3) Lawdar

a. Year of commission: 1984
b. Design population: 7,000 (10,000 for long term program)
c. Design sewage flow: 318 m^3/d
d. Design temperature: N.A.
e. Size, retention time and BOD loading

	Facultative
Size (LxW,m)	85.2x55.8
Area (m2)	4,754
Depth (m)	1.07
Volume (m^3)	5,087
R.T. (day)	16.0
Infl. BOD5 (mg/l)	500
Effl. BOD5 (mg/l)	N.A.
BOD Load (kg/d)	159
A.B.L. (kg/ha/d)	334

Note: Pond size is at the middle of water depth.

4. Considerations

Per capita sewage flow for Sabir and Al Hota pond systems are 120 lcd and 130 lcd, respectively. BOD concentration of 375 mg/l is used for both systems. With these per capita sewage flow and BOD concentration, per capita BOD loadings are calculated as 45 gcd and 49 gcd. On the other hand, per capita sewage flow and BOD loading for Lawdar pond system are 45 lcd and 23 gcd respectively. These figures are low compared with those for Sabir and Al Hota systems. Figures adopted for Sabir and Al Hota are considered to be very reasonable for the design of stabilization pond in Lahej. Figures for Lawdar seem to be low as design basis, although water consumption in the town is lower than that in Lahej.

Provision of anaerobic pond ahead of facultative pond is most desirable to make use of favorable climatic condition in Lahej. BOD reduction of 60 % can most likely be achieved with retention time of more than 2.5 days. The design temperature of 20°C is considered to be slightly conservative taking into the

fact that the mean temperature in the coldest month in Aden is over 25°C. Although the design temperature for Lawdar system is not known and temperature is generally lower than that in Lahej because of the altitude, provision of the anaerobic pond is also desirable for Lawdar system taking into account the high BOD concentration of the raw sewage.

Volumetric BOD loadings (V.B.L.) of the anaerobic ponds in the two systems in Lahej are 0.15 and 0.12 $kg/m^3/d$, and these are again slightly conservative in a standard range of 0.1 to 0.4 $kg/m^3/d$. Areal BOD loadings (A.B.L.) of the facultative ponds in Sabir and Al Hota systems are 316 and 150 kg/ha/d respectively. If maximum allowable loading is calculated by McGarry and Pescod's equation, it is 400 kg/ha/d at 20°C. Therefore, design BOD loadings are well below maximum level. Areal BOD loading of the Lawdar facultative pond is 334 kg/ha/d. Although the design temperature for the system is not known, this figure may be reasonable, since this figure can be converted to a maximum allowable BOD loading at 18 °C by McGarry and Pescod's equation.

BOD concentrations of the final effluent are set at 10 mg/l and 29 mg/l respectively for Sabir and Al Hota systems. Treatment goal of the Lawdar system is not clear. However, if design temperature can be considered to be 18°C as calculated above, influent BOD concentration of 500 mg/l can be reduced to 93 mg/l with 16 days of retention time. High BOD reduction can be expected with the total retention time in each system. However, carry over of green algae contributes to a high BOD concentration. Therefore, these low concentrations can only be achieved with effective removal of green algae from the effluent. Considering difficulty of effective algae removal, it is advisable to set treatment goal in term of BOD at 60 mg/l. Effluent BOD concentration of Lawdar system does not satisfy this requirement, indicating insufficient capacity of the system.

Faecal coliform reduction to 100/100 ml expected for Sabir system seems to be too strict. Moreover with a total retention time of 16.2 days in the pond system at 20°C, high reduction to achieve this level can not be expected. However, reduction of faecal coliform is highly temperature dependent, and if 25°C is taken as design temperature, this level of treatment goal can be achieved. If the design temperature of 18°C is also applied for the reduction of faecal coliform number in Lawdar system, the number can only be reduced to 10^5 order.

Faecal coliform number of 100/100 ml is required for non-restricted irrigation. If reuse of the treated sewage is restricted to certain crops which are not eaten raw, 5,000/100 ml can be allowed. In this respect, treatment goal for Al Hota system set at 3,038/100 ml is considered to be reasonable and achievable. On the other hand, effluent from Lawdar system by no means satisfy these requirements. Therefore design of the Lawdar system should be reviewed in the future.

APPENDIX L
COST ESTIMATION

APPENDIX L

COST ESTIMATES

Table of Contents

List of Tables

APPENDIX L

COST ESTIMATES

1. Basic Costs and Unit Construction Cost

1.1 Basic Labor and Material Costs

Costs of the materials and labor costs used for the construction works are shown in this appendix. Most of the construction materials for the sewerage facilities are not available in PDRY except for the some basic materials of civil and architectural works. Therefore, major materials used for each work are to be imported from outside of PDRY, for example, from EC countries and Japan.

