ANNEX to 8.3

Environmental Evaluation

Annex to 8.3 “Environmental Evaluation”

Contents

1 Environmental Legislation Related to Water Resources Management

1.1 National Environmental Laws and Policies

1.1.1 Basic Law of Environmental Protection

The basic environmental law in Jordan was enacted in 1995 as Environment Protection Law (Law No. 12/1995). The main provisions of this law are as followings:

- Establishment of a governmental agency called the General Corporation for Environment Protection (GCEP) as an autonomous body with administrative and financial independence, and the right to act in all legal procedures for environmental protection in Jordan;

- Establishment of a fund called Environment Protection Fund, to be managed by GCEP for environmental protection purposes.

- Establishment of a Higher Council for Environment Protection with the mandate to approve environmental policies and strategies, approve rules and regulations as developed by GCEP and, as its own discretion, issue regulations, decisions, and propose new laws.

- Specifications of punishment against violations of environmental regulations, such as improper economic activities, disposal of pollutant within the territorial waters or coastal areas, disturbance of corals, disposal of harmful materials to the environment, noise above limitation, and emission of pollutants from industries and vehicles.

Regarding water sector, Article 17 of the Law entrusted GCEP, in coordination with the concerned governmental agencies, to conduct issuance of general standards and specifications for water uses, and supervision of water sources for pollution control.

Under this Law, the Secretary General of MOWI was appointed the member of the Higher Council for Environment Protection. In MOWI, the Directorate of Environment is the functional department working for the environment related to water and irrigation.

1.1.2 Environmental Action Plan

The first comprehensive plan for environmental protection in Jordan, named National Environmental Action Plan (NEAP) was put forward by the Ministry of Planning in 1996.

The study for preparation of the NEAP was mainly supported by the World Bank, and also under the assistance of JICA.

The NEAP consists of four main parts. The first part sets the conceptual framework of the plan, with an overview of national development and the environment; the second part reviews the key environmental issues and concerns that are facing the country; the third part deals with the institutional and legal set-up of the environment sector in Jordan; the final part proposes plans for national environmental action. The NEAP has highlighted the main threats to water resources, land resources and land cover, urban environment, cultural and natural heritage. 10 issues are listed as main environmental issues in Jordan with water depletion and water pollution as the top two. It is pointed out that Jordan's main long term action plan in water resources should continue to focus on efficient water management and conservation. Table 4.1.1-1 outlines the measures and actions proposed in the NEAP as long-term action plans regarding the priority issues of water resource management.

The NEAP has proposed 20 priority actions to be taken within a five-year period regarding water resources, land resources, urban environment, cultural and natural heritage, as well as capacity building of GCEP. Table 4.1.1-2 summarizes the goal, objective and expected outputs of the actions related to water resource management.

Implementation of the priority actions and long-term actions shown in the two tables are under the responsibility of MOWI/WAJ/JVA. Most of the activities in MOWI are in fact related to these actions, and so are all the projects supported by foreign donors including this study.

1.1.3 Recent Movement of Environmental Legislation

Since its establishment in 1995 and commencement of its function as a governmental agency for environmental protection in Jordan, GCEP has engaged in preparation of national environmental regulations. Up to now, three newly established regulations have been approved by Parliament regarding marine protection, air pollution control and hazard waste management. Another three regulations regarding soil pollution control, pesticide control and environment administration and financing are submitted to the Parliament for final approve.

