- PN-AAT-761 41978 -
JORDAN 278-0234
Prog Development

The Hashemite Kingdom of Jordan
National Planning Council

FEASIBILITY STUDY

ZARQA – RUSEIFA

WATER DISTRIBUTION, SEWERAGE AND STORMWATER SYSTEMS

APPENDIX TO

INVESTIGATIONS, PRELIMINARY ENGINEERING DESIGN, FINANCIAL, AND SOCIO – ECONOMIC ANALYSIS REPORT

MALCOLM PIRNIE, INC.
in association with
JOUZY & PARTNERS

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INVESTIGATIONS, PRELIMINARY ENGINEERING
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ANALYSIS REPORT

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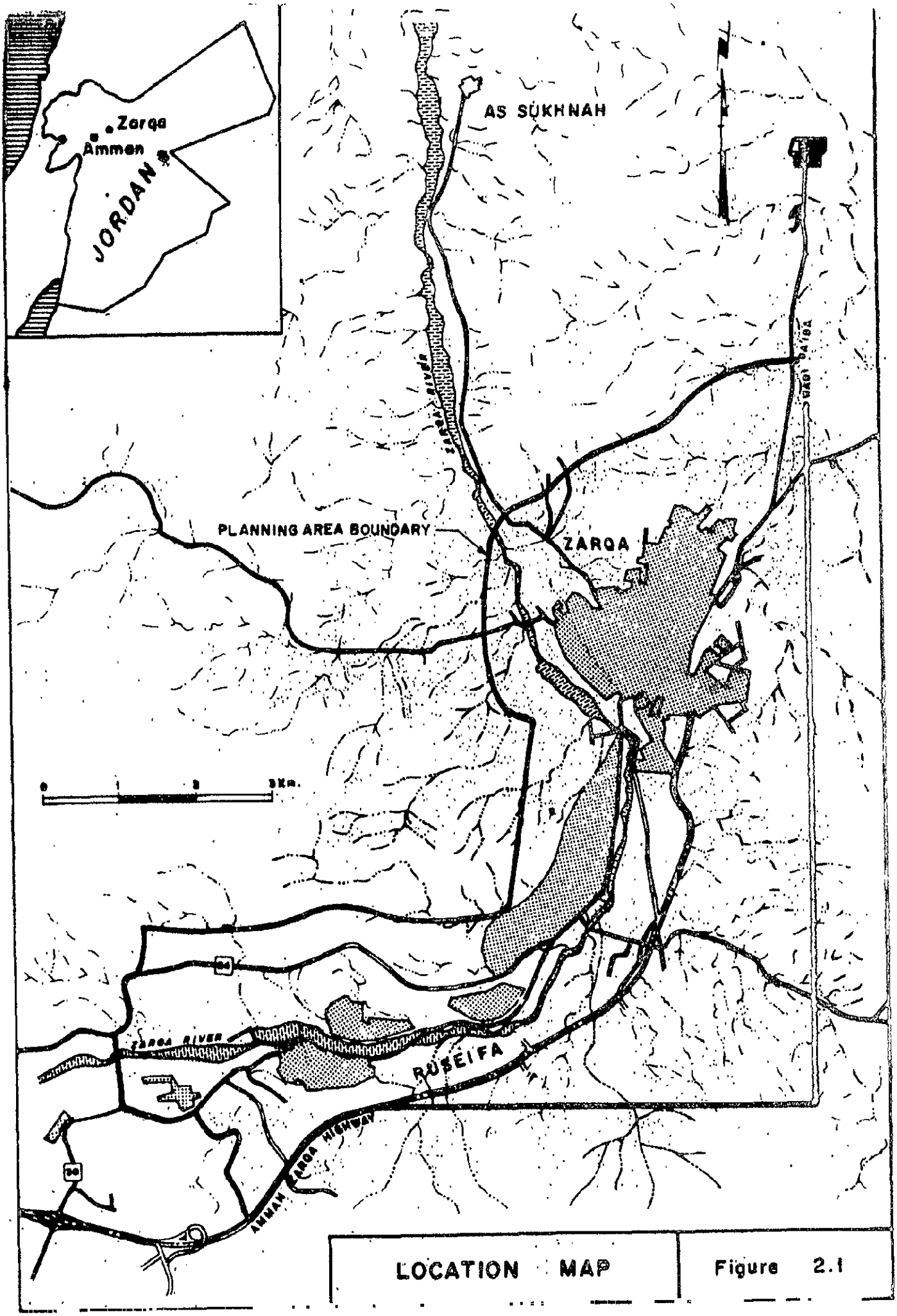
CHAPTER 2.0

PLANNING CONSIDERATIONS



LOCATION MAP

Figure 2.1

CHAPTER 3.0

SOCIO-ECONOMIC AND HEALTH CONDITIONS

APPENDIX 3.1

SOCIO-ECONOMIC STUDY
OF
RESIDENTIAL WATER USE PATTERNS
IN
ZARQA AND RUSEIFA, JORDAN

A Report Submitted To

Malcolm Pirnie, Inc.

And

Jouzy & Partners

By

Dr. Sari J. Nasir
Professor of Sociology
University of Jordan
Amman, Jordan

May 1980

"The city of Zarqa is sitting on a time bomb; if no action is taken soon, the bomb will explode, and Zarqa will sink in a sea of shit."

Zarqa Businessman

"At night, the city of Zarqa is transformed into a frightening place. As soon as it gets dark, cesspools are opened and pumped. The terrible odor of cesspools mingles with both the grinding sounds of pumps and the sound of splashing water in the streets. One cannot eat, entertain or sleep. I tell you it is a nightmare."

Zarqa Housewife

1.0 INTRODUCTION

1.1 Scope of the Study

This socio-economic study is part of the Zarqa-Ruseifa feasibility study for water distribution improvement, sewerage and stormwater systems design. Its purpose is to give the reader an insight into the attitudes of the residents in both Zarqa and Ruseifa towards water, its use and disposal.

1.2 Methodology

In-depth household interviews of 26 households were conducted in Zarqa and Ruseifa during the month of April 1980. The interviews were directed, but unstructured, a technique in which the interviewer seeks to obtain certain information by a series of probing questions that are based on the responses of the subjects rather than on a pre-determined questionnaire. This method was chosen for several reasons. Firstly, it lends itself to exploratory investigations, in which it is not certain what results are to be expected. Secondly, the subjects are likely to feel more at ease with the conversational format of the unstructured interview than with the formal approach of the fixed interview schedule. Thirdly, the time and budget limitations of the study did not permit development and testing of a more structured survey instrument. Lastly, the small sample size dictated by the budget greatly reduced the likelihood of obtaining a representative sampling, therefore it was concluded that less emphasis on quantitative results would be preferable.

In order to obtain a more complete picture of individual water using practices, the household interviews were conducted by the author with all family members present (insofar as possible), rather than just the head of household or the housewife.

2.0 HISTORICAL BACKGROUND

2.1 Zarqa

Today the population of the city of Zarqa is about 216,000 persons. Forty years ago, only a few hundred families lived in what was referred to as the village of Zarqa.

It is believed that the first people to inhabit the Zarqa area were the Bedouin tribes. One of these tribes, Beni-Hassan, settled on the land and eventually owned most of the territory. Another group, the Chechens, together with the Circassians arrived in the Zarqa area at the end of the 19th century. The Chechens and the Circassians, the descendants of Muslin tribes, emigrated from the Caucasus following its conquest by the Russians in the 19th century, particularly after the Berlin Congress of 1878. These people settled in Transjordan by permission of the Turkish Sultan Abd Al-Haind. A small group of about 200 Chechens chose to live near the water sources in the Zarqa area and developed irrigated agriculture, while the Beni-Hassan, it is claimed, were involved in dry farming. By 1920 both Beni-Hassan and the Chechens, together with two small groups of Syrian and Palestinian merchants, constituted the bulk of the population of Zarqa. Their houses were mostly built of mud and straw.

The sudden growth and expansion of Zarqa has been due primarily to an influx of refugees from Palestine and immigration from rural areas. In 1948 and as a result of the war, Palestinians were ejected from their lands and homes. Of the hundreds of thousands who emigrated to Transjordan, many went to Zarqa and settled in refugee camps. As a result of the 1967 war, many more Palestinian refugees joined the growing population of Zarqa.

Another factor which seems to have been instrumental in the growth of Zarqa is immigration from rural areas. Many rural residents have left their lands and moved to the city, motivated primarily by economic opportunity, especially since Zarqa has become the home of one the largest military bases in the country.

Today, the population of Zarqa is composed of people from widely diverse backgrounds who live and work there, close together in restricted living space.

2.2 Ruseifa

Ruseifa is an industrial city with a population of approximately 61,000 persons. It has grown primarily because of the phosphate industry.

As an industrial center, situated between the cities of Amman and Zarqa, Ruseifa has attracted unskilled and semi-skilled laborers from the rural areas of Transjordan and Palestine. Today, Ruseifa is the home for several industries, among them phosphates, plastics, weaving, dairy, etc. Most of the people who live in Ruseifa today earn their living from one of the industries in the city.

Being poor and homeless, many of the laborers built their modest homes on land that did not belong to them. As the city expanded, it was difficult to remove these squatters from the places they occupied. Squatter settlements have proved to be a difficult problem to government planners who are still searching for solutions to the problems of these communities.

3.0 CHARACTERISTICS OF THE SAMPLE HOUSEHOLDS

Twenty-six families (20 families in Zarqa and 6 families in Ruseifa) were interviewed. Characteristics of the sample households are given below. Because of the small sample size and because the sample was not randomly selected from all households, it should not be assumed that the sample results are representative of the population as a whole.

3.1 Zarqa

The 20 families interviewed in Zarqa included 7 low-income households, 8 middle-income households, and 5 high-income households.

Table 1

Income Distribution of Families in Zarqa Sample

Income Group	Average Annual Income J.D.	Number of Families	Percent
Lower Income	1,200	7	35
Middle Income	3,500	8	40
Upper Income	over 5,000	5	25
Total		20	100

The average number of persons per household was 7, which closely approximates the census result of 6.92 persons per household. More females (55 percent) than males (45 percent) were found.

Table 2

Number and Sex of Persons Interviewed in Zarqa

	Number	Percent
Females	77	55
Males	63	45
Total	140	100

Most families interviewed were Moslem, 70 percent); Christians constituted 30 percent.

Table 3

Religion of Families in Zarqa Sample

Religion	Number	Percent
Moslem	14	70
Christian	6	30
Total	20	100

3.2 Ruseifa

The six families interviewed in Ruseifa included 3 families from the low-income group, two families from the middle-income group, and one family from the upper-income group.

Table 4

Income Distribution of Families in Ruseifa Sample

Income Group	Average Income J.D.	Number of Families	Percent
Lower Income	1,000	3	50
Middle Income	3,000	2	33
Upper Income	over 4,500	1	17
Total		6	100

The average number of persons per household was 7. More females (57 percent) than males (43 percent) were found.

Table 5

Number and Sex of Persons Interviewed in Ruseifa

	Number	Percent
Females	24	57
Males	18	43
Total	42	100

Five of the six families were Moslem.

Table 6

Religion of Respondents in Ruseifa

Religion	Number	Percent
Moslem	5	83
Christian	1	17
Total	6	100

4.0 FINDINGS

4.1 Zarqa

4.1.2 Water Use

1. Water is available in Zarqa and people, in general, do not consider the availability of water to be a problem.

2. Upper-income persons use more water than low-income persons.

3. In low-income families the young use more water than the old. Older people who are poor are very frugal with water (especially those who come from rural areas where water is scarce), whereas their offspring who attend school use more water to maintain cleanliness.

4. Low-income persons usually bathe every ten days, whereas upper-income persons take daily baths. In summertime, well-to-do persons may shower more than once a day.

5. Low-income persons use less water in mostly everything because they want to save money and effort. For example, they tend to bathe less frequently because:

   a. It is too much trouble to heat water, transport it to bathroom, cool it, etc.; and

   b. Taking frequent baths would increase the volume of water discharged to cesspools and that means more money for pumpouts.

6. Upper-income families, as a rule, have hot and cold water with modern tubs and showers. It is much more convenient for them to take baths, and they do not worry as much about the expense of cesspool pumpouts.

7. Low-income families said that they used water primarily for drinking, cleaning and bathing; on the other hand, upper-income families tended to use water for cleaning and bathing. As for drinking, many of the latter preferred bottled mineral water in the belief that Zarqa water is contaminated. No water is used for irrigation (gardening).

8. Clothes washing machines seemed to be used in all households, regardless of income level.

9. Low-income groups tended to rank acquisition of water-using appliances over the acquisition of a water-based sewer system. All respondents have one or more washing machines and all seemed to want to own other water appliances if made available.

10. Hot-water heaters were used mostly by upper-income families, however, some middle-income families are introducing them in their homes.

11. Squat toilets are used primarily by the middle and low-income groups, whereas flush toilets are used by the upper-income families.

4.1.2 Wastewater Disposal

1. Most wastewater in Zarqa is disposed of into cesspools.

2. Every household and public establishment in the city of Zarqa has at least one cesspool.

3. All families, regardless of income, favored a sewerage system in Zarqa. All indicated that they would also be ready to pay whatever is required of them in order to do away with cesspools.

4. At present, low-income families dispose of much of their dirty water (sullage) by throwing it out in the streets, usually at night to avoid being caught and fined by municipal inspectors.

5. Throwing water in the streets seems to create friction and conflict between neighbors. It was claimed that housewives threw their water in front of their neighbors' houses.

6. Although families of all income levels wanted sewers to be installed immediately in Zarqa, they seemed to give different reasons:

   a. The low-income persons believed that the sewers will save them:

      (1) money

      (2) time and effort in getting trucks to pump their cesspools and

      (3) much trouble in paying fines to the municipality.

   b. Upper-income persons, on the other hand, seemed to worry more about the future of their city. They argue that:

      (1) if something is not done soon, the city might eventually cave in to the cesspools; and

      (2) daily pumping of cesspools gives the city a very bad odor and helps spread disease.

7. The well-to-do were skeptical about the credibility of the news that a sewer project is being seriously entertained. They said that they have heard this many times before and nothing was done. Furthermore, they point to the fact that, although Zarqa is the second largest city in Jordan, the government does not have enough interest in the problems of their city.

8. Although all families indicated a readiness to pay whatever fees were required of them for the sewers, some among the poor asked whether the costs would be borne by the landlord or the tenant.

9. When asked about the possibility of introducing flush toilets in their homes, low-income families responded that they could not change the existing arrangements in their homes because: (a) they do not have enough money, and (b) there is not sufficient space. The area available is very small and it is difficult to relocate their squat toilets which are usually located oustide the house.

10. People, in general, felt that having sewers in Zarqa will lessen their dependence on the municipality. Many persons resented the problems and delays they experienced in having their cesspools pumped out.

11. The number of times cesspools were pumped varied. In general, upper-income families had their cesspools pumped more often. However, there seemed to be certain factors which affect the frequency of cesspool pumping. (a) When a cesspool is first installed, it takes a long time (somewhere between one and two years) before pumping is necessary, since the water is easily absorbed. (b) After the first pumping, cesspools tend to fill sooner and must be pumped more often. People tend to dig a new cesspool in order to avoid frequent pumping charges.

12. Nonetheless, cesspools were pumped an average of four times a year.

13. The charge for pumping cesspools varied between 3 and 6 J.D.

14. Some persons estimated that their water consumption will increase between 10 and 15 percent with the availability of water-based sewer service. It was argued that people will use more water to clean, wash and bathe.

4.2 Ruseifa

4.2.1 Water Use

1. Attitudes of people in Ruseifa towards water use and wastewater disposal were very similar to those in Zarqa.

2. However, people in Ruseifa said that they used substantial amounts of water because it was necessary, they claimed, to wash the dust emanating from the phosphate factories. Most people believe that the dust is "poisonous."

4.2.2 Wastewater Disposal

1. All families were in favor of sewer service in the city.

2. Most people believed that sewers will give their city a sense of permanence. They argued that Ruseifa has been an impermanent place for transient laborers.

3. They also argued that sewers might make the government pay more attention to their city, especially to stop the "harmful poisonous dust."

4. Residents of Ruseifa were more concerned than residents of Zarqa about the cost of sewerage. They asked many more questions about the exact amounts to be paid by both the landlord and the tenant.

5.0 SUMMARY AND CONCLUSION

The in-depth interviews conducted in the Zarqa-Ruseifa area of twenty-six families, accentuated several new factors which might have an important role in influencing the attitudes of people toward water use and wastewater disposal.

Despite both physical and economic constraints, even low-income households owned or wanted to own water-using appliances. At the same time, the sampled households viewed the prospects of establishing a sewer system in both cities to be a positive step which will improve the quality of their lives.

Therefore, it seems that as more water-using appliances are made available in markets and the standard of living improves water consumption will definitely increase with the availability of a sewer system.

It also seems that residents of Zarqa and Ruseifa are acquiring a set of modern urban attitudes towards both themselves and their environment. This means that, in the long run, residents would want to equip their homes with modern facilities and appliances, such as flush toilets, hot water heaters and dishwashers.

Although people, in general, showed a willingness to cooperate and pay for sewer service, it seems that most residents are not fully aware of what a sewer system means, especially how to use it and maintain it. In Amman, for example, poor families did not know how to use the sewer system and the result was frequently clogged pipes.

Therefore, it seems appropriate to make the following recommendations:

1. A public information campaign should be launched on television to explain the idea of a sewer system and to advise residents what to do and what not to do to ensure its proper operation. Because water is a scarce resource in Jordan, residents should also be encouraged to conserve.

2. Most people in both cities showed hostility and resentment towards municipal government. They felt that with the present set-up, it is unlikely that they would be willing to cooperate fully with officials. Therefore, it seems that greater effort is required in both municipalities to encourage people to cooperate more.

DR SARI J. NASIR

CONSULTANT - JOUZY AND PARTNERS - C.E.B.

SOCIO-ECONOMIC STUDIES

EXPERIENCE

1967 - Present	Professor and Chairman Department of Sociology University of Jordan
1965 - 1967	Associate Professor of Sociology University of Jordan Amman, Jordan
1962 - 1964	Assistant Professor of Sociology University of New York New Paltz, New York

EDUCATION	St. Georges School, Jerusalem Roosevelt University Chicago, Ill. U.S.A.	B.A. 1956
	University of Chicago Chicago, Ill. U.S.A.	M.A. 1958
	Mass. Institute of Technology Cambridge, Mass	Fellow 1958-1959
	University of Illinois Urbana, Ill.	Ph.D. 1962
HONORS	Ford Foundation Travel Grant	1971
	Ford Foundation Fellow	1972-1973
	Population Council Fellow (London University)	1976

LIST OF PUBLICATIONS IN ENGLISH INCLUDES:

1. Portrayal of Arabs in American Popular Culture.
2. The Status of Women in the Changing Society of Jordan, Journal of Research, University of Jordan 1969.
3. The Portrayal of the Arabs in American Movie Titles, Journalism Quarterly 1963.

BOOKS

1. The Arabs and the English, Longman, London 1976
2. The Arabs and the English, Longman, London (2nd Edition) 1979.

APPENDIX 3.2

THE ENVIRONMENTAL CONDITIONS RELATED TO WATER-BORNE DISEASES IN ZARQA-RUSEIFA

A PRELIMINARY INVESTIGATION

A Report Submitted to

MALCOLM PIRNIE, INC.

AND

JOUZY & PARTNERS

BY

PROFESSOR AFTIM ACRA

Department of Environmental Health
Faculty of Health Sciences
American University of Beirut
Beirut, Lebanon

JUNE 1980

THE ENVIRONMENTAL CONDITIONS RELATED TO WATER-BORNE DISEASES IN ZARQA-RUSEIFA: A PRELIMINARY INVESTIGATION

1.0 INTRODUCTION

1.1 Purpose of the Study

The contractual agreement for the health study requires the following:

" Appraisal of the present situation (in Zarqa and Ruseifa) with respect to water-borne diseases and other health hazards which could be attributed to the present water distribution system, and to the lack of a general sewerage system;recommendations as to goals and objectives for improvement to be expected from completion of the various implementation phases of the Project".

Obviously, these requirements limit the appraisal to water-borne diseases and other health hazards. Such a constraint is considered to be impractical in view of the fact that an undertaking of this nature must be complemented by an assessment of the environmental conditions associated with health hazards. Accordingly, the investigation took into account these points as is evident in this report.

1.2 Methodology

The field work covered two periods, February 16-18 and March 21-24, 1980. Initial efforts were devoted to a review of available reports on water supplies and health conditions in the study area and the Amman Region. [1-8] This was followed by several visits to the cities of Zarqa and Ruseifa, during which the following were accomplished:

1. General survey of the two cities to observe the conditions and cleanliness of the streets, types of buildings, slum areas, refugee camps, markets, commercial centers, food shops, etc.

2. Inspection of specific places such as the Amman sewage treatment plant, dairy farms, restaurants, the Wadi Zarqa stream, schools, and cesspools.

3. Interviews with responsible persons in various governmental agencies in Amman, Zarqa and Ruseifa, as well as some university professors, physicians, pharmacists, engineers, and laymen.

The field surveys and inspections were rather superficial on account of the limited time available and the large number and variety of places to be visited. This is a shortcoming that could not be helped.

The proper investigation of water-borne diseases prevailing in Zarqa and Ruseifa would ideally be based on reliable and relevant epidemiological and environmental studies, and on accurate health statistics. Unfortunately, these are seriously lacking in Jordan particularly in the case of the two communities in question. It is, therefore, imperative for an investigator to utilize other approaches, possibly even indirect ones, to arrive at conclusions regarding the existing situation and the development of guidelines for the establishment of policies and plans of action.

1.3 Acknowledgements

The assistance and information provided by a number of persons is hereby acknowledged with gratitude, and in particular:

1.	Mr. Pat Johnson	-	National Planning Council
2.	Mr. Mohammad Dajani	-	Ministry of Health, Amman
3.	Dr. Sulaiman Haddadin	-	Directorate of Health, District of Zarqa
4.	Prof. Sami Khoury, M.D.	-	Faculty of Medicine, University of Jordan
5.	Dr. Mousa Owdeh	-	Municipality of Zarqa
6.	Mr. Mohammad Sowwan	-	Directorate of Health, District of Zarqa
7.	Eng. Mohammad Towfic	-	Municipality of Zarqa
8.	Mr. James Cassanos	-	USAID, Amman

2.0 EXISTING CONDITIONS IN THE STUDY AREA

2.1 Water Resources

The Amman Zarqa Basin covers an area of 850 km^2, and consists of the upstream part of the Zarqa River drainage system and two major groundwater aquifers referred to as the upper and lower aquifers.

All of the urban and rural communities geographically located within this basin, including Zarqa, Ruseifa, and Amman, are dependent on the groundwater extracted through public and private wells from the two aquifers for domestic, industrial and agricultural use. Madaba, a town outside the basin, is also supplied with groundwater from the aquifers of the Amman-Zarqa Basin.

The total population presently supplied with water from this basin is estimated by VBB at about 1.5 million.[8] VBB estimates a total water demand of 65 Mm^3/Y for domestic, agricultural, and industrial uses in 1980. Their forecast for the year 2000 is 165 Mm^3/Y for domestic purposes.

Most of the wells in the basin, estimated at well over two hundred, are located along the wadis and banks of the Zarqa River[8]. The municipalgroundwater sources that provide Zarqa and Ruseifa with domestic water supply are under the jurisdiction of the respective municipalities of the two cities.

As the water table was gradually lowered through excessive abstraction of groundwater from the upper, unconfined aquifer, the tendency in recent years is to obtain water from the more confined, lower aquifer.

The potential annual recharge to both of these aquifers has been estimated by VBB to be 25 Mm^3 partly from precipitation and partly from discharged wastewater[8]. In fact, it is believed that the extracted groundwater can be replenished only through recharge of wastewater from various sources.

Abstraction of groundwater at the present rate is hardly commensurate with the natural recharge.[2] It is, therefore, anticipated that an increase in the usage of the groundwater resources to meet the growing needs will inevitably lead to a critical stage, unless alternative resources are developed and utilized efficiently. But, this is expected to present a challenging issue that may not be resolved readily.

Evidence has also accumulated in recent years that seems to support the view that both the lower and upper aquifers are subject to pollution from domestic, industrial and agricultural sources.[2,8] This is illustrated by the fact that the treated sewage from the city of Amman is at present discharged into the Zarqa River. At the same time, the untreated portion of the Amman sewage is discharged into Zarqa River either directly or through cesspool overflows from the unsewered sectors of the city. A

somewhat different situation exists in the case of Zarqa and Ruseifa where no sewerage systems exist. In these two cases the wastewater accumulated in cesspools percolates into the upper groundwater aquifer, or is collected and discharged into the Zarqa River which passes by these two cities.

A much smaller quantity of wastewater is produced by rather small and somewhat dispersed industries, and is discharged into evaporation ponds in the vicinity of each source where part of the liquid waste evaporates and the rest infiltrates into the groundwater aquifer. Some industries located by water courses discharge their untreated wastewater directly into the streams.

Agricultural drainage water resulting from irrigation of cultivated land generally lying along Zarqa River ultimately percolates into the groundwater aquifers, thus contributing to their recharge. This, however, tends to increase the mineral content of the groundwater, particularly such plant nutrients as nitrates and phosphates derived from fertilizers. Contamination of the groundwater with pesticides from such a source cannot be ruled out.

Since the upper aquifer is not confined, it is evidently exposed to pollution from the various sources already mentioned. However, the available evidence indicates that the lower aquifer is also subject to pollution, although to a much lesser extent. This can partly be explained by the entry of pollutants through unsealed, or improperly sealed, deep wells that penetrate the aquiclude into the lower aquifer.

The obvious conclusion, then, is that natural recharge in the form of runoff water and of stormwater from the towns located within the Amman-Zarqa Basin accounts for a substantial share in the replenishment of the heavily extracted groundwater.

This is also substantiated by the infiltration into the groundwater aquifers of discharged wastewater generated through human activities. The pollution of the groundwater has reached such an extent that the arising concern seems to be justifiable.

While intervention with natural recharge is hardly feasible, the control of drainage of wastewater from human sources deserves special attention if the protection of the groundwater from serious pollution forms the candid objective of the governmental agencies concerned. Protection of surface waters, the Zarqa River in particular, also must not be ignored because of the potential impacts on the King Talal Reservoir downstream from the study area.

2.2. Major Sources of Pollution

The information presented above shows that one of the major sources of pollution of the groundwater in the Amman-Zarqa Basin consists of the domestic wastewater discharged, with or without treatment, into the Zarqa River, and by the widespread use of cesspools for disposal of sanitary waste. This applies essentially to the three major communities in the area - Amman, Zarqa and Ruseifa, in addition to the Palestinian refugee camps located in the area. The situation with respect to Amman differs from that of the other communities in that the capital city is partially provided with a sewerage system and a treatment plant. In the unsewered parts of Amman, as is the case for the other communities, domestic wastewater is collected in private cesspools that are emptied as necessary for disposal by special tankers. In the case of Amman, the tankers transport the liquid waste to the Amman Sewage Treatment Plant. In Zarqa and the other communities, the wastewater is transported by the tankers for dumping into the water courses or wadis, consequently causing ground or surface water pollution.

The typical situation in Zarqa, for instance, is that part of the domestic wastewater (usually excreta) is discharged into the cesspools, while the rest (usually sullage) is thrown freely into streets or backyards.

These small cesspools, commonly about 4 m^3, eventually fill and begin to overflow. This occurs much more frequently during the rainy season. In the absence of a stormwater system, the fecal matter is thus spread by surface runoff throughout the inhabited areas, eventually to percolate into the ground or to flow towards the low-lying areas of the city by the wadis. Since the side-streets and alleys are generally unpaved, the highly polluted surface runoff collects in puddles.

In those parts of Zarqa where the soil is phosphatic, highly compacted and impermeable, and also saturated with deposited fecal matter, percolation into the ground is much less likely compared to the other parts where the top soil is different. Fortunately, rainfall is infrequent and meager, which allows the abundant sunlight to accelerate evaporation and to help in the disinfection of the contaminated areas.

The Municipality of Zarqa empties the cesspools at a charge of J.D. 2.5. Private collectors are also available at a charge of J.D. 3 to J.D. 5, depending on the location and accessibility. According to municipal sources, the fecal matter is disposed in the Wadi Dulail area, some 25 km Northeast of Zarqa, an area where groundwater pollution is not likely.

It would be useful to consider briefly the treatment and ultimate disposal of that part of the sewage collected through the existing sewers in Amman as the plant effluent also contributes to surface and ground water pollution.

The Amman Sewage Treatment Plant, located on the bank of the Zarqa River, by the main road on the way to Zarqa, serves an estimated population of 250,000 which represents an incomplete coverage of the city. The plant employs the activated sludge process, and is provided with thickeners, sludge digesters, and sludge drying beds. In addition to the regular influent sewage, the plant also receives the Amman cesspool contents transported by tankers. During the rainy season, it is often necessary to bypass the whole of the incoming flow directly into the Zarqa River on account of the substantial stormwater inflow and the great amount of mud and silt carried by the stormwater as a result of soil erosion.

While the assessment of the plant is beyond the scope of this report, it should be noted that the plant is overloaded in terms of both volume and organic matter. The BOD value of the raw sewage, for instance, is reported to range from 1,000 to 1,500 mg/l with an effluent BOD value of 30 to 60 mg/l. The undersized sludge drying beds are used only as standby. The wet sludge which is normally transported and dumped at the refuse dump located between Amman and Zarqa is applied to the sludge drying beds on Fridays and holidays when transportation facilities are not available. In addition, the excess activated sludge is discharged along with the diverted influent raw sewage directly into the Zarqa River. At the point of discharge, the shallow groundwater pumped from an existing well for transport by tankers to Amman for sale to domestic and commercial consumers. Some of the tankers have been observed heading towards Ruseifa and Zarqa. Although the water is said to be chlorinated, the location of the well must be considered unacceptable.

Once all of Amman is provided with sewers, the increased wastewater flows would require substantial improvement and expansion of the existing treatment facilities, otherwise further deterioration of the environment and water resources are expected to occur.

The discharge of untreated industrial wastes constitutes a smaller, but important, source of pollution of the water resources and a potential risk to public health. The industries involved may be classified into two kinds with respect to the nature of discharged liquid wastes: (a) those that discharge appreciable quantities of biodegradable organic matter such as from the food-processing industries (e.g. yeast, tomato paste, and vegetable canning), and (b) those that discharge chemical pollutants, such as refineries and tanneries. The latter are presently being given attention by the Ministry of Health as they possess latent health hazards that are generally overlooked.

Recently, the Supreme Committee for Public Safety was formed for the identification and control of environmental problems in cooperation with other interested official bodies.

Some progress has been made with respect to legislation directed at curbing the indiscriminate and uncontrolled discharge of industrial liquid wastes. An outcome of such legislation is that the Minister of Health has the prerogative to prohibit any discharge of industrial wastes if, in his judgement, such a practice would constitute a hazard to public health, or would lead to the degradation of the environment.

Accordingly, the Minister can close any noncomplying industry that is known to be causing such hazardous problems. The large and financially capable industrial establishments have already been requested and encouraged to install the necessary facilities for the pretreatment of their liquid wastes prior to disposal. One of the difficult problems being faced in this connection pertains to the lack of national effluent quality criteria and standards. This shortcoming is, however, presently under consideration. The lack of reliable analytical data for industrial wastes is another major hindrance.

It is clear that legislation by itself can be ineffective unless it is supported by an appropriate infrastructure and by law enforcement.

2.3 Water Treatment

The minimum requirement set by the Ministry of Health for the treatment of drinking water throughout the kingdom, irrespective of the nature or ownership of the source, is disinfection by chlorination to assure the destruction of pathogenic organisms. This precaution was prompted by a cholers outbreak that occurred in 1977 when a number of cases were reported. Accordingly, noncompliers will be prohibited from continued use of the incriminated water source. In addition, frequent examinations for coliform organisms and residual chlorine are required. Chemical examinations on a routine basis are not deemed to be essential.

Acquaintance with the situation indicates that the current practices do notnecessarily comply with the established requirements and expectations. The result is that the false sense of security acquired by all concerned could ultimately lead to undesirable consequences. Several shortcomings may be cited in support of this information. An important observation, for instance, is that the operators in charge of the chlorination stations are generally not qualified for the operations involved. Delays in chlorine supplies, improper maintenance and repair of the installations, deficient disinfection, misinterpretation of the laboratory report, the lack of the sanitary surveys, and the absence of effective action whenever necessary are but some of the actual shortcomings. To some extent, these can and need to be corrected.

In the case of the drinking water supply for Zarqa and Ruseifa, the chlorine dose applied in emergency cases is 2.5 mg/l, while the normal dosage is 1.5 to 2.0 mg/l. Testing for residual chlorine is carried out routinely at various points throughout the distribution system. In general the results indicate values for residual chlorine ranging from about 1.0 mg/l at the point of chlorination to 0.0 mg/l at the peripheral parts of the distribution system.

2.4 Water Quality

An interpretation of the available scanty data on groundwater quality over the past decade supports the field observations that chemical and bacteriological pollution is occurring. The results vary from one source to another, but in general there is ample evidence of increasing deterioration in the quality of water in the upper and lower aquifers. It is expected that this situation will continue, unless preventive and corrective measures are taken. Similar observations and findings apply to water quality of the Zarqa River which is impounded by the King Talal Dam. The inference is that recycling of the groundwater may eventually lead to quite a serious situation.

From the standpoint of the macro-chemical contaminants, the abstracted groundwater appears to comply with the WHO International Standards for Drinking Water. The outstanding exception to this general statement concerns the fluoride and nitrate contents. It has been reported by various sources that the fluoride level has reached a value ranging from 0.5 to 1.0 mg/l, while the nitrate content ranges from 50 to 75 mg/l as NO_3, in the highly polluted sources.

Fluorides are known to be associated with dental caries and fluorosis. It is concluded from previous studies that the incidence of dental caries among the general population in the kingdom is relatively low. Dental fluorosis (mottled teeth) is not an uncommon occurrence, particularly in the southern parts of the country. This is attributed to the total intake of fluoride from both water and food. The common diet, which consists essentially of cereals rather than animal products, is suspected to be relatively rich in fluoride. Tea is known to have high fluoride content, and this may account for a substantial proportion of fluoride intake by the tea-loving populace.

Although the nitrate content of the drinking water is marginal with respect to the international standards, the occurrence of methemoglobinemia caused by the intake of fluoride amongst infants below one year of age has not been reported. This may be accounted for by the fact that physicians have often failed to associate such conditions with the high nitrate content of drinking water. It is also possible to incriminate the deficiency in reporting such cases, and in the lack of pertinent studies.

Nevertheless, the situation with respect to the fluoride and nitrate contents of drinking water warrants vigilance, monitoring of the water quality, and comprehensive epidemiological studies. An interesting investigation, for instance, would be to determine the relationship between bottle feeding of infants and the occurrence of methemoglobinemia since bottle-milk is prepared with water that may be high in nitrate content.

The association of nitrates and phosphates, both being plant nutrients, with eutrophication of impounded surface water is well known. Suffice it to state briefly here that the somewhat high levels of these two constituents in the Zarqa River are bound to cause quite serious eutrophication problems at the King Talal

Reservoir. The risk is not merely limited to the possible reuse of the water in future for domestic purposes, but also fishing and recreation. During a visit on March 23, 1980 to the King Talal Reservoir, visible evidence of rather marked eutrophication was observed. The condition is expected to become worse as the solar radiation increases during the coming summer and autumn.

With respect to heavy metals and other potentially toxic contaminants, it is not possible to express a candid opinion in the absence of comprehensive studies and reliable analytical data. However, the potential hazards involved in the use of water known to be contaminated from such sources as domestic and industrial wastes cannot be ruled out. Although the available analytical data for the Amman Sewage Treatment Plant effluent shows acceptable concentrations of such toxic metals as lead, chromium, cadmium and mercury, continuous monitoring is indicated.

The bacteriological quality of the domestic water supply in Zarqa and Ruseifa deserves special attention. Official verbal information obtained from municipal sources indicates that the water in the distribution systems in these two cities is considered to be bacteriologically contaminated. The available laboratory results for 1979 are as shown below:

a. Zarqa : 121 out of a total of 445 water samples examined yielded an MPN/100 ml value for coliform organisms of 2.2 or more.

b. Ruseifa : 23 out of a total of 132 water samples examined yielded an MPN/100 ml value for coliform organisms of 2.2 or more.

In both cases, about 25 percent of the samples were positive for E. coli. Upon receipt of the laboratory findings, the municipal authorities concerned take the necessary action

which is routinely in the form of field investigations with the aim of tracing the source and cause of contamination.

Not uncommonly, the problem is found to be associated with leaky and corroded water pipes and faulty joints that exist in the older parts of the citiés. The condition permits the entry of contaminants into a particular section of the distribution system, at times when the water supply is discontinued for any reason, or during operations involving repair or replacement of pipes. Fecal matter contained in the highly contaminated surface soil from overflooded cesspools can, therefore, enter the distribution system and contribute fecal microorganisms some of which may be pathogenic. Fortunately, pressure in the system is normally continuous.

Another port of entry of microbial contaminants within the household distribution system is through cross-connections which are not uncommon, or as a result of the practice of water storage in small roof that are not properly covered and tend to accumulate dirt from external sources. These storage tanks are not generally cleaned and properly maintained.

In the process of laying new pipes or replacing old ones, the section of the distribution system in question is flushed with water, but is not disinfected. This may constitute yet another mode of contamination. The replacement of the old corroded pipes has been given special attention by the municipal authorities in the past couple of years. According to municipal sources, the water main in Ramzi Street in Zarqa was recently replaced by a 12-in. pipe at a cost of J.D. 24,000. At the same time, a project involving the replacement of the old water mains in King Faisal, Emir Nayef, Emir Abdul-Illah and King Ghazi streets is now underway. It is obvious then that the corosion of pipes, apart from enhancing the contamination of water, are also apt to lead unnecessarily to losses in costs and effort, and in the disruption of traffic.

The phenomenon of corrosion of pipes deserves special attention. In the view of officials at the Municipality of Zarqa the corrosion is actually enhanced in the older parts of Zarqa where the phosphatic soil has been saturated with fecal matter from the overflow of cesspools. Indeed, it would seem logical to assume that in the areas in question the formation of sulfides in the highly contaminated soils through biological activity under anaerobic conditions is a contributing factor. The acquired corrosive properties of the incriminated soils may be further enhanced by the accumulated inorganic salts, the decomposition products of the phosphates, and the compactness of the soil which leads to anaerobic conditions at the subsurface levels. These assumptions form the basis for an interesting investigation in the future with the aim of determining the influencing local conditions, and the precautionary measures needed.

Without further elaboration on the matter, it should be convincingly evident that the existence of both operational and abandoned cesspools, particularly in the more densely populated areas where there is usually more than one cesspool per building, creates various compounded environmental health problems. Besides contamination of ground water, the other preventable problems include: (a) contamination of the soil to render it a medium for the transmission of disease and enhancement of pipe corrosion; (b) creation of a filthy and disgusting environment; and (c) formation of obnoxious odors.

2.5 Wastewater and Health

Human excreta and sewage contain a variety of microorganisms that are discharged in very great numbers from the human intestine. These include bacteria, viruses,

and protozoa. The eggs of intestinal worms (helminths) may also be present. Raw sewage, for instance, is estimated to contain 1 million bacteria per ml. As some of these micro-organisms are disease producing (pathogenic), the improper disposal of human excreta and sewage constitutesone of the major factors that threatens the health and comfort of people in areas where satisfactory sewerage systems are not available.

When improperly disposed, excreta and sewage can contaminate soil and water sources which can, in turn, contaminate food, hands, clothing and other inanimate objects (flies and cockroaches) or rodents (mice and rats). Therefore, contaminated soil, water, and food are potential sources and vehicles for the transmission of various types of intestinal diseases and systemic infections, some of which are prone to affect children more than adults. Awareness of those environmental conditions and their potential health hazards, in addition to adequate sanitray measures and practices for the protection of water supplies and food from contamination by fecal organisms can result in a substantial reduction in morbidity and mortality of the population at risk.

The proper collection, treatment and disposal of human wastes, both solid and liquid, form the basis for a comprehensive program for the protection of the general public against diseases transmitted via such vehicles as water, food, soil, insects and rodents.

Because water supplies constitute the focal point in this report, therefore, the health hazards associated with contaminated drinking water will be given special emphasis. There is a combination of factors that influence the conditions of

ill-health caused by impure water supplies.

These include: poor socio-economical status, adverse environmental conditions, unsatisfactory housing, high birth rates, and the lack of awareness. It is also important to remember that the transmission of some forms of microbial diseases are common to both water and food. Accordingly, difficulties can be encountered to one or the other of these two vehicles.

The microbial diseases that are known to be typically water-borne are cholera, typhoid fever, and infectious hepatitis. Cholera does not prevail in the Hashemite Kingdom of Jordan and only sporadic outbreaks brought about by imported cases have been reported in the past decade. Such waterbased diseases as malaria and schistosomiasis are also not common, and the few identified cases are attributed to expatriates or to citizens returning home from abroad.

2.6 Health Statistics

Reporting of communicable diseases in Zarqa and Ruseifa, as is the case in the kingdom as a whole, is not considered to be entirely satisfactory, as a result of which the available statistics relevant to water-borne diseases reflect a gross under estimation of the actual situation. The prevalence figures given verbally by officials at the Directorate of Health, District of Zarqa, for diseases that may be attributed to contaminated water and food in the Zarqa-Ruseifa area are recorded hereunder:

YEAR	TYPHOID	PARA-TYPHOID	INFECTIOUS HEPATITIS	POLIO	CHOLERA
1978	53	23	32	81	0
1979	35	6	30	3	28

A number of informed sources are in agreement in that the upper respiratory infections such as bronchitis predominate in winter, while the incidence of gastroenteritis and other intestinal diseases gains dominance in summer and autum. This is especially true amoung children. Although a locational analysis is not possible with available statistics, the local authorities indicate that the prevalence of such diseases is appreciably higher in the more densely populated and poorer quarters of the cities such as Al-Janna'ah, UNRWA refugee camps, and Al-Ghwairiyeh.

The occurrence of the communicable diseases in question in the Zarqa-Ruseifa area is attributed by some local sources to be due to the following prevailing conditions :

a. Soils within the cities are highly contaminated with fecal organisms, thereby serving as a prime source for the dissemination of these organisms into the air, water and food. These, in turn, offer a variety of routes for the transmission of disease.

b. The absence of a sewerage system, and the use of cesspools for excreta disposal are at the base of the problem.

c. The lack of awareness on the part of the general public as to the importance of personal hygiene practices. In addition, there is much to be desired with respect to effective health education programs.

d. The unwashed fruits and vegetables that are commonly eaten raw, particularly by children.

e. The lack of proper playgrounds and recreational facilities to discourage children from playing in the contaminated muddy streets, and bathing or wading in polluted puddles

and wadis. It is interesting to note in this connection that some children were seen wading and others washing vegetables in the neighbouring streams.

f. The inefficient, and usually ineffective, preventive and control measures instituted by the authorities concerned with public health, usually because of a shortage of qualified manpower.

Proper epidemiological investigations of water and food-borne diseases throughout the country are rather scarce. A recent study by Drs. Khoury and Abd Al-WALI showed that the supply of potable water on a continuous basis has resulted in a significantly lower incidence of water-borne enteric diseases in Karak, as compared to that in Salt where the flow of drinking water is intermittent for purposes of rationing. (4) The inference is that drinking water should be adequate, safe, and supplied continuously to prevent contamination in the distribution system by back-siphonage. In the case of Zarqa and Ruseifa, although the water supply is said to be continuous, the quantity actually consumed appears to be inadequate. Well-informed municipal sources estimate the average rate of water consumption at 40 l. per capita per day, with a rate as low as 10 l. per day among low-income families. It appears that the rate of water consumption is related to socio-economic status.

No documented or reliable information is readily available regarding the contamination of water supplies with chemical impurities that may adversely affect health. But, there is sufficient evidence based on impressions that the potential hazards of industrial wastes have become sufficiently important to warrant investigations and intervention.

2.7 Miscellaneous Conditions and Observations

There are a number of environmental conditions and problems that have been identified during the short and preliminary field investigations carried out in Zarqa and Ruseifa. These are briefly mentioned below:

a. The twin cities of Zarqa and Ruseifa have emerged and developed as a military base. Their rapid expansion was triggered by the great influx of Palestinian refugees who now constitute a majority of the population of about 300,000 persons. The sudden and rapid growth of the cities did not permit proper town-planning, and the situation has been further aggravated by the establishment of a variety of industries in the area. With some exceptions, the housing conditions are not entirely unsatisfactory, especially in the older and poorer quarters and refugee camps. In these areas, mud houses are still fairly common, although concrete and cement brick houses are gradually becoming popular.

The Zarqa quarters can be classified according to the socio-economic levels as shown below, knowing that these levels range from medium to low income:

(i) Upper level: Hai al-Dubbat, Jabal Al - Amira, Rahma Al-Sharqi, and Madkhal Al-Zarqa.

(ii) Intermediate level: Hai Qasr Shbib, Hai Al-Mustashfa, Hai Al-Nuzha, Hai Maqsoum, Hai Al-Hussain, and Share' Al-Sa'adeh. These lie in the older and central parts of Zarqa.

(iii) Low level: Zarqa Refugee Camp, Al-Ghwairiyeh, and Al-Janna'ah. The small, crowded houses here are made of mud bricks.

b. The Zarqa-Ruseifa area has traditionally been used by Shepherds as a grazing ground. Recently, dairy farms with samll cattle herds of up to 50 animals have replaced the herds of sheep and goats. This change was induced by the increasing demand for milk by the rapidly growing population, and by the dairy plants that have been established in the past decade. An outcome of city growth is that there are now over 100 small dairy farms within the limits of the two cities. These farms, in spite of the problems created, were tolerated until 1977 when a cholera outbreak occurred that prompted the founding of the Supreme Committee for Health and Safety.

The Committee recomended the transfer of the dairy farms to a designated area in Dulail District, some 25 km. northeast of Zarqa. The transfer, not being supported by established law, has been extremely sluggish.

These dairy farms are so improperly maintained that the health of the cows is at risk,and the complaints of the intolerant neighours can no longer be ignored. The unhygienic production of milk, and the accumulation of undisposed cow dung with the accompanying obnoxious odors and fly breeding are but some of the important outcomes.

One of the dairy farms located in a residential area was found to have been transferred to Dulaill about a month prior to the visit by the author, and the premises transformed hurriedly into an elementary school. Substantial cow-dung residue and one cow remain as a clue to the previous occupancy.

Coupled with the unsatisfactory conditions prevailing in most of the dairy farms established in the area, there is

no wonder that the processed milk and milk products sold in the local markets can hardly meet the hygienic and bacterial standards. These are expected to serve as a prime source of enteric diseases.

c. Not much detailed information can be provided at this stage regarding the hygienic conditions and current food-handling and storage practices prevailing in the fairly numerous, but small, public eating places. These usually cater to strangers such as casual laborers, employees and visitors, for residents are generally not inclined to eat outside their own homes. For this reason, these places probably do not play an important role in the transmission of food-borne diseases and intoxications, in spite of the fact that the conditions as observed are not at all satisfactory.

d. Rats do not seem to be present in abundance, although opinions differ in this regard. This may be due, in part, to the absence of sewers and stormwater drainage system where sewer rats could colonize. The fly and cokroach populations are said to increase in summer to a greater extent. These insects have been showing signs of resistance to the commonly applied insecticieds.

2.8 Outstanding Conclusions

Some of the most important conclusions that can be derived from the limited information regarding the environmental and health conditions in the Zarqa-Ruseifa area are highlighted hereunder:

a. The unsatisfactory sanitary conditions arising from the lack of a sewerage system and the use of cesspools for the disposal of human excreta are such that the ensuing pollution of water at the source and distribution system continues to enhance the dissemination of water-borne diseases.

b. Contaminated food and other influencing factors could also play a role in the spread of the enteric diseases and diarrheal conditions that are common in the area.

c. The improper disposal of solid and liquid wastes of domestic or industrial origin produced by the communities located in the Amman-Zarqa region are problems that require regional planning and management.

d. The provision of an adequate and safe domestic water supply for the twin cities of Zarqa and Ruseifa will not in itself guarantee the elimination of the prevailing communicable diseases, although a marked reduction is anticipated. This on account of the presence of a combination of conditions and influencing factors. A much more conprehensive program is therefore indicated.

3.0 PREDICTED HEALTH IMPACTS OF THE PROPOSED PROJECTS

An attempt has been made in this preliminary study to assess the current status of the environment in the Zarqa-Ruseifa area with a view to predicting the environmental health consequences of the proposed project.

By virtue of the variety, complexity, and inter-relationship of the factors that need to be considered, it can be realized that such an accomplishment is no easy task. These factors include .

a. The availability of reliable, and scientifically based information and statistics.

b. The expectations and demands of the communities involved for improvement in health and socio-economic conditions.

c. The objective of each of the proposed projects in terms of the health and well-being of man and his environment.

d. The established criteria and standards to be used as guidlines in passing judgement on a particular issue.

e. The costs versus the benefits to gained from the implementations of any specific project or program.

f. The relative usefulness of alternative and competitive projects with an equally high priority order.

g. The direct or indirect, short term and long term, effects of a specific proposed project on health, and on the physical, biological, and socio-economic environments.

h. Current and future trends in the socio-economic development of the communities concerned which may impose their influence on the outcome of specific projects or programs.

i. The practicability of integration of the specific projects in question as components of the national environmental health program.

j. The feasibility of proper and continued management of the proposed projects.

k. The constantly changing impacts with time and circumstances of a given project.

In the case of the proposed projects for Zarqa and Ruseifa, it must be admitted that the available information regarding most of the points listed above is limited. Under the circumstances, therefore, predictions can only be based on the assumption that all of the essential requirements for the successful implementation and management of each of the proposed projects are satisfactorily met. Also, experience in developed and developing countries with the same kinds of projects would serve as a useful guide.

In the light of these constraints and shortcomings , the preliminary prediction regarding the impact of an improved domestic water supply, and the provision of a sewerage system, is that the water-borne, and to a lesser extent the food-borne diseases, are apt to be reduced substantially, though not completely. The extent of improvement in health depends to some degree on the control of other environmental problems. The outcome is expected to become evident within a few years.

The impact of a stormwater drainage system on health is not anticipated to be direct and dramatic. However, it will certainly help to improve some of the existing environmental conditions as, for instance, flooding of streets. The storm water can be collected at one or more points for use in recharging the groundwater aquifers.