All the construction costs of the sewerage system are estimated on the current labor and material costs prevailing in Aden and in the source countries. Unit labor costs are estimated taking into account the transportation allowance, special tax, medical scheme, and life insurance. Construction costs are indicated at the late-1988 price level, and are defined as the sum of all expenditures to be required to complete the project. These expenditures are divided into direct and indirect items, and also divided into local currency and foreign currency potions. The direct items include civil and architectural works, and mechanical and electrical works for the project, and indirect items include office and administrative overhead, engineering and supervision. Materials, equipment and services to be imported are included in foreign currency portion. Costs for transportation and handling charges of these items are also included in foreign currency portion. The rest is considered to be local currency portion.

In estimating the construction costs of the facilities, first the unit costs for laborers, material, electricity, equipment and transportation were established, and then the construction costs for component works such as concrete works, excavations, masonry works, etc., were estimated. Some unit costs were directly obtained from GDLG and Aden Municipality.

Laborers required for the sewerage construction such as common workers, skilled operators for heavy equipment etc., are summarized in Tables L.1 and L.2.

Material costs, price list of clay pipes, price list of PVC pipes and powder coating ductile cast iron pipes are shown in Tables L.3 through L.6.

Table L.1 Labor Costs in Aden Governorate (Yemeni)

Type of Labor	Unit	Cost (YD)
Common worker	day	6.000
Concrete mixer operator	day	8.000
Steel worker	day	8.000
Carpenter	day	10.000
Brick builder	day	10.000
Plumber	day	7.000
Operator (construction machine)	day	8.000
Electric worker	day	5.000
Welder	day	10.000
Plasterer	day	10.000
Site engineer	day	12.000
Site manager	day	13.000
Office boy	day	6.000
Driver (light)	day	7.200
Driver (heavy)	day	8.000
Typist	day	7.600
Foreman	day	6.000
Clerk	day	10.000
Watchman	day	4.000

Notes: 1. Labor cost include following items:
* Allowance
* Transportation allowance
* Special tax
* Medical scheme
* Life insurance
* End of service benefits
* Leave salary

2. Above cost exclude overtime and defense tax.

Table L.2 Labor Costs in Aden Governorate (Foreigner)

Type of Labor	Unit	Cost (YD)
Common worker (I)	day	4.380
Common worker (II)	day	4.240
Steel worker	day	4.930
Painter	day	4.930
Frame worker	day	4.930
Carpenter	day	4.930
Mason	day	4.930
Brick builder	day	4.930
Scaffolding worker	day	5.130
Plumber	day	4.930
Electric worker	day	5.130
Plasterer	day	4.930
Driver	day	5.130
Foreman	day	8.550
Mechanic	day	8.550
Assistant worker	day	4.380

Table L.3 Material Costs in Aden Governorate

Type of Materials	Unit	Cost (YD)
Crusher Stone (0 to 5 mm)		5.250
Crusher Stone (5 to 12 mm)	M^3	5.750
Crusher Stone (12 to 20 mm)	M^3	5.250
Crusher Stone (20 to 30 mm)	M^3	5.000
Manually Treated Stone	M^3	11.600
Rubble Stone	M^3	7.000
Rocks non Assorted	M^3	7.500
Sand	M^3	1.200
Asphalt --- Prime Cost	M^2	0.500
Asphalt --- Hot Mix	M^2	7.700
Cement Type I	Ton	66.370
Caustic Lime	Ton	183.500
Round Steel Bar	Ton	139.470
Gasoline	Gallon	1.000
Diesel	Gallon	0.400
L.P. Gas	Kg	0.150
Oxygen Gas	Ton	2.100
Tap Water	M^3	0.160
Electric Bill --- Commercial	Kwh	0.060
Electric Bill --- Temporary	Kwh	0.150

Table L.4 Cost of Vitrified Clay Pipes

Dia.(mm) X Length (m)	Cost	
1,000 X 2.00	¥ 160,216	YD 421.621
800 X 2.00	¥ 97,160	YD 255.684
700 X 2.00	¥ 72,715	YD 191.355
600 X 2.00	¥ 55,403	YD 145.797
500 X 2.00	¥ 40,588	YD 106.811
450 X 2.00	¥ 31,255	YD 82.250
400 X 2.00	¥ 24,342	YD 64.058
350 X 2.00	¥ 19,223	YD 50.587
300 X 2.00	¥ 15,010	YD 39.500
250 X 2.00	¥ 11,332	YD 29.821
200 X 2.00	¥ 8,560	YD 22.526
150 X 1.50	¥ 3,749	YD 9.866
150 X 1.25	¥ 3,898	YD 10.258
100 X 1.25	¥ 2,349	YD 6.182

* Note: 1) Country of Origin : WEST GERMANY
2) NOT including Cost of VC Fittings
3) CIF in Aden