Table 1.1-1 National Environmental Actions Required in Water Resource Management

Priority Issue	Available Instruments					
	Legislation, Regulation	Investments	Economic	Institutional	Information	Public
Water Depletion						
Over	Enforce	Promote	Adjust pricing	Reorganize	Study	

extraction of groundwater	regulations/ Close unlicensed wells	water resource development and harvesting	of water	water sector (ongoing)/ Design water reallocation policy	alternative water development methods	
Water losses	Enforce laws and regulation	Rehabilitate water network (ongoing)/ Rehabilitate irrigation network		Reorganize water sector (ongoing)/ O&M capacity building (ongoing)	Study water losses (ongoing)	Intensive control measures and public information
Lack of use of non-conventional water	Enforce standards/ Upgrade standards/ Monitor wastewater quality (ongoing)	Upgrade the WWTPs (ongoing)/ Build desalination plants/ Promote regional cooperation		Promote water harvesting/ Improve coordination	Study available sources and technologies	
Water Pollution						
Domestic waste disposal	Enforce legislation, regulations, standards	Upgrade existing WWTP (ongoing)			Establish long-term monitoring program	
Industrial wastewater disposal	Enforce regulations	Adopt cleaner technology	Apply pollutant pays principle/ Charge industries for environmental damage	Enhance capabilities of existing labs (ongoing)		Enhance awareness of industrialists/ Provide industry specific guidelines
Salinization of water	Enforce regulations/ Close unlicensed wells		Charge marginal cost of water	Support MWI	Study aquifers (ongoing)	Enhance awareness among groundwater users

Source: Ministry of Planning (1996), National Environmental Action Plan

Table 1.1-2 NEAP Priority Actions in the Water Resources Sector

Priority Action	Overall Goal	Specific Objective	Expected Outputs
Rehabilitation of wastewater treatment plants	The action will contribute to alleviate Jordan's water shortage and reduce water pollution by ensuring optimum water treatment.	The specific objective is to rehabilitate the existing wastewater treatment plants.	The immediate priorities and targets for the next five years at specific sites and locations as identified by WAJ will be accomplished.
Upgrading of industrial technologies to minimize water pollution	The action will contribute to improve the quality of water in Jordan.	The specific objective is to provide up-to-date clean technology to major polluting industries in line with recommendations of the industrial audit	Key polluting industries will be provided with the technology to produce acceptable effluents. The immediate priorities for the next five years are to be based on the USAID report and

		sponsored by USAID and the Cowi Consult study of the MOP.	agreed upon by WAJ and the chamber of Industry and Industrialists.
Pricing of water	The action will contribute to improve the shortage of water in Jordan by minimizing waste.	The specific objective is to decrease water waste in different sectors by bringing the price of water in line with the actual cost of water operation and maintenance program.	Block tariffs are established in all sectors of the economy to reflect the actual cost of operation and maintenance of water production facilities. This tariff system will acknowledge the basic human needs for water by providing the first block at subsidized prices.
Enforcement of regulations in the water sector	The action will contribute to alleviate the shortage and improve the quality of water in Jordan.	The specific objectives are (1) to prevent over extraction of groundwater, and (2) to prevent liquid waste disposal by industry.	Development of groundwater wells without license is prohibited, and major industries connected to the sewer system comply with regulations for safe disposal of water.
Restructuring of the water sector	The action will contribute to improve the management of scarce water resources.	The specific objective is the enable quick and coordinated decision making.	The water sector is restructured, is better managed, and is operating more efficiently.
Development of water resources under the Jordan-Israel Peace Treaty	The action will contribute to increasing the quantity of water available to Jordan.	The specific objective is the increase national available water by 20% by constructing dams along Jordan river and related pipeline network.	Domestic water supply for large population in Amman is ensured.

Source: Ministry of Planning (1996), National Environmental Action Plan

According to information from GCEP, a new Environment Protection Law is under preparation and will probably put forward by end of 2000. This new law will lead to the establishment of the Ministry of Environment. The whole function of GCEP will thus be transferred to the new Ministry and the responsibility of the Minister of the Municipal and Rural Affairs and the Environment (MMRAE) for the environment protection in Jordan will be transferred to the Minister of Environment accordingly.

