The Hashemite Kingdom of Jordan
National Planning Council

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FEASIBILITY STUDY

ZARQA – RUSEIFA

WATER DISTRIBUTION, SEWERAGE AND STORMWATER SYSTEMS

SUMMARY REPORT

MALCOLM PIRNIE, INC.
in association with
JOUZY & PARTNERS

1980
Amman - Jordan

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His Excellency President
Dr. Hanna Odeh
National Planning Council
P.O. Box 555
Amman - Jordan

December 22, 1980

Re: Feasibility Studies of the Municipal Water Distribution Improvements and Sewerage and Stormwater Drainage Systems in Zarqa and Ruseifa, Jordan

Dear Dr. Odeh:

In accordance with our Agreement, we are pleased to submit the Summary Report for the referenced Feasibility Studies. The studies are summarized herein and presented in the following four separately bound volumes:

- Investigations, Preliminary Engineering Design, and Financial and Socio-Economic Analysis Report.
- Industrial Effluents Treatment Report
- Appendix to the Investigations, Preliminary Engineering Design, and Financial and Socio-Economic Analysis Report.
- Map Atlas for the Investigations, Preliminary Engineering Design, and Financial and Socio-Economic Analysis Report.

The recommended project and its estimated costs are summarized in Chapter 12 herein.

We wish to thank the NPC staff, the Ministry of Municipal, Environmental, and Rural Affairs, The Ministry of Trade and Industry, the Municipalities of Zarqa and Ruseifa, the Royal Scientific Society, the United States Agency for International Development, the industries in Zarqa and Ruseifa, and many others for the assistance given us during this project.

Respectfully Submitted,

Martin P. Daly
Resident Project Manager
Malcolm Pirnie, Inc.

Najeeb F. Tleel
Deputy Project Manager
Jouzy & Partners.

SUMMARY REPORT

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1. INTRODUCTION

Zarqa and Ruseifa share a common Town Plan border and are located about 20 km northeast of Amman.

The Zarqa-Ruseifa area is one of the principal industrial centers in Jordan. The wastewaters from the industries discharge to the nearest waterway with a minimum degree of treatment or no treatment at all.

Neither city has a general system for wastewater collection and treatment. Both cities are totally dependent on cesspools which have become increasingly inadequate and unacceptable both from health and other environmental considerations. The water distribution systems have not kept pace with the population growth. The need for an expanded stormwater drainage system is also evident in both cities.

On January 6, 1980, an Agreement was signed between the National Planning Council of the Government of the Hashemite Kingdom of Jordan and Malcolm Pirnie, Inc. for the Feasibility Studies. Jouzy & Partners of Amman is the associate consulting engineer. The United States Agency for International Development is paying all U.S. Dollar costs.

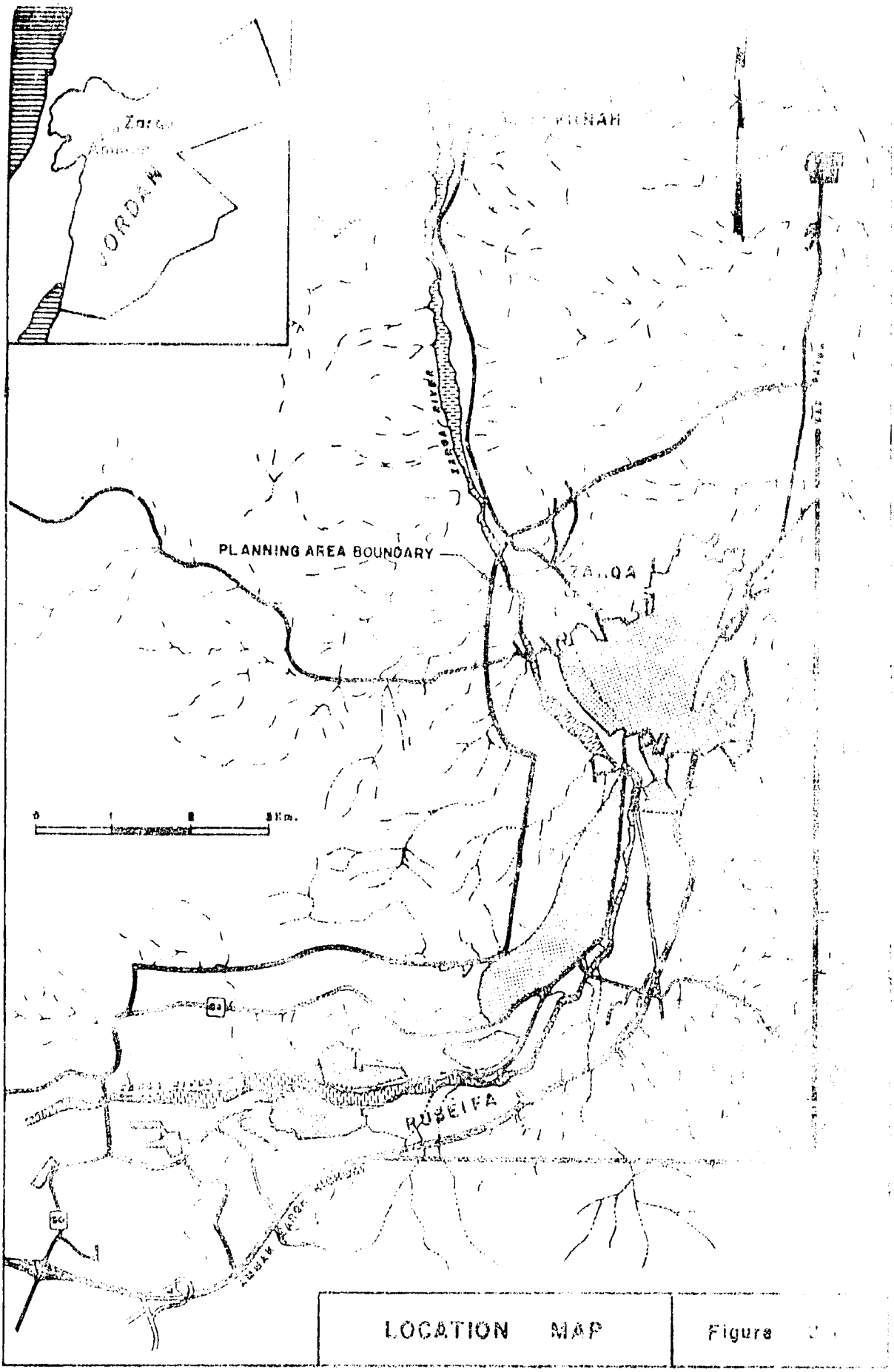
The purpose is to develop a comprehensive program for staged construction of wastewater and storm drainage facilities and improvements to the public water distribution systems in Zarqa and Ruseita.

The principal objective is to provide for the basic human needs. To this end, recommendations for phased investment in water, wastewater and storm drainage consider the special and immediate requirements of areas with high population densities, high incidences of waterborne diseases, and inadequacies in present service.

2. PLANNING CONSIDERATIONS

The planning area is shown in Figure 2.1. It includes the Town Plan areas of Zarqa and Ruseifa plus some adjacent areas. The wastewater flows from the Army Base east of Zarqa have been included but neither have the water distribution nor sewage collection systems within the base itself.

The planning period is through the year 2000. Phase I is to serve the needs through 1990.



LOCATION MAP

Figure

The total present population of the planning area is about 278,000 (Zarqa - 216,000, Ruseifa - 62,000).

Based on the projections of the Amman Urban Region Planning Group, the 1990 population is estimated as 386,000 and 2000 as 546,000. The average household size is about 7 persons and average density is about 350 persons per hectare. The saturation population is estimated as 795,300.

3. SOCIO-ECONOMIC AND HEALTH CONDITIONS

The major low income areas in Zarqa are the northeastern section, the Janna'ah area, and west side of the river. The central part of Ruseifa is also a low income area. The area does not exhibit the degree of spatial segregation of socio-economic groups that is generally found in European and American cities.

There is no perceived water shortage. The major constraint on water consumption is cesspool capacity. A sewerage system is favored by the inhabitants surveyed.

The sanitary conditions are unsatisfactory because of the lack of an adequate sewerage system. The use of cesspools pollutes the groundwater and the inadequate water distribution system enhances the dissemination of waterborne diseases. During the 1977-1979 period, the annual average number of serious diseases (total of hepatitis, typhoid, cholera) was about 85 cases.

The provision of adequate and safe water and sewerage systems will not in itself guarantee the elimination of the prevailing communicable diseases although a marked reduction is anticipated.

4. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The most distinctive feature of the climate is the concentration of rainfall in the cool winter and the drought conditions of the summer. Thus, water resources and their limited availability are a major concern.

Groundwater occurs in the upper and lower aquifers. The shallow upper unconfinded aquifer readily responds to seasonal water fluctuation. Its water quality has been degraded as a result of urban and industrial growth. The lower aquifer is separated from the upper by a layer of

massive limestone. The water level fluctuates less and the water quality is better.

The Zarqa River and its tributaries comprise the only significant running water environment in the region. In the planning area, it is intermittent and dries up during the arid summer months. Its water quality is poor.

The King Talal Reservoir is formed by the damming of the Zarqa River downstream of the planning area. It was constructed to provide irrigation water, but at a later date it was also considered as a potential source of potable water. But after the reservoir was partially filled, an examination of the quality of the water indicated that its use for potable water was very questionable.

Most soils are poorly suited for individual on-site wastewater disposal systems which rely on subsurface soil absorption.

The Zarqa River basin has numerous small vegetable farms. Commercial activity is concentrated in central Zarqa.

The older areas of Zarqa are organized in a gridiron pattern. Ruseifa and the Zarqa areas on the west side of the river are squatter settlements with more random street patterns.

5. WATER DISTRIBUTION

The supply for both cities is from groundwater. After the new Zarqa well becomes operational, the total maximum supply capacity for Zarqa will be 21,120 m^3/d. The Ruseifa Supply has a maximum capacity of 7,200 m^3/d. Both supplies are chlorinated.

Nearly the entire population of both cities derives its water supply from the municipal system. Most of the industrial supply is from private wells.

The existing distribution systems are generally serviceable. The major problem in both systems is the privately-constructed house services which corrode easily and exhibit considerable leakage.

The unaccounted-for-water averages about 40 percent. It is estimated that half of the losses occur in the distribution network and house services. The other 20 percent is considered as meter under-registration and meter stoppage.

The total estimated demand in m^3/d is as follows:

	1990	2000	2020
Zarqa	36,250	51,816	86,476
Ruseifa	8,810	12,110	27,780
Total	45,060	63,926	114,256

With no increase in current supplies, the projected supply deficiency in m^3/d is as follows:

	1990	2000	2020
Deficiency			
Zarqa	15,130	30,696	65,356
Ruseifa	1,610	4,910	20,580
Total	16,740	35,606	85,936

The major thrust of the Phase I improvements for both Zarqa and Ruseifa will be:

1. Additional Supply
2. Reinforce Existing System
3. Expansion to New Areas
4. Reduction of Unaccounted-for-Water
5. Reduction of Roof Tanks

The additional supply will be from a common (Zarqa and Ruseifa) 600 mm pipeline. The pipeline will run from the Azrak - East Ghor/ Amman pipeline being constructed on the east side of the planning area to the vicinity of the Zarqa River.

In both existing distribution systems, there are several incomplete distribution network loops and areas where there is poor flow distribution. The network should be reinforced in these areas.

Pipelines are provided to serve the areas that are expected to develop by 1990.

The unaccounted-for-water in both systems should be gradually reduced to about 20 percent by the year 2000. This can be accomplished by improved metering practices and pipe repair and/or replacement.

In general, each customer has a roof tank to store water for emergency use. In many cases, the tanks are open and a source of contamination. Ideally, the tanks should be eliminated but this does not appear feasible. It is suggested that the municipalities increase their efforts to have the tanks kept clean and covered.

The Phase II facilities are continued phased expansion to the new growth areas and, for Zarqa, transmission mains to convey the new supply to those areas that will become deficient because of growth nearer the existing supplies.

The recommended water distribution facilities are summarized as follows:

Zarqa

Phase I - 81 km of ductile iron mains ranging in diameter from 50 to 600 mm.

Phase II - 73 km of ductile iron mains ranging in diameter from 50 to 400 mm.

Ruseifa

Phase I - 40 km of ductile iron mains ranging in diameter from 50 to 600 mm.

Phase II - 15 km of ductile iron mains ranging in diameter from 50 to 150 mm

- 1 - 700 m^3 concrete reservoir.

The recommended facilities are shown on Figure 5.1.

The estimated construction costs for the recommended projects in June 1980 JD are as follows:

	Phase I	Phase II
Zarqa	JD 2,230,000	JD 1,725,000
Ruseifa	1,080,000	325,000
Total	JD 3,310,000	JD 2,050,000

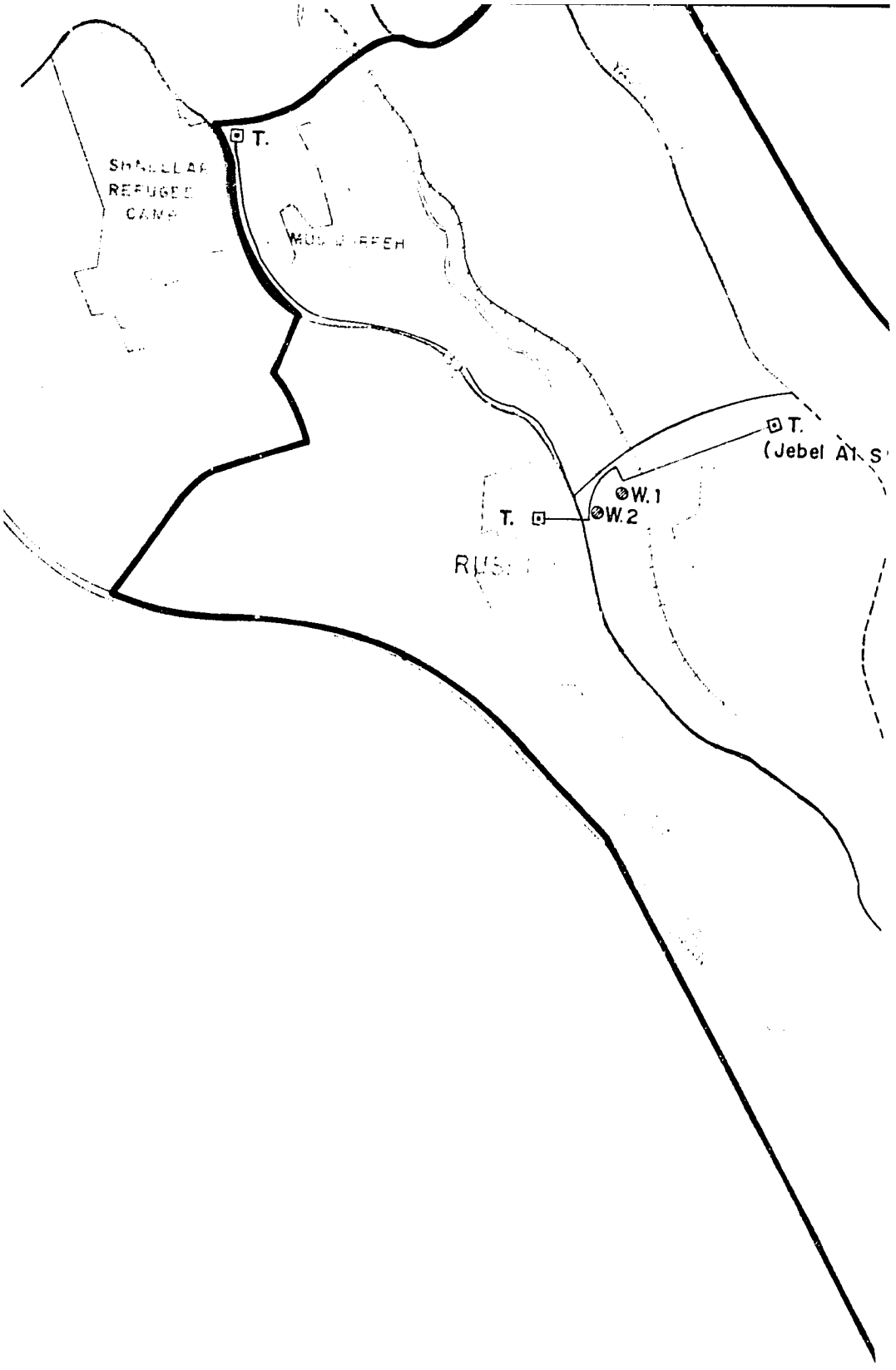
The Phase I and Phase II local and foreign costs are summarized as follows:

	Foreign ($JDx10^3$)	Local ($JDx10^3$)	Total ($JDx10^3$)
Phase I	1,588	1,722	3,310
Phase II	940	1,110	2,050

Local material and equipment has been used wherever possible. The major foreign cost is the ductile iron pipe.