Table L.5 Cost of Polyvinyl Chloride Pipes

Dia.(mm) X Length (m)	Cost	
600 X 5.00	¥ 63,505	YD 167.118
500 X 5.00	¥ 43,252	YD 113.821
450 X 5.00	¥ 34,912	YD 91.874
400 X 5.00	¥ 27,624	YD 72.695
350 X 5.00	¥ 21,230	YD 55.868
300 X 5.00	¥ 15,681	YD 41.266
250 X 5.00	¥ 11,163	YD 29.376
200 X 5.00	¥ 7,465	YD 19.645
150 X 5.00	¥ 3,432	YD 9.032
100 X 5.00	¥ 2,136	YD 5.621

* Note: 1) Country of Origin : Japan
2) Including Cost of PVC Fittings
3) CIF in Aden

Table L.6 Cost of Ductile Cast Iron Pipes

Dia.(mm) X Length (m)	Cost	
900 X 6.00	¥ 99,950	YD 263.030
800 X 6.00	¥ 76,900	YD 202.370
700 X 6.00	¥ 61,460	YD 161.740
600 X 6.00	¥ 49,340	YD 129.840
500 X 6.00	¥ 38,230	YD 100.610
450 X 6.00	¥ 33,190	YD 87.340
400 X 6.00	¥ 28,230	YD 74.290
350 X 6.00	¥ 23,970	YD 63.080
300 X 6.00	¥ 19,350	YD 50.920

* Note: 1) Country of Origin : Japan
2) Including Cost of Ductile Fittings
3) CIF in Aden

1.2 Unit Construction Cost

Unit construction cost for component works such as STP works, major pumping station works, force main works, gravity sewer works and other works are estimated taking into account the estimated basic costs of excavation, sheeting, bracing, dewatering, bedding, pipe laying, concrete placing, forming, reinforcing, restoration of pavement, and constructor's overhead and profit.

These unit costs estimation are developed for normal conditions, and any works to be carried out under special conditions are not considered. Estimated unit construction costs are shown in Table L.7 and port charges and transport charges are also shown in Table L.8.

Table L.7 Unit Construction Costs in for Component Works

Type of Work	Unit	Cost (YD)
Excavation --- Sand	M^3	3.000
Excavation --- Sand with rock	M^3	3.500
Excavation --- Rock	M^3	4.000
Backfilling	M^3	2.000
Banking	M^3	3.000
Soil disposal (L = 20 km)	M^3	2.500
Sheeting by timber up to 3 m deep	M^2	12.000
Sheeting by timber deeper than 3 m	M^2	12.000
Sheeting by sheet pile deeper than 3 m	M^2	20.000
Lean concrete (135 kg/cm2)	M^3	45.000
Plain structural concrete (165 kg/cm2)	M^3	50.000
Reinforced concrete (210 kg/cm2)	M^3	55.000
Form work for substructure	M^2	10.000
Form work for super structure	M^2	10.000
Masonry work	M^3	60.000
Cement mortar plastering	M^2	3.000
Asphalt pavement (t = 5 cm)	M^2	2.500
Asphalt pavement (t = 11 cm)	M^2	3.000

Source: Aden Capital Municipality

Table L.8 Port Charges and Transport Charges

	Unit	Cost (YD)
Landing Charge (Operation Department)		
General Cargoes	W/M	1.545
Cement	W/M	1.710
VC Pipe, Ductile Pipe, M/H Cover and Steel Bar	W/M	2.426
Drum	W/M	2.183
Charge for "Wharf Manager's Office"		
Tools & Wharfage	W/T	1.600
Crane Charge	Hour	7.200
Fork Lift Charge	Hour	2.800
Dock Labor Charge		
General Cargoes	W/T	1.204
Cement	Bag	0.100
Inland Transport	W/M	10.000

Source: Yemen Port Authority

Unit: W/M:

W/T:

2. Sewage Treatment Plant Construction Costs

The estimated costs for sewage treatment plant construction works are based on mainly two factors such as civil and architectural works and mechanical and electrical works. Civil and architectural work costs are calculated from the estimated volume of major basic materials and unit costs, while mechanical and electrical work costs are based on preliminary engineering for equipment.

Total costs for STP are divided into civil and architectural works and mechanical and electrical works are shown in Table L.9.

Table L.9 Construction Costs of Sewage Treatment Plant

(Unit: YD 1,000)

Each Works		Total Construction Costs	First Phase Construction Costs
Excavation/ Banking Work	C & A	2,910	1,119
	M & E	-	-
Inlet Work	C & A	12	12
	M & E	100	100
Outlet Work	C & A	41	22
	M & E	-	-
Yard Piping	C & A	46	12
	M & E	223	61
Miscellaneous Work	C & A	23	11
	M & E	-	-
Administration Building	C & A	127	127
	M & E	-	-
Total	C & A	3,159	1,303
	M & E	323	161
		YD 3,482 (¥ 1,323,160,000)	YD 1,464 (¥ 556,320,000)

3. Major Pumping Stations Construction Cost

Design of the sewerage facilities in 2010 include hydraulic calculation of the sewage collection system, a part of which is a design of major pumping stations for each district. Major pumping stations are designed by using vertical type screw volute pumps in a dry well which is separated from the wet well in a rectangular basin.