1.2 Regulations and Standards for Water Environment

1.2.1 Drinking Water Quality Standard

The drinking water quality standard currently applied in Jordan was JS 286 for Water – Drinking Water put forward by the Department for Standards and Metrology in 1997. The WHO Guidelines for Drinking-Water Quality (1993) were referred to a great extent in the preparation of this new Jordanian standard. Totally 51 water quality items were specified in the standard. Among them TTHM (total trihalomethanes) and 13 synthetic organic matters (mainly pesticides) are new items added to the standard list. Thermotolerant coliform is introduced as one of the bacteriological parameters instead of fecal coliform in the previous standard. Table 1.2-1 summarizes all the parameters and their standard values.

Table 1.2-1 Jordanian Drinking Water Quality Standard

Item	Maximum Allowable Level	Maximum Limit Level
(1) Bacteriological parameters		
Total coliform	1.1 MPN/100 mL (multi-tube method) MPN free from 100 mL sample (membrane filtration method)	
Thermotolerant coliform	Free from 100 mL sample	
Disease germs and intestinal viruses	Free from 100 mL sample	
* Drinking water should be free from all phases of living microorganisms		
(2) Aesthetic parameters		
Taste	No abnormality	
Odor	No abnormality	
Color (unit)	10	15
Turbidity	1	5
Residual free chlorine	0.2 – 1.0 mg/L after contact time for 15 min	
(3) Parameters with negative effects (mg/L)		
pH	6.5 – 8.5	
TDS	500	1500
Total Hardness	100	500
MBAS	0.2	0.5
NH_4	0.5	
Al	0.1	0.2
Mn	0.1	0.5
Fe	0.3	1.0
Cu	1.0	1.5
Zn	3.0	5.0
Na	200	400
Cl	200	500
SO_4	200	500
(4) Health significant parameters (mg/L)		
As	0.01	
Ba	0.2	
Pb	0.01	
Se	0.01	
B	0.3	
Cd	0.003	
Cr	0.05	
CN	0.07	
Hg	0.002	
Ni	0.1	
Sb	0.2	
F	0.005	
NO_2	1.5	
NO_3	50	70*
TTHM (g/L)**		
* In case no other resource available		
** Include bromoform, dibromochloromethane, bromodichloromethane, chloroform		
(5) Radioactive constituents (Bq/L)		
Alpha emitters	0.1	
Beta emitters	1.0	
(6) Organic chemicals (mg/L)		
Parathion	0.035	
Endrin	0.0002	
Lindane	0.004	

Item	Maximum Allowable Level	Maximum Limit Level
Methoxychlor	0.1	
Toxaphene	0.005	
Malathion	0.15	
Permethrin	0.002	
Dimethoate	0.02	
Diazinon	0.02	
BHC	0.04	
Chlorophenoxy acids		
2,4-D	0.1	
2,4,5-TP	0.01	
* The grand total for pesticides should not exceed 0.1 mg/L		

The Drinking Water Quality Standard also specified the frequency of sampling regarding chemical, physical and bacteriological analyses according to water sources and the scale of water supply system.

1.2.2 Standard for Industrial Wastewater Discharge and Reuse

Regarding industrial wastewater discharge and reuse, the standard currently applied is JS 202 for Water – Industrial Wastewater put forward in 1991. The standard specified 40 water quality parameters with their maximum allowable limits for irrigation, artificial recharge and discharge to the sea or surface waters. Table1.2-2 summarizes these parameters.

Table 1.2-2 Jordanian Standard for Industrial Wastewater

Parameters	The Maximum Allowable Limit			
	Irrigation	Artificial Recharge	Discharge to	
			Sea	Rivers, Wadis and Catchment Areas
BOD_5	-	50	-	50
COD	-	150	200	150
DO	1	1	5	1
TDS	2000	1500	-	3000
TSS	100	-	-	50
pH	6.5 – 8.4	6.5 – 9	5.5 – 9	6.5 – 9
Color (PCU)	-	15	75	15
Temperature (^oC)	-	-	4	-
Oil & Grease	5	-	4	-
Phenol	0.002	0.002	1	0.002
Detergents	-	15	-	25
NO_3-N	30	12	-	12
NH_4-N	5	5	12	5
Total N	50	-	125	-
PO_4-P	-	-	-	15
Cl	350	500	-	500
SO_4	400	500	-	500
F	-	1.5	-	1.5
HCO_3	500	-	-	-
Na	-	400	-	-
Mg	-	-	-	-

