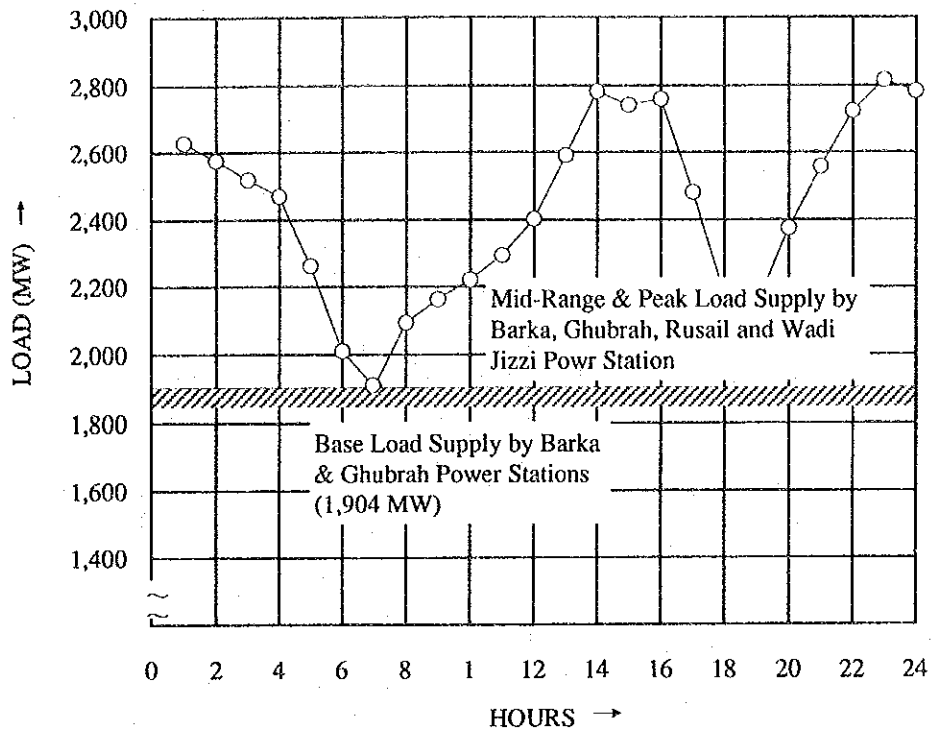


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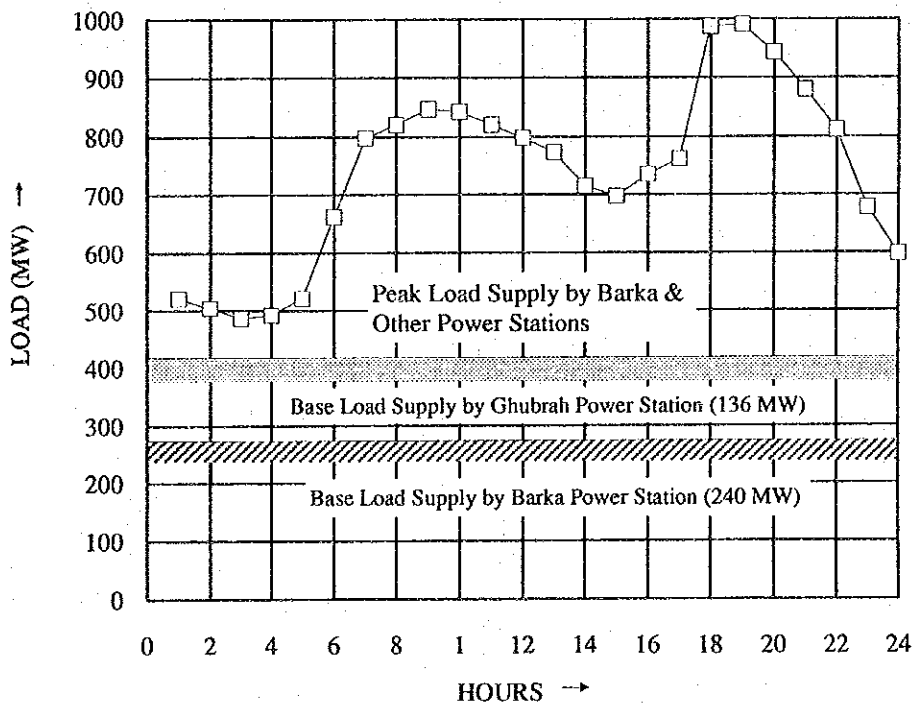
## APPENDIX 3