The structure of each major pumping station is shown in drawings in Volume Three. Construction costs are estimated under four work items, viz. civil, architectural, mechanical and electrical works. Construction costs of the pumping station are shown in Table L.10.

Table L.10 Construction Cost of Major Pumping Stations

(Unit: YD 1,000)

District		Total Construction Costs	First Phase Construction Costs
Ma'alla	C & A	104	104
	M & E	450	450
Tawahi	C & A	105	105
	M & E	376	376
Crater	C & A	103	-
	M & E	491	-
Khormaksar	C & A	103	-
	M & E	385	-
Total	C & A	415	209
	M & E	1,702	826
		2,117	1,035
		(¥ 804,460,000)	(¥ 393,300,000)

Notes: C & A: Civil and Architectural
M & E: Mechanical and Electrical

4. Force Main Construction Cost

In the sewerage system, multi-continuous transfer system is adopted as the most appropriate sewage transfer system. The length of each force main from major pumping stations to the proposed sewerage treatment plant is calculated based on the proposed system. Special protection on both external and internal surfaces of pipes are considered against erosion caused by aggressive soils and sewage.

Table L.11 Force Main Construction Cost

(Unit: YD 1,000)

Force Main Route	Total Construction Costs	First Phase Construction Costs
Tawahi P/S to Ma'alla P/S	291	291
Ma'alla P/S to STP	2,614	2,614
Crater P/S to Khormaksar	902	-
Khormaksar P/S to Delivery Line	12	-
Khormaksar to STP	1,101	-
Total	4,936 (¥ 1,875,680,000)	2,905 (¥ 1,103,900,000)

5. Gravity Sewers Construction Cost

Total construction costs for gravity sewers i.e. trunk sewers and branch and lateral sewers are shown in Table L.12. The greater part or about YD 0.63 million will be spent for trunk sewers in Ma'alla and Tawahi districts, and the rest is to be spent for the branch and lateral sewer constructions. No construction cost is considered for Crater, since all the existing sewers are in good condition and can be used until 2010. On the other hand, sewers in Khormaksar are badly damaged by hydrogen sulfide gas. It is assumed that half of the entire length is to be replaced. Construction costs for gravity sewers in Khormaksar will have to be reviewed.

Table L.12 Gravity Sewers Construction Cost

(Unit: YD 1,000)

District		Total Construction Costs	First Phase Construction Costs
Ma'alla	T/S	243	243
	B/L	116	116
Tawahi	T/S	223	223
	B/L	51	51
Crater	T/S	-	-
	B/L	-	-
Khormaksar	T/S	-	-
	B/L	1,479	-
Total		2,112 (¥ 802,560,000)	633 (¥ 240,540,000)

Notes: T/S: Trunk Sewer
B/L: Branch and Lateral Sewer

6. Cost for Rehabilitation for Pumping Stations

Small pumps with diameter up to 150 mm are designed as a submersible type in rectangular pump pit. Typical structure of this type of the small pumping stations and design outlines are shown in Appendix H.

It is considered that mechanical and electrical equipment in the existing pumping stations will have to be replaced once at proper time by 2010. Structures damaged by hydrogen sulfide gas or other causes will be abandoned and new structure will be built. Structures presently in good conditions are assumed to be used by 2010. Rehabilitation costs for the small existing pumping stations are shown in Table L.13.

Table L.13 Cost for Rehabilitation of Pumping Stations

(Unit: YD 1,000)

District		Total Construction Costs	First Phase Construction Costs
Ma'alla	C & A	101	101
	M & E	11	11
Tawahi	C & A	28	28
	M & E	65	65
Sub Total		205	205
Crater	C & A	26	-
	M & E	11	-
Khormaksar	C & A	206	-
	M & E	204	-
Sub Total		447	
Total		652 (¥ 247,760,000)	205 (¥ 77,900,000)

Notes: C & A: Civil and Architectural
M & E: Mechanical and Electrical

7. Cost for Improvement of Sweeper Passages

Existing sweeper passages have been thoroughly investigated in Ma'alla and Tawahi districts. The total length of existing sweeper passages are about 5,000 m which is shown in Appendix-C, and a total cost of YD 0.57 million will be required for the improvement of sweeper passages. Typical length of sweeper passage is 30 m per one building and it is assumed that about one month construction period will be required to complete one place.

Table L.14 Cost of Improvement of Sweeper Passages

(Unit: YD 1,000)

District	Total Construction Costs	First Phase Construction Costs
Ma'alla	291	291
Tawahi	278	278
Total	569 (¥ 216,220,000)	569 (¥ 216,220,000)

8. Total Project Costs

Total project costs consisting of the construction costs of the major facilities, branch and laterals, costs for rehabilitation and indirect costs, i.e. contingency and engineering costs are summarized in Table L.15. Contingency costs including physical and price escalation are estimated as 10 percent of the construction costs and indirect costs, and engineering cost is estimated as 7 percent of the sub-total costs.