4.0 RECOMMENDATIONS

The important recommendations pertaining to the proposed projects are summarized hereunder:

4.1. Domestic Water Supplies

a. The needs of all the communities that depend for their water for domestic, industrial and agricultural purposes on the Amman - Zarqa Basin should be treated equitably, and without any gross discrimination.

b. Top priority is to be given to the provision of domestic water supplies that are considered to be adequate and safe. The rationale in adopting and practicing such a policy is based on the desirability to achieve the prime objective of preventing the impairment of health that might be brought about by polluted water.

c. The quality of water intended for domestic purposes must be maintained at an acceptable level throughout the distribution system from source to consumer. In order to attain this objective it would be necessary to select the most appropriate source, and to assure the protection of the water at the source and in the distribution system.

d. Selection and protection of the water resources require previous knowledge. the water quality, including the nature and levels of pollutants, and their sources. Water resources can be protected by such neasures as the prevention of the discharge of untreated wastewater of domestic, industrial, or agricultural origin. This would require proper watershed management, supported by legislation, and stimulation of public awarness and assistance.

e. Surveillance and maintenance of the water distribution system essentially requires an effective program implemented by qualified personnel. Leak detection, repair

or replacement of defective water pipes, and regular water examination form some of the important components of such a program. The latter requires proper and conveniently located laboratory facilities.

f. The type and degree of treatment of the water depends essential on the nature and levels of pollutants. Disinfection by chlorination, commonly practice throughout the kingdom as the sole method of treatment, is no longer tenable in the case of Zarqa and Ruseifa under the present circumstances. Additional treatment should be considered.

4.2 Wastewater

a. Along with the provision adequate and safe domestic water supplies, it is important to assure the provision of s werage systems for the collection and disposal of the wastewater produced. This is an essential step towards curbing pollution of water resources, and prevention of water-borne diseases and other environmental problems.

b. In view of the limited water resources in the Amman-Zarqa Basin, water conservation measures, as well as reclamation and reuse of wastewater, should be given due consideration.

c. The wastewater generated by such large urban communities as Amman, Zarqa and Ruseifa should be effectively treated prior to final disposal into the Zarqa River. This is in order to prevent groundwater pollution, and to minimize the possibility of eutrophication of the waters of the King Talal Reservoir.

4.3. Priorities

In the event that the available funds are limited, then the preferred priority order for the proposed projects involving water, wastewater and stormwater would be as follows . (a) provision of sewerage systems for Zarqa and Ruseifa to improve certain environmental conditions, and to reduce diseases transmitted by water and food. (b) provision of adequate and [illegible] water supplies, and improvement of the existing water distribution systems, and (c) provision of proper stormwater drainage systems.

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DR AFTIM ACRA,

CONSULTANT - JOUZY AND PARTNERS - C.E.B,

SANITARY CHEMIST

EXPERIENCE

1957 - Present	Chairman, Department of Environmental Health, American University of Beirut.
1957 - Present	Consultant to various consulting firms on environmental health, worked on the following major projects :

- Consultant to various consulting firms in Beirut on: water quality control, pollution control and other environmental problems.
- Consultant to several governmental agencies dealing with pollution control and environmental problems.
- Member on the W.H.O. International Panel of Experts on community water supplies.
- A study of the water quality of seven hundred water sources in Lebanon.
- A study of the ground water quality in Beirut and suburbs, with particular reference to sea water intrusion.
- A study of the ground water quality in central Beka'a, Lebanon.
- A study of the causes and control of snails infesting the water distribution system in Qaisuma, Saudi Arabia.
- A study on the control of bilharzia snails by means of Gambusia fish, Litani River, Lebanon.
- Investigation of 4000 cases of typhoid in Hadath, Lebanon, caused by pollution of the water supply.
- A survey of the Lebanese coastal waters with respect to pollution by oil and community wastes.

- A study on the concentration of fluorides in drinking water in Lebanon, and its relation to dental caries.
- A study on the use of asbestos for the clarification of water and wastewater.
- A study on the use of novel methods for water and wastewater treatment using local materials.
- Assessment of the performance of an oxidation pond in Beka'a, Lebanon.

EDUCATION

American University of Beirut, Ph.D. 1946.

University of North Carolina, M.P.H. Sanitary Chemistry, 1957.

SOCIETIES

Membership of professional organizations:

Vice President, Lebanese Public Health Association,
Member, Royal Society of Health, London,
Member, Sigma Xi Society.

CHAPTER 4.0

DESCRIPTION OF THE AFFECTED ENVIRONMENT

بسم الله الرحمن الرحيم

THE HASHEMITE KINGDOM
OF JORDAN
NATIONAL PLANNING COUNCIL
AMMAN
Tel. 44466 - 44470
P. O. B. 555
Teleg. NPC - Amman

المملكة الأردنية الهاشمية
المجلس القومي للتخطيط
عمان
الهاتف : ٤٤٤٦٦ - ٤٤٤٧٠
ص.ب ٥٥٥

No. 128/9/2703 الرقم

Date 31/5/1980 التاريخ

Ref. الموافق

Mr. M.P. Daly,
Resident Manager
Malcolm Pirnie Inc.,
P.O. Box 9112
Amman.

Subject: Zerka/Ruseifa Water & Sewerage Study

Dear Mr. Daly,

Reference is made to your Scoping Statement on environment for Zerka/Ruseifa Water & Sewerage Study.

I am pleased to advise you that the Scoping Statement is approved. For your use, please find attached a copy of the approved version.

Yours sincerely

President

MALCOLM PIRNIE INC.
CONSULTING ENVIROMENTAL
ENGINEERS
AMMAN — JORDAN
- 5 JUN 1980
RECEIVED
ACTION
REFER H.1

SCOPING STATEMENT: ZARQA-RUSEIFA WATER AND SEWERAGE PROJECT (278-0234), JORDAN

In accordance with the requirements of 22 CFR 216, "A.I.D. Environmental Procedures" as proposed in the Federal Register of October 1, 1979, a scoping meeting was held in the offices of the National Planning Council (NPC) on 12 March 1980. The purpose of the meeting was to initiate the process of identifying the significant issues relating to the proposed action and determining the scope of issues to be addressed in the Environmental Assessment and the design of the proposed activity.

In order to assure adequate input from pertinent sources, individuals having expertise relevant to the environmental aspects of the proposed action were invited by NPC to attend. In addition, representatives of the planning consultants, Malcolm Pirnie, Inc. (MPI) of White Plains, N.Y. in association with Jouzy & Partners (J & P) of Amman were present to discuss the scope of work for the project. The attendees were as follows:

Boulos Kefaya	-	NPC	Project Liaison Officer
Hussein Shafaamri	-	NPC	Engineer
Pat Johnson	-	NPC	Advisor
Zaki Halaseh	-	Ministry of Municipal, Rural and Environmental Affairs	Head of Sanitary Engineering Division
Dr. Arafat Altamemi	-	Royal Scientific Society	Head of Chemical Department
Dr. Hani Shaka'a	-	Royal Scientific Society	Chemical Department
Remon Halteh	-	Ministry of Industry and Trade	Engineer
T. Batarseh	-	Ministry of Industry and Trade	Director of Industries
M. Dajani	-	Ministry of Health	Head of Sanitary Department
A.R. Khatib	-	Natural Resources Authority	Hydrologist

M. Tawfiq	- Municipalities of Zarqa & Ruseifa	Engineer
Martin Daly	- MPI	Project Manager
Najeeb Tleel	- J & P	Deputy Project Manager
John C. Henningson	- MPI	Environmental Specialist
Merlin J. Shelstad	- MPI	Planner
James G. Cassanos	- USAID	Sanitary Engineering Advisor
Royal R. Cline	- USAID	General Engineering and Environmental Officer
Stan Stalla	- USAID	Assistant Capital Development Officer

As a result of these discussions, the environmental issues of greatest potential significance have been identified. Further, issues of minor importance were delineated. These issues are presented below:

A. Potentially Significant Issues

The following impacts appear to warrant substantial attention in the environmental assessment:

1. Industrial Discharges: It is generally recognized that many of existing industrial discharges are compatible with the available municipal treatment processes and do not represent a risk to the environment. It is perceived that some of the industries may utilize materials which are toxic or hazardous and that the proper treatment of the associated wastes prior to discharge warrants substantial concern. The study should evaluate the individual industrial processes with respect to their potential for waste generation with special concern for seasonal or other changes which may affect the constituents of associated discharges. The 150-day time frame which has been established will not allow a comprehensive sampling and chemical analysis program. However, limited sampling of those industries which appear to have the most serious potential for pollution is provided in the existing scope for the Feasibility Study.

2. Sewage Treatment Plant Discharge: The impact of the effluent discharges on downstream usage must be evaluated. The current scope for the Feasibility Study does not provide for any

monitoring of flows or water quality encompassing wet and dry seasons. Therefore the analyses will be based on available data. The impact of the discharge on the use of the water from the Zarqa River downstream of the plant for the irrigation of non-edible crops such as trees as opposed to edible vegetables should be considered. Further, although the use of the King Talal Reservoir for a potable water supply is not currently anticipated, the impact of the proposed discharge on the future choice of this option should be evaluated. Similarly, the potential impact on the water quality with respect to establishing a new fishery in the reservoir warrants consideration.

3. Economic Concerns: The proposed improvements will result in increased costs to both individual residents and industry. Those costs must be compared to the benefits which will be realized with respect to protection of the public health and the natural resources of the area. In particular there must be a good understanding of the distribution of socio-economic and health characteristics within the study areas to assure an accurate assessment of impacts. Additionally the possible constraints on necessary industrial growth must be considered. Among the situations to be considered are: the extent of the facilities necessary to achieve the most benefit for the least cost; the separate treatment of industrial wastes either in individual or centralized facilities; and the incentives or disincentives for industry to locate or relocate in environmentally sensitive areas such as agricultural lands as a result of the new facilities. It appears that some of the industries recognize the need for improved treatment facilities and would be willing to assist in financing the construction.

4. Construction Impacts: Although the proposed facilities are generally acknowledged to have substantial environmental and public health benefits, it must be recognized that, collectively, the impacts associated with construction may be significant. Construction on steep cliffs has a great potential for erosion and reducing the stability of retaining walls. Construction of sewerage and stormwater facilities along the wadis has a great potential for erosion damage to retaining walls and wells. Further, construction in narrow streets and footpaths may cause noise, dust, traffic disruption, damage to foundations and existing expedient water supply facilities. It is essential that these construction impacts be clearly delineated and that measures are recommended to mitigate their magnitude and duration.

5. Land Use: The proposed facilities will result in the commitment of land currently used for agriculture. These commitments involve the sewage treatment plant and the rights of way for various pipelines. In addition, there is the potential that the improvements may encourage the development of industry or other uses on land which is intended for agriculture or open space. Strong land use controls are necessary to prevent these indirect or secondary impacts.

6. Groundwater: It is recognized that the collection and treatment of sewage in a single facility will eliminate the dispersal and recharge to the upper groundwater aquifer which is now occuring through the individual cesspools. Further, the provision of improved potable water service will probably result in increased usage. However, the current discharges have severely impaired the quality of the water in the upper aquifer, especially with respect to nitrate and bacterial contamination. These trade offs between quantity and quality must be addressed.

B. Minor Impacts

The following impacts do not appear to be significant and should be addressed only briefly in order to clarify why they are not particularly relevant to the project.

1. Air Quality: There does not appear to be any direct relation between the proposed facilities and air quality factors. It is apparent that modest benefits such as the elimination of septic odors emanating from cesspool overflows may be anticipated.

2. Flora and Fauna: The suitability of the Zarqa River as aquatic habitat has been seriously limited by both extremely low flow and poor water quality. The native fish species in the Zarqa River are characteristic of a running water environment and are not adaptable to the newly formed reservoir. At present the fish in the river have little or no commercial or recreational importance. Therefore the discharge from the sewage treatment plant will have no serious impact on existing fisheries resources. However the potential impacts of the project on the possible establishment of a new fishery in the reservoir must also be considered. The building, mining and agricultural practices within the study area have substantially reduced the suitability of nearby lands as wildlife habitat. Therefore, it is not anticipated that the proposed facilities will have any substantial effect on terrestrial flora or fauna of importance.

3. Antiquities: There is little information on the extent or location of sites of archeological and/or historical significance. However, considering the mining, agriculture and intensive urban development in the area, the possibility of uncovering an extensive archaeological and/or historical site in such shallow bedrock areas seems quite unlikely. This will be confirmed in discussions with the Department of Antiquities. It is proposed that the assessment recommend a procedure for assessing and salvaging significant archaeological and/or historical sites should they be encountered during construction.

4. Sludge Disposal: It is apparent that the nutrient and soil conditioning values of the sludge justify serious consideration of its utilization on agricultural land. The lands designated for reforestation and the reclamation of the area mined for phosphates are ideal candidates for the use of the material. It is anticipated that digestion and drying will be necessary to stabilize this material and neutralize any public health risk. Similarly, if the industrial survey indicates effluents may impair the quality of the sludge for this purpose, pretreatment may be required. Therefore the impact of sludge disposal should not be significant.

C. Timing and Decision Making

The 150-day project schedule necessitates concurrent development of the engineering feasibility, the socio-economic and health evaluations, and the environmental assessment. This procedure will allow the planning to develop giving adequate recognition to each of these factors and should assure that the environmental assessment will be an analytical document and not a justification for a predetermined activity. The required completion date of the draft is 24 June 1980. The draft report on the industrial survey is required to be completed 30 days earlier on 25 May 1980.

This is recognized as an ambitious schedule, requiring that the findings be based principally on existing data. Should the feasibility studies determine that additional information is necessary in order to make definitive determinations, supplementary work may be recommended. However it is anticipated that the feasibility study will provide sufficient basis for decision making.

D. Analysis Methods and Staffing

1. Methodology: It is intended that the feasibility studies be based principally on existing data and information. This will be supplemented by field visits and interviews

with key officials and staff of relevant agencies. Qualitative judgements with respect to water quality and other factors may be supported by the use of simple mathematical models and development of mass balances. It is intended to perform some limited sampling and chemical analysis of key industrial discharges as part of the industrial waste survey in order to identify potentially toxic or hazardous materials. Similarly limited surveys may be undertaken to support the socio-economic studies. Should further sampling and analysis be necessary, recommendations will be submitted for subsequent work in addition to the current Feasibility Study scope of services.

2. Staffing: The necessary staff will be provided to assure the full range of disciplines needed to assess the potential complexities of the environmental relationships. Key individuals involved in the environmental assessment are:

John Henningson	-	Environmental Specialist
Merlin Shelstad	-	Planner
Blair Bower	-	Socio-Economic Consultant
Dr. Aftim Acra	-	Health Specialist

In addition a full range of supporting staff are available to provide assistance, including engineers, hydrologists, geologists, soil scientists, aquatic and terrestrial biologists, meteorologists and archeologists.

3. Format: It is proposed that the environmental assessment be concise and analytical focusing on the key issues rather than providing a compendium of environmental background material. The assessment will be included in the body of the overall report for the Feasibility Study. The key elements to be included are as follows:

a. Description of the Affected Environment.

b. Comparison of Projected Environmental Conditions Associated with the Feasible Alternatives.

c. Identification of Environmental Consequence of the Proposed Action and Mitigating Measures.

d. Appendices (bibliography, tables, maps, list of prepares and credentials, etc.).

CHAPTER 5.0

WATER DISTRIBUTION

TABLE 5.1

WATER ANALYSIS REPORT

ZARQA MUNICIPALITY WELLS (1977)

WELL NO.	E.C. Mmho	TDS PPM	Ca^{++} Meq/l	Mg^{++} Meq/l	Na^{+}	K^{+}	Cl^{-}	$SO4^{--}$	CO_3^{--}	HCO_3^{-}	TOTAL CATIONS	Na%	SAR	pH
S14	0.790	506	2.48	2.13	2.75	0.43	2.72	0.90	0.60	3.60	7.79	35.31	1.81	8.10
S16	3.000	19020	8.5	6.44	15.00	0.20	17.42	6.60	0.00	6.18	30.14	49.74	5.5	7.00
S14A	1.800	1152	5.74	3.86	7.95	0.15	8.87	3.52	0.00	5.28	17.70	94.92	3.60	7.10
S14	1.800	1152	5.06	3.94	8.50	0.17	9.40	3.66	0.00	4.90	17.67	48.10	4.10	7.4

TABLE 5.2 (Cont'd)

ZARQA - THE STAFF OF THE WATER DEPARTMENT

	NO.	SUBTOTAL	TOTAL
4. Technical Section			98
a) Head Section	1	1	
b) Pumping Station		26	
1. Engineer	1		
2. Electrician	3		
3. Chlorine Operator	1		
4. Mechanics	3		
5. Assistant Mech.	3		
6. Guards	15		
c) Meter Workshop		20	
1. Supervisor	1		
2. Assist. Supervisor	1		
3. Clerk	1		
4. Meter Testing Mech.	1		
5. Repair Mech.	4		
6. Meter Records Cards	1		
7. Assist. Meter Readers	10		
8. Messenger	1		
d) Distribution System		48	
1. Inspector	1	1	
2. Distribution System (Pipes)		28	
i. Supervisor	1		
ii. Assistant Supervisor	1		
iii. Clerk	1		
iv. Pipe Fitter	6		
v. Assistant Pipe Fitters	4		
vi. Laborer	13		
vii. Guards	2		
3. House Connections		19	
i. Supervisor	1		
ii. Assistant Supervisor	1		
iii. Clerk	1		
iv. Pipe Fitters	9		
v. Assist. Pipe Fitters	6		
vi. Welder	1		
e) Drawing Office		3	
1. Surveyor	1		
2. Draftsman	1		
3. Chainman	1		

TABLE 5.2

ZARQA - THE STAFF OF THE WATER DEPARTMENT

	NO.	SUBTOTAL	TOTAL
1. Director		1	1
2. Accounts Section			45
a) Chief	1	1	
b) Billing		14	
1. Cashier	1		
2. Assistant Cashier	1		
3. Collectors	12		
c) Computor Section		9	
1. Supervisor	1		
2. Operators	8		
d) Accountants		6	
1. Chief	1		
2. Clerks	2		
3. Auditors	3		
e) House Connections		2	
1. Clerk	1		
2. Subscription Clerk	1		
f) Meter Reading		13	
1. Supervisor	1		
2. Inspector	2		
3. Meter Readers	10		
3. Administration			18
a) Transportation		6	
1. Transportation Officer	1		
2. Drivers	5		
b) Offices		9	
1. Superintendent	1		
2. Clerks	2		
3. Typist	1		
4. Messenger	3		
5. Telephone Operator	1		
6. Night Guard	1		
c) Stores		3	
1. Chief Storekeeper	1		
2. Assistant Storekeeper	1		
3. Laborer	1		

TABLE 5.3

RUSEIFA - THE STAFF OF THE WATER SECTION

		NO.
1.	Head of Section	1
2.	Clerks	4
3.	Accountant	1
4.	Meter Readers	4
5.	Collectors	2
6.	Pipe Fitters	7
7.	Mechanics	2
8.	Guards	2
9.	Drivers	2
10.	Laborers	7
		32

TABLE 5.4

ZARQA - DETAILED COST ESTIMATE

ZARQA PHASE I

PIPE SIZE INCHES	QUANTITY M	UNIT COST JD/M	TOTAL JD
2"	22,000	16	352,000
4"	30,000	20	600,000
6"	10,000	24	240,000
8"	5,000	27	135,000
10"	1,000	30.5	30,500
12"	6,000	34	204,000
16"	4,000	45	180,000
24"	3,000	66	198,000
			1,939,500
Fittings, etc.			290,500
TOTAL PHASE I			2,230,000

ZARQA PHASE II

PIPE SIZE INCHES	QUANTITY M	UNIT COST JD/M	TOTAL JD
2"	40,000	16	640,000
4"	10,000	20	200,000
6"	5,000	24	120,000
8"	9,000	27	243,000
12"	4,000	34	136,000
16"	5,000	45	225,000
			1,564,000
Fittings, etc.			161,000
TOTAL PHASE II			1,725,000

TABLE 5.5

RUSEIFA - DETAILED COST ESTIMATE

RUSEIFA PHASE I

PIPE SIZE INCHES	QUANTITY M	UNIT RATE JD/M	TOTAL JD
2"	20,000	16	320,000
4"	12,000	20	240,000
6"	3,300	24	79,200
8"	1,300	27	35,100
12"	3,000	34	102,000
24"	600	66	39,600
			815,900
Fittings, etc.			114,100
Meters			150,000
TOTAL PHASE I			1,080,000

RUSEIFA PHASE II

PIPE SIZE INCHES	QUANTITY M	UNIT RATE JD/M	TOTAL JD
2"	10,000	16	160,000
4"	4,000	20	80,000
6"	1,000	24	24,000
			264,000
Fittings, etc.			11,000
			275,000
700 m^3 Reservoir			50,000
TOTAL PHASE II			325,000

TABLE 5.6

FOREIGN AND LOCAL CONSTRUCTION COSTS FOR PHASE I. WATER FACILITIES

(THOUSAND JD)

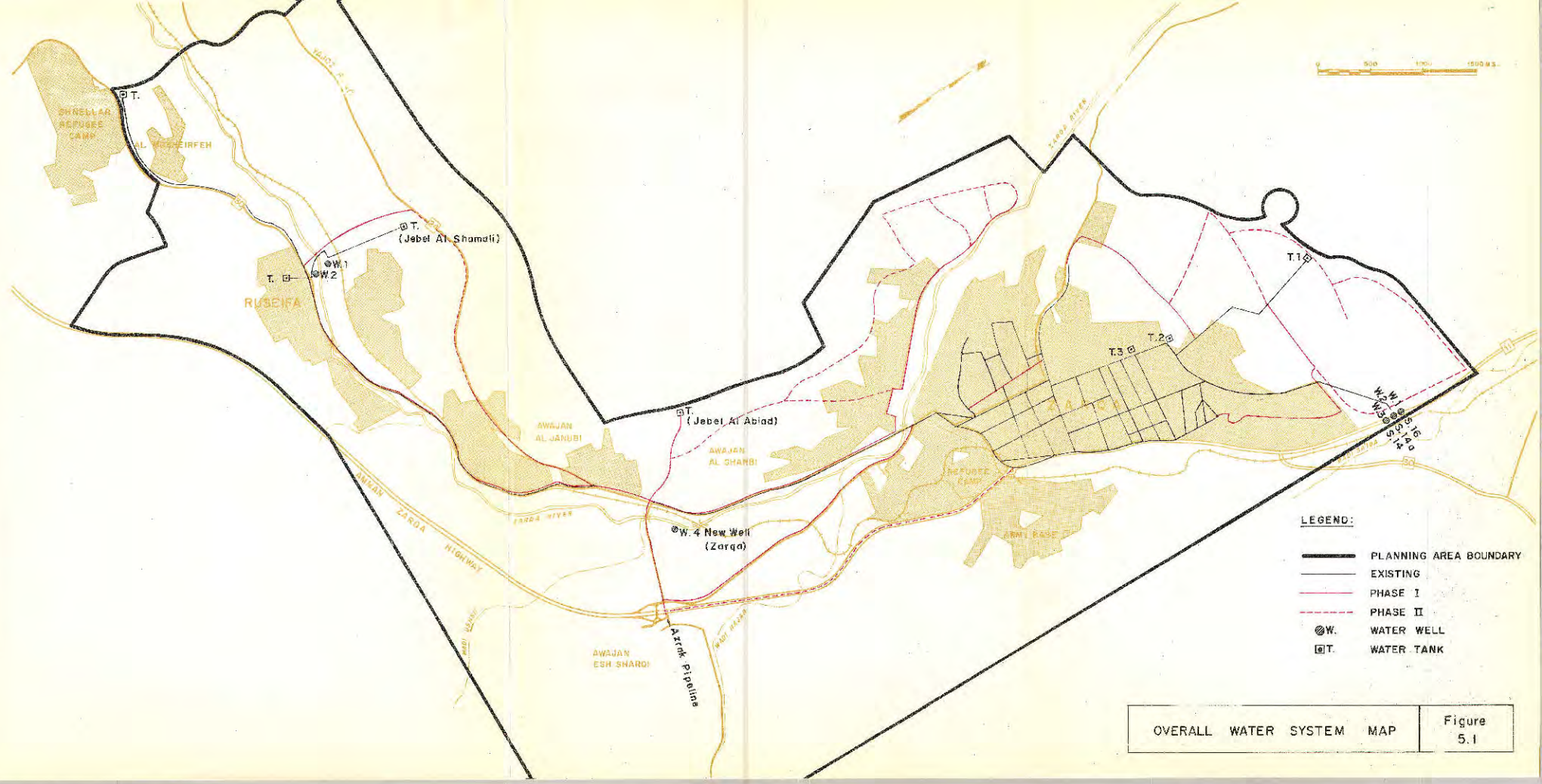
	PIPE SIZE In.	mm	MATERIAL TOTAL	MATERIAL FOREIGN	MATERIAL LOCAL	LABOR TOTAL	LABOR FOREIGN	LABOR LOCAL	TOTAL FOREIGN M+L	TOTAL LOCAL M+L	TOTAL COST
ZARQA	2	50	44.0	26.4	17.6	308.0	123.2	184.8	149.6	202.4	352.0
	4	100	150.0	90.0	60.0	450.0	180.0	270.0	270.0	330.0	600.0
	6	150	70.0	42.0	28.0	170.0	68.0	102.0	110.0	130.0	240.0
	8	200	47.5	28.5	19.0	87.5	35.0	52.5	63.5	71.5	135.0
	10	250	13.0	7.8	5.2	17.5	7.0	10.5	14.8	15.7	30.5
	12	300	99.0	59.4	39.6	105.0	42.0	63.0	101.4	102.6	204.0
	16	400	100.0	60.0	40.0	80.0	32.0	48.0	92.0	88.0	180.0
	24	600	138.0	82.8	55.2	60.0	24.0	36.0	106.8	91.2	198.0
	Fittings, Valves, Valve Boxes, Hydrants,etc.								139.9	150.6	290.5
								TOTAL	1,048.0	1,182.0	2,230.0
RUSEIFA	2	50	40.0	24.0	16.0	280.0	112.0	168.0	136.0	184.0	320.0
	4	100	60.0	36.0	24.0	180.0	72.0	108.0	108.0	132.0	240.0
	6	150	23.1	13.9	9.2	56.1	22.4	33.7	36.3	42.9	79.2
	8	200	12.4	7.4	5.0	22.8	9.1	13.6	16.5	18.6	35.1
	12	300	49.5	29.7	19.8	52.5	21.0	31.5	50.7	51.3	102.0
	24	600	27.6	16.6	11.0	12.0	4.8	7.2	21.4	18.2	39.6
	Fittings, Valves, Valve Boxes, Hydrants, Meters, etc.								171.1	92.9	264.0
								TOTAL	540.0	540.0	1,080.0

TABLE 5.7

FOREIGN AND LOCAL CONSTRUCTION COST FOR PHASE II. WATER FACILITIES

(THOUSAND JD)

	PIPE SIZE In.	PIPE SIZE mm	MATERIAL TOTAL	MATERIAL FOREIGN	MATERIAL LOCAL	LABOR TOTAL	LABOR FOREIGN	LABOR LOCAL	TOTAL FOREIGN M+L	TOTAL LOCAL M+L	TOTAL COST
ZARQA	2	50	80.0	48.0	32.0	560.0	224.0	336.0	272.0	368.0	640.0
	4	100	50.0	30.0	20.0	150.0	60.0	90.0	90.0	110.0	200.0
	6	150	35.0	21.0	14.0	85.0	34.0	51.0	55.0	65.0	120.0
	8	200	85.5	51.3	34.2	157.5	63.0	94.5	114.3	128.7	243.0
	12	300	66.0	39.6	26.4	70.0	28.0	42.0	67.6	68.4	136.0
	16	400	125.0	75.0	50.0	100.0	40.0	60.0	115.0	110.0	225.0
									713.9	850.1	1,564.0
Fittings, Valves, Valve Boxes, Hydrants etc.									96.1	64.9	161.0
								TOTAL	810.0	915.0	1,725.0
RUSEIFA	2	50	20.0	12.0	8.0	140.0	56.0	84.0	68.0	92.0	160.0
	4	100	20.0	12.0	8.0	60.0	24.0	36.0	36.0	44.0	80.0
	6	150	7.0	4.2	2.8	17.0	6.8	10.2	11.0	13.0	24.0
									115.0	149.0	264.0
Fittings, Valves, Valves Boxes, Hydrants etc.									5.0	6.0	11.0
700 M^3 Reservoir									10.0	40.0	50.0
									130.0	195.0	325.0



OVERALL WATER SYSTEM MAP

Figure 5.1

APPENDIX 5.1

TRANSLATED

REGULATION NUMBER 41 FOR THE YEAR 1978
WATER REGULATIONS FOR MUNICIPALITIES PUBLISHED IN ACCORDANCE WITH ARTICLE (41) OF THE MUNICIPALITIES LAW NUMBER (29) FOR THE YEAR 1955.

ARTICLE (1) These regulations which are called (Municipal Water Regulations for the Year 1978), take effect from the date published in the Official Gazette.

ARTICLE (2) The following words and expressions has its exact meaning unless it is noted:

MUNICIPALITY - Municipal Council or Municipal Committee except the Municipality of Amman.

MAYOR - The Mayor or the Head of Municipal Council

MUNICIPAL ZONE- The Area within the Municipal Boundary

APPLICANT - The Person who apply for water connection.

SUBSCRIBER - The Person connected to the Water Supply System in accordance to these regulations

DISTRIBUTION PIPE - That Part of the pipe that distribute water, which is located between the main pipe and the customer's meter and is under pressure from the main pipe.

SUPPLY PIPE - That part of the pipe that is located beyond the water meter.

ARTICLE (3) A) Applications for water connection or disconnection and other special matters concerning the water network from the subscriber or applicant should be submitted to the Municipality on the special forms.

B) The applicant should pay an application fee of (250 fils).

ARTICLE (4) A) After being accepted the applicant shall pay (JD 5) as establishment fee and a deposit of (JD 5) in case of failing to pay the bill the amount would be deducted from this deposit sum.

B) The deposit fee is refundable at the end of the service period after discounting the due bills.

ARTICLE (5) The Municipality has the right of owning the water meters and to reach this end the Council would:

a) Specify the type of meter and its cost or rental charge.

b) Expropriate the water meters of the subscribers at the time of these regulations come into effect and would estimate the compensation.

ARTICLE (6) The amount of the water consumed is measured using a special meter, measuring in cubic meters. The Mayor selects the kind, and specification of the water meter. The meter is placed in an iron box with a lock, in a place selected by a Municipal Officer. The Municipality collects a fee of (1 JD) for the installation of the meter.

ARTICLE (7) Disconnecting, connecting or changing the meter after being installed is forbidden unless done by the Municipal Officer.

ARTICLE (8) The meter shows the correct reading is considered to be the correct amount of water consumed. The subscriber has the right to object to the Mayor the correctness of the reading. A fee of 500 fils will be collected for testing the meter if it is proved that the meter was out of order the 500 fils will be refunded.

ARTICLE (9) The Mayor or a Deputy Representing him from the Municipality has the right of estimating the amount of water consumed in the period when the meter was

out of order.The estimate will be according to the same past consumption period before the meter was out of order if there was such a record. Otherwise the estimate will be estimated according to the consumption in the place of the subscriber and the number of persons. The subscriber has the right to object to the Municipal Council.

ARTICLE (10) The Municipality has the right of checking the meter which is owned by the customer and ask him to change it in a specific period of time, if failed to do so, water will be disconnected.

ARTICLE (11) The subscriber will be charged for the pipes and installation to the water meter in his place. These pipes will be owned by the Municipality and is considered a part of network in the Municipality area. The Municipality has the right of using it to its benefit, change it or change its location in the way the Municipality finds it convenient. It also has the right of collecting charges for doing so from other subscriber benefitting from these lines.

ARTICLE (12) If the distribution pipe from the main lines serve more than one customer then the expenses of the laying of pipes is shared according to the lengths of pipes serving each one of them.

ARTICLE (13) Every owner of a construction area, a commercial shop, an office or residential complex should have a separate meter for each such premises.

ARTICLE (14) The Municipality has the right of disconnecting water for any reason listed below:

a) If failed to pay the bill after 8 days from the date notified of his consumption.

b) If a change is done to the distribution pipe or the water meter without permission from the Municipality and caused damage.

c) If failed or refused to comply to any article of these regulations.

ARTICLE (15) If water is disconnected for any reason stated in these regulations then the subscriber losses his subscription and all rights based upon his subscription unless he applies for reconnection within (60) days from the date of disconnection. A fee of (1 JD) will be collected for reconnection.

ARTICLE (16) The Municipality has the right of not supplying water for the period when work or repairs are being done on the engines, equipments or laying of main lines provided a notice ahead of time is given.

ARTICLE (17) The reading of the meter is taken periodically with an average of two months per period. The amount of the Bill due is calculated by dividing the quantity of water consumed by two and the official tarrif will be applied to the resultant then the total amount due for one month will be multiplied by two.

ARTICLE (18) The price of water is set by the Council of Ministers upon the recommendation of the Minister of Municipal and Rural Affairs, and these rates will be published in the Official Gazette.

ARTICLE (19) The Municipality determine the price of water distribution to the customers by the date.

ARTICLE (20) The minimum water consumption is six cubic meter for each billing period.

ARTICLE (21) All regulations governing municipal water are hereby cancelled if they are in conflict with the above regulations.

Fees and Water Rates (Latest)

1. Water Consumption for Domestic, Commercial and Industrial Rates

   a- Minimum Charge is $6m^3$/rotation i.e 480 fils

   b- Up to 10 m^3 80 fils/m^3

   c- 11 - 30 m^3 120 fils/m^3

   d- 31 - 50 m^3 220 fils/m^3

   e- 50 - 300 fils/m^3

2. Deposit for house connection JD 5.00

3. Connection Fee 0.750

4. Application form 0.250 fils

5. Connection charges 5.000 fils

Fees charged to consumers	JD
1. Connection to 6" line	3.000
2. Connection to 4" line	2.500
3. Connection to 3" line	1.500
4. Connection to 2" line	1.000
5. Connection to 1" line	0.500
6. Repair of broken line ½"	1.000
7. Installation of ½" meter	1.000
8. Installation of 1" meter	1.750
9. Installation of 2" meter	3.000
10. Installation of meter over 2"	5.000
11. Seal for meter	0.250
12. Installation of elbow ½"	0.100
13. Installation of value 1"	0.075
14. Installation of pipes ½" per meter	0.050
15. Installation of stap cock ½"	0.050
16. Threading ½" pipe	0.050
17. Threading 1" pipe	0.075
18. Cutting ½" up to 2" pipes	0.050

19. Threading 2" pipe	0.100
20. Cutting pipes over 2" diam	0.100
21. Disconnection outside line/m	0.010
22. Installation of value ½"	0.030
23. Installation of pipe 1"/m	0.050

APPENDIX 5.2

UNIT COSTS

5.2.1 Introduction

The purpose of this appendix is to provide the basis on which the estimates of construction were prepared.

5.2.2 Unit Construction Costs

The labor rates and unit prices of selected construction materials used in preparing construction cost estimates have been listed in Tables 5.2-1 and 5.2-2. The labor rates pertain to June 1980. The unit prices for construction materials also pertain to June 1980 and are delivered prices with no allowances for contractor overhead and profit.

TABLE 5.2-1

1980 LABOR RATES

Category	Rate (JD/Hour)
Common Labor	0.480
Trench Laborer	0.520
Trench Leveller	0.720
Pipe Fitters	1.000
Carpenter	1.250
Steel-Worker	1.250
Truck/Vehicle Driver	1.000
Heavy Truck Driver	1.200
Excavator/Traxavator Driver	1.450
Working Supervision/Foreman	1.050

TABLE 5.2-2

1980 SELECTED CONSTRUCTION MATERIALS UNIT PRICES

Item	Unit	Unit Cost JD
CIVIL ENGINEERING WORKS		
General Excavation	m^3	1.5-2.00
Excavation for Foundations - Soft	m^3	2.5-3.00
Excavation in Rock	m^3	5.0-7.00
Back Fill/Sand Fill	m^3	3.750
CONCRETE		
Mass Concrete	m^3	25.00
Structural Concrete	m^3	40-45.00
Reinforcing Steel		
Mild with Workmanship	Tonne	240-260
High Tensile with Workmanship	Tonne	280-300
BUILDING WORKS		
Industrial Buildings/Such as Pumping Stations	m^2	100.00
Offices	m^2	90.00

5.2.2.1 Sewer Line Construction

Sewer line construction rates have been derived using local rates for PVC and concrete pipes together with excavation, transport, laying, joining, testing and backfill elements.

Cost per meter for installing sewers and trunk lines for various diameters and at various depths and for various pipe materials are shown graphically in Figures 5.2-1, 5.2-2 and 5.2-3. Pipe diameter up to and including 300 mm reflect the use of PVC pipe of local manufacture. The costs shown for pipe diameter over 300 mm reflect the installation of reinforced concrete pipes.

5.2.2.2 Force Main Ductile Iron Pipes

The estimated construction; unit costs for force mains of various diameters are based upon the use of imported ductile iron pipe.

The sewers, trunk sewers and force mains costs include all labor, material, excavation, dewatering sheeting, backfill, resurfacing of streets as well as paths, all for June 1980 prices. Costs do not include contingencies, engineering, legal and administrative allowances.

The costs of force mains complete and ready to be used are shown in Table 5.2-3.

TABLE 5.2-3

Force Main	Unit	Cost Complete In JD
150	mm	30,000
500	mm	57,000

5.2.2.3 Manhole Construction

Manhole construction costs have been developed using local rates for precast concrete rings plus excavation, poured in place concrete covers, backfill, repairing of streets and testing.

Tables 5.2-4 and 5.2-5 show the costs of M.H. per meter depth, complete ready for use for sewer sizes up to and including 300 mm. The cost estimate of Manholes are based on 900 mm diameter precast concrete rings with poured-in-place concrete base for sewers up to 300 mm.

TABLE 5.2-4

MANHOLE IN STREETS

Depth of Manhole	Cost Estimate of M.H. With Medium Duty Cover JD	Cost Estimate of M.H. With Heavy Duty Cover JD
1-1.2m	155.000	185.000
2.00 m	185.000	215.000
3.00 m	250.000	280.000
4.00 m	360.000	390.000

TABLE 5.2-5

MANHOLE IN PATHS

Depth Manhole	Cost Estimate of M.H. With Medium Duty Cover
1.00	170.000
2.00	205.000
3.00	275.000
4.00	400.000

For sewer sizes in excess of 300 mm cast-in-place manholes will be used. Cast-in-place manholes will also be used for manholes having depths in excess of 4.0 meters. The estimated cost of such manholes will be JD 160.000 for the cast-in-place base plus the cost of the precast chimney as per Table 5.2-4 and 5.2-5.

5.2.2.4 House Connection

The cost estimates for connecting the main sewer in street and/or path to the house plot boundary are as follows:

o In Street

We need for such connection a 6m long Ø 150 mm PVC pipe with an average depth of 1.0 m plus a Y-pipe and a bend for the connections with the main line.

COST ESTIMATE IN JD

Cost	6m x 17.5 =	103.800
	Y-Pipe	20.000
	Bend	17.000
Installation for Y-Pipe and Bend		15.200
Total House Connection Cost in Street		JD 156.000

o In Paths

We need for such connection 1 m long Ø mm PVC. pipe with an average depth of 1 m plus a Y-pipe and a bend.

COST ESTIMATE IN JD

Ø 150 mm Pipe 1 x 12.000	= 12.000
Y-Pipe	= 20.000
Bend	= 17.000
Installation for Y-pipe and Bend	= 11.000
Total cost for house connection in paths	JD 60.000

o On Plot Connection

As for the on-plot sewer connection, we need a 2m long Ø 150 mm PVC pipe and one shallow manhole (600 x 600 mm) with a concrete or light wt. cast iron cover.

COST ESTIMATE IN JD

Pipes	2 x 12.50	= 25.000
M.H. on Plot		50.000
		JD 75.000

5.2.3 Water Constructions

The estimated costs of water pipes, complete and ready for use, are shown in Table 5.2-6. These prices include cost of all materials, excavation installation and joining of pipes, bedding for pipes, backfill, testing and disinfection and resurfacing of streets and footpaths.

5.2.4 Sewage Treatment Plant and Pumping Station Construction

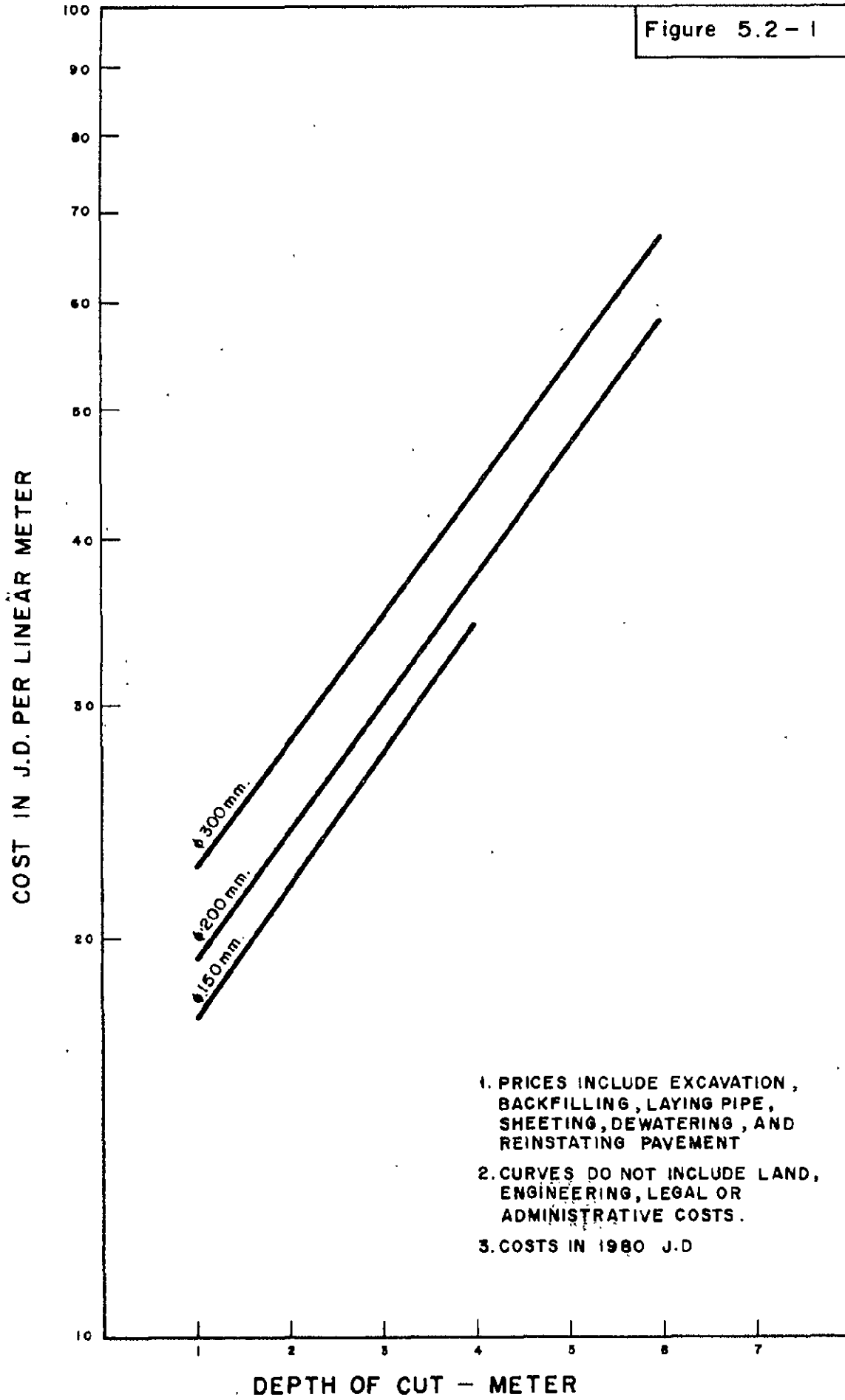
The unit costs for labor and civil works as presented in this Appendix have been used to estimate the civil and mechanical works required. The cost of imported mechanical equipment includes all costs delivered to the site plus the installing contractors overhead and profit.

TABLE 5.2-6

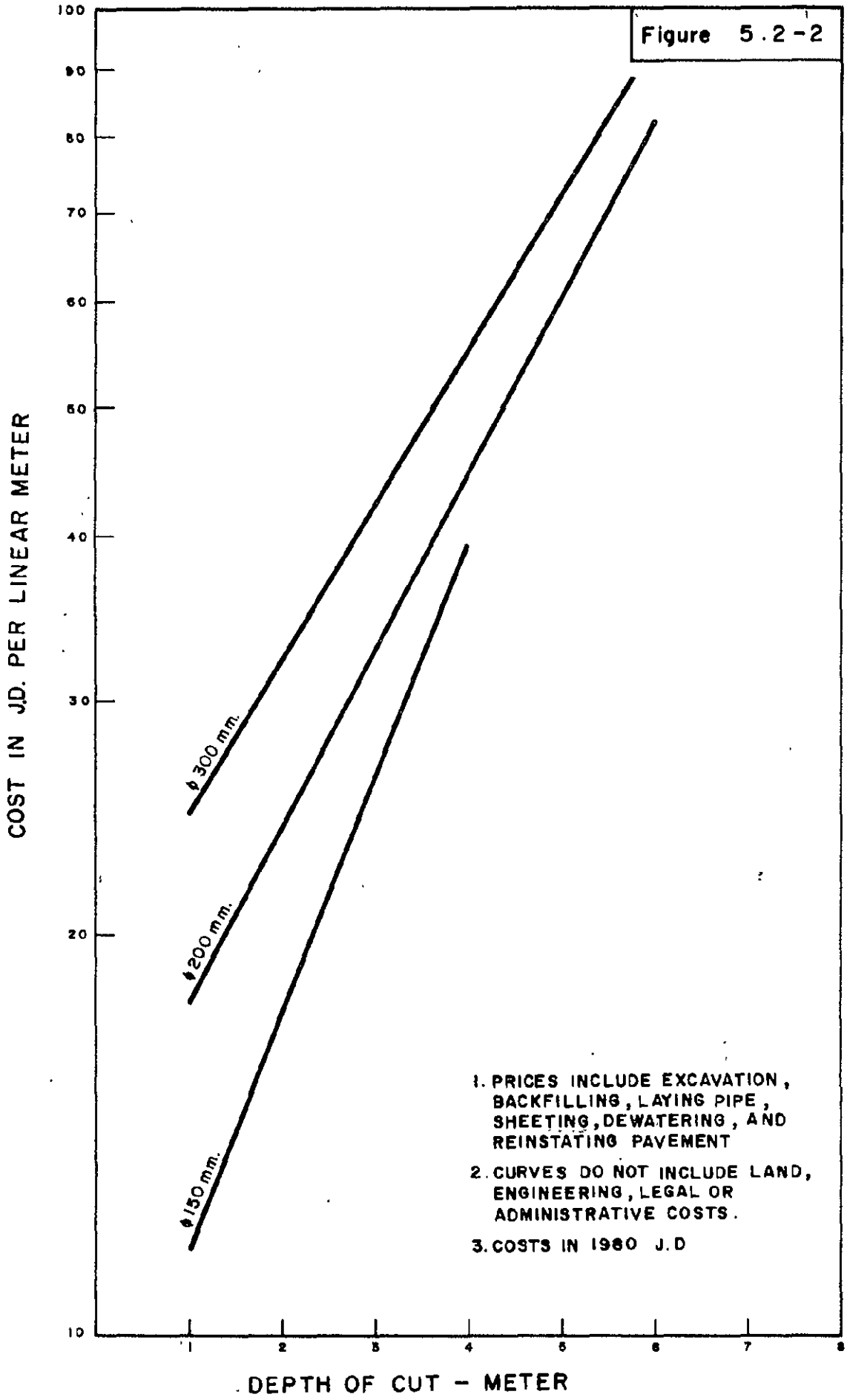
WATER DISTRIBUTION SYSTEM COST ESTIMATES

Nominal Internal Pipe Size Diameter In.	(mm)	Cost of Pipe D.I. JD/M	Transport In Site	Total JD/M	Exc. Laying Backfilling & Reinstating	Total Cost Complete JD/M
2"	(50)	1.90	0.10	2.00	14.0	16.0
4"	(100)	4.85	0.15	5.00	15.0	20.0
6"	(150)	6.72	0.28	7.00	17.0	24.0
8"	(200)	9.12	0.38	9.50	17.5	27.0
10"	(250)	12.52	0.48	13.0	17.5	30.5
12"	(300)	16.00	0.50	16.5	17.5	34.0
16"	(400)	23.50	1.50	25.0	20.0	45.0
20"	(500)	33.40	1.60	35.0	20.0	55.0
24"	(600)	44.00	2.00	46.0	20.0	66.0

Fittings, Valves, Valve Boxes, Hydrants etc. add. 10-15%.

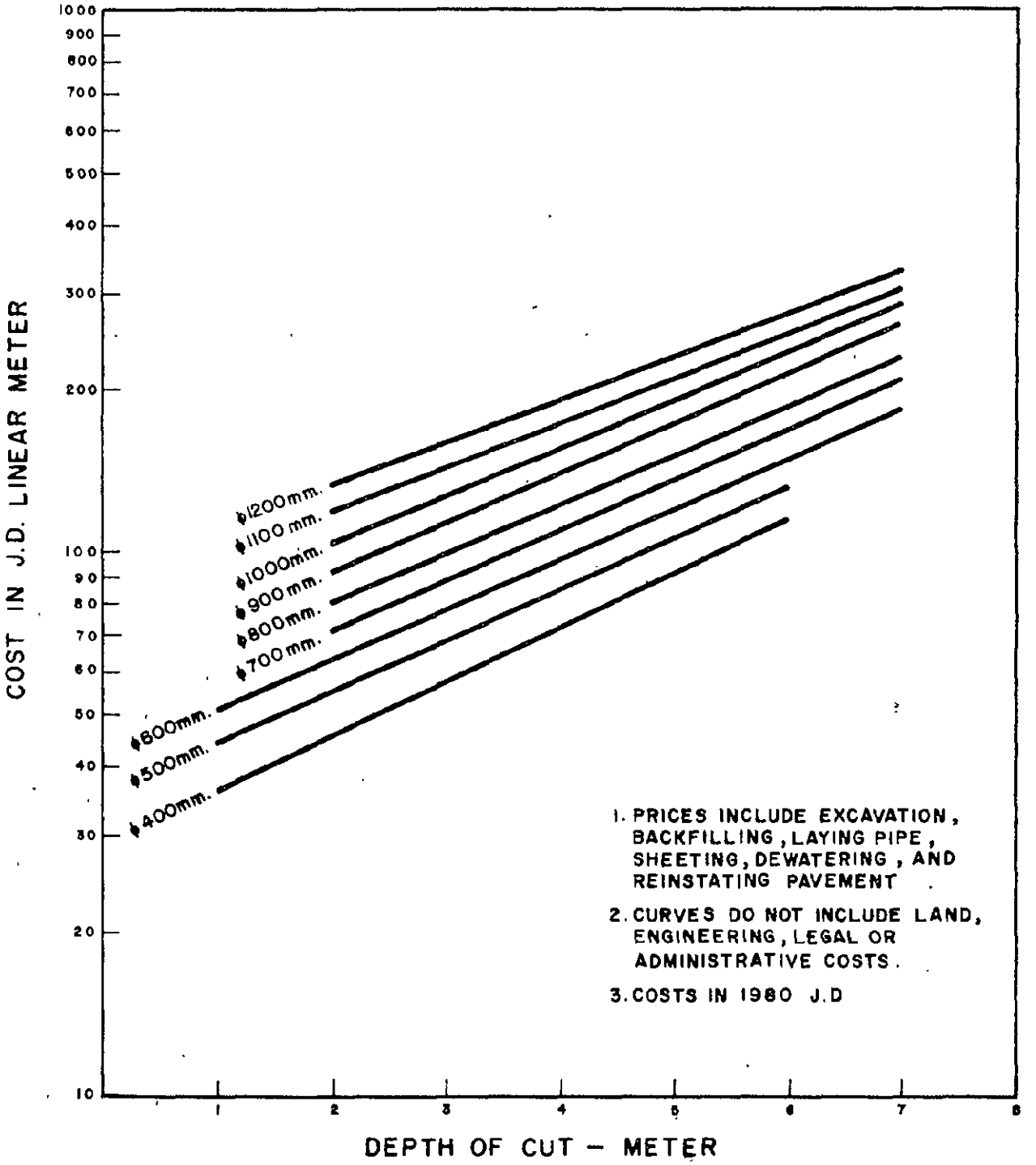


COST OF P.V.C. SEWERS IN STREETS



COST OF P.V.C. SEWERS IN PATHS

Figure 5.2-3



COST OF R.C. SEWERS

CHAPTER 6.0

SEWER SYSTEM

TABLE 6.1

POPULATION ESTIMATES BY SUBAREAS

Year	1979	1984	1990		2000		2020	
Subarea	Total Pop.	Service Pop.	Total Pop.	Service Pop.	Total Pop.	Service Pop.	Total Pop.	Service Pop.
I	27,600	16,560	42,300	26,100	61,900	48,900	80,000	66,250
II	41,000	34,850	43,000	38,700	45,000	42,800	46,000	45,100
III	58,000	55,100	59,000	56,600	60,000	58,800	62,000	61,400
IV	14,800	7,400	37,500	17,300	82,800	62,600	136,000	108,800
V	2,400	0	20,400	0	30,000	7,700	52,000	41,600
VI	17,000	6,800	25,000	10,000	36,700	18,000	58,000	49,300
VII	23,000	18,400	25,000	20,000	27,000	21,500	30,000	24,000
VIII	12,500	2,500	14,000	4,800	30,000	18,000	50,000	40,000
IX	4,200	0	8,900	2,700	16,600	6,600	23,700	16,600
X	5,800	1,160	7,800	2,300	10,800	4,300	15,500	11,300
XI	800	0	1,900	0	4,700	1,200	11,600	8,700
XII	9,700	4,850	21,000	10,500	30,300	15,200	61,000	42,700
XIII	12,800	7,680	15,400	11,600	18,000	14,400	22,300	19,000
XIV	100	0	3,300	0	7,800	2,000	19,000	14,300
XV	800	0	8,400	4,400	17,500	9,900	34,500	27,600
XVI	22,900	17,175	24,100	18,100	25,400	20,300	27,800	23,650
XVII	13,100	9,170	18,000	14,400	25,000	20,000	30,000	25,500
XVIII	100	0	1,900	0	6,700	0	24,600	17,200
XIX	100	0	100	0	100	0	100	0
XX	8,600	0	9,000	0	10,000	7,500	11,200	9,000
ARMY BASE	35,000	35,000	35,000	35,000	40,000	40,000	45,000	45,000
TOTAL	310,300	216.645	421,000	272,500	586,300	419,700	840,300	697,000
PERCENT SERVED		59.9*		64.7		71.6		82.9

*Based upon estimated total population of 361,500 in 1984.