### Table of Contents

Figure 3.1	Projected Daily Load Variation Curve in 2010-----	3 - 1
Figure 3.2	Daily Load Variation Curve for Muscat System in 1993 -----	3 - 2
Figure 3.3	System Diagram of Power and Desalination Plant -----	3 - 5
Table 3.1	Daily Load Variation for Muscat System in 1993 -----	3 - 2
Table 3.3	Existing Power Stations of Muscat System -----	3 - 3
Table 3.4	Existing Power Station of Wadi Jizzi System-----	3 - 3
Table 3.5	Assumed Operation Life of Existing Power Plant Unit-----	3 - 4



(a) MAXIMUM LOAD DAY



(b) MINIMUM LOAD DAY

Figure 3.1 Projected Daily Load Variation Curve in 2010

Table 3.1 Daily Load Variation for Muscat System in 1993

Time (Hrs)	Maximum Load Day (June 22 : 826 MW)			Minimum Load Day (January 16 : 137 MW)		
	System Load		Amb. Temp.	System Load		Amb. Temp.
	(MW)	(%)	(°C)	(MW)	(%)	(°C)
0100	741	89.7	38.0	147	52.7	16.5
0200	726	87.9	37.0	142	50.9	16.0
0300	710	86.0	38.0	137	49.1	17.0
0400	696	84.3	37.0	139	49.8	16.5
0500	638	77.2	37.0	147	52.7	16.0
0600	567	68.6	37.0	187	67.0	16.0
0700	537	65.0	39.0	225	80.6	16.0
0800	591	71.5	41.0	231	82.8	16.0
0900	610	73.8	41.5	239	85.7	17.0
1000	626	75.8	43.5	237	84.9	17.0
1100	647	78.3	44.0	231	82.8	18.0
1200	677	82.0	44.0	225	80.6	19.0
1300	730	88.4	44.5	218	78.1	19.0
1400	785	95.0	43.5	202	72.4	19.0
1500	773	93.6	44.0	197	70.6	19.0
1600	778	94.2	44.5	207	74.2	18.5
1700	700	84.7	43.0	215	77.1	18.0
1800	614	74.3	41.0	278	99.6	17.5
1900	605	73.2	40.0	279	100.0	17.5
2000	670	81.1	39.0	266	95.3	16.0
2100	721	87.3	39.0	248	88.9	16.0
2200	768	93.0	40.0	229	82.1	16.0
2300	794	96.1	40.0	191	68.5	16.5
2400	785	95.0	37.0	169	60.6	16.0

