WATER AND SANITATION FOR HEALTH PROJECT

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EVALUATION OF ALTERNATIVES FOR INTERIM TREATMENT AND DISPOSAL OF TRUCKED WASTEWATER IN SALALAH TOWN, SULTANATE OF OMAN

WASH FIELD REPORT NO. 243

JULY 1988

Prepared for
the Omani - American Joint Commission
for Economic and Technical Cooperation
WASH Activity No. 429

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under WASH Activity No. 429

by

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and
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July 1988

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TABLE OF CONTENTS

	Page
PREFACE	v
EXECUTIVE SUMMARY	vii
1. INTRODUCTION	
1.1 Purpose of Report	1-1
1.2 The Study Area	1-1
1.3 "Wastewater" in Salalah	1-1
1.4 Scope of Study	1-3
2. QUANTITY AND QUALITY OF WASTEWATER	
2.1 Available Data	2-1
2.2 Volume of Wastewater Requiring Treatment	2-1
2.3 Major Sources of Wastewater	2-3
2.4 Strength of Wastewater	2-3
3. TREATMENT AND DISPOSAL OPTIONS	
3.1 Alternatives for Treatment	3-1
3.2 Description of Pond Facilities	3-2
3.3 Details of Construction	3-5
3.3.1 Facilities for Trucks to Discharge Wastewater	3-5
3.3.2 Pond Construction	3-5
3.3.3 Pipe to First Pond	3-5
3.3.4 Piping Between Ponds	3-5
3.3.5 Other Details	3-9
3.4 Operation and Maintenance	3-9
3.5 Cost Estimates	3-10

TABLE OF CONTENTS (Cont'd)

		Page
4.	SITING INVESTIGATION	
	4.1 The WASH Team's Investigations in Salalah	4-1
	4.2 Subsequent Work by Liaison Committee	4-1
5.	IMPLEMENTATION	
	5.1 Interim Solution	5-1
	5.2 Schedule of Required Actions	5-1
	5.3 Selection of Site	5-1
	5.4 Selection of Consulting Firm	5-1
	5.5 Selection of Design and Construction Contractor	5-2
	5.6 Pond Design and Construction	5-2
	5.7 Final Acceptance and Placement into Operation	5-2
APPENDICES		
A.	Proposed Scope of Work	A-1
B.	Schedule of Meetings and Field Visits	B-1
C.	References and Material Revieved	C-1
D.	Wastewater Quantities	D-1
E.	Design of Anaerobic/Facultative/Maturation Ponds	E-1
F.	Basis of Cost Estimates	F-1
G.	Form L and Suggested Responses	G-1
H.	Siting Investigation Conducted by WASH Team	H-1

LIST OF TABLES

No.	Title	Page
1	Summary of Flows to Wadi Sahalnaut	2-2
2	Analysis of Wastewater Hauling Records	2-4
3	Chemical Analysis of Treated Wastewater	2-5
4	Data on Proposed Pond System	3-4
5	Estimated Construction Costs	3-11
6	Estimated Operating Costs	3-12

LIST OF FIGURES

No.	Title	Page
1	Study Area	1-2
2	Schematic Layout of Proposed Pond Facilities	3-3
3	Discharge Facilities	3-6
4	Pipe to First Pond	3-7
5	Pipe Connection Between Ponds	3-8
6	Potential Sites for Wastewater Treatment	4-2
E-1	Frequency of Trucks	E-5
E-2	Location of Facilities Pumped on March 1988	E-8

PREFACE

This report was prepared by a team consisting of Dr. Albert B. Pincince and Leo A. St. Michel. Both are employees of Camp Dresser and McKee Inc. Logistical and advisory support for the team was provided by Dhofar Municipality and by the Omani-American Joint Commission for Economic and Technical Cooperation.

The assistance and cooperation of the organizations and persons contacted during the study was truly outstanding. At all levels the team was provided with timely and helpful information. It was not unusual for officials to take time from their busy schedules to personally assist in making visits and in providing practical advice. This high degree of cooperativeness was displayed at both the private and public sectors. Particular acknowledgment is made to the staffs of Dhofar Municipality, the Directorate General of Water Supply and Transport, the Directorate General of Housing the Planning Committee for Development and Environment in the Southern Region, offices of the Diwan of Royal Court Affairs, and the Council for the Conservation of the Environment and Prevention of Pollution.

EXECUTIVE SUMMARY

This report was prepared to provide the Dhofar Municipality with preliminary information and recommendations on options for treating wastewater that is currently being discharged to Wadi Sahalnaut. The wastewater includes septage from septic tanks, liquid from holding tanks, and sludge from wastewater treatment plants. The wastewater sources include homes and commercial facilities, such as car washes, hospitals and bottling plants.

The WASH team reviewed and analyzed three months of data on the quantity of wastewater hauled to Wadi Sahalnaut. (The Municipality maintains detailed records on the wastewater quantity hauled and on the collecting companies.) It is estimated that about 160 truckloads of wastewater are hauled each day to the Wadi, on the average. The associated volume of wastewater is about 1,100 to 1,200 cubic meters per day. We recommend that facilities be constructed to treat 1,200 cubic meters per day, and that provision be made in siting and design to allow for doubling the capacity in a second-stage construction project.

Sampling of 15 truck loads of wastewater provided an average BOD of 260 mg/L for wastewater from the Salalah area. More sampling should be conducted to verify this value for design purposes.

The WASH team recommends that the facilities for interim treatment include a pond system consisting of discharge facilities for the tanker trucks, two anaerobic ponds, a facultative pond and three maturation ponds. Future expansion would include an additional anaerobic pond, a facultative pond, and three maturation ponds. Costs for chlorination and for pumping effluent have also been estimated.

Construction cost for the first-stage construction would be about R.O. 250,000. Annual operating costs would be about R.O. 62,000.

A site at Upper Qaftawt site is recommended for the facility.

We recommend the following schedule for implementing the project:

15 May 1988	Select site (already done by municipality), provide for preparing detailed maps of the area, submit an Environmental Impact Statement (Form L) to the Ministry of Environment and Water Resources, and issue a request for proposal for engineering services.
15 July 1988	Select an engineering consultant to prepare tender documents.
1 October 1988	SELECT CONTRACTOR FOR DESIGN-AND-CONSTRUCTION.
Early February 1989	Complete construction and place ponds in operation.

Chapter 1

INTRODUCTION

1.1 Purpose of Report

This report was prepared to provide the Dhofar Municipality with preliminary information on options for treating wastewater that is currently being trucked and discharged to Wadi Sahalnaut. The report is based on a rapid-type assessment performed during the period 13 to 23 March 1988.

The options studied address urgent short-term solutions that can be quickly implemented and, to the extent feasible, incorporated into the facilities to be proposed in master plan studies that are tentatively scheduled to start later in 1988.

1.2 The Study Area

The study area shown in Figure 1 is the developed area of Salalah Town reaching from Mamurah on the east to Raysut on the west. The area includes the old city of Salalah and the developing surrounding area, including a very significant number of agricultural plots. The estimated population is currently 60,000. The current area of discharge of wastewaters is Wadi Sahalnaut.

1.3 "Wastewater" in Salalah

Various terms have been used for the material being discharged to the wadi as hauled by municipal and private carriers in the Salalah area. In some cases, the term "septage" has been used and is based on the pumping of the sludge from septic tanks. The septic tanks are typically connected to a soak-away pit. Because a soak-away disposes of most of the water found in the waste into the ground, its septage has a relatively high strength when measured in terms of BOD. However, in Salalah, many areas are restricted from the installation of septic tanks in order to protect the highly valuable groundwater aquifer, and holding tanks are required. As the name implies, a holding tank does not have an outlet and the contents are essentially that of raw sewage. Because the holding tanks must be serviced or they will overflow, the pumping from holding tanks is much more frequent than that required for septic tanks. Wastes from such commercial facilities as car washes and bottling plants also are hauled to the dumping area. In addition, a major source of wastewater is from poorly functioning or inoperable existing wastewater treatment plants. In some cases, sludge from such plants is discharged at the dumping site.

All of the above wastewaters from septic tanks, holding tanks, commercial establishments, schools, hospitals, plants and industry are collectively referred to in this report as wastewater.

The quantities and properties of the wastewater being discharged to Wadi Sahalnaut are described in Chapter 2.

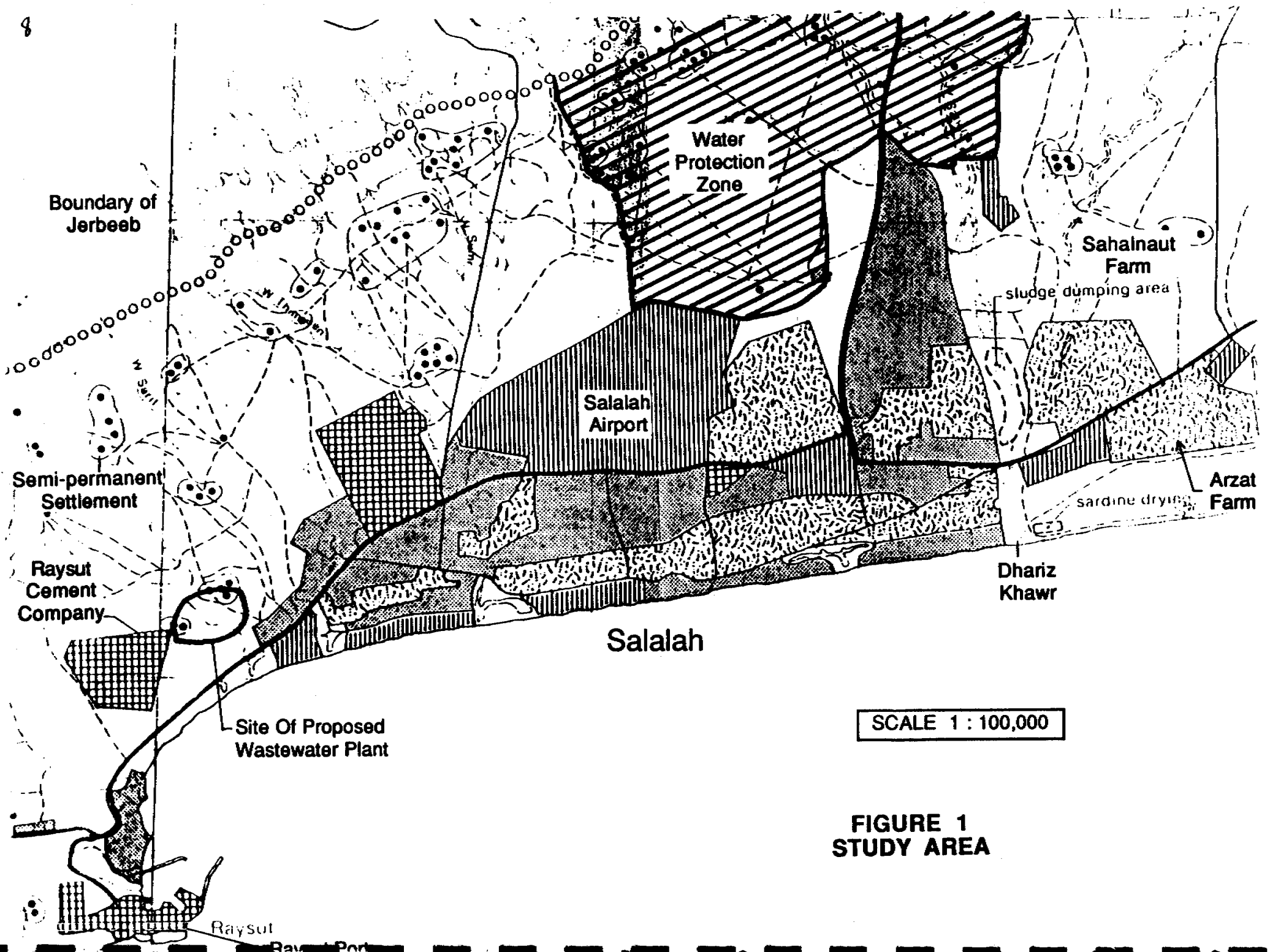


FIGURE 1
STUDY AREA

1.4 Scope of Study

The scope of this study, which is presented in Appendix A, included data collection and analysis of the problem, development of recommendations, and preparation of a final report.

The data collection section of the scope of work sought to obtain an understanding of the problem and concerns related to the current method and location of wastewater disposal. The data collection also included reviews of pertinent reports and data, discussions with knowledgeable people, field observations, and the review of discharge records maintained by the municipality. In addition, studies were made of the type of facilities being served by the wastewater hauling organizations.

Development of recommendations included identifying alternative solutions and developing conceptual designs, developing capital and operating costs, estimating schedules for implementation, recommending immediate measures, preparing a presentation of findings and recommendations, and incorporating comments from the Municipality, the Liaison Committee and the Joint Commission into a final draft report.

The last section of the scope of work was the completion of the final report after revisions to reflect comments on the draft and final adjustment of costs and conceptual designs.

Chapter 2

QUANTITY AND QUALITY OF WASTEWATER

2.1 Available Data

The municipality monitors all discharges to Wadi Sahalnaut. All vehicles entering the dumping area are identified by an attendant who records the following information:

- Owner and number of licensed vehicle
- Time of day when entering discharge area
- Quantity of material discharged (assumption is made that the full capacity of the haulage truck is utilized on each trip).

The daily logs prepared by the site attendant are filed with the municipality. The WASH team was provided with complete information as noted above for the period March 1987 through February 1988.

2.2 Volume of Wastewater Requiring Treatment

Three full months (January and February of 1988, and September of 1987) were fully analyzed to develop information on the volume of wastewater discharged. Data from January and February were analyzed because they are the most recent. September data represent a wet month, and the records were investigated to determine whether wastewater pumping increases during wet weather.

The analysis produced the following information:

- Number of trucks discharging per day
- Maximum and average volume of wastewater discharged per day
- Peak number of trucks entering per hour.

A summary of the analysis is shown in Table 1, and Appendix D includes details of the flow information developed from the review of existing records. Table 1 shows that total volume hauled is about 1,100 to 1,200 cu m/day. The WASH team recommends that interim facilities be constructed soon for 1,200 cu m/day.

The Salalah area is growing at a rate exceeding 5 percent per year, and provision should be made to allow for growth until permanent facilities are built. The Liaison Committee suggested that provision be made in siting and design to allow for doubling the capacity in a second-stage construction project.

