0,16	0,03	0,03	0,13		0,11	0,26	0,03
	18. Mai 98	2,46	0,16	0,12	0,44		0	0,28	0,15
	07. Apr 99	0,35	0,07	0,51	0,59		0,07	0,03	0,02
	30. Aug 99	0,2	0,48	0,08	0,72		0,01	0,47	0,002
	21. Feb 00	0,25	0,01	0,01	1,02		0,01	0,1	0,09

Water Quality Data for Industrial Effluent (1995-2000 by WAJ Lab.) (continued)

Factory	Date	Fe *mg/l*	Mn *mg/l*	Cu *mg/l*	Zn *mg/l*	Cd *mg/l*	Cr *mg/l*	Ni *mg/l*	Pb *mg/l*
Kamel Azar for Soap Factory	02. Dez 99	0,63	0,08	0,15	1,12		0,72	0,08	2,3
	09. Dez 99	0,5	0,1	0,1	0,8		9,9	0,01	3
Medmak Factory for Vet. Medicine	06. Mrz 00	0,23	0,03	0,04	0,15		0,01	0,02	0,11
Pepsi Cola Co./Irbid	02. Jun 96	0	0	0	0		0	0,01	0,05
	06. Jul 96	0	0	0	0,01		0,02	0	0,04
	18. Apr 98	0,45	2,13	0	0,44		0,12	0,01	0
	14. Sep 98	0,3	1,53	0,03	0,45		0,2	0,03	0,01
	12. Aug 99	0,63	0,89	0,05	0,25		0,07	0,18	0,06
	11. Sep 99	0,81	1,2	0,04	0,77		0,09	0,07	0,2
	27. Sep 99	0,9	1,62	0,07	1,59		0,1	0,13	0,1
	09. Okt 99	0,29	0,15	0,1	0,38		0,04	0,07	0,09
	10. Nov 99	0,32	0,44	0,01	0,39		0,01	0,01	0,06
	02. Dez 99	0,2	0,18	0,24	0,18		0,01	0,04	0,07
	15. Dez 99	0,2	0,18	0,24	0,18		0,01	0,04	0,07
	03. Feb 00	0,06	0,35	0,01	0,12		0,01	0,05	0,09
	20. Apr 00	0,5	0,12	0,22	0,33		0,06	0,17	0,001
	02. Mai 00	0,32	0,08	0,01	0,35		0,01	0,1	0,06
	13. Jul 00	0,07	0,09	0,13	0,32		0,01	0,01	1,8
Agricultural Mafraq Co.	19. Sep 96	0,34	0,07	0,07	0		0,14	0,68	0
	29. Apr 00	0,12	0,01	0,02	0,32		0,04	0,1	0,01
Aread Co. for Oil & Detergent	28. Feb 99	1,93	0,48	0,21	1,32		0,06	0,11	0,4
	06. Sep 99	2,16	0,17	0,26	1		0,13	0,1	0,1
	17. Feb 00	1,82	0,05	0,13	0,51		0,04	0,02	0,03
Poultry Slaughter House	08. Dez 99	0,45	0,07	0,02	0,6		0,01	0,1	0,004
	05. Jan 00	0,13	0,15	0,01	0,15		0,01	0,01	0,03
ICA Company Ltd.	09. Mai 96	0,06	0	0	0		0	0,07	0,12
	05. Aug 96	0,91	0,04	0,23	0			0,86	
	30. Mrz 97	0,18	0	0,01	0,36		0,02	0	0,01
	04. Jun 97	1,13	0,07	0	0,81		0,05	0,04	0
	13. Sep 97	1,99	0,05	0,05	0,72		0,04	0,12	0,48
	19. Apr 98	0,22	0,03	0	0,48		0,08	0,05	0
	12. Mai 98	1,23	0	0,24	0,66		0	0,29	0,23
	08. Sep 98	3,65	0,25	0,05	0,16		0,63	0,34	0,26
	19. Apr 99	0,08	0,04	0,04	0,15		0,08	0,05	0,05
	25. Dez 99	0,08	0,02	0,02	0,19		0,09	0,04	0,02
Jordan Yeast Co.	04. Jun 97	26,6	1	0,38	1,53		0	0,97	0
	06. Mrz 99	6,1	0,21	13,3	1,96		7,92	0,25	0,07
	21. Mrz 99	3,6	4,7	0,14	0,38		0,02	0,2	0,1
	04. Apr 99	4,9	0,61	0,1	0,76		0,67	0,71	0,08
	18. Apr 99	1,72	0,24	0,08	0,65		0,13	0,19	0,06
	19. Apr 99	4,93	0,27	0,08	0,71		0,22	0,25	0,25
	20. Apr 99	2,67	0,24	0,1	1,01		0,14	0,29	0,036
	13. Jun 99	1,49	0,06	0,01	0,44		0,3	1,33	0,075
	30. Jun 99	3,45	0,35	0,11	0,55		0,14	0,99	0,1
	05. Jul 99	3,2	0,26	0,09	1,2		0,14	0,85	0,14
	01. Dez 99	3,35	0,96	0,1	1,76		0,07	0,29	0,17
	06. Apr 00	5,3	0,28	0,14	0,7		0,24	0,49	0,48

QualndWWhm

Water Quality Data for Industrial Effluent (1995-2000 by WAJ Lab.) (continued)