Table L.15 Total Project Costs

(Unit: YD 1,000)

Classification and Work Item	Total Costs	First Phase Costs
Direct Costs		
1. Sewage Treatment Plant	3,482	1,464
2. Major Pumping Stations	2,177	1,035
3. Force Main	4,948	2,905
4. Gravity Sewers	2,112	633
5. Rehabilitation of Pumping Stations	652	205
6. Improvement of Sweeper's Passages	569	569
7. Sub-total	13,880	6,811
Indirect Costs		
8. Provisional Sums	7,239	3,528
9. Sub-total	21,119	10,339
10. Physical Contingency 5% of Item 9	1,056	517
11. Sub-total	22,175	10,856
12. Engineering Cost 9% of Item 11	1,896	927
13. Total Project Cost	24,071	11,373

9. Operation and Maintenance Cost

Operation and maintenance cost include labor, electricity, vehicles, materials and spare parts for major equipment. The procedure adopted for the estimation of these costs are described below.

9.1 Sewer

The following assumptions are made for the estimation of operation and maintenance costs of the sewer pipes.

- Pipe cleaning will be carried out every two years.
- Daily cleaning length will be 30 m.
- Cleaning gang consists of six laborers.
- Working days in a year is 250 days.

Maintenance costs are estimated as follows.

- Total length of the sewer pipes including trunk, branch and lateral sewers is 74,860 m in the four districts.
- Total length of pipe cleaning per year
  74,860 (m) / 2 (years) = 37,430 (m/year)
- Number of teams
  37,430 (m/year) / 30 (m) X 250 (days/year) = 5 (teams)
- Number of Labors

Pipe Cleaning	6 (persons) X 5 (teams)	=	30 (persons)
Pipe Laying	9 (persons) X 2 (teams)	=	8 (persons)
		Total	48 (persons)

- Labor Cost

Superintendents	2 (persons) X 250 (days/year) X 12 YD	= YD	6,000/year
Technician	6 (persons) X 250 (days/year) X 9 YD	= YD	14,000/year
Non-Skilled	40 (persons) X 250 (days/year) X 6 YD	= YD	60,000/year
		Total YD	80,000/year

9.2 Pumping Station

The following assumptions were made for the estimation of the operation and maintenance costs of the pumping stations

- Number of manpower were estimated to be 10 persons for craftmen, 14 persons for technician and 21 persons for non-skilled labors.

- Operation of the pumps is assumed at 12 hours per day, taking into consideration the ratio of daily average flow to peak flow.

- Unit electricity cost is at 60 Fills/kwh.

9.3 Sewage Treatment Plant

Labor and vehicle costs are estimated according to required staff number. Repair costs are assumed at 0.5 percent of the construction costs. Total operation and maintenance costs are shown in Table L.16.

Table L.16 Operation and Maintenance Cost

Facility	O & M Cost (YD 1,000/annum)			
	Labor	Power	Repair Cost	Total
Sewers	80	-	20	100
P/S	94	125	30	249
STP	26	11	20	57
Total	200	136	70	406

APPENDIX M

SEWAGE DISPOSAL FOR MOI CAMP AND AL ARISH VILLAGE

APPENDIX M

SEWAGE DISPOSAL FOR MOI CAMP AND AL ARISH VILLAGE

Table of Contents

List of Tables

APPENDIX M

SEWAGE DISPOSAL FOR MOI CAMP AND AL ARISH VILLAGE

1. Introduction

MOI camp and Al Arish village are isolated from Khormaksar district by the airport and defined as extra catchment area because of their locations. Present population in the two areas are estimated to be 5,000 in MOI camp and 1,700 in Al Arish village. There are no sewerage systems in the two areas. Sewage produced in the areas are disposed of by soak pits.

Although approximately 20 to 25 septic tank and soak pit systems are provided in MOI camp, these systems were constructed in 1930s and their capacities are insufficient for the present population. MOI camp has two vacuum cars for dewatering overflowed septic tanks and soak pits. Removed sewage is dumped into the sea.

Al Arish is a fishermen's village and all the houses are wooden huts. Al Arish village is included in the future development area and existing houses will be demolished when development starts.

Because of difficulty residents are facing and proximity to the proposed sewerage system, feasibility to connect these two areas to the proposed system is examined.

2. MOI Camp

Three possible alternatives are considered for disposal of sewage in MOC camp. These are described below.

Alternative 1 On site treatment and disposal by constructing new septic tank and soak pit systems.

Alternative 2 Direct connection to the force main from Khormaksar Main P/S to STP.

Alternative 3 Connection to the existing P/S M in Khormaksar.

Alternative 2 was not found to be technically feasible, because of the small quantity of sewage flow and difficulty to control heavy fluctuation of pump head resulting from direct connection to the force main. Therefore. two alternatives, Alternatives 1 and 3 are evaluated by estimating their construction costs.

For cost estimation, the following component facilities are considered for each alternative.