TABLE 1

SUMMARY OF FLOWS TO WADI SAHALNAUT

Month	Truck Trips				Volume (Cu M)				Avg. Truck (Cu M)
	Mun.	Private	Total	Per Day	Mun.	Private	Total	Per Day	
Feb 88	1076	3,462	4,538	156	7705	23,835	31,540	1,088	7.0
Jan 88	975	3,912	4,887	157	6978	26,103	33,081	1,141	7.3
Sep 87	1037	3,770	4,801	160	7420	27,710	35,130	1,171	7.3

2.3 Major Sources of Wastewater

Analysis of wastewater hauling records was performed in order to identify major contributors. Information regarding analysis of wastewater hauling records for major private haulers is provided in Table 2. Private companies haul about 78 percent of the wastewater. The results show that three organizations -- Bahadoor Trading Company, the Diwan, and Sultan Qaboos Hospital -- usually account for almost half of the wastewater hauled by private firms. These three firms collect more than a third of the wastewater hauled to Wadi Sahalnaut.

At the WASH Team's request, the Municipality had two drivers complete forms about the tanks from which they collected wastewater.

Appendix D includes a copy of an inventory form with instructions developed and used to record information on a typical hauling day for private sector haulers. The results in monitoring the number and type of properties served by two haulers on 19 and 20 March 1988 also are included in Appendix D.

2.4 Strength of Wastewater

Although records of the number of trucks discharging wastes to Wadi Sahalnaut each day are thorough and valuable, no testing had been conducted to determine the strength of the wastewater when the WASH team was in Salalah. At that time, the only information available on trucked wastewater came from wastewater trucked from the Capital Area (Muscat) to the al Ansab pond system. Eleven samples collected by the Diwan in 1986 showed that the BOD averaged 560 mg/l.

The WASH team recommended that samples of wastewater be collected and analyzed from the tank trucks that haul the most wastewater. For five days in May, the Dhofar Municipality collected wastewater samples from the three major contributors to Wadi Sahalnaut. The results show that the BOD of the wastewater averaged about 260 mg/L. (See Table 3 for details of the results.)

For this analysis, we used a BOD strength of 300 mg/L. Sampling should be continued, however, to verify this value.

TABLE 2

ANALYSIS OF WASTEWATER HAULING RECORDS

PERCENT HAULED (EXCLUDING MUNICIPALITY)

ORGANIZATION	7 Sept.	26 Sept.	10 Feb.	18 Feb.	28 Feb.
1. Bahadoor Trad. Co.	11	12	13	13	12
2. Diwan	18	20	15	20	11
3. Hospital	17	16	20	15	12
SUBTOTAL	46	48	48	48	35
4. Others More than 4%					
a. A. Salam	9	4	9	6	14
b. Bin Saaboob	6	4	6	4	4
c. J&P	4	6	7	6	5
d. Abdulla Ali	-	-	-	5	-
e. Saeed Khanis	-	-	-	8	-
SUBTOTAL	19	14	22	29	23
5. All Others Less than 4%					
Number	(16)	(14)	(18)	(17)	(20)
Percentage	35	38	30	23	42

Note: 60 to 70 percent of wastewater comes from 6 to 8 principal haulers.

TABLE 3

CHEMICAL ANALYSIS OF TRUCKED WASTEWATER

SOURCE	QABOOS HOSPITAL		DIWAN		BAHADUR CO.		REMARKS
PARAMETER / DATE	BOD_5 (mg/L)	SS (mg/L)	BOD_5 (mg/L)	SS (mg/L)	BOD_5 (mg/L)	SS (mg/L)	
10 May 88	30	225	———	———	———	———→	Aerated wastewater
			270	120	———	———→	Raw wastewater
TUESDAY					960	1805→	Raw & septage sludge
11 May 88	150	302	———	———	———	———→	Aerated wastewater
			210	116	———	———→	Raw wastewater
WEDNESDAY					490	6415→	Raw & septage sludge & car wash
12 May 88	100	128	———	———	———	———→	Settled wastewater
			330	3315	———	———→	Raw wastewater
THURSDAY					100	78→	Raw wastewater
14 May 88	90	160	———	———	———	———→	Aerated settled sevage
			210	124	———	———→	Raw sewage
SATURDAY					210	286→	Raw sewage
15 May 88	110	52	———	———	———	———→	Aerated settled sevage
			130	92	———	———→	Raw sewage
SUNDAY					330	198→	Raw sewage

Chapter 3

TREATMENT AND DISPOSAL OPTIONS

3.1 Alternatives for Treatment

To meet the Ministry of Environment and Water Resource's requirements listed in Appendix G, the treatment process would have to be able to meet stringent requirements for BOD, suspended solids, ammonia nitrogen, and coliform, as follows:

	Concentration (mg/L)	
Parameter	Maximum	Maximum monthly average
BOD	15	10
Suspended solids	15	10
Ammonia nitrogen	5	1
Kjeldahl nitrogen	10	5
Total coliforms (MPN per 100 ml)	23	2.2
Viable pathogenic ova and cysts	Not detectable	Not detectable

The optimum treatment to meet these requirements most likely would include primary settling, biological treatment (for BOD, suspended solids, ammonia nitrogen, and Kjeldahl nitrogen), filtration (to remove BOD and suspended solids down to low concentrations), and disinfection (such as by chlorination).

Because construction and operation of these facilities are expensive, they should not be constructed until after the master plan is completed; however, Salalah urgently needs a facility to treat the wastewater now hauled to Wadi Sahalnaut.

The WASH Team recommends that the facilities for interim treatment include a pond system consisting of anaerobic, facultative, and maturation ponds. Anaerobic ponds do not contain dissolved oxygen. Facultative ponds are aerobic (have oxygen) near the surface and are anaerobic near the bottom. Maturation ponds should contain oxygen. This type of treatment has been used in many parts of the world, and has had particular success in warm climates. A version is now being used at Al Ansab, although the "anaerobic" lagoons at Al Ansab are only 2 meters deep, and are not completely anaerobic. The purpose of the anaerobic and facultative sections is to remove BOD and suspended solids, while the maturation ponds provide polishing and increased destruction of pathogens.

The concentration of total coliform organisms will be less than 1000 per 100 ml. About 95 percent of the BOD and suspended solids should be removed. If the influent concentration of BOD is 560 mg/L, then the effluent concentration should be about 30 mg/L. The effluent would be suitable for use for irrigation of crops or for recharge in areas where the groundwater is not suitable for domestic use. Costs for chlorinating the effluent have been included, to allow for greater safety.

These ponds could continue to be used in facilities recommended in the master plan. For example, their effluent could be treated in facilities providing biological or chemical treatment. As wastewater flows increase, the ponds could be expanded as necessary.

3.2 Description of Pond Facilities

Figure 2 shows a schematic layout of the proposed pond facilities. (See Appendix E for the design procedure for sizing the ponds.) The proposed initial construction consists of inlet works, two anaerobic ponds in parallel, a facultative pond, and three maturation ponds. Provision will also be made to recirculate flow from the outlet of the first maturation pond to the inlet of the anaerobic or facultative pond, to guard against odor problems. Sizes of the ponds are summarized on Table 4.

We recommend that site planning and design be developed for two phases. Only the first phase would be constructed initially, however.

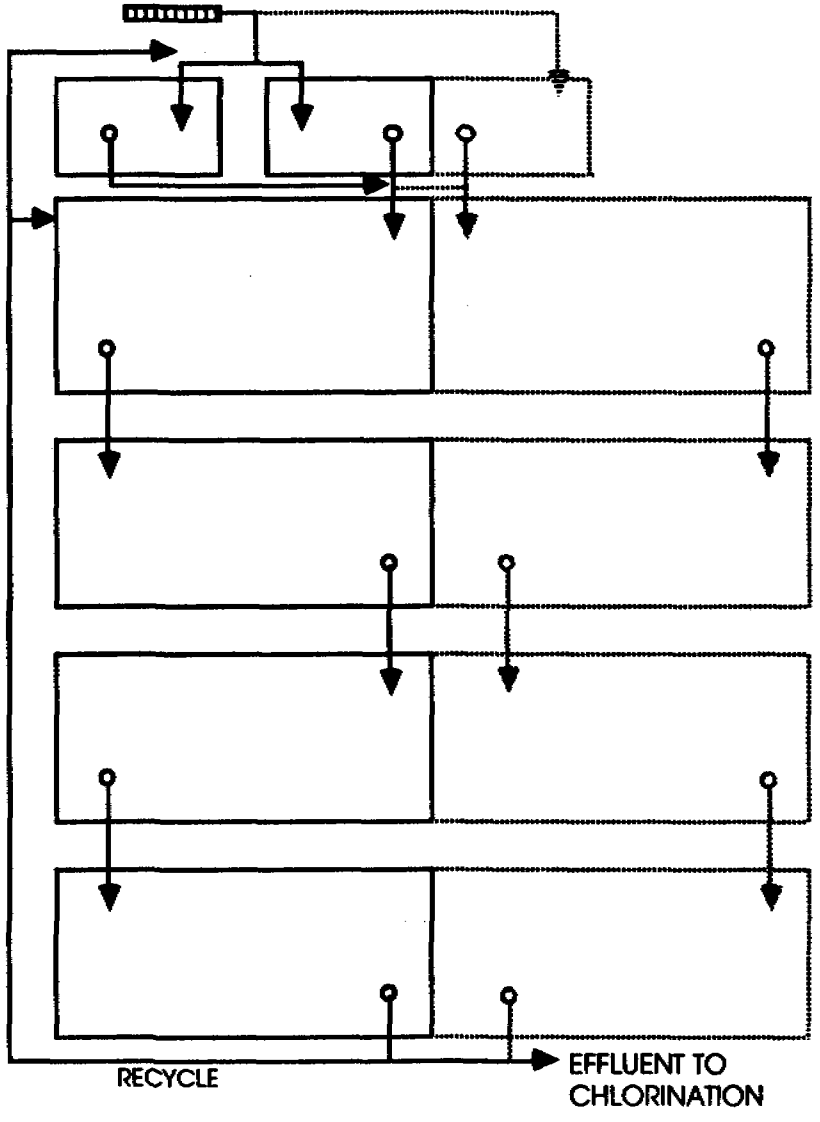
As flows increase, one anaerobic pond, one facultative pond, and three maturation ponds of the same sizes as in the initial construction can be added. After these additions, two of the three anaerobic lagoons will be in operation. The third anaerobic lagoon will be used when solids have to be removed from one of the other two. The facultative and maturation ponds will be in operation.

Each anaerobic pond will provide a detention time of 2 days and be 3 meters deep. Two ponds are recommended, because solids in the wastewater will settle in the ponds, and sludge will have to be removed about every year.

Design of facultative ponds is based on the kg of BOD applied per day per hectare. The depth of the pond would be about 1.8 m, and the resulting detention time would be about 5.7 days. The surface area at the water surface would be about 6,800 sq m.

The purpose of the maturation ponds is to achieve reduction in the pathogenic organisms in the wastewater. We recommend three maturation ponds in series, each with a detention time of 5 days. With all the ponds in operation, the percentage of fecal coliform removed would exceed 99.999 percent. But, as noted above, disinfection by chlorination will be provided.

FIGURE 2
SCHEMATIC LAYOUT OF PROPOSED POND FACILITIES



	DETENTION Time (days)	DIMENSIONS (m)
Anaerobic Pond	2 (each)	2 - 30 X 50 (3m deep)
Facultative Pond	5.7	44 X 100 (1.8m deep)
Maturation Pond No 1	5	50 X 100 (1.5m deep)
Maturation Pond No 2	5	50 X 100 (1.5m deep)
Maturation Pond No 3	5	50 X 100 (1.5m deep)

0 50 100

Scale In Meters

TABLE 4

DATA ON PROPOSED POND SYSTEM (FIRST STAGE)

Pond	Number	Flow Pattern	Volume of Water (cu m each)	Area at Top of Dike (sq m each)	Water Depth (m)
Anaerobic	2	Parallel	2,400	1,500	3
Facultative	1		6,800	4,400	1.8
Maturation	3	Series	6,000	5,000	1.5

3.3 Details of Construction

3.3.1 Facilities for Trucks to Discharge Wastewater

On the average, about 160 trucks discharge wastes each day at Wadi Sahalnaut, but over 200 trucks discharge wastes on some days. At the peak hour, up to about 30 trucks discharge wastes. If the trucks take about 15 minutes to discharge, then about eight trucks discharge at a time during the peak hour. To avoid having trucks wait in line, facilities should be available for 12 trucks.

The discharge facility could be as shown in Figure 3. This design is based on the discharge facilities at al Ansab ponds, serving the Capital Area. The discharge facility consists of a concrete trough with an enclosed bottom section and an open channel for the top section. Inserted in the horizontal section separating the bottom section and the top section would be 12 100-mm vertical pipe sections. The discharge facility would be 15 meters long.

A truck would be backed to the discharge facility and the driver would attach the hose to one of the vertical pipes. The hose and the pipe would have a coupling to insure that the hose will not release from the pipe. The driver would discharge the truck, and the wastewater would flow in the lower section to the anaerobic facility.

The purpose of the top section is to contain spills. When spills occur, the spill would flow in the top section to a pipe connecting the top section to the pipe to the anaerobic pond. Water could be trucked to the wastewater treatment plant to flush solids from the top section.

3.3.2 Pond Construction

The ponds would be formed by dikes constructed with a side slope of 2:1 (horizontal:vertical) and have a 1 m freeboard. The horizontal dimension of the top of the dike would be about 3 m, to allow for service vehicles.

The bottom of the ponds would be lined with soil cement about 200 mm thick, to prevent water from leaking. If the ponds are in an area subject to flooding, rip-rapping of the outside of the affected dike with 150-mm to 200-mm stones would be recommended. The inside banks of the dikes would also be protected with rip rap to 0.5 m below the water level.

3.3.3 Pipe to First Pond

The pipe from the discharge facility to the first pond would be placed on the sloping portion of the berm on a bed of concrete or stone, as shown in Figure 4. The pipe would end at the bottom of the pond about one-third of the way into the pond.

