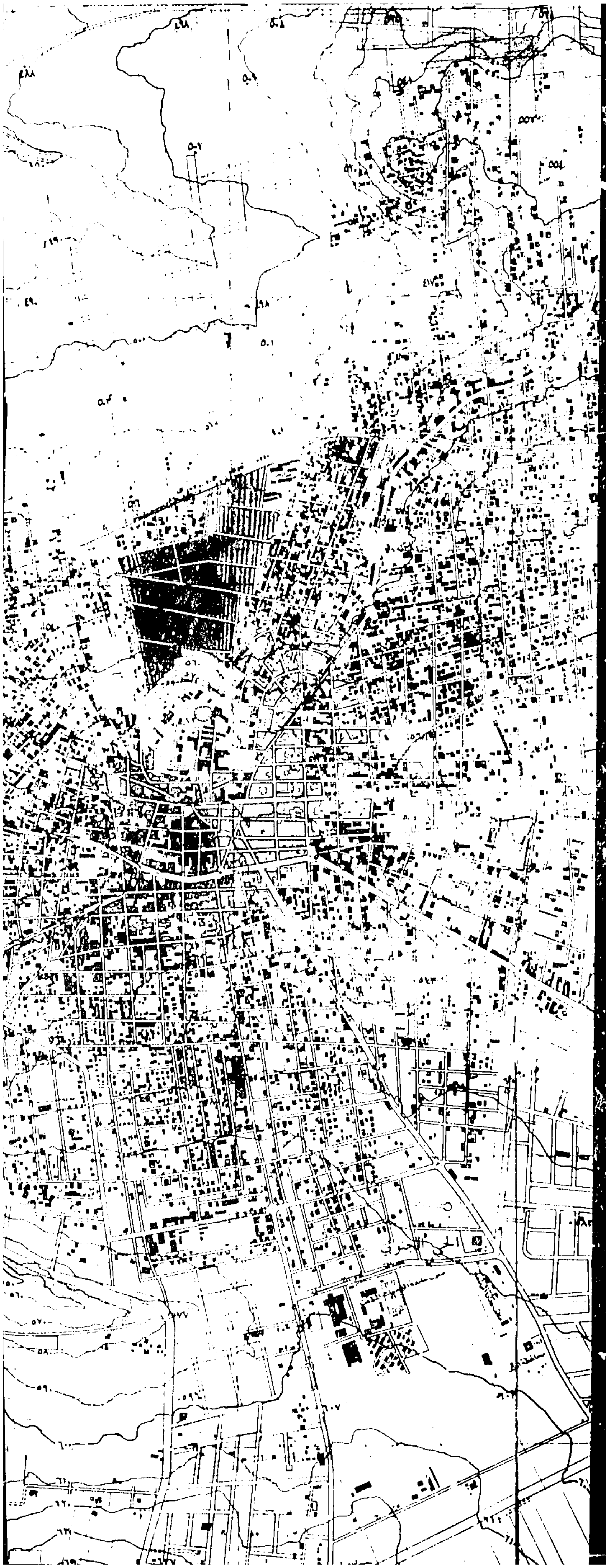

Revised
Final
Report
Summary

FEASIBILITY REPORT
AND PRELIMINARY
ENGINEERING STUDIES

IRBID MUNICIPAL WATER DISTRIBUTION, SEWERAGE, STORM DRAINAGE AND SOLID WASTE DISPOSAL PROJECT

SUBMITTED THRU

MINISTRY OF MUNICIPAL, RURAL AND ENVIRONMENTAL AFFAIRS - EXECUTING AGENCY

TO THE

NATIONAL PLANNING COUNCIL - THE HASHEMITE KINGDOM OF JORDAN

August 1980

By
WESTON INTERNATIONAL, INC.

in association with
STANLEY CONSULTANTS, INC.
SIGMA-CONSULTING ENGINEERS
MRM-CONSULTING ENGINEERS
CO., LTD.

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Feasibility Report and Preliminary
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CHAPTER 1

REVISED FINAL REPORT SUMMARY

1.1 INTRODUCTION

On 1 May 1979, authority was given to proceed with the Feasibility and Preliminary Engineering Studies Project Phase of the subject project by the Ministry of Municipal, Rural Environmental Affairs (MMREA), acting as executing agency for the National Planning Council (NPC). The consultant group selected by NPC to provide engineering and design services was Weston International, Inc., with its subcontractors Stanley Consultants, Inc., SIGMA-Consulting Engineers, and MRM Consulting Engineers Co., Ltd.

Weston's Project Director and Resident Project Manager arrived in Amman to begin work on 17 May 1979. A project office, located near the University of Jordan, was opened shortly thereafter to provide working space for all members of the Weston association. Using both American and Jordanian engineers, planners, and economists, the feasibility study was performed and submitted in draft form to NPC/MMREA on 25 October 1979.

After an extensive review of the draft report, the NPC, MMREA, and other concerned agencies provided review comments to the consultant which were used to amend and expand some sections of the report, and to finalize the recommendations contained therein. This revised final report summary is a very condensed abstract of the final report, and presents its major findings, conclusions, and recommendations.

1.2 SCOPE

The objective of this feasibility study was to investigate the technical and economic feasibility of constructing four types of municipal services for the Irbid Town Plan area. They are:

1. A water distribution system.
2. A sewage collection, treatment, and disposal system.
3. A limited stormwater drainage system.
4. A solid waste collection and disposal system.

In addition, preliminary engineering studies were performed to the extent necessary to demonstrate technical feasibility of recommended facilities, and to provide a basis for cost estimating.

1.3 BACKGROUND

At the time the feasibility studies were initiated in May 1979, Irbid already had a water storage and distribution system that was designed in 1964, and constructed to deliver up to 1.5 million cubic meters per annum (M cu m/yr) of water supplied by the Water Supply Corporation (WSC) from groundwater supplies extracted from the Summayya, Dhuleil, and Azraq well fields. The system has been expanded since 1964 to increase its delivery capacity to more than 2.5 M cu m per year. More water could be distributed if supplies were made available by the WSC. In general, the existing reservoir and water distribution system have several design deficiencies, and are in need of major expansion and replacement to meet the increasing water demands of the City. The need for this expansion and replacement program, however, is dependent on the ability of the WSC and the Jordan Valley Authority (JVA) to supply additional water to meet the demands projected for Irbid and the surrounding areas.

At present (1979-1980), Irbid has no general system for the collection, treatment, and disposal of municipal wastewater, and only a limited stormwater collection system. The City is totally dependent on individual disposal systems which have become increasingly inadequate and unhealthy as Irbid has grown in population and area. A well-designed sewage collection, treatment, and disposal system is needed to serve Irbid, regardless of any concurrent water system improvement plans. Existing sewage connections to the present drainage system also must be changed to alleviate the existing highly unsanitary conditions. Minor storm drainage improvements are also needed to relieve localized drainage problem areas.

Irbid also has a solid waste collection and disposal system that is inadequate in terms of collection facilities, available equipment, and scheduling. Presently there are small, open refuse dumping sites throughout the City, and the main disposal site is also an open dump. These conditions are very unsanitary and provide a food source for infectious vectors such as insects and rodents.

These conditions led the Government of Jordan to decide that the existing situation must be improved and that a project to do so would be justified on a "basic human needs" basis.