TABLE 6.2

ESTIMATED SEWAGE FLOW, BOD_5 AND SUSPENDED SOLIDS LOADINGS FROM DOMESTIC AND COMMERCIAL SOURCES BY SUBAREAS

YEAR	1984		1990		2000		2020	
SUBAREA	AVG FLOW M^3/D	BOD_5 & S.S. Kg/D	AVG FLOW M^3/D	BOD_5 & S.S. Kg/D	AVG FLOW M^3/D	BOD_5 & S.S. Kg/D	AVG FLOW M^3/D	BOD_5 & S.S. Kg/D
I	1,093	994	1,879	1,566	3,912	2,934	6,625	3,975
II	2,300	2,091	2,786	2,322	3,424	2,568	4,510	2,706
III	3,637	3,306	4,075	3,396	4,704	3,528	6,140	3,684
IV	488	444	1,246	1,038	5,008	3,756	10,880	6,528
V	0	0	0	0	616	462	4,160	2,496
VI	449	408	720	600	1,440	1,080	4,930	2,958
VII	1,214	1,104	1,440	1,200	1,720	1,290	2,400	1,440
VIII	165	150	346	288	1,440	1,080	4,000	2,400
IX	0	0	194	162	528	396	1,660	996
X	77	70	166	138	344	258	1,130	678
XI	0	0	0	0	96	72	870	522
XII	320	291	756	630	1,216	912	4,270	2,562
XIII	430	461	731	696	1,022	864	1,729	1,140
XIV	0	0	0	0	142	120	1,301	858
XV	0	0	277	264	703	594	2,512	1,656
XVI	962	1,030	1,140	1,086	1,441	1,218	2,152	1,419
XVII	514	550	907	864	1,420	1,200	2,320	1,530
XVIII	0	0	0	0	0	0	1,565	1,032
XIX	0	0	0	0	0	0	0	0
XX	0	0	0	0	532	450	819	540
ARMY	2,310	2,100	2,520	2,100	3,200	2,400	4,500	2,700
TOTAL	13,959	12,999	19,183	16,350	32,908	25,182	68,473	41,820
SAY	14,000	13,000	19,200	16,400	32,900	25,200	68,500	41,800

TABLE 6.3

INDUSTRIAL WASTEWATER QUANTITIES AND CHARACTERISTICS

SUBAREA	INDUSTRY	1984			1990			2000			2020		
		AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D	AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D	AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D	AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D
IV	New Industrial Development	230	190	190	580	470	470	1170	940	940	2340	1880	1880
	Subtotal - Subarea IV	230	190	190	580	470	470	1170	940	940	2340	1880	1880
	Amounts to Sewers	0	0	0	580	470	470	1170	940	940	2340	1880	1880
VIII	Jordan Ceramic and Firebrick Co.*	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l
	United Factories, Ltd	36	1000	1	47	1310	2	65	1810	3	65	1810	3
	Imperial Underwear Co.	37	18	6	37	24	7	37	33	10	37	33	10
	Arab Breweries Co.	150	135	52	135	200	77	135	200	77	135	200	77
	Jordan Brewery Co., Ltd.	310	270	110	260	380	150	260	380	150	260	380	150
	Eagle Distilleries	210	1400	17	210	1830	22	290	2520	31	290	2520	31
	Zeidan Refrigeration Co.	4	4	2	5	5	2	7	7	3	7	7	3
	Big Zarqa Mill	2	Neg'l	Neg'l	2	Neg'l	Neg'l	3	Neg'l	Neg'l	3	Neg'l	Neg'l
	Cream Tex	10	5	2	13	7	2	18	10	4	18	10	4
	Subtotal - Subarea VIII	760	2832	190	710	3756	262	816	4960	277	816	4960	278
	Amounts to Sewers	760	2832	190	710	3756	262	816	4960	277	816	4960	278
IX	Jordan Match Co.	7	Neg'l	Neg'l	9	Neg'l	Neg'l	13	Neg'l	Neg'l	13	Neg'l	Neg'l
	Jordan Ceramic Ind. Co.*	3	Neg'l	Neg'l	4	Neg'l	Neg'l	5	Neg'l	Neg'l	5	Neg'l	Neg'l
	New Industrial Development	285	235	235	730	585	585	1465	1170	1170	2930	2340	2340
	Int'l Leather Product Co.	2	Neg'l	Neg'l	3	Neg'l	Neg'l	5	Neg'l	Neg'l	5	Neg'l	Neg'l
	Subtotal - Subarea IX	297	235	235	746	585	585	1488	1170	1170	2953	2340	2340
	Amounts to Sewers	0	0	0	0	0	0	1488	1170	1170	2953	2340	2340
X	Jordan Tanning Co., Ltd	700	770	35	500	930	35	690	1280	35	690	1280	35
	Jordan Paper & Cardboard	2310	400	277	1390	240	167	1390	240	167	1390	240	167
	Jordan Iron & Steel Co.	1260	Neg'l	Neg'l	43	Neg'l	Neg'l	43	Neg'l	Neg'l	43	Neg'l	Neg'l
	Jordan Army Blanket Fact.	300	180	50	300	180	50	300	180	50	300	180	50
	Arab Thinner Factory	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l
	Jopolymer	9	Neg'l	Neg'l	12	Neg'l	Neg'l	16	Neg'l	Neg'l	16	Neg'l	Neg'l
	Clenkers, Ltd.	12	Neg'l	36	12	Neg'l	36	12	Neg'l	36	12	Neg'l	36
	Jordan Fiberglass Co.	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l
	Jordan Chemical Industries*	36	Neg'l	Neg'l	40	Neg'l	Neg'l	56	Neg'l	Neg'l	56	Neg'l	Neg'l
	New Industrial Development	300	235	235	730	585	585	1465	1170	1170	2930	2340	2340
	Subtotal - Subarea X	4929	1585	633	3029	1935	863	3974	2870	1453	5439	4040	2628
	Amounts to Sewers	4929	1585	633	3029	1935	863	3974	2870	1453	5439	4040	2628

TABLE 6.3 (Cont'd)

INDUSTRIAL WASTEWATER QUANTITIES AND CHARACTERISTICS

SUBAREA	INDUSTRY	1984			1990			2000			2020		
		AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D	AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D	AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D	AVG FLOW M^3/D	BOD_5 Kg/D	S.S. Kg/D
XII	Noralux Industrial Comm.Co.	2	Neg'l	4	5	Neg'l	5	7	Neg'l	7	7	Neg'l	7
	Kholaghassi Foam & Mattress Factory	1	Neg'l	Neg'l	1	Neg'l	Neg'l	2	Neg'l	Neg'l	2	Neg'l	Neg'l
	Subtotal - Subarea XII	3	0	4	6	0	5	9	0	7	9	0	7
	Amounts to Sewers	3	0	4	6	0	5	9	0	7	9	0	7
XIII	Oriental Mineral Water Factories (7-Up)	200	550	270	200	550	270	200	550	270	200	550	270
	Transjordan Mineral* Research Co.	1	Neg'l	Neg'l	1	Neg'l	Neg'l	2	Neg'l	Neg'l	2	Neg'l	Neg'l
	Jordan Overall Co., Ltd.	7	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l
	Jordan Dairy Co., Ltd	115	520	210	150	680	280	210	940	380	210	940	380
	Jordan Worsted Mills	93	54	360	120	71	470	170	98	650	170	98	650
	Sultan Plastics Co.	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l	1	Neg'l	Neg'l
	Subtotal - Subarea XIII	417	1124	840	473	1301	1020	584	1588	1300	584	1588	1300
	Amounts to Sewers	417	1124	840	473	1301	1020	584	1588	1300	584	1588	1300
XVII	Oriental Star Distillery	44	10	10	32	10	10	39	12	10	39	12	12
	Hussein Industrial City (I.C.A.)												
	Detergent Factory	78	3	3	78	4	4	78	5	5	78	5	5
	Soap Factory	1515	100	20	99	130	34	138	180	65	138	180	65
	Ice Cream Factory	25	41	16	8	53	21	11	74	29	11	74	29
	Cosmetics Factory	1	Neg'l	Neg'l	1	Neg'l	Neg'l	2	Neg'l	Neg'l	2	Neg'l	Neg'l
	Paint Factory	3	Neg'l	5	4	Neg'l	6	6	Neg'l	8	6	Neg'l	8
	Subtotal - Subarea XVII	1666	154	54	222	197	75	274	271	119	274	271	119
	Amounts to Sewers	1666	154	54	222	197	75	274	271	119	274	271	119
XVIII	Jordan Phosphate Co.*	4630	Neg'l	686000	4630	Neg'l	686000	0	0	0	0	0	0
	Amounts to Sewers	0	0	0	0	0	0	0	0	0	0	0	0
XIX	Yeast Industries Co., Ltd	113	300	100	150	390	130	205	540	180	205	540	180
	Amounts to Sewers	0	0	0	0	0	0	0	0	0	0	0	0
	Total All Subareas	13040	6420	688246	10546	8643	690410	8520	12339	5449	12620	15619	8732
	Amounts to Sewers	7769	5695	1721	5020	7668	2695	8315	11799	5269	12620	15619	8732

* Produces non-biodegradable wastewater containing sand, silt, cement, dust or other inorganic substances which can best be treated on-site in conjunction with water conservation measures. Flows shown are sanitary wastewaters only.

TABLE 6.4

ESTIMATED WASTEWATER QUANTITIES AND CHARACTERISTICS BY SUBAREAS

YEAR	1984			1990			2000			2020		
SUBAREA	AVG. FLOW M^3/D	BOD_5 LOAD Kg/D	S.S. LOAD Kg/D	AVG. FLOW M^3/D	BOD_5 LOAD Kg/D	S.S. LOAD Kg/D	AVG. FLOW M^3/D	BOD_5 LOAD Kg/D	S.S. LOAD Kg/D	AVG. FLOW M^3/D	BOD_5 LOAD Kg/D	S.S. LOAD Kg/D
I	1,093	994	994	1,879	1,566	1,566	3,912	2,934	2,934	6,625	3,975	3,975
II	2,300	2,091	2,091	2,786	2,322	2,322	3,424	2,568	2,568	4,510	2,706	2,706
III	3,637	3,306	3,306	4,075	3,396	3,396	4,704	3,528	3,528	6,140	3,684	3,684
IV	488	444	444	1,827	1,508	1,508	6,179	4,696	4,769	13,221	8,408	8,408
V	0	0	0	0	0	0	616	462	462	4,160	2,496	2,496
VI	449	408	408	720	600	600	1,440	1,080	1,080	4,930	2,958	2,958
VII	1,214	1,104	1,104	1,440	1,200	1,200	1,720	1,290	1,290	2,400	1,440	1,440
VIII	925	2,982	340	1,056	4,044	550	2,256	6,050	1,357	4,816	7,360	2,678
IX	0	0	0	194	162	162	2,014	1,566	1,666	4,613	3,336	3,336
X	5,006	1,655	703	3,195	2,073	1,158	4,318	3,128	1,716	6,569	4,718	3,306
XI	0	0	0	0	0	0	96	72	72	870	522	522
XII	323	291	295	762	630	635	1,225	912	966	4,279	2,562	2,569
XIII	847	1,585	1,301	1,204	2,006	1,716	1,616	2,472	2,264	2,313	2,728	2,440
XIV	0	0	0	0	0	0	142	120	120	1,301	858	858
XV	0	0	0	277	262	262	703	594	594	2,512	1,656	1,656
XVI	962	1,030	1,030	1,140	1,086	1,086	1,441	1,218	1,218	2,152	1,419	1,419
XVII	2,174	704	604	1,129	1,061	939	1,714	1,491	1,419	2,594	1,801	1,649
XVIII	0	0	0	0	0	0	0	0	0	1,565	1,032	1,032
XIX	0	0	0	0	0	0	0	0	0	205	540	180
XX	0	0	0	0	0	0	532	450	450	819	540	540
Army Base	2,310	2,100	2,100	2,520	2,100	2,100	3,200	2,400	2,400	4,500	2,700	2,700
TOTAL	21,728	18,694	14,720	24,204	24,016	19,200	41,242	37,041	30,900	81,094	57,439	50,552
Say	21,700	18,700	14,700	24,200	24,100	19,200	41,200	37,000	30,900	81,100	57,400	50,600

TABLE 6.5

COST ESTIMATES FOR ALTERNATIVE TRUNK SEWER AND TREATMENT SCHEMES
(1980 JD's)

ALTERNATIVE 1 - TREATMENT PLANT ON ZARQA RIVER

PROJECT COST	COST IN JD
Sewage Treatment Plant (1)	7,021,000
Trunk Sewers along Zarqa River	1,302,400
Trunk Sewer to Awjan esh Sharqi	193,000
Trunk Sewer on East Side of City of Zarqa	322,300
East Side Pumping Station (23,860 m^3/d cap.)	245,000
500 mm Dia Force Main	169,600
Trunk Sewer in Subarea I	150,800
Subtotal	9,404,100
Contingencies, Engineering, Legal, and Administrative Costs (44%)	4,137,800
Subtotal	13,541,900
Land Costs	624,000
Total Project Cost	14,165,900
Salvage Value	- 1,150,900
Project Present Worth Value	13,015,000
OPERATION AND MAINTENANCE COSTS	
Sewage Treatment Plant O/M	240,000
Subtotal Sewage Treatment Plant	240,000
Pumping Station O/M	
Labor	9,500
Electric Power	53,200
Equipment and Supplies	2,500
Misc.	200
Subtotal Pumping Station	65,400
Trunk Sewer O/M	6,000
Total O/M	311,400

(1) See Table 7.1

TABLE 6.6

COST ESTIMATES FOR ALTERNATIVE TRUNK SEWER AND TREATMENT SCHEMES
(1980 JD's)

ALTERNATIVE 2 - TREATMENT PLANT ON WADI SAIDA

PROJECT COST	COST IN JD
Sewage Treatment Plant(1)	7,021,000
Trunk Sewers along Zarqa River	778,200
Trunk Sewer to Awjan esh Sharqi	193,000
Trunk Sewer on East Side of City of Zarqa	770,000
Pumping Station on Zarqa River (57,000 m^3/d cap.)	350,000
900 mm Dia. Force Main	156,000
Trunk Sewer in Subarea I	126,000
Subtotal	9,394,200
Contingencies, Engineering, Legal, and Administrative Costs (44%)	4,133,500
Subtotal	13,527,700
Land Cost	624,000
Total Project Cost	14,151,700
Salvage Value	- 1,149,700
Project Present Worth Cost	13,002,000
OPERATION AND MAINTENANCE COSTS	
Sewage Treatment O/M(1)	240,000
Sewage Treatment Pumping Station	18,800
Subtotal - Sewage Treatment	258,800
Pumping Station O/M	
Labor	9,500
Electric Power	96,300
Equipment and Supplies	3,500
Misc.	300
Subtotal Pumping Station	109,600
Trunk Sewer O/M	6,000
TOTAL O/M	374,400

(1) See Table 7.1

TABLE 6.7

COST ESTIMATES FOR ALTERNATIVE TRUNK SEWER AND TREATMENT SCHEMES
(1980 JD's)

ALTERNATIVE 3 - SEPARATE SEWAGE TREATMENT PLANTS ON ZARQA RIVER AND WADI SAIDA

PROJECT COSTS	COST IN JD
Sewage Treatment Plant on Zarqa River(1)	5,148,000
Sewage Treatment Plant on Wadi Saida(1)	2,991,000
Trunk Sewers along Zarqa River	1,138,000
Trunk Sewer to Awajan esh Sharqi	193,000
Trunk Sewer on East Side of City of Zarqa	392,000
Subtotal	9,862,000
Contingencies, Engineering, Legal, and Administrative Costs (44%)	4,339,300
Subtotal	14,201,300
Land Cost	688,000
Total Project Cost	14,889,300
Salvage Value	1,276,300
Project Present Worth Value	13,613,000
OPERATION AND MAINTENANCE COSTS	
Sewage Treatment Plant on Zarqa	170,000
Sewage Treatment Plant on Wadi Saida	104,000
Sewage Treatment Plant Pumping Station	15,600
Subtotal Sewage Treatment Plant	289,600
Trunk Sewer O & M	6,000
TOTAL O & M	295,600

(1) See Table 7.1

TABLE 6.8

COLLECTION AND SUBTRUNK SEWER FACILITIES CONSIDERED FOR PHASE I CONSTRUCTION BY SUBAREAS

SUBAREA	LENGTH OF SEWERS (METERS)						TOTAL ALL SIZES (M)	NO.OF HOUSE CONNECTIONS
	200mm		250mm	300mm	400mm	600mm		
	STREETS	PATHS	STREETS	IN STREETS	IN STREETS	IN STREETS		
I	9,875	10,000	430	1,064	510	160	22,039	2,365
II	11,400	17,000	1,075	550	-	-	30,025	5,000
III	19,855	35,000	620	-	-	-	55,475	7,870
IV	6,450	5,200	650	-	740	-	13,040	1,060
V	No Initial Phase Project Considered							
VI	5,200	3,000	-	350	-	-	8,550	970
VII	10,550	8,200	-	320	-	-	19,070	2,630
VIII	2,620	600	-	-	-	-	3,220	360
IX	No Initial Phase Project Considered							
X	3,800	300	750	300	-	-	5,150	165
XI	No Initial Phase Project Considered							
XII	2,140	2,000	560	460	550	-	4,510	695
XIII	4,880	3,340	400	-	-	-	8,620	1,100
XIV	No Initial Phase Project Considered							
XV	No Initial Phase Project Considered							
XVI	9,310	8,510	450	1,070	-	-	19,340	2,460
XVII	6,320	4,300	300	650	1,320	-	12,890	1,310
XVIII	No Initial Phase Project Considered							
XIX	No Initial Phase Project Considered							
XX	3,600	2,000	400	2,050	-	-	8,050	860
TOTAL	96,000	99,450	5,335	6,814	3,120	160	210,879	26,845
Say	96,000	99,450	5,350	6,820	3,120	160	210,900	26,850
Army Base	Army will Construct its own Collection Sewer System.							

TABLE 6.9

ESTIMATED CONSTRUCTION COSTS FOR COLLECTION AND SUBTRUNK SEWERS BY SUBAREAS (JD)

SUBAREA	ESTIMATED CONSTRUCTION COSTS*	ADD FOR EXTENSION OF HOUSE LATERAL AND TERMINAL MANHOLE	ADD FOR WATER MAINS IN FOOTPATHS
I	841,300	177,375	100,000
II	1,273,700	375,000	170,000
III	2,221,400	590,250	350,000
IV	339,700	79,500	52,000
V	No Initial Phase Project Recommended		
VI	332,000	72,750	30,000
VII	844,000	197,250	82,000
VIII	135,300	27,000	6,000
XI	No Initial Phase Project Recommended		
X	192,600	12,375	3,000
XI	No Initial Phase Project Recommended		
XII	231,400	52,125	20,000
XIII	323,500	82,500	33,000
XIV	No Initial Phase Project Recommended		
XV	No Initial Phase Project Recommended		
XVI	761,700	184,500	85,000
XVII	503,600	98,250	43,000
XVIII	No Initial Phase Project Recommended		
XIX	No Initial Phase Project Recommended		
XX	628,900	64,500	20,000
Army Base	Army will Construct its own Collection Sewers and Connection to Trunk		
TOTAL	8,629,100	2,013,375	994,000
USE	8,629,000	2,013,000	995,000

* Includes Tee and 6 Meters in Street or 1 Meter in Footpath.

TABLE 6.10

EVALUATION OF PROJECT PHASING ALTERNATIVES ON BASIS OF CONSTRUCTION COST PER PERSON SERVED

DESCRIPTION	SERVICE OR EQUIVALENT POPULATION*	COLLECTION SEWER COST (JD)	TRUNK SEWER COST (JD)	TOTAL SEWER COST (JD)	INCREMENTAL COST PER PERSON SERVED (JD)	TOTAL SEWER COST PER PERSON SERVED (JD)
Basic Proj. for Subareas I,II,III,IV	113,910	6,570,225	1,726,200**	8,296,425	-	72.833
Add Subarea VII	23,000	1,123,250	49,900	1,173,150	51.007	-
Total Project	136,910	7,693,475	1,776,100	9,469,575	-	69.166
Add Subarea X	47,266	207,975	143,000	350,975	7.426	-
Total Project	184,176	7,901,450	1,919,100	9,820,550	-	53.322
Add Subarea VI	6,800	434,750	111,900	546,650	80.390	-
Total Project	190,976	8,336,200	2,031,000	10,367,200	-	54.285
Add Subareas VIII, XII and XIII	33,045	910,825	406,200	1,317,025	39.856	-
Total Project	224,021	9,247,025	2,437,200	11,684,225	-	52.157
Add Subarea XVII	12,534	644,850	56,900	701,750	55.988	-
Total Project	236,555	9,891,875	2,494,100	12,385,975	-	52.360
Add Subarea XVI	17,175	1,031,200	83,500	1,114,700	64.902	-
Total Project	253,730	10,923,075	2,577,600	13,500,675	-	53.209
Add Subarea XX	8,600	713,400	84,000	797,400	92.721	-
Total Project	262,330	11,636,475	2,661,600	14,298,075	-	54.504

* Industrial population equivalents calculated as industrial flow divided by 66 litres/person/day.

** Includes 1980 present worth of 1984 O&M from year 1984 thru 2000.

TABLE 6.11

RECOMMENDED PHASE I TRUNK FACILITIES AND ESTIMATED CONSTRUCTION COST

DESCRIPTION	LENGTHS OF PIPE IN METERS							EST. CONST. COST (JD)
	300mm	400mm	500mm	600mm	700mm	900mm	1100mm	
Trunk sewer from treatment plant to Awjan esh Sharqi	1,180	960	1,040	1,680	-	1,540	2,250	836,800
Trunk sewer and force main from Zarqa River to East Side Pump Station	-	-	2,975*	1,262	426	-	-	320,400
Trunk sewer along east side of Zarqa	150	520	850	150	2,143	-	-	322,300
Ruseifa trunk sewer	-	1,330	1,975	2,665	2,220	-	-	658,500
Subtotal-Trunk Sewer Facilities	1,330	2,810	6,840	5,757	4,769	1,540	2,250	2,138,000
East Side Pumping Station								245,000
TOTAL								2,383,000

* Force main

TABLE 6.12

RECOMMENDED PHASE I COLLECTION FACILITIES AND ESTIMATED CONSTRUCTION COST

SUBAREA	LENGTHS OF PIPE IN METERS					NUMBER OF HOUSE CONN.	ESTIMATED CONSTRUCTION COST (JD)
	200mm	250mm	300mm	400mm	600mm		
I	19,875	430	1,064	510	160	2,365	841,300
II	28,400	1,075	550	-	-	5,000	1,273,700
III	54,855	620	-	-	-	7,870	2,221,400
IV	11,650	650	-	740	-	1,060	339,700
VI	8,200	-	350	-	-	970	332,000
VII	18,750	-	320	-	-	2,630	844,000
VIII	3,220	-	-	-	-	360	135,300
X	4,100	750	300	-	-	165	192,600
XII	4,140	260	460	550	-	695	231,400
XIII	8,220	400	-	-	-	1,100	323,500
XVI	17,820	450	1,070	-	-	2,460	738,700
XVII	10,620	300	650	1,320	-	1,310	503,600
Subtotal	189,850	4,935	4,764	3,120	160	25,985	7,977,400
XVI 68 m^3/hr pumping station and 220 m of 150 mm force main							22,600
Total Collection System							8,000,000
Terminal Manholes 25,985 @ 75 JD							1,949,000
Water Mains							974,000
TOTAL RECOMMENDED SYSTEM							10,923,000

NOTE: The total is different from Table 6.9 because Subarea XX is not included in the recommended Phase I facilities.

TABLE 6.13

ESTIMATE OF SERVICE POPULATION AND SEWERAGE FACILITIES COSTS FOR 1984-1990 CONSTRUCTION PHASE

SUBAREA	TOTAL INCREASE IN SERVICE POPULATION	NUMBER SERVED BY PHASE I SEWERS	NUMBER SERVED BY NEW SEWERS	LENGTHS OF NEW SEWERS REQ'D (M)			NUMBER OF HOUSE CONNECTIONS	ESTIMATED CONSTRUCTION COST (JD)
				200mm	250mm	300mm		
I	9,540	1,000	8,540	10,000	840	0	1,362	448,800
II	3,850	200	3,650	4,000	0	0	550	169,500
III	1,500	1,400	100	100	0	0	214	26,200
IV	9,900	300	9,600	13,400	400	600	1,414	551,209
V	0	0	0	0	0	0	0	-
VI	3,200	500	2,700	3,250	500	0	457	154,400
VII	1,600	1,200	400	450	0	0	228	37,700
VIII	2,300	100	2,200	2,000	650	0	328	109,800
IX	2,700	0	2,700	2,800	0	800	385	144,000
X	1,140	100	1,040	1,200	0	0	162	40,800
XI	0	0	0	-	0	0	0	-
XII	5,650	300	5,350	5,600	700	1,000	807	293,900
XIII	3,920	200	3,720	4,800	0	0	560	192,600
XIV	0	0	0	0	0	0	0	-
XV	4,400	0	4,400	4,800	0	1,000	628	232,300
XVI	925	100	825	1,000	0	0	132	41,800
XVII	5,230	200	5,030	5,500	600	0	0	-
XVIII	0	0	0	0	0	0	0	-
XIX	0	0	0	0	0	0	0	-
XX	0	0	0	0	0	0	0	-
Army Base	0	0	0	Army will build add'l facilities			-	-
TOTALS	55,855	5,600	50,255	58,900	3,690	3,400	7,974	2,693,000
Terminal Manholes 7,974 @ 75 JD								598,000
			TOTAL RECOMMENDED SYSTEM					3,291,000

TABLE 6.14

ESTIMATE OF SERVICE POPULATION AND SEWERAGE FACILITIES COSTS FOR 1990-2000 CONSTRUCTION PHASE

SUBAREA	TOTAL INCREASE IN SERVICE POPULATION	NUMBER SERVED BY PREVIOUS SEWER CONST.	NUMBER SERVED BY NEW SEWERS	LENGTHS OF NEW SEWERS REQ'D (M)			NUMBER OF HOUSE CONNECTIONS	ESTIMATED CONST. COST (1980 JD)
				200mm	250mm	300mm		
I	22,800	2,300	20,500	25,600	0	0	3,257	1,058,700
II	4,100	200	3,900	5,000	0	0	585	140,900
III	2,200	2,000	200	150	0	0	314	38,400
IV	45,300	1,200	44,100	56,000	3,000	1,000	6,471	1,140,700
V	7,700	0	7,700	9,630	0	*	1,100	405,100
VI	8,000	1,000	7,000	8,800	0	0	1,142	366,400
VII	1,500	500	1,000	1,275	300	300	214	77,000
VIII	13,200	500	12,700	16,500	0	0	1,885	660,400
IX	3,900	300	3,600	4,500	600	0	557	202,100
X	2,000	200	1,800	2,250	0	0	285	92,700
XI	1,200	0	1,200	1,400	0	400	171	69,200
XII	4,700	1,000	3,700	4,500	500	0	671	212,200
XIII	2,800	600	2,200	2,900	0	0	400	171,900
XIV	2,000	0	2,000	2,200	600	0	285	109,600
XV	5,500	400	5,100	6,400	300	0	785	270,100
XVI	2,200	600	1,600	2,000	0	0	314	89,000
XVII	5,600	1,400	4,200	5,600	0	0	800	24,100
XVIII	0	0	0	0	0	0	0	0
XIX	0	0	0	0	0	0	0	0
XX	7,500	0	7,500	9,600	400	2,050	1,071	451,900
Army Base	5,000	4,000	1,000	Army will build add'l facilities			-	-
Subtotal	147,200	16,200	131,000	195,305	5,700	3,750	20,307	5,580,400
Other Costs - Expand East Side Pumping Station Capacity and Parallel Force Main								249,600
TOTAL								5,830,000
Terminal Manholes 20,307 @ 75 JD								1,523,000
TOTAL RECOMMENDED SYSTEM								7,353,000

* Include 252 m^3/hr pumping station.

TABLE 6.15

FOREIGN AND LOCAL CONSTRUCTION COSTS FOR RECOMMENDED PHASE I SEWER FACILITIES (THOUSANDS OF JD)

ITEM	MATERIAL			LABOR			TOTAL FOREIGN M + L	TOTAL LOCAL M + L	TOTAL COST
	TOTAL	FOREIGN	LOCAL	TOTAL	FOREIGN	LOCAL			
From Treatment Plant to Awjan esh Sharqi	335	134	201	502	75	427	209	628	837
From Zarqa River to East Side Pump Station	128	51	77	192	29	163	80	240	320
Along East Side of Zarqa	129	52	77	193	29	164	81	241	322
East Side Pumping Station	135	74	61	110	16	94	90	155	245
Ruseifa Trunk Sewer	269	106	158	395	59	336	165	494	659
Subtotal Trunk	991	417	574	1,392	208	1,184	625	1,758	2,383
I	337	135	202	504	76	428	211	630	841
II	510	204	306	764	115	649	319	955	1,274
III	888	355	533	1,333	200	1,133	555	1,666	2,221
IV	136	54	82	204	31	173	85	255	340
VI	133	53	80	199	30	169	83	249	332
VII	338	135	203	506	76	430	211	633	844
VIII	54	22	32	81	12	69	34	101	135
X	77	31	46	116	17	99	48	145	193
XII	93	37	56	138	21	117	58	173	231
XIII	130	52	78	194	29	165	81	243	324
XVI W/PS	308	124	184	453	68	385	192	569	761
XVII	202	81	121	302	45	257	126	378	504
Subtotal Collection	3,206	1,283	1,923	4,794	720	4,074	2,003	5,997	8,000
TOTAL	4,197	1,700	2,497	6,186	928	5,258	2,628	7,755	10,383

TABLE 6.16

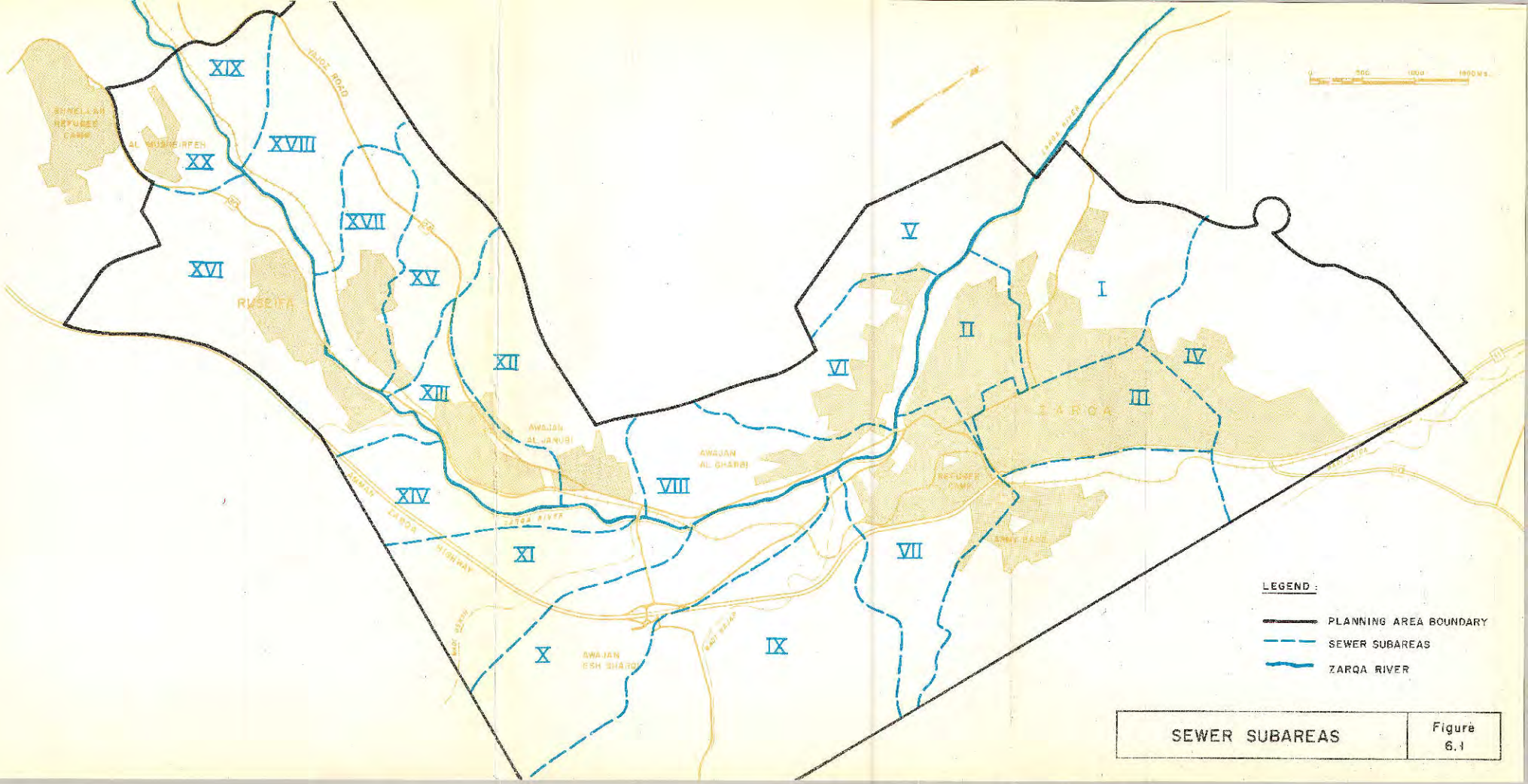
FOREIGN AND LOCAL CONSTRUCTION COSTS FOR ESTIMATED 1984-1990 SEWER FACILITIES (THOUSAND JD)

SUBAREA	MATERIAL			LABOR			TOTAL FOREIGN M + L	LOCAL M + L	TOTAL COST
	TOTAL	FOREIGN	LOCAL	TOTAL	FOREIGN	LOCAL			
I	180	72	108	269	40	229	112	337	449
II	68	27	41	101	15	86	42	127	169
III	10	4	6	16	2	14	6	20	26
IV	220	88	132	331	50	281	138	413	551
VI	62	25	37	92	14	78	39	115	154
VII	15	6	9	23	3	20	9	29	38
VIII	44	18	26	66	10	56	28	82	110
IX	58	23	35	86	13	73	36	108	144
X	16	6	10	25	4	21	10	31	41
XII	118	47	71	176	26	150	73	221	294
XIII	77	31	46	116	17	99	48	145	193
XV	93	37	56	139	21	118	58	174	232
XVI	17	7	10	25	4	21	11	31	42
XVII	100	40	60	150	23	127	63	187	250
TOTAL	1,078	431	647	1,615	242	373	673	2,020	2,693

TABLE 6.17

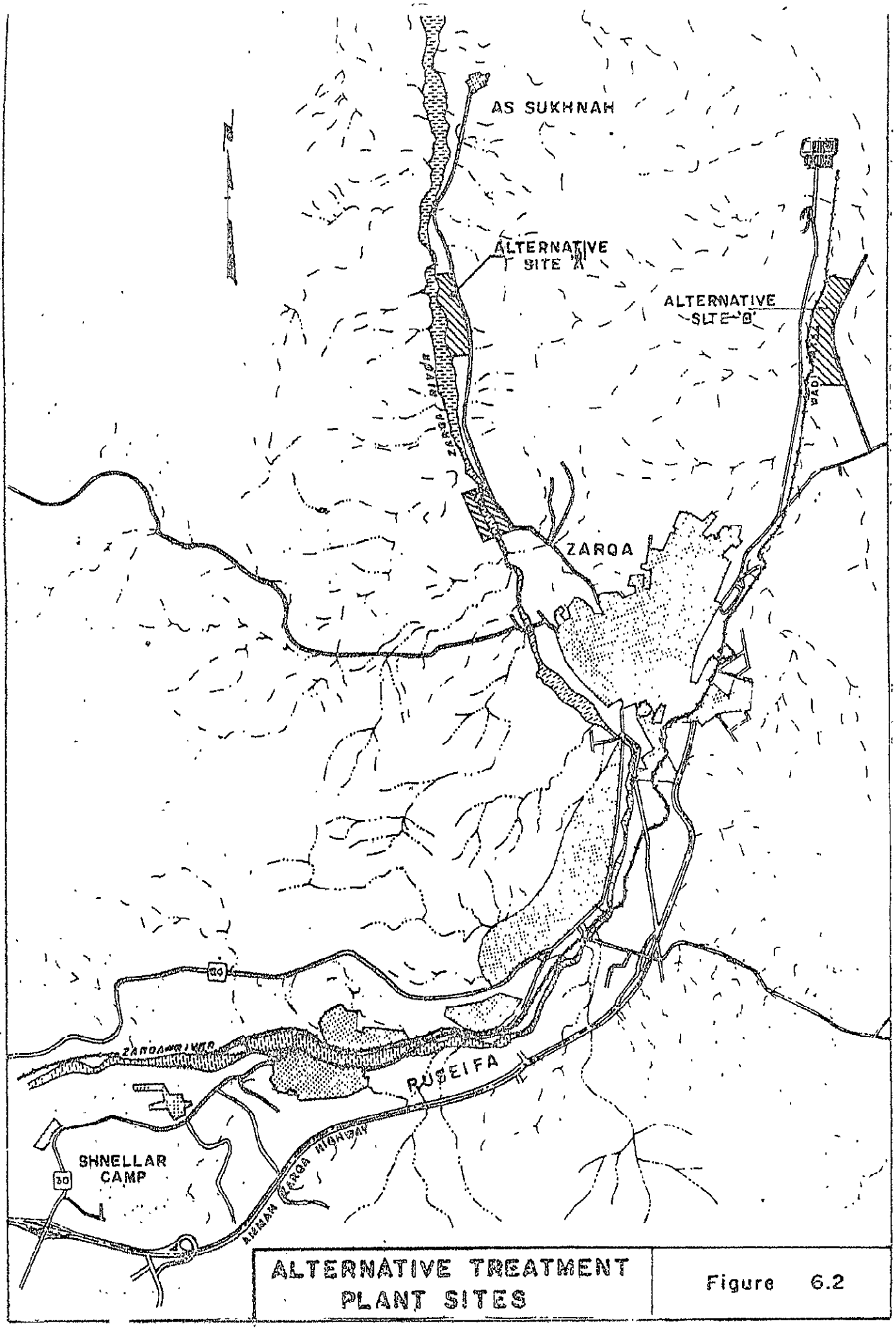
FOREIGN AND LOCAL CONSTRUCTION COSTS FOR ESTIMATED PHASE II FACILITIES (THOUSAND JD)

SUBAREA	MATERIAL			LABOR			TOTAL FOREIGN M + L	TOTAL LOCAL M + L	TOTAL COST
	TOTAL	FOREIGN	LOCAL	TOTAL	FOREIGN	LOCAL			
I	424	170	254	635	95	540	265	794	1,059
II	56	22	34	85	13	72	35	106	141
III	15	6	9	23	3	20	9	29	38
IV	456	182	274	685	103	582	285	856	1,141
V	154	62	92	231	35	196	97	288	385
V-PS	11	6	5	9	1	8	7	13	20
VI	146	58	88	220	33	187	91	275	366
VII	31	12	19	46	7	39	19	58	77
VIII	264	106	158	396	59	337	165	495	660
IX	81	32	49	121	18	103	50	152	202
X	37	15	22	56	8	48	23	70	93
XI	28	11	17	41	6	35	17	52	69
XII	85	34	51	127	19	108	53	159	212
XIII	69	28	41	103	15	88	43	129	172
XIV	44	18	26	66	10	56	28	82	110
XV	108	43	65	162	24	138	67	203	270
XVI	36	14	22	53	8	45	22	67	89
XVII	10	4	6	14	2	12	6	18	24
XX	181	72	109	271	41	230	113	339	452
Subtotal	2,236	895	1,341	3,344	500	2,844	1,395	4,185	5,580
PS+FM	112	51	61	138	20	118	71	179	250
TOTAL	2,348	946	1,402	3,482	520	2,962	1,466	4,364	5,830



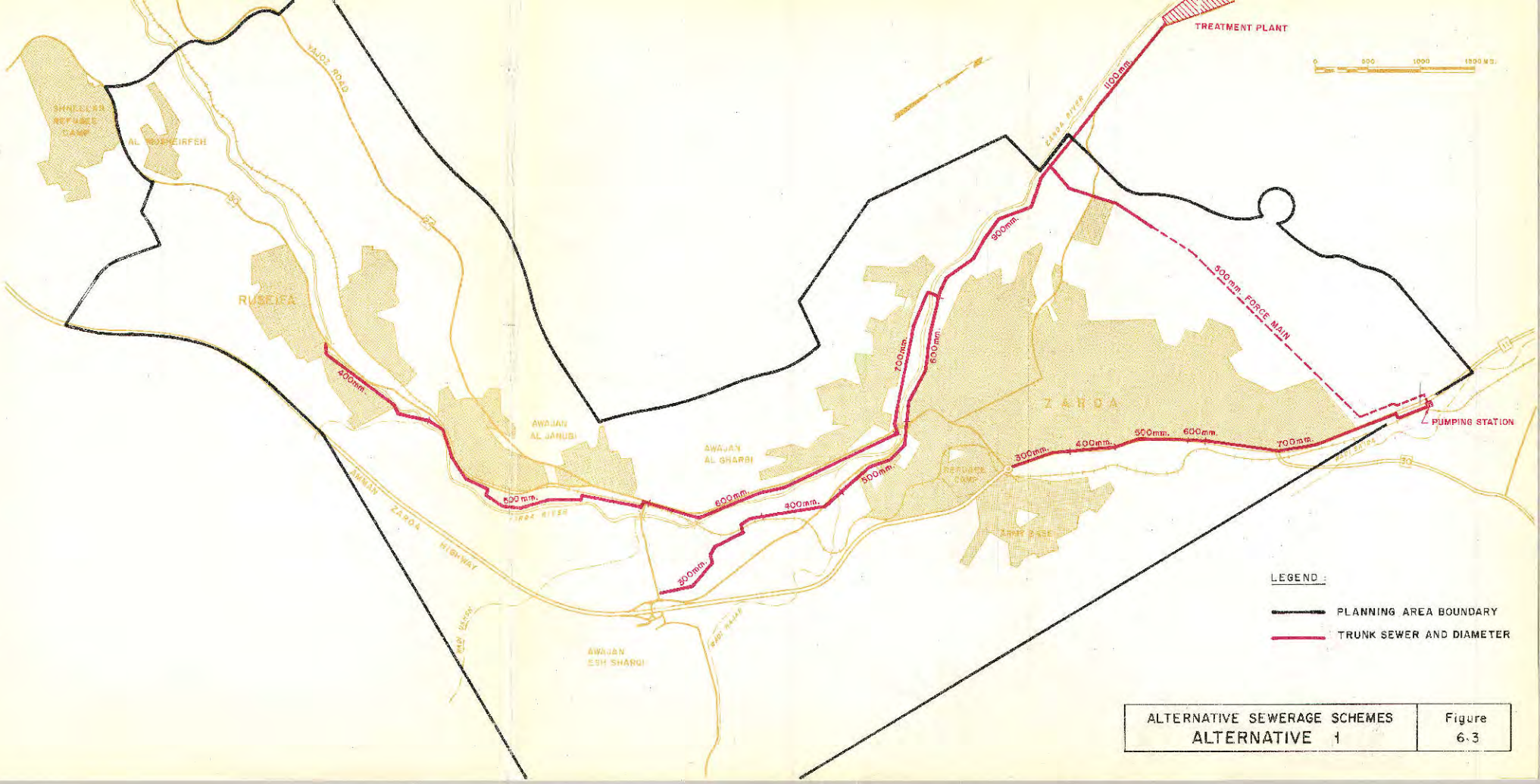
SEWER SUBAREAS

Figure 6.1



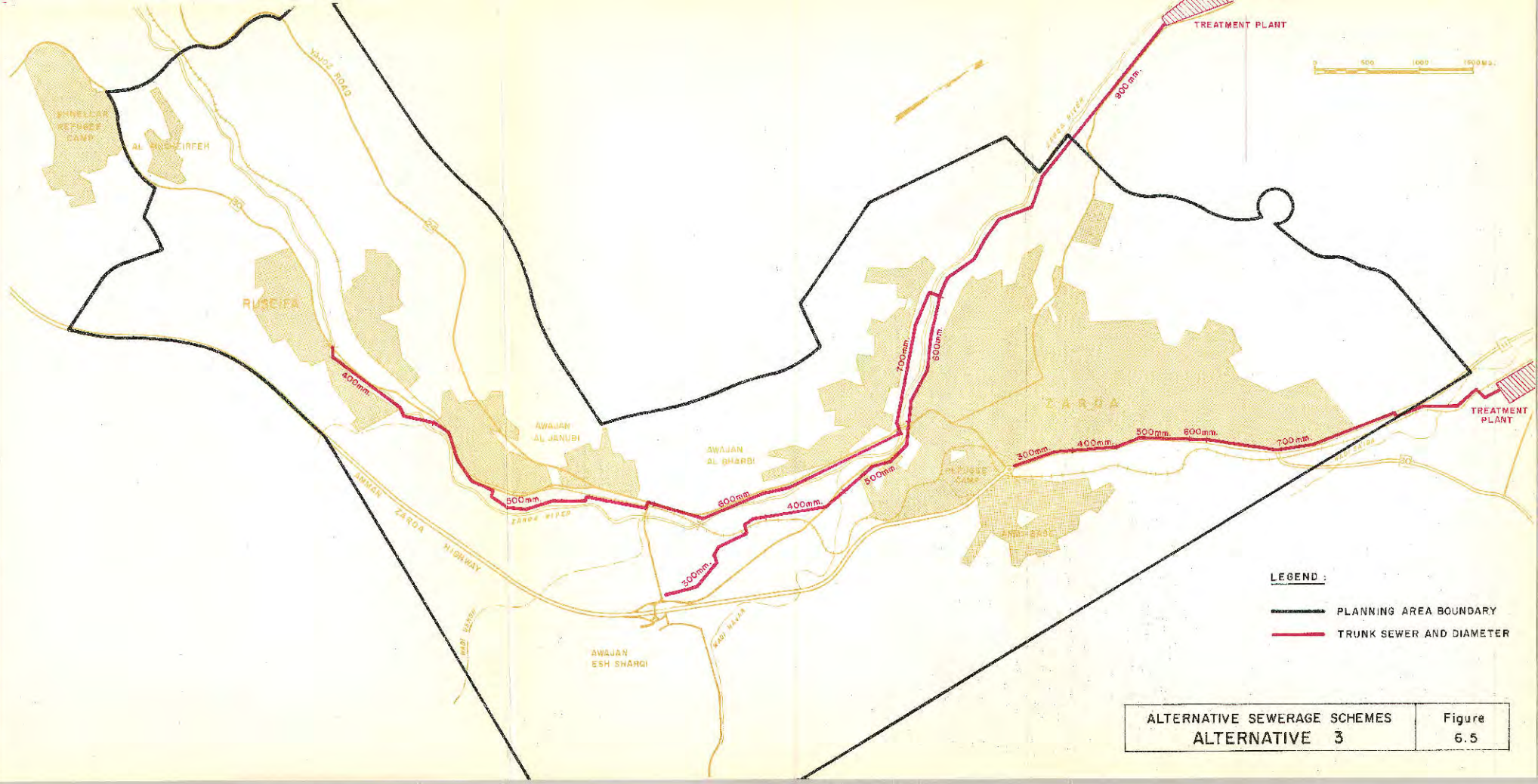
ALTERNATIVE TREATMENT PLANT SITES

Figure 6.2



ALTERNATIVE SEWERAGE SCHEMES ALTERNATIVE 1	Figure 6.3

ALTERNATIVE SEWERAGE SCHEMES ALTERNATIVE 2	Figure 6.4



ALTERNATIVE SEWERAGE SCHEMES ALTERNATIVE 3	Figure 6.5

APPENDIX 6.1

SEWER PIPE MATERIAL

6.1.1. Pipe Materials

The type of sewer pipe used in construction of the proposed sewerage system will have a significant effect upon the economy, reliability, and life expectancy of the entire project. Four different types of sewer pipe are currently manufactured in Jordan as shown below. Ductile iron pipe and vitrified clay pipe are available thru the import market.