3.3.4 Piping Between Ponds

Figure 5 shows a detail of the piping connection between ponds. The upstream pipe section would consist of a vertical pipe with a baffle to prevent floating material from passing to the next pond. The horizontal

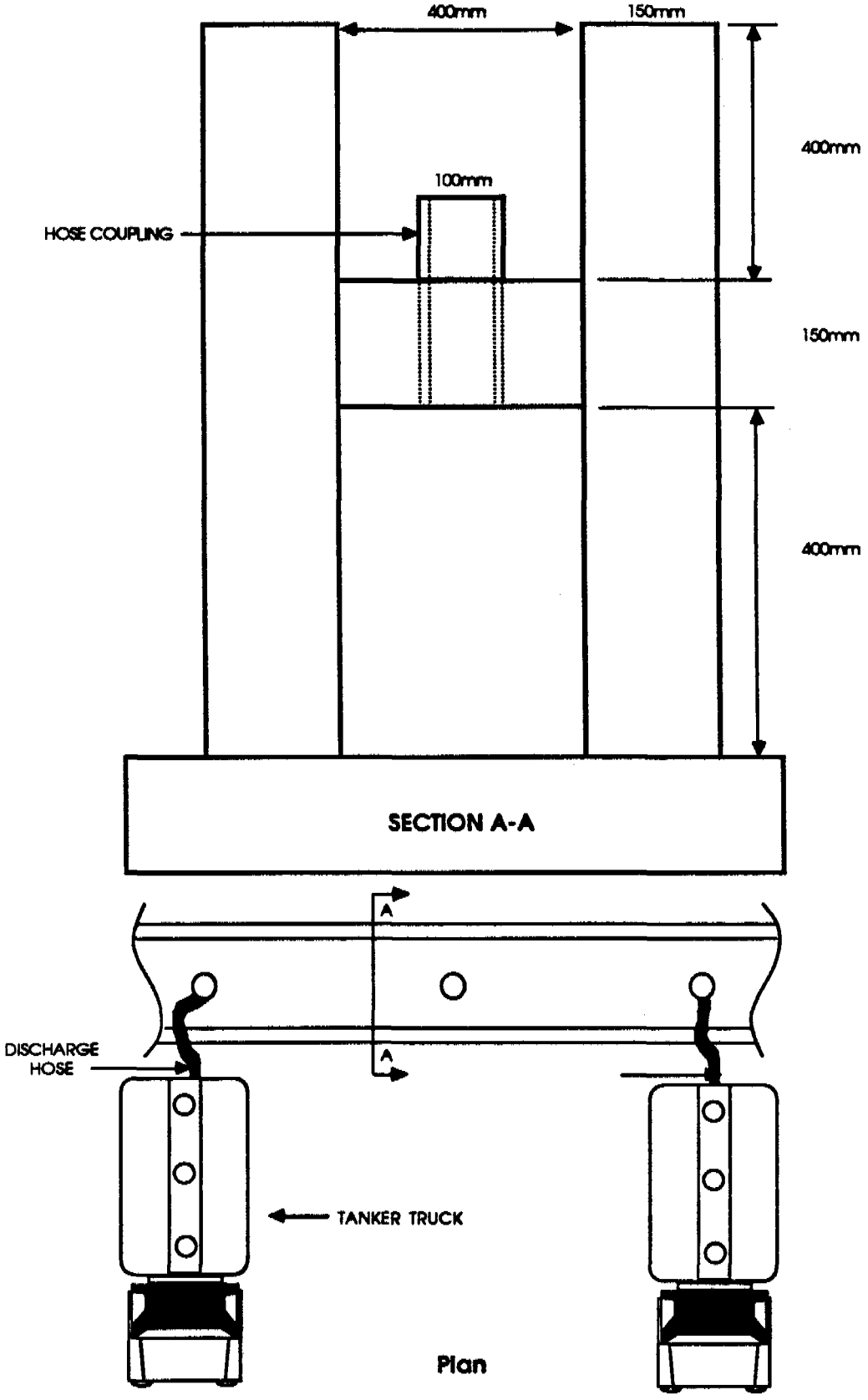


FIGURE 3
DISCHARGE FACILITIES

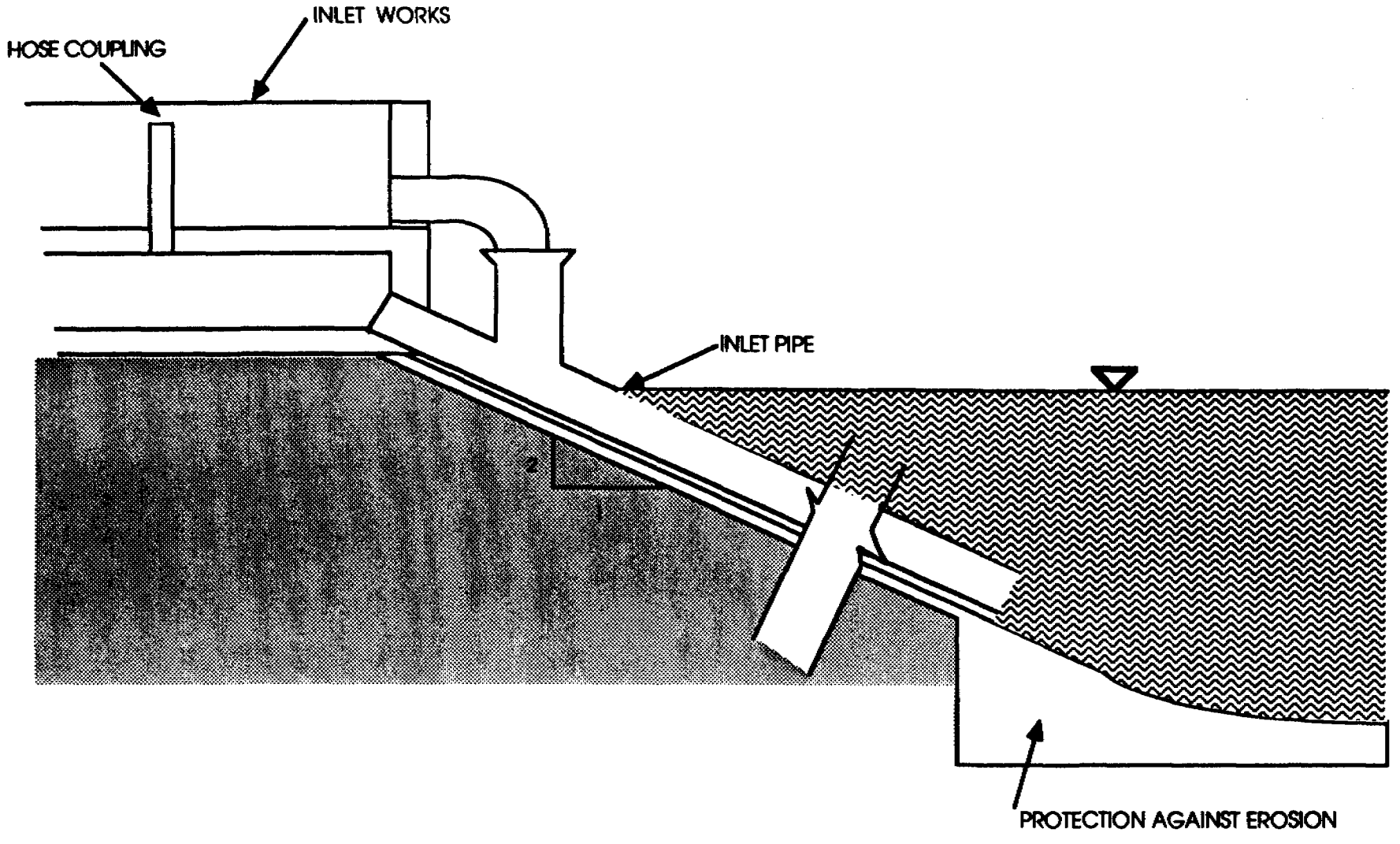


FIGURE 4
PIPE TO FIRST POND

CONNECTION BETWEEN PONDS

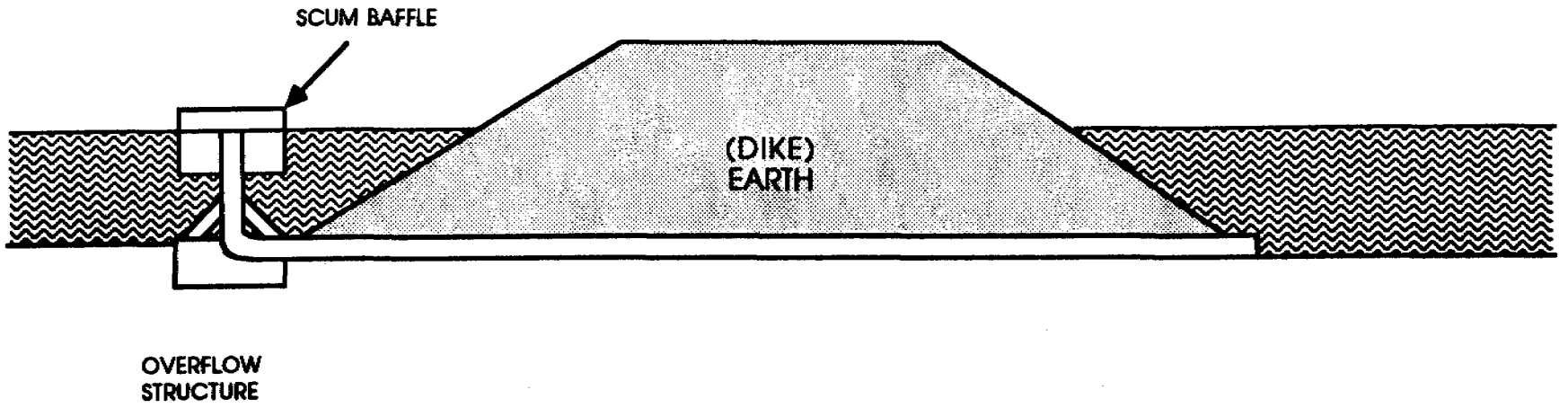


FIGURE 5
PIPE CONNECTION BETWEEN PONDS

portion of the pipe would simply extend into the next pond at about the same elevation as the bottom of the downstream pond.

3.3.5 Other Details

The entire area around the ponds would be surrounded with a strong fence, about 3 m high, and a small trailer would be provided for a gate house, where records would be kept. Other components for which costs have been included include facilities for recirculating effluent from the final maturation pond back to either the anaerobic pond or the facultative pond, chlorination facilities, chlorine contact tank, effluent holding tank, and mobile laboratory.

3.4 Operation and Maintenance

Pond systems for treatment require much less attention than mechanized treatment systems. Nevertheless, the ponds must be maintained to avoid nuisance from flies and odors.

The operation and maintenance would include:

- Record keeping
- Control of vegetation
- Removal of scum and floating material
- Removal of solids from inlets and outlets
- Maintenance of embankments
- Sludge removal
- Analysis of wastewater at various stages in the process
- Effluent pumping for reuse.

Currently, records are kept of the number of trucks and the wastewater loads from each truck. The information should continue to be collected and should be evaluated at least every month, in order to obtain better information on the sources of the wastewater and to spot trends in wastewater flows.

If vegetation is allowed to grow at the edges of the lagoons, fly breeding will be encouraged. This vegetation should be removed.

Scum will accumulate at the surface of the first pond, and rafts of algae might form in some other ponds. According to Arthur (1983), the scum on the anaerobic pond is beneficial and it might be left in place. Scum and algae rafts on other ponds should be removed.

Solids might collect at influent and effluent pipes, and these should be removed.

Embankments should be inspected periodically to determine if there has been any damage from animals or from wave action. Repairs should be made as necessary.

THE SLUDGE SHOULD BE REMOVED FROM THE ANAEROBIC POND WHEN THE POND HAS ABOUT 1 M OF SLUDGE. In the climate of the Dhofar region, the sludge could be allowed to dry in place. If a crust forms on the sludge and the crust

prevents drying, a bulldozer could be used to break up the crust. The dried sludge could be used as a soil amendment.

Performance of the ponds should be monitored by weekly sampling of effluent from the anaerobic and facultative ponds, and from the final effluent. All samples should be analyzed for BOD and suspended solids, and the effluent samples should be analyzed for pathogens and indicator organisms.

Effluent from the ponds could be pumped to reuse sites, and recycled as necessary to control odors or improve treatment. The pumping facilities would have to be maintained.

Labor required would include nine laborers, ten technicians, a chemist, an engineer, and a supervisor.

3.5 Cost Estimates

The cost of construction for the ponds and appurtenances would be about R.0.250,000 for initial construction, as shown in detail in Table 5. The estimates are based on current construction costs in the Salalah area. (See Appendix F for the unit costs.) Second-stage construction would cost about R.0.110,000.

Cost for operation and maintenance would be about R.0.62,000 per year, as shown in Table 6.

TABLE 5

ESTIMATED CONSTRUCTION COSTS

Capital Costs	R.O.	
	First Stage	Second Stage
Embankment	43,000	21,000
Stabilization	40,000	38,000
Concrete	7,000	5,000
Rip-Rap	21,000	11,000
Piping	5,000	2,000
Fencing	24,000	4,000
Power	5,000	--
Entrance Building	3,000	--
Improved Access	3,000	--
Effluent Pumping (for reuse)	3,000	--
Pumping for recycle	3,000	3,000
Asphalt Road	20,000	--
Chlorination Equipment	8,000	4,000
Mobile Laboratory	10,000	---
Miscellaneous Equipment	2,000	---
Subtotal	197,000	88,000
Engineering	20,000	9,000
Contingencies	30,000	15,000
	R.O. 247,000	R.O. 112,000

TOTAL R.O. 359,000

TABLE 6

ESTIMATED OPERATING COSTS

Item	R.O./yr
Labor *	38,000
Electricity	10,000
Vehicle Costs	10,000
Chlorine	4,000
Total	R.O. 62,0000/yr

* Labor estimate is based on nine laborers, two technicians, one chemist, one engineer, and one supervisor.

Chapter 4

SITING INVESTIGATION

4.1 The WASH Team's Investigations in Salalah

During the WASH team's visit, discussions were held with various authorities in Salalah, to determine potential sites. Sites identified were:

Wadi Thet

Wadi Sahalnaut

Near Arzat Farm

The Wadi Thet site is within the area set aside for the future treatment plant. It is just east of the Raysut Cement Company and about 1,500 m from Qaboos Street.

Wadi Sahalnaut offers two types of sites. One is in the channel of the Wadi in the area now used for wastewater dumping. Another is in the east side of the Wadi, where the impact from flooding would be less severe. The locations are about 2,000 m from the roundabout.

The site near Arzat Farm is located about 1,000 m east of Dhariz Khawr, between Arzat Farm and the ocean.

Although construction in the channel of Wadi Sahalnaut would be more expensive than construction at other sites, all these sites were judged to be acceptable. They are more than 1,000 m from developed areas, and they offer the potential for reuse by agriculture or (for Wadi Thet) at rock crushing facilities. They are approximately 10 to 11 km from the center of the city and would not impact potable groundwater. All sites except the channel at Wadi Sahalnaut are outside the area flooded during the 1983 storm. The site at Wadi Thet has already been included in the Structure Plan.

See Appendix H for more details about this portion of the investigation.

4.2 Subsequent Work by the Liaison Committee

On 5 March 1988, the Liaison Committee for Water and Wastewater Master Plan for Salalah met to give further consideration to siting. The Committee dropped the Arzat Farm and Wadi Sahalnaut sites from further consideration. The Wadi Thet Site was kept, and two sites near the Wadi Thet Site were added for consideration. The additional sites are called the Upper Qaftawt and the Lower Qaftawt sites.