6. SEWER SYSTEM

The planning area was divided into subareas along drainage basin lines with consideration given to natural divisions between existing



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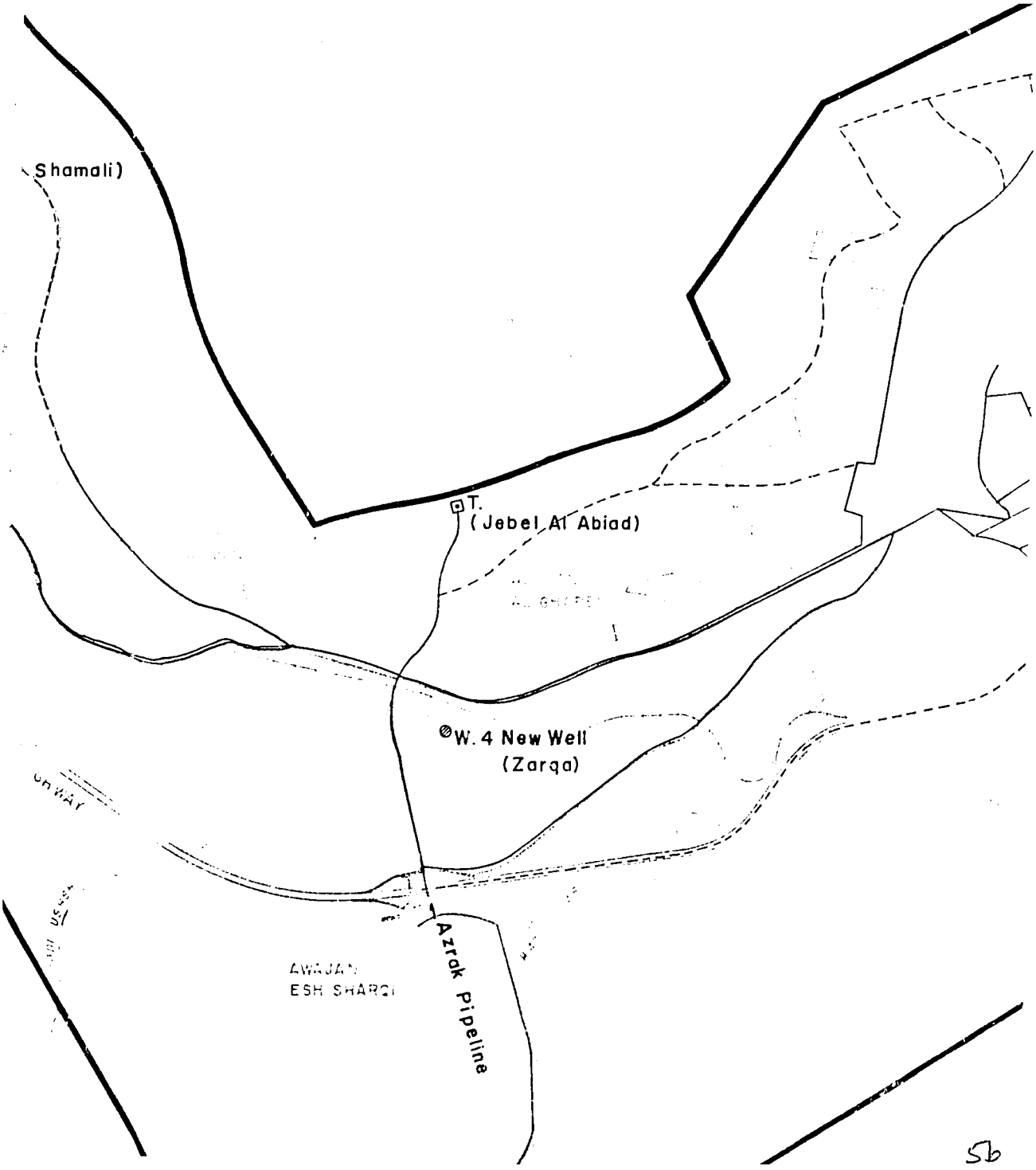
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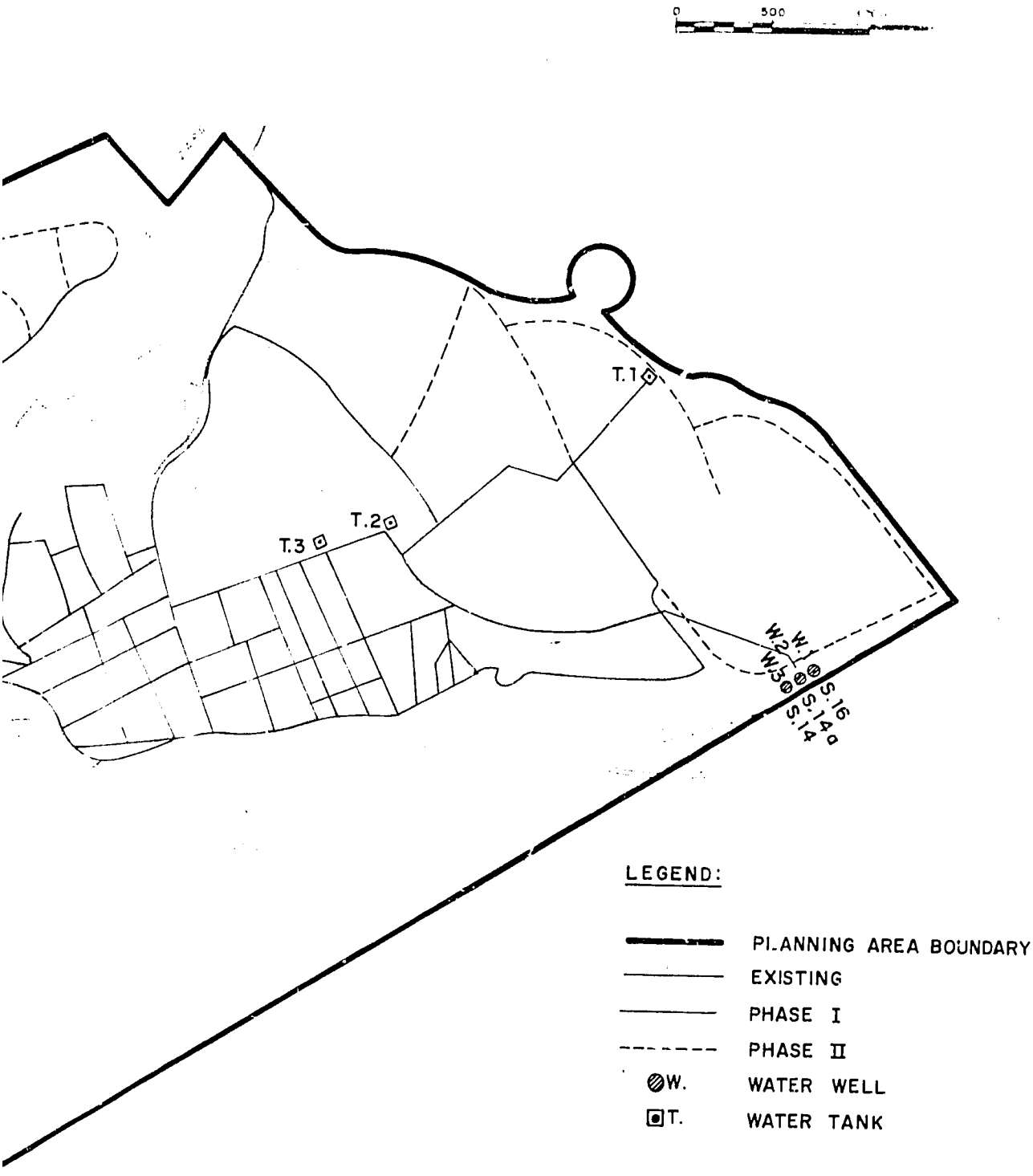


OVERALL WATER SYSTEM MAP

Figure 5.1

SC

population centers. An estimate was also made of the population which can be economically included in the sewer system. In determing the extent of the Phase I collection sewer project, the basic criteria are to serve streets on which more than half the lots were developed and to avoid long interceptors through open areas.

Estimates of the projected total and served population of the planning area, including the Army Base, are:

Year	Total Population	Served Population	Percent
1990	241,000	272,500	64.7
2000	586,300	419,700	71.6
2020	840,300	697,000	82.9

Per capita domestic and commercial sewage flows can be expected to be about 80 percent of the per capita water consumption and a separate allowance has been made for groundwater infiltration and stormwater inflow.

Five-day biochemical oxygen demand (BOD_5) and suspended solids (SS) quantities are based on 60 grams per day for both parameters. The resulting concentrations are similar to those experienced at the Amman plant.