LOCALLY MANUFACTURED SEWER PIPE

Type	Number of known manufactures	Sizes Currently Available (mm)
Reinforced Concrete Pipe with O-ring Joints	3	150-1500
Polyvinyl Chloride Pipe with O-ring Joints or Solvent Weld Joints	2	150-300*
Asbestos-Cement Pipe with O-ring Joints	1	150-400
Fiberglass Reinforced Plastic Pipe with Solvent Weld Joints	1	250-1800

* 200 mm currently made and 300 mm reported to be available on request.

In addition to availability, a number of factors must be considered in selecting the type of sewer pipe to be used. However, three factors are of particular importance for this project: (1) resistance to internal corrosion, (2) weight of a standard length of pipe, and (3) water tightness of joints.

Rapid corrosion of interior pipe walls is a frequent occurence in a hot, flat area such as the Middle East. The cause is generally accepted to be sulfuric acid (H_2SO_4), formed through the oxidation of Hydrogen Sulfide (H_2S), a product of anaerobic decomposition of sewage. The corrosion occurs mainly on the walls of the pipe above the normal flow line of the sewage and in manholes. It can lead to accelerated structural failure of the system. The reasons for the excessive production of H_2S

are primarily related to low water use which results in a high strength sewage that rapidly depletes the available oxygen supply in the sewer and poor flushing action which leads to deposition of solids in the pipelines and manholes. High temperatures accelerate the generation of H_2S, its conversion to H_2SO_4, and increase the severity of the problem.

The only access to over 50 percent of the properties in the heavily developed portions of Zarqa and Ruseifa is via footpaths which are generally less than two meters in width. In order to provide service to these properties, it will be necessary to excavate and install the sewers by hand labor. Standard lengths of sewer pipe which weigh more than can conveniently be carried by two men will add significantly to the cost of construction. The necessity of dragging heavy pipes along steep pathways using rollers or sleds may result in damage to pipe joints and excessive leakage.

Much of the proposed sewer system will be constructed in rock trenches which may be less porous than the pipe bedding. The crushed stone or gravel bedding material placed around the pipe will act as a drain to convey infiltrating surface waters along the pipe trench until: a) a low point is reached which will force the water back to the surface, b) the water reaches a portion of the trench where percolation downward can occur, or c) the water enters the sewer through broken pipes or poor joints.

High rates of infiltration result in the need for increased capacity in the treatment plant and pumping stations and can substantially increase those operating and maintenance costs which are flow dependent.

Poor sewer joints will result in excessive leakage of sewage to the ground surface or the groundwaters during the dry summer months. The groundwaters of the upper aquifer already have high nitrate concentrations caused by the disposal of sewage in cesspools and any leakage from the sewers will prolong the time required for improvement in the groundwater quality.

The suggested leakage allowance is 100 gal/inch dia/mile/day for all types of pipe except reinforced concrete for this material the allowance increases to 200.

Each of the types of pipe which are manufactured locally have been evaluated with respect to the above factors plus a number of other factors of importance. Table 6.1 presents some pertinent data on each type of pipes, and a discussion of the relative merits of each type follows.

TABLE 6.1.1

SUMMARY OF SEWER PIPE CHARACTERISTICS

PIPE MATERIAL	DIAMETER (MM)	AVAILABLE PIPE LENGTHS (M)	SUGGESTED LEAKAGE ALLOWANCE M^3/KM/DAY	CURRENT PURCHASE PRICE JD/M
Reinforced Concrete With O-Ring Joints	150	1.10	3.0	1.2
	200	1.14	4.0	1.7
	300	2.20	6.0	5.3
	400	2.20	8.0	9.0
	500	3.06	12.0	13.5
	750	3.06	15.0	16.0
	900	3.04	18.0	23.0
	1100	3.04	22.0	27.5
Polyvinyl Chloride Pipe w/ O-Ring Joints	150	6.0	1.5	1.7
	200	6.0	2.0	2.8
	250	6.0	2.5	
	300	6.0	3.0	
Asbestos Cement Pipe With O-Ring Joints	150	3.0	1.5	2.5
	200	5.0	2.0	3.8
	250	5.0	2.5	4.9
	300	5.0	3.0	6.6
	350	5.0	3.5	8.8
	400	5.0	4.0	11.4
Fiberglass Reinforced Plastic Pipe With Solvent Welded Joints	250	6.0	2.5	9.5
	300	6.0	3.0	10.5
	400	6.0	4.0	12.5
	500	6.0	5.0	20.0
	600	6.0	6.0	27.0
	700	6.0	7.0	33.5
	800	6.0	8.0	42.5
Cement Lined Ductile Iron Pipe O-Ring Joints	150	6.0	1.5	5.3
	200	6.0	2.0	6.9
	250	6.0	2.5	9.3
	300	6.0	3.0	11.7
	400	6.0	4.0	
	500	6.0	5.0	
	600	6.0	6.0	32.3
	700	7.0	7.0	
Vifrified Clay Pipe With O-Ring Joints	200	2.0	2.0	8.4
	300	1.5	3.0	28.5
	450	1.5	4.5	35.0
	500	1.5	5.0	42.7
	600	3.0	6.0	63.0

6.1.2 Reinforced Concrete Pipe

Reinforced concrete pipe (RCP) has been used for the construction of sewers in Amman, Salt, and other areas in Jordan. The pipe is the bell and spigot type and utilizes a rubber O-ring to effect a seal. However, the spigot end of the pipe does not contain a groove to prevent movement of the O-ring during assembly and great care must be exercised to insure a tight joint. The pipe is manufactured in relatively short lengths to prevent flexure failures and this results in a large number of joints per 100 meter of sewer. It cannot be field cut to effect a closure between manholes or to insert an additional wye or tee for a house connection unless the resulting joint is encased in concrete to achieve some degree of water tightness.

Concrete pipe is susceptible to attac . by sulfuric acid, but can be made reasonably resistant if manufactured with calcareous aggregate. The pipe is heavy and is best handled by machine. The weight of a standard length of pipe limits its acceptability for use in footpaths which are too narrow for machines, but weight is considered an advantage where pipe is to be installed in areas subject to flooding.

6.1.3 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe (PVC) has gained wide acceptance for use in sewer construction throughout the United States, Europe, and parts of the Middle East. While it has recently been used for the construction of water mains in Amman, it has apparently not been widely used for sewer systems in Jordan.

PVC pipe is available with two types of joints: a bell and spigot type with a molded rubber O-ring held in a groove in the bell, and spigot type where a solvent is used to weld the two lengths together. Both types are easy to install and produce water tight seals. The pipe itself is available in different wall thicknesses and pressure ratings to meet different conditions of use.

PVC pipe is manufactured in 6 meter standard lengths and is easily field cut without effecting its jointing ability. Tee and wye fittings are not manufactured in Jordan and must be imported from Saudi Arabia, Lebanon, or elsewhere.

Polyvinyl chloride is not effected by hydrogen sulfide or sulfuric acid. Furthermore, its interior wall surfaces are very smooth and deposition of solids under low flow conditions is not as severe a

problem as in pipes with greater roughness coefficients.

A standard 6 meter length of PVC pipe can readily be carried by two men. Its light weight and good jointing characteristics make it an excellent choice for use in narrow footpaths and streets where hand labor is required for installation.

6.1.4 Asbestos Cement Pipe

Asbestos cement pipe with standard, O-ring couplings is available in Jordan in a number of different pressure ratings and wall thicknesses. Pipe of 150 mm diameter is manufactured in 3 meter lengths while 5 meter lengths are supplied for diameter of 200 mm and larger. Fittings are not manufactured locally but are available through the import market. The pipe can be field cut, but a special tool is required to bevel the spigot end of the joint after cutting. The pipe joints are relatively easy to make and generally tight.

Asbestos cement pipe is attacked by sulfuric acid and its thin walls make it susceptible to corrosion failure. Thus, it should be used with great care where septicity is likely to be a problem.

A standard, 5 meter length of 200 mm diameter pipe can be carried by two men.

6.1.5 Fiberglass Reinforced Plastic Pipe

Fiberglass reinforced plastic pipe is very expensive in diameters up to about 500 mm but is generally competitive with ductile iron pipe in larger sizes. This pipe is manufactured in various wall thicknesses and pressure rating and is usually supplied in 6 meter lengths. The pipe joint is made by a solvent weld method and is generally reliable and watertight. Tee and wye connections are usually made in the field using solvent welded saddles.

The pipe is highly resistant to sulfuric acid attack. It is relatively light in weight but should not be used in cuts over 4 meters deep without special backfill and bedding.

6.1.6 Ductile Iron Pipe

Ductile iron pipe is not manufactured in Jordan but is available through the import market. Its cost is considerably higher than that of concrete, PVC or asbestos cement pipe, but its great strength makes it an attractive choice where a sewer is to be installed at depths in excess of 4 meters.

Ductile iron pipe is available in a number of different lengths but is most commonly supplied in 6 meter pieces. Its weight is such that a machine is normally required for its installation. Both mechanical and push-on bell and spigot joints are available and are generally watertight.

All iron pipes, including ductile iron, are susceptible to attack by sulfuric acid and should not be used unless cement-lined. The cement lining will not, however, prevent corrosion but will merely prolong the useful life of the pipe.

6.1.7 Virtified Clay Pipe

Virtified clay sewer pipe is not manufactured in Jordan. It has the best resistance to corrosion but is also the heaviest and most expensive pipe.

6.1.8 Recommended Pipe Materials

Based on the above factors, the following recommendations are made with respect to sewer pipe materials:

- For sewers up to and including 300 mm in diameter installed at depths up to 4 meters, PVC pipe should be specified. Asbestos -cement pipe would be the second choice but should only be used where slopes are steep and low flow rates are not expected to occur.
- For sewers up to and including 300 mm in diameter installed at depths greater than 4 meters, cement-lined ductile iron is the first choice. PVC or asbestos cement pipe could also be used if encased in concrete to provide the necessary strength to withstand the backfill loads.
- For sewers over 300 mm in diameter and all sewers installed in alluvial deposits along the Zarqa River where flooding and erosion might expose the pipe, reinforced concrete pipe manufactured with calcareous aggregation is recommended. However, all joints should be diapered and grouted as an added protection against excessive infiltration. Ductile iron pipe or concrete encased asbestos-cement pipe would be a second choice because of the higher cost of the pipe and concrete encasement.
- For sewage force mains up to and including 300 mm in diameter, PVC pipe with the proper pressure rating is recommended.
- For sewage force mains over 300 mm in diameter, either cement-lined ductile iron pipe or fiberglass reinforced plastic pipe is recommended depending upon cost of materials at the time of construction.

APPENDIX 6.2

SEWER SYSTEM DESIGN CRITERIA

6.2.1 General

The design criteria described herein are generally consistent with modern engineering practice throughout the world. The cost estimates developed for the proposed sewerage system have been based upon a system designed in accordance with these criteria.

6.2.2 Design Periods

The following design periods have been adopted for the various components of the sewerage system.

System Component	Design Period (years)
Treatment Facilities	
Available Land Area	50
Administration & Laboratory Bldg.	40
Settling Tanks and Other Major Process Structures	Modular design, 8-12 yr. increments
Major Process Equipment	16-24
Electrical Equipment	10-15
Instrumentation	10-15
Sewage Pumping Stations	
Major Structures	40 yr.
Minor Structures	20 yr.
Pumps	15 yr.
Electrical Controls	15 yr.
Pipes and Conduits	
Trunk sewers	50
Local collector sewers	*
Force Mains	20-40

* Design to handle flows from fully-developed tributary area.

6.2.3 Gravity sewer sizes, slopes and depths

Criteria governing minimum pipe sizes, slopes and depth of burial have been selected as follows:

Minimum pipe diameters : 200 mm for street sewers
150 mm for service laterals from lateral sewer to property line
150 mm for house connection from property line to house plumbing.

Minimum Depth	:	1 m cover over pipe
Minimum Slope	:	Sufficient to provide 0.6 m/s velocity in the sewer when flowing full.
Maximum Velocity	:	3.5 m/s unless special provisions are made for energy dissipation at manholes and erosion protection in pipe.

6.2.4 Peak Flow Factors

It is generally accepted that instantaneous peak domestic sewage flow rates are related to the size and population of the area upstream of the sewer under consideration. Peaking factors selected for design of the Zarqa-Ruseifa system are shown in Figure 6.1. Peak industrial wastewater flow rates are related to the industrial process used and to the degree of flow equalization provided and have been considered separately.

6.2.5 Sewage Force Mains

The following design criteria are recommended for sewage force mains:

Minimum Diameter	:	150 mm
Minimum Depth	:	1 m cover over pipe
Minimum Velocity	:	0.75 m/s

6.2.6 Sewage Pumping Stations

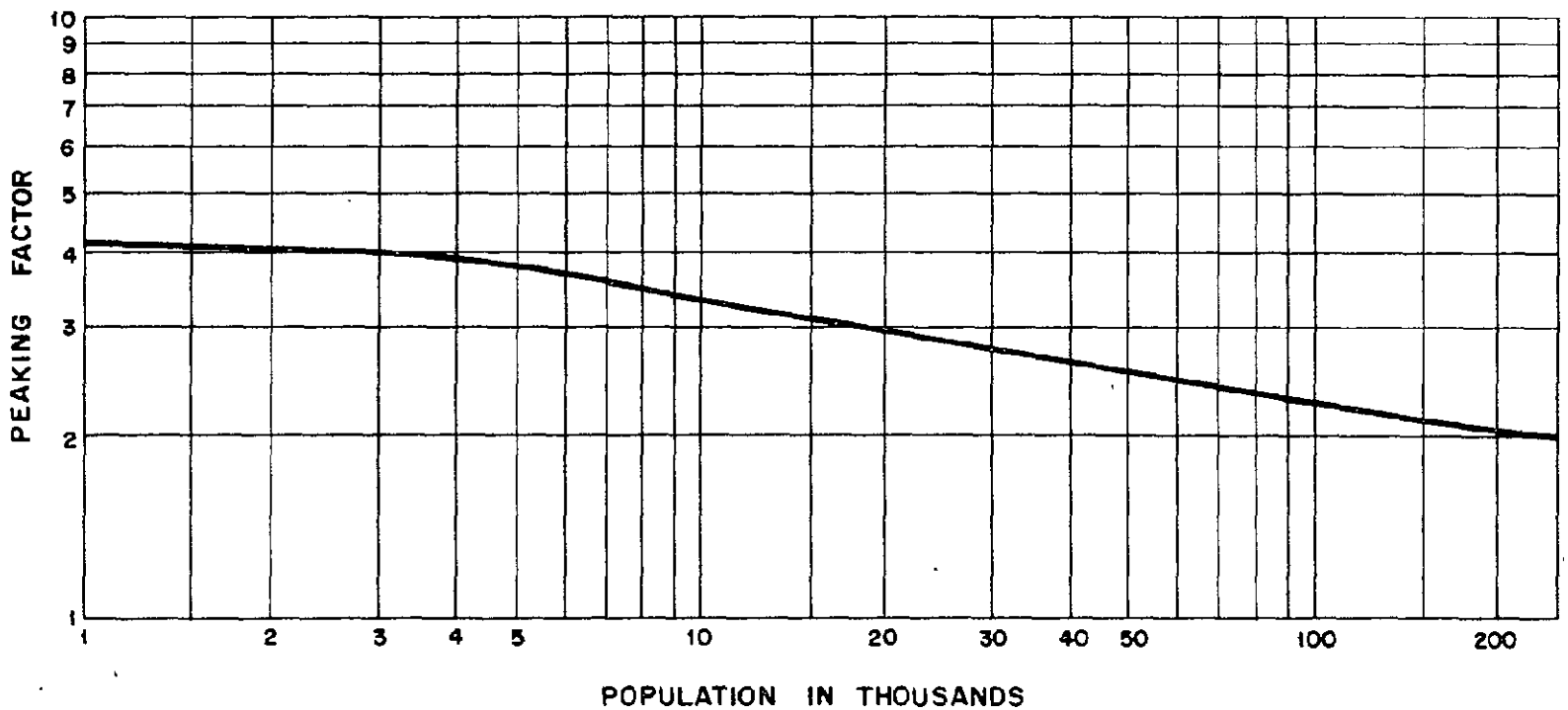
Sewage pumping stations will be required in Zarqa and Ruseifa. The following criteria are recommended for the design of these stations:

Station Type	:	Separate wetwell and drywell for stations with over 4000 m^3/day firm capacity; Submersible pumps for stations with firm capacities of 4000 m^3/day or less.
Pump Type	:	Centrifugal, nonclog type capable of passing 75 mm sphere.
Firm Pumping Capacity	:	Adequate to handle peak flow, without surcharging the influent sewer, with largest pump out of service.

Pump Protection	:	Manually cleaned bar screens
Auxiliary Power	:	Diesel electric generating set at major pumping stations.

6.2.7 Manholes and Other Appurtenant Structures

Manhole type	:	900 mm diameter precast, reinforced concrete manhole barrel sections set on poured-in-place concrete for sewers up to 300 mm in diameter; Poured-in-place reinforced concrete manholes for sewers over 300 mm in diameter.
Manhole Frames and Covers	:	Heavy duty, gray cast iron units for installation in streets, light duty, gray cast iron units in footpaths.
Manhole Steps	:	Cast iron steps for manholes over 1.2m deep; no steps for manholes less than 1.2 m deep.
Manhole Location	:	At all changes in grade or alignment; maximum spacing 120m.
Force Main Appurtenances	:	Manually operated air relief valves at all high points; blow-off valves at low points.



PEAKING FACTORS FOR DOMESTIC & COMMERCILAL SEWAGE FLOWS

Figure A6.1

GEOLOGICAL AND SOIL INVESTIGATION

FOR

ZARQA AND RUSEIFA AREA

JOUZY & PARTNERS

MAY 1980

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1.0 BACKGROUND, PURPOSE AND SCOPE

The purpose of this study is to determine the quality of foundations for major structures and character of material in pipe trenches. This information will be utilized in the preliminary cost estimates and preliminary design in the Zarqa - Ruseifa Feasibility Study.

The scope includes a review of the material presented in the December 1975 Report by Scan Plan Coordinator and Jouzy & Partners plus additional information based on field reconnaissance.

2.0 GEOLOGY

2.1 GENERAL

The Zarqa - Ruseifa Area is situated northeast of Amman and is one of the fastest growing regions in Jordan. The area is generally formed of the Zarqa river and topographically low extensions surrounded by relatively high hills on both sides of the river from the Al Musheirfeh region to Zarqa. Side wadis intermittently feed the base flow of the main river.

The terrain of this area is fairly accessible by ashphalt and dirt roads. In some parts, the topography becomes rugges and confusing due to the dominating rock formations and huge phosphate dumps which changed the morphology of the region to the southern and eastern side of Ruseifa. These dumps confused the natural drainage pattern and cause some surface water to stagnate in low points.

2.2 Structure

The Amman - Zarqa region forms the southeastern limb of the Baqa'-Mobis dome (Fig. S-1). The part of this region between Al Musheirfeh and Zarqa form the major part of the Amman - Zarqa syncline. This syncline begins from Wadi Marka through Wadi El-Qattar, Wadi El-Ishih to Wadi El-Hajar. The southern flank of this syncline is formed of the steep flank (50° dip) of the Amman - Zarqa flexure. Its northern flank forms the Wadi - El-Maghtala plunging anticline. Wadi Um Bayada anticline takes place in the northeastern side of the plunging side of the anticline.

This area suffers a northwestern southeastern striking set of normal faults. Most of these faults take place on the western part of the region. But a significant fault occurs right before Zarqa.

2.3 Stratigraphy

The soils and rocks exposed in the area are mainly patchy thin soil covers, terrace-like bodies on both sides of the major course of the Zarqa river, alluvial deposits (filling the river course), and phosphate dumps. These materials overlie the Belqa series (B_1, B_{2L}, B_{2u}, and B_3 formations) which cover the whole area (Fig. S-2).

The KCaa in Fig. S-6 (Masri 1962) was subdivided into B_{2L} and B_{2u} being the lower and upper Belqa two (B_2) (Abdullatif 1971).

Overlying the Belqa two (B_2) formation is the Belqa three (B_3) formation which does not show up in the region. Underlying the B_2 formation is the B_1 formation which does not show up on Masri's 1962 map where he considered it as the lowest part of the B_2.

Figures and description of the formations deminating the area are based on the following succession from bottom to to : A7, B_1, B_{2L}, B_{2u}. A description of each of these layers is contained in the Appendix.

3.0 DRAINAGE AND GROUNDWATER

The project area forms one drainage system as can be seen from the topographic maps. Most of the land is the barren, semi-arid type, and annual rainfall ranges between 150mm - 250mm. 10% to 15% of this rainfall runs off from the side wadis to the Zarqa River.

The base flow of Zarqa river in the project area is mainly formed of the effluent of the Amman Sewage Treatment Plant plus what is dumped in the river along the way to Zarqa. It is, therefore, expected to have saturated zones of wadi gravel and fill.

In the project area the static water level of the upper aquifer is more than one hundred meters deep. The artersian aquifer is more than 250 meters deep. Recharge areas of the previously mentioned aquifers are to the far western side project area.

4.0 SOILS

Wash and wind are the most important agents of transport in semi-arid regions. Fine sediments are precipitated in the form of soil terraces and wadi alluvial fill.

Semi-arid climates leave certain features in the landscape as broad surfaces, sharp forms and dendritic hydrographic network. Red soils are normally derived from the insoluble residues of the chemically eroded limestones. Chalks and chalky limestons form clayey yellow soils..

Steep slopes in the area increase the runoff. Therefore, the shallow soil profile cannot retain a considerable amount of water and, consequently, becomes very dry and hard in summer time.

Alluvial soils are normally young and develop on flood plains, on beds of wadis, on some terraces and along drainage ways, and perenial and intermittent streams. However they seldom cover lare areas. Recent poorly-cemented debris mixtures with a clay and lime matrix constitute most of the alluvial deposits. They contain silt, clay, sands and conglomerates. The alluvial deposits differ in composition and thickness from one location to the other. Geologic structures and in-situ rock types play a role in alluvium thicknesses determinations.

5.0 SITE INVESTIGATION

The purpose of the site investigation was to determine the soil nature and condition in the project area along the proposed routes of trunk lines, the collection sewers, and the sewage treatment plant site.

This study was directed towards collecting information on the nature of the soil which could be encountered in the execution of

the work. The study provides data related to the trench excavation, preliminary foundation design, and to groundwater presence. Data have been collected from the rock outcrops, wadi beds, and from numerous cuts of foundation in construction sites in the vicinity of the sewer routes. Visits were also made to the proposed treatment plant site. A visual inspection was made and information collected from the farmers.

In addition, ten boreholes were made during the 1975 study to obtain more specific information on the nature of subsurface conditions. The boreholes were located within the project area and the logs were prepared to a depth of 6 meters. Of the ten boreholes, 2 were located at the originally proposed teatment plant site, 5 at the originally proposed sewage pumping stations and 3 along the wadi where the main line will pass. The location of the boreholes and the logs are indicated contained in the Atlas on the stormwater plates. The borehole logs are Figures S-6/1 to S-6/10.

6.0 DESCRIPTION OF SOIL

The topography of the area, in general, is hilly. The Zarqa river divides the area and usually runs dry during the summer period.

In general, 70% - 80% of the area is covered either by the B_{2u} or the B_{2L} formations with soil cover not exceeding 10 meter thick. Deposits of gravel and alluvium soil lie on both sides of the Zarqa river.

Inspection of foundations excavations, rock outcrops, wadi beds and the logs of boreholes have revealed that soils such as sand, gravel with hard flint, and limestone are characteristics of the area.

In the hills of Ruseifa and Zarqa, a large area of the bed rock is exposed or covered by a thin layer of alluvium soil (less than 2 meter thick). The alluvium deposits increase in thickness in the main streams varying from 2 to 6 meters thick, then, bedrock is encountered. Shallow agricultural soils form part of the overburden soils on the sides of the main stream of the Zarqa river.

The proposed trunk lines are located mainly, on the sides of the main stream.

The boreholes drilled at the originally proposed treatment plant site revealed that the overburden consists of soft soil, gravel, and river sand with some chert boulders. Bed rock was encountered in borehole No.7 at a depth of 6 meters.

The information collected from visits to the proposed Treatment Plant site have revealed that the area is covered by fertile agricultural top soil 4-5 meter deep, overlaying river sand, gravel with some boulders to an approximate depth of 7-12 meters. The bed rock is expected to be at a depth of 7-12 meters. It was observed also that few water wells are operating in the area adjacent to the running wadi (about 8 in 3 km). The level of the water varies from year to another and with seasons. The existing water level observed in May in the well located at the proposed plant site was 10-12 meters. The wells are fed from the saturated zones of wadi gravel and fill and may get dry in the summer season.

7.0 GEOTECHNICAL EVALUATION

The area is predominantly covered with hard rock formations of the B_{2L} and B_{2u}. It is estimated that 70% -80% of the landscape is covered with these formations. However, most of proposed trunk lines are located mainly on the sides of the main stream which consist of thick alluvial deposits.

It is anticipated that, during construction, excavation in the rock areas should not require any protection arrangements against caving. However, final determinations will be made during construction. Mechanical excavation equipment such as compressors and jackhammers and pits excavations in trenching may be necessary.

It is anticipated that in the wadi terraces and alluvial fans or alluvial loose deposits in the main wadi course, protection from caving and from surface water seepage in the ditches may be necessary during construction especially in the wadi base flow.

With the anticipated ground conditions at the estimated foundations levels of the proposed sewage treatment plant, it is considered that excessive ground settlement is unlikely to occur especially if foundations are laid on the bed rock encountered which can bear 3 kg/cm^3.

However, protection from caving and from surface water seepage may be necessary during construction. Measures against tanks uplifting should be considered also.

APPENDIX

DESCRIPTION OF GEOLOGICAL FORMATIONS

		Page
1.	A_7 FORMATION	(A-S1)
2.	B_1 FORMATION	(A-S2)
3.	B_{2L} FORMATION	(A-S3)
4.	B_{2u} FORMATION	(A-S4)

Description of Geological Formations

A_7 Formation

This formation is about 80m - 110m thick. It forms the cliffy and morphologically distinctive outcrops of the investigated area of greater Amman. The upper part is the section that is of interest to this project. It is a 25m thick limestone, greyish, pinkish, highly fossilliferous (Figure S-3), cavernous, medium, hard and recrystallized rocks. The rocks of this unit fracture semi-conchoidally. The facies change to dolomite in some places. It was described by Grieger and Touqan (1963) as " Thin chert layers and chert sodules are intercalated in this rock unit". It weathers to form a steep greyish cliff and shows a honey comb like surface.

It forms an excellent aquifer, where it falls under the water table. In some cases, it forms a unified hydraulic system with the B_{2L}, where the B_1 thins out or has vertical conduits in few permeable zones (leaky aquiclude).

The upper 25-50 meters of this unit are extensively quarried.

B_1 Formation

This rock unit separates lithologically the Ajlun Group from the Belqa Group. It is a good marker rock unit, and ranges in thickness from 0-30m. It consists of early limestone, marl and chalks, light yellow to white in color, hard to soft. The marly limestone (12m) is overlying the upper contact of the A_7 Formation;it is overlain by a 7m of marls, followed upwards by a 6m thick chalk.

It ends at the base of the first thick continuous chert bed (Figure S-3), that forms the beginning of the B_{2L} Formation. A thick Oyster bed is overlying the chert bed.

This marly, chalky, soft formation constitutes a focus of problems anywhere it crops out. Any change in its natural condition can increase its porosity, and consequently its void ratio. Swell might occur due to water saturation in a high winter season. Thixotropy might take place, where the marl of a high montmorillinite content is found. Moreover, this phenomenon cause troubles (sudden slides) as traffic acoustic effects are prevailing.

B_{2L} Formation

This formation is abundant. It covers all the investigated area, especially the western and northwestern parts of the area. In some cases it might get covered by either a soil cover or crust. It consists of laternating thin, wavy, bedde cherts and silicified limestones.

Massive cherts and silicified limestone beds intercalations, limestone concretions are abdundant. Brecciated cherts are intercalated into silicified limestone, and limestone lenses or concretions are embedded in chert beds.

Chert beds vary from brown, deep brown grey, dark grey, red, grey to white in color. But, the intercalated limestones are light grey, whitish to rosy. The thickness of this formation ranges between 30m to 50m. (Figure S-4).

The upper part of this formation consists of thin layers of limestone sometimes silicified, phosphates, cherty phosphates, phophatic cherts and wavy intercalated thin lenses.

Careful investigation showed that traces of Tripoli are present withing this formation due to the severe weathering of the silicified limestone, that leaves the fine grained traces.

The presence of a highly fractured greyish, brownish chert bed indicates the beginning of the B_{2u}, a phosphatic limestone formation.

The contorted cherts of this unit, where folds are conspicuous, are the very characteristic of the B_{2L}. The concave sections of the indulations are thick, while they are thin at the convex ones.

B_{2u} Formation

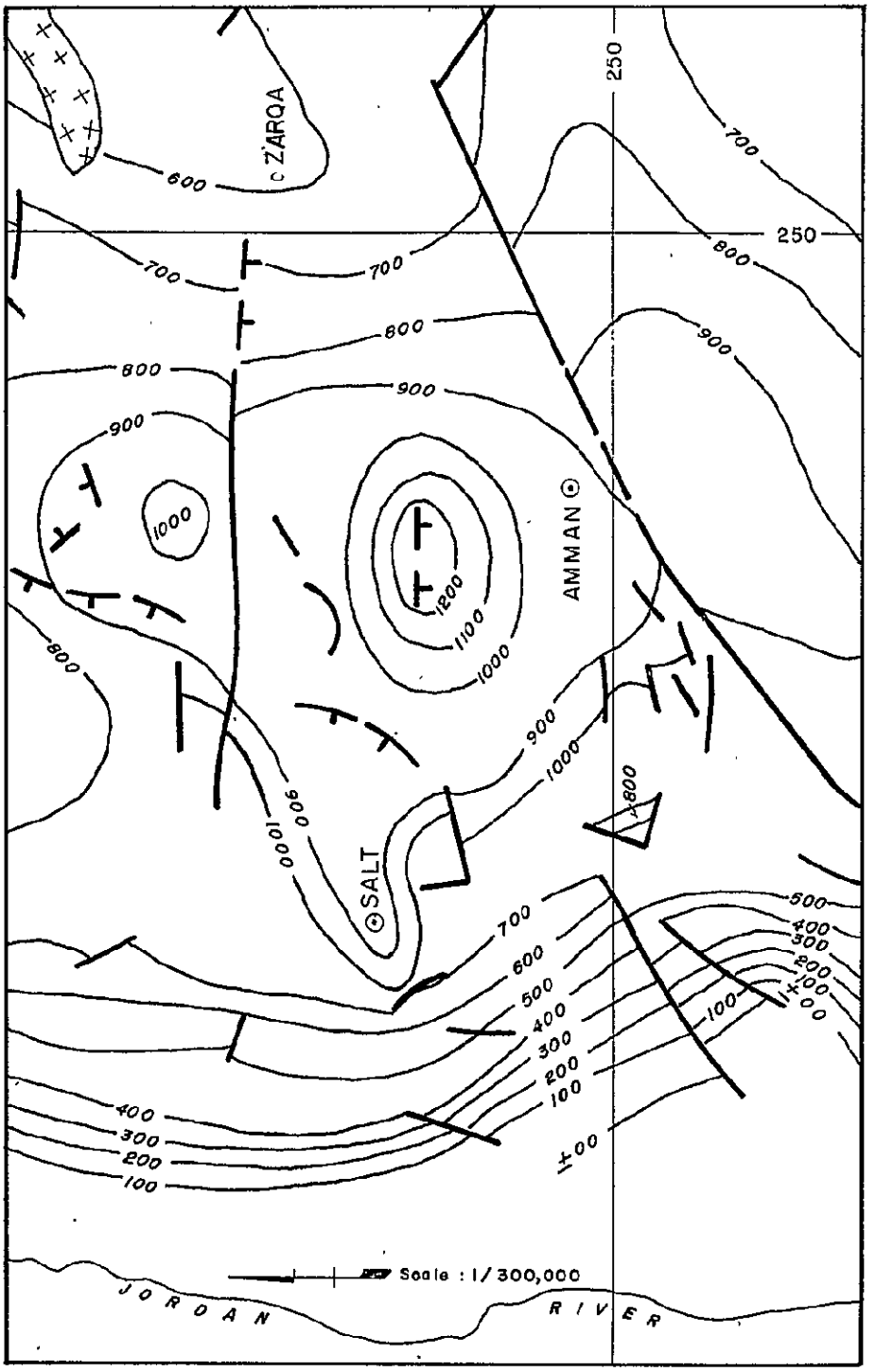
This formation begins where the uppermost dark brown brecciated chert bed of the B_{2L} shows up. It consists of alternating crystalline limestone, thin bedded, marly limestones and marls. Few chert and limestone layers are interbedded with several phosphorite beds (Figure S-5). These beds are rosy, grey, yellowish and whitish rosy. Small phophatic nodules are distributed all over the whole sequence.

In this region Grieger and Touqan (1963) described the limestone of this unit as "crystalline, hard, cherty and phosphatic Marls and marly limestones are existing between the phosphate beds". It is 25m to 30m thick as shown in (Figure S-5).

Most of the B_{2u} outcrops are covered with the overburden of soils, talus and debris.

FIGURES

NO.	TITLE
S-1	STRUCTURAL MAP OF TOP TUROAIAN A_7 CONTOUR LINES.
S-2	THE DOMINATING ROCK UNITS IN THE INVESTIGATED AREA (INNER SQUARE). FITTEL IN THE REGIONAL STRATIGRAPHY OF NORTH JORDAN
S-3	COLUMNER SECTION AT THE FULL THICKNESS OF THE B1 (MOSTLY MARIS) AT IRJAN QUARRY REGION
S-4	COLUMNER SECTION OF THE FULL THICKNESS OF $B2_1$ (MOSTLY CHERTS) AT AIN GAZAL REGION
S-5	COLUMNER SECTION OF THE THICKNESS OF THE B2u (MOSTLY PHOSPHATE) CAST OF AMMAN.
S-6/1 to S-6/10	LOGS OF BOREHOLES DRILLED FOR 1975 SCAN PLAN COORDINATOR/ JOUZY & PARTNERS REPORT



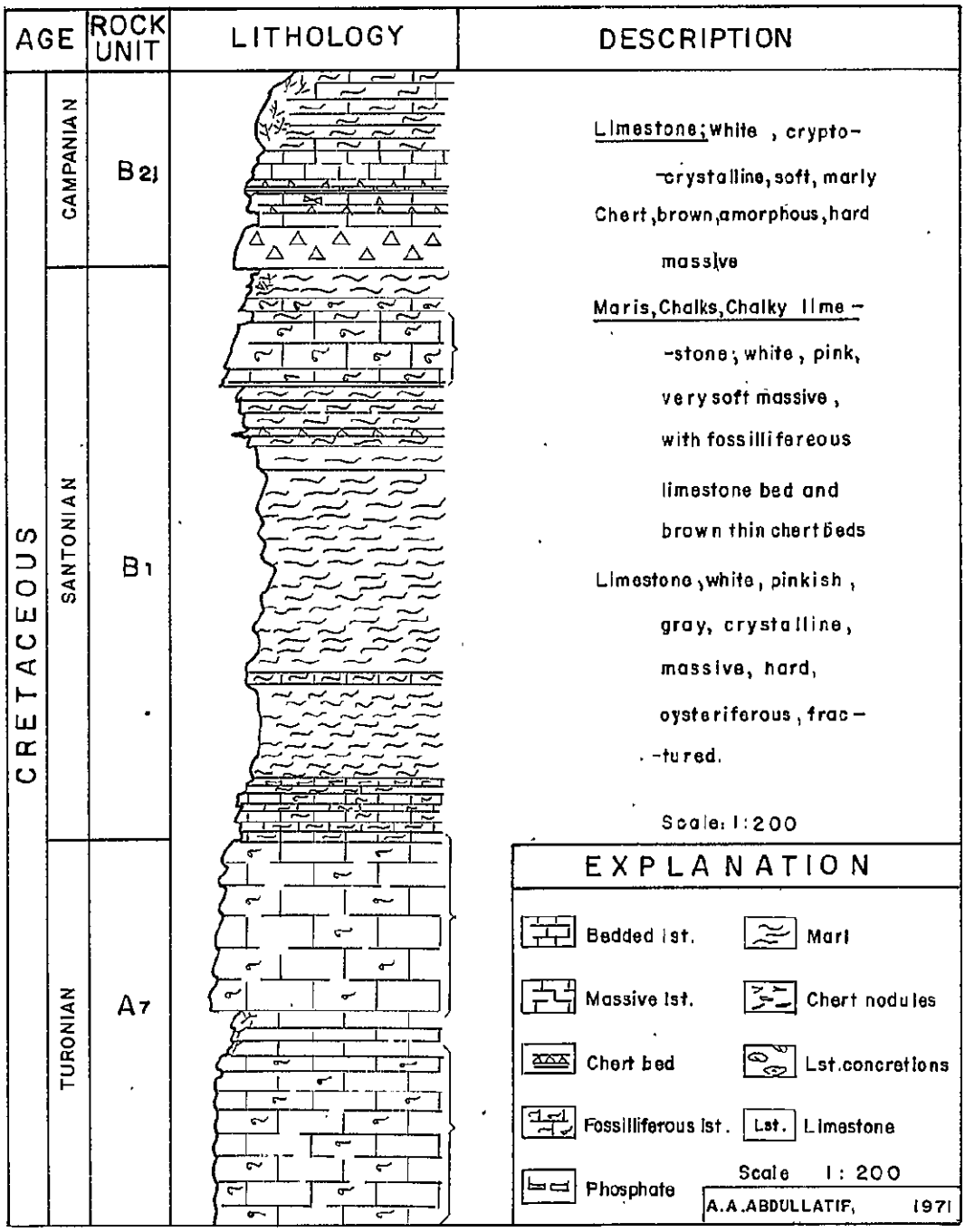
NOTE: MODIFIED BY F. BENDER 1967

STRUCTURAL MAP OF TOP TURONIAN A7	FIGURE : S-1

AGE			VARIOUS NOMENCLATURE								
ERA	SYSTEM	EPOCH	QUENNEL 1951		MASRI (1961)		RUF OR RALTI		MACDONALD		GERMAN GEDOGIRAL MISSION 1963-1965
			SERIES	FORMATION	SERIES	FORMATION	SERIES	FORMATION	SERIES	FORMATION	STRATIGRAPHIC UNITS
CENOZOIC	QUATERNARY	HOLOCENE	RECENT				RECENT	NORI GRAVEL	RECENT		MOTOCENE
		PLEISTOCENE	LISAN SERIES				LISAN	LISAN	PLATACU	GRAVEL	LISAN AND GHOR OF KAFAR SERIES
	TERTIARY	PLIOCENE	NEOGENE					BEIDA	JORDAN SERIES	JV3	SHAGUR FORMATION
		MIOCENE								JVI-2	SYNTECTONIC CONGLOMERATES
		OLLGOCENE	EMERGENCE AND PLANATIOB								
		EOCENE	BELQA SERIES		BELQA		BELQA	REEF L.S.	BELQA	B5	CHALKY LIMESTONE UNIT
		POLEOCENE						BEDDED L.S.			CHERT - L.S. UNIT
MESOZOIC	CRETACEOUS	DANIAN				RIJAM		L.S. & CHALK		B4	
		MAESTRICHTIAN				MUWAQQAR		CHALK & L.S.		B3	CHALK - MARL UNIT
		CAMPANIAN				AMMAN		UNDEFFERENTIATED		B2 (u,L)	PHOSPHORITS UNIT AND SILICIFIED UNIT
		SANTONIAN				RUSEIFA		CHERT		B1	
		TURONIAN	AJLUN SERIES	MARINE TERONIAN	AJLUN	WADI ES SIR	AJLUN	CHALK	AJLUN	A7	MASSIVE L.S. UNIT
		CENOMANIAN		MARINE CENOMARIAN		SHUEIB		JERUSALEM		A5-6	ECHINOID L.S. UNIT
						HUMMER		BETH LEHEM		A4	
						FUHEIS		HEBRON		A3	NODULAR L.S. UNIT
						NAUR		YATTA		A1-2	
		ALBIAN APTIAN NEOCOMIAN	KURNUP SD. ST.	KURNUB	KURNUB	BAQA	KURNUB	UPPER BEIT KAHIL	KURNUB	K2	VARICOLORED SD. ST. UNIT
								LOWER BEIT KAHIL			MASSIVE WHITE SD. ST. UNIT
	JURASSIC	PORTEDIAN OXFORDIAN						RAMAN		K1	
		CATLOVIAN BATHONIAN BAJOCIAN LIAS	UM. SAHM SD. ST. ZARQA GROUP	MARINE M. JURASSIC	ZARQA	ZARQA	ZARQA	UPPER MALIT LOWER MALIT	ZARQA	Z2	LIMESTONE AND DOLOMITE UNIT
											SPOTTED SANDSTONE AND DOLOMITIC SANDSTONE UNIT
	TRIASSIC	RHAETIAN NORIAN KARNIAN LADINIAN ANISIAN SKYTHIAN		MARINE M. JURASSIC						Z1	GYPSIFEROUS SEQUENCE
											WADI EL HANA SD. ST.
											SANDSTONE or MARL SEQUENCE

THE DOMINATING ROCK UNITS IN THE INVESTIGATED AREA (INNER SQUARE) FITTED IN THE REGIONAL STRATIGRAPHY OF NORTH JORDAN, (ABDULLATIF A.A.1975)

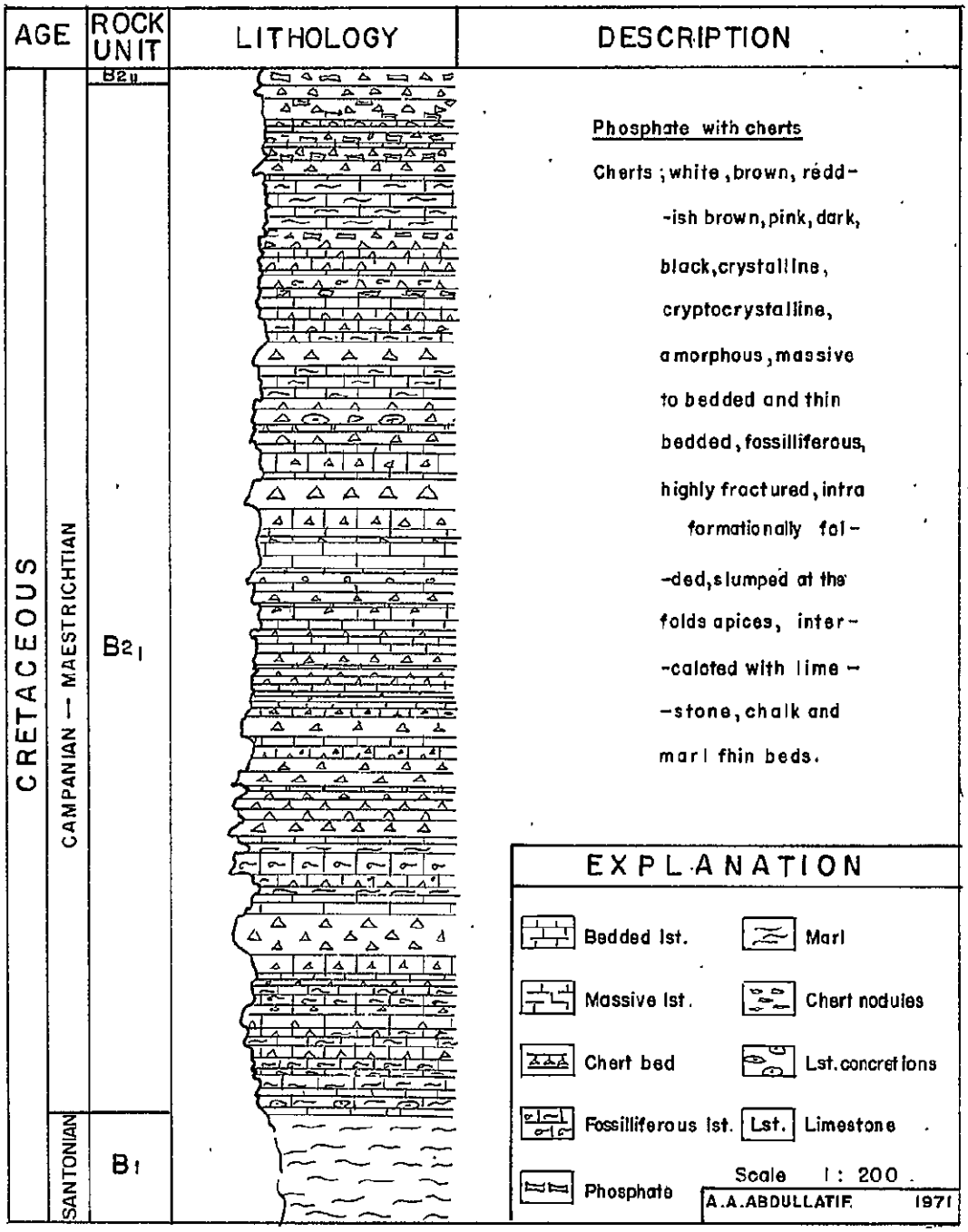
FIGURE:S-2



LOCATION: E. 237.000 / N. 154.300

COLUMNER SECTION AT THE FULL THICKNESS OF THE B1 IRJAN QUARRY REGION

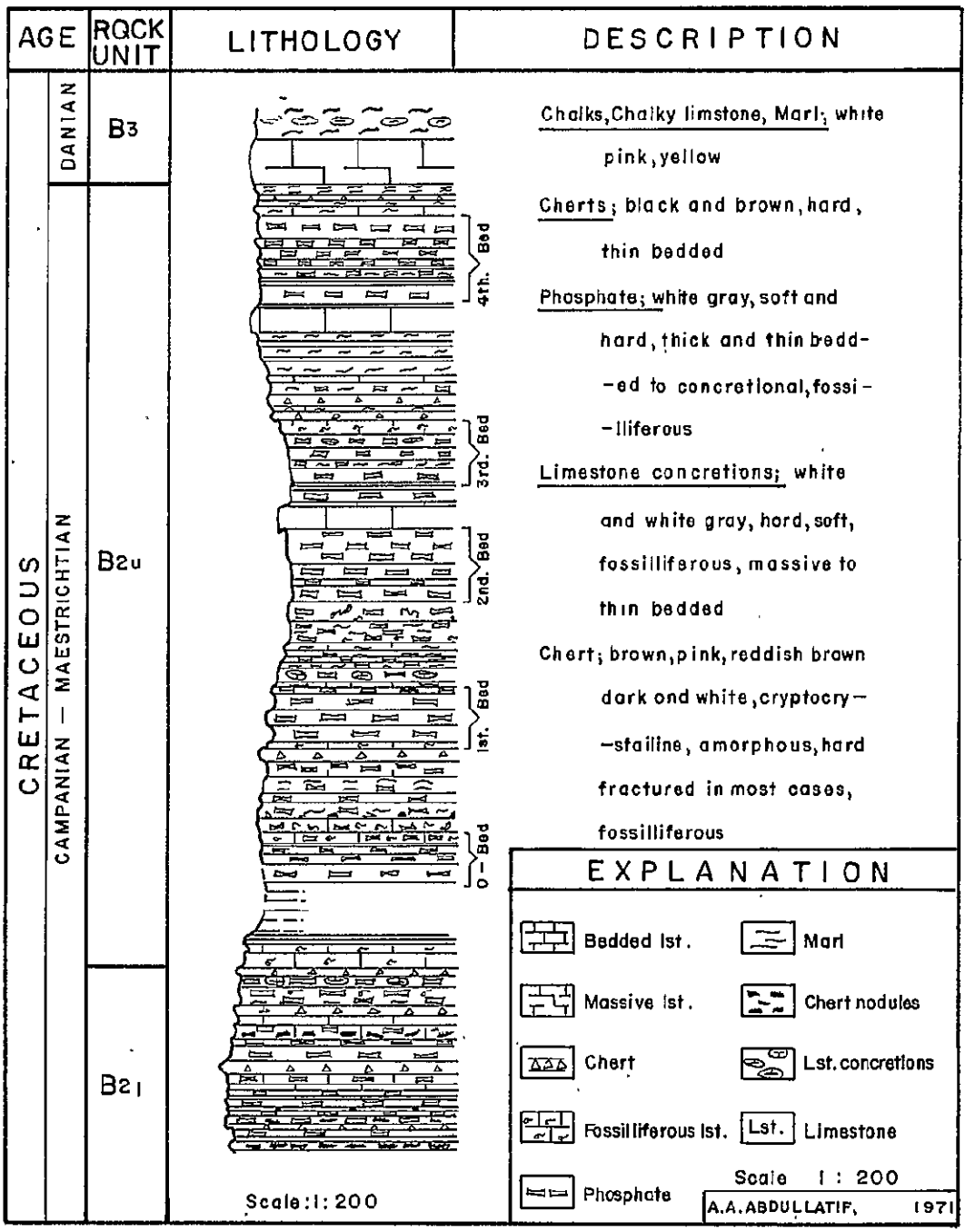
FIGURE : S-3



LOCATION : E. 242.000 / N. 154.550

COLUMNER SECTION OF THE FULL THICKNESS OF $B2_I$
AIN GAZAL REGION

FIGURE : S-4



LOCATION: E. 247.620 / N. 158.700

NOTE: THIS OVERLINES THE $B2_1$ AND UNDERLINES THE B3

COLUMNER SECTION OF THE THICKNESS OF THE B2u EAST OF AMMAN

FIGURE: S-5

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SURFACE SOIL	
1.00			
2.00		SAND & GRAVEL	
3.00			
4.00		CHERT, BOULDERS & SAND	
5.00		SAND & SOIL	
6.00		CHALKY LIMESTONE	
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

NORTH OF ARMY CAMP

(RAILWAY TRACK)

LOG OF BOREHOLE No. 1	FIGURE S - 6 / 1

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SOFT SOIL	
1.00		SOIL & GRAVEL	
2.00		SOIL & FINESAND	
		SOIL & GRAVEL	
3.00		SOFT LIME & CHERT LAYERS	
4.00			
5.00		SOFT LIME (PINK)	
		SOFT LIMESTONE	
6.00			
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

REFINERY ROAD

LOG OF BOREHOLE No. 2

FIGURE S-6/2

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SOFT SOIL	
1.00			
2.00		OVERBURDEN, CHERT & RIVER SAND	
3.00			
4.00			
5.00		RIVER SAND	
6.00			
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

LOG OF BOREHOLE No. 3

FIGURE S-6/3

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SOFT SOIL	
1.00			
2.00		MARLY LIMESTONE	
3.00		LIME (PINK)	
4.00		LIMESTONE	
5.00		CHERT LAYERS & CLAY, (INTERBEDDED)	
6.00			
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

LOG OF BOREHOLE No. 4

FIGURE S-6/4

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SOFT SOIL	
1.00		GRAVEL	
2.00		SOIL & CHERT BOULDERS	
3.00			
4.00		SOIL & RIVER SAND	
5.00			
6.00		SOIL & RIVER SAND	
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

LOG OF BOREHOLE No. 5

FIGURE S-6/5

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00			
1.00			
2.00		SURFACE SOIL	
3.00			
4.00			
		THIN LAYER OF ROCK	
5.00			
		SILT & CHERT	
6.00			
		BEDROCK	
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA : 1975 SITE INVESTIGATION

LOG OF BOREHOLE No. 7	FIGURE S-6/6

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00			
1.00		SURFACE OVERBURDEN	
2.00			
3.00			
4.00		WET SOIL	
5.00		GROUND WATER LEVEL	
6.00			
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

WADI

LOG OF BOREHOLE No. 8

FIGURE S-6/7

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SURFACE OVERBURDEN	
1.00		FLINT BOULDERS & OVERBURDEN	
2.00			
3.00			
4.00			
5.00			
6.00			
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

WADI

LOG OF BOREHOLE No. 9

FIGURE S-6/8

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SOIL OVERBURDEN	
1.00			
2.00		CHERT & RIVER SAND	
3.00			
4.00		LAYER OF LIMESTONE	
5.00		RIVER SOIL	
6.00			
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

WADI

LOG OF BOREHOLE No. 10

FIGURE S-6/9

DEPTH (m.)	SYMBOL	DESCRIPTION	REMARKS
0.00		SURFACE SOIL	
1.00			
2.00			
3.00		CHERT & RIVER SAND	
4.00			
5.00		MARLY LIMESTONE & THIN LAYERS OF CHERT.	
6.00			
7.00			
8.00			
9.00			
10.00			
11.00			
12.00			

SOURCE OF DATA: 1975 SITE INVESTIGATION

NEAR ELECTRICITY COMPANY

LOG OF BOREHOLE No. 11

FIGURE S-6/10

CHAPTER 7.0

SEWAGE TREATMENT SYSTEM

TABLE 7.1

COST COMPARISON BETWEEN SINGLE TREATMENT PLANT AND DUAL TREATMENT PLANTS[1]
(Costs in 1,000 JD)

	Alternative 1	Alternative 2		
		Dual Plants		
	Single Plant at Lower Zarqa or Wadi Saida	Plant At Lower Zarqa	Plant at East Wadi	Combined Cost
Capital Costs				
Equipment	4,076	2,871	1,668	4,539
Civil Works	2,945	2,277	1,323	3,600
Subtotal	7,021	5,148	2,991	8,139
44% Contingencies,[2] Admin. Engin., etc.	3,089	2,265	1,316	3,581
Subtotal	10,110	7,413	4,307	11,720
Land Acquisition	624	450	238	688
Subtotal	10,734	7,863	4,545	12,408
Less Salvage Value	938	715	408	1,123
Net Capital	9,796	7,148	4,137	11,285
Annual O&M Costs				
Labor	75	58	35	93
Power	14	11	7	18
Chemical	64	42	24	66
Maintenance & Supplies	40	28	18	46
Hauling	26	16	10	26
Admin. & Overhead	8	6	3	9
Total O&M	227	161	97	258
Present Worth Cost Com.				
Net Capital	9,796	7,148	4,137	11,285
Present Worth of O&M	1,932	1,370	825	2,196
Total Present Worth of Project	11,728	8,518	4,962	13,481

Notes:

1. The above analysis is based on the cost-effectiveness analysis presented in Table 7.4. 1980 prices are used.

2. See Chapter 9.

TABLE 7.2

COST-EFFECTIVENESS ANALYSIS ON DEWATERING ALTERNATIVES[1]
(Costs in JD)

	Drying Beds	Vacuum Filtration[2]
Capital Costs		
Equipment	105,500	910,800
Civil Works	528,300	160,000
Subtotal	633,800	1,070,800
44% Contingencies, Admin.[3] Engin., etc.	278,900	471,200
Subtotal	912,700	1,542,000
Land Acquisition	252,000	8,600
Subtotal	1,164,700	1,550,600
Less Salvage Value	212,000	43,100
Net Capital	952,700	1,507,500
Annual O&M Costs		
Labor	9,500	7,700
Power	157	2,406
Chemical	0	40,900
Maintenance & Supplies	10,500	13,500
Hauling	26,200	52,300
Total O&M	46,357	116,806
Present Worth Cost Comparison		
Net Capital Cost	952,700	1,507,500
Present Worth of O&M	394,500	994,000
Total Present Worth	1,347,200	2,501,500

Notes:

1. Analysis based on year 2000 plant loadings and 1980 Prices.

2. Selected as the least-cost mechanical dewatering device.

3. See Chapter 9.

TABLE 7.3

ESTIMATED PROJECT COST FOR
SINGLE PLANT AT UPPER ZARQA SITE[1]
(w/activated sludge & mechanical dewatering)

(Costs in 1,000 JD)

Capital Costs	
Equipment	4,645
Civil Works	2,720
Subtotal	7,365
44% Contingencies, Admin.,[2] Engin., etc.	3,241
Subtotal	10,606
Land Acquisition	312
Subtotal	10,918
Less Salvage Value	784
Net Capital	10,134
Annual O&M Costs	
Labor	88
Power	39
Chemical	105
Maintenance & Supplies	65
Hauling	52
Admin. & Overhead	8
Total O&M	357
Present Worth of Project	
Net Capital Cost	10,134
Present Worth of O&M	3,038
Total Present Worth	13,172

Notes:

1. Analysis based on year 2000 plant loadings and 1980 Prices.

2. See Chapter 9.

TABLE 7.4

COST-EFFECTIVENESS ANALYSIS ON TREATMENT ALTERNATIVES[1]
(Costs in 1,000 JD)

	Alternative 1 Activated Sludge (Diffused Air System)[2]	Alternative 2 Stone Trickling Filters[2]	Alternative 3 Plastic Trickling Filters[2]	Alternative 4 Plastic Trickling Filters with Aerobic Digestion[3]
Capital Costs				
Equipment	3,903	4,305	4,076	3,792
Civil Works	3,232	4,222	2,945	2,226
Subtotal	7,135	8,527	7,021	6,018
44% Contingencies, Admin.,[4] Engin., etc.	3,139	3,752	3,089	2,648
Subtotal	10,274	12,279	10,110	8,666
Land Acquisition	633	936	624	624
Subtotal	10,907	13,215	10,734	9,290
Less Salvage Value	1,014	1,358	938	750
Total Capital	9,893	11,857	9,796	8,540
Annual O&M Costs				
Labor	82	75	75	75
Power	36	16	14	343
Chemical	70	64	64	64
Maintenance & Supplies	50	40	40	40
Hauling	28	26	26	26
Administration & Overhead	8	8	8	8
Total O&M	274	229	227	556
Present Worth Cost Comparison				
Net Capital Cost	9,893	11,857	9,796	8,540
Present Worth of O&M	2,332	1,949	1,932	4,732
Total Present Worth of Project	12,225	13,806	11,728	13,272

Notes:
1. Analysis based on year 2000 plant loadings and 1980 Prices.
2. With anaerobic digestion and gas utilization for power generation.
3. No on-site power generation - off-site electric energy source.
4. See Chapter 9.