The three sites were rated for environmental acceptability, accessability, and land use value. The Committee found the Upper Qaftawt Site to be the most suitable.

Chapter 5

IMPLEMENTATION

5.1 Interim Solution

This report has been focused on the options available to provide treatment of wastewaters now being hauled and discharged to Wadi Sahalnaut in an uncontrolled manner. The resolution of this problem requires immediate, top-priority action. Provision has also been made to double the capacity of the proposed facilities as a second phase. This provision has been made to accommodate the possible increase in the hauling of wastewaters prior to the implementation of works to be identified in the upcoming master plan studies.

5.2 Schedule of Required Actions

The following sections outline the actions required in order to have the first-stage facilities in operation early in 1989.

5.3 Selection of Site

This report provides the following information:

- Potential locations for the proposed facilities
- Conceptual designs with capacities and dimensions
- Performance criteria
- Estimated construction costs
- Estimated operating and maintenance costs
- Preliminary draft of Ministry of Environment and Water Resources forms related to the environmental approval process.

The schedule assumed that Dhofar Municipality would select the preferred site on or before 15 May 1988 and make provision for the preparation of detailed topographic maps of the selected areas. (The site was selected by that date.) At the same time, the Environmental Impact Statement (Form L) should be submitted to the Ministry of Environment and Water Resources. It is anticipated that a decision will be made regarding a No Environmental Objection (N.E.O.) within 60 days of the date the impact statement is submitted to and registered by the Ministry, unless additional information is requested.

5.4 Selection of Consulting Firm

The proposed schedule calls for Dhofar Municipality to prepare the request for proposal for engineering services to be issued on or before 15 May 1988 in order to have the consultant selected by 15 July 1988.

5.5 Selection of Design and Construction Contractor

This schedule calls for the selection of the design and construction contractor on or before 1 October 1988. The schedule would require the consulting engineer to prepare the required Request for Proposals and tender documents within four weeks and allow a six-week period for submittal of tenders and selection of a contractor.

5.6 Pond Design and Construction

During a four-month period starting on or about 1 October 1988, the contractor would prepare detailed optimum design of the ponds from the standpoint of balancing excavation and fill in conformance with required height of embankment. Approval of the detailed design would be provided by the engineer providing services during construction prior to actual performance of the work. Construction of the required ponds and appurtenances would be completed early in February 1989.

5.7 Final Acceptance and Placement into Operation

During February 1989, final acceptance would be achieved and the waste stabilization ponds placed into operation.

APPENDIX A

PROPOSED SCOPE OF WORK

PHASE A: DATA COLLECTION AND EVALUATION OF THE PROBLEM

1. Review all available information.

   - Socio-Demographic Survey - Southern Region 1985 (Parts A and B)

     - Planning Committee for Development and Environment in the Southern Region

   - Detailed Scope of Work for Water and Wastewater Masterplan for Salalah - Omani-American Joint Commission for Economic and Technical Cooperation, February 1988

2. Review pertinent hydrogeological and hydrological data.

3. Review land use studies and plans for Salalah.

4. Review the current situation and future requirements with Salalah authorities, other knowledgeable people in the Government of Oman, Omani-American Joint Commission for Economic and Technical Cooperation to assure an adequate understanding of problems, concerns, and objectives.

5. Conduct field observations of existing facilities and review operational procedures.

6. Field observations of septic tank construction and operation, and tanker truck facilities and operation.

PHASE B: DEVELOPMENT OF RECOMMENDATIONS

1. Recommend any immediate measures that might be taken to improve existing situation.

2. Identify and describe interim solutions and prepare conceptual designs.

3. Estimate construction costs for alternative solutions.

4. Estimate operation and maintenance costs for alternative solutions.

5. Prepare implementation schedules for alternative solutions.

6. Develop a decision matrix which includes considerations in addition to costs and implementation time in order to facilitate a comparison of alternative solutions.

7. Prepare draft report which discusses the positive and negative aspects of the various alternatives, identifies the critical factors to be taken into consideration in selecting the most suitable, least cost, option.

8. Obtain comments on draft report from Dhofar Municipality, Ministry of Environment and Water Resources, Joint Commission and Government of Oman authorities.

PHASE C: PREPARATION OF FINAL REPORT

1. Revise draft report as required to reflect review comments.

2. Finalize conceptual designs.

3. Finalize cost estimates.

4. Prepare final report, including an executive summary of key findings and recommendations.

The proposed schedule for the study is as follows:

Phase A:

Day/March	
1/12	Briefings and finalize scope of work (Muscat)
2/13	Briefings (Muscat) and travel to Salalah
3/14	Data Collection and Evaluation of Problem - Salalah
4/15	Data Collection and Evaluation of Problem - Salalah
5/16	Data Collection and Evaluation of Problem - Salalah
6/17	Data Collection and Evaluation of Problem - Salalah

Phase B:

Day/March	
7/18	Development of Recommendations - Salalah
8/19	Development of Recommendations - Salalah
9/20	Development of Recommendations - Salalah
10/21	Development of Recommendations - Salalah
11/22	Development of Recommendations - Salalah
12/23	Travel to Muscat
13/24	Muscat
13/25	Travel to U.S.A.

Phase C:
5 working days in U.S.A.

The study team will include Dr. A. B. Pincince, who previously was on WASH assignment in Oman to address similar problems in the Capital Area, and Mr. Leo A. St. Michel, who also was previously in Oman on WASH assignment.

APPENDIX B

SCHEDULE OF MEETINGS AND FIELD VISITS

12 March 1988

0200 Arrival in Muscat

1000-1030 Discussions at Joint Commission Offices

1030-1115 Meeting with Joint Commission Staff

Dr. Duncan R. Miller	U.S. Representative
David H. Mandel	Assistant Representative
Stan Stalla	Project Officer
Edvard Markeset	Chief Engineer
Musa Al-Mazroui	Joint Commission Engineer
Dr. Albert B. Pincince	WASH Project
Leo A. St. Michel	WASH Project

13 March 1988

0830-0930 Meeting at Dhofar Municipality

Ali Bin Saeed Bin Bader Al-Rawas -	His Excellency The Chairman of Dhofar Municipality
Hamid Bin Abdullah Burhan	Executive Director Dhofar Municipality
Dr. Abd El-Rahman El Bashir	Administration Advisor Dhofar Municipality
Salim Bin Ali Baktheer	Director of Public Health Affairs - Salalah
Ghali Almashali	Engineer - Salalah
Hafeed A. Al-Hafeed	Engineer, D.G. of Housing - Salalah
Edvard Markeset	Chief Engineer Joint Commission
Dr. Albert B. Pincince	WASH Project
Leo A. St. Michel	WASH Project

Reviewed scope of work and schedule. His Excellency offered every assistance and requested that he be personally contacted if any problems occurred in performing the work. (See attached copy of the detailed scope of work.)

1000-1100 Tour of Wadi Sahalnaut where rav sewage pumped from septic tanks and holding tanks, partially treated sewage, sullage sludge and other wastewaters are discharged. Essentially land application of wastewaters in a random manner, however limited to a particular area of approximately 50 hectares. Wastes accumulate in scattered anaerobic ponds followed by aerobic areas with abundant plant life. Discharge areas apparently selected as bowser drivers move from an area as the area becomes saturated.

1115-1215 Tour of extended aeration treatment plant serving MOD complex at Pink Cliffs. Very well operated plant. (Plant includes extended aeration, screening, chlorine contact, trickling through a bed of fine stone.) Sludge is dried on beds. Effluent discharged into small drainage ditch.

1230-1315 Visit to wastewater handling facilities at Qaboos Hospital

- Treatment plant (extended aeration) not operable.
- Plant not able to meet 10/10 standards when in operation because of hydraulic loadings exceeding capacity of plant.
- All wastewater currently being bowsered to Wadi Sahalnaut. Estimated to be 85,000 gallons per day.
- Hospital beds 325 versus design for 285. However design also did not take into consideration that at least one additional family member for each patient would be using hospital facilities or adequate estimate of hospital support staff.

1330-1400 Discussions with "Digger" Jones, consultant to the Council for Conservation of Environment and Water Resources (CCEWR)

Suggested references:

"Salalah Water Supply Well Field Protection Zones" by Alvin F. Pendelton, prepared by PAWR Report PAWR I-86-19 September 1986.

Draft of Ministerial Decision No. __/87 dealing with water protection zones.

"Groundwater Use and Availability in the Central Salalah Plain" by Al Pendleton, R.J. Dingman, Glenn Ainsworth, prepared by Public Authority for Water Resources, Sultanate of Oman. Report: PAWR 86-I-4, April 1986.

SALALAH OMAN 1:100,000, Sheet NE 40-9D, Series K6611, Edition 1-GSGS.

CCEWR Drawing OFR 87-3, Salalah Plain Aquifer Groundwater Quality Zones, January/February 1987. Scale 1:1,000,000.

15 March

0830-1030 Meeting with Steering Committee of the Master Plan for Water and Wastewater for Salalah

Ali Bin Saeed Bin Bader Al-Rawas	
Dr. Abd El-Rahman El Bashir	
Azzan bin Ahmed al Shanfari	D.G. Water and Transportation
Dr. Rowan Mactaggart	Acting Technical Coordinator of Planning and Development Committee
Mohammed Mohammed El-Sayed Ismail	Economic Advisor Projects Administration Wali of Dhofar Office
Dr. Nader Fayek	Public Health Compound Qaboos Hospital
Ghali Almashali	Engineer - Municipality
Saeed bin Salem al-Shanfari	Engineer with Municipality
K.G. George	D.G. Housing
Hafeed A. Al-Hafeed	Eng. Housing
Leo A. St. Michel	WASH
Albert B. Pincince	WASH
Edvard Markeset	Joint Commission

Extensive discussions on the WASH team scope of work and its relationship with the master plan studies that are anticipated in the near future.

1100-1200 Visit to wastewater treatment plant serving the Diwan compound in Salalah. Extended aeration plant that is well operated. Only problem is the ability in handling sludge. Sludge is hauled to the Sahalnaut site.

1200-1300 Tour of potential treatment plant site west of Salalah as designated in the structure plan prepared by the Directorate General-Housing. Information provided by K.G. George during steering committee meeting.

16 March Public Holiday

0800-1700 Analyses of wastewater handling records

17 March

0800-0900 Discussions with Dr. El-Rahman El Bashir

0915-1100 Meeting with Planning Committee for Development and Environment in the Southern Region

Planning Committee of a Council of Ministers: including Environment and Water Resources, Communication, Electricity and Water Petroleum and Minerals, Agriculture and Fisheries, Housing Under Secretary of Finance, Secretary General of the Council for Conservation of Water Resources. The Wali of Dhofar is the Chairman of the Committee.

The committee is primarily charged with the responsibility of establishing development policy. This includes three major activities:

- preparation of a regional development plan
- preparation of land use plans
- development of coordination procedures for land allocation

Present at the meeting were the following:

Dr. Rowan Mactaggart	Regional Planning Ao-Technician/Coordinator
Dr. Robert Whitcombe	Ecologist
Ahmed Al-Ghassani	RCDGSR
Eng. Saeed Al-Shanfari	Municipality
Dr. Albert B. Pincince	WASH
Leo A. St. Michel	WASH

1115-1230 Meeting with Directorate General of Planning and Housing

Present were the following:

K.J. George	Head of Follow Up and Execution of Planning Section of DGH
Hafeed A. Al-Hafeed	Dept. of Planning and Survey (DPS)
Ahmed Suliaman Ah-Ghafri	DPS (Acting Chief)
Eng. Omar Mohammed Al-Shaikh	DPS

	Eng. Saeed Al-Shanfari	Municipality
	Dr. Albert B. Pincince	WASH
	Leo A. St. Michel	WASH

18 March

0900-1600 Tour throughout Dhofar Municipality

19 March

0830-0930 Discussions at municipality

0945-1015 Return of documents borrowed from Dr. MacTaggart

1030-1045 Return of documents borrowed from Mr. George at the Director General Housing

1100-1145 Discussions at the Directorate General of Water Supply and Transport

Eng. Azzan Bin Ahmed Shafari	Director General
Dr. Yassim Abdul Salam El Hagger	Advisor to D.G. Water and Transport
Eng. Saeed Al-Shanfari	Municipality
Albert B. Pincince	WASH
Leo A. St. Michel	WASH

1200-1315 Meeting with Shanfari & Partners L.L.C. Civil Engineering and Building Contractors

Saeed Abdul Aziz Sabah Rawas	Managing Partner
Bryan L. Jones	Construction Manager
Eng. Saeed Al-Shanfari	Municipality
Albert B. Pincince	WASH
Leo A. St. Michel	WASH

Received information regarding construction costs and procedures currently in use in Salalah. They also supported design and construct procedures that would be most appropriate for a project of this nature, particularly if time was of importance.

1330-1500 Tour of potential site for treatment facilities to east in the vicinity of Arzat farm (later found out that this was not the specific site preferred by the Director General of Water Supply and Transport)

20 March

0815-0845 Discussions with Dr. Rahman

0900-0930 Meeting with Dr. Nader Fayek at Qaboos Hosital

1000-1030 Discussions with Dr. Mactaggart

1130-1300 Visit to Wadi Sahalnaut to reconfirm location of dumping areas

21 March

0800-0830 Discussions with Dr. Rahman

0900-0945 Tour of potential treatment plant site with Eng. Azzan Bin Ahmed Al Shanfari, Director General - Water Supply and Transport

22 March

0900-1030 Meeting of the Liaison Committee

Presentation of findings and recommendations by WASH

In attendance:

His Excellency Ali Saeed - Chairman

Dr. Rahman	Municipality
Dr. MacTaggart	Regional Planning
Dr. Nader	Health
Mr. George	Housing
Eng. Hafeed	Housing
Eng. Azzan	Water Supply and Transport
Eng. Saeed	Municipality
Ed Markeset	Joint Commission
A.B. Pincince	WASH
L.A. St. Michel	WASH

1200-1300	Meeting to brief Deputy Wali for Local Affairs	
	Mohammed Bin Marhom al Ma'amary	Deputy Wali
	H.E. Ali Saeed, Chairman, Dr. Rahman, Eng. Saeed, Pincince, St. Michel and Markeset	
1300-1400	Meeting to brief Deputy Wali for Finance and Adminstration	
	Mahammed Autit al-Shanfari	Deputy Wali
	Dr. Rahman, Eng. Saeed, Markeset, Pincince and St. Michel	
1400-1430	Short meeting with Chairman to schedule activities for 23 March 1988	
23 March	Briefing of Joint Commission in Muscat	
	Musa Al-Mazroui	Joint Commission
	Duncan Miller	Joint Commission
	Ed Markeset	Joint Commission
	A.B. Pincince	WASH
	L.A. St. Michel	WASH
	J. Keith Mason	Supreme Committee for Town Planning

APPENDIX C

REFERENCES AND MATERIAL REVIEWED

Al-Marhubi, Ali, and Rudolf J.G. Krafft (1983) Report on a Fact Finding Mission to Salalah, Capital of Southern Province, Dhofar in the Sultanate of Oman. Ministry of Health, Muscat and World Health Organization (WHO) Project OMA/BSM/002.