Ca	-	-	-	-
SAR	9	-	-	-
Al	5	0.3		5
As	0.1	0.05	0.1	0.05
B	1	1	-	1
Total Cr	0.1	0.05	0.3	0.1
Cu	0.2	2	0.1	2
Fe	5	1	2	1
Mn	0.2	0.2	0.2	0.2
Ni	0.2	0.1	0.02	0.2
Pb	1	0.1	0.1	0.1
Se	0.02	0.05	0.02	0.02
Cd	0.01	0.02	0.07	0.01
Zn	2	15	-	15
CN	0.1	0.1	1	0.1
Hg	0.001	0.001	0.001	0.001
TFC (MPN/100mL)	-	-	5000	-
TFCC (MPN/100mL)	1000	1000		1000
Nematodes (Eggs/L)	< 1	-	-	< 1

*The unit is mg/L unless otherwise indicated

The maximum allowable limits are not specified in the standard for the industrial wastewater connected to the public sewer system. In this case, the quality must meet the instructions of WAJ for linkage into the sewer system. Although WAJ has its own criteria in this regard, it is advisable that the criteria should be put forward as a national regulation or added to this standard to increase their legal power.

1.2.3 Standard for Treated Domestic Wastewater

The current standard applied for the discharge and reuse of the treated domestic wastewater is JS 893 for Water – Treated Domestic Wastewater put forward in 1995. The categories of wastewater reuse include irrigation for agriculture (with further sub-categories as that for vegetables and that for fruit trees and other crops), irrigation for fodder, fisheries, artificial recharge and public parks. There are totally 47 water quality parameters specified in the standard with the maximum allowable limits (Table 1.2-3).

The values for some of the parameters related to the acceptability of water for irrigation are comparable with those proposed by FAO (FAO Guidelines for Interpretations of Water Quality for Irrigation, 1989). For instance, TDS of 2000 mg/L equals the FAO limit of severe restriction on irrigation use.

Sampling frequency is also specified in the standard. Frequent sampling of microbiological

tests is required because disease related problem is of public concern during the treated domestic wastewater reuse. It is noticeable that the standard stresses the importance of disinfection of the treated wastewater by requiring a concentration of residual chlorine as 0.5 mg/L regarding reuse for vegetables and public parks.