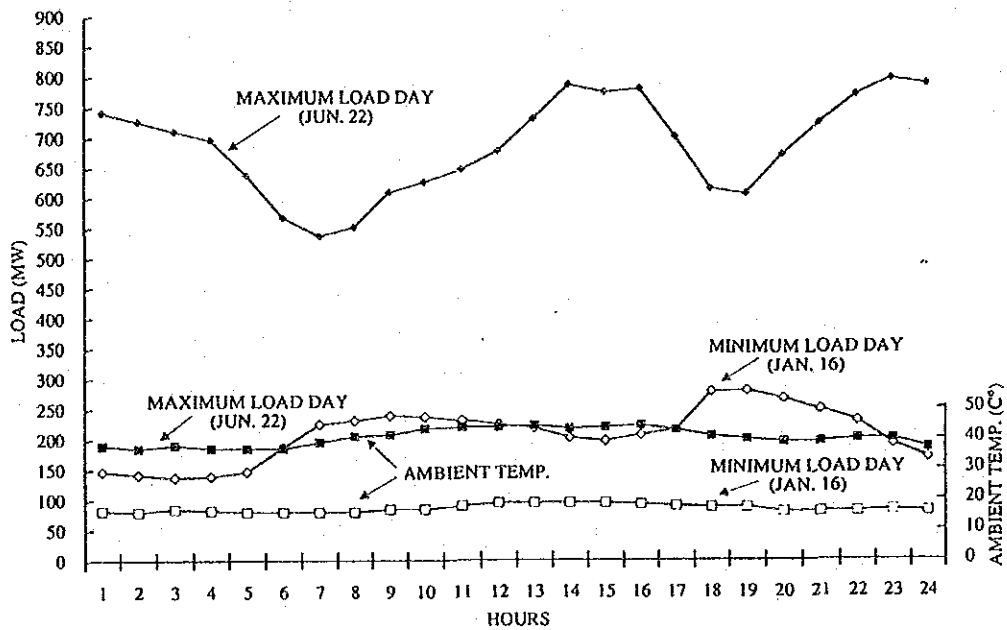


Figure 3.2 Daily Load Variation Curve for Muscat System in 1993

Table 3.3 Existing Power Stations of Muscat System

Power Stations	Unit No.	Machine Type/Model	Maker	Installed Capacity (MW)	Year of Commissioning
Ghubrah	ST - 1	KAE/20/71/118/100	BBC	8.5	1976
	ST - 2	KAE/20/71/118/100	BBC	8.5	1976
	ST - 3	KAE/20/71/118/100	BBC	8.5	1976
	ST - 4	KAE/20/106/180/200	BBC	50.0	1977
	ST - 5	1-K-2301	ABB	30.0	1993
	GT - 1	GE Frame 5	Alsthom	17.5	1978
	GT - 2	GE Frame 5	Alsthom	17.5	1978
	GT - 3	GE Frame 5	Alsthom	17.5	1978
	GT - 4	GE Frame 5	Alsthom	17.5	1979
	GT - 5	GE Frame 5	Alsthom	17.5	1979
	GT - 6	GE Frame 5	Alsthom	17.5	1979
	GT - 7	GE Frame 5	Alsthom	17.5	1979
	GT - 8	GE Frame 5	Alsthom	17.5	1979
	GT - 9	GE Frame 5	Alsthom	17.5	1979
	GT-10	GE Frame 6	GE	27.0	1983
	GT-11	GE Frame 6	GE	27.0	1983
	Total				317.0 MW
(ST Total 105.5MW, GT Total 211.5MW)					
Rusail	GT - 1	GE Frame 9	JBE	83.0	1984
	GT - 2	GE Frame 9	JBE	83.0	1984
	GT - 3	GE Frame 9	JBE	83.0	1984
	GT - 4	GE Frame 9	GE	83.0	1987
	GT - 5	GE Frame 9	GE	83.0	1987
	GT - 6	GE Frame 9	GE	83.0	1987
	Total				498.0 MW
Total of Insulated Capacity				815.0 MW	

Source : MEW Statistical Year Book 1992  
MEW Annual Report 1993

(Note) ST : Steam Turbine, GT : Gas Turbine

Table 3.4 Existing Power Stations of Waji Jizzi System

Power Stations	Unit No.	Machine Type/Model	Maker	Installed Capacity (MW)	Year of Commissioning
Waji Jizzi	GT - 1	GE Frame 5	GE	18.0	1982
	GT - 2	GE Frame 5	GE	18.0	1982
	GT - 3	GE Frame 5	GE	18.0	1982
	GT - 4	GE Frame 6	Thomassen	28.0	1985
	GT - 5	GE Frame 6	Thomassen	28.0	1985
	GT - 6	GE Frame 6	Alsthom	28.0	1986
	GT - 7	GE Frame 6	Alsthom	28.0	1986
	GT - 8	GE Frame 6	Thomassen	28.0	1990
	GT - 9	GE Frame 6	Thomassen	28.0	1993
Total				222.0 MW	