Arthur, J.P. (1983) Notes on the Design and Operation of Waste Stabilization Ponds in Warm Climates of Developing Countries. World Bank Technical Paper Number 7, Washington, D.C.

Consulting Engineering Services (India) Private Limited (1983) Structure Plan -- Salalah. Volume II Structure Plan -- 2001.

Gloyna, E.F. (1971) Waste Stabilization Ponds. World Health Organization Monograph Series No. 60, Geneva.

Kachinsky, R.J. and A.B. Pincince (1986) Evaluation of Alternatives for Interim Treatment and Disposal of Trucked Septage in the Capital Area, Sultanate of Oman. Prepared for Omani-American Joint Commission for Economic and Technical Corporation. Water and Sanitation for Health Project Activity No. 247.

Institute of Health Sciences (1987) Notes from Wastewater Reuse Seminar. Prepared by Environmental Health Section, Preventive Medicine Department, Ministry of Health, Sultanate of Oman.

Office of the Minister of State and Wali of Dhofar (1987) Report for Water and Water Resources for Salalah During the Future Twenty-Five Years. Directorate General for Water and Transport.

Planning Committee for Development and Environment in the Southern Region (1988) Socio-Demographic Survey -- Southern Region (Parts A and B).

Salem, Y.A., and M. Bin Ahur (1985) Preliminary Results of Pollution Detection in the Salalah Well Field Protection Zone. 4th National Conference on Drinking Water Supply, Muscat.

APPENDIX D

WASTEWATER QUANTITES

CONTENTS OF APPENDIX D

D-2 - Summary of Flows to Wadi Sahalnaut

D-5 - Figure D-1 -- Frequency of Trucks

D-6 - Information Sheet Used in Monitoring Wastewater Haulage

D-7 - Notes on Completing Information Sheet

D-8 - Summary of Haulage for Two Vehicles on 20 March 1988

D-9 - Figure D-2 - Location of Facilities Pumped on 20 March 1988

SUMMARY OF FLOWS TO WADI SAHALNAUT

MONTH/YEAR February 88

	*****MUNICIPALITY******					****************PRIVATE****************										TOTAL	TOTAL
DAYS	4	7.2	8	Total	Cu M	3.4	4	5	6	7.2	8	17	20	Total	Cu M	TRIPS	CU M
1	8	4	29	41	292.8	22	2	42	28	24	12	1	7	138	886.6	179	1179
2	5	5	17	27	192	17		40	40	36	10	1	6	150	974	177	1166
3	8	7	24	39	274.4	10	2	18	13	18	15	2	6	84	613.6	123	888
4	8	7	22	37	258.4	21	2	29	47	29	13	2	3	146	913.2	183	1172
5			16	16	128	12		19	23				8	62	433.8	78	562
6		8	32	40	313.6	18	1	39	34	28	18	2	5	145	943.8	185	1257
7		8	30	38	297.6	14		34	29	29	13	1	4	124	801.4	162	1099
8	8	8	17	33	225.6	12		44	26	26	10	1	8	127	861	160	1087
9	8	8	24	40	281.6	15	1	32	49	27	17		8	149	999.4	189	1281
10	8		32	40	288	9	2	26	14	14	11	1	8	85	618.4	125	906
11			16	16	128	16		33	30	23	12	1	3	118	738	134	866
12	8	7	24	39	274.4	5		22	32			1	8	68	496	107	770
13	8	8	22	38	265.6	12		34	41	21	9	1	5	123	797	161	1063
14	8	5	24	37	260	15		32	41	26	5	1	6	126	821.2	163	1081
15	8	6	23	37	259.2	17	2	46	33	23	11	2	8	142	941.4	179	1201
16	8	7	24	39	274.4	9	1	33	37	29	14	3	7	133	933.4	172	1208
17	9	11	24	44	307.2	9	1	30	40	28	12	2	6	128	876.2	172	1183
18	8	15	24	47	332	9	1	34	32	29	11	2	7	125	867.4	172	1199
19			16	16	128	6		9	11	2	3	1	8	40	346.8	56	475
20	8	16	24	48	339.2	6		37	37	30	14	3	6	133	926.4	181	1266
21	8	16	24	48	339.2	7		39	48	31	13	2	6	146	988	194	1327
22	8	16	23	47	331.2	7		39	48	31	13	2	6	146	988	193	1319
23	5	16	20	41	295.2	8		33	42	25	21	3	5	137	943.2	178	1238
24	8	16	24	48	339.2	7		20	14	25	13	3	8	90	702.8	138	1042
25	8	16	24	48	339.2	10		42	33	31	2	4	6	128	869.2	176	1208
26			16	16	128	6		45	20	7	2	7	15	102	850.8	118	979
27	8	8	24	40	281.6	6		23	38	14	8	5		94	613.2	134	895
28	8	8	20	36	249.6	9		50	26	26	9	10	11	141	1086	177	1335
29	8	8	24	40	281.6	8		45	26	24	11	8	10	132	1005	172	1287
30				0	0									0	0	0	0
31				0	0									0	0	0	0
																	0
TOTAL	179	234	663	1076	7705	322	15	969	932	656	302	72	194	3462	23835	4538	31540

SUMMARY OF FLOWS TO WADI SAHALNAUT

MONTH/YEAR January 88

	*****MUNICIPALITY******					********** PRIVATE **********										TOTAL	TOTAL
DAYS	4	7.2	8	Total	Cu M	3.4	4	5	6	7.2	8	17	20	Total	Cu M	TRIPS	CU M
1			16	16	128	8		17	21		4	1	7	58	427.2	74	555
2	8	16	14	38	259.2	8	1	43	28	27	9	2	6	124	834.6	162	1094
3	8	16	14	38	259.2	6		31	30	28	9	2	8	114	823	152	1082
4	5	13	14	32	225.6	16	1	30	23	30	11	4	5	120	818.4	152	1044
5	5	16	16	37	263.2	15	5	33	42	19	10	3	8	135	915.8	172	1179
6	3	15	16	34	248	9	1	19	10	30	8	1	8	86	646.6	120	895
7	5	9	18	32	228.8	23	2	44	32	30	5	2	3	141	848.2	173	1077
8			16	16	128	6		29	6	2	4	1	10	58	464.8	74	593
9	5	8	21	34	245.6	18	1	41	24	21	12	3	6	126	832.4	160	1078
10	4	3	21	28	205.6	16	1	41	12	31	9	1	5	116	747.6	144	953
11	5	13	13	31	217.6	23	26	33	28	28	10	2	5	155	930.8	186	1148
12	8	16	11	35	235.2	8	1	35	30	24	4	4	4	110	739	145	974
13	5	15	16	36	256	12		33	8	16	4	3	8	84	612	120	868
14	5	16	14	35	247.2	16		47	30	30	6		9	138	913.4	173	1161
15			16	16	128	16		31	17			1	10	75	528.4	91	656
16	8	15	14	37	252	25		41	31	27	7	4	4	139	874.4	176	1126
17	5	19	10	34	236.8	26	1	45	41	30	6	1	6	156	964.4	190	1201
18	4	14	14	32	228.8	18	2	52	28	38	4	2	7	151	976.8	183	1206
19	5	15	14	34	240	15	2	40	59	33	16	6	10	181	1281	215	1521
20	8	16	17	41	283.2	17		33	23	30	16	3	9	131	935.8	172	1219
21	5	16	15	36	255.2	16		51	48	33	9		10	167	1107	203	1362
22				0	0	16		22	27			1	6	72	463.4	72	463
23	4	16	15	35	251.2	16		39	40	31	9	2	4	141	898.6	176	1150
24	5	16	16	37	263.2	23	3	59	33	39	7		8	172	1080	209	1343
25	5	7	24	36	262.4	16		57	42	33	6	2	6	162	1031	198	1293
26	5		24	29	212	20	1	31	47	28	6	3	7	143	949.6	172	1162
27	5		32	37	276	10	1	39	17	21	13	4	9	114	838.2	151	1114
28	5		32	37	276	19		62	33	33	6	2	10	165	1092	202	1368
29			16	16	128	8		37	30		4	1	9	89	621.2	105	749
30	7	7	24	38	270.4	25	2	52	25	26	12	3	9	154	1017	192	1288
31	8	6	24	38	267.2	19		46	39	11	9	3	8	135	890.8	173	1158
																	0

SUMMARY OF FLOWS TO WADI SAHALNAUT

MONTH/YEAR: September 1987

	*****MUNICIPALITY******					****************PRIVATE****************										TOTAL	TOTAL
DAYS	4	7.2	8	Total	Cu M	3.4	4	5	6	7.2	8	17	20	Total	Cu M	TRIPS	CU M
1	8	7	24	39	274.4	10		23	31	31	11	4	5	115	814.2	154	1089
2	8	16	14	38	259.2	11		36	30	35	16	5	5	138	962.4	176	1222
3	8	16	16	40	275.2	11		21	30	40	14	5	5	126	907.4	166	1183
4			8	8	64	4		20	9	5	4		4	46	315.6	54	380
5	8	15	15	38	260	5	9	25	39	39	22	4	5	148	1037	186	1297
6		14	22	36	276.8	9		25	35	34	18	4	8	133	982.4	169	1259
7		15	18	33	252	8		27	32	33	21	4	8	133	987.8	166	1240
8		15	24	39	300	11		25	26	34	12	9	7	124	952.2	163	1252
9	8	15	18	41	284	7		33	31	32	23	5	11	142	1094	183	1378
10	8	7	23	38	266.4	12		31	32	32	12	5	11	135	1019	173	1286
11			14	14	112	5		12	8	24	5	1	11	66	574.8	80	687
12	8	8	24	40	281.6	11		23	30	37	19	5	10	135	1036	175	1317
13	8		31	39	280	10		18	36	29	12	6	5	116	846.8	155	1127
14	8		31	39	280	5		40	33	29	17	3	8	135	970.8	174	1251
15	8		32	40	288	10		31	30	33	16	3	9	132	965.6	172	1254
16	8		32	40	288	11		30	38	32	26	6	8	151	1116	191	1404
17	8	6	24	38	267.2	12		31	34	30	13	7	8	135	998.8	173	1266
18			14	14	112	5		12	11	12	5		9	54	449.4	68	561
19	8	8	20	36	249.6	17		24	39	33	17	4	8	142	1013	178	1263
20	8	7	24	39	274.4	13		28	38	37	18	4	8	146	1051	185	1325
21	8	7	24	39	274.4	9		26	37	38	23	3	8	144	1051	183	1326
22	8	7	23	38	266.4	10		23	32	30	9	6	7	117	871	155	1137
23	8	8	24	40	281.6	12		22	31	23	24	7	9	128	993.4	168	1275
24	8	8	24	40	281.6	12		32	40	33	26	3	9	155	1117	195	1399
25			14	14	112	6		14	10	15	5		9	59	478.4	73	590
26	5	8	24	37	269.6	15		28	36	37	15	3	9	143	1024	180	1294
27	8	7	24	39	274.4	18		34	35	38	16	2	9	152	1057	191	1331
28	5	7	23	35	254.4	13		29	44	39	7	4	9	145	1038	180	1292
29	6	7	24	37	266.4	12		27	33	33	17	2	8	132	941.4	169	1208
30	8	7	14	29	194.4	16		33	26	35	19	5	9	143	1044	172	1239
31				0	0									0	0	0	0
																	0
TOTAL	176	215	646	1037	7420	310	9	783	916	932	462	119	239	3770	27710	4807	35130

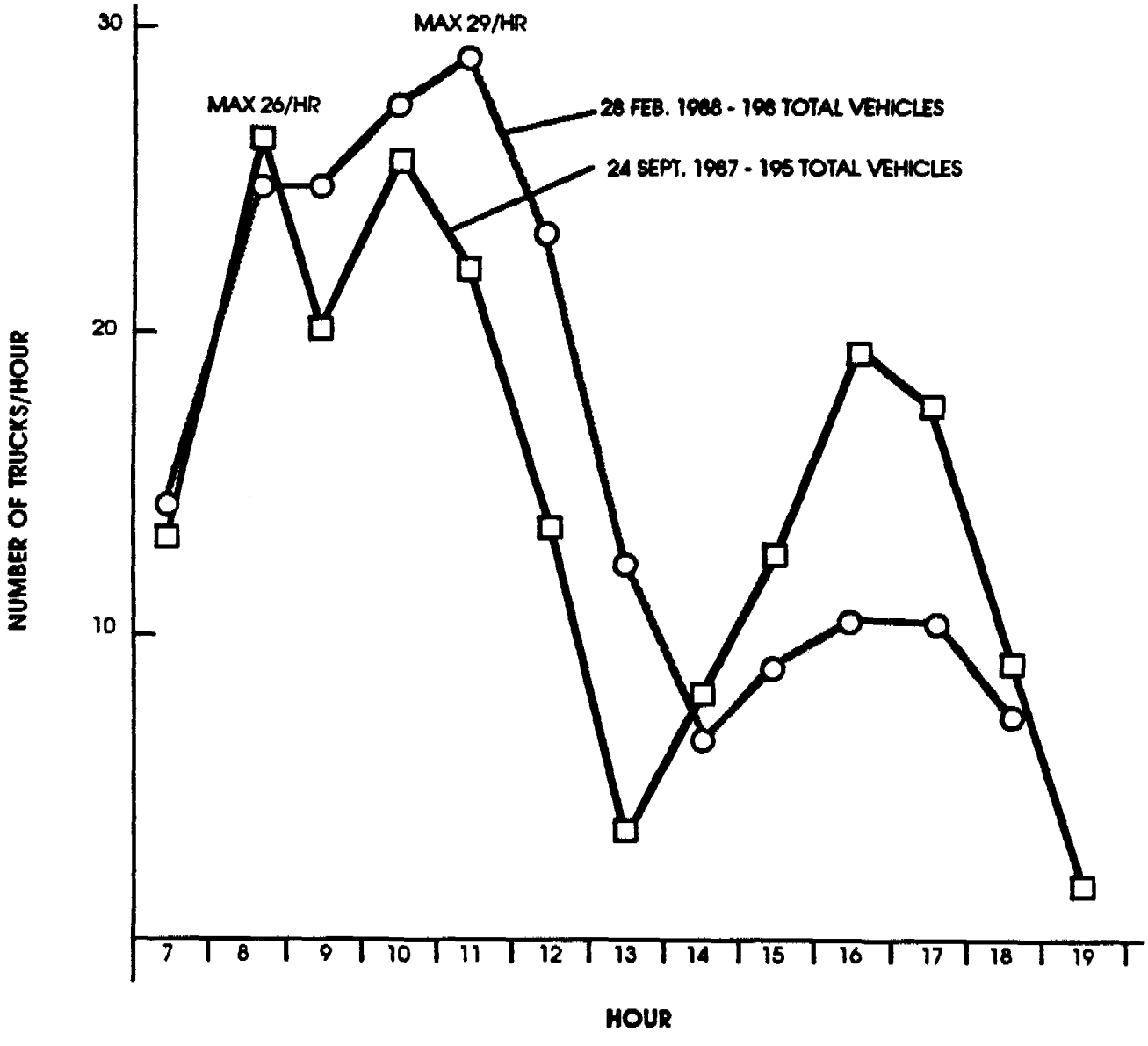


FIGURE D-1
FREQUENCY OF TRUCKS

INFORMATION SHEET ON WASTEWATER HAULAGE IN SALALAH

	STOP NO. 1	STOP NO. 2	STOP NO. 3	TOTAL NO. OF TRIPS
1. Location				
2. Brief description				
3. Est. number of people served				
4. Est. capacity of holding tank or septic tank	liters	liters	liters	
5. Est. amount of material removed in liters	liters +	liters +	liters =	liters
6. Cost of service				
7. Date unit was previously pumped				
8. Estimated frequency pumping required				
9. Schedule for filling Time Start Time End				
10. Schedule for discharge at Sahalnaut Wadi Time Start Time End				