The consultant reviewed all available data, information, reports, policies, guidelines, and goals regarding the situation as it exists in Irbid. Based on these data, the consultant prepared feasibility and preliminary engineering studies designed to meet the scope of work as summarized. Because the supply of water to Irbid was not included within this scope, the consultant's designs are based on the assumption that sufficient water will be supplied to meet present and future water demands that correspond to the predicted increases in population.

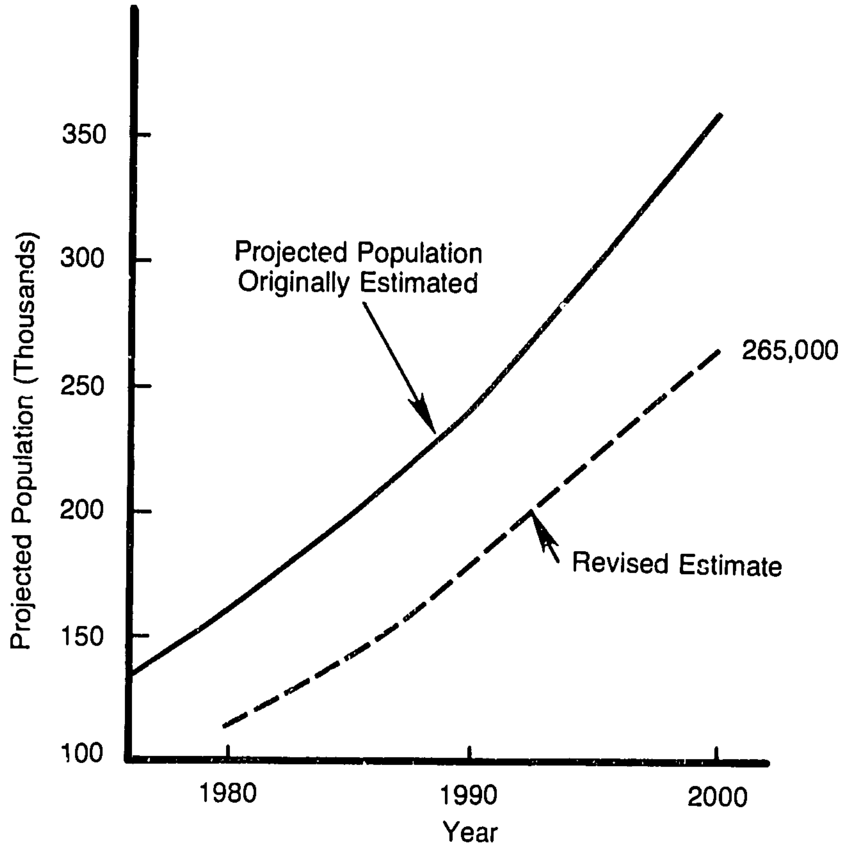
1.4 SOCIOECONOMIC STUDIES

Socioeconomic studies are the basis for all municipal utility services planning and design studies. Of particular importance is proper identification of the project area's present (1979) population and land use characteristics, and the realistic prediction of the area's future growth rates and land development patterns.

During the feasibility studies phase of this project, socioeconomic studies were made using the best information available, and correlated with other studies that had been made or were ongoing.

Estimates of the present and future population, land use, and industrial development characteristics of the project area (defined as the Irbid Town Plan area) were made. These estimates were prepared from 1961 census data, prior and concurrent planning studies prepared by others, and information supplied by the Municipality of Irbid. The 1978 Irbid population was estimated to be 146,000. Population growth rates of 4.5 percent through 1985, and 4.0 percent for the remaining period 1986 to the year 2000 were projected by the government for the Irbid Town Plan area. Concurrent projections of land use were also made for residential, commercial, mixed commercial/industrial, and industrial uses.

Subsequent to the completion of the feasibility studies, preliminary results of a new national census of population became available (January 1980). The census was taken in November 1979, and lists the population of Irbid as 113,000. Figure 1-1 shows in graphic and tabular form the results of the 1979 census.



Year	Projected Population	
	Original[1]	1979 Census
1975	128,000	
1979	159,000	113,000 (Actual)
1990	242,000	179,000 (Estimated)[2]
2000	358,000	265,000 (Estimated)[2]

Note:
[1]Does not include 16,000 in refugee camp.
[2]Using same growth rate assumptions as before.

FIGURE 1-1 POPULATION PROJECTIONS

In 1980, the actual population is about 39,000 less than originally estimated, or about 74 percent. Using the same growth rates used before, it is apparent that by the year 2000, the population will be about 74 percent of that originally projected, or about 265,000 people. The new figures shift the projected growth curve by about 10 years. The impact of a change of this magnitude on the results of the original study is negligible, in terms of the sizing and other technical characteristics of the proposed systems. However, adjustments were required to the economic analysis, as described subsequently.

Also included in the socioeconomic studies were investigations of the social and economic characteristics of Irbid and the health conditions within the City. These studies show that Irbid is a rapidly growing, reasonably affluent municipality with a primarily agricultural economic basis, and a small, but developing commercial, industrial, and educational base

Attempts to rigorously quantify the relationships between health conditions and the provision of water and sewer services were not very successful due to poor available records and underreporting of disease, which seems to be common, in Irbid and other developing countries in general. Improvements to the Irbid municipal services are needed for several reasons, all of which have been well documented in many similar cases, as follows:

1. An improved water supply will permit increased per-capita water use resulting in improved cleanliness and general hygiene, as well as a reduction of water-based diseases.

2. A continuous, pressurized distribution of potable water and provision of a sewage collection system will permit existing cesspools, septic tanks, and absorption pits to be phased out. The continuous pressurization of the water system and connection of households to a sewage collection system will dramatically reduce the potential for septage effluent infiltration into the water pipes.

3. A continuously-pressurized system will eliminate the need for unhealthy in-house storage tanks which are presently a major source of water contamination.

These conditions are known to exist and are particularly harmful to lower income groups. Provision of a 24-hour continuously-pressurized supply of potable water, a well-designed sewerage system, and an efficiently-operated solid waste system, all operating together, will remove the potential for widespread contamination and other unhealthy conditions that presently exist in Irbid.

1.5 STUDY CRITERIA

Various technical, cost, and economic criteria were developed by the consultant to provide uniform guidelines for the feasibility studies. Included were development of factors for water use rates, sewerage generation rates, rainfall intensity/duration criteria, and solid waste generation factors. In addition, cost data and prototypical facilities designs were developed. These criteria were discussed with various governmental agencies, local engineers and contractors, and other interested individuals, and modified as necessary to insure that the criteria applied to this study are representative of the conditions present in Jordan in general, and in Irbid in particular.

1.6 WATER DISTRIBUTION STUDIES

The Municipality of Irbid presently receives most of its water from the Water Supply Corporation (WSC), and distributes it to customers through a small-diameter distribution system. Because of this system's hydraulic deficiencies and unmet water demands, an analysis of the existing system was not carried out, as it has no long-range usability.

Present water use rates in Irbid are less than 30 liters per capita per day. Previously water supply to Irbid was restricted, resulting in a substantial percentage of unmet demand. Although in 1980 the WSC will increase the water supply available to Irbid to 2.5 million cubic meters per year, increases in per capita water use rates are not instantaneous.

As water availability is improved by the North Jordan water supply project and/or improvements in the WSC supply system, the demand for water will increase to normal use rates for Jordan which are estimated to be as follows:

	1980	1990	2000
Domestic (liters/capita/day)	75	85	95
Total (liters/capita/day)	126	144	160

The difference between domestic and total water use rates is caused by commercial/industrial use, unmetered illegal connections, and system leakage.