Factory	Date	Fe mg/l	Mn mg/l	Cu mg/l	Zn mg/l	Cd mg/l	Cr mg/l	Ni mg/l	Pb mg/l
Jordanian Dairy Co. Ltd.	20. Feb 99	0,38	0,06	0,11	0,75		0,14	0	0,25
Eagle Distilleries Co.	16. Feb 00	0,32	0,01	0,01	0,34		0,01	0,01	0,02
Hussein Steel Factory	07. Jul 96	0,36	0	0	0,01		0,01	0	0
	15. Okt 96	0,28							
	19. Jan 97	0,63							
	30. Nov 97	1,31	0,23	0,04	0,22		0,01	0,19	0,37
	24. Feb 98	2,11	0,36	1,79	0,3		1,46	1,66	0,15
	08. Mrz 99	0,13	0,18	0,17	0,2		0,01	0,04	0
	19. Apr 00	0,39	0,39	0,05	0,31		0,02	0,22	0,04
Middle East for Textile Co.	11. Mai 97	0,18	0,04	0,53	0,59		0,12	0,84	0
	04. Apr 99	0,8	0,21	0,05	0,48		0,16	0,3	0,07
	16. Okt 99	0,65	0,15	0,09	0,71		0,05	0,2	0,05
	11. Jan 00	0,08	0,16	0,01	0,36		0,02	0,15	0,03
	31. Jan 00	0,12	0,14	0,03	0,4		0,05	0,13	0,04
	11. Apr 00	0,17	0,05	0,02	0,25		0,05	0,17	0,09
National Iron & Steel Co.	07. Apr 97	0,1							
	30. Nov 97	0,31	0,08	0,14	0,29		0	0,11	0,33
	19. Apr 00	0,06	0,23	0,03	0,22		0,01	0,19	0,001
Intermediate Petrochemicals Ind.	30. Mai 96	35,7	0,46	0,14	0,14		0	0	0,31
	19. Aug 96	3,8	0	0,01	0,02			0	
	06. Okt 96	0,84	0	0,04	0		0,12	0	0,06
	06. Aug 97	0,04	0,02	0	0		0,13	0,11	0
	05. Feb 98	0,37							
	07. Nov 98	20,06	0,84	1,08	0,64		1,08	0,25	0,14
	09. Sep 99	0,17	0,06	0,15	0,25		0,15	0,23	0,1
J. Petroleum Refinery/Domastic	28. Aug 97	0,66	0,09	0,05	0,08		0,31	0,36	0,03
	21. Apr 98	0,395	0,036	0,016	0,206		0,023	<0.05	<0.03
Selpho Chemicals Co.	04. Sep 95		0,12	0,1	0,68		0,13	0,06	0,22
	12. Sep 95		0,06	0,2	0		0	0,05	0,11
	15. Okt 95	0,15	0	0,17	0,07		0	0,14	0,02
	09. Jun 96	14,48	0,24	0,56					0,46
	15. Jun 96	0,01	0,05	0	0		0	0	0
	25. Jul 96	0,46	0	0	0			0	
	13. Okt 96	0,14	0,24	0,03	0,22		0,15	0,87	0,09
	28. Apr 97	0,05	0,03	0	0,18		0,04	0,02	0,5
	06. Dez 97	0,51	0	0	0,14		0	0,17	0
	05. Feb 98				2,42				
	14. Mai 98	0,63	0,01	0,04	0,47		0,01	0,14	0,14
	24. Mai 98	0,89	0,08	0,1	0,23		0,03	0,34	0
	14. Okt 98	9,25	0,13	0,04	0,46		1,6	0,1	
	17. Dez 98	0,54	0,38	0,02	0,44		0,52	0,08	0,06
	19. Mai 99	1,92	0,28	0,13	0,73		0,01	0,4	0,3
	31. Jan 00	7,22	0,54	0,26	1,94		0,31	0,5	0,7
	25. Mrz 00	0,08	0,01	0,01	1		0,04	0,09	0,05
Jordan Tanning Co. Ltd.	29. Aug 95		0,12	0	0		1	0,02	0
	24. Apr 96	0,24	0,08	0	0		0,6	0	0,25
	19. Jun 96	0,79	0,24	0,17	0		1,05	1,31	
	15. Okt 96						0,63		
	12. Jan 97						0,17		
	11. Mai 97	1,35	0,11	0,41	0,73		0,51	0,49	0,01
	05. Jun 97	0,62	0,04	0	0,44		0,1	0,56	0,04
	13. Sep 97	0,85	0,1	0	0,34		0,19	0,5	0,55
	04. Okt 97						0,6		
	19. Jan 98	0,63	0,13	0,18	0,59		0,68	0,49	0,3
	21. Mrz 98	0,44	0,15	0,04	0,25		0,02	0,26	0,29
	13. Mai 98	1,09	0,12	0,15	0,16		0,23	0,38	0,66
	03. Mrz 99	2,1	0,11	0,14	5,6		0,5	0,47	0,4
	26. Aug 99	1,47	0,11	0,01	0,95		0,2	0,2	0,06
	29. Sep 99	0,15	0,17	0,19	0,57		0,15	0,13	0,07
	16. Okt 99	0,48	0,1	0,08	0,16		0,33	0,5	0,47