Estimates of total industrial wastewater quantities and characteristics were made on the basis of a detailed industrial waste study. Some of the industrial wastewaters can best be treated on-site and water recycled rather than disposal of in the sewer system.

For the planning area, the total flow, BOD_5 and SS the municipal sewage system are as follows:

Year	Flow m^3/d	BOD_5 kg/d	SS kg/d
1984	21,700	18,700	14,700
1990	24,200	24,100	19,200
2000	41,200	37,000	30,900
2020	81,100	57,400	50,600

These flows are based on the assumption that the recommendations for service areas and industrial pretreatment and connection are implemented.

Two alternative plant sites have been investigated. Alternative site A is located along the Zarqa River about 3 km north of the city.

The site is currently used for agricultural purposes and slopes gently toward the river. Alternative site B is situated about 2 km northeast of Zarqa on nearly level ground immediately north of an Army Ordnance depot. A plant at this site would discharge to the Wadi Saida. The site is currently owned by the Army.

Both sites are large enough to accommodate plant expansion to serve well beyond the year 2000. A site considered in 1975 for Zarqa only is not large enough to accommodate the Zarqa plus Ruseifa flow.

The two sites offer three alternatives for sewering the planning area.

Alt. 1 - Treatment of all wastewaters at Alternative Site A

Alt. 2 - Treatment of all wastewaters at Alternative Site B

Alt. 3 - Treatment of those wastewaters which flow by gravity to the Zarqa River at Site A and those that drain naturally to the Wadi Saida at Site B.

Three alternative trunk sewer systems corresponding to the three plant configuration alternatives were developed.

Economic and qualitative analysis indicated that the best alternative is Alternative 1, a single plant on the Zarqa River. The major features of this alternative are shown on Figure 6.3.

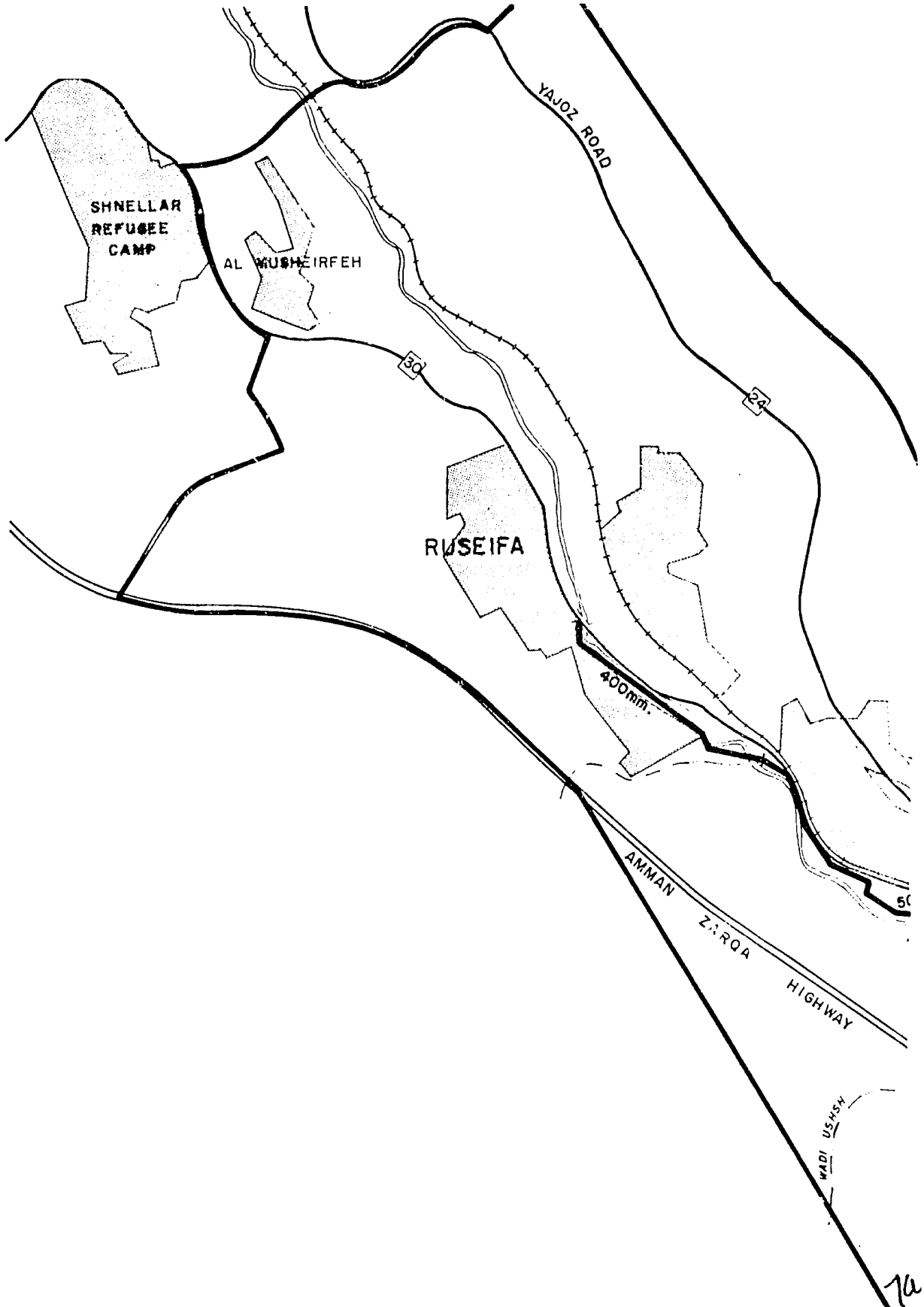
The collection and subtrunk sewers flow to the trunk sewers. The recommended collection system includes the following appurtenances:

- House lateral, house connection, and terminal manhole for the individual properties
- Replacement of existing privately-owned water services with a publicly-owned 50 mm galvanized steel water line in footpaths
- Footpath resurfacing

The project gives the highest phasing priority to basic human needs. In general, the older areas have the highest population density, the most difficulty in disposing of their wastewaters, and the greatest need.

Based on economic and qualitative analysis, it is recommended that the Phase I trunk and collection system extend from the proposed treatment plant up to and including the major part of Ruseifa.