Table 1.2-3 Jordanian Standard for Treated Domestic Wastewater

Parameters	Vegetables	Fruit Trees, Forestation, Crops and Grains	Discharge to Wadis & Catchment Areas	Artificial Recharge	Fisheries	Public Parks	Fodder
BOD_5	150	150	50	50	-	50	250
COD	500	500	200	200	-	200	700
DO	> 2	>2	> 2	>2	> 5	>2	>2
TDS	2000	2000	2000	1500	2000	2000	2000
TSS	200	200	50	50	25	50	250
pH	6 – 9	6 – 9	6 – 9	6 – 9	6.5 – 9	6 – 9	6 – 9
Color (PCU)	-	-	75	75	-	75	-
FOG	8	8	8	Nil	8	8	12
Phenol	0.002	0.002	0.002	0.002	0.001	0.002	0.002
MBAS	50	50	25	15	0.2	15	50
NO_3-N	50	50	25	25	-	25	50
NH_4-H	-	-	15	15	0.5	50	-
T-N	100	100	50	50	-	100	-
PO_4-P	-	-	15	15	-	15	-
Cl	350	350	350	350	-	350	350
SO_4	1000	1000	1000	1000	-	1000	1000
CO_3	6	6	6	6	-	6	6
HCO_3	520	520	520	520	-	520	520
Na	230	230	230	230	-	230	230
Mg	60	60	60	60	-	60	60
Ca	400	400	400	400	-	400	400
SAR	9	9	9	9	-	12	9
Residual Chlorine	0.5	-	-	-	-	0.5	-
Al	5	5	5	1	-	5	5
As	0.1	0.1	0.05	0.05	0.05	0.1	0.1
Be	0.1	0.1	0.05	0.05	0.05	0.1	0.1
Cu	0.2	0.2	0.2	0.2	0.04	0.2	0.2
F	1.0	1.0	1.0	1.0	1.5	1.0	1.0
Fe	5.0	5.0	2.0	1.0	1.5	1.0	1.0
Li	2.5	5.0	1.0	1.0	-	3.0	5.0
Mn	0.2	0.2	0.2	0.2	1.0	0.2	0.2
Ni	0.2	0.2	0.2	0.2	0.4	0.2	0.2
Pb	5.0	5.0	0.1	0.1	0.15	0.1	5.0
Se	0.02	0.02	0.02	0.02	0.05	0.02	0.02
Cd	0.01	0.01	0.01	0.01	0.015	0.01	0.01
Zn	2.0	2.0	15	15	0.6	2.0	2.0
CN	0.1	0.1	0.1	0.1	0.005	0.1	0.1
Cr	0.1	0.1	0.05	0.05	0.1	0.1	0.1
Hg	0.001	0.001	0.001	0.001	0.00005	0.001	0.001
V	0.1	0.1	0.1	0.1	-	0.1	0.1
Co	0.05	0.05	0.05	0.05	-	0.05	0.05
B	1.0	1.0	2.0	1.0	-	3.0	3.0
Mo	0.01	0.01	0.01	0.01	-	0.01	0.01

Parameters	Vegetables	Fruit Trees, Forestation, Crops and Grains	Discharge to Wadis & Catchment Areas	Artificial Recharge	Fisheries	Public Parks	Fodder
TFCC (MPN/100mL)	1000	-	1000	1000	1000	200	-
Pathogens	-	-	-	-	100000	Nil	-
Ameba & Gardia (Cyst/L)	< 1	-	-	-	-	Nil	-
Nematodes (Eggs/L)	< 1	-	< 1	-	-	< 1	< 1

*The unit is mg/L unless otherwise indicated

2 Present Condition of Water Environment

In Jordan, water shortage is in any sense the most serious environmental problem as has been stressed in the NEPA report. The present condition regarding the two top issues, i.e. water depletion and water pollution, are reviewed in Chapter 4 of Main Report with details and hence will not be repeated in this chapter. The following sections will discuss other problems related to water environment.

2.1 Water Quality for Domestic Water Supply

In the interview survey to inhabitants covering the whole Kingdom, coliform tests were conducted using portable bacteria checker regarding drinking water from the distribution network, storage wells and storage tanks. The results are summarized in Table 2.1-1.

The results show clearly the tendency of bacteria pollution of drinking water in the process of water supply. From the network, 61.1% of the samples are free from coliform, but when water enters the storage wells in the residential area, the percent drops to 34.5%. It further drops to 25% as water is pumped to the water tanks on the roof of the residential building. The term 'Much Detected' in the table indicates the samples with uncountable number of coliform. It is noticeable that even from the network, 13.9% of the samples are bacterially unsuitable for drinking. The percent increases to 27.6% and then 50% for storage wells and storage tanks, respectively. In Jordan, due to scarcity water, drinking water is supplied to the consumers only once or twice per week through the network. In order to keep certain amount of water for daily use, every building has a storage well to receive water from the network, and then pump water from the well to the elevated water tank from where water is finally supplied to every household. Apparently, such a system increases the stagnant time of water up to several days before being used. This thus results in an environment for bacteria to grow in the storage facilities.