As studies of wholesale water supply were not included within the scope of this project by the government, the consultant was forced to design the water distribution system on a "demand" basis which assumes that water will be supplied by WSC or the JVA on an "as-needed" basis, commensurate with the population growth rates and per-capita water use rates just described. Figure 1-2 shows the annual demand for water that was projected for Irbid. This demand corresponds to the original population projections. Also, shown on this figure is a modified demand curve which reflects the impact of the revised population figures based on the preliminary results of the 1979 census. The impact, a one-year delay in the demand for additional supplies, is minor, as shown on Figure 1-2. Also, on this figure, assumed water supply requirements are shown. If water is not supplied in the quantities and schedule shown, or some comparable alternative, serious financial impacts will be experienced.

Various alternative methods of providing improved water service to Irbid were studied. The recommended plan calls for a four-zone distribution system that eventually will be fed through a single connection to the (proposed) JVA transmission pipeline. The location of this connection allows water to enter the distribution system before it has to be pumped up to the JVA reservoir at Natifa. Once the water enters the system, it can be distributed by gravity without the need for pumping or elevated/ground storage reservoirs. Pressure-reducing stations are needed between distribution zones to maintain reasonable distribution pressures. Initially, the new distribution system will be connected to the new WSC supply line. All alternatives were analyzed using computer techniques.

The system is sized to deliver sufficient water to meet an average daily demand of 55,600 cu m per day by the year 2000. Service pressures in all parts of the City will be within a range of 210 to 620 kPa (30-90 psi). Nearly 75 km of new water mains are proposed, ranging in size from 10 cm (4 in.) to 80 cm (32 in.). Operation, maintenance, and training programs were

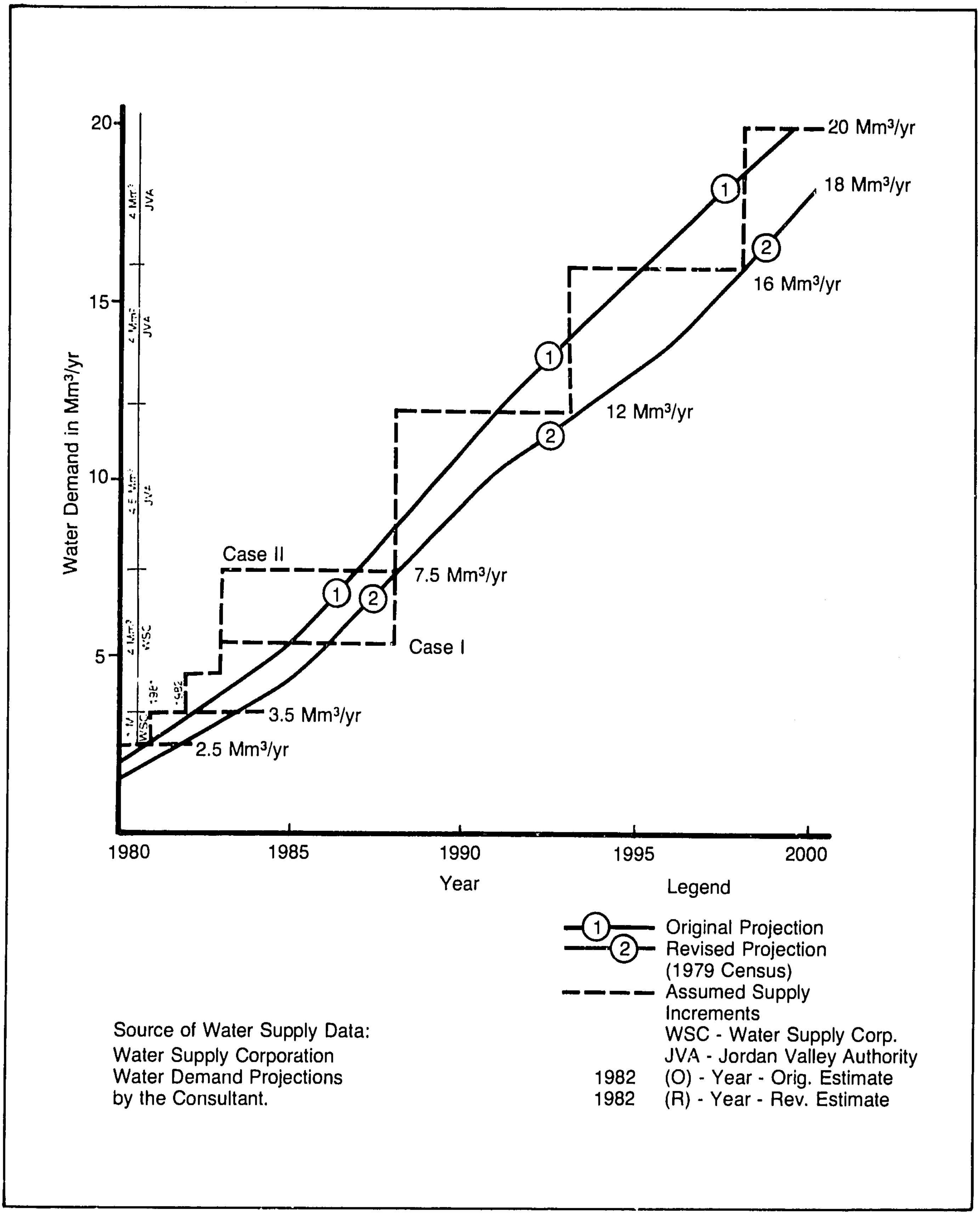


FIGURE 1-2 WATER DEMAND PROJECTIONS

formulated especially for the proposed system.

1.7 WASTEWATER SYSTEM

The existing sewer system in Irbid consists of three short lengths of 50 cm (20 in.) pipe having a total length of about 600 m. Wastewater from these sewers is discharged untreated into a stormwater box culvert located in the Wadi Tariq Saum. All other domestic and commercial sewage is collected and disposed of in cesspools or septic tanks. Septic tank solids that are collected are trucked to Wadi el Hamam and discharged untreated.

Soil conditions in Irbid are not amenable to long-term, widespread use of septage systems. There is a great deal of limestone and marly soils that are heavily fractured, but otherwise relatively impermeable. Because of this septage tends to flow to solution cavities or to reappear as surface flow, a very unhealthy condition. In addition, it can infiltrate water lines that are not under pressure, an extremely hazardous condition.

Some sewer connections have also been made to the existing storm drainage lines which discharge these wastes untreated into the Wadi Arab.

Alternative methods of providing sewage collection service to Irbid were formulated and analyzed. The results of the 1971 Czechoslovakian report were used as input to these studies. Based on this analysis, an optimum sewer routing scheme was developed that minimizes the need for pumping and lift stations. It also reduced the number of major interceptors (three) recommended in the Czechoslovakian report to two.

A total of 10.5 km of interceptor sewers is recommended for the master plan system, and over 340 km of trunk sewers and laterals, staged as follows:

	Stage I	Stage II
Interceptors, trunk sewers, and laterals	188.3 km	162.0 km
Pumping stations	3	3

It was estimated that the water use/wastewater generation factor applicable to Irbid is 80 percent, and the sewers were designed accordingly. The collection system is designed to serve 87 percent of the projected 1990 population, and the entire projected population by the year 2000. Included in the areas to be served in the first phase are low-income areas identified as having potential health problems.