Alternative 1 Septic tank and soak pit system
5 units of 1,000 persons capacity
Connection pipes, 200 mm dia., VCP, 250 m length

Alternative 3 Connection pipes, 200 mm dia., VCP, 500 m in length.
One pumping station, 2 sets of pumps, 80 mm dia.
Force main, 150 mm dia., DCIP, 3,200 m length

Construction cost for each alternative is shown in Table M.1 below

Table M.1 Construction Cost of Alternatives, MOI Camp

Alternative	Facility	Construction Cost (YD)		
		F.C.	L.C.	Total
Alternative 1	Septic Tank and Soak Pit Systems	68,323	12,563	80,886
	Connection Pipes	7,719	100	7,819
	Total	76,042	12,663	88,705
Alternative 3	Connection Pipes	17,743	200	17,943
	Pumping Station	43,935	2,144	46,079
	Force Mains	284,086	20,400	304,486
	Total	345,764	22,744	368,508

As shown in Table M.1, construction cost for Alternative 3, connection to the existing system by pumps and force main, is approximately four times that for Alternative 1. High cost for Alternative 3 is due to the long force main required to connect MOI camp to the existing pumping station in Khormaksar. Low cost on-site treatment and disposal by septic tank and soak pit system is, therefore, recommended for MOI camp.

3. Al Arish Village

Four possible alternatives are considered for Al Arish village as described below.

Alternative 1 On site treatment by constructing new septic tank and soak pit systems.

Alternative 2 Direct connection to the force main from Khormaksar Main P/S to STP.

Alternative 3 Connection to the existing P/S M in Khormaksar.

Alternative 4 Connection to the proposed STP.

Alternative 2 was not found to be technically feasible for the same reason mentioned above. Thus, construction costs for the three alternatives, Alternatives 1, 3 and 4 are estimated. Component facilities for the cost estimation are as follows.

Alternative 1 Septic tank and soak pit system
3 units of 600 persons capacity
Connection pipes, 200 mm dia., VCP, 150 m length

Alternative 3 Connection pipes, 200 mm dia., VCP, 300 m length
One pumping station, 2 sets of pumps, 80 mm dia.
Force main, 100 mm dia., DCIP, 2,050 m length

Alternative 4 Connection pipes, 200 mm dia., VCP, 300 m length
One pumping station, 2 sets of pumps, 80 mm dia.

Force main, 100 mm dia., DCIP, 2,200 m length

Construction cost for each alternative is shown in Table M.2 below.

Table M.2 Construction Cost of Alternatives, Al Arish Village

Alternative	Facility	Construction Cost (YD) F.C.	L.C.	Total
Alternative 1	Septic Tank and Soak Pit Systems	38,553	6,828	45,381
	Connection Pipes	4,631	60	4,691
	Total	43,184	6,888	50,072
Alternative 3	Connection Pipes	10,730	120	10,850
	Pumping Station	43,935	2,144	46,079
	Force Main	130,901	8,713	139,614
	Total	185,566	10,977	196,543
Alternative 4	Connection Pipes	10,730	120	10,850
	Pumping Station	43,935	2,144	46,079
	Force Main	140,335	9,350	149,685
	Total	195,000	11,614	206,614

Again, construction cost for alternatives having a pumping station and force main system is far higher than that for on-site system for the same reason mentioned above. On-site system is recommended for Al Arish village.

APPENDIX N

ADDITIONAL WORKS IN EXTRA CATCHMENT AREAS AND COST

APPENDIX N

ADDITIONAL WORKS IN EXTRA CATCHMENT AREAS AND COST

Table of contents

List of Tables

APPENDIX N

ADDITIONAL WORKS IN EXTRA CATCHMENT AREAS AND COST

1. Additional Works

Although design of the sewerage facility in military and government areas is out of the scope of the study and the rehabilitation of existing pumping stations in this area may not be responsibility of the Aden Municipality, need for replacement of the mechanical equipment and structures were recognized by the investigation carried out during the on-site work. Existing pumping stations in these areas are limited to Tawahi and Khormaksar districts, and there are no such kind of areas in Ma'alla and Crater districts.

Need for rehabilitation of pumping stations in the two districts are shown in Tables N.1 and N.2.

There are two extra catchment areas north of the airport where sewerage system is not provided. These are MOI camp and Al Arish village. Since these areas are isolated from the project area, a study on sewage disposal system was carried out by comparing construction costs for possible alternative systems. As the results of the study, on-site disposal system by communal septic tank and soak pit system is recommended for both areas. Necessary facilities for the system are summarized below, and cost comparison is presented in Appendix M, Volume Three.