NOTES ON COMPLETING INFORMATION SHEET

1. Provide approximate location of unit being pumped.
2. Brief description such as private home, office, group of homes, school, garage, commercial establishment, etc.
3. Provide an estimate of the number of people seived by the unit.
4. Obtain estimated capacity of septic or holding tank. Obtain dimensions (H-W-D) if possible.
5. Estimated amount of material removed (in liters or gallons) - Based on information from operation, time required to remove contents, etc.
6. Obtain cost of service. Is it based on volume of material removed or service provided.
7. Obtain estimate of last time unit was pumped.
8. Also obtain estiamte as to frequency that pumping is required such as 1/week, 2/month, 4/year -
9. Provide time for start and end of pumping (each unit serviced).
10. Provide time for start and end discharge at Sahalnaut Wadi.

SUGGESTED OBSERVATION SCHEDULE

1-person to monitor private sector vehicle for entire operating day - suggest ruck No. 3112 (or equivalent) from Bahadoor Trading Co. (largest operator in the private sector)

1-person to monitor municipal vehicle for entire operating day - suggest truck No. 13655 (or equivalent) (usual driver is Fernando)

SUMMARY OF HAULAGE FOR TWO VEHICLES - 20 MARCH 1988

Facility Served	Location Number*	Size or Capacity of Holding Tank	No. of Trips	Amount Hauled(liters)
Truck No. 6772				
Police Garage	#2	20'x15'x10'	2	12,000
Taylor Woodrow (Construction Firm)	#3	20'x20'x10'	2	12,000
Service Station	#4	50'x25'x5'	4	24,000
Truck No. 4074				
Office Building	#5	72,000 liters	3	10,200
Hotel (20 rooms)	#6	15,000 liters	1	3,400

* See Page D-9

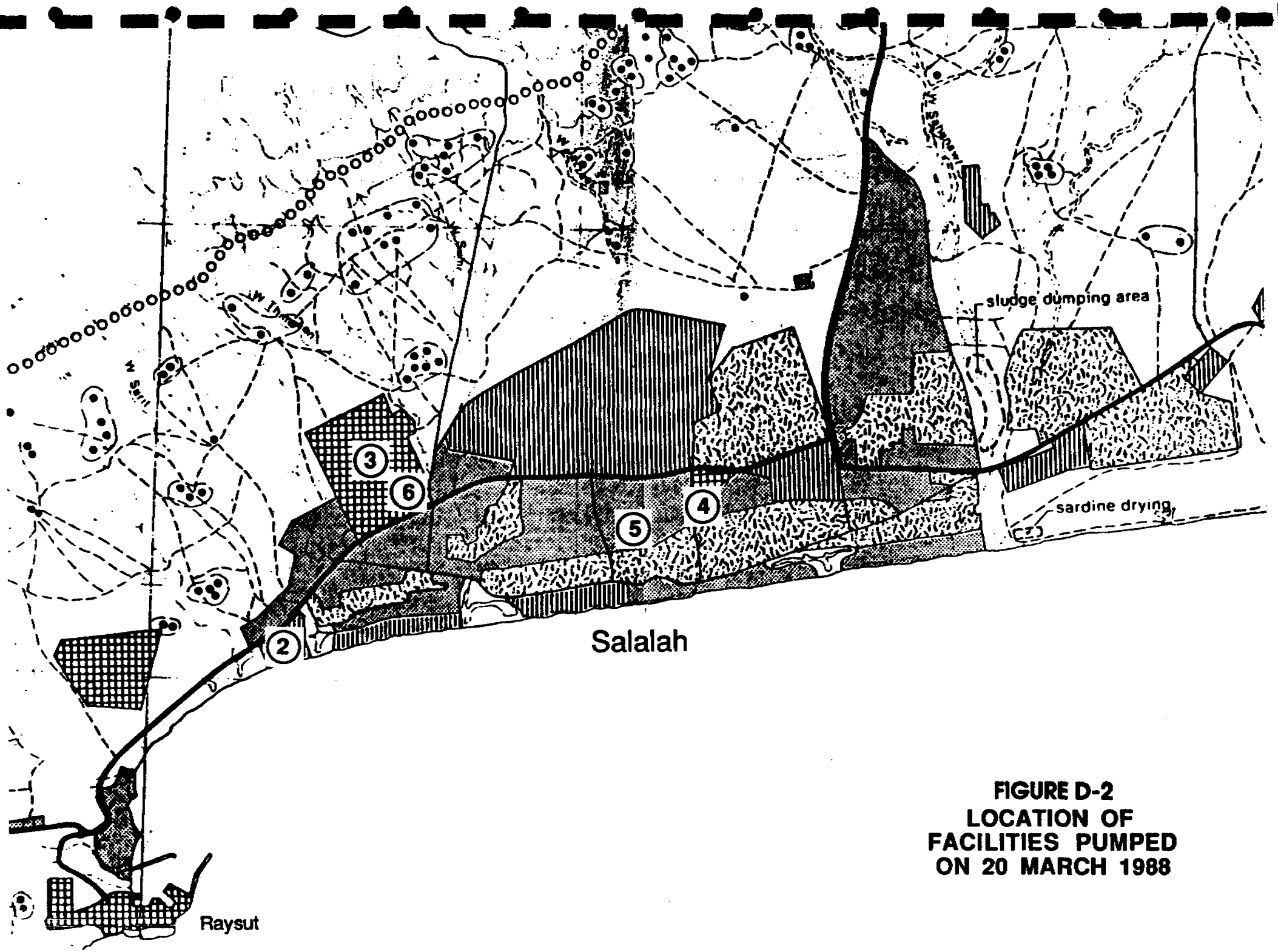


FIGURE D-2
LOCATION OF FACILITIES PUMPED ON 20 MARCH 1988

APPENDIX E

DESIGN OF ANAEROBIC/FACULTATIVE/ MATURATION PONDS

E.1 Design Criteria and Unit Size

The design procedure used to size the pond system was based on work by Arthur (1983).

For anaerobic ponds, the ponds were sized to provide a detention time of 2 days and a depth of 4 meters. As recommended by Arthur (1983) two ponds, each with the required detention time, would be provided for the first stage. Two ponds are recommended because solids in the wastewater will settle in the ponds, and sludge will have to be removed about every year. About 60 percent of the BOD would be removed in the anaerobic pond.

Design of facultative ponds is based on the kg of BOD applied per day per hectare. The areal loading rate allowed depends on the minimum monthly average temperature (about 22°C for Salalah). The relationship is:

$$\text{kg BOD/ha/day} = 20\ T - 60,$$

where T = minimum monthly average temperature.

For 22°C, the design loading rate is 380 kg BOD/ha/day. For a BOD of 560 mg/L, a flow of 1,200 cu m/day, and removal of 60 percent of the BOD in the anaerobic pond, the surface area of the wastewater in the facultative pond would be about 0.7 ha. Only one pond would be required for this alternative, because the rate of sludge deposition would be low.

The depth of the pond would be about 1.8 m, and the resulting detention time would be about 10.6 days.

The purpose of the maturation ponds is to achieve reduction in the pathogenic organisms in the wastewater. The rate at which the organism die off in the wastewater can be described by first-order kinetics. This means that the rate at which the organism die is directly proportional to their number. The rate coefficient is dependent on temperature by the relationship:

$$K = 2.6 \times 1.19^{T-20}$$

For one pond, the percent of the organism removed is:

$$100 - \frac{100}{1 + K\ t^*}$$

where t* is the detention time.

For several ponds, the percent of organisms removed is:

$$100 - \frac{100}{(1 + K\ t^*_{an})(1 + K\ t^*_{fac})(1 + K\ t^*_{mat})n}$$

where t^*_{an} = detention time in anaerobic pond

t^*_{fac} = detention time in facultative pond

t^*_{mat} = detention times in each maturation pond

n = number of maturation ponds in series.

We suggest that three maturation ponds in series, each with a detention time of 5 days be constructed.

With all the ponds in operation, the percentage of fecal coliform removed would exceed 99.9999 percent.

E.2 Design Calculations

Design calculations follow.

	A	B	C	D
1				
2				
3	TABLE			
4				
5	CALCULATIONS FOR LAGOON SYSTEM			
6				
7				
8	ITEM			VALUE
9				
10	Flow to lagoons (cu m/d)			1,200
11				
12	BOD (mg/L)			300
13				
14	BOD load (kg/d)			360
15				
16	Pond temperature (°C)			22
17				
18				
19	ANAEROBIC LAGOONS			
20				
21	Number (in parallel)			2
22				
23	Detention time (each) (days)			2
24				
25	Volume (each) (cu m)			2,400
26				
27	Depth (m)			3
28				
29	Surface area (at mid depth)			
30		each (ha)		0.08
31		total (ha)		0.16
32		each (sq m)		800
33				
34	Slope			2
35				
36	Distance to bottom of water (m)			1.5
37				
38	Distance to surface of water (m)			1.5
39				
40	Freeboard (m)			1
41				
42	Length to width ratio			2
43				
44	Mid depth dimensions (m)			
45	Width			20.0
46	Length			40.0
47				
48	Bottom dimensions (m)			

	A	B	C	D
49	Width			14.0
50	Length			34.0
51				
52	At inside of top of dike (m)			
53	Width			30.0
54	Length			50.0
55				
56	Surface area at inside of top of dike (ha)			0.15
57				
58	BOD removed (%)			60
59				
60	BOD in effluent (mg/L)			120
61		(kg/day)		144
62				
63				
64	FACULTATIVE LAGOON			
65				
66	Areal loading rate (kg BOD/ha/day)			380
67				
68	Area required at surface (ha)			0.38
69		(sq m)		3789.47
70				
71	Pond depth (m)			1.8
72				
73	Slope			2
74				
75	Freeboard (m)			1
76				
77	Length to width			2.5
78				
79	Dimensions at surface (m)			
80	Width			39
81	Length			97
82				
83	Bottom dimensions (m)			
84	Width			32
85	Length			90
86				
87	At inside of top of dike			
88	Width			43
89	Length			101
90				
91	Surface area at inside of top of dike (ha)			0.44
92				
93	Total pond volume (cu m)			6,821
94				
95	Total detention time (days)			5.7
96				

	A	B	C	D
97	Number of ponds			1
98				
99	Detention each (days)			5.7
100				
101	Volume each (cu m)			6821
102				
103				
104	MATURATION PONDS			
105				
106	Number (in series)			3
107				
108	Detention (each) (days)			5
109				
110	Volume (each) (cu m)			6,000
111				
112	Depth (m)			1.5
113				
114	Area at middepth (ha)			0.4
115		(total)		1.2
116		sq m each		4000
117				
118	Length to width ratio			2.2
119				
120	Freeboard (m)			1
121				
122	Slope			2
123				
124	Dimensions at middepth (m)			
125	Width			42.64
126	Length			93.81
127				
128	Dimensions at bottom (m)			
129	Width			36.64
130	Length			87.81
131				
132	At inside of top of dike (m)			
133	Width			49.64
134	Length			100.81
135				
136	Surface area at inside of top of dike (ha)			0.50
137				
138	Decay coefficient for fecal coliform (1/day)			3.68
139				
140	Decrease in fecal coliform (%)			99.9999254
141				
142				
143				
144				

	A	B	C	D
145				
146	TOTAL LAGOON DATA			
147				
148	Detention time (days)			23
149				
150	Surface area of ponds inside dikes (ha)			2.24

APPENDIX F

BASIS OF COST ESTIMATES

F.1 Construction Costs

Item	Unit	Unit Cost (R.O.)
Earth excavation and embankment	cu m	1.000
Soil cement	sq m	1.500
Reinforced concrete	cu m	40.000
Yard piping (asbestos-cement pipe)		
150 mm	m	3.000
200 mm	m	5.000
Berm protection (150 mm stones)	sq m	3.000
Fencing (chain link)	m	12.000
Mobile trailer	ea	5000.
Power	--	2000.

F.2 Operating Costs

Unskilled labor	per month	120
Technician	per month	300
Engineer	per month	500
Electricity	kWh	0.020

Appendix G

FORM L AND SUGGESTED RESPONSES

SULTANATE OF OMAN
Ministry of Environment
and Water Resources

سلطنة عمان
وزارة البيئة ومصادر المياه

ENVIRONMENTAL IMPACT STATEMENT

GUIDANCE NOTES

FORM L

INTRODUCTION

It is the objective of the Sultanate of Oman that a development should proceed only when it has beendemonstrated that the proposals will not have unacceptable impacts on the environment. In the interests of the nation and its people, developments should be safe, should not damage the natural environment or cultural heritage of the country and should maintain, and, if possible, enhance the amenities of the areas where they are located.

To assist this objective, the Law on the Conservation of Environment and Prevention of Pollution (Royal Decree 10/82) requires that a statement of the environmental impact of a development be submitted with the application for a licence for that development. This statement now needs to be accompanied by a No Environmental Objection (N.E.O.) decision issued by the Ministry of Environment.