Generally speaking, disinfection by chlorination is performed at each public water supply station before the water is pumped into the network. According to the Jordanian Drinking Water Quality Standard (Table 1.2-1), coliform in drinking water should be less than 1.1 MPN/100 mL (using multi-tube method). However, according to the drinking water quality monitoring data collected from WAJ Lab (refer to Attachment for the data table), coliform contents higher than the standard limit frequently occur at some of the stations for water supply. Insufficient disinfection may be one of the reasons for the occurrence of coliform in the network.

On the other hand, secondary pollution is easy to happen after water is supplied to the consumers but stored in the wells or head tanks for a long period of time without application of in situ disinfection. Even though there is residual free chlorine in the water entering the network, it runs out gradually in the process of water distribution and thus cannot effectively prevent bacteria growth in the storage wells or tanks. Because drinking water with high contents of coliform is of high risk for prevailing intestinal disease, further investigation on this problem is extremely necessary.

Although water storage is under the consumer's responsibility, it is still advisable that governmental agencies of water supply and public health should take effective measures. Advisories and guidance on the protection of secondary water pollution should be given to all the consumers. This includes not only technical assistance, but also public awareness on this issue.

2.2 Quality of Treated Wastewater for Irrigation Reuse

As has been highlighted in the Water Utility Policy (MOWI, 1997), appropriately treated wastewater generated from the urban area is one important part of water resources in Jordan. Actually, large scale wastewater reuse has been practiced in Jordan since years ago through the KTR-Zarqa River-KAC system which partially carries the effluent from As Samra WWTP to Jordan Valley for irrigation.

Table 2.2-1 summarizes the quantity of irrigation water used in Jordan Valley in the recent 5 years, with the amounts from two sources – KAC North and KTR. It is seen from this table that from 1995 to 1999, totally 501.89 MCM water was used for irrigation in the middle and south Jordan Valley area. Of this amount, 365.13 MCM or 72.75% is from KTR, and 136.76 MCM or 27.25% is from KAC North. From Table 4.1.1-3 in Chapter 4 of Main Report, it is calculated that about 61% of the KTR water was from As Samra effluent in the past five years. Using this figure, the amount of treated wastewater actually used in Jordan Valley in the past five years can be roughly estimated as 222.73 MCM, or 44.38% of the total irrigation water.

Table 2.1-1 Results of Coliform Tests Conducted by JICA Study Team for Selected Residential Area in Each Governarate

No	Governorate	Total Tests	WAJ Water Network						Storage Wells						Storage Tank etc.					
			Not Detected		Detected		Much Detected		Not Detected		Detected		Much Detected		Not Detected		Detected		Much Detected	
			Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
1	Amman	60	31	58.5	22	41.5	5	9.4	1	20.0	4	80.0	1	20.0	0	0.0	2	100.0	1	50.0
2	Zarqa	34	24	70.6	10	29.4	5	14.7	-	-	-	-	-	-	-	-	-	-	-	-
3	Mafraq	11	9	90.0	1	10.0	0	0.0	-	-	-	-	-	-	1	100.0	0	0.0	0	0.0
4	Irbid	69	28	60.9	18	39.1	4	8.7	7	38.9	11	61.1	5	27.8	0	0.0	5	100.0	3	60.0
5	Ajloun	5	4	100.0	0	0.0	0	0.0	-	-	-	-	-	-	0	0.0	1	100.0	1	100.0
6	Jerash	10	5	62.5	3	37.5	0	0.0	0	0.0	2	100.0	1	50.0	-	-	-	-	-	-
7	Balqa	20	17	100.0	0	0.0	2	11.8	2	100.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
8	Madaba	10	2	28.6	5	71.4	1	14.3	0	0.0	2	100.0	1	50.0	0	0.0	1	100.0	1	100.0
9	Karak	14	5	35.7	9	64.3	3	21.4	-	-	-	-	-	-	-	-	-	-	-	-
10	Ma'an	9	2	25.0	6	75.0	5	62.5	-	-	-	-	-	-	1	100.0	0	0.0	0	0.0
11	Tafielah	5	1	20.0	4	80.0	1	20.0	-	-	-	-	-	-	-	-	-	-	-	-
12	Aqaba	10	4	40.0	6	60.0	4	40.0	-	-	-	-	-	-	-	-	-	-	-	-
	Total	257	132	61.1	84	38.9	30	13.9	10	34.5	19	65.5	8	27.6	3	25.0	9	75.0	6	50.0