Source : MEW Statistical Year Book 1992  
MEW Annual Report 1993

(Note) GT : Gas Turbine

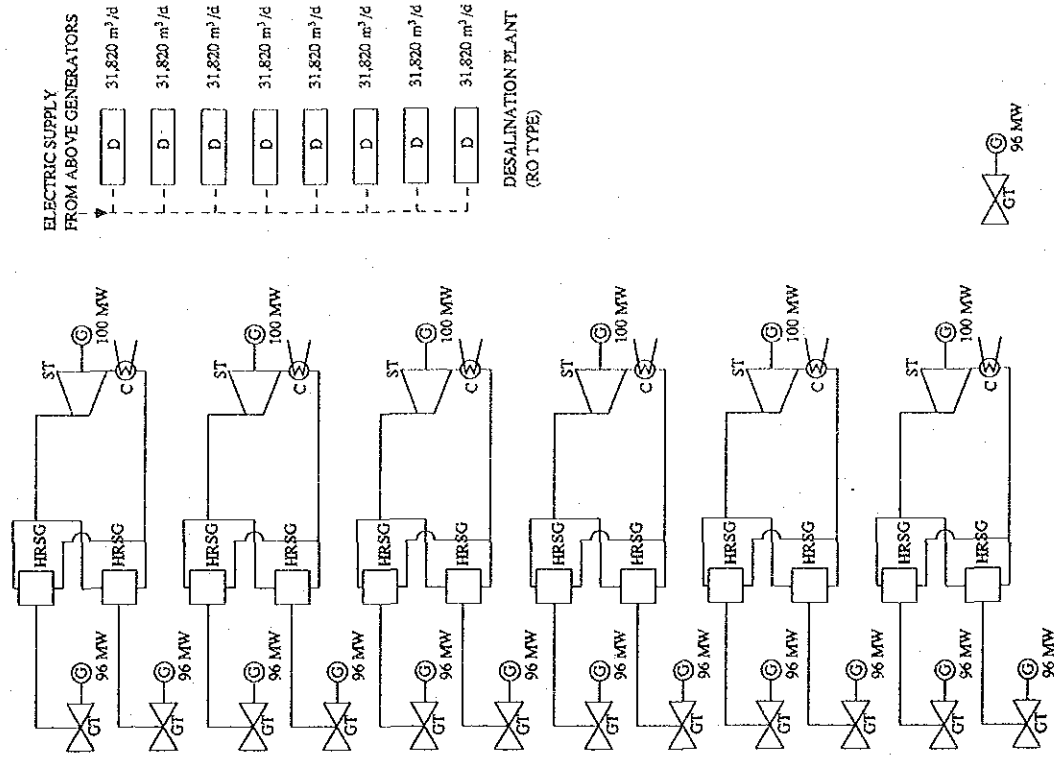
Table 3.5 Assumed Operational Life of Existing Power Plant Unit

ST: STEAM TURBINE (20 YEARS)  
GT: GAS TURBINE (20 YEARS)