Several low- and medium-technology alternatives were formulated and analyzed regarding appropriate methods of treatment and disposal of wastewater from Irbid, including:

1. Direct land application of wastewater.
2. Waste stabilization ponds (various types).
3. Biological treatment systems (various types).

Figure 1-3 and Table 1-1 show these alternatives, the method of comparison, and summarize the cost analysis showing the least-cost solution. A type of biological treatment system, called the extended aeration process, has been recommended for several reasons, including its ability to meet recommended discharge standards, cost-effectiveness, and other technical, socio-economic, environmental, reliability, and safety considerations. The sensitivity of the selection of the process alternative in terms of variations in land and energy costs were tested and show that increased land and energy costs reinforce the selection of the recommended alternative.

1.8 STORMWATER DRAINAGE SYSTEM

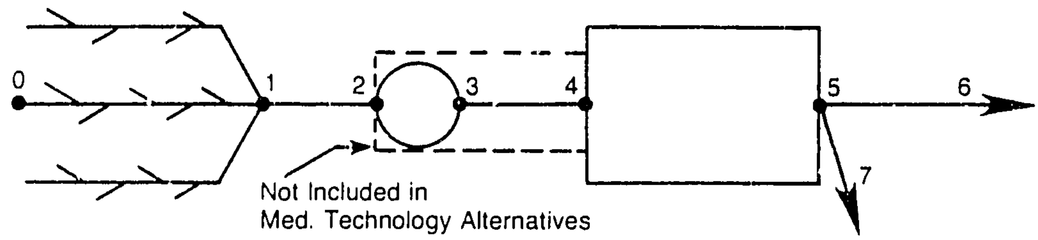
Two major drainage basins receive stormwater runoff from Irbid: Wadi Tariq Saum and Wadi el Hamam. Both of these basins contain existing stormwater drainage facilities that:

1. Are hydraulically constrained due to the location of inlets.

2. Have sediment accumulation and structural damage.

3. Carry sanitary wastewater flows.

4. Have flooding problems due to inadequate design capacity.



Schematic Treatment System

System Components			LT-1 Facultative-Waste Stabilization Ponds I	LT-2 Facultative-Waste Stabilization Ponds II	LT-3 Anaerobic/Aerobic Ponds I	LT-4 Anaerobic/Aerobic Ponds II	LT-5 Aerated Lagoons I	LT-6 Aerated Lagoons II	LT-7 Anaerobic Pond/Aerated Lagoons I	LT-8 Anaerobic Ponds/Aerated Lagoons II	MT-1 Rotating Biological Filter	MT-2 Trickling Filter/Activated Sludge	MT-3 Activated Sludge with Nitrification	MT-4 Extended Air/Activated Sludge	MT-5 Oxidation Ditch/Activated Sludge
			Elements Included in Alternative No..												
0	1	Collection System	●	●	●	●	●	●	●	●	●	●	●	●	●
1	2	Interceptor	●	●	●	●	●	●	●	●	●	●	●	●	●
2	3	Raw Sewage Pump Station	●	●	●	●	●	●	●	●					
3	4	Force Main	●	●	●	●	●	●	●	●					
4	5	Treatment Process	●	●	●	●	●	●	●	●	●	●	●	●	●
5	6	Effluent Disposal	●	●	●	●	●	●	●	●	●	●	●	●	●
5	7	Sludge Disposal	●	●	●	●	●	●	●	●	●	●	●	●	●

LT - Low Technology
MT - Medium Technology

Parameters Included in Analysis Alternatives:	LT-1	LT-2	LT-3	LT-4	LT-5	LT-6	LT-7	LT-8	MT-1	MT-2	MT-3	MT-4	MT-5
1 Collection System/Interceptor	–	–	–	–	–	–	–	–	–	–	–	–	–
2 Raw Water Pump Station Power Cost	●	●	●	●	●	●	●	●	–	–	–	–	–
3 Force Main	●	●	●	●	●	●	●	●	–	–	–	–	–
4 Treatment Process													
4-1 Land Area/Cost	●	●	●	●	●	●	●	●	●	●	●	●	●
4-2 Site Preparation/Grading/Fencing	●	●	●	●	●	●	●	●	●	●	●	●	●
4-3 Capital Construction Costs (Structures/Equipment)	●	●	●	●	●	●	●	●	●	●	●	●	●
4-5 O&M Costs													
-Materials	●	●	●	●	●	●	●	●	●	●	●	●	●
-Labor	●	●	●	●	●	●	●	●	●	●	●	●	●
-Power	●	●	●	●	●	●	●	●	●	●	●	●	●
-Chemicals	●	●	●	●	●	●	●	●	●	●	●	●	●
5 Sludge Disposal	●	●	●	●	●	●	●	●	●	●	●	●	●
6 Effluent Disposal	●	●	●	●	●	●	●	●	●	●	●	●	●
7 Environmental Impacts	●	●	●	●	●	●	●	●	●	●	●	●	●

Note: Items common to all alternatives are not included in analysis.

FIGURE 1-3 IRBID WASTEWATER TREATMENT SYSTEM -- ALTERNATIVES ANALYSIS

Table 1-1

Comparison of Wastewater Alternatives

Parameter	Stage	LT-1	LT-2	LT-3	LT-4	LT-5	LT-6	LT-7	LT-8	MT-1	MT-2	MT-3	MT-4	MT-5
		Costs in Thousands of JD - Alternative												
1. Land Area Required - hectares		172	172	132	132	60	60	27	27	6	6	6	6	6
CAPITAL COSTS														
1. Raw Sewage Pump Station	I	200	250	200	250	200	250	200	250	-	-	-	-	-
	II	100	125	100	125	100	125	100	125	-	-	-	-	-
2. Force Main	I	85	200	85	200	85	200	85	200	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Land Costs	I	2,580	2,580	1,980	1,980	900-	900	405-	405	90	90	90	90	90
	II	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Site Preparation/Grading/Fencing	I	1,040	572	800	436	436	238	97	97	40	40	40	40	40
	II	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Preliminary Treatment Works	I	67	67	67	67	67	67	67	67	100	100	100	100	100
	II	37	37	37	37	37	37	37	37	50	50	50	50	50
6. Primary Treatment Works	I	-	-	-	-	-	-	-	-	150	150	150	-	-
	II	-	-	-	-	-	-	-	-	75	75	75	-	-
7. Biological Treatment	I	-	-	-	-	-	-	-	-	3,430	1,211	1,068	982	1,84[illegible]
	II	-	-	-	-	-	-	-	-	1,528	314	418	599	911
8. Final Clarification	I	-	-	-	-	60	60	60	60	149	149	149	149	149
	II	-	-	-	-	30	30	30	30	74	74	74	74	74
9. Disinfection/Reaeration	I	15	15	15	15	15	15	15	15	15	15	15	15	15
	II	5	5	5	5	5	5	5	5	5	5	5	5	5
10. Gravity Thickeners	I	-	-	-	-	-	-	-	-	92	92	92	-	-
	II	-	-	-	-	-	-	-	-	46	46	46	-	-
11. Sludge Holding Tanks	I	-	-	-	-	-	-	-	-	-	-	-	109	210
	II	-	-	-	-	-	-	-	-	-	-	-	64	105
12. Two-Stage Anaerobic Digesters	I	-	-	-	-	-	-	-	-	561	561	561	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Mechanical Sludge Dewatering	I	-	-	-	-	-	-	-	-	109	109	109	109	109
	II	-	-	-	-	-	-	-	-	35	35	35	35	35