TABLE 7.5

ESTIMATED CONSTRUCTION COSTS[1]
(Costs in 1,000 JD)

Item	Alternative 1 Activated Sludge		Alternative 2 Trickling Filters (Stone Media)		Alternative 3 Trickling Filters (Plastic Media)		Alternative 4 Trickling Filters (Plastic Media & Aerobic Digestion)	
	U.S. Share	Local Share	U.S. Share	Local Share	U.S. Share	Local Share	U.S. Share	Local Share
1. Pretreatment Facilities								
Equipment	395	105	395	105	395	105	395	105
Civil Work	-	73	-	73	-	73	-	73
Subtotal	395	178	395	178	395	178	395	178
2. Primary Clarifiers								
Equipment	420	86	420	86	420	86	420	86
Civil Work	-	157	-	157	-	157	-	157
Subtotal	420	243	420	243	420	243	420	243
3. Bio-oxidation Facilities								
Equipment	292	74	499	268	815	105	815	105
Civil Work	-	306	-	1,041	-	238	-	238
Subtotal	292	380	499	1,309	815	343	815	343
4. Final Clarifiers								
Equipment	569	122	754	155	502	103	502	103
Civil Work	-	210	-	307	-	210	-	210
Subtotal	569	332	754	462	502	313	502	313
5. Chlorination & Post-Aeration Facilities								
Equipment	92	12	39	9	39	9	39	9
Civil Work	-	123	-	75	-	75	-	75
Subtotal	92	135	39	84	39	84	39	84

TABLE 7.5 (Cont'd)

ESTIMATED/CONSTRUCTION COSTS[1]
(Costs in 1,000 JD)

Item	Alternative 1 Activated Sludge		Alternative 2 Trickling Filters (Stone Media)		Alternative 3 Trickling Filters (Plastic Media)		Alternative 4 Trickling Filters (Plastic Media & Aerobic Digestion)	
	U.S. Share	Local Share	U.S. Share	Local Share	U.S. Share	Local Share	U.S. Share	Local Share
6. Recycle/Returned Sludge Pumping Station								
Equipment	93	31	369	99	308	82	308	82
Civil Work	-	37	-	50	-	42	-	42
Subtotal	93	68	369	149	308	124	308	124
7. Primary and Wasted Sludge Pumping Station								
Equipment	59	20	54	18	54	18	54	18
Civil Work	-	24	-	22	-	22	-	22
Subtotal	59	44	54	40	54	40	54	40
8. Flotation Thickeners								
Equipment	314	46	-	-	-	-	-	-
Civil Work	15	126	-	-	-	-	-	-
Subtotal	329	172	0	0	0	0	0	0
9. Primary & Secondary Digesters								
Equipment	446	122	446	122	446	122	136	27
Civil Work	-	949	-	949	-	949	-	150
Subtotal	446	1,071	446	1,071	446	1,071	136	177
10. Drying Beds								
Equipment	88	13	88	13	88	13	88	13
Civil Work	68	439	68	439	68	439	68	439
Subtotal	156	452	156	452	156	452	156	452

TABLE 7.5 (Cont'd)

ESTIMATED CONSTRUCTION COSTS[1]
(Costs in 1,000 JD)

Item	Alternative 1 Activated Sludge		Alternative 2 Trickling Filters (Stone Media)		Alternative 3 Trickling Filters (Plastic Media)		Alternative 4 Trickling Filters (Plastic Media & Aerobic Digestion)	
	U.S. Share	Local Share	U.S. Share	Local Share	U.S. Share	Local Share	U.S. Share	Local Share
11. Effluent & Plant Water Pump Station								
Equipment	138	37	138	37	138	37	138	37
Civil Work	-	42	-	42	-	42	-	42
Subtotal	138	79	138	79	138	79	138	79
12. Administration/Laboratory/ Maintenance Building	31	60	31	60	31	60	31	60
13. Site Work	-	181	-	518	-	181	-	181
14. Yard Piping	118	132	138	173	124	155	124	155
15. Electrical/Instrumentation/HVAC	362	108	224	46	224	46	319	151
Subtotal (in 1,000 J.D.)	3,500	3,635	3,663	4,864	3,652	3,369	3,437	2,581
U.S. Share (in U.S. $1,000)	11,375	-	11,905	-	11,869	-	11,170	-
Total Construction Cost (in 1,000 J.D.)	7,135		8,527		7,021		6,018	

Notes: 1. Analysis based on year 2000 plant loadings and 1980 prices.
2. Alternative 4 includes cost of aerobic digesters in lieu of primary and secondary anaerobic digesters included under other alternatives.

TABLE 7.6

UNIT DESIGN CRITERIA
SELECTED ALTERNATIVE

(Average Flow = 41,242 m^3/day)

	Unit	Criteria
Screens		
Type	-	Mechanically cleaned coarse and fine
No. of Screens - coarse	-	3
- fine	-	3
Bars - coarse	cm	1.27 x 8.89 @ 7.62 clear openings
- fine	cm	1.59 x 5.08 @ 2.54 clear openings
Gross width of screens	m	5.5
Net area of screens	m^2	5.0
Aerated Grit Chambers		
No. of chambers	-	3
Size of each chamber	m	15.2 x 3.1 x 2.0 swd
Detention time at Q avg.	min	9.4
Detention time at Q peak	min	3.5
Cleaning method	-	Mechanical bucket & chain
Primary Clarifiers		
No. of tanks	-	5
Size of each tank	m	18.3 dia. x 3.1 swd
Total surface area	m^2	6,565
Overflow rate at Q avg.	lpd/m^2	31,372
Overflow rate at Q peak	lpd/m^2	62,744
Detention time at Q avg.	hrs	2.3
Suspended solids removed at Q avg.	%	65
BOD_5 removed at Q avg.	%	40
Trickling Filters		
Type of filter media	-	Plastic
No. of filters	-	5
Size of each filter	m	22.9 dia. x 7.3 media depth
Total area filters	m^2	2,060
Total volume filters	m^3	15,038
Recirculation ratio	-	3:1
Organic loading	Kg BOD_5/m^3/day	1.9
Hydraulic loading	lpm/m^2	55.8
Removal efficiency at 15 C	%	83

TABLE 7.6 (Cont'd)

UNIT DESIGN CRITERIA
SELECTED ALTERNATIVE

(Average Flow = 41,242 m^3/day)

	Unit	Criteria
Final Clarifiers		
No. of tanks	-	5
Size of each tank	m	21.3 dia. x 3.7 swd
Overflow rate at Q avg.	lpd/m^2	23,020
Overflow rate at Q peak	lpd/m^2	46,039
Disinfection/Post-Aeration Tanks		
No. of tanks	-	2
Size of each tank	m	17.7 x 9.1 x 3.7 swd
Detention time at Q avg.	min	40
Detention time at Q peak	min	20
Primary Digesters		
Type	-	High rate anaerobic digestion
No. of tanks	-	4
Size of each tank	m	29.0 dia. x 6.10 swd
Volume of tanks	m^3	16,117
Detention time at Q avg.	Days	20
Organic loading	Kg VSS/m^3/day	2.4
Temperature	C	35
Volatile suspended solids destroyed	%	50
Type of mixing	-	External pump
Secondary Digesters		
No. of tanks	-	5
Size of each tank	m	29.0 dia. x 6.1 swd
Volume of tanks	m^3	20,145
Detention time at Q avg.	Days	30
Drying Beds		
No. of beds	-	20
Size of bed	m	121.9 x 15.2 x .025 sludge depth
Volume of beds	m^3	941
Detention time at Q avg.	Days	21

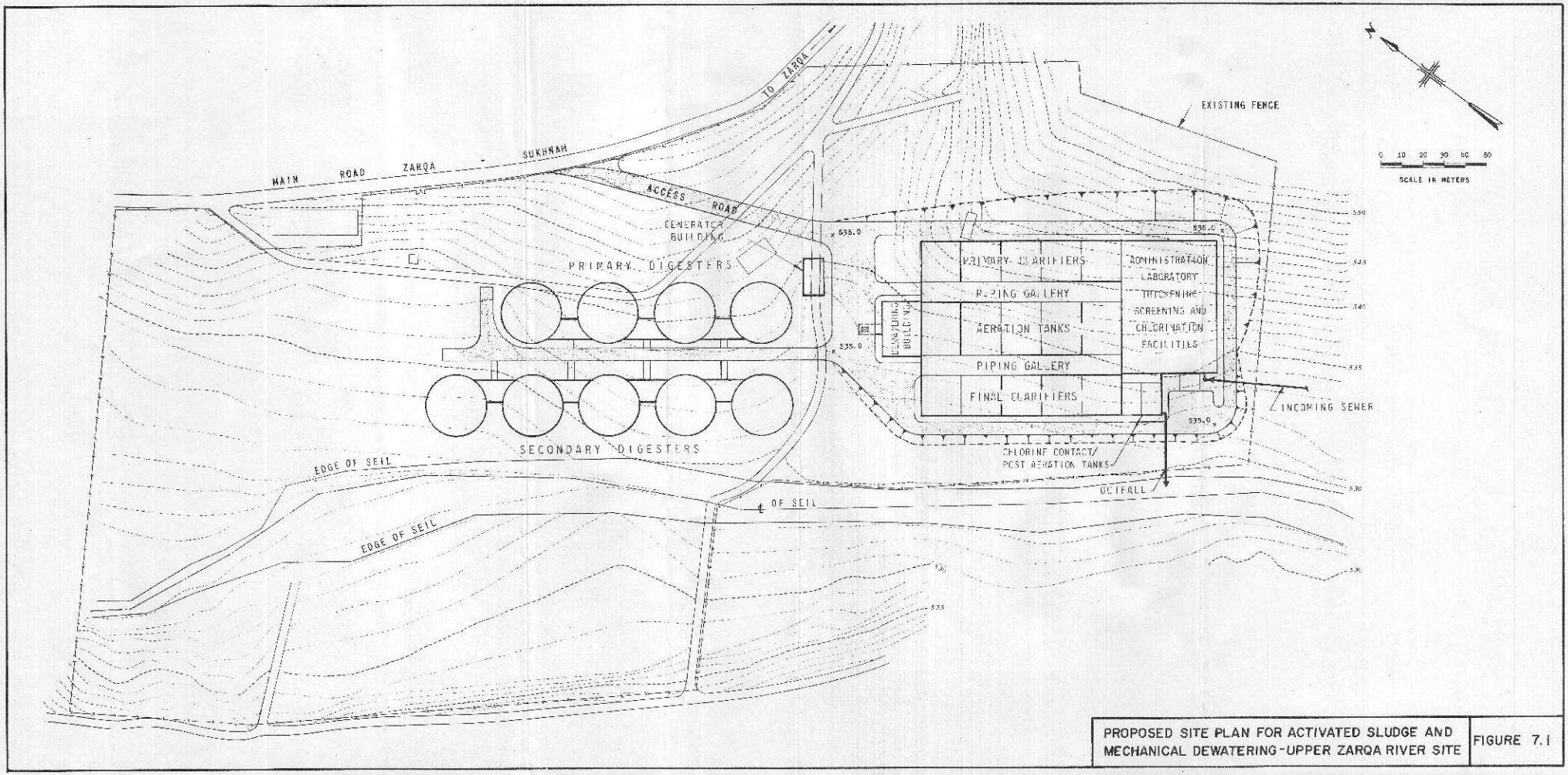
TABLE 7.7

PROJECT COST AND ANNUAL O&M COSTS FOR STAGED CONSTRUCTION OF TREATMENT PLANT AT LOWER ZARQA SITE[1]

(Costs in 1,000 JD)

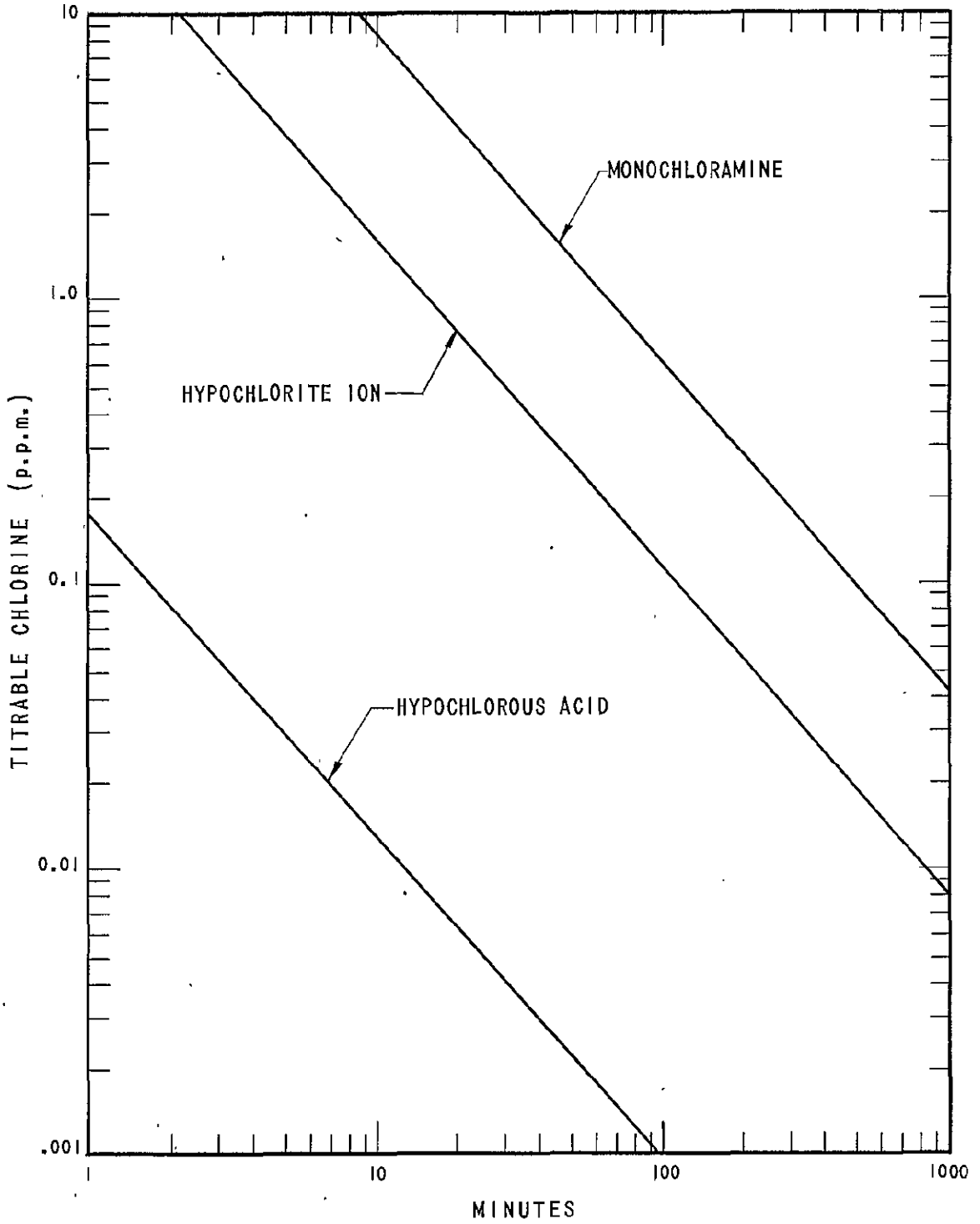
	Year 1990	Year 2000
Capital Costs		
Equipment	2,844	1,232
Civil Work	2,054	891
Subtotal	4,898	2,123
44% Contingencies, Admin.,[2] Engin., etc.	2,155	934
Subtotal	7,053	3,057
Land Acquistion[3]	624	0
Total Capital	7,677	3,057
Annual O&M Costs[4]		
Labor	48	75
Power	9	14
Chemical	38	64
Materials & Supplies	24	40
Hauling	15	26
Administration & Overhead	8	8
Total O&M	142	227

Notes:
1. Analyses based on respective year 1990 and 2000 loadings and 1980 prices.
2. See Chapter 9.
3. Land for full developed purchased initially.
4. No escalation for inflation has been included (1980 prices used).



PROPOSED SITE PLAN FOR ACTIVATED SLUDGE AND MECHANICAL DEWATERING-UPPER ZARQA RIVER SITE

FIGURE 7.1

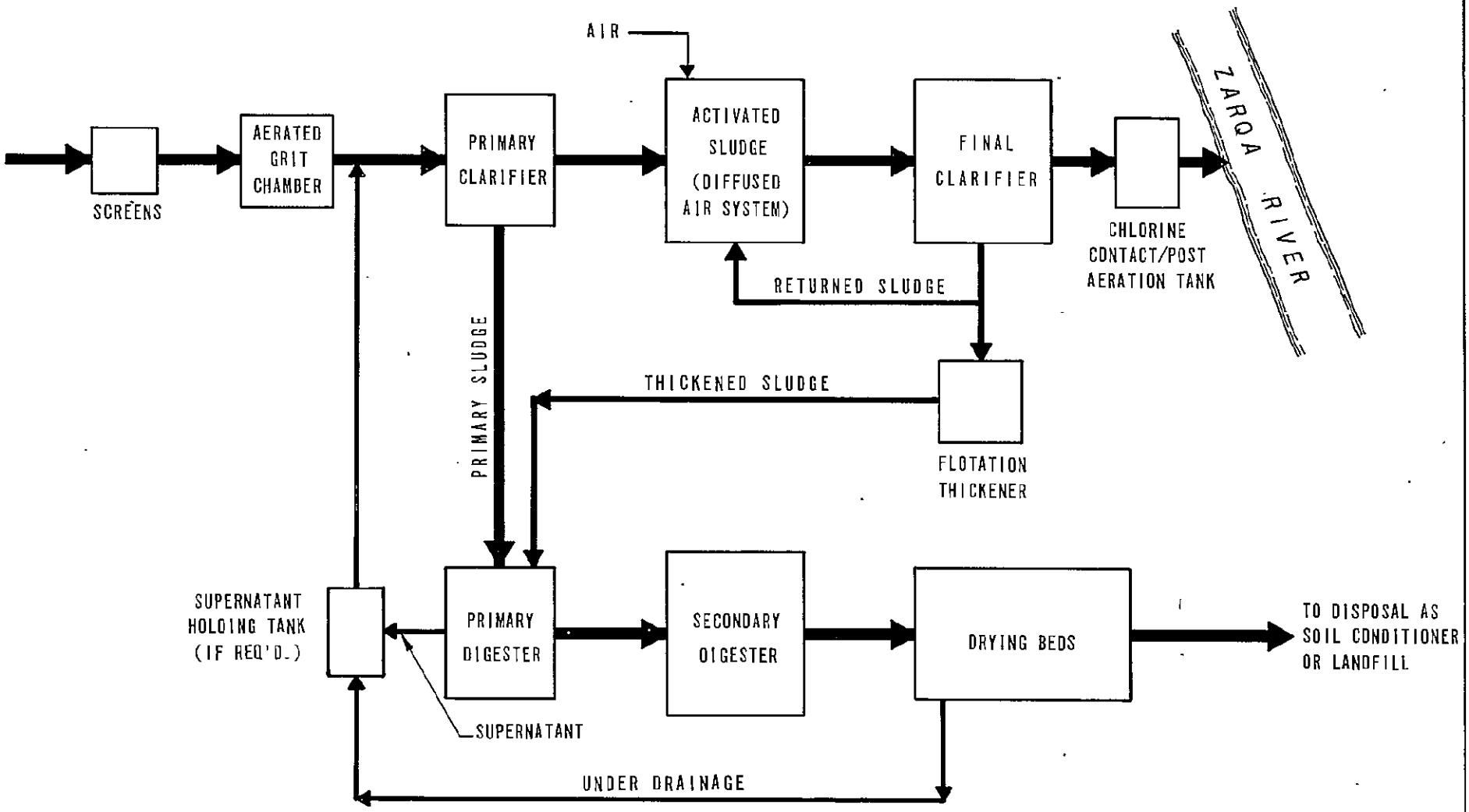


99 percent destruction of E. coli at 2-6°C.

COMPARISON OF GERMICIDAL EFFICIENCY OF HYPOCHLOROUS ACID, HYPOCHLORITE ION, AND MONOCHLORAMINE

(ADOPTED FROM HANDBOOK OF CHLORINATION, 1972 BY GEO. CLIFFORD WHITE)

FIGURE 7.2



FLOW DIAGRAM - ACTIVATED SLUDGE

FIGURE 7.3

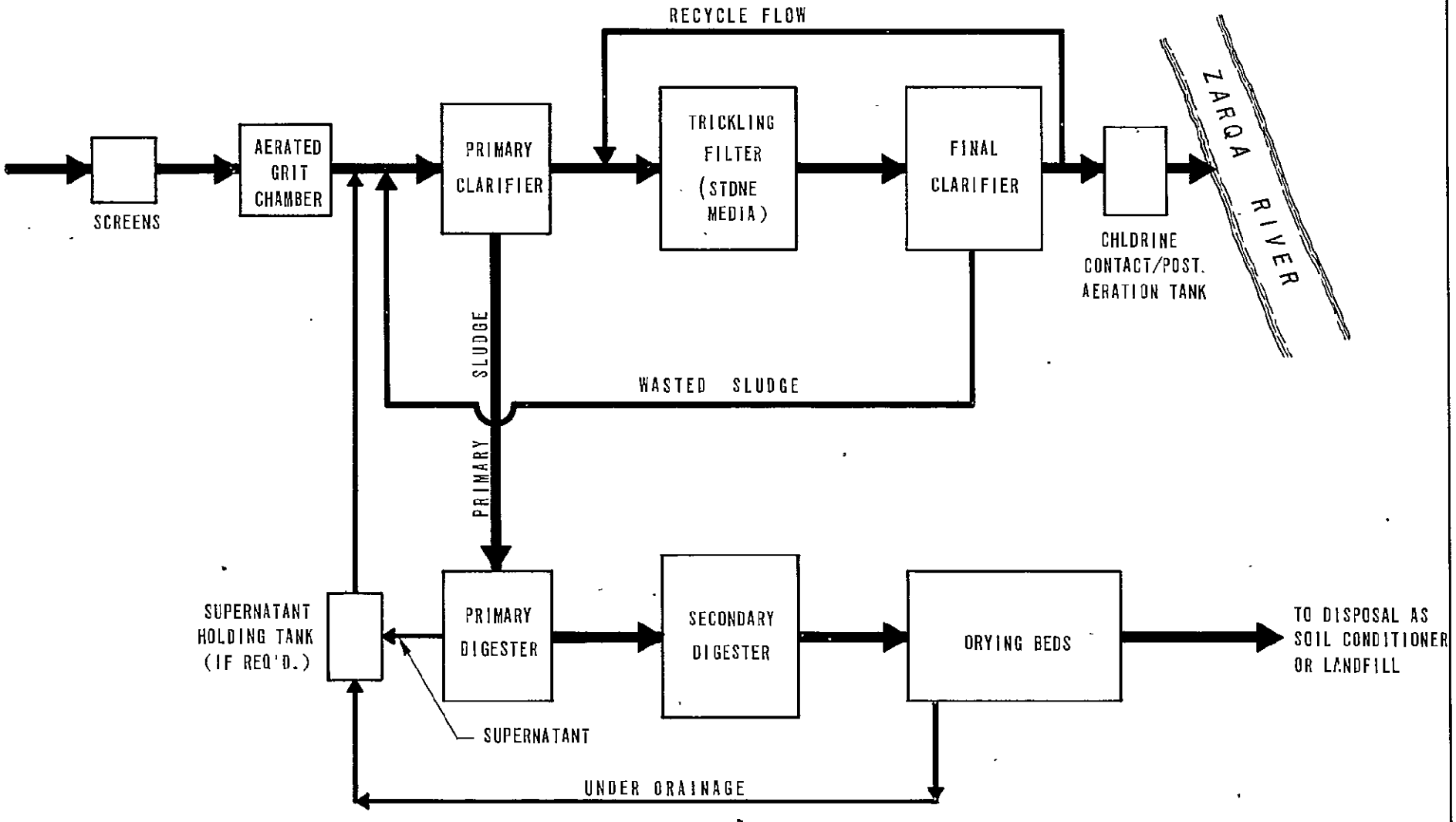
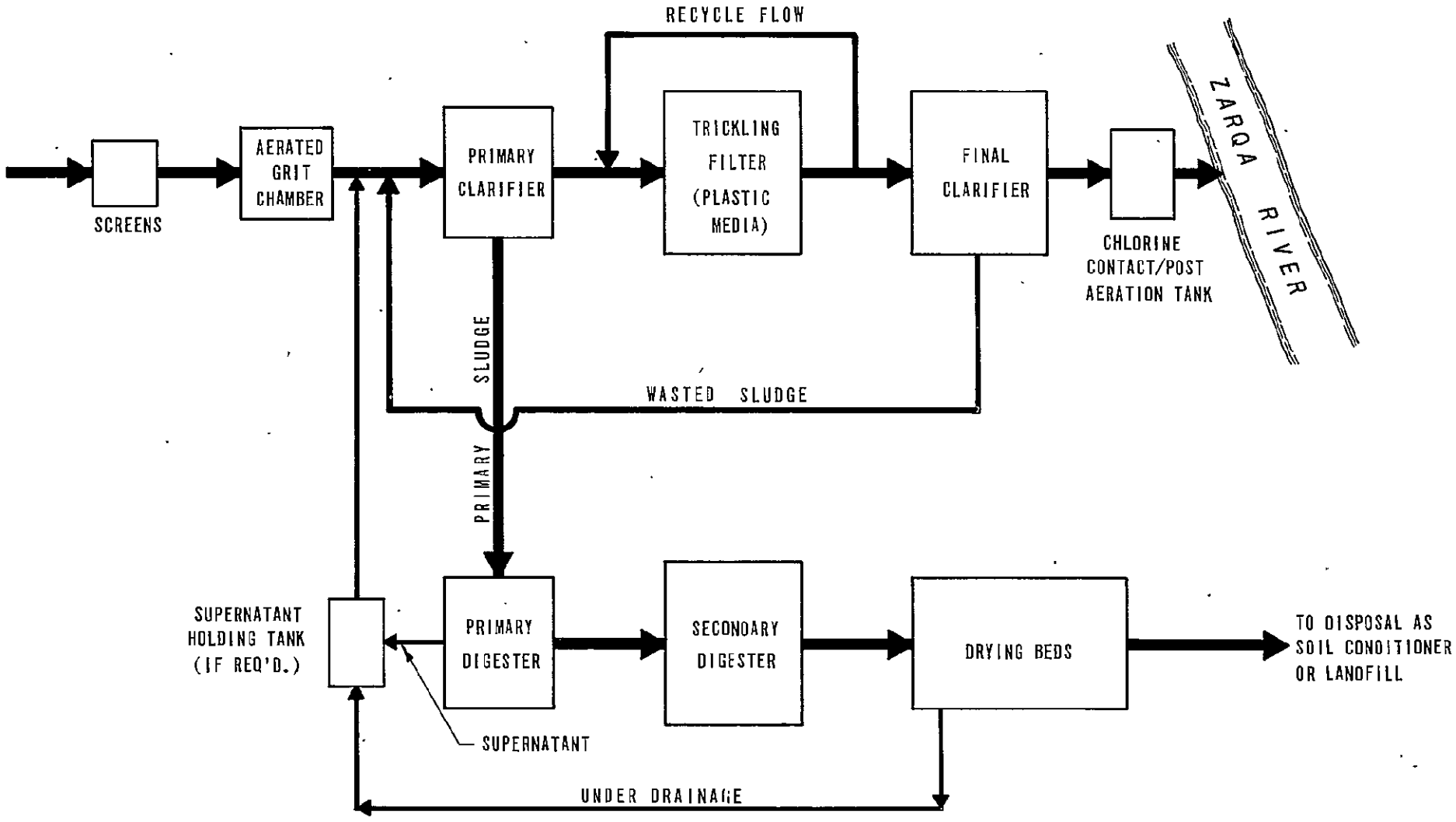
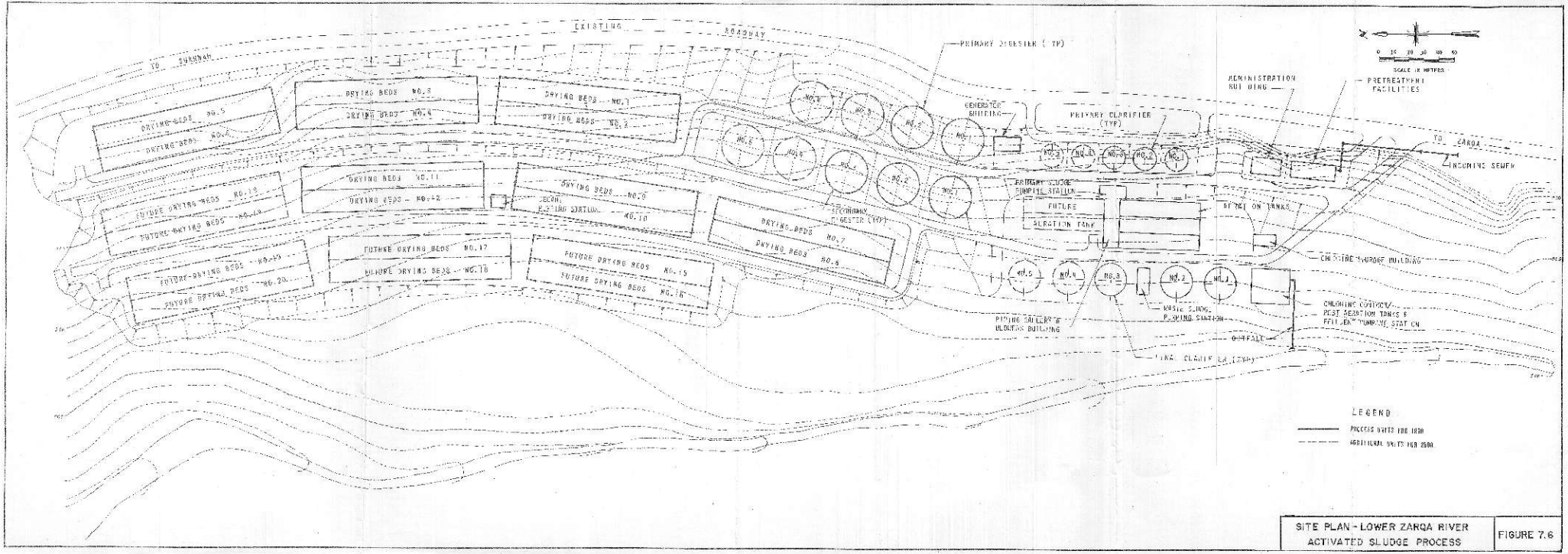


FIGURE 7.4 FLOW DIAGRAM - STONE TRICKLING FILTER



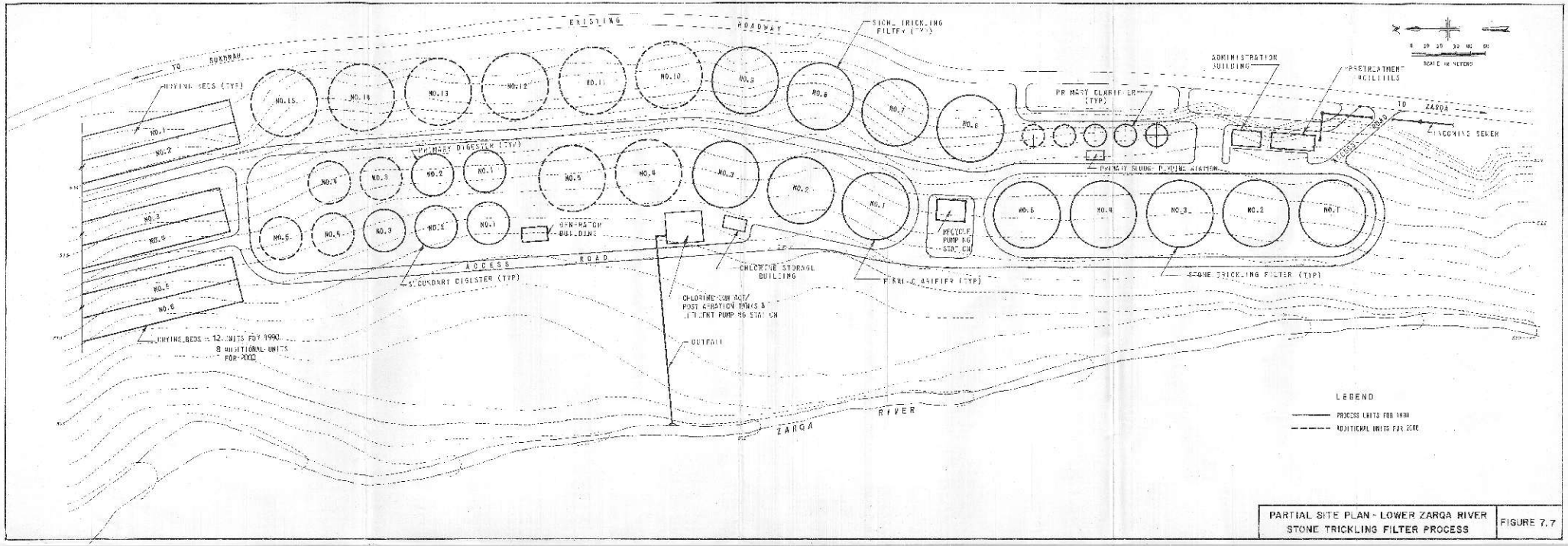
FLOW DIAGRAM - PLASTIC TRICKLING FILTER

FIGURE 7.5



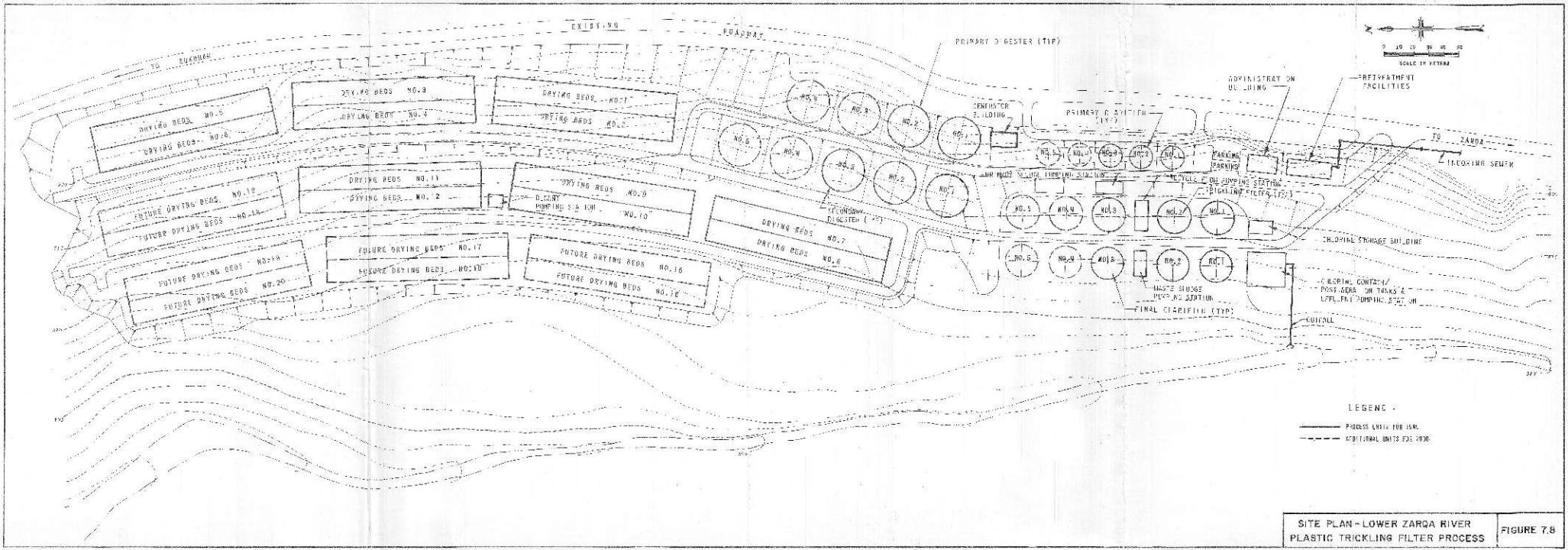
SITE PLAN - LOWER ZARQA RIVER ACTIVATED SLUDGE PROCESS

FIGURE 7.6



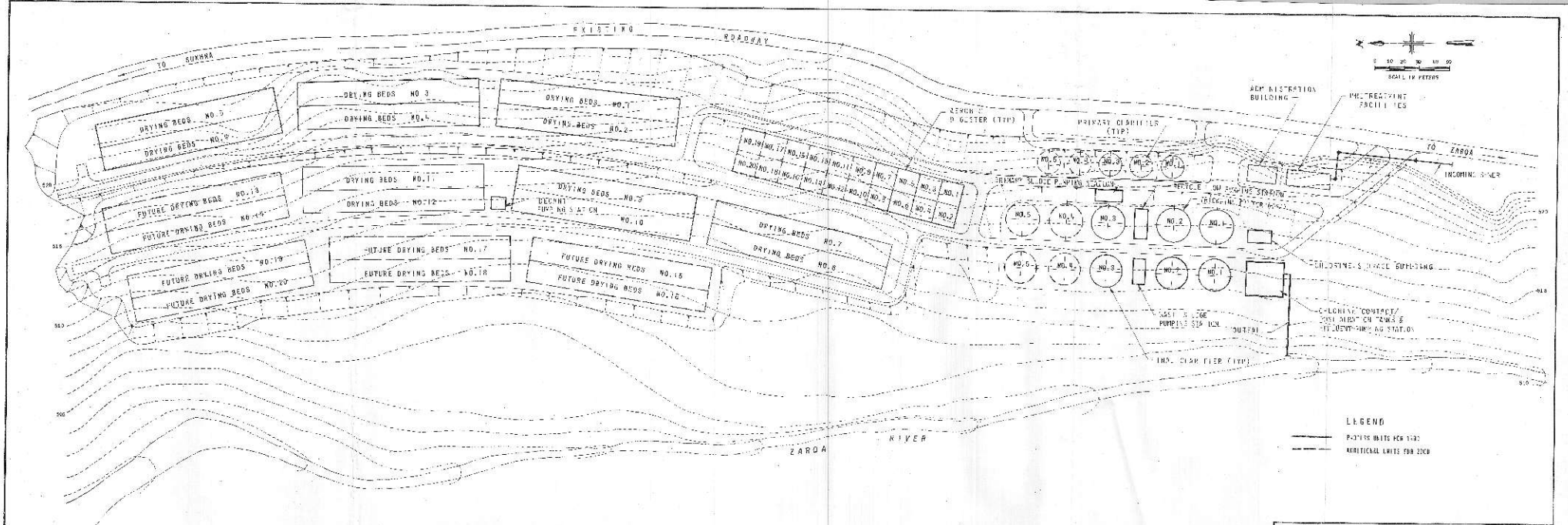
PARTIAL SITE PLAN - LOWER ZARQA RIVER
STONE TRICKLING FILTER PROCESS

FIGURE 7.7



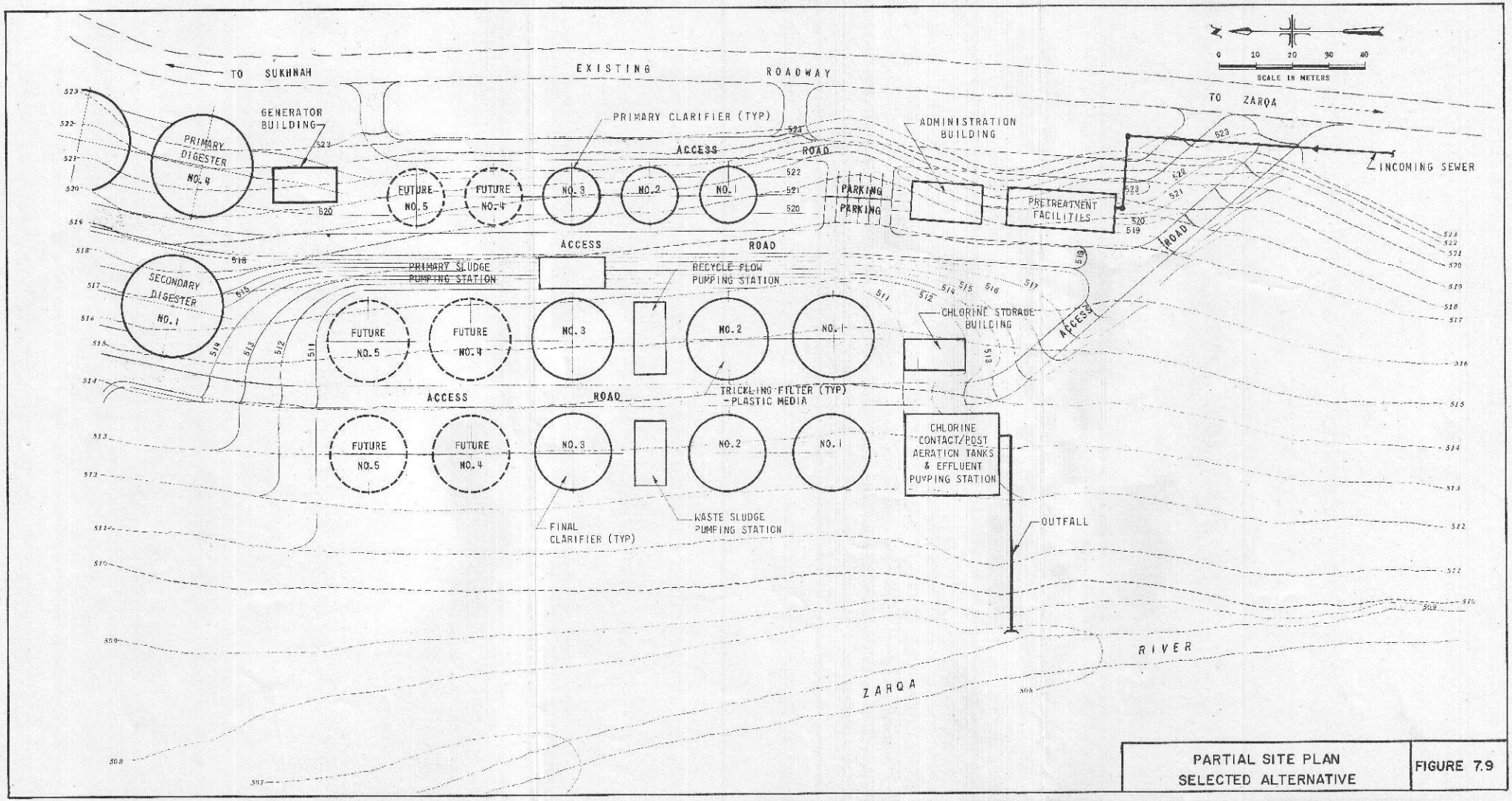
SITE PLAN - LOWER ZARQA RIVER PLASTIC TRICKLING FILTER PROCESS

FIGURE 7.8



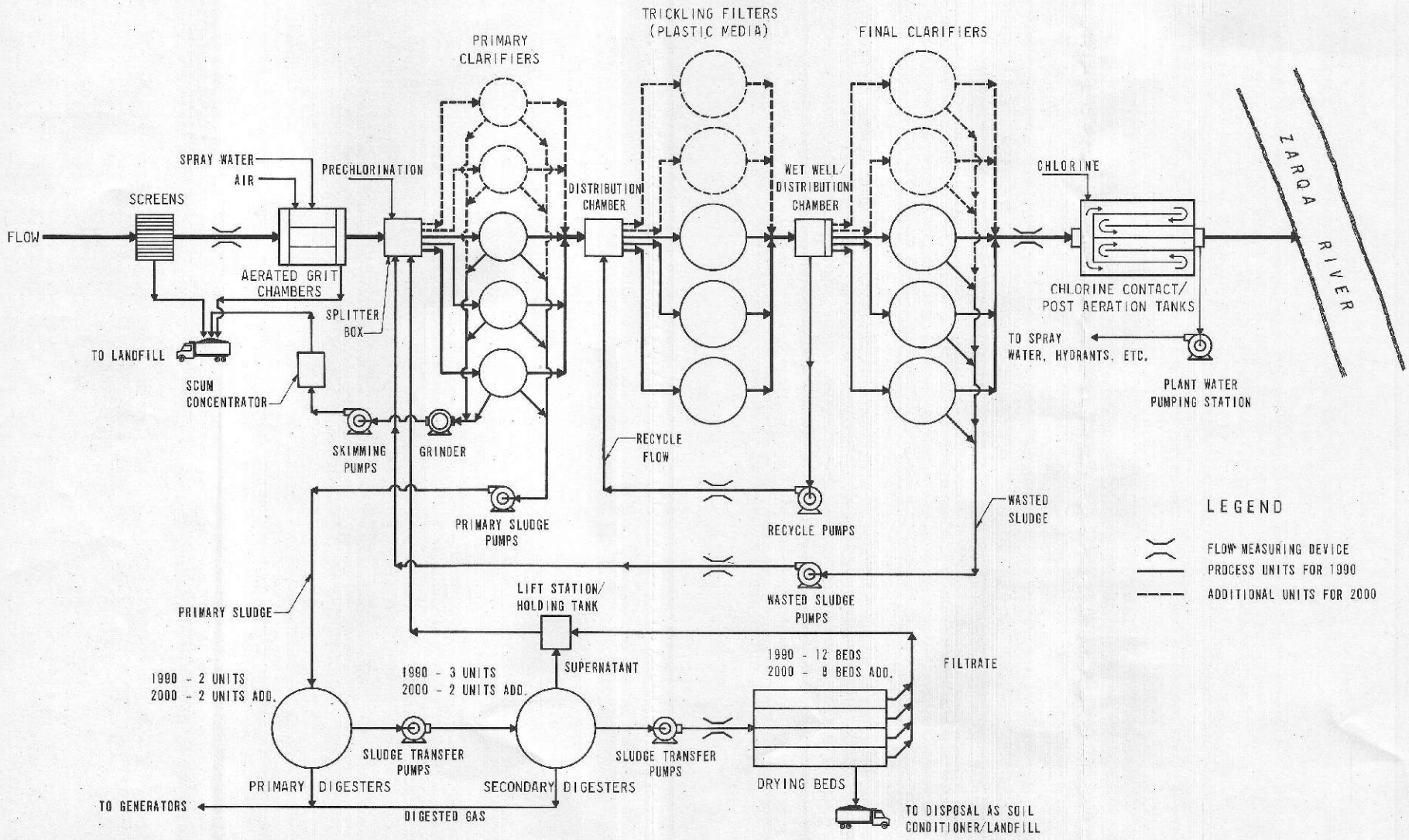
SITE PLAN - LOWER ZARQA RIVER
PLASTIC TRICKLING FILTER PROCESS
(AEROBIC DIGESTION)