MOI Camp

Septic Tank and Soak Pit

5 units of 1,000 persons capacity

Connection Pipes

200 mm dia., VCP, approximately 250 m length

Al Arish Village

Septic Tank and Soak Pit

3 units of 600 persons capacity

Connection Pipes

200 mm dia., VCP, approximately 150 m length

Table N.1 Rehabilitation of Pumping Stations in Military and Government Areas, Tawahi

Name of P/S	Alfath	Military Area	Military Area	Military Area	Military Area
No.	202	203	204	205	206
Replacement of Pump Unit	Yes	Yes	Yes	Yes	Yes
Re-building of Structure	Yes	Yes	Yes	No	Yes
Diameter of Pump (mm)	100	80	80	80	80
Number of Units	2	2	2	2	2
Motor Power (kW)	5.5	2.2	2.2	3.7	2.2
Type of Pump	Submersible	Submersible	Submersible	Submersible	Submersible

Name of P/S	Ministry of Defence
No.	207
Replacement of Pump Unit	Yes
Re-building of Structure	Yes
Diameter of Pump (mm)	80
Number of Units	2
Motor Power (kW)	2.2
Type of Pump	Submersible

Table N.2 Rehabilitation of Pumping Station
in Military and Government Areas, Khormaksar

Name of P/S	Badr Camp	Tareq Camp	Tareq Policey	Gomholia Hospital	Foreign Embassy
No.	411	416	-	-	-
Replacement of Pump Unit	Yes	Yes	Yes	Yes	Yes
Re-building of Structure	Yes	No	Yes	Yes	Yes
Diameter of Pump (mm)	80	100	80	80	80
Number of Units	3	2	2	2	2
Motor Power (kW)	2.2	5.5	2.2	2.2	2.2
Type of Pump	Submersible	Submersible	Submersible	Submersible	Submersible

Name of P/S	Political Institute	YSP	Hi Badr	Badr 1	Badr 2
No.	-	-	-	-	-
Replacement of Pump Unit	Yes	Yes	Yes	Yes	Yes
Re-building of Structure	Yes	Yes	Yes	Yes	Yes
Diameter of Pump (mm)	80	80	80	80	80
Number of Units	2	2	2	2	2
Motor Power (kW)	2.2	2.2	2.2	2.2	2.2
Type of Pump	Submersible	Submersible	Submersible	Submersible	Submersible

Name of P/S	Badr 3
No.	-
Replacement of Pump Unit	Yes
Re-building of Structure	Yes
Diameter of Pump (mm)	80
Number of Units	2
Motor Power (kW)	2.2
Type of Pump	Submersible

2. Additional Construction Cost

Additional cost necessary for the construction and the rehabiltation of sewerage facilities in extra catchment areas was estimated in the same manner described in Chapter 4 of the Main Report, although the implementation of these works may not be responsibility of the Aden Municipality. Works included in the additional construction cost are identified in Section 1.

Additional construction cost of approximately YD 715,000, of which YD 669,000 in foreign currency and YD 46,000 in local currency, will be required as shown in Table N.3

Table N.3 Additional Construction Cost

(unit: YD 1,000)

District	Works	F.C.	L.C.	Total
Tawahi	Rehabilitation of P/S (6 Nos.)	187	9	196
	Rehabilitation of P/S (11 Nos.)	363	17	380
Khormaksar	MOI Camp On-site Disposal	76	13	89
	Al Arish Village On-site Disposal	43	7	50
	Khormaksar Total	482	37	519
	Total	669	46	715

APPENDIX O

FINANCIAL ANALYSIS AND ECONOMIC ANALYSIS

APPENDIX O

FINANCIAL ANALYSIS AND ECONOMIC ANALYSIS

Table of Contents

List of Tables

1. External Debt of Yemen

The position of external debt of Yemen has been relatively better-off. The main creditors are Soviet Union and China whereas international organizations such as the IDA and Arab Fund have increased their lending to Yemen in recent years. It is recorded that the debt-service ratio has risen from 3.6% in 1983 to 19.9% in 1986. The following is the summary table of external public debt outstanding of Yemen during 1983-88.

Table 0.1 Yemen: External Public Debt Outstanding, 1983-88

(In US$ million)

	1983	1984	1985	1986	1987	1988
1.Multilateral						
IDA	77.1	97.2	113.2	133.7	138.2	150.3
Kuwait Fund	59.2	63.8	67.7	71.1	72.2	77.1
AFESD	72.9	82.4	92.1	106.3	117.7	140.7
Abu Dhabi Fund	46.7	50.3	50.8	51.2	51.2	53.1
Islamic Bank	6.8	8.0	8.8	10.8	13.6	13.7
OPEC Fund	17.3	20.2	27.3	32.1	32.5	34.0
EEC	2.5	2.5	2.5	2.5	2.5	4.8
IFAD	6.0	7.8	10.2	11.9	12.9	14.6
2. Bilateral						
USSR	360.7	435.1	532.4	656.8	722.8	894.6
China	138.2	141.1	145.1	145.1	145.1	143.0
East Germany	35.1	38.5	41.2	42.8	43.4	44.1
Bulgaria	36.9	40.4	42.7	45.4	48.8	49.9
Csechoslovakia	22.7	26.0	26.9	29.1	31.7	31.7
Hungary	11.2	11.2	11.2	11.2	14.8	14.8
Iraq	25.2	25.2	25.2	25.2	25.2	25.2
Libya	18.2	18.8	18.8	18.8	18.8	18.8
Algeria	26.6	26.6	26.6	26.6	29.1	29.1
Denmark	3.9	1.8	1.3	1.3	—	—
France	1.3	20.6	24.0	25.4	25.4	25.4
Others		7.5	7.5	8.7	8.7	6.9
Total	976.0	1125.0	1275.5	1456.0	1554.6	1771.8
Repayment	31.2	43.6	63.6	81.6	92.6	114.3
Others	116.8	99.9	63.6	n.a.	n.a.	n.a.
Total External Indebtedness	1124.0	1268.5	1402.7	1528.2	n.a.	n.a.
Debt Service Ratio (%)	3.6	4.8	10.6	19.9	n.a.	n.a.