Even though not in the planning area, on a strictly basic human needs basis, Schnellar Camp should be served. The decision for service must be made by the government, pending resolution of the refugee situation. It has not been included in the recommended project.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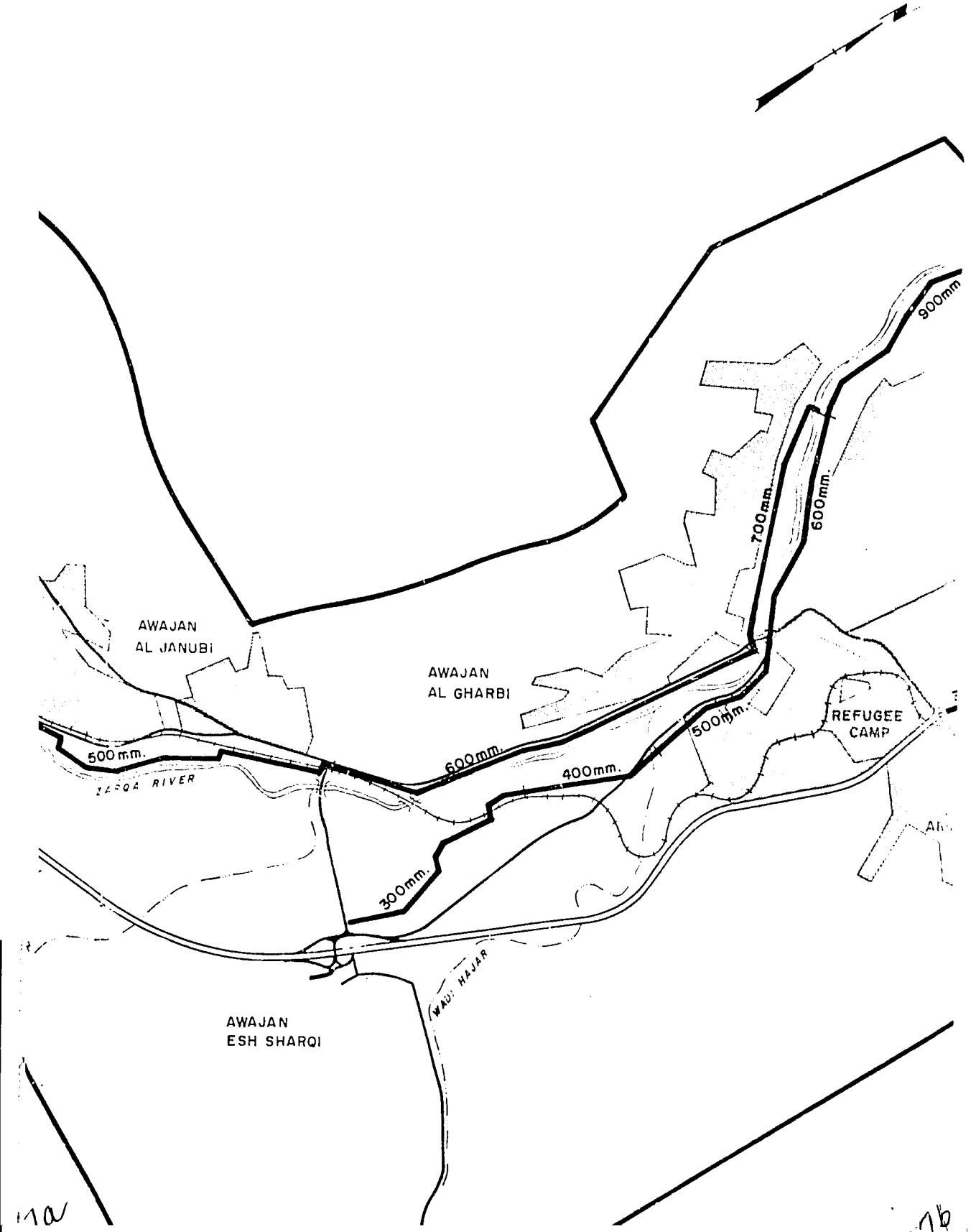
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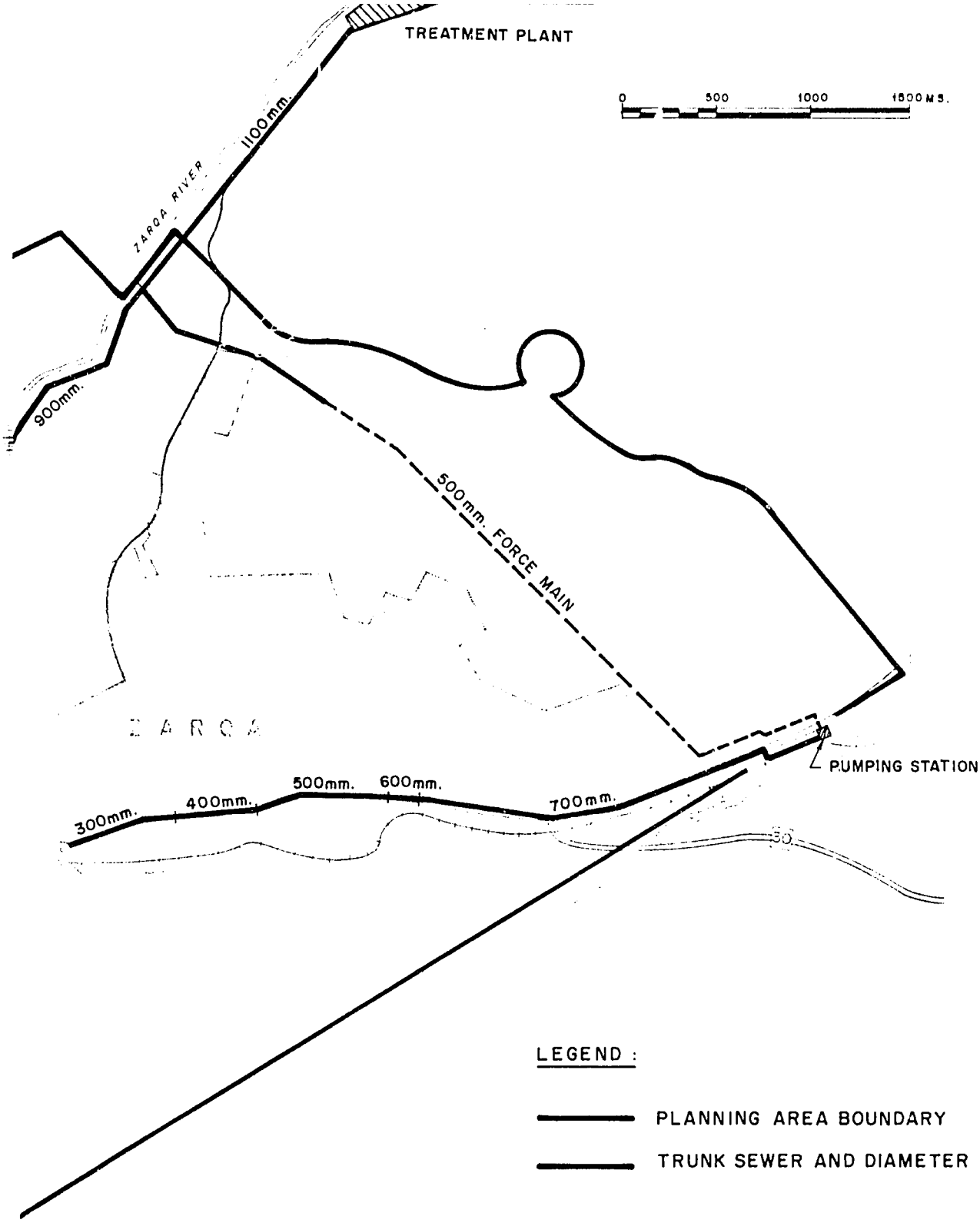


ALTERNATIVE SEWERAGE SCHEMES ALTERNATIVE 1	Figure 6.3

The recommended Phase I trunk sewer system will include:

- o 22.3 km of trunk sewer ranging in diameter from 300 to 1100mm
- o 3.0 km of 500 mm force main
- o The 1175 m^3/hr Zarqa East Side Pumping Station

The recommended Phase I collection sewer system will include:

- o 202.8 km of collection and subtrunk sewer ranging in diameter from 200 to 600 mm.
- o A 68 m^3/hr pumping station
- o 26,000 house connections

The estimated construction costs in 1980 JD are:

Trunk Sewer System	JD 2,383,000
Collection Sewer System	8,000,000
Terminal Manholes	1,949,000
Water Mains	974,000
Total	JD13,306,000

The recommended Phase I trunk and collection sewer project is designed to provide service to currently developed areas only. A significant amount of new development is projected to occur by the year 2000. Extension of sewer service to newly developed areas may be accomplished by ongoing small sewer projects, or larger projects undertaken at 5 or 10 year intervals. We have assumed that the sewer extensions will be undertaken yearly as necessary since this is the preferred solution.

Although it is not possible to predict with any real certainty the locations in which new families will build houses between now and 2000, an attempt has been made to estimate service population categorized by Phase I sewers or new sewers, number of house connection, and 1980 construction cost. These estimates are as follows:

Description	1984-1990	1990-2000
Total Increase in Service Population	55,850	147,200
Number Served by Phase I Sewers	5,600	16,200
Number Served by New Sewers	50,250	131,000
Length of Pipe Sewers - km	66	205
Number of House Connections	7,975	20,300
1980 Construction Cost Including Terminal Manhole (JD x 10^3)	3,291	7,353

The construction costs have been divided into foreign and local costs as follows:

	Foreign ($JDx10^3$)	Local ($JDx10^3$)	Total ($JDx10^3$)
Phase I	3,711	9,595	13,306
1984-1990	825	2,466	3,291
Phase II	1,852	5,501	7,353

Use of locally manufactured material has been used wherever possible. Sewers up to 300 mm will be of PVC and larger sewers of reinforced concrete. Both types of pipe are locally manufactured.

7. SEWAGE TREATMENT SYSTEM

As part of the overall Feasibility Studies, an industrial waste survey was made. All known industries in the Zarqa-Ruseifa area (43) were canvassed and evaluated. Of these, 13 required pretreatment of their wastewater before they would be acceptable for treatment at the proposed plant. Five were classified as being suitable for treatment at their source for discharge directly to the Zarqa River. The industrial loads, after pretreatment, were added to the domestic and commercial loads.

The total raw sewage anticipated at the proposed plant is as follows:

	1990	2000	2020
Flow (m^3/d)	24,200	41,200	81,100
BOD_5 (kg/d)	24,100	37,000	57,400
SS (kg/d)	19,200	30,900	50,600

Although the National Water Master plan proposes certain specific standards for effluent discharges to water courses, there are at the present time no water quality standards. The degree of treatment must be analyzed on a site-specific basis and must be fully adequate to protect the health and welfare of the area including protection of the groundwater.