FIGURE 7.8A

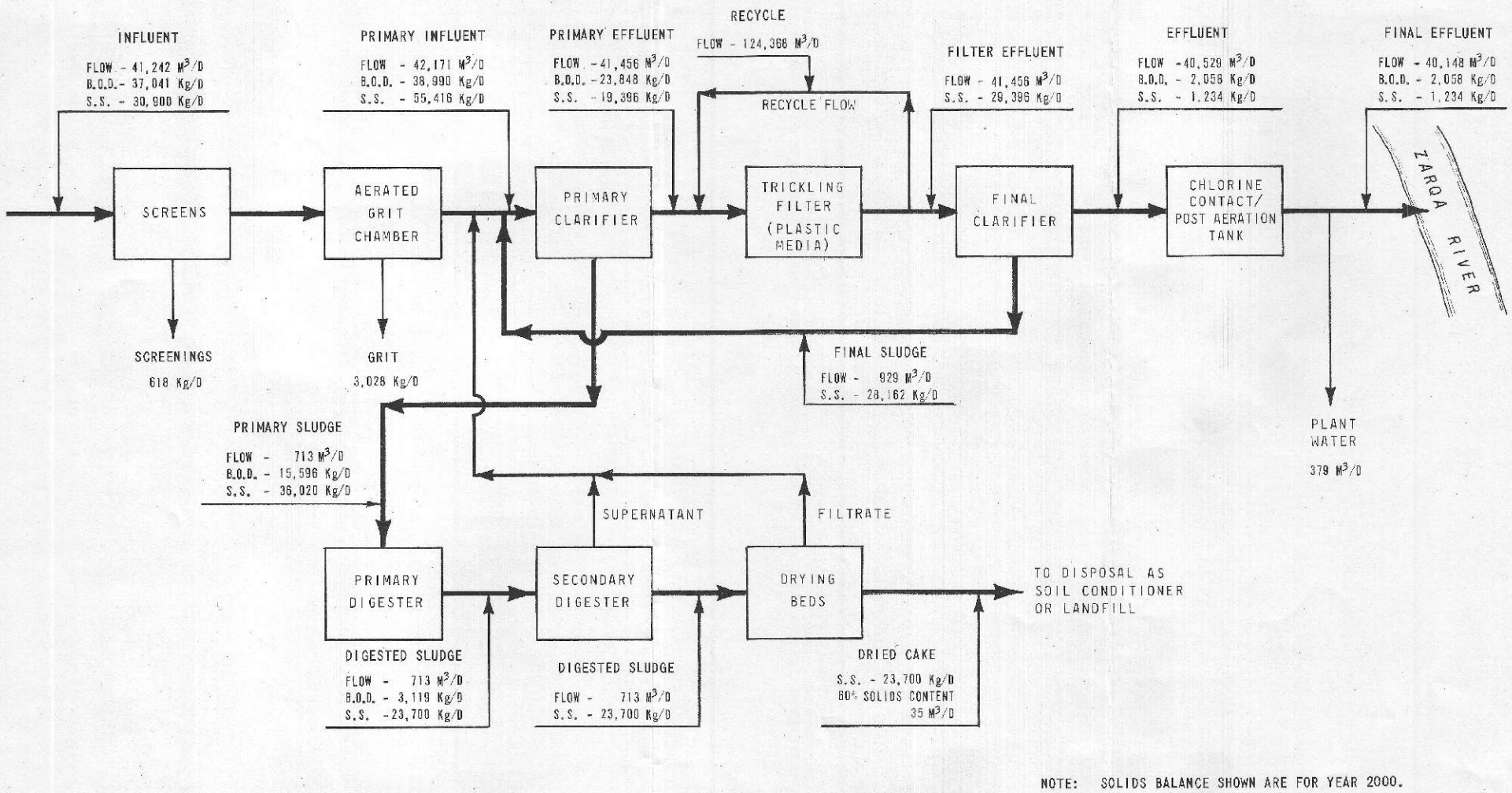


PARTIAL SITE PLAN
SELECTED ALTERNATIVE

FIGURE 7.9

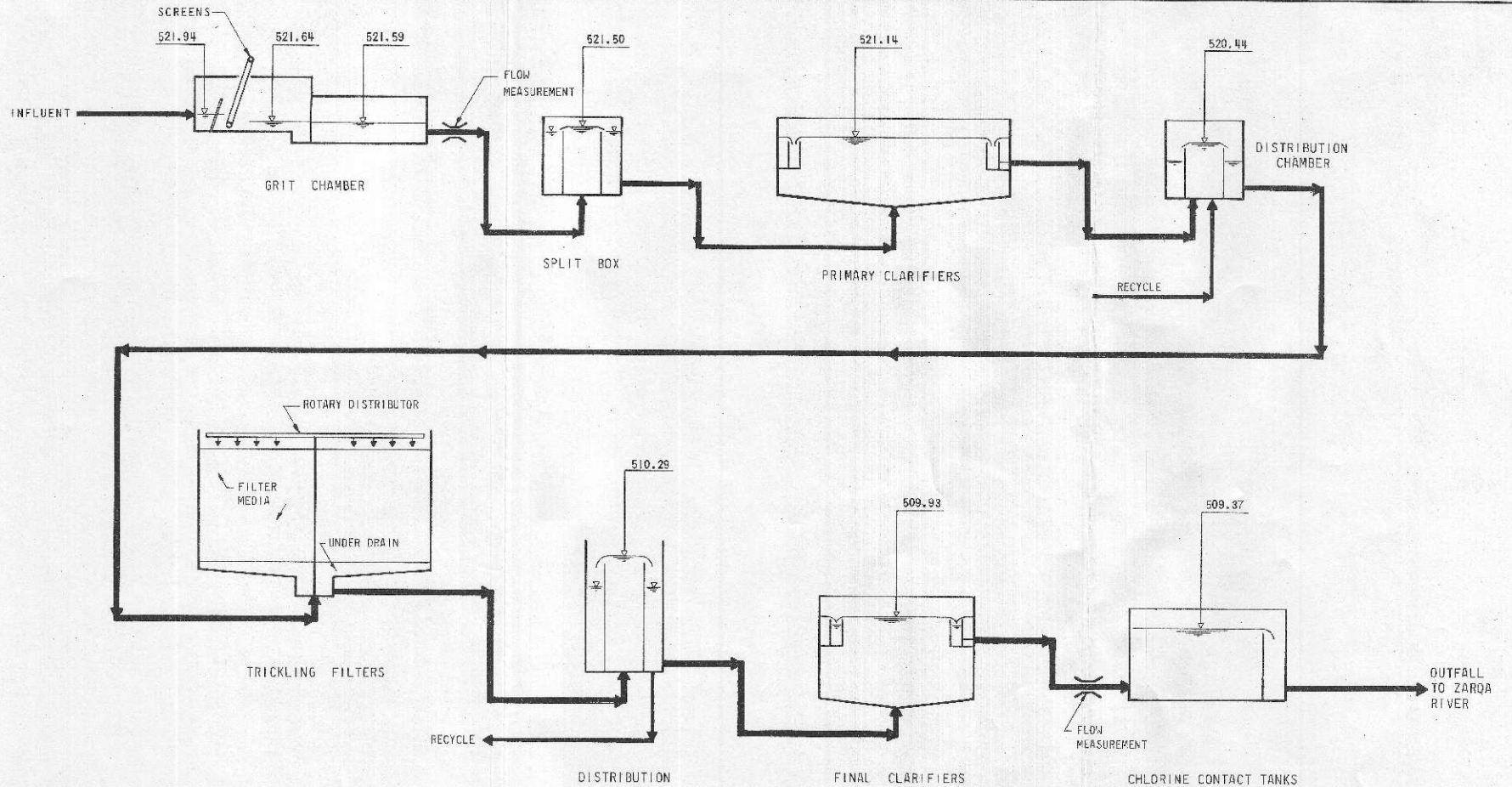


PROCESS FLOW-SELECTED ALTERNATIVE | FIGURE 7.10



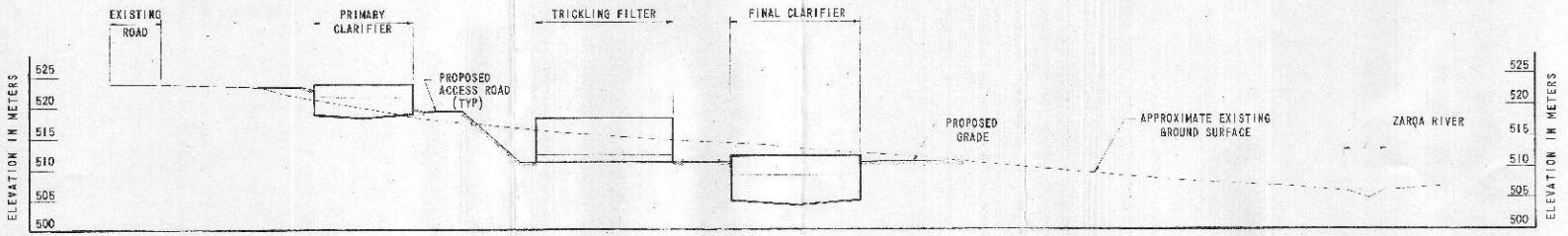
NOTE: SOLIDS BALANCE SHOWN ARE FOR YEAR 2000.

SOLIDS BALANCE - SELECTED ALTERNATIVE | FIGURE 7.11



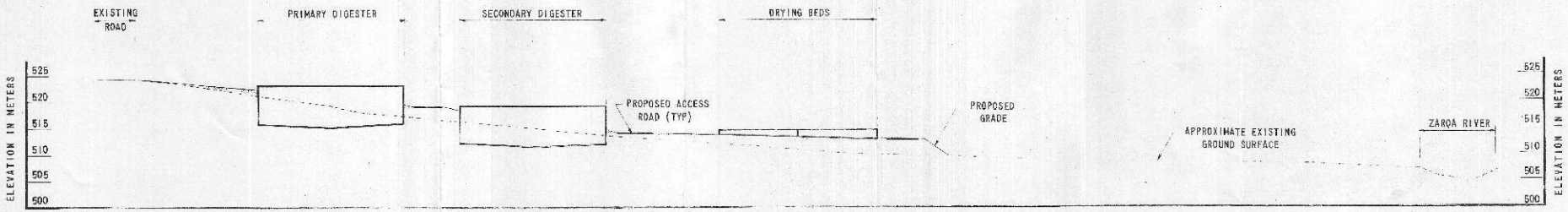
NOTE: HYDRAULIC PROFILE SHOWN IS FOR YEAR 2000.

HYDRAULIC PROFILE - SELECTED ALTERNATIVE | FIGURE 7.12



PROFILE THRU WET STREAM PROCESS

SCALE: 1 = 500



PROFILE THRU SLUDGE PROCESS

SCALE: 1 = 500

PROFILES THRU PROCESS UNITS SELECTED ALTERNATIVE	FIGURE 7.13

APPENDIX 7.1

ELECTRICAL POWER GENERATION FROM SEWAGE GAS

With the cost of energy continuously rising in those countries that have to import oil the utilization of any reasonable local source of energy should be fully explored. The solids removed in the process of treating sewage contain a high percentage of organic material that can be converted by biological oxidation to water and gaseous products. When the bio-oxidation is accomplished in an anaerobic state (without dissolved oxygen being present) the resultant gas contains a high percentage of methane gas. This gas, after cleaning, can be utilized to run internal combustion engines that can drive pumps and blowers or electric generators.

At the proposed Zarqa-Ruseifa sewage treatment plant the solids removed during the treatment process will be anaerobically digested and methane gas will be produced. In the digestion process the solids being digested have to be maintained at a near uniform temperature of approximately 35 C. Heating of the contents of the digesters as well as the solids being fed to the digesters will be required, the degree depending on the time of the year. Normally the gas produced is used for this purpose plus heating other treatment plant facilities.

In the case of the Zarqa-Ruseifa plant the concentration of the solids in the sewage is several times that found in United States or European wastewaters. This fact combined with the selection of the trickling filter treatment process located at the Lower Zarqa River site results in a plant with a low hydraulic loading, a low energy demand and high solids production. For the first stage of design, the year 1990, 26,500 Kg/d of solids are calculated to be removed daily. These solids when digested will produce 2,753,000 kilogram calories of heat from the gas generated.

Utilizing internal combustion gas engines driving generators, this source of energy can produce approximately 725 KW of continuous electric energy. The estimated average electric energy demand for the 1990 facilities is 7,200 KWH/day or a steady demand of approximately 300 KW. By the year 2000, the estimated steady demand will be 500 KW and the gas production is estimated as having the potential to generate approximately 1400 KW of electric power. Based on these figures it appears

that the generation of electric power at the treatment plant should be considered, if found to be cost effective.

In making a cost-effective analysis the following have to be taken into consideration:

- Cost of electricity at the plant site if furnished by the public utility
- Cost of providing the electric service by the public utility
- Cost of furnishing gas-generator sets with their necessary appurtenances
- Cost of extra labor to operate the gas-generators
- Cost of maintaining the gas-generators
- Cost of providing standby fuel to run the generators prior to gas generation or if gas supply is interrupted

The following cost-effective analysis will be based on the projected conditions for the year 2000:

- Electric energy demand - 12,000 KWH/d
- Solids production - 50,300 Kg/d
- Gas production - 125,420,000 kilogram calories per day
- Electric power generation capacity - 1400 KW
- Electric energy cost - JD 0.039/KWH
- Cost of electric service connection by utility - 15,000 JD

A generating facility at the treatment plant will require the following:

- Gas pumps
- Gas coolers and scrubbers
- Water pumps
- High efficiency air filters
- Gas engine generators
- Exhaust heat exchangers
- Water softening facilities
- Building

For the 20-year planning period it is assumed that the engines will have to be completely rebuilt twice. The estimated cost of the initial installation plus rebuilding the engines is JD 310,000.

The labor for operating the generating facilities is estimated to require a crew of five operators plus maintenance backup. The estimated cost of labor is:

5 x JD 180/mo x 12 = JD 10,800/yr

The normal annual operating and maintenance cost is estimated to be three percent of the cost of furnishing the mechanical equipment or JD 4,000/yr.

The cost of electric power, if purchased is:

12,000 KWH/d x 365 x JD 0.039/KWH = JD 170,820/yr

A summary of the costs for each alternative is as follows:

	Gas Engines	Purchased
Facilities	JD 310,000	JD 15,000
Labor	JD/yr 10,800	-
Maintenance	JD/yr 4,000	-
Electric Energy	-	JD/yr 170,820

The present worth of the annual costs is estimated to be as follows: (10% discount)

	Gas Engines	Purchased
Labor	JD/yr 10,800	-
Maintenance	JD/yr 4,000	-
Electric Energy		JD/yr 170,800
	JD/yr 14,800	JD/yr 170,800
Present Worth	JD 126,000	JD 1,454,200

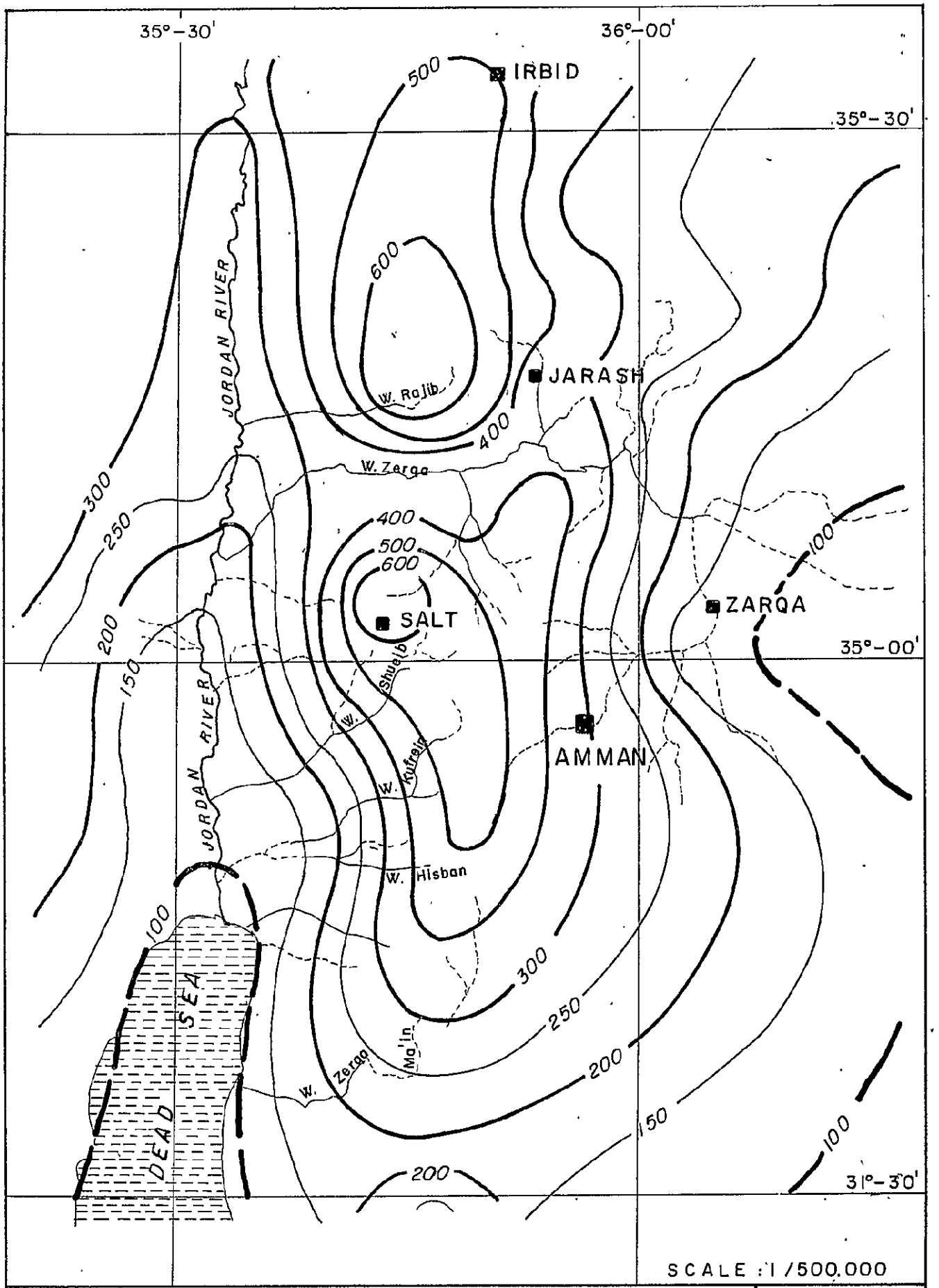
The combined capital costs plus present worth of the estimated annual costs is as follows:

Capital	JD 310.000	JD 15,000
PW of O&M	126,000	1,454,200
Total	JD 436,000	JD 1,469,200

The generation of electric power at the plant plus the recovery of heat from the gas engines is the most cost-effective alternative.

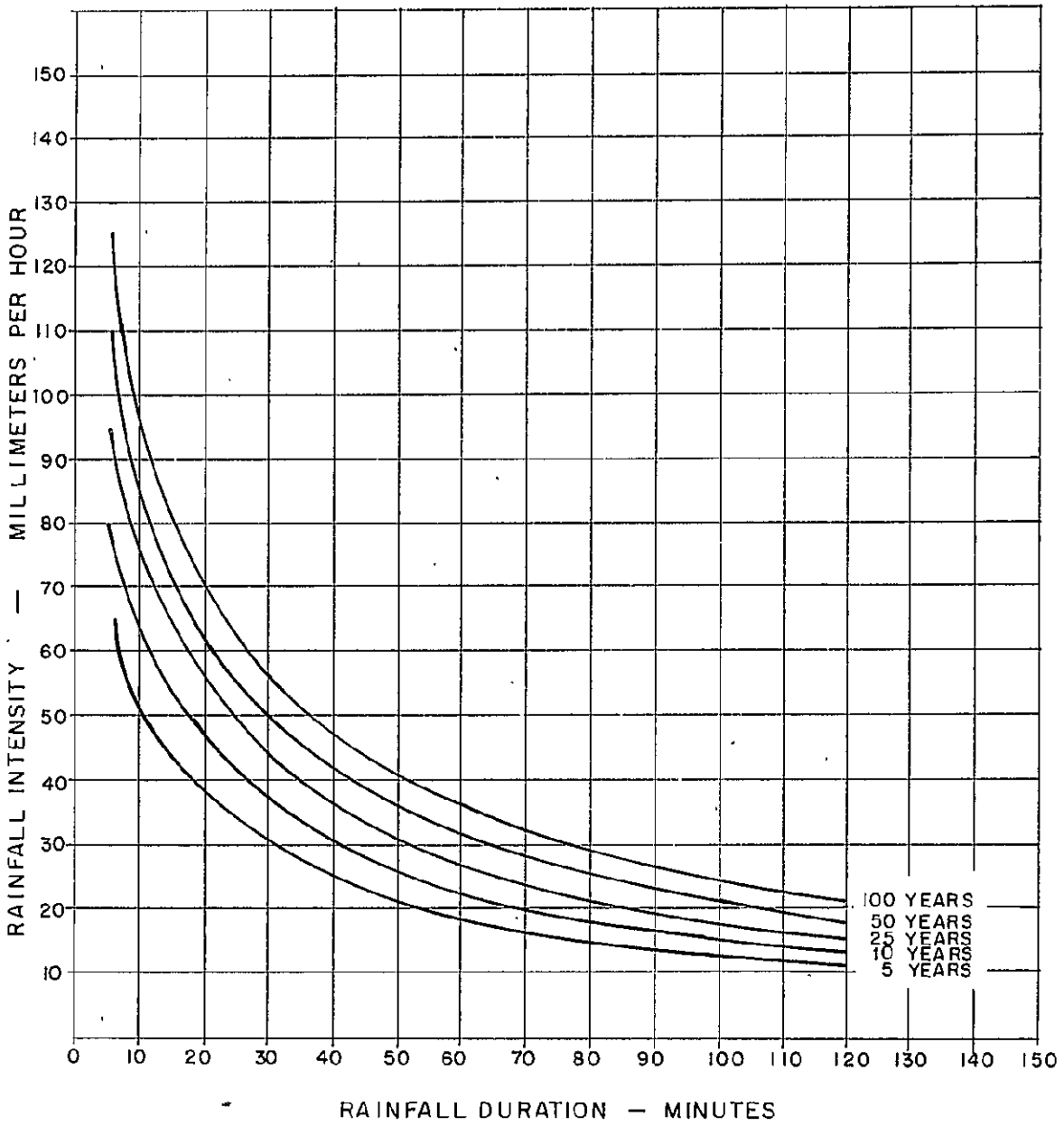
CHAPTER 8.0

STORMWATER DRAINAGE SYSTEM



ISOHYETAL MAP OF 30 YEARS MEAN ANNUAL RAINFALL IN MM. 1931-1960

APPENDIX 8.1



RAINFALL INTENSITY-DURATION-FREQUENCY CURVES
(ADOPTED FROM N R A)

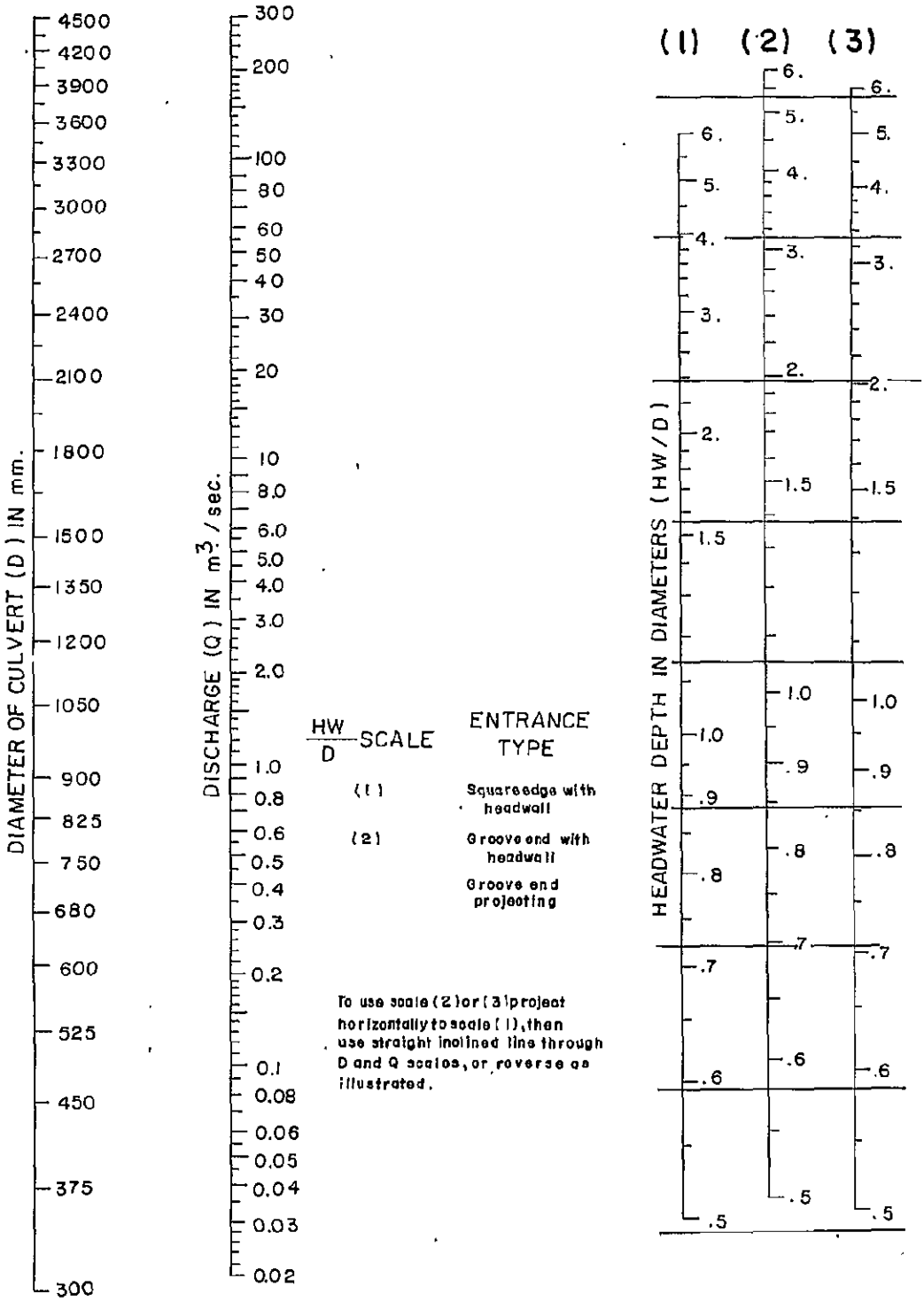
APPENDIX 8.2

APPENDIX 8.3

RUNOFF COEFFICIENT 'C' FOR USE IN

RATIONAL METHOD

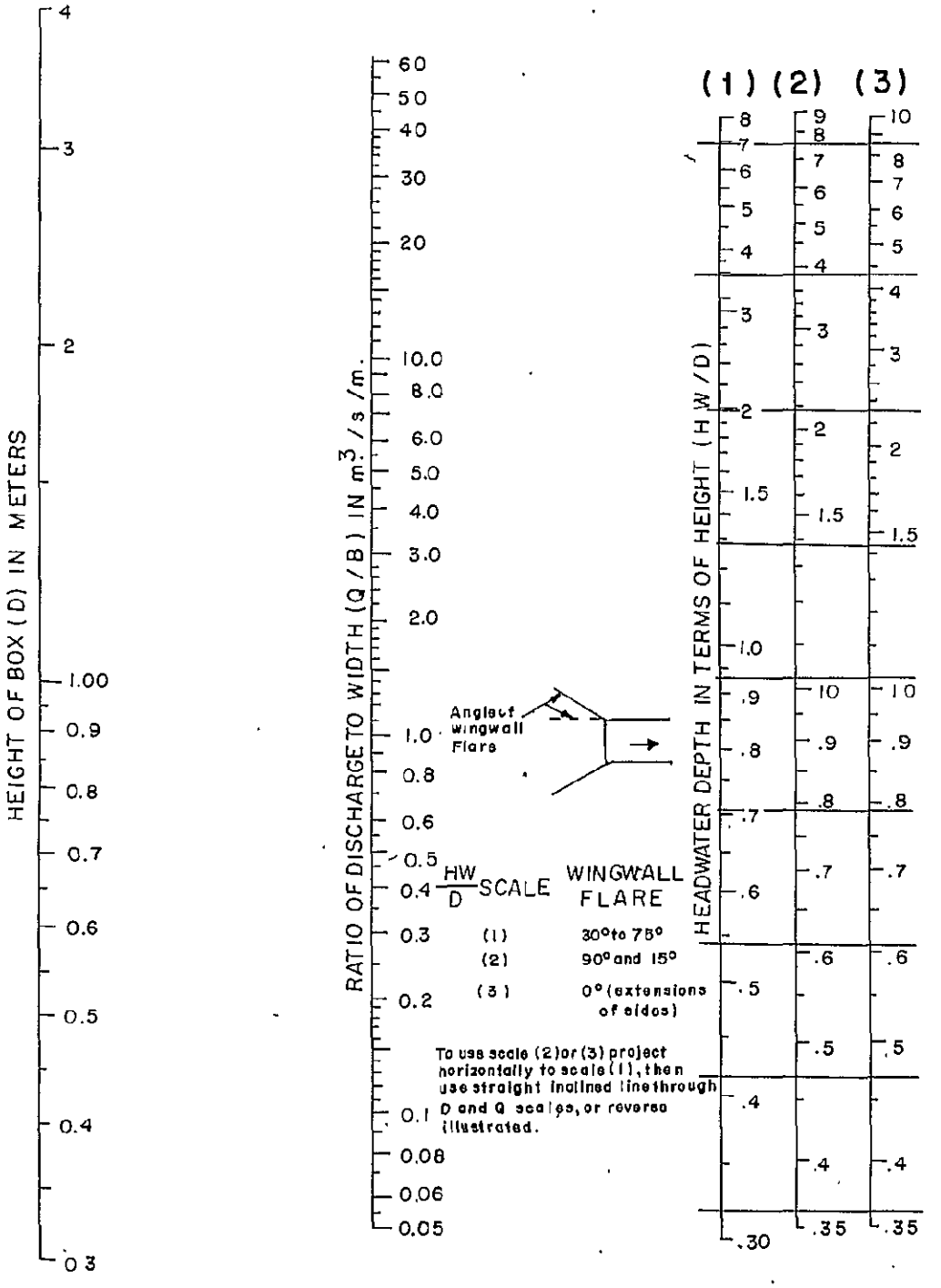
Type of Watershed Area	Runoff Coefficient 'C'
Urban	
Business District	0.7 to 9.9
Residential Areas	0.5 to 0.7
Roads, Footpaths	0.7 to 0.9
Unimproved Areas	0.1 to 0.3
Rural	
Steep, barren, imprevious surfaces	0.70 to 0.80
Rolling barren	0.50 to 0.70
Flat barren	0.50
Mountainous	0.30
Farmlands, flat pervious regions	0.20
Sandy soil,cultivated or light growth	0.30
Gravel, bare or light growth	0.40
Clay soil, bare or light growth	0.75



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

(ADOPTED FROM HYDRAULIC ENG. CIR. No. 5 U.S. BUREAU OF PUBLIC ROADS)

APPENDIX 8.4

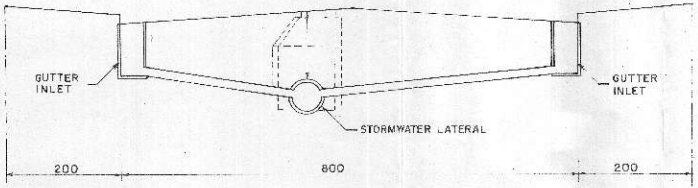


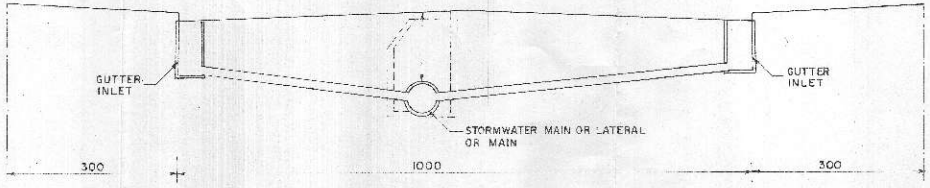
HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

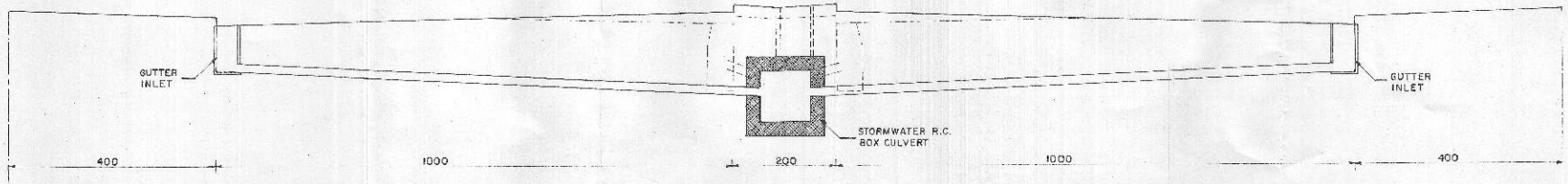
(ADOPTED FROM HYDRAULIC ENG. CIR. No. 5 U.S. BUREAU OF PUBLIC ROADS)

APPENDIX 8.5

NOTE:
ALL DIMENSIONS ARE IN CMS.

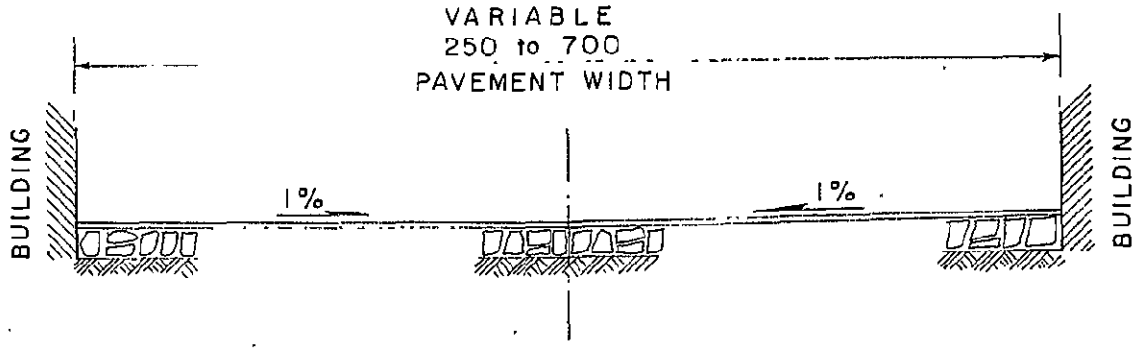






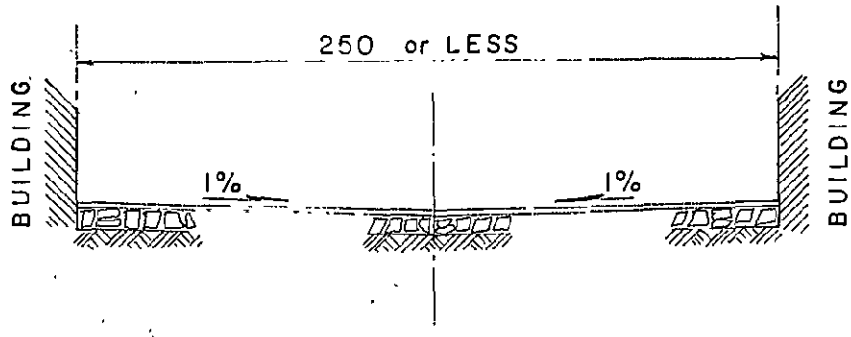
SCALE: 1/50

TYPICAL CROSS SECTIONS OF STREETS (WITH UNDERGROUND DRAINAGE FACILITIES)	APPENDIX 8.6



STREET

SCALE: 1/50

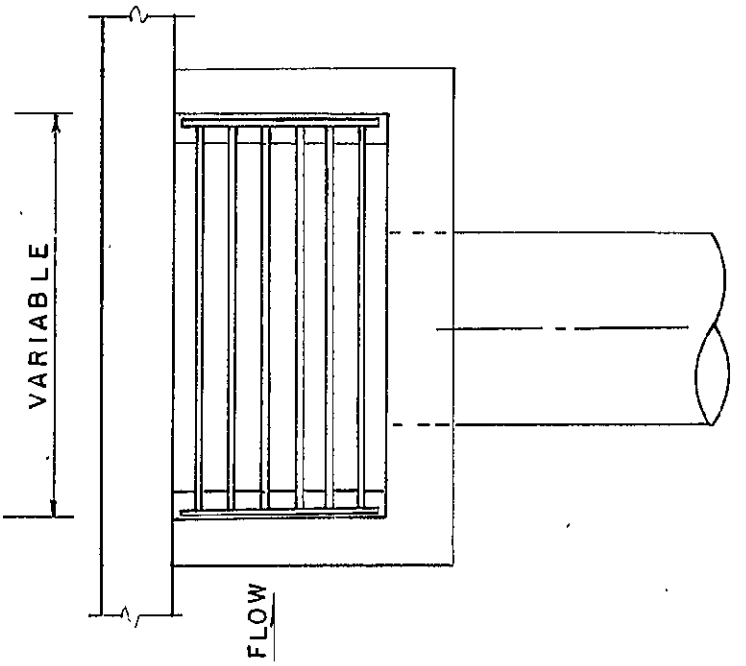


PAVED FOOTPATH

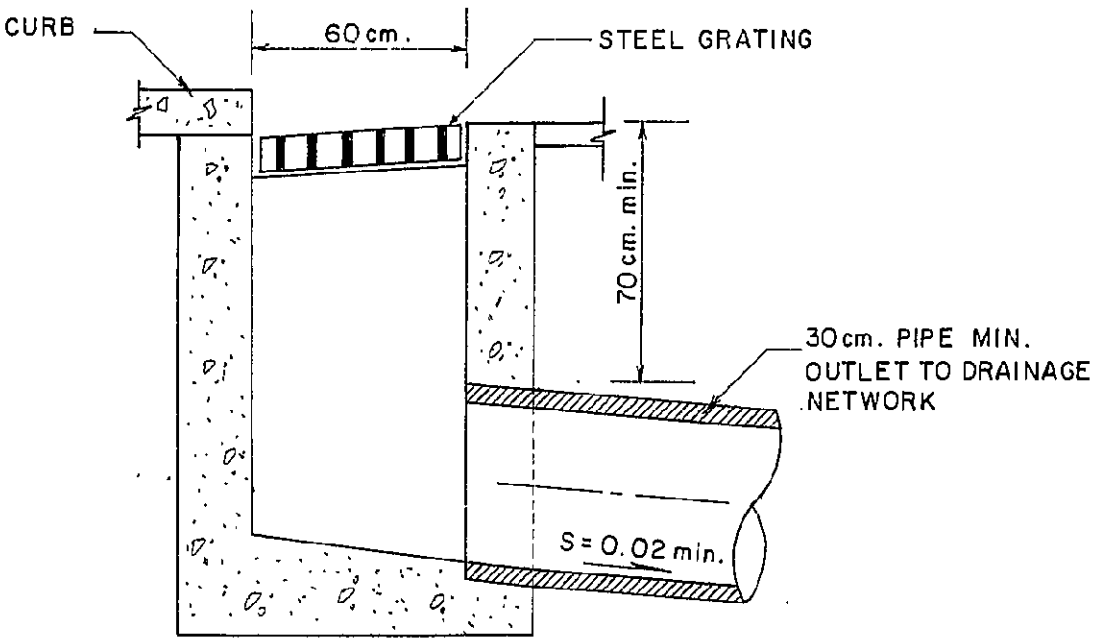
SCALE: 1/20

ALL DIMENSIONS ARE IN CMS.

TYPICAL CROSS-SECTIONS OF STREETS & FOOTPATHS (WITHOUT UNDERGROUND DRAINAGE FACILITIES)	APPENDIX 8.7



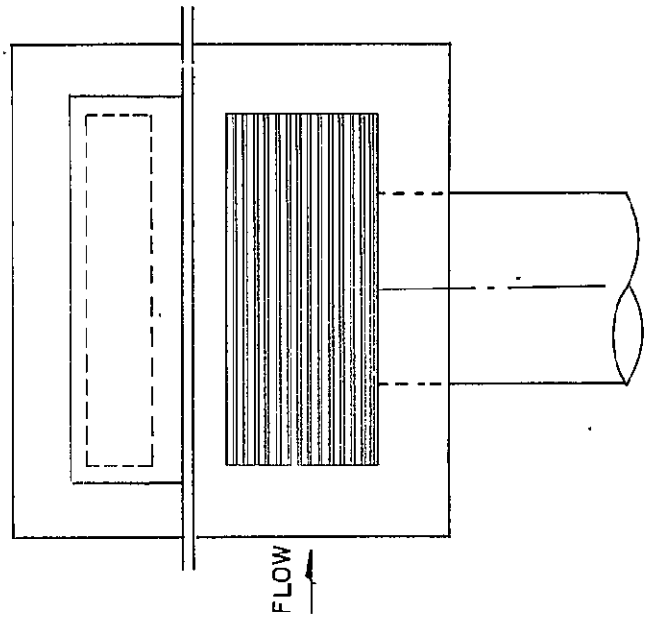
PLAN



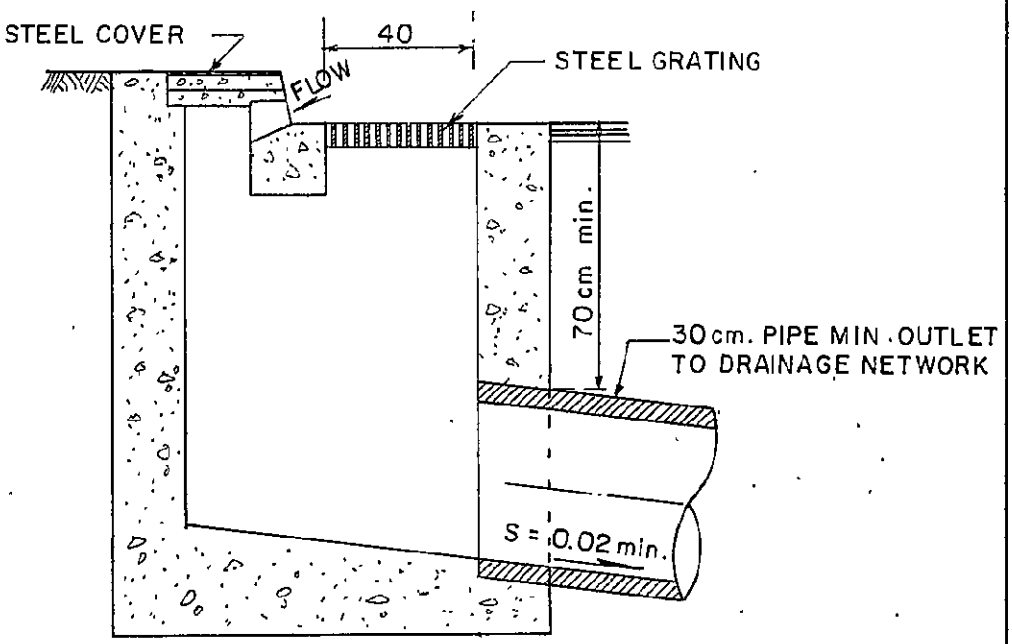
SECTION

SCALE: 1/20

GUTTER INLET	APPENDIX 8.8

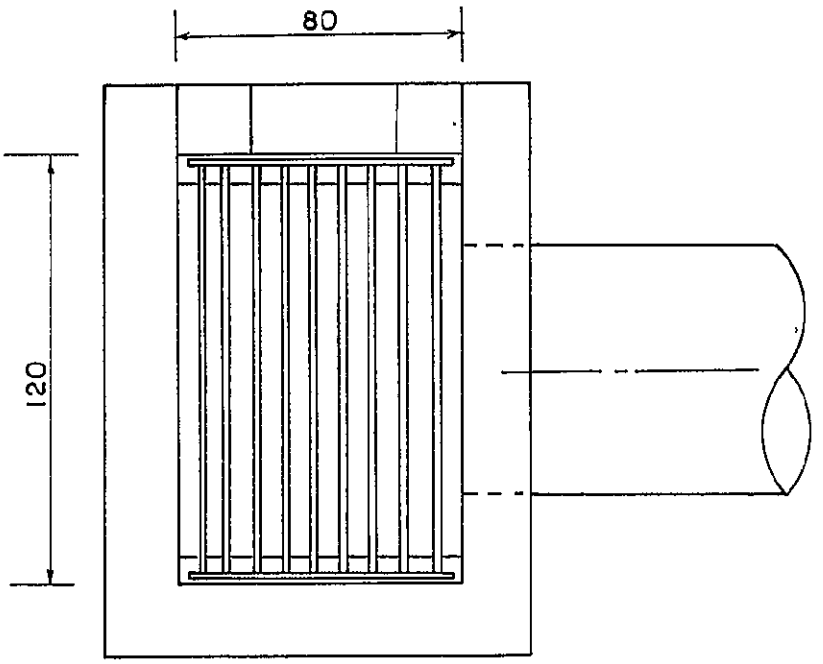


PLAN



SCALE : 1/20

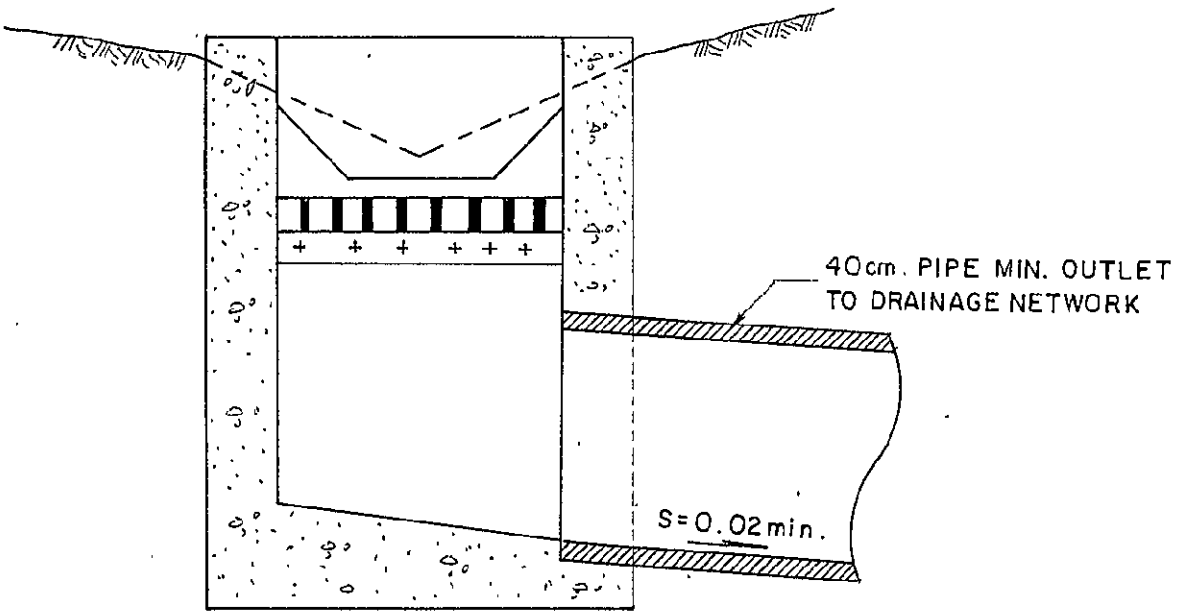
CURB & GUTTER INLET	APPENDIX 8.9



PLAN

NOTE:

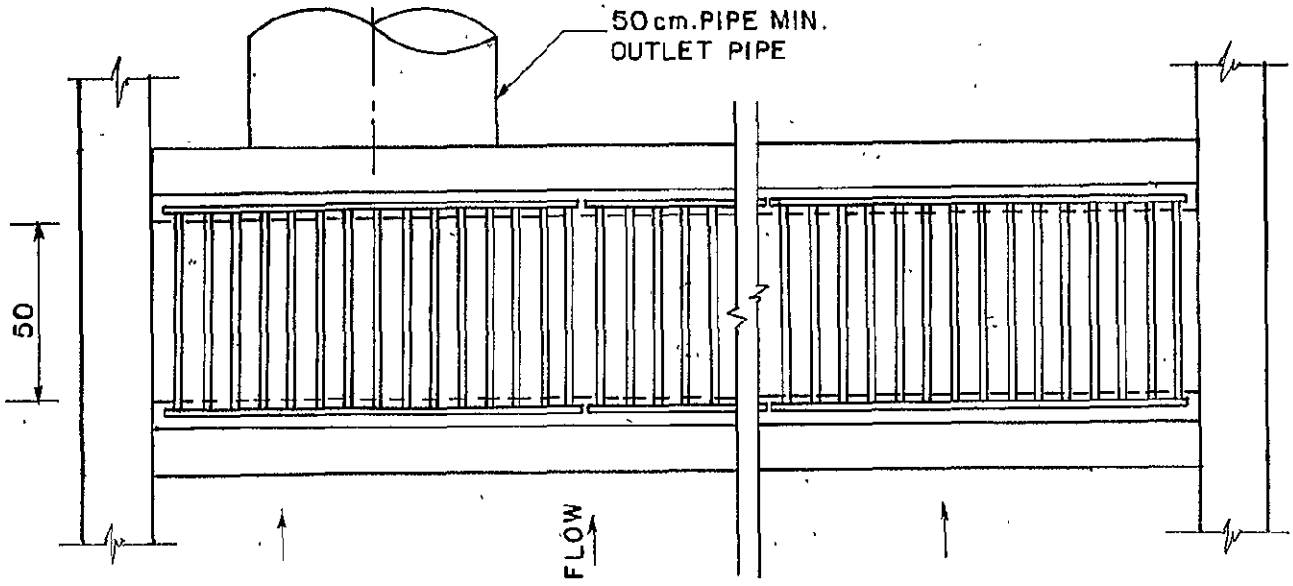
THIS TYPE OF INLET USED IN CHANNELS OR DITCHES TO INTERCEPT THE FLOW.