Source: Economic Report 1987, IBRD and National Bank of Yemen, 1988

2. Opportunity Cost of Capital

In estimating an opportunity cost of capital in Yemen, interest rates of the national bank loan to public sector and private sector have been examined. For a government project, particularly a project under the national plan, the rate for public sector is 3.0% while 8.0% is for private, mixed, and foreign sectors. The relevant data on prevailing interest rates in Yemen are as follows.

Table O.2 National Bank of Yemen - Interests Rates

(In per cent per annum)

	Others (1)	Public Sector
Deposits in Local Currency		
Current Accounts	-	-
Time Deposits - three months	4.5	1.0
Time Deposits - six months	5.0	1.5
Time Deposits - twelve months	6.0	2.0
Saving Deposits	5.0	-
Deposits of Yemen Emigrants in Foreign Currency		
Time Deposits - three months	5.0	-
Time Deposits - six months	7.0	-
Time Deposits - twelve months	9.0	-
Saving Deposits	5.0	-
Loans and Credit Facilities		(2)
Commercial, Personal	8.0	6.0
Industry, Agriculture, Fisheries	8.0	6.0
Projects under Development Plan	8.0	3.0

Note: (1) Includes the private, mixed, and foreign sectors.
(2) Applies only to the national companies.

Source: National Bank of Yemen, 1988

3. Project Cost Parameters

In estimating project cost, some of the cost parameters such as physical contingency and price contingency need to be examined. In view of the uncertainty faced prior to project commencement, these contingencies are essential for the project cost forecasting. Through analysis on recent similar projects of water supply implemented in PDRY and discussions with the Public Water Corporation (PWC), the following ratios have been reviewed.

Table 0.3 Relevant Physical and Price Contingencies

	Physical Contingency	Price Contingency Local	Price Contingency Foreign
Greater Aden Second Water Supply (1986.10)	15%	5 - 7%	5 - 7.5%
Al Mukalla Water Supply (1988.6)	10%	3%	1 - 3.5%
Latest PWC Estimates	15%	2%	12%

Note: The date is the time when the contingencies were estimated in the study of the respective project.

For price contingency of the foreign currency portion of the project cost, the following estimates made by the World Bank were also refered to.

Table 0.4 Price Contingency Prospect

	1989	1990	1990-95	1996-2000
IBRD (1988.10)	6.3%	1.5%	3.6%	4.6%

Source: Price Prospect for Major Primary Commodities 1988-2000, IBRD

On the basis of the estimates said above and price index by the Central Statistical Organization (CSO), it is forecasted that the local currency portion of price contingency would be around 2% p.a. as no significant rising elements are not identified locally.

On the other hand, the foreign currency portion's contingency would be about 5% in view of an anticipated international oil price increase which would affect prices of industrial products.

For physical contingency, about 5% is proposed for the proposed project since the present study has gone through in-depth analysis on project cost elements and as a result, the uncertainty may arise only in civil work cost compornents.

4. Price Index in Aden

According to the statistical Yearbook prepared by CSO, a general index of wholesale prices reveals a moderate price increase from 351 in 1980 to 403 in 1987, resulting in 2.0 % growth per annum. For the items related to the proposed project, major materials such as cement, iron, pipes, and even fuel have been remained constant in spite of substantial increases in prices at international market. This is mainly due to government policies to maintain commodity prices as low as possible. Nevertheless, in case of iron an increase rate is 2.0% p.a. while fuels show 2.7% rise p.a. It implies that from economic point of view the commodity prices in Aden are rather undervalued compared to the international prices. The details are shown in the following table.

Table 0.5 Wholesale Price Index in Aden, 1980-87
(Base Year = 1960)

Item	1980	1985	1986	1987
General Index	351	398	399	403
Food Stuff	321	367	370	378
Raw Materials	246	244	245	245
Industrial Products	403	360	460	460
Building Materials:				
- Cement	359	359	395	359
- Iron	275	317	317	317
- Wood	478	547	547	547
- Tiles	817	817	817	817
- Glass	538	544	544	544
- Water Pipes	412	412	412	412
- Drainage Pipes	376	460	460	460
- Fuel	502	606	606	606

Source: Statistical Yearbook, 1988 (CSO)