Table 1-1
(continued)

Parameter	Stage	Costs in Thousands of JD - Alternative												
		LT-1	LT-2	LT-3	LT-4	LT-5	LT-6	LT-7	LT-8	MT-1	MT-2	MT-3	MT-4	MT-5
14. Ancillary Buildings/Structures	I	60	60	60	60	60	60	60	60	71	71	71	71	71
	II	-	-	-	-	-	-	-	-	20	20	20	20	20
15. Facultative Ponds	I	1,305	1,305	-	-	-	-	-	-	-	-	-	-	-
	II	650	650	-	-	-	-	-	-	-	-	-	-	-
16. Anaerobic Ponds	I	-	-	260	66	-	-	260	66	-	-	-	-	-
	II	-	-	130	34	-	-	130	34	-	-	-	-	-
17. Aerobic Ponds	I	-	-	538	538	-	-	-	-	-	-	-	-	-
	II	-	-	269	269	-	-	-	-	-	-	-	-	-
18. Slow Sand Filters	i	-	-	25	25	-	-	-	-	-	-	-	-	-
	II	-	-	12	12	-	-	-	-	-	-	-	-	-
19. Aerated Lagoons (including aerators)	I	-	-	-	-	3,600	1,620	1,764	924	-	-	-	-	-
	II	-	-	-	-	1,800	800	640	288	-	-	-	-	-
20. Emergency Generators	I	30	60	30	60	30	60	30	60	33	41	54	54	54
	II	15	30	15	30	15	30	15	30	14	17	23	23	23
21. Site Piping	I	30	30	20	20	15	15	10	10	528	282	268	181	288
	II	20	20	10	10	8	8	5	5	228	93	105	119	136
22. Total Using Mechanical Dewatering														
a. Capital Cost		-	-	-	-	-	-	-	-	7,443	3,640	3,618	2,689	4,329
b. Annual Cost		-	-	-	-	-	-	-	-	724.5	374.9	363.5	272.1	406.4
23. Sludge Drying Beds (area) - hectares		-	-	-	-	7.0	7.0	7.0	7.0	9.2	9.2	9.2	9.2	9.2
24. Sludge Drying Cost	I	-	-	-	-	193	193	193	193	251	251	251	251	251
	II	-	-	-	-	27	27	27	27	36	36	36	36	36
25. Total Using Sludge Drying Beds (22 - 13 + 24)														
a. Capital Cost		6,239	6,006	4,658	4,239	7,683	4,740	4,236	2,988	7,586	3,783	3,761	3.032	4,472
b. Annual Cost		673.1	642.8	505.3	460.2	756.5	480.1	426.1	309.0	741.2	391.6	380.3	284.7	427.1
O&M COSTS														
26. Materials	I	4.0	4.0	4.0	4.0	8.0	8.0	8.0	8.0	24.5	39.6	48.3	40.1	40.1
	II	5.0	5.0	5.0	5.0	10.0	10.0	10.0	10.0	35.5	53.9	62.0	52.3	52.3
27. Power	I	26.3	50.0	26.3	50.0	381.8	405.5	200.3	224.0	34.9	48.5	82.7	89.9	81.6
	II	39.4	85.0	39.4	85.0	552.4	598.0	282.0	322.0	44.0	58.5	100.6	98.0	89.2
28. Labor	I	56.3	56.3	56.3	56.3	69.4	69.4	69.4	69.4	89.6	89.6	87.5	83.2	83.2
	II	62.5	62.5	62.5	62.3	77.2	77.2	77.2	77.2	100.2	99.3	96.9	92.4	92.4
29. Chemicals	I	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
	II	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
30. Sludge Disposal	I	-	-	5.0	5.0	8.0	8.0	6.3	6.3	12.0	12.0	12.0	12.0	12.0
	II	-	-	7.0	7.0	11.1	11.1	8.7	8.7	16.7	16.7	16.7	16.7	16.7
31. Total O&M Costs (Stage II)		110.6	156.2	117.6	163.2	654.4	700.0	381.6	421.6	200.1	232.1	279.9	263.1	254.3
32. Total Annual Costs (25b + 31)		783.7	799.0	622.9	623.4	1,410.9	1,180.1	807.7	730.6	941.3	623.7	660.2	547.8	681.4

Major drainage problem areas were identified in both basins. Meteorological and hydrological studies were made to determine the statistical characteristics of rainfall intensity and duration patterns for the Irbid region. Based on the results of these studies, alternative methods of managing stormwater runoff were investigated. The recommended system derived from this optimizing process includes limited use of existing facilities and construction of new facilities to relieve flooding problem areas.

In Wadi el Hamam, a new major collector network will be routed along the natural drainage course. An extension of this line, running southwest along Heckma Street, will relieve a flood problem area to the east of the refugee camp.

In Wadi Tariq Saum, a new storm drain line is also recommended to intercept the runoff from the large southern area of the basin. It also will relieve the overloaded existing drain which will continue in service, but with a much smaller contributing area.

1.9 SOLID WASTE DISPOSAL SYSTEM

The Municipality of Irbid presently provides solid waste collection and disposal service to its residents. Currently, waste material is placed in plastic or burlap bags, and stored in vacant lots until it is picked up by a collection truck. Pick-up schedules are irregular.

Studies show that solid waste is presently generated at the rate of about 0.55 kg per capita per day (1.2 lbs/capita/day) which is less than one-half European or United States generation rates. The rates are expected to increase slowly throughout the study period as the standard-of-living in Irbid continues to improve.

Several solid waste disposal alternatives were studied, including energy recovery, landfilling, and composting. Landfilling was selected mostly on the basis of economic cost-effectiveness. The recommended plan calls for the construction of a sanitary landfill on a 22-hectare (54.6 acres) site with simultaneous construction of a 10-ton per day pilot composting facility. The latter facility is recommended to provide data and demonstrate to area residents the use of composted wastes for agricultural purposes.

Improvements to the collection system have also been recommended in terms of scheduled collection and improved containers.

1.10 ENVIRONMENTAL ASSESSMENT

An assessment of the environmental impacts of each major alternative for the major systems was made.

The major long-term effect of the project will be to improve public health in Irbid by decreasing water contamination and increasing sanitation. Adverse impacts of the projects include a slight decrease in surface-water quality in the Wadi Arab drainage system, and short-term effects on air quality, noise levels, and community surroundings during construction. The adverse impacts are small compared to the potential health benefits to be derived from construction of these facilities.

Because Irbid is such an ancient city, it is probable that during construction of the proposed water and sewer lines, areas containing artifacts of archaeological interest will be encountered. A plan providing for inspection and notification has been formulated and will be made part of the construction specifications.

1.11 ECONOMIC AND FINANCIAL FEASIBILITY ANALYSIS

The total estimated Phase 1 project capital costs are 17,891,000 JD (in constant 1979 JD). These include water distribution system costs of 5,909,000 JD, wastewater and collection system costs of 8,020,000 JD, stormwater drainage system costs of 2,974,000 JD, and solid waste disposal system costs of 988,000 JD. The estimated Phase 2 capital costs are 12,161,000 JD. (See Table 1-2, Capital Cost Summary.)

The Phase 1 capital costs are to be expended during the entire 10-year period as indicated in the construction funding schedule presented in Table 1-3. An annual capital cost inflation rate of 10 percent has been assumed for the project.

Table 1-4 presents the inflated capital costs estimated for the Phase 1 period. The total inflated costs for the project, financed in accordance with the schedule presented in Tables 1-2 and 1-3, is 26,688,000.