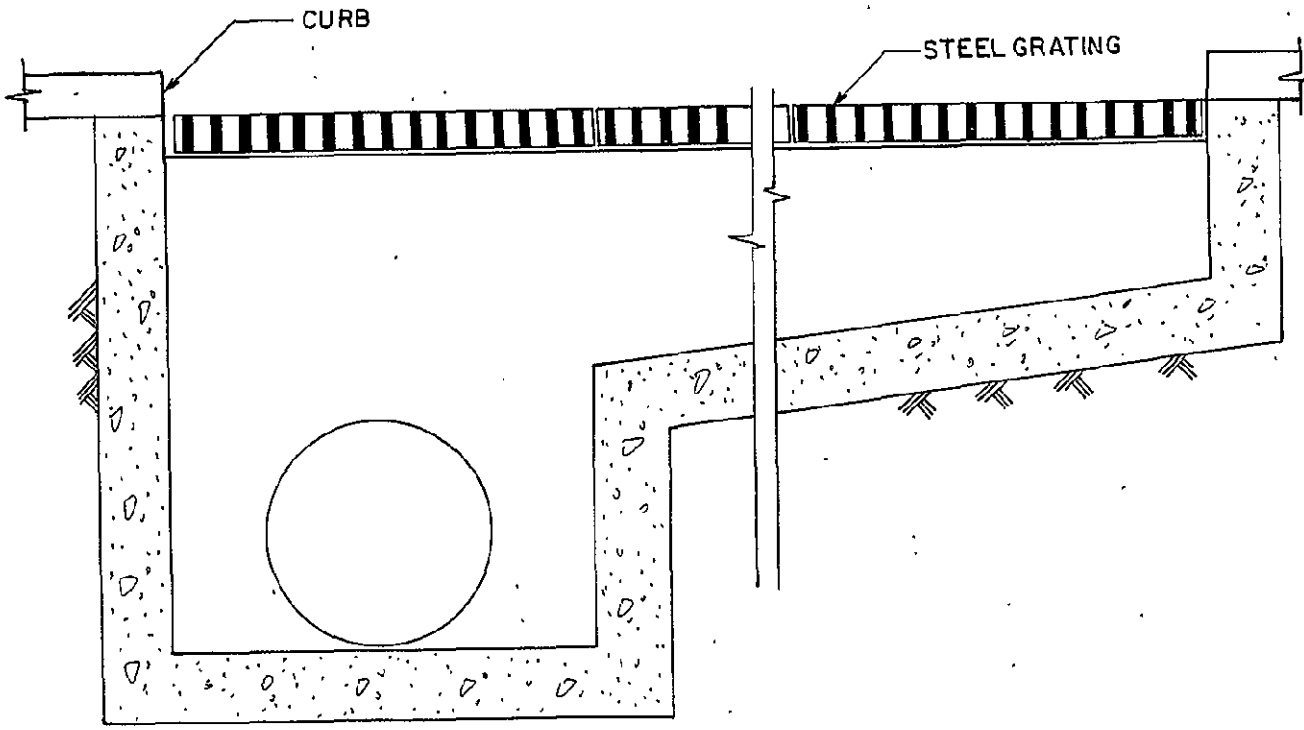
SECTION

SCALE: 1/20

CHANNEL INTERCEPTING INLET	APPENDIX 8.10



PLAN



SECTION

NOTE:
THIS TYPE OF INLET IS INSTALLED ACROSS WHOLE WIDTH OF STREET.

SCALE: 1/20

STREET INTERCEPTING INLET	APPENDIX 8.11

APPENDIX 8.12

DESIGN DISCHARGES FOR AREAS OF MORE THAN 250 HECTARES

Watershed Reference No.	Area Hectares	Time of Concentration	Rainfull Intensity mm/hr.	Runoff Coefficient	Design Discharge m^3/Sec.
W.S.1	12,580	170	15	0.3	157
W.S.5	580	37	40	0.5	32
W.S.12	250	36	40	0.5	14
W.S.16	8,640	140	15	0.3	108
W.S.18	470	45	35	0.5	23
W.S.24	5,270	140	15	0.3	71
W.S.35	390	37	40	0.3	11

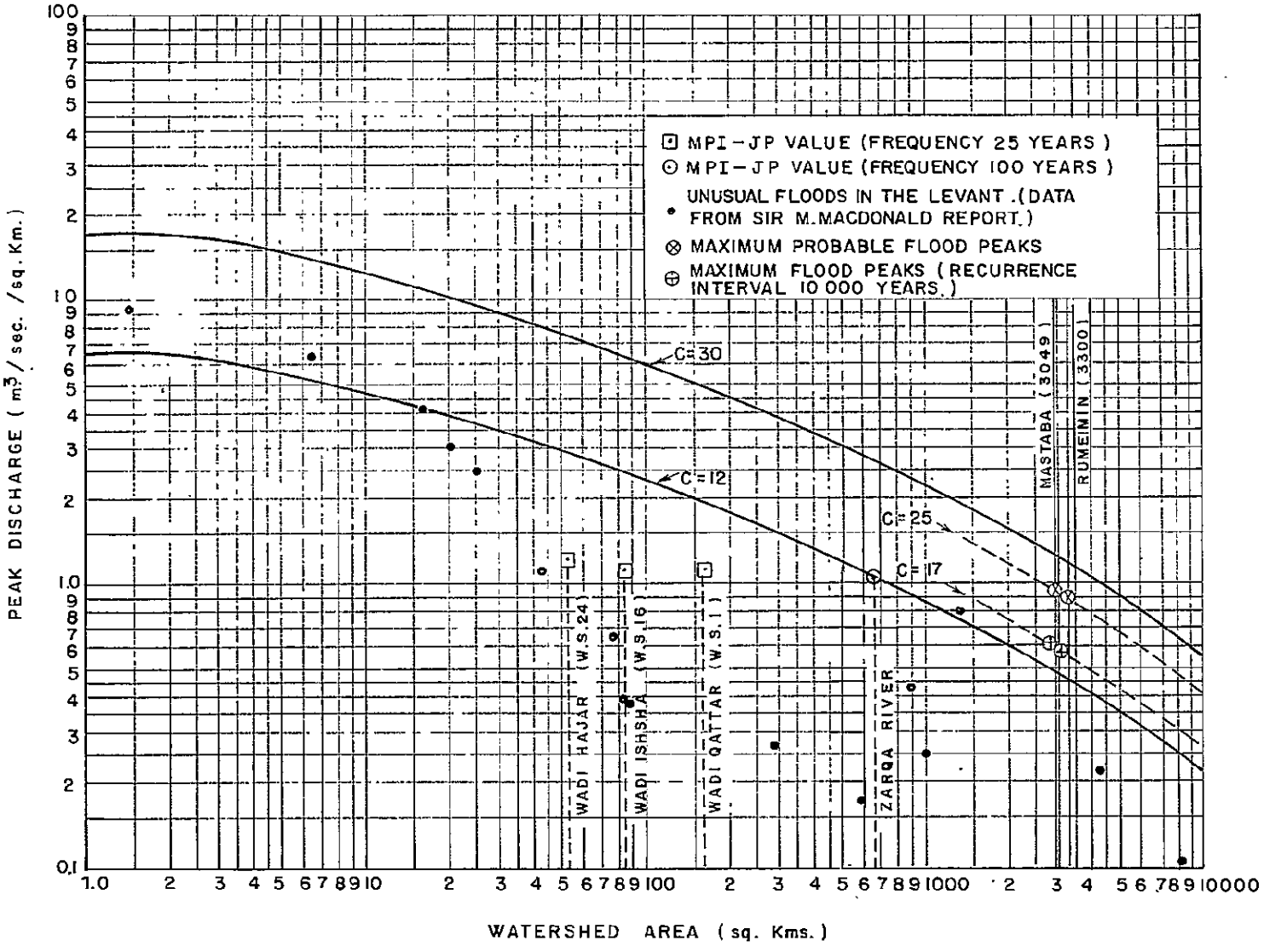
APPENDIX 8.13

Ten Years Frequency Runoff Values in Areas of Different Usage

Time of Concentration (Minutes)	Runoff (Litres per Second per Hectare)		
	Business Districts (C = 0.9)	Residential Areas (C = 0.6)	Unimproved Areas (C = 0.3)
5	200	133	67
10	162	108	54
15	138	92	46
20	118	78	39
30	95	63	32

Five Years Frequency Runoff Values in Areas of Different Usage

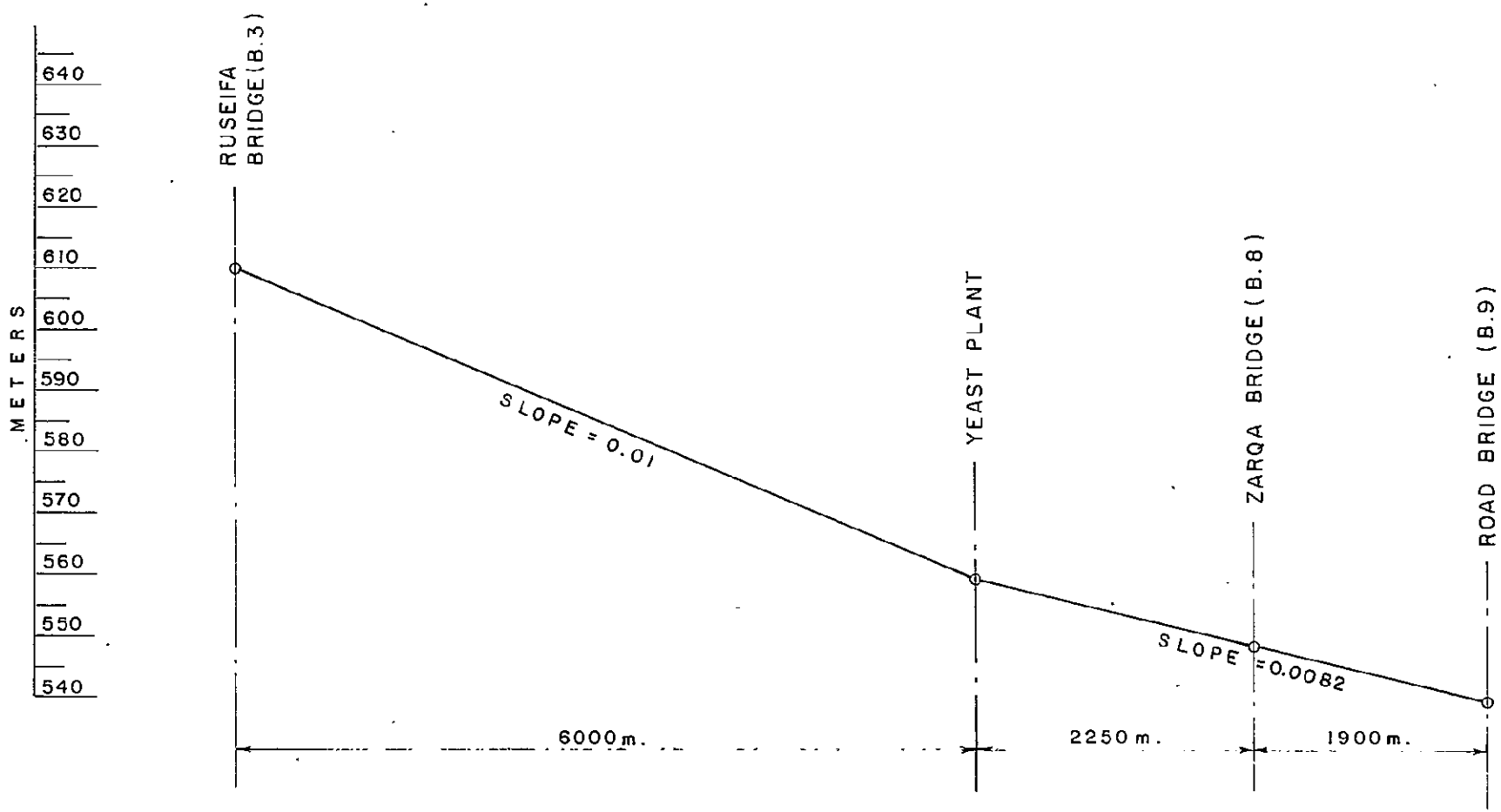
Time of Concentration (Minutes)	Runoff (Litres per Second per Hectare)		
	Business Districts (C = 0.9)	Residential Areas (C = 0.6)	Unimproved Areas (C = 0.3)
5	163	108	54
10	130	87	44
15	113	75	38
20	95	63	32
30	80	53	27



FLOODS OF UNUSUAL INTENSITY IN THE MIDDLE EAST

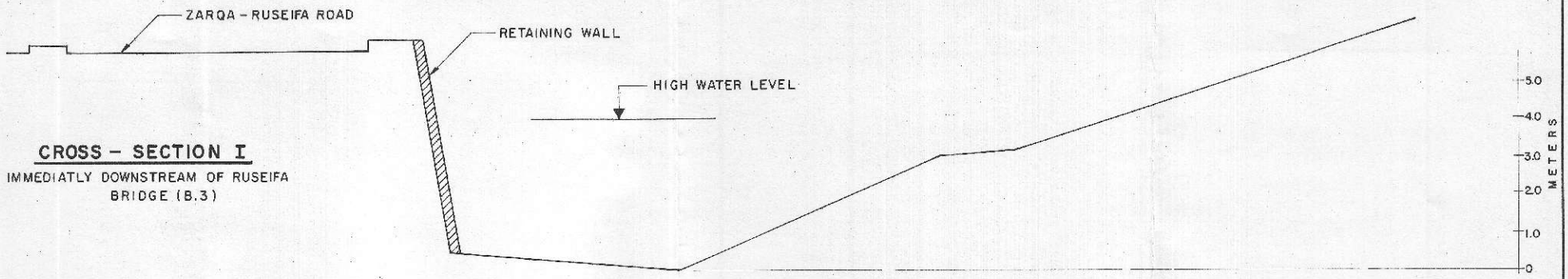
(ADOPTED FROM SIR MACDONALD REPORT 1965)

APPENDIX 8.14



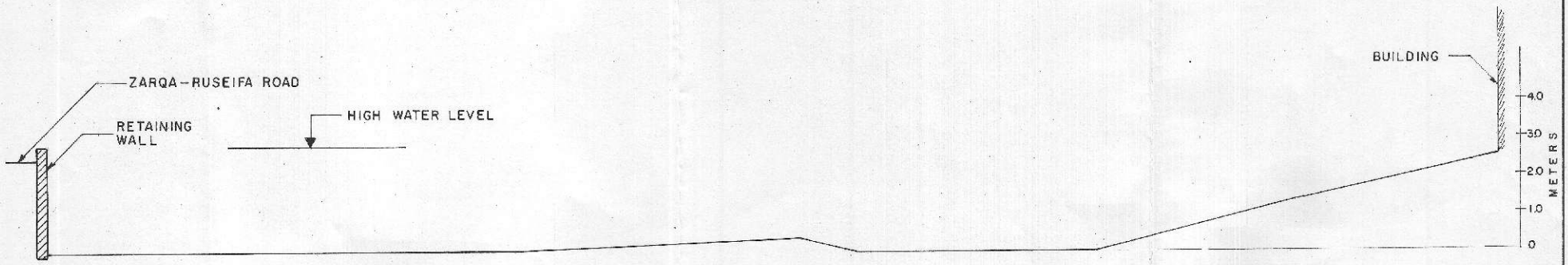
PROFILE ZARQA RIVER

APPENDIX 8.15



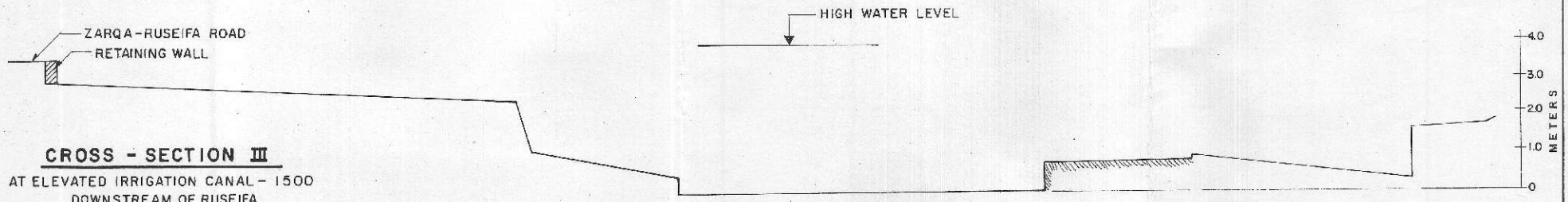
CROSS - SECTION I

IMMEDIATLY DOWNSTREAM OF RUSEIFA BRIDGE (B.3)



CROSS - SECTION II

450 METERS DOWNSTREAM OF RUSEIFA BRIDGE (B.3)

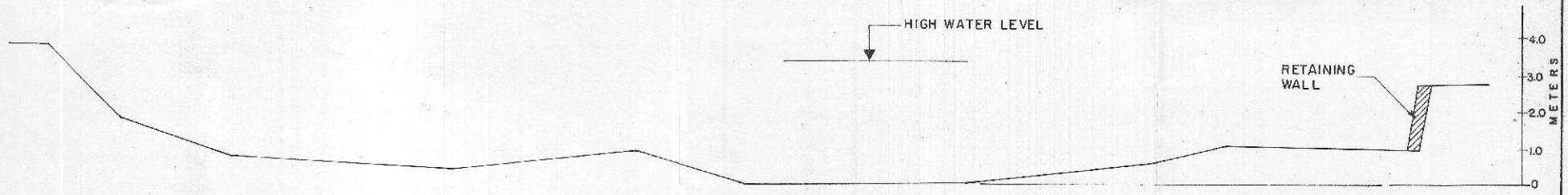


CROSS - SECTION III

AT ELEVATED IRRIGATION CANAL - 1500 DOWNSTREAM OF RUSEIFA BRIDGE (B.3)

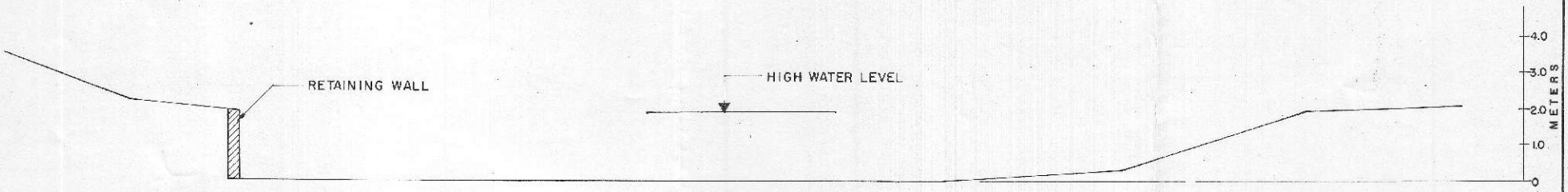
SCALES : H. 1/100
V. 1/100

CROSS - SECTIONS ZARQA RIVER	APPENDIX 8.16 SHEET 1



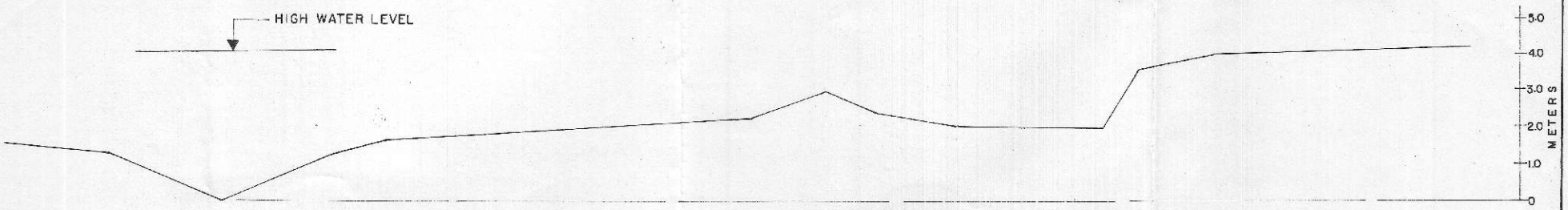
CROSS - SECTION IV

60 METERS DOWNSTREAM OF RAIL ROAD BRIDGE (8.5)



CROSS - SECTION V

200 METERS DOWNSTREAM OF ZARQA BRIDGE (8.8)



CROSS - SECTION VI

50 METERS DOWNSTREAM OF ROAD BRIDGE (8.9)

SCALES: H. 1/100
V. 1/100

CROSS - SECTIONS ZARQA RIVER	APPENDIX 8.16 SHEET 2

APPENDIX 8.17

CHARACTERISTIC OF

EXISTING STRUCTURES - BRIDGES

BRIDGE NO.	STREAM	REMARKS
B.1	Zarqa	Good structural condition. Overtopped in storm of November 28-29, 1979.
B.2	Zarqa	Good structural condition. Overtopped in storm of November 28-29, 1979.
B.3	Zarqa	Good structural condition. Hydraulically adequate.
B.4	Zarqa	Damaged in storm of November 28-29, 1979. Badly scoured to a depth of over a meter on the downstream side. Repair work, by Municipality, underway.
B.5	Zarqa	Good structural condition. Hydraulically adequate. Badly scoured on downstream side.
B.6	Hajar	Good structural condition. Hydraulically adequate.
B.7	Hajar	Good structural condition. Hydraulically adequate.
B.8	Zarqa	Good structural condition. Hydraulically adequate.
B.9	Zarqa	Good structural condition. Overtopped in storm of 28-29 November 1979.

APPENDIX 8.18

CHARACTERISTICS OF

EXISTING STRUCTURES - CULVERTS

CULVERT NO.	TYPE	SIZE	REMARKS
C.1	R.C. Pipe	60 cm. dia.	Partially blocked
C.2	R.C. Pipe	2-60cm. dia.	Partially blocked
C.3	R.C. Pipe	60 cm. dia.	Approach channel completely blocked
C.4	R.C. Pipe	7-90 cm. dia.	Inadequate hydrautically. Serves as Irish Bridge.
C.5	R.C. Box	140x140 cm.	Good condition
C.6	R.C. Box	500 x 90 cm.	Good condition
C.7	R.C. Box	500 x 90 cm.	Outlet channel blocked
C.8	R.C. Pipe	50 cm. dia.	Completely blocked
C.9	R.C. Pipe	50 cm. dia.	Completely blocked
C.10	R.C. Pipe	60 cm. dia.	Partially blocked
C.11	R.C. Pipe	60 cm. dia.	Partially blocked
C.12	R.C. Box	500x200 cm.	Good condition. Minor Scour on downstream side
C.13	R.C. Pipe	60 cm. dia.	Hydraulically inadequate
C.14	R.C. Box	100cmx90 cm.	Good condition
C.15	R.C. Pipe	2-60 cm. dia.	Good condition
C.16	R.C. Pipe	2-60 cm. dia.	Good condition
C.17	R.C. Pipe	3-60 cm. dia.	Good condition
C.18	R.C. Box	153 x 117 cm.	Good condition
C.19	R.C. Box	140 x 140 cm.	Good condition
C.20	R.C. Box	5-250x250 cm.	Good condition
C.21	R.C. Box	1-150x150 cm.	Good condition
C.22	R.C. Box	1-100x100 cm.	Good condition
C.23	C.M. Pipe	180 cm. dia.	Good condition
C.24	R.C. Box	1-200x200 cm.	Good condition
C.25	R.C. Box	5-250x250 cm.	Severe bed degradation downstream side
C.26	R.C. Box	2-150x150 cm.	Good condition
C.27	R.C. Box	1-150x150 cm.	Good condition
C.28	R.C. Box	4-250x250 cm.	Severe bed degradation downstream side
C.29	C.M. Pipe	210 cm. dia.	Good condition
C.30	C.M. Pipe	180 cm. dia.	Good condition

APPENDIX 8.19

RECOMMENDED STORMWATER SYSTEM PHASE I - LENGTHS OF PIPE - METERS

LINE	R.C. BOX CULVERT BxH CM				CONCRETE PIPE DIAMETERS IN MM.								
No.	100x100	125x125	150x150	200x200	300	400	450	500	600	700	900	1000	TOTAL
I	-	-	-	-	280	-	-	40	-	-	-	300	620
II	-	-	-	-	720	330	160	40	270	-	130	-	1,650
III	520	-	1500	-	2000	-	-	300	-	-	-	-	4,320
IV	-	450	220	1400	-	100	-	100	-	-	-	-	2,270
V	-	-	-	-	-	100	-	100	-	150	-	350	700
VI	200	100	-	-	-	100	-	100	-	-	-	220	720
VII	-	110	270	-	1000	100	-	120	160	170	240	180	2,350
TOTAL	720	660	1990	1400	4000	730	160	800	430	320	370	1050	12,630

APPENDIX 8.20

RECOMMENDED STORMWATER SYSTEM PHASE I CONSTRUCTION COSTS (THOUSAND JORDAN DINARS)

DRAINAGE LINE	MATERIAL			LABOR			TOTAL FOREIGN M+L	TOTAL LOCAL M+L	TOTAL
	TOTAL	FOREIGN	LOCAL	TOTAL	FOREIGN	LOCAL			
I	26	9	17	14	2	12	11	29	40
II	46	16	30	24	4	20	20	50	70
III	189	66	123	102	15	87	81	210	291
IV	242	85	157	131	20	111	105	268	373
V	35	12	23	13	3	16	15	39	54
VI	40	14	26	21	3	18	17	44	61
VII	92	32	60	49	7	42	39	102	141
					TOTAL		288	742	1030

APPENDIX 8.21

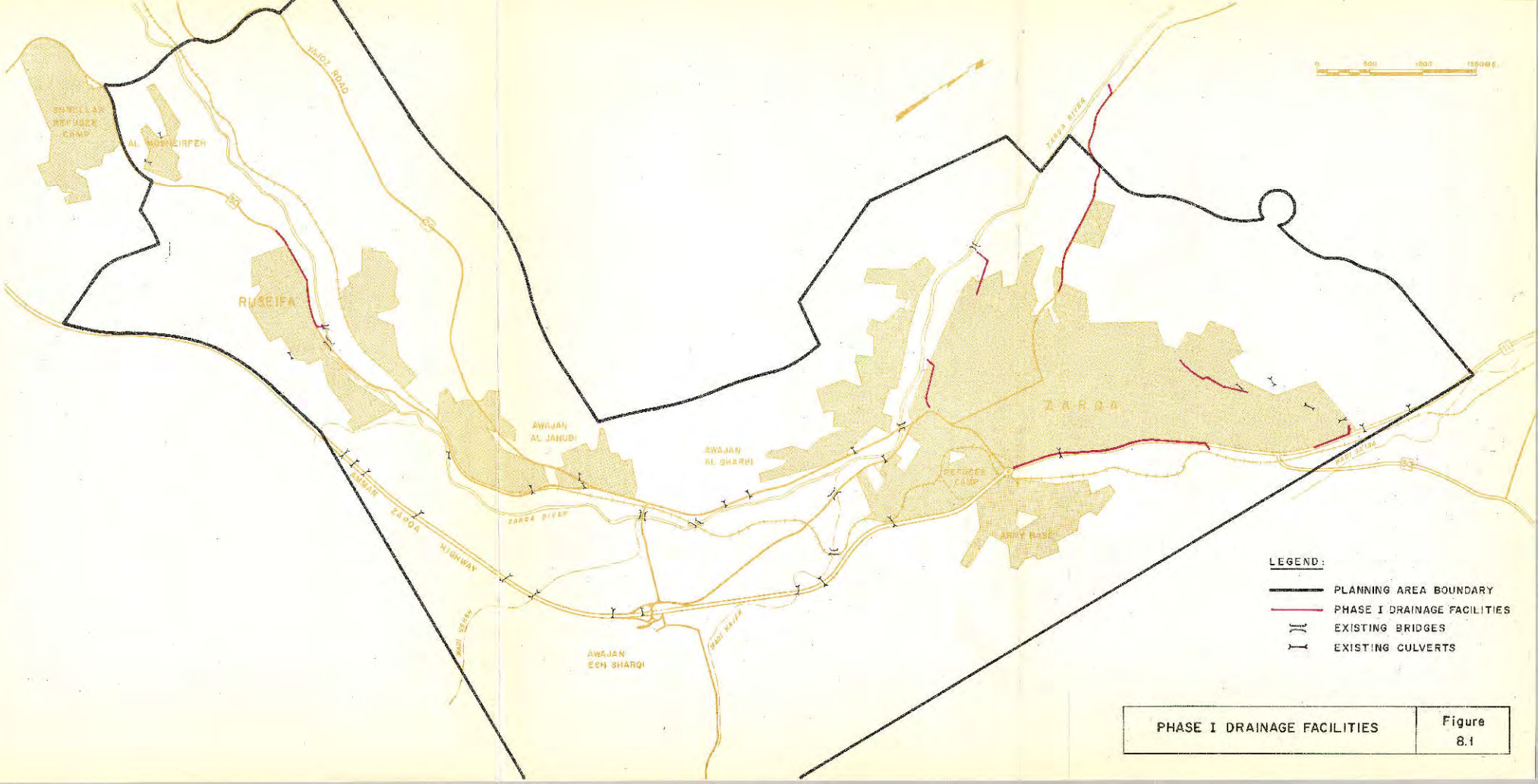
RECOMMENDED STORMWATER SYSTEM PHASE II - LENGTHS OF PIPE - METERS

DRAINAGE LINE No.	CONCRETE PIPE DIAMETERS IN MILLIMETER										TOTAL
	300	350	400	450	500	600	650	700	800	1000	
I	60	-	-	-	40	-	-	280	-	-	380
II	380	-	40	-	40	-	-	-	-	-	460
III	8020	1500	1420	710	2130	850	140	560	-	-	15,330
IV	1090	430	570	620	360	40	-	350	290	350	4,100
V	1040	-	290	250	360	220	-	-	780	300	3,240
VI	1220	140	120	180	270	410	-	-	10	-	2,350
VII	60	-	320	-	40	-	-	-	-	-	420
TOTAL	11870	2070	2760	1760	3240	1520	140	1190	1080	650	26,280

APPENDIX 8.22

RECOMMENDED STORMWATER SYSTEM PHASE II CONSTRUCTION COSTS (THOUSAND JORDAN DINARS)

DRAINAGE LINE	MATERIAL			LABOR			TOTAL FOREIGN M+L	TOTAL LOCAL M+L	TOTAL
	TOTAL	FOREIGN	LOCAL	TOTAL	FOREIGN	LOCAL			
I	18	6	12	10	2	8	8	20	28
II	10	4	6	6	1	5	5	11	16
III	395	138	257	212	32	180	170	437	607
IV	139	49	90	75	11	64	60	154	214
V	122	43	79	65	10	55	53	134	187
VI	62	22	40	33	5	28	27	68	95
VII	12	4	8	7	1	6	5	14	19
					TOTAL		328	838	1166



PHASE I DRAINAGE FACILITIES | Figure 8.1

CHAPTER 9.0

PRELIMINARY RATE STUDY

TABLE 9.1

ZARQA WATER DEPARTMENT OPERATING EXPENDITURES (THOUSANDS OF JD - NO INFLATION)

ITEM	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Salaries	83.9	94.9	137.3	150.0	160.0	165.0	170.0	175.0	180.0	185.0	190.0	195.0	200.0	205.0
Maint. of Struct.	0.1	0.1	0.1	0.1	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7
Maint. of System	0.1	0.1	0.1	0.1	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7
Buildings	1.0	1.3	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
Fuel	2.4	3.0	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Pumping Power	35.0	31.6	150.0	160.0	169.7	179.6	189.7	199.9	240.7	252.2	263.8	275.6	287.6	299.8
Parts and Tools	4.4	5.6	6.3	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0
Chlorine	2.6	2.2	2.5	3.0	3.2	3.4	3.6	3.7	4.5	4.7	4.9	5.2	5.4	5.6
Administration	3.1	2.0	5.8	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0
Transportation	0.1	0.0	0.2	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0
Miscellaneous	0.5	0.2	0.4	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0
TOTAL	133.2	141.0	306.8	335.7	356.9	372.3	388.3	403.9	451.2	468.2	485.7	503.1	521.0	538.7

Note: 1977 to 1979 Actual 1980 Budget 1981 to 1990 Estimated

5 % Inflation Compounded	-	374.7	410.5	449.5	490.9	575.8	627.4	683.4	743.3	808.2	877.5
7.5 % Inflation Compounded	-	383.7	430.2	482.4	539.4	647.7	722.6	805.8	897.3	998.9	1110.3
10 % Inflation Compounded	-	392.6	450.5	516.8	591.3	726.7	829.4	946.5	1078.4	1228.5	1397.2
15 % Inflation Compounded	-	410.4	492.4	590.5	706.4	907.5	1083.0	1292.0	1539.0	1832.8	2179.3

TABLE 9.2

RUSEIFA WATER DEPARTMENT OPERATING EXPENDITURES (THOUSANDS OF JD - NO INFLATION)

ITEM	1978 (1)	1978 (2)	1979 (2)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Salaries	10.0	11.1	18.0	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0
Maint. of Struct.	0.1	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1
Maint. of System	0.2	0.2	2.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Buildings	0.6	2.5	3.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Fuel	0.4	0.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Pumping Power	18.5	20.0	19.0	21.0	22.4	23.8	25.3	26.8	33.8	35.6	37.4	39.3	41.2	43.1
Parts and Tools	3.2	3.5	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8
Chlorine	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.8	0.8	0.9	0.9	1.0	1.0
Administration	0.7	0.8	1.3	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Transportation	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6
Miscellaneous	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7
TOTAL	35.5	40.9	47.4	47.7	49.7	52.0	54.1	56.3	64.2	66.7	69.2	71.8	74.4	77.0

(1) Actual (2) Budget

5 % Inflation Compounded	52.2	57.3	62.6	68.4	81.9	89.4	97.4	106.1	115.4	125.4
7.5 % Inflation Compounded	53.4	60.1	67.2	75.2	92.2	102.9	114.8	128.0	142.6	158.7
10 % Inflation Compounded	54.7	62.9	72.0	82.4	103.4	118.2	134.8	153.9	175.4	199.7
15 % Inflation Compounded	57.2	68.8	82.3	98.5	129.1	154.3	184.1	219.6	261.7	311.5

TABLE 9.3

ZARQA-RUSEIFA JOINT WATER AGENCY

ESTIMATED OPERATING EXPENDITURES (THOUSANDS OF JD - NO INFLATION)

ITEM	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Salaries	180.5	186.0	191.5	197.0	202.5	208.0	213.5	219.0	224.5	230.0
Maint. of Struct.	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
Maint. of System	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7
Buildings	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
Fuel	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Pumping Power	192.1	203.4	215.0	226.7	274.5	287.8	301.2	314.9	328.8	342.9
Parts and Tools	8.4	8.6	8.7	8.9	9.0	9.2	9.3	9.5	9.6	9.8
Chlorine	3.7	4.0	4.2	4.3	5.3	5.5	5.8	6.1	6.4	6.6
Administration	8.0	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0
Transportation	2.1	2.1	2.2	2.2	2.4	2.4	2.5	2.5	2.6	2.6
Miscellaneous	0.9	0.9	1.1	1.1	1.3	1.3	1.5	1.5	1.7	1.7
TOTAL	406.6	424.3	442.4	460.2	515.4	534.9	554.9	574.9	595.4	615.7
5 % Inflation Comp'd	426.9	467.8	512.1	559.3	657.7	716.8	780.8	849.4	923.6	1,002.9
7.5 % " "	437.1	490.3	549.6	614.6	739.9	825.5	920.6	1,025.3	1,141.5	1,269.0
10 % " "	447.3	513.4	588.8	673.7	830.1	947.6	1,081.3	1,232.3	1,403.9	1,596.9
15 % " "	467.6	561.2	672.8	804.9	1,036.6	1,237.3	1,476.1	1,758.6	2,094.5	2,490.8

TABLE 9.4

ZARQA WATER DEPARTMENT

FINANCIAL STATEMENTS 1977-1980 (THOUSANDS OF JORDAN DINARS)

ITEM	1977 ACTUAL	1978 ACTUAL	1979 ACTUAL	1980 BUDGET
GROSS REVENUE				
Water Sales	186.6	204.7	373.5	530.0
Meter Repair	18.0	15.6	15.0	20.0
Connection Fees	2.8	7.8	14.0	15.0
Bank Interest	0.5	0.6	1.3	1.5
Pension Revenue	1.0	1.1	1.2	1.6
Miscellaneous	10.7	3.1	6.6	23.0
TOTAL	219.6	232.9	411.6	591.1
OPERATING EXPENDITURES	133.2	141.0	306.8	335.7
NET OPERATING INCOME	86.4	91.9	104.8	255.4
CAPITAL IMPROVEMENTS	39.9	53.6	51.7	285.0
DEBT SERVICE				
Existing IDA Loan	30.9	27.6	24.4	24.4
NET INCOME	15.6	10.7	28.7	(54.0)
CUMULATIVE CASH	28.2(1)	38.9	67.6	13.6
DEBT SERVICE COVERAGE	2.80	3.33	4.30	10.[illegible]
NET FIXED ASSETS	652.6	684.3	712.7	755.[illegible]
DEPRECIATION	21.9	22.9	24.2	25.5
RATE OF RETURN	10.0	10.3	11.5	31.3

(1) prior balance required to give JD 67.6 cash balance on Dec. 31, 1979, a known figure.

TABLE 9.5

RUSEIFA WATER DEPARTMENT

FINANCIAL STATEMENTS 1978-1979 (THOUSANDS OF JORDAN DINARS)

ITEM	1978 BUDGET	1978 ACTUAL	1979 BUDGET
GROSS REVENUE			
Water Sales	62.3	68.2	78.8
Meter Fees	0.5	1.0	0.7
Miscellaneous	0.5	0.7	0.4
TOTAL	63.3	69.9	79.9
OPERATING EXPENDITURES	40.9	35.5	47.4
NET OPERATING INCOME	22.4	34.4	32.5
CAPITAL IMPROVEMENTS	9.0	8.8	27.3
DEBT SERVICE	10.9	10.9	10.3
NET INCOME	2.5	14.7	(5.1)
CUMULATIVE CASH	7.5(1)	19.7	14.6
DEBT SERVICE COVERAGE	3.75	3.26	4.60
NET FIXED ASSETS	171.0	171.0	168.7
DEPRECIATION	2.3	2.3	4.9
RATE OF RETURN	16.8	26.8	16.2

(1) Balance Jan. 1, 1978 5.0

TABLE 9.6

ZARQA-RUSEIFA JOINT WATER AGENCY

PRO FORMA INCOME STATEMENT - EXISTING RATES & NO INFLATION

(THOUSANDS OF JD)

ITEM	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TOTAL WATER SALES - 1000 m^3										
ZARQA	4,050	4,357	4,675	5,019	6,122	6,512	6,916	7,353	7,765	8,209
RUSEIFA	903	977	1,054	1,139	1,452	1,553	1,657	1,770	1,878	1,994
REVENUES										
Zarqa Sales @ 120 fils/m^3	486.0	522.8	561.0	602.3	734.6	781.4	829.9	882.4	931.8	985.1
Zarqa Other	38.0	39.0	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0
Ruseifa Sales @ 115 fils/m^3	103.8	112.4	121.2	131.0	167.0	178.6	190.6	203.6	216.0	279.3
Ruseifa Other	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5
TOTAL	629.5	676.1	724.3	776.6	946.1	1,005.7	1,067.4	1,134.1	1,197.1	1,264.9
OPERATING EXPENDITURES	406.6	424.3	442.4	460.2	515.4	534.9	554.9	574.9	595.4	615.7
NET OPERATING INCOME	222.9	251.8	281.9	316.4	430.7	470.8	512.5	559.2	601.7	649.2
DEBIT SERVICE										
Existing - Zarqa	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	-	-
Existing - Ruseifa	17.4	17.0	16.5	9.5	9.1	3.7	3.5	3.3	3.2	-
Proposed	-	-	-	-	283.3	283.3	283.3	283.3	283.3	283.3
TOTAL	41.8	41.4	40.9	33.9	316.8	311.4	311.2	311.0	286.5	283.3
CAPITAL IMPROVEMENTS										
ZARQA	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
RUSEIFA	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
TOTAL	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
NET INCOME	56.1	85.4	116.0	157.5	(11.1)	34.4	76.3	123.2	190.2	240.9
CUMULATIVE CASH	56.1	141.5	257.5	415.0	403.9	438.3	514.6	637.8	828.0	1,068.9
DEBT SERVICE COVERAGE	5.33	6.08	6.89	9.33	1.36	1.51	1.65	1.80	2.10	2.29
DEPRECIATION	33.2	37.5	41.7	46.0	135.5	139.8	144.0	148.3	152.5	156.8
NET FIXED ASSETS	1,056.5	1,144.1	1,227.4	4,717.4	4,706.9	4,692.2	4,673.2	4,649.9	4,622.4	4,590.7
RATE OF RETURN (%)	19.3	19.5	20.3	9.1	6.3	7.0	7.9	8.8	9.7	10.7

TABLE 9.7

ZARQA-RUSEIFA JOINT WATER AGENCY

PRO FORMA INCOME STATEMENT - EXISTING RATES & 7.5 % INFLATION

(THOUSAND OF JD)

ITEM	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TOTAL WATER SALES - 1000 m^3										
ZARQA	4,050	4,357	4,675	5,019	6,122	6,512	6,916	7,353	7,765	8,209
RUSEIFA	903	977	1,054	1,139	1,452	1,553	1,657	1,770	1,878	1,994
REVENUES										
Zarqa Sales @ 120 fils/m^3	486.0	522.8	561.0	602.3	734.6	781.4	829.9	882.4	931.8	985.1
Zarqa Other	38.0	39.0	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0
Ruseifa Sales @ 115 fils/m^3	103.8	112.4	121.2	131.0	167.0	178.6	190.6	203.6	216.0	229.3
Ruseifa Other	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5
TOTAL	629.5	676.1	724.3	776.6	946.1	1,005.7	1,067.4	1,134.1	1,197.1	1,264.9
OPERATING EXPENDITURES	437.1	490.3	549.6	614.6	739.9	825.5	920.6	1,025.3	1,141.5	1,269.0
NET OPERATING INCOME	192.4	185.8	174.7	162.0	206.2	180.2	146.8	108.8	55.6	(4.1)
DEBIT SERVICE										
Existing - Zarqa	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	-	-
Existing - Ruseifa	17.4	17.0	16.5	9.5	9.1	3.7	3.5	3.3	3.2	-
Proposed	-	-	-	-	283.3	283.3	283.3	283.3	283.3	283.3
TOTAL	41.8	41.4	40.9	33.9	316.8	311.4	311.2	311.0	286.5	283.3
CAPITAL IMPROVEMENTS										
ZARQA	107.5	115.6	124.2	133.5	143.6	154.3	165.9	178.3	191.7	206.1
RUSEIFA	26.9	28.9	31.1	33.4	35.9	38.6	41.5	44.6	48.0	51.6
TOTAL	134.4	144.5	155.3	166.9	179.5	192.9	207.4	222.9	239.7	257.7
NET INCOME	16.2	(0.1)	(21.5)	(38.8)	(290.1)	(324.1)	(371.8)	(425.1)	(470.6)	(545.1)
CUMULATIVE CASH	16.2	16.1	(5.4)	(44.2)	(334.3)	(658.4)	(1,030.2)	(1,455.3)	(1,925.9)	(2,471.0)
DEBT SERVICE COVERAGE	4.60	4.49	4.27	4.78	0.65	0.58	0.47	0.35	0.19	(0.01)
DEPRECIATION	33.2	37.8	42.7	48.0	138.9	145.1	151.7	158.7	166.3	174.5
NET FIXED ASSETS	1,065.9	1,172.5	1,285.1	4,815.0	4,855.5	4,903.3	4,959.1	5,023.3	5,096.7	5,179.8
RATE OF RETURN (%)	16.1	13.2	10.7	3.7	1.4	0.7	(0.1)	(1.0)	(2.2)	(3.5)

TABLE 9.8

ZARQA-RUSEIFA JOINT WATER AGENCY

PRO FORMA INCOME STATEMENT - PROPOSED RATES & 7.5 % INFLATION

(THOUSANDS OF JD)

ITEM	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TOTAL WATER SALES - 1000 m^3										
ZARQA	4,050	4,357	4,675	5,019	6,122	6,512	6,916	7,353	7,765	8,209
RUSEIFA	903	977	1,054	1,139	1,452	1,553	1,657	1,770	1,878	1,994
REVENUES										
Zarqa Sales @ 120 fils/m^3	486.0	522.8	561.0	-	-	-	-	-	-	-
Zarqa Other	38.0	39.0	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0
Ruseifa Sales @ 115 fils/m^3	103.8	112.4	121.2	-	-	-	-	-	-	-
Ruseifa Other	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5
Z-R Sales @ 165 fils/m^3	-	-	-	1,016.1	1,249.7	1,330.7	1,414.5	1,505.3	1,591.1	1,683.5
TOTAL	629.5	676.1	724.3	1,104.4	1,294.2	1,376.4	1,461.4	1,553.4	1,640.4	1,734.0
OPERATING EXPENDITURES	437.1	490.3	549.6	614.6	739.9	825.5	920.6	1,025.3	1,141.5	1,269.0
NET OPERATING INCOME	192.4	185.8	174.7	489.8	554.3	550.9	540.9	528.1	498.9	465.0
DEBT SERVICE										
Existing - Zarqa	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	-	-
Existing - Ruseifa	17.4	17.0	16.5	9.5	9.1	3.7	3.5	3.3	3.2	-
Proposed	-	-	-	-	283.3	283.3	283.3	283.3	283.3	283.3
TOTAL	41.8	41.4	40.9	33.9	316.8	311.4	311.2	311.0	286.5	283.3
CAPITAL IMPROVEMENTS										
ZARQA	107.5	115.6	124.2	133.5	143.6	154.3	165.9	178.3	191.7	206.1
RUSEIFA	26.9	28.9	31.1	33.4	35.9	38.6	41.5	44.6	48.0	51.6
TOTAL	134.4	144.5	155.3	166.9	179.5	192.9	207.4	222.9	239.7	257.7
NET INCOME	16.2	(0.1)	(21.5)	289.0	58.0	46.6	22.2	(5.8)	(27.3)	(76)
CUMULATIVE CASH	16.2	16.1	(5.4)	283.6	341.6	388.2	410.4	404.6	377.3	301.3
DEBT SERVICE COVERAGE	4.60	4.49	4.27	14.44	1.75	1.77	1.74	1.70	1.74	1.64
DEPRECIATION	33.2	37.8	42.7	48.0	138.9	145.1	151.7	158.7	166.3	174.5
NET FIXED ASSETS	1,065.9	1,172.5	1,285.1	4,815.0	4,855.5	4,903.3	4,959.1	5,023.3	5,096.7	5,179.8
RATE OF RETURN (%)	16.1	13.2	10.7	14.5	8.6	8.3	7.9	7.4	6.6	5.7

TABLE 9.9

SUMMARY PHASE I LAND COST

	JD
TREATMENT PLANT	
Phase I (See Table 7.7)	450,000
Phase II (See Table 7.7)	174,000
EAST SIDE PUMPING STATION	
1600 m^2 @ JD 10/m^2	16,000
RUSEIFA TRUNK	
Permanent 17,000 m^2 @ JD 1/m^2	17,000
Temporary 21,000 m^2 @ JD 1/m^2	21,000
STP TO AWJAN ESH SHARQI TRUNK	
Permanent 18,000 m^2 @ JD 1/m^2	18,000
Temporary 22,000 m^2 @ JD 1/m^2	22,000
EAST SIDE FORCE MAIN	
Permanent 8,000 m^2 @ JD 1/m^2	8,000
Temporary 10,000 m^2 @ JD 1/m^2	10,000
TOTAL	736,000

TABLE 9.10

ZARQA-RUSEIFA JOINT SEWERAGE AGENCY

RECOMMENDED STAFF

ADMINISTRATION		
Executive Director	1	
Chief Engineer	1	
Assistant Engineer	3	
Secretary	4	
Billing Clerk	1	
Accountant	1	
Bookkeeper	1	
Industrial Waste Technician	2	
Subtotal		14
TRUNK		
Supervisor	1	
Trunk Sewer Foreman	3	
Laborer	9	
Pumping Station Operator	9	
Pumping Station Mechanic	1	
Subtotal		23
COLLECTION		
Supervisor	1	
Foreman	3	
Laborer	9	
Subtotal		13
PLANT		
Superintendent	1	
Administrative Assistant	1	
Clerk	1	
Chemist	1	
Laboratory Technician	1	
Wastewater Lead Operator	4	
Wastewater Operator	13	
Dewatering Lead Operator	1	
Dewatering Operator	4	
Drivers/Laborers	3	
Power Generation Operator	4	
Maintenance Supervisor	1	
Mechanics	2	
Electricians	2	
Subtotal		39
TOTAL		89

TABLE 9.11

ZARQA-RUSEIFA JOINT SEWERAGE AGENCY

PRO FORMA INCOME STATEMENT - PROPOSED RATE & 7.5% INFLATION

(THOUSANDS OF JORDANIAN DINARS)

	1984	1985	1986	1987	1988	1989	1990
TOTAL BILLABLE SEWAGE FLOW - 1000 m^3							
Domestic & Commercial	1,840	4,597	4,960	5,341	5,757	6,162	6,485
Industrial	1,418	2,669	2,501	2,321	2,167	2,000	1,832
Army Base	190	380	380	380	380	380	380
TOTAL	3,448	7,646	7,841	8,042	8,304	8,542	8,697
REVENUE @ 375 Fils/m^3	1,293	2,867	2,940	3,016	3,114	3,203	3,261
OPERATIONAL EXPENDITURES	328	366	407	453	503	558	620
NET OPERATING INCOME	965	2,501	2,533	2,563	2,611	2,645	2,641
DEBT SERVICE	-	2,574	2,574	2,574	2,574	2,574	2,574
CAPITAL IMPROVEMENT	848	912	980	1,053	1,133	1,217	1,309
NET INCOME	117	(985)	(1,021)	(1,064)	(1,096)	(1,146)	(1,242)
CUMULATIVE CASH	117	(868)	(1,889)	(2,953)	(4,049)	(5,195)	(6,437)
DEBT SERVICE COVERAGE	-	0.97	0.98	1.00	1.01	1.03	1.03
NET FIXED ASSETS	31,065	31,181	31,342	31,551	31,814	32,133	32,514
DEPRECIATION	775	796	819	844	870	898	928
RATE OF RETURN	0.6	5.5	5.5	5.5	5.5	5.5	5.3

CHAPTER 10.0

ECONOMIC AND SENSITIVITY ANALYSIS

TABLE 10.1

ZARQA-RUSEIFA JOINT WATER AGENCY

INTERNAL ECONOMIC RATE OF RETURN (1980-2024)

(THOUSAND - JD)

YEAR	INCREMENTAL RECEIPTS	INCREMENTAL COST	NET INCREMENTAL CASH FLOW	PRESENT WORTH @ 7%	PRESENT WORTH @ 8%
1980	0	150	(150)	(150)	(150)
1981	0	625	(625)	(584)	(579)
1982	37	1,513	(1,476)	(1,105)	(1,265)
1983	75	1,524	(1,449)	(939)	(1,150)
1984	162	159	3	2	2
1985	314	222	92	66	63
1986	356	252	104	69	66
1987	399	338	61	38	36
1988	446	812	(366)	(213)	(198)
1989	505	842	(337)	(183)	(169)
1990	568	872	(304)	(155)	(141)
1991	643	390	253	120	109
1992	729	423	306	136	122
1993	819	456	363	151	133
1994	913	489	424	164	144
1995	1,010	532	478	173	151
1996	1,111	565	546	185	159
1997	1,214	598	616	195	167
1998	1,322	631	691	204	173
1999	1,433	664	769	213	178
2000	1,544	697	847	219	182
2001-24	37,056	16,728	20,328	2,332	1,732
			21,174	938	(235)

Approximate Rate = $7 + \frac{938}{1173}(8-7) = 7.80$

Say 7.8%

TABLE 10.2

ZARQA-RUSEIFA JOINT SEWERAGE AGENCY

INTERNAL ECONOMIC RATE OF RETURN (1980 - 2024)

(THOUSAND - JD)

YEAR	INCREMENTAL RECEIPTS	INCREMENTAL COST	NET INCREMENTAL CASH FLOW	PRESENT WORTH @ 3%	PRESENT WORTH @ 4%
1980	0	483	(483)	(483)	(483)
1981	0	7,000	(7,000)	(6,796)	(6,731)
1982	0	9,250	(9,250)	(8,719)	(8,553)
1983	0	9,259	(9,259)	(8,473)	(8,231)
1984	775	5,897	(5,122)	(4,551)	(4,378)
1985	1,720	908	812	700	667
1986	1,764	918	846	709	669
1987	1,810	1,261	549	446	417
1988	1,868	2,938	(1,070)	(845)	(782)
1989	1,922	3,948	(2,026)	(1,553)	(1,423)
1990	1,956	2,959	(1,003)	(746)	(678)
1991	2,120	1,077	1,043	753	678
1992	2,277	1,088	1,189	834	743
1993	2,440	1,100	1,340	913	805
1994	2,610	1,111	1,499	991	866
1995	2,787	1,122	1,665	1,069	925
1996	2,968	1,133	1,835	1,144	980
1997	3,159	1,144	2,015	1,219	1,035
1998	3,358	1,156	2,202	1,293	1,087
1999	3,564	1,167	2,397	1,367	1,138
2000	3,775	1,178	2,597	1,438	1,185
2001-24	90,600	28,272	62,328	24,202	17,770
			47,104	4,912	(2,294)

Approximate Rate = $3 + \frac{4912}{7206}(4-3) = 3.68$

Say 3.7%

TABLE 10.3

COMBINED WATER AND SEWERAGE PROJECT

INTERNAL ECONOMIC RATE OF RETURN (1980-2024)

(THOUSAND JD)

YEAR	INCREMENTAL RECEIPTS	INCREMENTAL COST	NET INCREMENTAL CASH FLOW	PRESENT WORTH @ 4%	PRESENT WORTH @ 5%
1980	0	633	(633)	(633)	(633)
1981	0	7,625	(7,625)	(7,331)	(7,262)
1982	37	10,763	(10,726)	(9,917)	(9,728)
1983	75	10,783	(10,708)	(9,519)	(9,250)
1984	937	6,056	(5,119)	(4,376)	(4,211)
1985	2,034	1,130	904	743	708
1986	2,120	1,170	950	751	709
1987	2,209	1,599	610	464	434
1988	2,314	3,750	(1,436)	(1,049)	(972)
1989	2,427	4,790	(2,363)	(1,660)	(1,523)
1990	2,524	3,831	(1,307)	(883)	(802)
1991	2,763	1,467	1,296	842	758
1992	3,006	1,511	1,495	934	832
1993	3,259	1,556	1,703	1,023	903
1994	3,523	1,600	1,923	1,111	971
1995	3,797	1,654	2,143	1,190	1,031
1996	4,079	1,698	2,381	1,291	1,091
1997	4,373	1,742	2,631	1,351	1,148
1998	4,680	1,787	2,893	1,428	1,202
1999	4,997	1,831	3,166	1,503	1,253
2000	5,319	1,875	3,444	1,572	1,298
2001-24	127,656	45,000	82,656	23,565	17,349
			68,278	2,380	(4,694)

Approximate Rate = $4 + \frac{2380}{7074}(4-5) = 4.36$

Say 4.4%

TABLE 10.4

COSTS OF WASTEWATER DISPOSAL

INCOME GROUP	RANGE OF ANNUAL INCOME (JD)	AVERAGE WATER INTAKE (M^3/MONTH)	PERCENTAGE DISPOSED IN CESSPOOL	CESSPOOL DISCHARGE (M^3/MONTH)	PROPORTIONAL FREQUENCY OF OF PUMPOUTS	ANNUAL EXPENDITURE FOR PUMPOUTS (JD)	AVERAGE PUMPOUT EXPENDITURE AS PERCENTAGE OF INCOME
Lowest Fifth	0 - 1000	5.0	60	3.0	1.0	3.500	0.3% or more
Second Fifth	1001 - 1320	6.5	65	4.2	1.4	4.900	0.4 - 0.5%
Middle Fifth	1321 - 1620	8.9	70	6.2	2.0	7.000	0.4 - 0.5%
Fourth Fifth	1621 - 2460	12.2	75	9.2	3.0	10.500	0.4 - 0.6%
Upper Fifth	2461 or more	15.0	80	12.0	3.9	13.650	0.6% or less

Note: Assumes an average number of 2.0 pumpouts per household per year and an average cost of 3.500 JD.