An N.E.O. decision can only be issued after the Ministry has been given sufficient information about a proposed development and about the likely environmental impacts of the project. The environmental impact statement prepared by the developer willprovide much of the information on which the Ministry's decision will be based. The Ministry will need to be satisfied that environmental impacts are acceptable before an N.E.O. decision is issued.

Developers may wish to discuss their project with the Technical Secretariat of the Ministry before submission of their Environmental Impact Statement (EIS). The Ministry may require discussions with developers following the submission of the Environmental Impact Statement. At the time of the submission of an EIS which is adequate for the Ministry's needs, the developer will be given the date when an N.E.O. decision can be expected. This will be stated on a receipt handed to the developer by the Ministry. The decision will be made within sixty days of the date when the impact statement is submitted to and registered by the Ministry, unless additional information has to be requested from the developer by the Ministry.

The N.E.O. decision will only relate to that development described in the completed Environmental Impact Statement. If changes are subsequently made to the proposals prior to construction starting either in site location or in other aspects of the development such as the process to be used or the height of buildings, a new E.I.S. will have to be prepared. A new E.I.S. will also have to be submitted if the development is extended at some time in the future.

The issue of an N.E.O. decision by the Ministry does not exempt applicants from the need to obtain licences from other Ministries.

GUIDELINES FOR FORM L

For all infrastructure projects, information will need to be supplied on the topics set out in Form L.

Infrastructure projects include roads, airports and heliports, ports, harbours, jetties and marinas, railways, pipelines, electricity transmission lines and dams, reservoirs and wells. Refuse and effluent disposal facilities which receive wastes from a number of sources are also classified as infrastructure projects.

These guidance notes have been prepared to help developers to complete the Environmnetal Impact Statement Form L in a manner which will be most useful to the Ministry of the Environment. This will help the Ministry to process the application quickly and effectively.

1. PROJECT ORGANISATION

a) Project Title

Enter the same title used, or intended to use, in any other application to be made for this project.

b) Brief Description

Enter sufficient information to indicate the nature, purpose and scope of the project. For roads, pipelines, and electricity transmission lines, state length of route and general specification of facility (for example, dual carriage road with flyovers or underpasses, 600mm pipeline at a stated average depth). For airports and heliports, ports, harbours, jetties and marinas, dams reservoirs and wells and refuse and effluent disposal facilities, attach schematic plans showing the proposed layout and state the gross site area to be occupied by the project in hectares.

c) Location

Attach a map showing the location of the development or the route of the road, railway, pipeline or transmission line. A map at 1:10000 scale will usually be sufficient. Give grid references.

d) Owner

Owner means any person or group of persons or Government or private organisation whether national or foreign owning or leasing an area of work or being responsible for its running and administration (Article 4/17 of Royal Decree 10/82).

e) Contact

Enter the name and title of the person nominated by the owner to be contacted by the Ministry of Environment on matters relating to the project. If the contact and the owner are the same, enter "as for d". If different, give the address and telephone number of the contact.

f) Consultants

State the name, address, telephone number and name of contact of any consultant responsible for the planning and/or design of the project. If more than one consultant is employed, enter details of all consultants indicating the special responsibilities of each on the project.

g) Proposed Starting Date

(i) State the expected date of the first construction contract.

(ii) State when the facility to be constructed is expected to begin operation.

h) Future Development

If future developments are planned, give a brief description. If the expansion is to be carried out in stages, give details, including dates, of phases. State the additional site area required for future expansion in hectares.

2. PROJECT DETAILS

a) Construction Details

Indicate the types and sources of materials to be used in construction, such as quarried, purchased locally, or directly imported. State the proposed method of transporting construction materials to the site (for example, trucks, pipeline, conveyor). Indicate which public roads will be used. State how materials will be stored.

b) Utilities Requirements

(i) Give details separately of anticipated demand for fresh water, for sea water and for saline ground water in m^3/day.

(ii) Give details of anticipated demand for electricity in KW.

(iii) State the types (for example, oil and gas of different types, coal and wood products), sources of supply, methods of transport and uses of any fuels. Give details of anticipated consumption of fuels on a daily, weekly or monthly basis.

c) Other Locations Considered

Give brief details of any other locations or routes considered in the course of prefeasibility or other studies, with reasons for their rejection.

d) Factors Determining Project Location

Give brief details of those factors which determined the location of the project. (For example, the location of essential services, water resource availability, infrastructure provision, environmental factors).

e) Details of Preliminary Investigations Already carried Out

If the results of any studies of the proposed development are available, please supply, preferably in summary or abridged form.

3. OFF-SITE ANCILLARY DEVELOPMENTS

Enter details of any offsite infrastructure developments or facilities necessary for the construction or operation of the main project. Examples could include:

* housing development for construction or operations personnel (for example, work camps, accommodation for airport staff);

* new or extended harbours or jetties for importing construction materials to the project site;

* new road or other transport facilities developed specially for the movement of materials to the project site;

* new water pipelines or desalination or water purification plant;

* development of a quarry to supply construction materials;

* exploitation of new fresh groundwater resources;

* establishment of a crusher or asphalt plant to prepare stone for a specific road scheme.

4. POLLUTION CONTROL

a) b) c) Waste Water, Emissions to Atmosphere, Solid Wastes

(i) State the nature and the chemical composition of each potential source of pollution.

(ii) Give anticipated quantities of effluents, emissions and wastes which will be produced per day, per week or per month. Include gases emitted from incinerators under gaseous emissions.

(iii) State methods proposed for controlling pollutants. Give details of any specific treatment facilities (for example, extended aeration and filtration).

(iv) Detail the points of disposal of potentially polluting materials.

(v) Give details of proposals for monitoring liquid effluents, gaseous and particulate emissions and solid wastes. State whether it is proposed to monitor environmentql parameters, such as air and water quality, outside the project area. State if monitoring will be continous; if periodic, state the frequency at which recordings will be taken.

d) Pollution Control Official

State whether a Pollution Control Official will be designated for the project site. If not, state who will be responsible for pollution control matters.

5. POLLUTION HAZARDS

a) Toxic or Hazardous Materials

(i), (ii), (iii). Give the nature and chemical composition, quantities and origins of any raw materials, other process materials, products, by-products or waste materials which are toxic or otherwise hazardous (for example, corrosive, inflammable, or radioactive).

b) Special Facilities and Operational Procedures

State proposed special facilities and operational procedures planned for the handling, storage and transport of toxic or hazardous materials and products in order to protect the environment. (Pollution hazard may arise during project construction, when the facility is operating, or as a result of ancillary developments). State the results of any risk or hazard analysis undertaken. Give details of any proposals for evacuating the local population in the event of a potentially hazardous incident, including procedures for notifying local officials responsible for the welfare of the population.

c) Safety Official

State whether a Safety Official will be designated for the project site. If not, state who will be responsible for safety matters.

d) Explosives

Give details of any explosives to be used either during construction or operation. Indicate the location of any explosives store on an appropriate scale map. Give information on any licensing certificates for explosives issued by the Royal Oman Police.

6. IMPACTS ON AMENITIES AND SERVICES

a) Effects on Amenities and Services

Give details of the anticipated effects of the project and of any ancillary developments on public amenities and services. Distinguish between the effects of construction and the effects of operation. Effects may include, but will not necessarily be limited to:

* interference with groundwater flows;
* interference with surface water flows and water bodies;
* effects on storm and flood water drainage;
* effects on the coastal and marine environment, including corals;
* destruction of plants, other vegetation and topsoil;
* effects on land and marine animals and birds;
* impacts on nature conservation areas;

* impacts on sites of national historical or cultural heritage;

* impacts on tourist or recreation areas;

* odour nuisances;

* noise impacts;

* visual intrusion;

* impacts from increases in traffic movements.

b) Measures to Alleviate Harmful Effects

Describe measures proposed to alleviate any harmful effects identified. These measures might include landscaping, noise barriers, or specific nature conservation measures.

The attention of applicants is drawn to Article 26 of Royal Decree 10/82. This states that any owner giving any false or misleading information in statements establishing effects on the environment shall be imprisoned for a period not exceeding six months or shall receive a maximum fine of 10% of the capital invested in the area of work.

بسم الله الرحمن الرحيم

SULTANATE OF OMAN
MINISTRY OF ENVIRONMENT AND WATER RESOURCES

سلطنة عمان
وزارة البيئة ومصادر المياه

ENVIRONMENTAL IMPACT STATEMENT FORM L INFRASTRUCTURE PROJECTS	بيان التأثير على البيئة النموذج (ل)- مشروعات البنية الأساسية
Refer to separate notes for explanation of Questions	يرجى الرجوع الى نقاط الإسترشاد لمزيد من الاستيضاح.
1. PROJECT ORGANISATION	١ - تنظيم المشروع:
A. PROJECT TITLE	ا - إسم المشروع:
B. BRIEF DESCRIPTION	ب - ملخص مختصر للمشروع:
C. LOCATION	ج - موقع المشروع :

D. OWNER

د ـ مالك المشـــــروع :ـ

NAME

١ ـ الاســـــم :

ADDRESS

٢ ـ العنـوان :

TELEPHONE NUMBER

٣ ـ رقم التليفون:

E. CONTACT

هـ ـ المسئول الذي يمكن الاتصال به :

NAME

١ ـ الاســـــم :

ADDRESS

٢ ـ العنـوان :

TELEPHONE NUMBER

٣ ـ رقم التليفون:

F. CONSULTANTS

و ـ الأستشـــاريـــــون :ـ

NAME

١ ـ الأســـــم :

ADDRESS

٢ ـ العنـوان :

TELEPHONE NUMBER

٣ ـ رقم التليفون:

NAME OF CONTACT

٤ ـ أسم الشخص الذي يمكن الاتصال به :

G. PROPOSED STARTING DATE

ز ـ التاريخ المقترح للبـــدء :ـ

i. CONSTRUCTION

١ ـ الانشـــــاء :

ii. OPERATION

٢ ـ التشغيـــل :

H. FUTURE DEVELOPMENT

ح ـ التوسعـــات المستقبليـــــة :

2. PROJECT DETAILS

٢ ـ تفاصيل خاصة بالمشـــروع:ـ

A. CONSTRUCTION DETAILS

ا ـ التفاصيل الخاصة بالإنشاءات :

B. UTILITIES REQUIREMENTS

ب ـ متطلبات التشغيـــــل:

i. WATER

ا ـ المياه

ii. ELECTRICITY

٢ ـ الكهربـاء

iii. FUELS

٣ ـ الوقـــود

C. OTHER LOCATIONS CONSIDERED

ج ـ المواقع الاخرى التي تؤخذ في الإعتبار:

D. FACTORS DETERMINING PROJECT LOCATION

د ـ العوامل التي تحدد موقع المشروع :

E. DETAILS OF PRILIMINARY INVESTIGATIONS ALREADY CARRIED OUT

هـ ـ بيانات تفصيلية عن الاختبارات الاولية التي تمـــت .

3. OFF SITE ANCILLARY DEVELOPMENTS ٣ ـ العوامل المساعدة خارج الموقع :ـ

4. POLLUTION CONTROL ٤ ـ مراقبة التلوث :ـ

A. WASTE WATER ا ـ مخلفات المياه :ـ

i. NATURE AND CHEMICAL COMPOSITION ١ ـ طبيعة المخلفات ومكوناتها الكيمائية :

ii. QUANTITIES ٢ ـ الكميات :

iii. METHODS OF CONTROL ٣ ـ طرق المراقبة :

iv. POINTS OF DISPOSAL ٤ ـ نقاط التصريف :

v. MONITORING PROPOSALS ٥ ـ مقترحات الرصد :

B. EMISSIONS TO ATMOSPHERE ب ـ إنبعاثات الغبار والأبخرة والدخان في الغلاف الجوي:

i. NATURE AND CHEMICAL COMPOSTION ١ ـ طبيعة هذه الاشيا ومكوناتها الكيمائيه :

ii. QUANTITIES ٢ ـ الكميات :

iii. METHODS OF CONTROL ٣ ـ طرق المراقبة :

iv. POINTS OF DIPSOSAL ٤ ـ نقاط التصريف :

v. MONITORING PROPOSALS ٥ ـ مقترحات الرصد :

C. SOLID WASTES — جـ - المخلفات الصلبة :-

i. NATURE AND CHEMICAL COMPOSITION — ١ - طبيعة المخلفات والمكونات الكيميائية :

ii. QUANTITIES — ٢ - الكميات :

iii. METHODS OF CONTROL — ٣ - طرق المراقبة :

iv. POINTS OF DISPOSAL — ٤ - نقاط التصريف :

v. MONITORING PROPOSALS — ٥ - مقترحات الرصد :

D. POLLUTION CONTROL OFFICIAL

5. POLLUTION HAZARDS — ٥ - أخطار التلوث :

A. TOXIC OR HAZARDOUS MATERIALS — ا - المواد السامة والخطرة :-

i. NATURE AND CHEMICAL COMPOSITION — ١ - طبيعة المواد والمكونات الكيماوية :

ii. QUANTITIES — ٢ - الكميات :

iii. ORIGINS — ٣ - الأصول :

B. SPECIAL FACILITIES AND OPERATIONAL PROCEDURES — ب - التسهيلات الخاصة واجراءات التشغيل :

i. SAFETY OFFICIAL — ١ - مسئول السلامة :

ii. EXPLOSIVES — ٢ - المتفجرات :

6. IMPACTS ON AMENITIES AND SERVICES — ٦ ـ التأثير على وسائل الراحة والخدمات

A. EFFECTS ON AMENITIES AND SERVICES — أ ـ التأثير على وسائل الراحة والخدمات

B. MEASURES TO ALLEVIATE HARMFUL EFFECTS — ب ـ الإجراءات التي أتخذت للحد من الآثار الضارة:

SIGNATURE OF APPLICANT — توقيع مقدم الطلب

DATE — التاريخ : / / ١٩م.

STAMP

NAME OF OWNER/COMPANY — اسم المالك / الشركة :

SIGNATURE OF OWNER — توقيع المالك:

SUGGESTED RESPONSES TO FORM L, ENVIRONMENTAL IMPACT STATEMENT, OF THE MINISTRY OF ENVIRONMENT AND WATER RESOURCES

1. PROJECT ORGANIZATION

a) Project Title

Wastewater Stabilization Ponds for Treatment of Trucked Wastewaters in Salalah

b) Brief Description

The proposed facilities will treat wastewaters removed from holding tanks, septic tanks, soak-away pits, existing treatment plants, and commercial facilities throughout Salalah. The facilities include inlet works, two parallel anaerobic ponds, one facultative pond, and three maturation ponds in series. Please see attachments from the WASH report on the matter. The effluent from the treatment facilities would be re-used for agricultural purposes.