Table 1-2

Capital Cost Summary

(Costs - JD x 1,000)

Major Work Element	Phase 1			Phase 2			Total Project		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
Water Supply System									
Probable construction cost[1]	2,279	2,264	4,543	1,978	1,799	3,777	4,257	4,063	8,320
Contingencies	341	342	683	295	272	567	636	614	1,250
Engineering and administration[2]	228	455	683	189	378	567	417	833	1,250
Subtotal	2,848	3,061	5,909	2,462	2,449	4,911	5,310	5,510	10,820
Wastewater System									
Probable construction cost[1]	4,170	1,910	6,080	3,025	1,367	4,392	7,195	3,277	10,472
Contingencies	625	345	970	454	205	659	1,079	550	1,629
Engineering and administration[2]	625	345	970	454	205	659	1,079	550	1,629
Subtotal	5,420	2,600	8,020	3,933	1,777	5,710	9,353	4,377	13,730
Storm Drainage System									
Probable construction cost[1]	2,289	123	2,412	928	14	942	3,217	137	3,354
Contingencies	272	18	290	139	2	141	411	20	431
Engineering and administration[2]	91	181	272	47	94	141	138	275	413
Subtotal	2,652	322	2,974	1,114	110	1,224	3,766	432	4,198
Solid Waste System									
Probable construction cost[1]	449	438	937	--	316	316	449	754	1,253
Contingencies	26	--	26	--	--	--	26	--	26
Engineering and administration[2]	13	12	25	--	--	--	13	12	25
Subtotal	538	450	988	--	316	316	538	766	1,304
Total Project Costs	11,458	6,433	17,891	7,509	4,652	12,161	18,967	11,085	30,052
Equivalent U.S. $ Cost (U.S. $ = 0.300 JD)		59,637,000			40,537,000			100,174,000	

[1]Including right-of-way.

[2]Engineering and administration is a fee equal to 15% of the probable construction cost. This represents a commonly used fee which is suitable for the budgetary accuracy required here. A more accurate estimate will be made at the end of the design period.

Table 1-3

Phase 1 Construction Funding Schedule

(Costs - JD x 1,000)

Description	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total Phase 1 Cost
Water Supply System											
Water supply system costs	0	924	925	930	930	440	440	440	440	440	5,909
Wastewater System											
Wastewater treatment	-	423	829	324	323	323	323	-	-	-	2,545
Sewer construction	-	887	1,883	845	753	410	697	-	-	-	5,475
Subtotal -- Wastewater System Costs	0	1,310	2,712	1,169	1,076	733	1,020	-	-	-	8,020
Storm Drainage System											
Storm drainage system costs	991	1,983	-	-	-	-	-	-	-	-	2,974
Solid Waste System											
Landfill development	440	110	-	-	-	-	-	-	-	-	550
Equipment procurement	162	-	25	-	22	100	30	69	-	30	438
Subtotal -- Solid Waste System	602	110	25	-	22	100	30	69	-	30	988
Total Project Costs	1,593	4,327	3,662	2,099	2,028	1,273	1,490	509	440	470	17,891
Equivalent U.S. Dollar Cost (1.00 U.S. Dollar = 0.300 JD)	5,310,000	14,423,000	12,207,000	6,997,000	6,760,000	4,123,000	4,967,000	1,697,000	1,467,000	1,567,000	59,518,000

Note: All costs in this table are constant 1979 costs.

Table 1-4

Phase 1 Construction Funding Schedule
Escalated Costs

(Costs - JD x 1,000)

Description	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total Phase 1 Cost
Water Supply System											
Water supply system costs	0	1,118	1,230	1,358	1,497	779	857	943	1,037	1,141	9,142
Wastewater System											
Wastewater treatment	0	512	1,102	473	520	572	630	-	-	-	3,809
Sewer construction	-	1,073	2,504	1,234	1,212	726	1,359	-	-	-	8,108
Subtotal -- Wastewater System Costs	0	1,585	3,606	1,707	1,732	1,308	1,989	-	-	-	11,917
Storm Drainage System											
Storm drainage system costs	1,090	2,399	-	-	-	-	-	-	-	-	3,489
Solid Waste System											
Landfill development	484	133	-	-	-	-	-	-	-	-	617
Equipment procurement	178	-	33	-	35	177	58	147	-	77	705
Subtotal -- Solid Waste System	662	133	33	-	35	177	58	147	-	77	1,322
Total Project Costs	1,752	5,253	4,869	3,065	3,264	2,264	2,904	1,090	1,037	1,218	26,588
Equivalent U.S. Dollar Cost (1.00 U.S. Dollar = 0.300 JD)	5,840	17,450	16,230	10,217	10,879	7,546	9,680	3,633	3,456	4,059	88,960

Note: All costs in this table are escalated from 1979 costs, using 10% inflation.

Source: Tables 9-9, 9-12, and 9-15

Table 1-5 presents the proposed schedule for connecting water and wastewater customers to the new systems. These estimates reflect the Kingdom's objectives for project construction.

A computerized cash flow analysis model was developed and used to project annual revenues, project costs for proposed facilities, integrate costs with existing system expenses, and compare projected costs and revenues for each element of the project. User charges and connection fees were manipulated in the model to produce positive accumulated surpluses on the income and expenditure statement as close to zero as possible.

Output from the model was used to produce cash flow statements, balance sheets, and income/expenditure statements which were checked for viability. Where outputs from these statements were unsatisfactory (e.g., insufficient cash flow was identified as a problem), user charges and connection fees were adjusted to produce new income/expenditure statements.

The cash flow model was then used to evaluate the sensitivity of the proposed facility to various factors, including inflation, water use rates, user charges, capital costs, and user population. The user charges were further analyzed, together with socioeconomic data, to determine the ability of low-income residents in the City of Irbid to pay for the proposed municipal utility services.

Table 1-6 presents a summary of the average user charges that residents of the Municipality of Irbid will pay over the next decade. The charges relate only to the construction of Phase 1. For reasons of suggesting stability for the operating agency, rates increase infrequently over the period. Rates reflect expected annual inflationary impacts and the proposed facility construction schedules, as well as future operation and maintenance costs.

The average cost per user (residential family) will increase from 25.2 JD in 1980 to 61.7 JD in 1989 for all project elements.

The solid waste costs are a significant part of the total annual charge, and increase by 53 percent over the 10-year period. This is a very labor-intensive effort, and is significantly influenced by inflation (15 percent).

Table 1-5

Project Construction Schedule
Residential and Nonresidential Connections

	Water Supply		Wastewater	
	Residential	Nonresidential	Residential	Nonresidential
1980	15,500	2,800	0	0
1981	16,300	3,000	3,000	1,000
1982	17,100	3,100	6,000	2,000
1983	18,000	3,200	8,000	3,000
1984	18,900	3,400	10,000	3,400
1985	21,100	3,500	14,500	3,500
1986	22,200	3,700	17,300	3,700
1987	23,200	3,800	21,400	3,800
1988	24,200	4,000	24,200	4,000
1989	25,300	4,100	25,300	4,100

Source: Tables 9-9a and 9-15a.