Discharge of properly disinfected treated sewage would not preclude the downstream use of the river for irrigation. Future downstream use as a potable water source would require nitrification/denitrification. It has been assumed that the Zalal Reservoir water would be used solely for irrigation. The main objective of treatment will be to produce a disinfected effluent low in SS to minimize river bed buildup and low

in BOD_5 to maintain aerobic river conditions.

After all technologies were reviewed, the secondary processes evaluated in detail were: 1) air activated sludge, 2) stone trickling filters, 3) plastic media trickling filters, all with anaerobic digestion, and 4) plastic media trickling filters with aerobic digestion.

Based on economic and qualitative analysis, the recommended treatment and disposal system is outlined as follows:

Preliminary Treatment	- Mechanical Screening - Aerated Degritting - Chlorine Odor Control
Primary Treatment	- Sedimentation
Secondary Treatment	- Plastic Media Trickling Filters
Final Sedimentation	- Sedimentation
Disinfection/Post Aeration	- Chlorination and Mechanical Aeration
Solids Handling	- Anaerobic Digestion - Spreading on Drying Beds - Landfilling

It is significant to note that on site power generation utili. methane gas from the anaerobic digesters will meet 100 percent of the plant energy needs. Auxiliary fuel will provide start-up and standby capability.

The estimated construction cost (June 1980 JD) of the recommended treatment and disposal system for Phase I and expansion of Phase II, in both foreign and local components, is:

	Foreign ($JDx10^3$)	Local ($JDx10^3$)	Total ($JDx10^3$)
Phase I	2,548	2,350	4,898
Phase II	1,104	1,019	2,123
Total	3,652	3,369	7,021

The major foreign cost in the mechanical equipment and locally available material has been utilized wherever possible.

8. STORMWATER DRAINAGE SYSTEM

The primary objective of the stormwater drainage system is to avoid, to the maximum feasible extent, flooding conditions which represent a threat to human life and health and which may cause property damage.

At present, there is no comprehensive stormwater drainage system in the planning area. The result is public inconvenience, hazard to public safety, risk of property damage, erosion, and unsanitary conditions.

The primary network, Phase I, are the main pipelines, culverts, and open channels which will convey runoff to the Zarqa River and its major wadis. The secondary network, Phase II, are the smaller facilities which will convey run-off to the primary network.

The proposed primary network is shown in Figure 8.1. The facilities are on the periphery of the currently developed areas of Zarqa and convey runoff to the Zarqa River or the Wadi Saida. The primary line in Ruseifa is to protect the old Amman-Zarqa Road from flooding.

The recommended project is:

Phase I

- 13 km of 300 to 1000 mm diameter reinforced concrete pipelines and larger box culverts.

Phase II

- 26 km of 300 to 1000 mm diameter reinforced concrete pipelines.

The estimated construction cost (June 1980 JD) including the pipes, culverts, manholes, culverts and other appurtenances is:

	Foreign ($JDx10^3$)	Local ($JDx10^3$)	Total ($JDx10^3$)
Phase I	288	742	1,030
Phase II	328	838	1,166

9. PRELIMINARY RATE STUDY

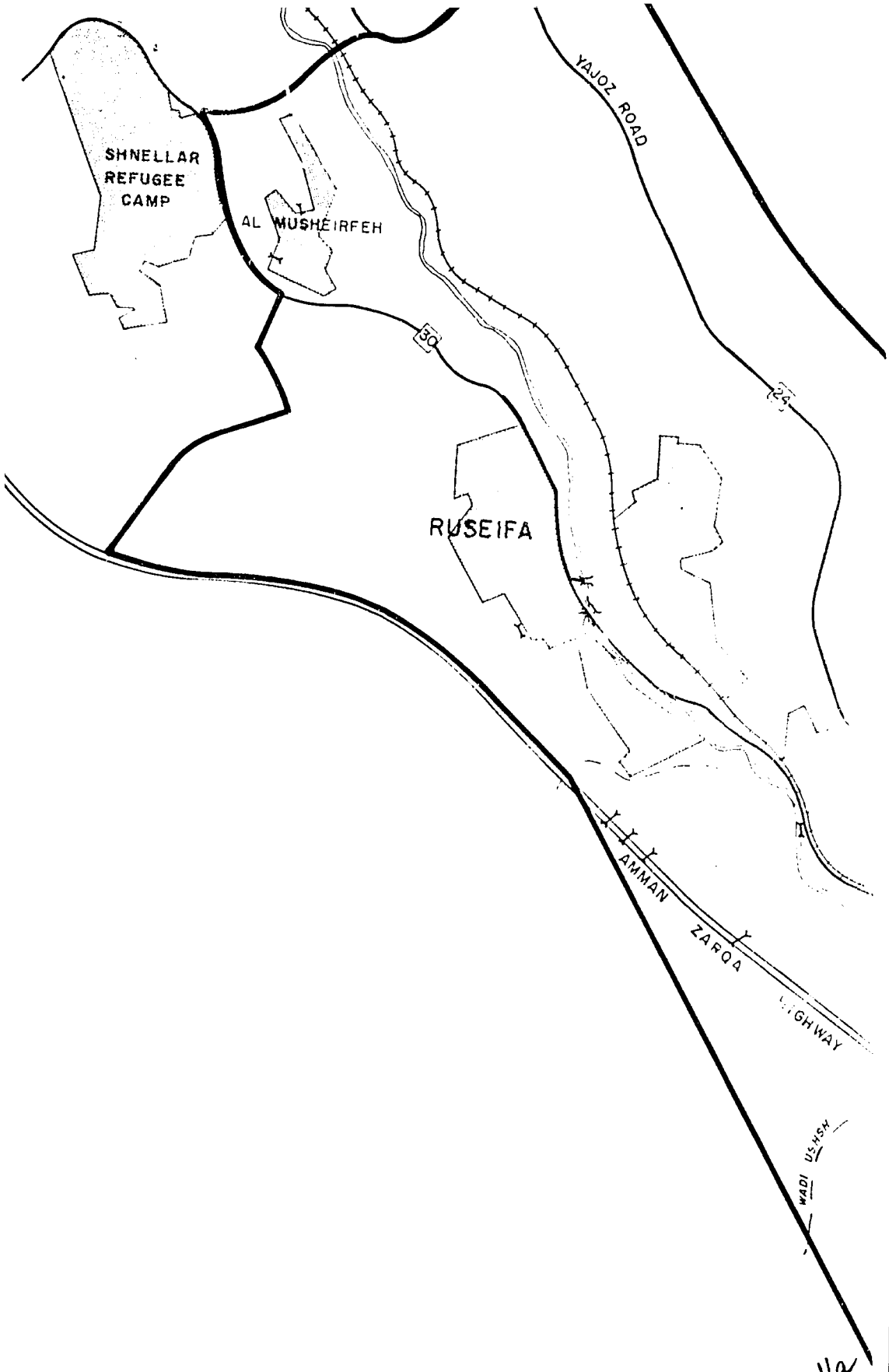
The purpose of the preliminary rate study is to establish the proposed rate structure required to finance the recommended water distribution, sewerage and stormwater projects.

For estimating purposes, the following items have been added to the construction costs to determine total project cost:

- o 10% Construction Contingency
- o 14% Inflation
- o 10% Engineering
- o 7% Management Services and Staff Training
- o 15% Interest During Construction
- o Land

An analysis of the major alternatives available for implementing and operating the proposed facilities indicated that:

- o A joint (Zarqa-Ruseifa) agency should be used to implement and operate the water facilities.
- o A joint (Zarqa-Ruseifa) agency should be used to implement and operate the sewerage facilities.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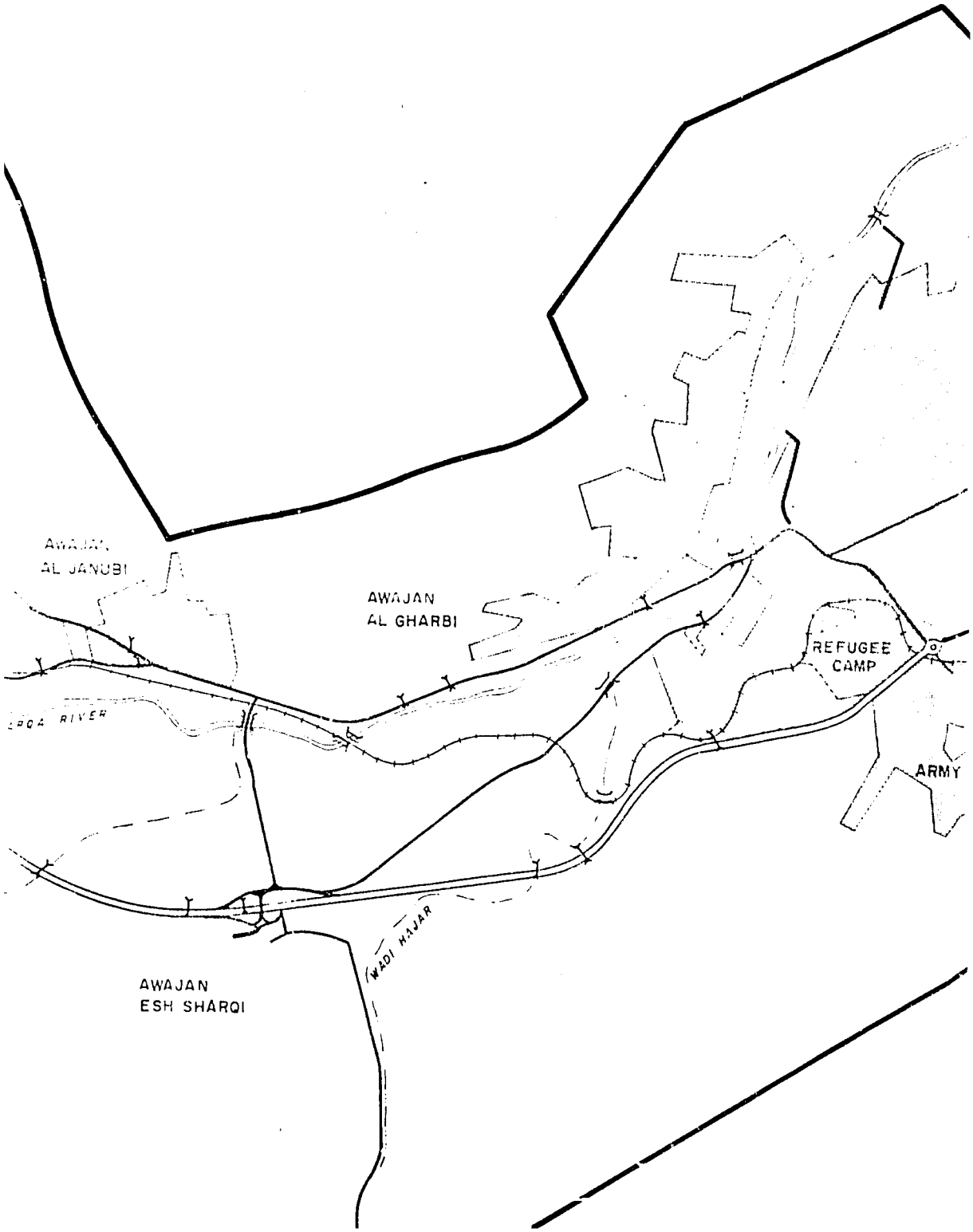
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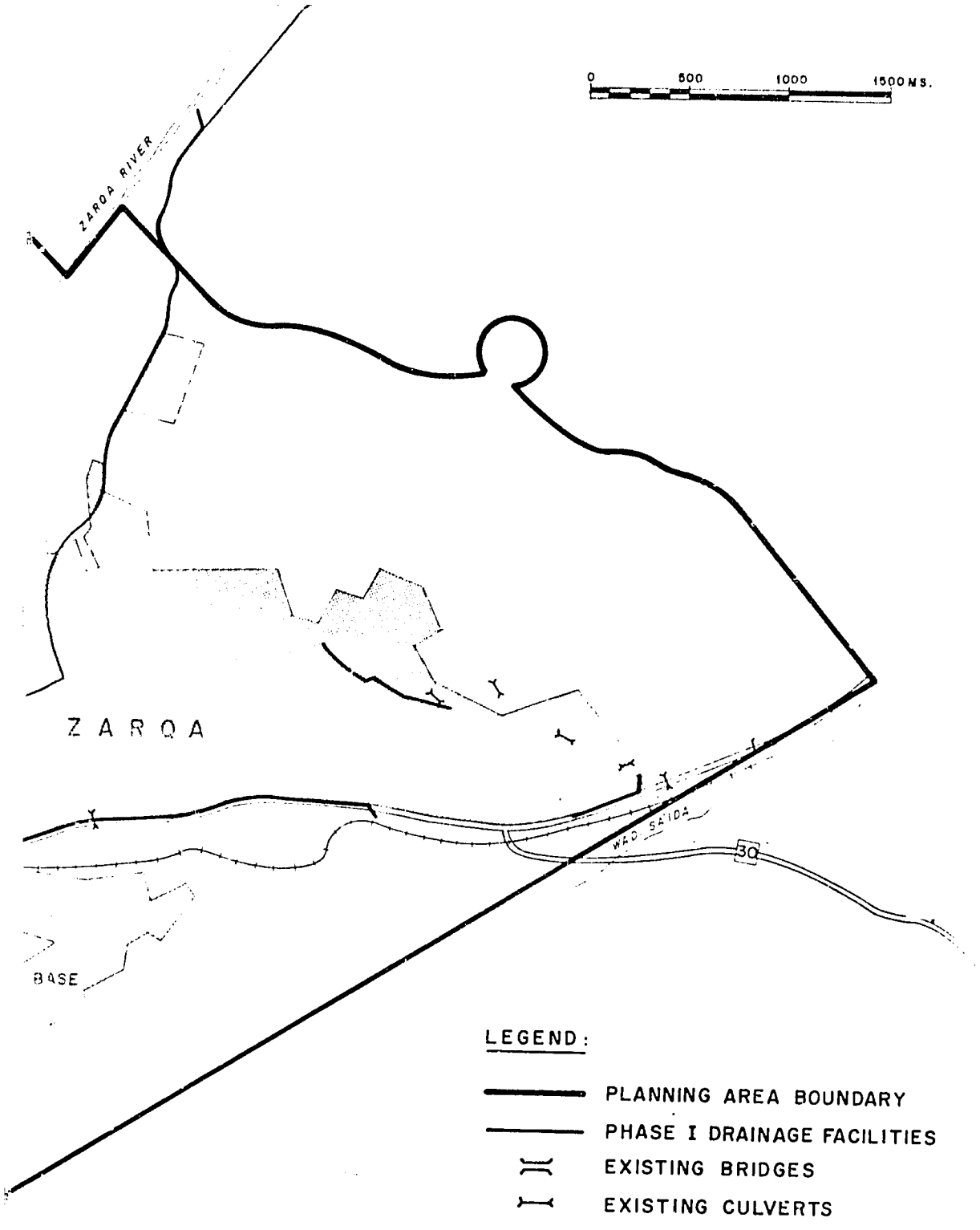

PHASE I DRAINAGE FACILITIES	Figure 8.1

- Consideration should be given to combining the water and sewerage agencies into one agency responsible for both.

The various capital cost parameters for the Phase I water distribution project are:

Construction Cost	JD 3,310,000
Annual Improvements (1981-1990)	JD 125,000/yr
Borrowed Project Cost	JD 3,411,000
Annual Repayment*	JD 283,300

*(22 years - 6 percent interest)

The operating expenditures were estimated using recent records and assuming a 7.5 percent annual inflation rate. The average operating and maintenance expenditures including the annual improvement cost between 1981 and 1990 are estimated as about JD 800,000 per year.

The existing rate structure results in an average rate of 120 fils/m^3 for Zarqa. Allowing for a water use pattern similar to Zarqa, the estimated average rate for Ruseita is 115 fils/m^3.

The proposed rate schedule must: 1) maintain a net positive cash flow between 1980 and 1990, and 2) maintain an average rate of return of about 8 percent during the 1985 to 1990 period.

The recommended average rate is 165 fils/m^3, effective January 1, 1984. If the existing rate is escaled from 1979 to 1984 at 7.5 percent, the result is 172 fils/m^3. Therefore, the recommended rate is realistic. Since there is no firm information on the price that the government will charge the municipalities for imported water, the cost has not been included in the proposed rate structure.

The various capital cost parameters for the Phase I sewerage system are:

Construction Cost	JD 18,204,000
Borrowed Project Cost	JD 30,992,000
Annual Repayment	JD 2,574,000

The estimated annual operating and maintenance cost plus JD 635,000 per year (JD 1980) annual capital cost for growth between 1984 and 1990 and assuming 7.5 percent inflation is about JD 1,525,000.

It is proposed that the sewerage charges be recovered as a surcharge on the water bills. In addition, additional revenue will be obtained from those industries with private wells and the Army Base.

If 7.5 percent inflation is assumed, the cost per m^3 of sewage is 499 fils.

An "ability to pay" analysis showed that JD 26.5 per year could be paid by combination of the lowest and second lowest income groups for water and sewerage service.