The total gross site requirements are five hectares.

c) Location

(Detailed site description to be provided by the municipality)

d) Owner

Dhofar Municipality

e) Contact

Ali Bin Saeed Bin Bader Al-Rawas
Chairman - Dhofar Municipality

f) Consultants

(To be determined by the municipality)

g) Proposed Starting Date

(1) Initial construction expected to start October 1, 1988

(2) Expected date for initial operation is February 1, 1989

h) Future Development

The facilities to be provided may or may not be used as treatment units in the wastewater treatment facilities to be provided based on the results and implementation of proposed master plan studies.

2. PROJECT DETAILS

a) Construction Details

The facilities are essentially ponds requiring the placement and compaction of soils. If compaction and permeability tests confirm the need for sealing of the basins, soil cement would be used on the bottom and interior slopes of all ponds. In addition a relatively small quantity of reinforced concrete would be required for the construction of inlet works, control structures, ramps and their ancillary facilities. The site would be enclosed with a chain-link fence.

The very limited quantity of materials required would be hauled by trucks to the construction site. Storage of materials would not be involved.

b) Utilities Requirements

(i) water supply would not be required at the facility.

(ii) electricity would only be required if it were necessary to implement night-time operation. Such utilization of the facilities is not anticipated.

(iii) fuels other than for trucks hauling wastewater to the site are not involved.

c) Other Locations Considered

See attachments from the WASH report.

d) Factors Determining Project Location

The following factors were taken into consideration in determining and evaluating potential project locations:

- distance from nearest developed areas
- distance from proposed development areas
- reuse potential
- distance from potential reuse locations
- size of area available
- distance from sources of wastewater nov hauled for disposal
- potential impact on groundwater resources
- would site have been affected by the flood of April 4, 1983
- suitability for long-term use

- relative construction costs
- environmental acceptability

e) Details of Preliminary Investigations Already Carried Out

(Provide selected attachments from WASH report)

3. OFF-SITE ANCILLARY DEVELOPMENTS

No off-site ancillary development is required for the construction and operation of the project.

4. POLLUTION CONTROL

a) Wastewater, Emissions to Atmosphere, Solid Wastes

The proposed facilities will provide for controlled and appropriate treatment of wastewater now being discharged in an improper manner into Sahalnaut Wadi. The effluent will be fully satisfactory for agricultural reuse and no public health risks are involved.

Please refer to selected attachments from the WASH report regarding quantities and characteristics of wastewater flows and the design calculations utilized in sizing of the treatment units.

The quality of the influent and effluent would be monitored weekly. Arrangements would be made to utilize the laboratory facilities available in Salalah at MOD.

b) Pollution Control Officials

(To be designated by the municipality)

5. POLLUTION HAZARDS

a) Toxic or Hazardous Materials

No hazardous materials would be involved.

b) Special Facilities and Operational Procedures

Does not apply since the use of hazardous materials is not involved.

c) Safety Official

The need for a safety official is not envisioned because of nature of construction involved and the non-mechanical treatment facility being provided.

d) Explosives

The use of explosives is not anticipated.

6. IMPACTS ON AMENITIES AND SERVICES

a) Effects on Amenities and Services

- interference with groundwater flows - does not apply.
- interference with surface water flow and water bodies - does not apply.
- effects on storm and flood waters - facilities would be above or protected from potential flood water drainage. The extent and nature of the Salalah flood of April 4, 1983 have been taken into consideration in evaluating potential sites.
- air pollution - The construction of the earther ponds would result in dusty conditions during the limited construction period of 6 to 8 weeks. During the construction of the embankments surfaces would be moistened in order to obtain maximum density and also achieve a degree of control on the creation of dusty conditions.
- animal and bird life - The constructed facility (a series of ponds) would be attractive to birds. No harmful effects would be anticipated. The existing operating facility of this nature at Al Ansab in Muscat demonstrates the effectiveness of the pond system without creating detrimental effects.
- odour nuisances - Odour problems would not be involved with a properly operating system.
- visual nuisance - Based on the location and nature of the facilities no violation of visual esthetics would be anticipated.
- truck traffic - No change in present practice would result. On an average approximately 160 trucks currently discharge each day with a maximum rate of 30 per hour.

b) Measures to Alleviate Harmful Effects

No harmful effects would be involved. The proposed facilities would completely eliminate the concerns now associated with the discharge of about 1,200 cubic meters of wastewaters into Sahalnaut Wadi each day. The series of ponds would provide a storage of 28 days and the effluent could be used landscaping and tree planting in order to provide additional visual barrier.

Appendix H

SITING INVESTIGATION CONDUCTED BY WASH TEAM

4.1 Potential Sites

Concerns that have to be addressed in selecting a site for a stabilization pond system include:

- Area
- Distance from developed areas
- Use of developed area
- Potential for reuse
- Distance to reuse
- Haul distance
- Impact on groundwater resources
- Potential for flooding
- Suitability for long-term use
- Impact of site on construction costs
- Environmental acceptability.

With these concerns in mind, discussions were held with various authorities in Salalah to identify potential sites. Sites identified and shown in Figure H-1 are:

- Wadi Thet
- Wadi Sahalnaut
- Near Arzat Farm.

The Wadi Thet area is at the site set aside for the future treatment plant. It is just east of the Raysut Cement Company, and about 1,500 m from Qaboos Street.

Wadi Sahalnaut offers two types of sites. One is in the channel of the wadi in the area now used for wastewater dumping. Another is on the east side of the wadi, where the impact from flooding would be less severe. The locations are about 2,000 m from the roundabout.

The site near Arzat Farm is located about 1,000 m east of Dhariz Khawr, between Arzat Farm and the ocean.

4.2 Analysis of Potential Sites

Selection of a site for treatment requires detailed knowledge of the sites themselves and of the political process for selecting sites. In the time available for this project, the WASH team could not be expected to become expert on the selection of sites for Salalah. This task has to be left to local authorities who have the detailed knowledge.

The WASH team prepared Table H-1, showing attributes of the sites, to assist local authorities in selecting the site for interim facilities. The table shows that all sites are adequate distance from the nearest developed

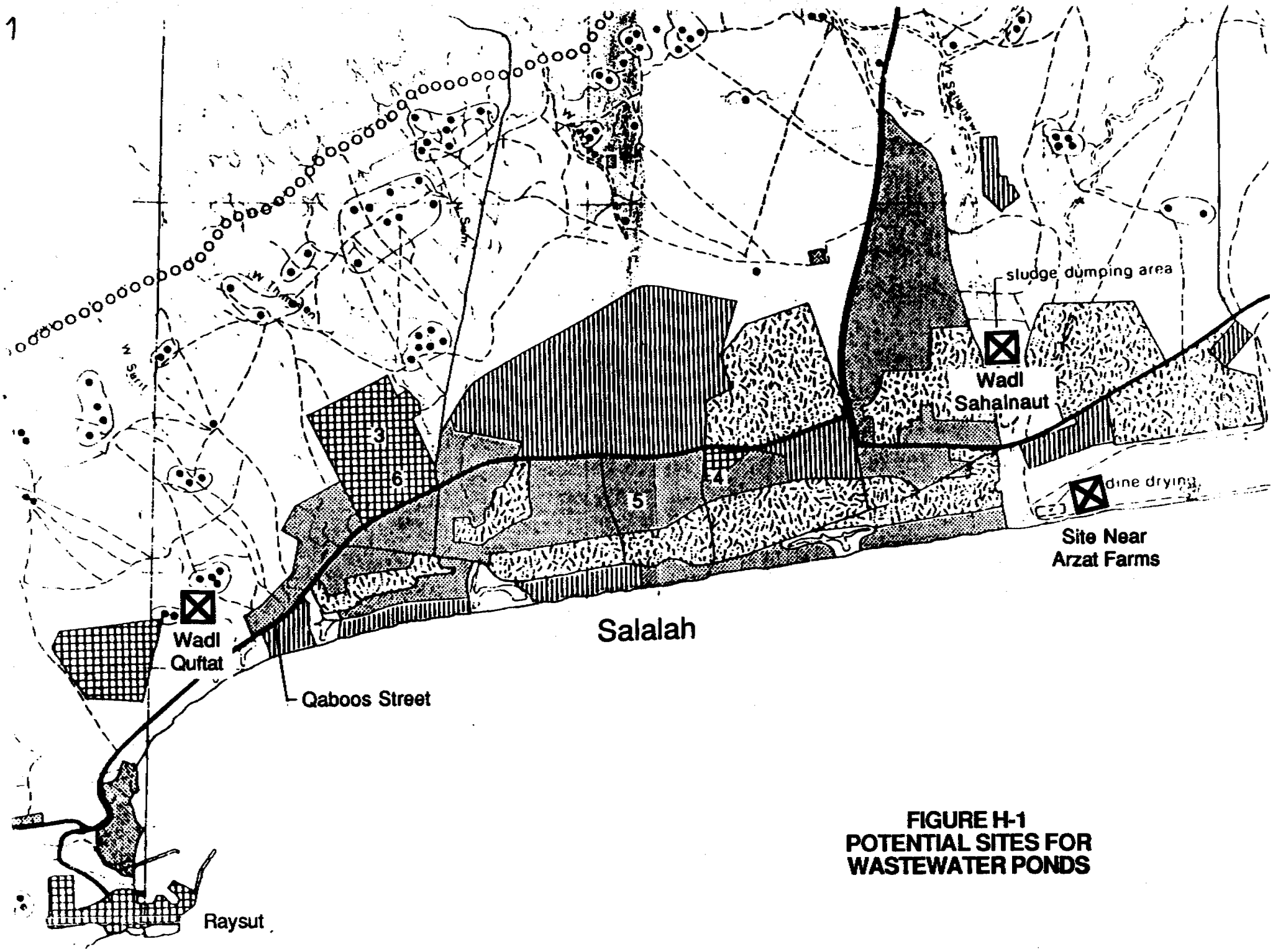


FIGURE H-1
POTENTIAL SITES FOR
WASTEWATER PONDS

TABLE H-1

ANALYSIS OF WASTEWATER TREATMENT SITES

Name of site	WADI THET	WADI SAHALNAUT (IN CHANNEL)	WADI SAHALNAUT (OUTSIDE)	NEAR ARZAT FARM
Nearest developed area	North Awqad Development	Madinat al Saadah	Madinat al Saadah	Dhariz
Distance to developed areas (m)	1,000	1,000	1,200	1,500
Reuse potential	Agriculture and rock-crushing facilities	Agriculture (Sahalnaut Farm)	Agriculture (Sahalnaut Farm)	Agriculture (Arzat Farm)
Distance to reuse	Adjacent	1,000 m	800 m	Adjacent
Adequate area	Yes	Yes	Yes	Yes
Distance from City Centre (km)	10	11	11	11
Potential use of existing groundwater resources	Limited use	Agriculture	Agriculture	Limited use
Impact on existing potable groundwater	None	None	None	None
Flooded in 1983	No	Yes	No (?)	No
Structure Plan	In Plan	Not in Plan	Not in Plan	Not in Plan
Construction cost?	Average	High — would need extensive flood protection	Average	Average
Environmental acceptability	Good	Good	Good	Good

(residential) area. For all but the Wadi Thet site, the developed area listed already have some residents. For the Wadi Qurfat site, homes have not been built, but the development has been approved.

Effluent from all the sites could be used for agriculture. Effluent from the Wadi Thet also could be used at the rock-crushing facilities. The reuse sites for Wadi Thet and Arzat Farm sites are adjacent. The reuse sites for Wadi Sahalnaut (Sahalnaut Farms) are 800 to 1,000 m away.

Hauling distance is important in selecting a site. For this analysis, the WASH team measured distances from city centre. All sites are roughly equidistant from the city centre -- 10 to 11 km. A more detailed analysis should consider the centroid of the sources of wastewater.

None of the sites is above groundwater sources suitable for drinking. The Wadi Sahalnaut sites are above groundwater suitable for agricultural use. The Wadi Thet and Arzat Farm sites are above water good enough only for limited use. The ponds would have no impact on groundwater suitable for drinking.

Every five to seven years the area is subject to cyclonic storms, which can cause extensive flooding. Flood maps of the most recent major storm (on 4 April 1983) were used to determine the flood potential. The site in the channel of Wadi Sahalnaut would require extensive flood protection. At the other sites, the treatment plant would be located outside the area that was flooded in 1983.

The site at Wadi Thet is the one selected in the Structure Plan for the permanent treatment plant. Gaining approval for use of that site for the proposed pond system would be simpler than that for other sites, and their use for the interim ponds would require changes in the Structure Plan.

Construction costs in the channel of Wadi Sahalnaut would be much higher than for the other sites. Ponds located in the channel would require extensive protection from flooding.

All sites are considered to be suitable with respect to impact on the environment. Construction of the ponds would end the uncontrolled dumping now occurring in Wadi Sahalnaut.

4.3 Environmental Impact

The environmental impact of the current dumping operation in Wadi Sahalnaut has not been determined. It is thought, however, that the dumping could have a negative impact on the environment, possibly by contributing to overfertilization of Dhariz Khawr from the groundwater or during storms. In addition, there is no fence around the area, and animals are seen in the dumping area. Finally, the operation is unsightly.

It is anticipated that constructing and operating a pond-system wastewater treatment plant will lessen the environmental impact of wastewater disposal for Dhofar. With the pond system, disposal will be controlled; the indiscriminate dumping pattern now in effect will be replaced by an orderly

system; and the unsightly dumping operation will be replaced by a more attractive system.

If the dump site is moved from Wadi Sahalnaut, then the potential for overfertilization of the kwahr is eliminated. Even if the pond system is built in Wadi Sahalnaut, reuse will still remove the waste from the wadi, and the vegetation receiving the effluent will remove nutrients, such as nitrogen and phosphorus, which fertilize the khawr.

For all sites, the pond system will either be out of the potential flood area, or the pond system will be protected from flood flows, so that wastewater will not be released to wadis and kwahrs during floods.

The reuse will be beneficial. The treated effluent can be used for irrigation of ornamental plants, trees, grass, and many other types of vegetation. Use of treated effluent will save higher-quality water for drinking and cooking.

The pond system will have some negative impacts. Ponds attract large numbers of birds, for example, so the facilities should be sited far enough from the airport to insure that the birds do not endanger aviation. All of the sites investigated in this report are considered far enough from the airport to avoid problems of this nature.

All wastewater treatment systems (both pond systems and mechanical systems) are subject to odor problems. With careful maintenance -- including removal of floating materials -- odor problems will be minimized. Moreover, all sites are in the order of a kilometer or more from residential areas.

Visual impact of the facilities also is important. Because all sites are at some distance from residential areas and from roads, the visual impact will be negligible.

Overall, we judge that the environmental impact of the proposed pond system will be substantially better than the current impact.