Table 1-6

Summary of Household Average Annual
User Charges and Fees for Proposed Municipal Services
(1980-1989)

(in JD)

Year	Water Supply[1] Administrative Connection Fee	Water Supply[1] Annual User Charge	Wastewater Administrative Connection Fee	Wastewater Annual User Charge	Solid Waste Annual User Charge	Stormwater Annual User Charge	Total Annual User Charge
1980	14	7.2	0	0	18.00	0	25.2
1981	19	7.2	32	0	18.00	11.30	36.5
1982	19	7.2	32	0	18.00	10.70	35.9
1983	19	7.2	32	4.8	18.00	10.30	40.3
1984	19	9.6	32	4.8	27.60	9.70	51.7
1985	19	9.6	32	4.8	27.60	9.30	51.3
1986	19	9.6	32	15.6	27.60	8.90	62.0
1987	19	10.8	32	15.6	27.60	8.50	69.3
1988	19	10.8	32	15.6	27.60	8.00	62.0
1989	19	10.8	32	15.6	27.60	7.70	61.7

[1]Charges do not include wholesale water costs.

Over the 10-year period, wastewater rates increase the most dramatically. Average annual household rates (4.8 JD per year) are initiated in 1983, when the system is first operational, and increase to 15.6 JD per year by 1986. This 225 percent increase reflects the effects of the heavy construction period between 1981 and 1986 (Table 1-3), and the attempts to postpone user payment of the system with a 3-year grace period. The grace period permits sufficient users to be connected to the system before the full costs of the system would begin to be covered.

Administrative/connection fees are also presented in Table 1-6. These fees provide for the administrative/connection (water supply) activities that are associated with bringing new users into a system. Those fees will be collected by the operating agency as a part of providing service. Wastewater connection fees are normally the responsibility of the homeowner. A 200-JD fee is anticipated and will be paid by each resident who connects to the collection system. Subsidies and short-term loans will be needed to assist the residents of Irbid with this significant cost (estimated impact on average income is 12.6 percent, and possibly as high as 25 percent of low income).

An additional analysis of the water supply connection fee was prepared to determine the impact of various approaches for reconnection of the customers on the existing water supply system. A reduced fee (14 JD) was considered in the "base" analysis condition, as shown in Table 1-6. The reconnection of these existing customers is controversial since they have already paid to connect to a water supply system (most of which is being replaced over the 10-year period). The alternative considered was to capitalize the reconnection costs to recover these expenses with the regular monthly user charge from all customers. The effect was a 15-percent increase in the monthly rate. A subsidy of 294,500 JD (the cost of reconnection) is recommended as the alternative to capitalizing the reconnection costs.

Additional project analyses included evaluation of grants at 30 percent and 100 percent, and consideration of earning an 8 to 9 percent rate of return on average net fixed assets. The grants will reduce the monthly charges needed to cover the costs of operation, depending on the significance of the capital investment. The rate of return analysis indicated that the increase in user charges would interfere with the ability to pay of certain residents in Irbid.

In general, the analysis indicated that residents can afford the proposed project. Table 1-7 summarizes the ability to pay findings of the study with respect to three water use consumption groups and with respect to water charges inclusive and exclusive of wholesale water costs (since wholesale water costs are a significant part of the cost of water).

The percentage of income that will be spent by each of the three consumption groups increases from 2.52 percent for the lowest water use group, to 8.50 percent for the highest use group (and income group). Although this level exceeds the 5.0 percent guideline from the World Bank for water (the water component is 6.81 percent of income for this group), the estimating procedure is conservative and most likely understates the income of this group. The project is believed to be affordable and should be funded.

Table 1-8, Summary of Loan Financing Requirements (in current JD), indicates that loans or grants are required to implement the project. The table lists by year the loans that will be required for each element and for the overall project. Table 1-9 summarizes the annual costs associated with financing the project at 6 percent over 20 years, including local debt repayment (principal and interest), and the operation and maintenance cost of the project.

An internal rate of return evaluation was conducted to measure the viability of the proposed project.

These analyses indicate the project is affordable to the people of Irbid, and should be financed based on the benefits that will accrue to the people of Irbid.

1.12 INSTITUTIONAL ARRANGEMENT AND PROJECT IMPLEMENTATION

Unless the institutional needs necessary to ensure proper installation, operation, and maintenance of the proposed facilities plans are satisfied, the facilities plans will not provide the level of service intended.

Basic implementation criteria covering three major categories, facility implementation, coordination with National Resources Authority Management policy, and regional and local development, have been developed.

Table 1-7

Ability-to-Pay Summary for 1985

Water Use Consumption Group (cu m/month)	Water Supply: With Wholesale Cost — Monthly User Charge (JD)	Water Supply: With Wholesale Cost — Percent of Income	Water Supply: Without Wholesale Cost — Monthly User Charge (JD)	Water Supply: Without Wholesale Cost — Percent of Income	Total All Project Elements: With Wholesale Water Cost — Monthly User Charge (JD)	Total All Project Elements: With Wholesale Water Cost — Percent of Income
0 - 15	1.70	0.86	0.54	0.28	4.98	2.52
16 - 25	8.26	4.39	4.22	2.25	12.31	6.54
More than 25	18.80	6.81	7.36	2.67	23.46	8.50

Table 1-8

Summary of Loan Financing Requirements[1,2]

(Current 000 JD)

Year	Water Supply	Wastewater	Solid Waste	Stormwater	Total
1980	0	0	662	1,090	1,752
1981	1,118	496	133	2,399	4,146
1982	1,231	3,476	0	0	4,707
1983	1,361	1,711	0	0	3,072
1984	1,497	1,732	0	0	3,229
1985	779	1,298	0	0	2,077
1986	857	1,987	0	0	2,844
1987	943	0	0	0	943
1988	1,037	0	0	0	1,037
1989	1,141	0	0	0	1,141

[1]Includes inflated capital costs that will be financed by loans. Source: Tables 9-9b and 9-15b.
[2]Loans and grants reported to be available from AID, $21.0 million and $3.0 million, respectively. The supplemental analysis information contained in Section 5 evaluates systems with a $2.5 million grant. The grant was applied to the wastewater project.

Table 1-9

Summary of Annual Costs (Revenue Requirements)[1]

(000 JD)

Year	Water Supply: Local Debt Repayment	Water Supply: O&M	Water Supply: Total	Wastewater: Local Debt Repayment	Wastewater: O&M	Wastewater: Total	Solid Waste: Local Debt Repayment[2]	Solid Waste: O&M	Solid Waste: Total	Stormwater: Local Debt Repayment	Stormwater: O&M	Stormwater: Total
1980	0	137	137	0	0	0	57	187	244	86	3	89
1981	0	158	158	0	0	0	68	220	288	276	3	279
1982	0	182	182	0	0	0	68	296	364	276	4	280
1983	0	209	209	0	209	209	68	314	382	276	4	280
1984	127	241	368	56	273	329	68	410	478	276	5	281
1985	267	277	544	452	351	803	68	661	729	276	6	282
1986	422	319	741	646	449	1,095	68	585	653	276	7	283
1987	592	367	959	843	651	1,494	68	825	893	276	8	284
1988	680	422	1,102	990	809	1,799	68	717	785	276	9	285
1989	778	485	1,263	1,216	999	2,215	68	950	1,018	276	11	287

[1] Includes loan repayment requirements at 6 percent over 20 years.
Source: Tables 9-9b, 9-15b, and 9-19b.
[2] O&M costs include salaries, expenses, and amortized capital expenditures for trucks and heavy equipment depreciated over 7-year periods.

Three alternative institutional arrangements are evaluated as follows:

1. Regional authority.
2. Regional planning/district authority.
3. Municipal departments.

It should be noted that all existing water department and solid waste department employees in the City of Irbid will be employed in each of the proposed alternatives.