Irrigation water quality is often a matter attracting public concern when treated wastewater is used for irrigation. At present the effluent from As Samra is not suitable for irrigation directly for its high concentrations of BOD_5, TN and TP at the WWPT outlet, due to insufficient treatment under the condition of over loading of the stabilization pond system. However, after the processes of self-purification in the stream from As Samra to the KTR and within the KTR, and also dilution by the inflow from other sources, at the outlet of KTR water quality is remarkably improved and becomes acceptable for irrigation according to the Jordanian standard (Table 1.2-3). The main parameters of the actual quality of water supplied to Jordan Valley from KTR are as TDS=1206 mg/L, BOD_5=13.2 mg/L, TN=26.1 mg/L, TP=4.5 mg/L (average of 1995-1999 at the Diversion Weir). After blending with the water from KAC North, these parameters become TDS=1150 mg/L, BOD_5=11.2 mg/L, TN=18.7 mg/L, TP=3.5 mg/L (average of 1995-1999 at KAC South). These values are all below the limits specified in the Jordanian standard (TDS<2000 mg/L, BOD_5<50 mg/L, TN<50 mg/L, PO_4-P<15 mg/L).

Table 2.2-1 Quantity of Irrigation Water in Jordan Valley Area

Year	Area	Source				Total (MCM)
		KAC North		KTR		
		Quantity (MCM)	%	Quantity (MCM)	%	
1995	KAC South	12.60	24.74	38.31	75.26	50.91
	Middle Ghor	2.15	4.45	46.15	95.55	48.30
	Subtotal	*14.75*	*14.86*	*84.46*	*85.14*	*99.21*
1996	KAC South	17.14	31.81	36.75	68.19	53.89
	Middle Ghor	6.69	14.99	37.92	85.01	44.60
	Subtotal	*23.83*	*24.19*	*74.66*	*75.81*	*98.49*
1997	KAC South	22.56	36.13	39.89	63.87	62.45
	Middle Ghor	10.44	25.02	31.28	74.98	41.72
	Subtotal	*33.00*	*31.68*	*71.17*	*68.32*	*104.17*
1998	KAC South	54.35	68.42	25.09	31.58	79.44
	Middle Ghor	3.64	8.78	37.80	91.22	41.44
	Subtotal	*57.99*	*47.98*	*62.88*	*52.02*	*120.87*
1999	KAC South	7.18	17.48	33.89	82.52	41.07
	Middle Ghor	0.02	0.05	38.06	99.95	38.08
	Subtotal	*7.20*	*9.10*	*71.95*	*90.90*	*79.15*
1995-1999	KAC South	113.83	39.56	173.93	60.44	287.75
	Middle Ghor	22.94	10.71	191.20	89.29	214.14
	Subtotal	***136.76***	***27.25***	***365.13***	***72.75***	***501.89***

Source: Jordan Valley Authority

Bacteriological parameters are also very important regarding the suitability of water for irrigation, because they relate to health risks associated with wastewater reuse (D.W. Westcot, FAO Water Report-10, 1997). Control of TFCC (total fecal coliform count) is supposed to be of first priority. The maximum limit of TFCC in Jordanian standard is

1000 MPN/100 mL for irrigation. By calculating the average TFCC at different locations in the KTR – KAC system based on the RSS monitoring data from 1995-1999, Fig. 2.2-1 is obtained for evaluating the suitability of water for irrigation from the bacteriological viewpoint.