The recommended sewerage service charge is 375 fils/m^3, effective January, 1984. This rate is sufficient to cover operation and maintenance, capital improvements, plus about 59 percent of the debt service. About JD 920,000 per year will be required from other sources to balance the cash flow. These other sources could be property taxes, general revenue, central government subsidy, a grant, or a graduated rate structure.

The total construction cost of the Phase I stormwater project is JD 1,030,000. Using the previously developed borrowing assumptions, the total project cost is JD 1,706,000. The annual repayment is JD 142,000.

The source of this revenue is usually general taxes similar to the Urban Property Tax.

10. ECONOMIC AND SENSITIVITY ANALYSIS

The recommended projects will result in both short - and long-term economic gains. Some of these are increased labor productivity, property value, and industrial development.

The internal economic rates of return for the 1980 to 2024 period are:

Project	Internal Economic Rate of Return
Water	7.8%
Sewerage	3.7%
Combined	4.4%

The purpose of the sensitivity analysis is to estimate the effect on the project costs and proposed rates caused by variation from the initial estimates. The following types of major variables were investigated:

- Inflation Rate
- Over-and underestimate of project costs
- Overestimate of water use.

The required rates (1984 increase) for a self-sufficient water project at the various inflation rates are:

Percent Inflation	Required Rate (fils/m^3)
0	110
5	145
7.5	165
10	190
15	255

These rates generally follow the overall inflation rate because the debt service payments are a relatively small portion of the total cost.

The rates for the proposed Joint Sewerage Agency are based on ability to pay rather than true cost. With increasing inflation rates, the ability to pay increases but the debt service repayments remain fixed.

The proposed rates and average annual subsidy for the Joint Sewerage Agency at the various inflation rates are:

Percent Inflation	Proposed Rate (fils/m^3)	Average Subsidy (1984 - 1990)
0	225	JD 1,426,000
5	315	1,128,000
7.5	375	920,000
10	440	850,000
15	600	229,000

Because there are several items in the total project cost, we have examined the effect of a 10 and 25 percent overrun in Phase I total project cost. Because there is also a possibility of not utilizing all of the contingency allowances, we have also examined a 10 and 25 percent decrease in Phase I costs.

For the sewerage project, there is a possibility of obtaining a direct grant. The amount of any grant is unknown but to cover this possibility an additional trial of a 50 percent total cost underage was made for the sewerage project.

Since we have examined the proposed rates at 7.5 percent inflation, the sensitivity analyses for the rate changes will also be performed at this inflation rate. Listed below are the rates with similar financial consequences as the proposal rates:

Item	Water (fils/m^3)	Sewerage (fils/m^3)
Current Proposed Rate	165	375
Rate with 10% Overage	170	405
Rate with 25% Overage	180	450
Rate with 10% Underage	160	345
Rate with 25% Underage	150	300
Rate with 50% Underage	-	225

Since the sewage rates were set on the ability to pay, a different way to view the sensitivity analysis would be to have the 375 fils/m^3 rate constant and determine the amount of subsidy which would be required to stabilize the rate. This additional amount is JD 257,000 per year if there is a 10 percent increase and JD 644,000 per year if there is a 25 percent increase. If there is a decrease, the decreased subsidy would be about the same amounts.

If the water demand and water sales have been overestimated, the rates will have to be increased to produce the same revenue.

Listed below are the rates with similar financial consequences as the proposed rates for a 10 percent and 25 percent overestimate of water and sewage sales:

Item	Water (fils/m^3)	Sewerage (fils/m^3)
Current Proposed Rate	165	375
Rate with 10% Less Sales	185	415
Rate with 25% Less Sales	225	500

11. HEALTH-RELATED AND ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

The major impacts of the "No Action" alternative are outlined as follows:

- o Health Conditions
  - No improvement in current unsatisfactory health conditions
- o Climate and Air Quality
  - Continued septic odors
- o Water Resources
  - Become increasingly polluted
  - Continued substantial polluted groundwater recharge

- The Man-Made Environment
  - Continued flooding and erosion
  - No land use controls by an attractive infrastructure

The significant impacts of the proposed action and mitigating measures are summarized as follows:

- Health Conditions
  - Provide significant health benefits
  - Adverse effect of possible contamination of irrigated crops and sludge can be mitigated by careful monitoring and control
- Climate and Air Quality
  - Eliminate septic odors
  - Short-term dust and erosion problems if not properly controlled
- Water Resources
  - Decreased water losses and may reduce roof tanks
  - Greater water use will be induced
  - Eliminate pollution and recharge of upper aquifer
- The Man-Made Environment
  - Cesspool elimination will remove constraint on higher density
  - Short-term traffic disruption, dust and noise, and odors caused by cesspool drainage

12 RECOMMENDED PROJECT

The recommended projects are developed for the following phases:

- Phase I - Provide adequate service for the 1990 population
- Phase II - Provide adequate service for the 2000 population

The recommended water distribution facilities are:

Zarqa

Phase I - 81 km of mains ranging in diameter from 50 to 600mm

Phase II - 73 km of mains ranging in diameter from 50 to 400mm

Ruseifa

Phase I - 40 km of mains ranging in diameter from 50 to 600mm

Phase II - 15 km of mains ranging in diameter from 50 to 150mm
- 1-700 m^3 reservoir.

The recommended sewerage project is:

Phase I

- 24,200 m^3/d plastic media trickling filter treatment plant adjacent to Zarqa River northwest of city
- 1175 m^3/hr Zarqa East Side Pumping Station
- 22 km of trunk sewer ranging in diameter from 300 to 1,100mm
- 3 km of 500 mm diameter force main
- 203 km of collection and subtrunk sewer ranging in diameter from 200 to 600 mm
- 68 m^3/hr collection pumping station
- 26,000 house connections

1984-1990 Growth

- 66 km of collection sewer ranging in diameter from 200 to 300mm
- 7,970 house connection

Phase II

- Expand treatment plant to 41,200 m^3/d
- 205 km of collection and subtrunk sewers ranging in diameter from 200 to 300 mm
- 20,300 house connection

The recommended stormwater drainage project is:

Phase I

- 13 km of 300 to 1000 mm diameter pipelines and larger box culverts

Phase II

- 26 km of 300 to 1000 mm diameter pipelines

The construction cost of the recommended projects has been estimated on the basis of June 1980 costs. These are summarized as follows:

Phase I	Construction Cost (JD)
Water	3,310,000
Sewerage	18,204,000
Stormwater	1,030,000
	22,544,000
1984-1990	
Sewerage	3,291,000

Phase II		
Water	2,050,000	
Sewerage	9,476,000	
Stormwater	1,166,000	
	12,692,000	
Total - All Phases		38,527,000

All projects require certain other costs which must be added to the construction cost to obtain the total project cost.

The estimated total project costs, including the 1984-1990 sewerage growth project with Phase I, by Phase, are:

Phase I	Total Project Cost (JD)	
Water	4,661,000	
Sewerage	35,435,000	
Stormwater	1,706,000	
	41,802,000	
Phase II		
Water	2,673,000	
Sewerage	14,153,000	
Stormwater	1,931,000	
	18,757,000	
Total - Phase I and Phase II		60,559,000

The estimated total project costs, by type of project, are:

Water	Total Project Cost (JD)
Phase I	4,661,000
Phase II	2,673,000
Total	7,334,000
Sewerage	
Phase I	35,435,000
Phase II	14,153,000
Total	49,588,000
Stormwater	
Phase I	1,706,000
Phase II	1,931,000
Total	3,637,000
Total - All Projects	60,559,000

Assuming a 7.5 percent rate of inflation, the water rate schedule would have to be increase from the current average rate of 120 fils/m^3 to an average rate of 165 fils/m^3. This increase, effective January 1,1984, will make the recommended water distribution projects financially self-sufficient.

The recommended sewerage rate is 375 fils/m^3 effective January 1, 1984. This rate is based on "ability to pay". It will cover the estimated operation and maintenance costs plus about 59 percent of the debt service. An average annual subsidy of about JD 920,000 will be required to balance the cash flow.

The annual debt service of the Phase I stormwater drainage project is JD 142,000.

In situations similar to this project, the construction of the sewage treatment facilities usually sets the critical path of the implementation schedule. The sewage trunk and collection system should start at the plant and proceed progressively away from it. It is suggested the one contract include all the water, sewerage, and stormwater drainage facilities for each geographical area.

The proposed facilities are a major undertaking and cannot be successfully accomplished without trained personnel. Recruitment and training of the required staff should be completed before the facilities are ready for operation.

A public education program should be used to help prevent the recurrence of many of the problems experienced in other collection and conveyance system.