Alternative 2 is recommended for implementation because:

1. The regional planning agency, water council, or regional department provides the necesssary regional institution to provide separation between the national government and local municipalities.

2. The District operating authorities provide a dispersion of power to the municipalities while providing local economies of scale and improved efficiency.

The regional agency can administer the Kingdom's policy on resources utilization, guide the development of the region, and assist in financing projects.

A recommended institutional plan is developed to implement alternative 2. The plan defines policy needs, institutional arrangements, and facility plan development. A recommended personnel training program is outlined. Qualified, adequately compensated personnel will be the key to a successful district utilities project in Irbid.

A proposed list of construction contracts and an initial construction schedule was developed after discussions with financing agencies, MMREA, and NPC. The list is presented in Figure 1-4. This schedule takes into account the mandate to serve the low income, public health problem areas first. The wastewater collection system contracts include the Phase 1 interceptor sewers, as well as trunk and lateral sewers in the low-income areas. These contracts, together with the wastewater treatment plant contract, will produce a technically-viable sewerage project, however, the revenues generated by this limited project will be much less than the estimated revenues for the base case presented in Chapter 9 of the draft feasibility report.

Construction Operations Plan

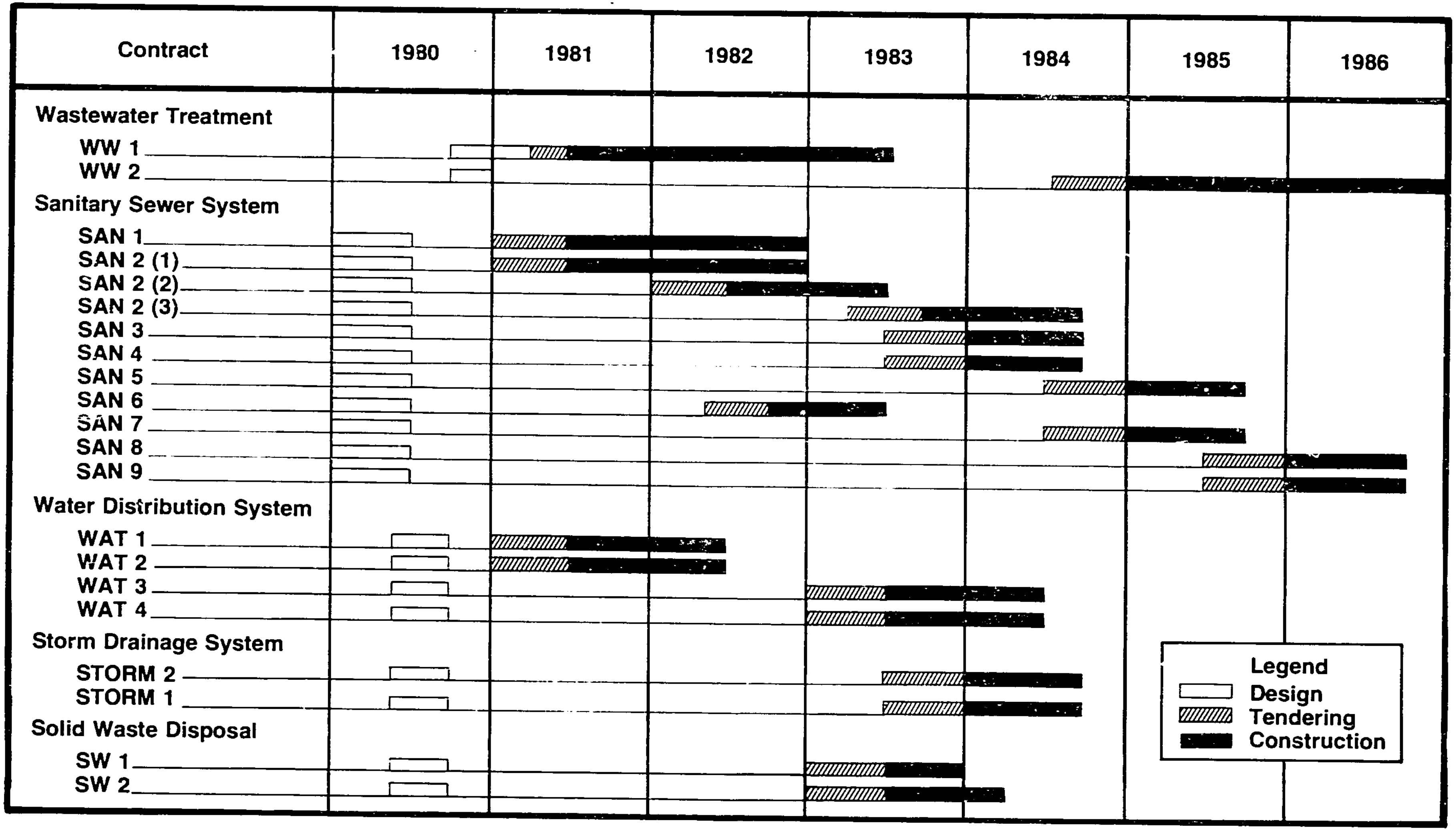


FIGURE 1-4 INCREMENTAL IMPLEMENTATION PLAN

1.13 RECOMMENDATIONS AND REQUIRED POLICY DECISIONS

1. The project is affordable by the people of Irbid, and should be financed based on the benefits that will accrue.

2. Recommended project elements should be financed and work initiated as soon as possible since projected inflation factors have significant effects on overall project costs.

3. Guidelines and procedures should be adopted to create the new implementing agency by the end of 1980. Accounting and cost control should be in accordance with the methods and procedures of the Financial Accounting Standards Board, Stamford, Connecticut, USA. The new agency should be audited annually, and should report to WSC or a similar agency.

4. For purposes of maintaining institutional stability, user charges and rate schedules should be established and the frequency of rate changes minimized to provide a positive image to the public.

5. Decisions regarding the new water system should be made concerning reconnection of residents who are currently part of the existing water supply system. It is recommended that the 19 JD administrative/connection fee for the 1980 population of 15,500 residential users be covered by a governmental subsidy. This subsidy would be equal to 294,500 JD in 1980 to be used as revenues in the water distribution system.

6. Grants should be made available to low-income families who cannot afford the costs of connection, estimated at 200 JD per connection, to the wastewater collection system. A short-term loan program should also be developed to reduce the burden of wastewater connections for other residents. The schedule of subsidies for assisting low-income families is as follows:

Low Income Subsidies
(JD)

1981	251,000
1982	251,000
1983	165,600
1984	165,600
1985	372,700
1986	231,900
1987	338,800
1988	231,900
1989	90,300

Figures are based on a constant 251 JD administrative/connection fee (not escalated) for a combined water and wastewater system.

7. Constrained water supply is likely to have severe impacts on the system and its users. A program to deal with water shortage should be developed to allocate water efficiently and equitably to residential users and to commercial and industrial needs. This coordination should be provided by the National Planning Council.

8. The user charges associated with this project are relatively high. Estimates of ability to pay indicate, for the water project, that some users will pay nearly 7 percent of their income. For all elements of the project some users will pay nearly 9 percent of their income. Two solutions are recommended:

   a. Additional grants and low interest loans should be secured in addition to those available from AID.

   b. Wholesale costs of water are significant, ranging from 45 to 68 percent of total unit water costs. These costs could be further subsidized by the WSC.