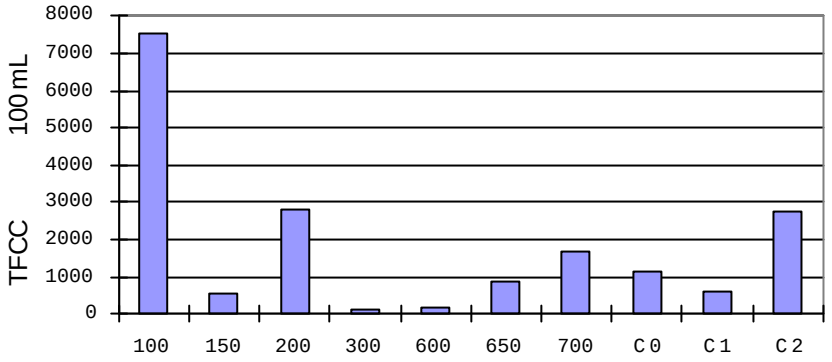

Fig. 2.2-1 TFCC at Different Locations in the KTR-KAC System
Source: RSS Annual Reports of Water Quality Monitoring for KTR (1995-1999)

(Where: Site 100 – KTR inflow from R. Zarqa; Site 150 – flow at W. Rmiemeeh; Site 200 – KTR inflow from W. Rmiemeeh; Site 300 – within KTR; Site 600 – KTR outlet; Site 650 – Diversion Weir; Site 700 – Abu Zeighan canal; Site C0 – KAC inflow from Yarmouk; C1 – KAC at Deir Alla; C2 – KAC South)

The TFCC of the As Samra effluent was 140000 MPN/100 mL in 1998 and 1999 (As Samra WWTP data). As is shown in Fig. 2.2-1, the number drops to about 7500 at the inlet of KTR and below 200 in the KTR and at the outlet. The increase as water flows to the Diversion Weir and then to Abu Zeighan before entering KAC is believed to be from the human activity downstream of the KTR but not the treated wastewater itself. The water finally used for irrigation has a TFCC bout 2700 MPN/100 mL. This further increase is due to pollution in the Jordan Valley area. From this comparison, we understand that at present time the treated wastewater from As Samra has no impacts on irrigation in Jordan Valley from the bacteriological point of view. However, before entering the KTR, farmers are pumping water from Zarqa River for irrigation. In this case, the negative impacts of the high TFCC cannot be ignored. Therefore, disinfection should be strengthened in the WWTP as the final treatment process. This is not only the problem for As Samra, but also for the other WWTPs where the effluent is used for irrigation in the local area.

2.3 Other Environmental Issues

Regarding water environment, there are also other pollution sources, such as industrial wastewater, solid wastes from both domestic and industrial sources, unrestricted usage of fertilizers and pesticides etc. For most of wadis in Jordan, there is no flow in the long dry season. Thus people often regard them as places to dispose wastes, especially for the wadis near towns and villages. These wastes may become pollution sources of surface water and groundwater. Sanitary landfill is yet a common practice of solid waste disposal for most of the cities in Jordan.

According to the information from the Ministry of Agriculture, the quantities of fertilizers and pesticides imported to and manufactured in Jordan increased quickly in the 1990s. Potassium chloride and di-ammonium phosphate are the main fertilizers used for agriculture. Groundwater pollution by irrigation return flow is a common problem, and the problem of algae growth in the KAC may be partially due to nutrient substances from the agricultural activities along the canal in Jordan Valley. Fertilizer is suspected to be one source of the nitrate and phosphorus. This needs to be investigated thoroughly. Regarding water pollution by pesticides, almost no information is available at present.

With an increase in the number of organic chemicals used in industry, agriculture and other economic activities as well as daily life, the impacts of micropollutants on water, air and other environment elements are drawing scientific and public attentions. Environmental monitoring and comprehensive studies in this regard are only at the very beginning in Jordan.