TABLE 10.5

ZARQA-RUSEIFA JOINT WATER AGENCY

FINANCIAL CHARACTERISTICS WITH ALTERNATIVE INFLATION

ITEM	INFLATION RATE (%)				
	0	5	7.5	10	15
EXISTING RATE					
Year(s) Net Income Deficit	1985	1985-90	1982-90	1982-90	1981-90
1990 Cumul. Cash-JDx1000	1069	435	(2471)	(4063)	(8075)
Aver.1985-1990 D.S. Cover.	1.79	0.93	0.37	(0.38)	(1.96)
Aver. 1985-1990 R. of Return	8.4	2.6	(0.8)	(4.6)	(13.4)
PROPOSED RATE					
Proposed Rate (fils/m^3)	110	145	165	190	255
Year(s) Net Income Deficit	1984 & 1985	0	1982-3 & 1988-90	1982-3 & 1988-90	1981-3 & 1988-90
1990 Cumul Cash - JDx1000	533	435	301	148	(7)
Aver.1985-1990 D.S. Cover.	1.52	1.69	1.72	1.80	2.03
Aver.1985-1990 R.of Return	6.7	7.5	7.4	7.7	8.8

TABLE 10.6

ZARQA-RUSEIFA JOINT SEWERAGE AGENCY

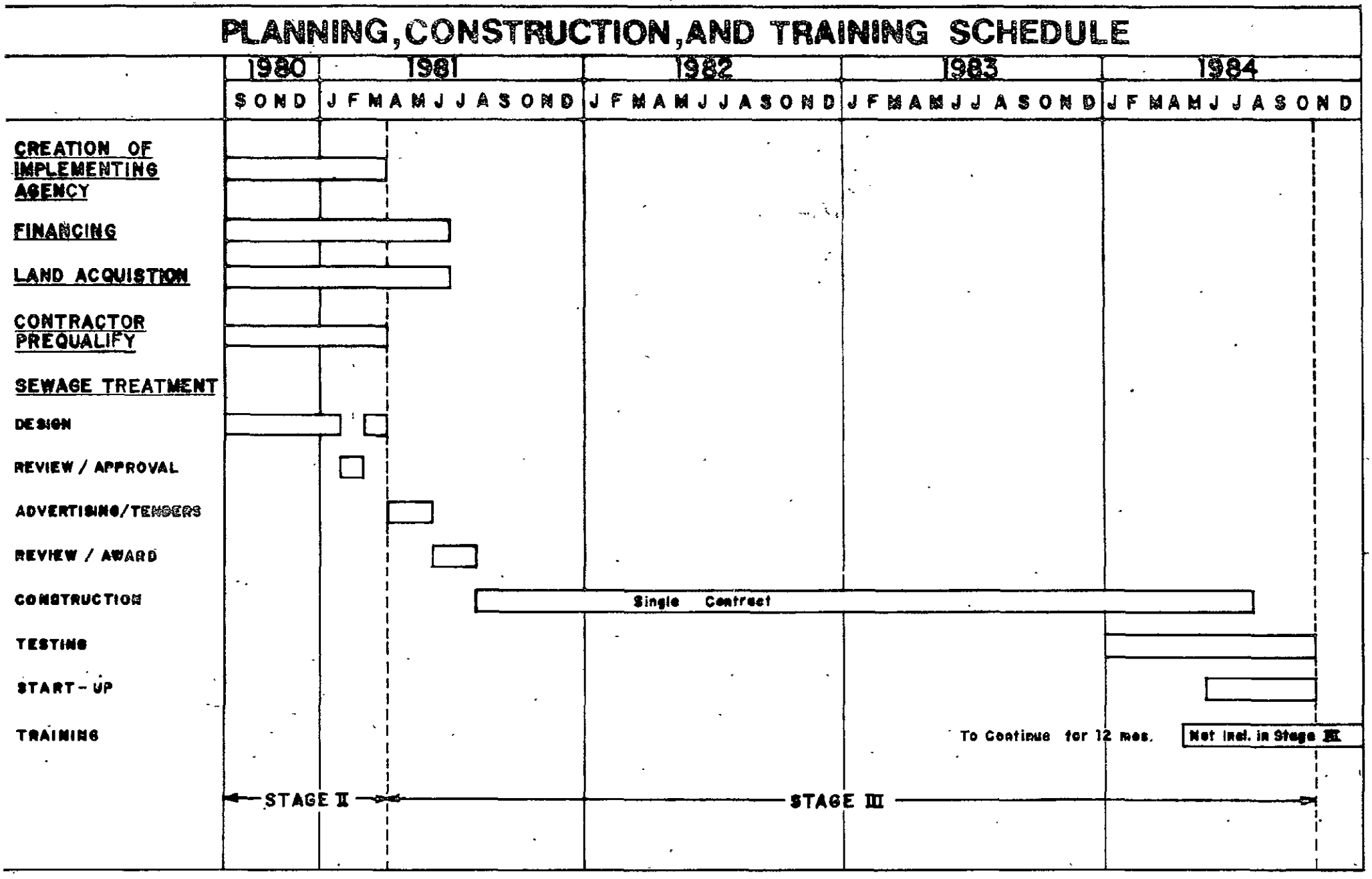
FINANCIAL CHARACTERISTICS WITH ALTERNATIVE INFLATION

ITEM	INFLATION RATE (%)				
	0	5	7.5	10	15
Proposed Rate	225	315	375	440	600
Year(s) Net Income Deficit	1984-90	1985-90	1985-90	1985-90	1987-90
1990 Cumul. Cash-JDx1000	(9984)	(7899)	(6437)	(5948)	(1604)
Aver. Subsidy Req'd JDx1000*	1426	1128	920	850	229
Aver. 1985-1990 D.S.Coverage	0.61	0.84	1.00	1.17	1.58
Aver. 1985-1990 R.of Return	2.4	4.3	5.5	6.7	9.5

* (1984 to 1990 - 7 years)

CHAPTER 12.0

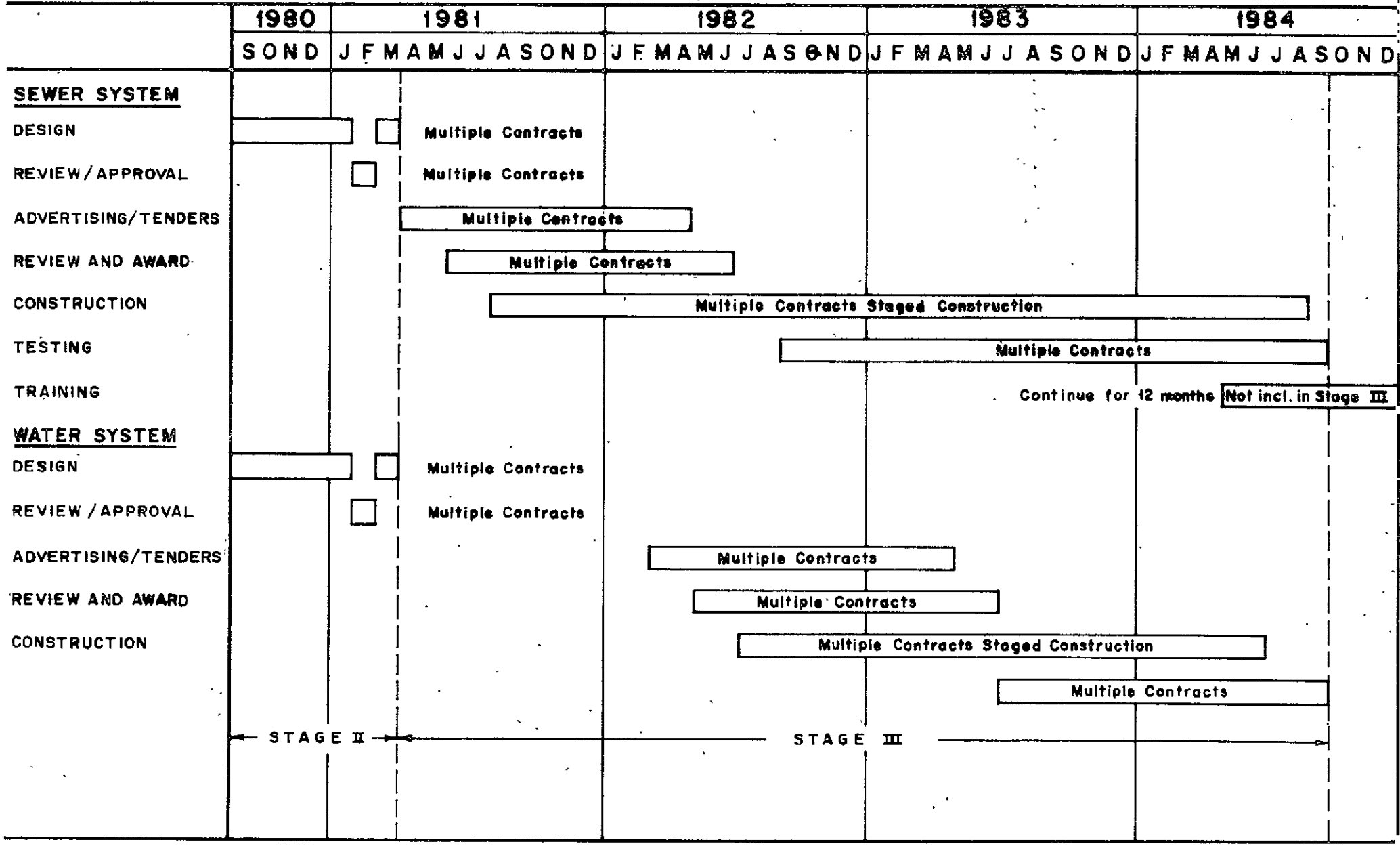
RECOMMENDED PROJECT



SHEET 1 OF 3

Figure 12.1

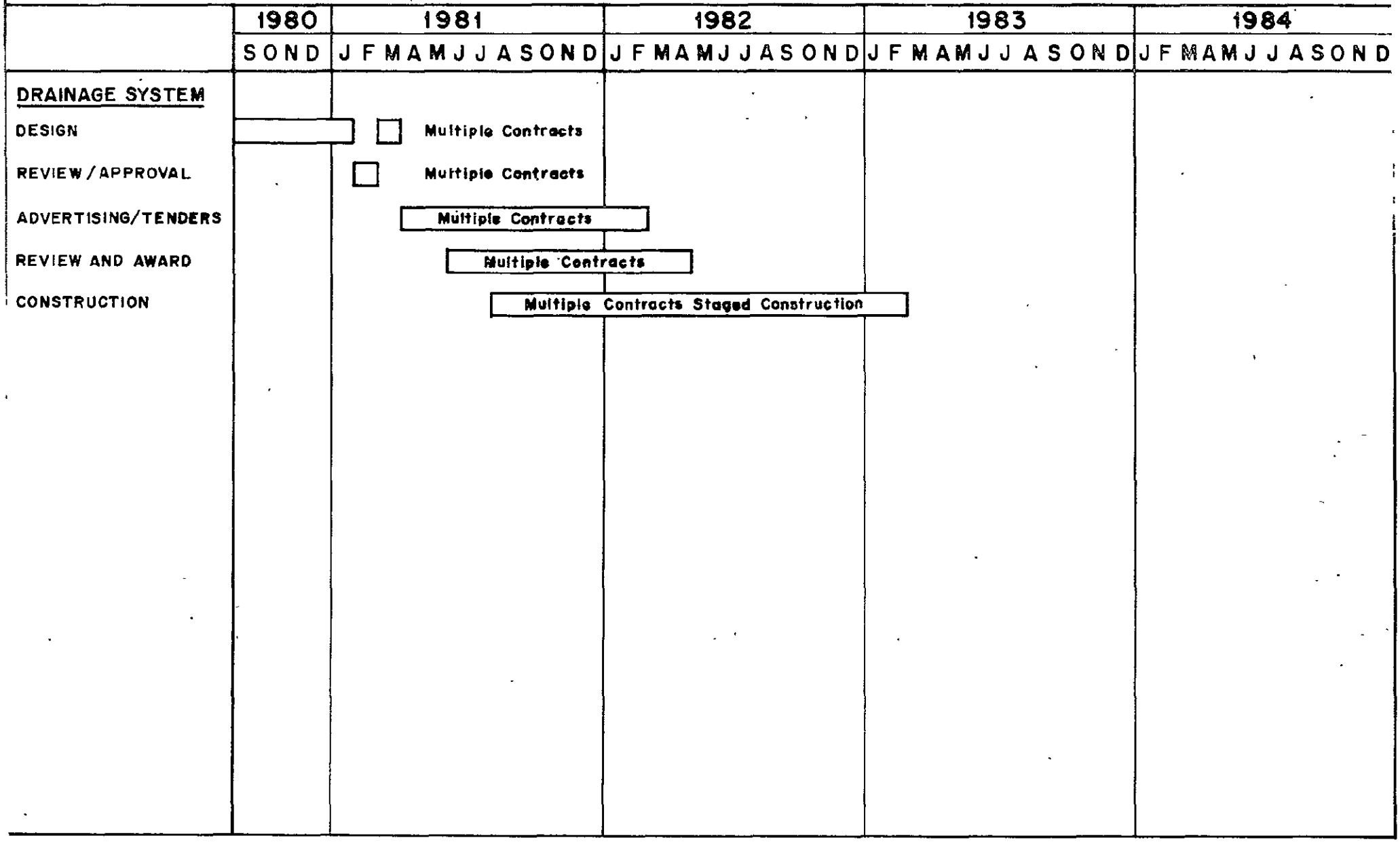
PLANNING, CONSTRUCTION, AND TRAINING SCHEDULE



SHEET 2 OF 3

Figure 12.1

PLANNING, CONSTRUCTION, AND TRAINING SCHEDULE



SHEET 3 OF 3

Figure 12.1

Appendix 12.1

PRELIMINARY TOPIC OUTLINE
CLASSROOM TRAINING PROGRAM

I. Orientation

A. General
1. Objectives of Agency
2. Objectives of the training program
3. General health considerations and hygiene
4. Employer and employee commitments
5. Man and his relation to the environment

B. Wastewater Collection, Treatment, and Disposal System
1. Objectives
2. Sources and characteristics of wastewater
3. Introduction and identification of wastewater systems
   a. Gravity collection
   b. Pumping and force mains
   c. Treatment unit processes
   d. Disposal methods
4. Duties and responsibilities
5. On-site demonstrations
6. General work safety
7. Public health practice

II. Basic Sciences and Mathematics

A. Sciences
Relevant areas of mathematics should be taught concurrently with the following:
1. Physics
2. Electricity
3. Hydraulics
4. Chemistry
5. Practical biology and microbiology

III. Collection System Cleaning and Maintenance

A. General
1. Objectives
2. Personnel responsibilities
3. Sewer system maps
4. Physical survey
   a. Surface inspection
   b. Flow monitoring
   c. Manhole and sewer inspection techniques
   d. Force main inspections

B. Sewer and Force main Cleaning
   1. Hydraulic cleaning
      a. High velocity cleaning machines
      b. Flushing
   2. Mechanical cleaning
      a. Power bucket machines
      b. Power rodding machines
      c. Hand rodding machines
   3. Chemical controls
   4. On-site demonstrations
   5. Manpower requirements
   6. General work safety procedures

C. Sewer and Force Main Maintenance Programs
   1. General
   2. Preventive Maintenance
      a. Records management system
      b. System maintenance priorities
      c. Preventive maintenance crews
      d. Equipment and materials
   3. Corrective maintenance
      a. Records management system
      b. Repair priorities
      c. Corrective maintenance crews
      d. Equipment and materials
   4. On-site demonstrations
   5. General work safety procedures

IV. Operation and Maintenance of Pumping Facilities and Treatment Plants

A. General
   1. Objectives
   2. Responsibilities of operation and maintenance personnel
   3. Introduction to wastewater pumping and treatment systems
   4. Characterization of wastewater

B. Wastewater Pumping
   1. Process description
   2. Equipment types, appurtenances, and controls
      a. Centrifugal pumps
      b. Positive displacement pumps
      c. Pneumatic ejectors
   3. Operational procedures
      a. Pre-start-up and safety procedures
      b. Start-up procedures
      c. Routine operation procedures
      d. Shutdown procedures
      e. Abnormal and emergency operating procedures

4. Records management program
   a. Data collection
   b. Pumping time
   c. Flow rates and total pumpage
5. Maintenance management program
   a. Records system
   b. Routine maintenance
   c. Preventive maintenance
   d. Corrective maintenance
6. On-site demonstrations

C. Wastewater Treatment Plants
1. Process descriptions
   a. Preliminary treatment
   b. Primary treatment
   c. Secondary treatment
   d. Solids handling and disposal
   e. Tertiary treatment (as applicable)
   f. Effluent disinfection and disposal
2. Process equipment controls
   a. Electrical appurtenances
   b. Instrumentation
      (1) Electrical
      (2) Pneumatic
3. Process operational procedures
   a. Pre-start-up and safety procedures
   b. Start-up procedures
   c. Routine operation procedures
   d. Shutdown procedures
   e. Abnormal and emergency operating procedures
4. Laboratory quality control
   a. Laboratory quality assurance and safety
   b. Laboratory equipment and supplies
   c. Sampling and testing
      (1) Process sampling techniques
      (2) Biological analyses
      (3) Physical and chemical analyses
   d. Process control
      (1) Interpretation of laboratory tests by unit process
      (2) Performance evaluation of unit processes
      (3) Process control parameters and strategies
   e. Laboratory records management
      (1) Work sheets
      (2) Report forms
5. Plant records management
   a. Daily plant logs
   b. Personnel daily logs
   c. Monthly plant operational and performance logs
   d. Safety and accident reports
   e. Equipment and supply inventories

f. Personnel scheduling
g. Time sheets

6. Plant maintenance management
   a. Maintenance and inventory records
   b. Preventive maintenance
      (1) Lubrication
      (2) Corrosion protection
      (3) Equipment maintenance procedures
   c. Corrective maintenance
      (1) Basic maintenance skills
      (2) Equipment repair and replacement
      (3) Electrical maintenance
      (4) Instrumentation maintenance
      (5) Engine maintenance
   d. Maintenance safety requirements
      (1) Mechanical
      (2) Electrical
      (3) Pneumatic
7. On-site demonstrations

Appendix 12.2

PRELIMINARY OUTLINES
DUAL LANGUAGE TRAINING MANUALS

Sewer System and Force Main Cleaning and Maintenance Manual

I. Overall Manual Foreword and Introduction

II. Overall Manual Table of Contents

III. Sewer Systems
- A. General
  - 1. Functional Design
  - 2. Sewer System Maps
    - a. Sewer and manhole locations and direction of flow
- B. Wastewater Flow Data
  - 1. Sewer System Subareas
  - 2. Wastewater Flow Measurement
    - a. Key Manholes
    - b. Flow monitoring techniques and procedures
      - (1) Manual depth measurements
      - (2) Instrument depth measurements
      - (3) Flow measurement control devices
    - c. Illustrations
- C. Sewer System Inspection
  - 1. Physical Survey
    - a. Surface inspections
    - b. Manhole and sewer line inspections and techniques
      - (1) Procedures
    - c. Records
    - d. Illustrations
  - 2. Internal Inspection
    - a. Preparatory cleaning
    - b. Inspection techniques and procedures
      - (1) Television inspection
      - (2) Photographic inspection
      - (3) Air testing
      - (4) Water testing
    - c. Records
    - d. Illustrations
- D. Sewer System Maintenance
  - 1. Maintenance Program
    - a. Records system
    - b. Repair priorities

2. Manhole and Sewer Line Cleaning
   a. Hydraulic cleaning techniques and procedures
   b. Mechanical cleaning techniques and procedures
   c. Hand cleaning techniques and procedures
   d. Chemical cleaning technique and procedures
   e. Flushing techniques and procedures

(The above techniques and procedures would be provided as applicable to the Agency Systems and would include appropriate safety precautions, illustrations, and equipment and manpower requirements.)

IV. Force Mains
A. General
1. Functional Design
   a. Valves
   b. Air/vacuum release valves
   c. Pipe materials
   d. Cathodic protection system (as applicable)
   e. Retriever structures (as applicable)
   f. Other vacuum release facilities (as applicable)
2. Illustrations

B. Operational Procedures
1. Monitoring Pipelines Performance
   a. Pumping rates versus pipeline flow rates
2. Routine Operating Procedures
   a. Air/vacuum release valves
   b. Cathodic protection systems
   c. Valves

C. Force Main Pipeline Maintenance
1. Maintenance Program
   a. Records systems
2. Pipeline Flushing and Cleaning
   a. Techniques and procedures

(Applicable to Agency system force mains and would include appropriate safety precautions, illustrations, and equipment and manpower requirements.)

V. Appendices
A. Safety Equipment Requirements

B. Manhole and Underground Vault Entry Safety Procedures

C. Chemical Handling Storage and Safety Procedures and Precautions

Pumping Station Operation and Maintenance Manual

(The following format would be applicable to both pump and pneumatic type pumping facilities.)

I. Overall Manual Foreword and Introduction

II. Overall Manual Table of Contents

III. Operations Division

- A. Process Sections
  - 1. Introduction
  - 2. Table of Contents
  - 3. Pump Station Description
    - a. Purpose and intent
    - b. Functional design
    - c. Wastewater characteristics
    - d. Expected performance
    - e. Operational modes
      - (1) Recommended mode
    - f. Illustrations
  - 4. Operational Procedures
    - a. Pre start-up and start-up procedures
      - (1) Safety procedures
    - b. Routine operating procedures
    - c. Shutdown procedures
    - d. Abnormal operating procedures
      - (1) Emergency operations
      - (2) Alternate operations
      - (3) Troubleshooting process operations
    - e. Illustrations
- B. Utility System Sections
  - 1. Introduction
  - 2. Table of Contents
  - 3. System Description
    - a. Purpose and intent
    - b. Functional design
    - c. Operational modes
  - 4. Operational Procedures
    - a. Pre start-up and start-up procedures
      - (1) Safety procedures and precautions
    - b. Routine operation procedures
    - c. Shutdown procedures
    - d. Abnormal operations
    - e. Illustrations
  - 5. Chemical Handling Precautions and Procedures (as applicable)

C. Instrumentation System Section
   1. Introduction
   2. Table of Contents
   3. System Description
      a. Purpose and intent
      b. Functional design
   4. Operational Mode
      a. Control systems
      b. Instruments and meters
      c. Control boards
      d. Communication system
      e. Telemetry system
      f. Illustrations

D. Appendices
   1. Safety
   2. Staffing and Personnel Recommendations
   3. Records Systems
   4. References
      a. Will consist of the list of publications, texts, and other references developed for the training program which are pertinent to pumping facilities.
   5. Contingency Plan for Emergency Operation

IV. Maintenance Division
   A. Introduction

   B. Table of Contents

   C. Maintenance System Instructions

   D. General Routine Maintenance Procedures

   E. Maintenance System
      1. Maintenance Data Cross Reference Index
      2. Equipment Maintenance Data Procedures
         a. Equipment reference number
         b. Maintenance frequency
         c. Lubricant requirements

   F. Manufacturer's Installation, Operation and Maintenance Literature

<u>Wastewater Treatment Plant Operation and Maintenance Manual</u>

I. Overall Manual Foreword and Introduction

II. Overall Manual Table of Contents

III. Operations Division

A. Unit Process Sections

1. Introduction
2. Table of Contents
3. Process Description
   a. Purpose and intent
   b. Functional design
   c. Wastewater characteristics
   d. Expected process performance
   e. Operational modes
      (1) *Recommended mode*
   f. Illustrations
4. Operational Procedures
   a. Pre start-up and start-up procedures
      (1) Safety procedures
   b. Routine operating procedures
   c. Shutdown procedures
   d. Abnormal operating procedures
      (1) Emergency operations
      (2) Alternate operations
      (3) Troubleshooting process operations
   e. Illustrations
5. Process Control and Performance Evaluation
   a. Discussion of control parameters to achieve optimum process performance
   b. Procedures for fine tuning and optimization of each unit process
   c. Procedures for calculating and interpreting control parameters
   d. Procedures for evaluating process performance and operational adjustments to achieve effluent quality requirements
   e. Illustrations

B. Laboratory Sampling and Testing Section

1. Introduction
   a. Purpose and intent
2. Description of Sampling and Testing Program
   a. Sampling points and tests for each unit process and for effluent quality monitoring
   b. Type, frequency, and application of test results
3. Illustrations

C. Utility System Sections

1. Introduction
2. Table of Contents

3. System Description
   a. Purpose and intent
   b. Operational modes
4. Operational Procedures
   a. Pre start-up and start-up procedures
      (1) Safety procedures and precautions
   b. Routine operating procedures
   c. Shutdown procedures
   d. Abnormal Operations
   e. Illustrations
5. Chemical Handling Precautions and Procedures

D. Instrumentation System Section
1. Introduction
2. Table of Contents
3. System Description
   a. Purpose and intent
4. Operational Mode
   a. Process control systems
   b. Instruments and meters
   c. Control boards
   d. Communication system
   e. Telemetry system
   f. Illustrations

E. Appendices
1. Safety
2. Staffing and Personnel Recommendations
3. Plant Records Systems
4. References
   a. Will consist of the list of publications, texts, and other references developed for the training program which are pertinent to plant facilities
5. Contingency Plan for Emergency Plant Operation

IV. Maintenance Division
A. Introduction

B. Table of Contents

C. Maintenance System Instructions

D. General Routine Maintenance Procedures

E. Unit Process Sections
   1. Maintenance Data Cross Reference Index
   2. Equipment Maintenance Data Procedures
      a. Equipment reference number
      b. Maintenance frequency
      c. Lubricant requirements

F. Manufacturer's Installation, Operation and Maintenance Literature

Appendix 12.3

OCCUPATIONAL DESCRIPTIONS

for following

WASTEWATER TREATMENT PLANT

PERSONNEL

- SUPERINTENDENT
- LEAD OPERATOR
- OPERATOR
- CHEMIST
- LABORATORY TECHNICIAN
- MAINTENANCE SUPERVISOR
- DRIVER/LABORER

OCCUPATION DESCRIPTION

Title: SUPERINTENDENT, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Responsible for administration, operation, and maintenance of entire plant. Exercises direct authority over all plant functions and personnel, in accordance with approved policies and procedures. Inspects plant regularly. Analyzes and evaluates operation and maintenance functions; initiates or recommends new or improved practices. Develops plans and procedures to insure efficient plant operation. Recommends plant improvements and additions. Coordinates data and prepares or reviews and approves operation reports and budget requests. Controls expenditure of budgeted funds and requests approval for major expenditures, if required. Recommends specifications for major equipment and material purchases. Organizes and directs activities of plant personnel, including training programs. Maintains effective communications and working relationships with employees, government officials, and general public.

QUALIFICATIONS PROFILE

1. Formal Education
   College degree in sanitary, civil, chemical, or mechanical engineering highly desirable. Minimum high school graduate or equivalent, plus 5 to 7 years practical experience in treatment plant operations, depending upon size and complexity of plant.

2. General Requirements
   a. Knowledge of processes and equipment involved in wastewater treatment, including basic chemical, bacteriological, and biological processes.
   b. Understanding of managerial, administrative, and accounting practices and procedures involved in successful plant operation.
   c. Knowledge of industrial wastes and their effects on treatment processes and equipment.
   d. Ability to prepare or supervise preparation of clear, concise reports and budget recommendations.
   e. Ability to plan, direct, and evaluate plant operation and maintenance functions.
   f. Ability to establish and maintain effective communication and working relationships.

3. General Educational Development
   a. Reasoning
      (1) Apply principles of logic to define problems, collect and analyze data, and draw valid conclusions. Deal with a variety of concrete and abstract variables.
      (2) Interpret a wide variety of technical instructions, in book, manual, and mathematical or diagrammatic form.

Title: SUPERINTENDENT (Cont'd)

b. Mathematical
   Perform ordinary arithmetical, algebraic, and geometric procedures in standard, practical applications.

c. Language
   (1) Write and edit operation reports.
   (2) Evaluate and interpret engineering and other technical data.
   (3) Interview applicants and employees.
   (4) Establish and maintain communications with employees, government officials, and the public.

4. Specific Vocational Preparation
   a. Completion of operator training course or equivalent training and experience.
   b. Five to 7 years experience in wastewater treatment plant operation, depending upon size and complexity of plant and educational background. Minimum of one year supervisory experience.

5. Aptitudes-Relative to General Working Population

a.	Intelligence	) Highest third excluding
b.	Verbal	) top 10 per cent
c.	Numerical	)
d.	Form Perception	)
e.	Spatial	)
f.	Clerical Perception	)
g.	Motor Coordination	) Middle third
h.	Finger Dexterity	)
i.	Manual Dexterity	)
j.	Eye-Hand-Foot Coordination	)
k.	Color Discrimination	)

6. Interests
   Prefer working with people in situations involving organization and supervision of varied activities.

7. Temperament
   Prefer situations involving the direction, control, and planning of an entire activity or the activity of others.

8. Physical Demands
   Sedentary work, except for regular plant inspection trips.

9. Working Conditions
   Largely inside. Occasional exposure to weather, fumes, odors, dust, and risk of bodily injury. Possible exposure to toxic conditions.

ENTRY SOURCES: Assistant Superintendent, Operations Supervisor, Shift Foreman, or Chief Chemist; depending on individual qualifications and size and complexity of plant.

PROGRESSION TO: Similar position in larger or more complex plant.

OCCUPATION DESCRIPTION

Title: LEAD OPERATOR, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Performs any combination of following tasks pertinent to controlling operation of plant: Operates treatment facilities to control flow and processing of wastewater, sludge, and effluent. Monitors gages, meters, and control panels. Observes variations in operating conditions and interprets meter and gage readings and test results to determine processing requirements. Operates valves and gates either manually or by remote control; starts and stops pumps, engines and generators to control and adjust flow and treatment processes. Maintains shift log and records meter and gage readings. Extracts samples and performs routine laboratory tests and analyses. Operates and maintains power generating equipment and incinerators. Makes operating decisions in absence of superintendent.

QUALIFICATIONS PROFILE

1. Formal Education
   High school graduate or equivalent training and experience.

2. General Requirements
   a. Knowledge of processes and equipment involved in wastewater treatment.
   b. Ability to maintain and evaluate records.
   c. Ability to perform all required duties.
   d. Ability to maintain working relationship with other shift workers.

3. General Educational Development
   a. Reasoning
      (1) Apply knowledge of wastewater treatment to solve practical problems.
      (2) Interpret a variety of written and oral instructions.
   b. Mathematical
      Perform ordinary arithmetical and algebraic procedures in standard, practical applications.
   c. Language
      (1) Establish and maintain communications with superiors and co-workers.
      (2) Ability to comprehend oral and written instructions, record information, and request supplies and work materials orally or in writing.

4. Specific Vocational Preparation
   a. Completion of operator training course or equivalent training and experience.
   b. Three to 12 months experience in wastewater treatment plant, depending upon formal training and prior experience.

Title: LEAD OPERATOR (Cont'd)

5. Aptitudes - Relative to General Working Population

a.	Intelligence	)
b.	Verbal	)
c.	Numerical	)
d.	Spatial	)
e.	Form Perception	)
f.	Clerical Perception	) Middle third
g.	Motor Coordination	)
h.	Finger Dexterity	)
i.	Manual Dexterity	)
j.	Eye-Hand-Foot Coordination	)
k.	Color Discrimination	)

6. Interests

   Prefer activities of a routine, concrete, organized nature; dealing with things and objects.

7. Temperament

   Worker must adjust to situations involving a variety of duties, including evaluation of information against measurable criteria and precise attainment of set limits or standards.

8. Physical Demands

   Medium work; involving climbing, balancing, stooping, kneeling, crouching, reaching, handling, fingering, talking, hearing, visual acuity, depth perception, and color vision.

9. Working Conditions

   Both inside and outside. Exposed to weather, fumes, odors, and dust. May be exposed to toxic conditions. Definite risk of bodily injury.

ENTRY SOURCES: Operator

PROGRESSION TO: Similar position in larger or more complex plant.

OCCUPATION DESCRIPTION

Title: OPERATOR, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Assists Lead Operator in performance of any combination of following tasks pertinent to controlling operation of plant or performs various tasks as directed: Operates treatment facilities to control flow and processing of wastewater, sludge, and effluent. Monitors gages, meters, and control panels. Observes variations in operating conditions and interprets meter and gage readings and test results to determine processing requirements. Operates valves and gates either manually or by remote control; starts and stops pumps, engines, and generators to control and adjust flow and treatment processes. Maintains shift log and records meter and gage readings. Extracts samples and performs routine laboratory tests and analyses. Operates and maintains power generating equipment and incinerators.

QUALIFICATIONS PROFILE

1. Formal Education
   High school graduate or equivalent training and experience.

2. General Requirements
   a. Ability to learn operation of plant processes and equipment.
   b. Ability to maintain and evaluate simple records.
   c. Ability to maintain working relationship with other shift workers.

3. General Educational Development
   a. Reasoning
      Apply common sense understanding to carry out written, oral, or diagrammatic instructions. Deal with problems involving concrete variables in or from standardized situations.
   b. Mathematical
      Perform ordinary arithmetical calculations.
   c. Language
      Ability to comprehend oral and written instructions, record information, and request supplies and work materials orally or in writing.

4. Specific Vocational Preparation
   On-the-job training from date of employment. Completion of an operator training course highly desirable. Previous experience as laborer or equipment operator in wastewater treatment plant also desirable.

Title: OPERATOR (Cont'd)

5. Aptitudes - Relative to General Working Population

a.	Intelligence	)
b.	Verbal	)
c.	Numerical	)
d.	Spatial	) Lowest third excluding
e.	Form Perception	) bottom 10 per cent
f.	Clerical Perception	)
g.	Motor Coordination	)
h.	Finger Dexterity	)
i.	Manual Dexterity	) Middle third
j.	Eye-Hand-Foot Coordination	) Lowest third excluding bottom 10 per cent
k.	Color Discrimination	) Middle third

6. Interests
   Preference for activities of a routine, concrete, organized nature; dealing with things and objects.

7. Temperament
   Worker must adjust to situations involving a variety of duties and evaluation of information against measurable criteria.

8. Physical Demands
   Medium work; involving climbing, balancing, stooping, kneeling, crouching, reaching, handling, fingering, talking, hearing, visual acuity, depth perception, and color vision.

9. Working Conditions
   Both inside and outside. Exposed to weather, fumes, odors, and dust. May be exposed to toxic conditions. Definite risk of bodily injury.

ENTRY SOURCES: Graduates of operator training courses, treatment plant laborers or equipment operators, general public.

PROGRESSION TO: Lead Operator.

OCCUPATION DESCRIPTION

Title: CHEMIST, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Supervises and performs specialized and complex chemical, bacteriological and physical tests and analyses of raw, partially treated, and treated wastewater and by products to determine efficiency of plant processes and insure that plant effluent meets established requirements. Conducts or supervises less complex routine tests. Supervises collection of laboratory samples. When laboratory technicians are present, supervises technicians and provides routine procedures to be followed. Evaluates and interprets test results, establishes test priorities, and prepares reports. Assembles data, maintains records, and prepares periodic reports. Sets up pilot processes when conducting research on improved procedures. Provides direct or indirect instructions to operating personnel regarding chemical requirements and adjustments, changes, or additions to various treatment processes.

QUALIFICATIONS PROFILE

1. Formal Education
   College degree in chemistry or high school graduate plus college-level courses in chemistry, biology, and bacteriology.

2. General Requirements
   a. Thorough knowledge of wastewater treatment processes and chemical, biological, or bacteriological action involved in each process.
   b. Thorough knowledge of pertinent local, state, and federal regulations and requirements.
   c. Ability to work on own initiative and establish proper testing procedures.
   d. Ability to organize and interpret data and transmit instructions.

3. General Educational Development
   a. Reasoning
      Apply principles of chemistry, biology, and bacteriology to solve problems related to wastewater treatment and deal with a variety of concrete variables; interpret a variety of written, oral, and diagrammatic instructions.
   b. Mathematical
      Perform ordinary arithmetical and algebraic procedures in standard, practical applications may require knowledge of higher mathematics.
   c. Language
      Ability to evaluate and interpret technical data, prepare reports, and maintain communications with supervisory personnel and co-workers.

Title: CHEMIST (Cont'd)

d. Science
Understand chemical, biological, and bacteriological processes pertinent to wastewater treatment, and possess sound knowledge of problems and processes involved.

4. Specific Vocational Preparation
Laboratory experience in a position of responsibility. Six to 18 months on-the-job training or prior experience in wastewater treatment plant operations, depending upon education, size of plant, and complexity of treatment.

5. Aptitudes - Relative to General Working Population

a.	Intelligence	) Highest third excluding top 10 per cent
b.	Verbal	)
c.	Numerical	)
d.	Form Perception	) Middle third
e.	Clerical Perception	) Highest third excluding top 10 per cent
f.	Motor Coordination	) Middle third
g.	Finger Dexterity	)
h.	Manual Dexterity	)
i.	Eye-Hand-Foot Coordination	)
j.	Color Discrimination	) Highest third excluding top 10 per cent

6. Interest
Prefer scientific and technical activities.

7. Temperament
Worker must adjust to situations involving evaluation of information against measurable criteria.

8. Physical Demands
Sedentary or light work. May require considerable standing.

9. Working Conditions
Inside. May be subject to fumes, odors, and toxic conditions.

ENTRY SOURCES: Laboratory technicians with proper qualifications. Chemists in smaller or less complex plants. Other qualified chemists.

PROGRESSION TO: Superintendent or similar position at larger or more complex plant.

OCCUPATION DESCRIPTION

Title: LABORATORY TECHNICIAN, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Performs any combination of routine laboratory tasks such as following: Collects samples of plant influent, partially treated wastewater, sludge, effluent, and other byproducts. Assembles instruments and equipment for analytical or research work. Prepares chemical and bacteriological media, stains, reagents, and test solutions routinely used in laboratory. Operates equipment and conducts tests as directed. Maintains test result records, prepares data sheets. Prepares or assists in preparation of reports. Cleans, maintains, and stores instruments and equipment. Maintains inventory and orders supplies. Performs custodial duties in laboratory.

QUALIFICATIONS PROFILE

1. Formal Education
   High school graduate or equivalent. Courses in chemistry and biology highly desirable.

2. General Requirements
   a. Knowledge of basic principles of chemical, physical, and bacteriological examination and treatment of wastewater, sludge, effluent, and by-products.
   b. Knowledge of standard laboratory principles, technology, and equipment.
   c. Ability to follow prescribed methods and processes and maintain proper records.

3. General Educational Development
   a. Reasoning
      Apply common sense understanding to carry out instructions in written, oral, or diagrammatic form and deal with problems involving a few concrete variables in or from standardized situations.
   b. Mathematics
      Make arithmetical calculations involving fractions, decimals, and percentages.
   c. Language
      Ability to learn job duties from oral instructions or demonstration, fill in report forms and accurately record data.

Title: LABORATORY TECHNICIAN (Cont'd)

d. Science
Understand basic chemical, bacteriological, and biological processes; standard laboratory principles, methods, and equipment.

4. Specific Vocational Preparation
One to 3 months on-the-job training or experience in laboratory work of a similar nature.

5. Aptitudes - Relative to General Working Population

a.	Intelligence	)
b.	Verbal	)
c.	Numerical	)
d.	Spatial	) Middle third
e.	Form Perception	)
f.	Clerical Perception	)
g.	Motor Coordination	)
h.	Finger Dexterity	) Highest third excluding top 10 per cent
i.	Manual Dexterity	)
j.	Eye-Hand-Foot Coordination	) Middle third
k.	Color Discrimination	) Highest third excluding top 10 per cent

6. Interests
Prefer scientific and technical activities of a routine, concrete, organized nature; dealing with things and objects.

7. Temperatment
Worker must adjust to situations involving evaluation of information against measurable criteria and repetitive operations carried out according to set procedures or sequences.

8. Physical Demands
Light work. Requires walking and standing to a significant degree, and frequent lifting of objects weighing up to 5 kilograms.

9. Working Conditions
Inside work. Subject to fumes, odors, and toxic conditions.

ENTRY SOURCES: High school graduates. General public.

PROGRESSION TO: Chemist.

OCCUPATION DESCRIPTION

Title: MAINTENANCE SUPERVISOR, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Supervises all preventive and corrective maintenance on plant and equipment. Plans, schedules, and directs maintenance of wide variety of specialized mechanical and electrical equipment plus buildings, structures, and grounds. Inspects plant frequently to ensure proper maintenance procedures are followed. Determines the necessity for and establishes long-range maintenance programs. Decides remedial action in emergency situations. Supervises and instructs maintenance personnel. Supervises installation and testing of new or rebuilt equipment. Supervises inspection of contracted maintenance work. Submits maintenance budget requests. Supervises maintenance records. Performs related work as required.

QUALIFICATIONS PROFILE

1. Formal Education
   High school or trade school graduate or equivalent in training and experience.

2. General Requirements
   a. Ability and knowledge necessary to supervise maintenance and repair of plant equipment, buildings, structures and grounds.
   b. Ability to implement and initiate preventive maintenance programs.
   c. Ability to maintain records and prepare reports.

3. General Educational Development
   a. Reasoning
      Apply principles of logical thinking to define problems, collect data, establish facts, and draw valid conclusions. Interpret an extensive variety of technical instructions, in books, manuals, and mathematical or diagrammatic form. Deal with several abstract and concrete variables.
   b. Mathematical
      Perform ordinary arithmetical, algebraic, and geometric procedures in standard, practical applications.
   c. Language
      Interpret technical manuals as well as drawings and specifications, such as layouts, blueprints, and schematic.

Title: MAINTENANCE SUPERVISOR (Cont'd)

4. Specific Vocational Preparation
   a. Three to 8 years experience in the maintenance and repair of mechanical and electrical equipment, depending on education and size and complexity of plant.
   b. Minimum one year supervisory experience.

5. Aptitudes - Relative to General Working Population
   a. Intelligence)
   b. Verbal)
   c. Numerical) Middle third
   d. Spatial)
   e. Form Perception)
   f. Clerical Perception)
   g. Motor Coordination)
   h. Finger Dexterity) Highest third excluding
   i. Manual Dexterity) top 10 per cent
   j. Eye-Hand-Foot Coordination)
   k. Color Discrimination) Middle third

6. Interests
   Preference for sientific and technical activities, concerned with people and the communication of ideas.

7. Temperament
   Worker must adjust to situations involving direction, control, and planning of an entire activity or the activities of others.

8. Physical Demands
   Sedentary or light work, requiring walking and standing. Occasional heavy lifting possible in emergencies.

9. Working Conditions
   Inside. Occasionally exposed to outside weather conditions. Frequently encounters wet environment, definite risk of bodily injury, fumes, odors, and toxic conditions.

ENTRY SOURCES: Mechanic or Electrician.

PROGRESSION TO: Similar position at larger or more complex plant.

OCCUPATION DESCRIPTION

Title: DRIVER/LABORER, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Performs any combination of tasks such as following: Cleans equipment such as bar screens, comminutors, and weirs. Lubricates machinery. Drives, loads and unloads trucks; spreads sand, gravel, and dirt. Paints (rough) and performs other minor maintenance. Digs and refills ditches. Cleans drains, ditches, and culverts. Cuts grass, weeds, and brush; trims trees and bushes; rakes grass, leaves, and trash; seeds and cares for lawn and ornamental plantings. Removes snow and ice from walkways, driveways, and equipment. Collects and disposes of trash. Washes and cleans vehicles, tools, and equipment. Carries or holds material, supplies, or tools to assist operating and/or maintenance personnel.

QUALIFICATIONS

1. Formal Education
   Elementary school education desirable. Must be able to speak, read, and write Arabic.

2. General Requirements
   a. Ability to understand and carry out oral and written instructions.
   b. Ability to perform strenuous manual labor under adverse weather conditions.
   c. Ability to use a variety of hand and power tools and equipment.
   d. Valid vehicle operator's license, if required.

3. General Educational Development
   a. Reasoning
      Apply common sense understanding to carry out simple instructions.
   b. Mathematical
      Perform simple addition and subtraction for counting and recording purposes.
   c. Language
      Ability to learn job duties from oral instructions or demonstrations and request supplies and materials orally or in writing.

4. Specific Vocational Preparation
   On-the-job training or previous experience as a laborer/driver.

Title: DRIVER/LABORER (Cont'd)

5. Aptitudes - Relative to General Working Population

a.	Intelligence	) Lowest third excluding bottom 10 per cent
b.	Verbal	)
c.	Numerical	)
d.	Spatial	)
e.	Form Perception	)
f.	Clerical Perception	)
g.	Motor Coordination	) Middle third
h.	Finger Dexterity	)
i.	Manual Dexterity	)
j.	Eye-Hand-Foot Coordination	)
k.	Color Discrimination	)

6. Interests
   Preference for activities dealing with things and objects.

7. Temperament
   Worker must adjust to situations involving working only under specific instruction, allowing little or no room for independent action or judgment in working out job problems.

8. Physical Demands
   Heavy to very heavy work. Involves lifting heavy objects, climbing, balancing, stooping, kneeling, crouching, crawling, reaching, and handling.

9. Working Conditions
   Primarily outside. No protection from weather. Subject to noise and vibration, hazards, fumes, odors, and toxic conditions.

ENTRY SOURCES: Unskilled labor market.

PROGRESSION TO: Mechanic, Electrician, or Operator.