POWER STATION	TYPE	NO. & CAPACITY (MW)	YEAR																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
			1976	1978	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
CHUBRAH	ST	3 x 8.5 (25.5)	← 25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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	GT	3 x 17.5 (52.5)	← 52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
(537 MW)	GT	6 x 17.5 (105)	← 105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
	GT	2 x 27 (54)				← 54	54	54	54	54	54	54	54	54	54	54	54	54	54	54																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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TOTAL INSTALLED CAPACITY (MW)			25.5	75.5	128	233	233	287	341	390	446	502	551	601	651	702	752	802	852	902	951	1,009	1,065	1,123	1,185	1,248	1,311	1,372	1,432	1,492	1,552	1,611	1,671	1,731	1,791	1,851	1,911	1,971	2,031	2,091	2,151	2,211	2,271	2,331	2,391	2,451	2,511	2,571	2,631	2,691	2,751	2,811	2,871	2,931	2,991	3,051	3,111	3,171	3,231	3,291	3,351	3,411	3,471	3,531	3,591	3,651	3,711	3,771	3,831	3,891	3,951	4,011	4,071	4,131	4,191	4,251	4,311	4,371	4,431	4,491	4,551	4,611	4,671	4,731	4,791	4,851	4,911	4,971	5,031	5,091	5,151	5,211	5,271	5,331	5,391	5,451	5,511	5,571	5,631	5,691	5,751	5,811	5,871	5,931	5,991	6,051	6,111	6,171	6,231	6,291	6,351	6,411	6,471	6,531	6,591	6,651	6,711	6,771	6,831	6,891	6,951	7,011	7,071	7,131	7,191	7,251	7,311	7,371	7,431	7,491	7,551	7,611	7,671	7,731	7,791	7,851	7,911	7,971	8,031	8,091	8,151	8,211	8,271	8,331	8,391	8,451	8,511	8,571	8,631	8,691	8,751	8,811	8,871	8,931	8,991	9,051	9,111	9,171	9,231	9,291	9,351	9,411	9,471	9,531	9,591	9,651	9,711	9,771	9,831	9,891	9,951	10,011	10,071	10,131	10,191	10,251	10,311	10,371	10,431	10,491	10,551	10,611	10,671	10,731	10,791	10,851	10,911	10,971	11,031	11,091	11,151	11,211	11,271	11,331	11,391	11,451	11,511	11,571	11,631	11,691	11,751	11,811	11,871	11,931	11,991	12,051	12,111	12,171	12,231	12,291	12,351	12,411	12,471	12,531	12,591	12,651	12,711	12,771	12,831	12,891	12,951	13,011	13,071	13,131	13,191	13,251	13,311	13,371	13,431	13,491	13,551	13,611	13,671	13,731	13,791	13,851	13,911	13,971	14,031	14,091	14,151	14,211	14,271	14,331	14,391	14,451	14,511	14,571	14,631	14,691	14,751	14,811	14,871	14,931	14,991	15,051	15,111	15,171	15,231	15,291	15,351	15,411	15,471	15,531	15,591	15,651	15,711	15,771	15,831	15,891	15,951	16,011	16,071	16,131	16,191	16,251	16,311	16,371	16,431	16,491	16,551	16,611	16,671	16,731	16,791	16,851	16,911	16,971	17,031	17,091	17,151	17,211	17,271	17,331	17,391	17,451	17,511	17,571	17,631	17,691	17,751	17,811	17,871	17,931	17,991	18,051	18,111	18,171	18,231	18,291	18,351	18,411	18,471	18,531	18,591	18,651	18,711	18,771	18,831	18,891	18,951	19,011	19,071	19,131	19,191	19,251	19,311	19,371	19,431	19,491	19,551	19,611	19,671	19,731	19,791	19,851	19,911	19,971	20,031	20,091	20,151	20,211	20,271	20,331	20,391	20,451	20,511	20,571	20,631	20,691	20,751	20,811	20,871	20,931	20,991	21,051	21,111	21,171	21,231	21,291	21,351	21,411	21,471	21,531	21,591	21,651	21,711	21,771	21,831	21,891	21,951	22,011	22,071	22,131	22,191	22,251	22,311	22,371	22,431	22,491	22,551	22,611	22,671	22,731	22,791	22,851	22,911	22,971	23,031	23,091	23,151	23,211	23,271	23,331	23,391	23,451	23,511	23,571	23,631	23,691	23,751	23,811	23,871	23,931	23,991	24,051	24,111	24,171	24,231	24,291	24,351	24,411	24,471	24,531	24,591	24,651	24,711	24,771	24,831	24,891	24,951	25,011	25,071	25,131	25,191	25,251	25,311	25,371	25,431	25,491	25,551	25,611	25,671	25,731	25,791	25,851	25,911	25,971	26,031	26,091	26,151	26,211	26,271	26,331	26,391	26,451	26,511	26,571	26,631	26,691	26,751	26,811	26,871	26,931	26,991	27,051	27,111	27,171	27,231	27,291	27,351	27,411	27,471	27,531	27,591	27,651	27,711	27,771	27,831	27,891	27,951	28,011	28,071	28,131	28,191	28,251	28,311	28,371	28,431	28,491	28,551	28,611	28,671	28,731	28,791	28,851	28,911	28,971	29,031	29,091	29,151	29,211	29,271	29,331	29,391	29,451	29,511	29,571	29,631	29,691	29,751	29,811	29,871	29,931	29,991	30,051	30,111	30,171	30,231	30,291	30,351	30,411	30,471	30,531	30,591	30,651	30,711	30,771	30,831	30,891	30,951	31,011	31,071	31,131	31,191	31,251	31,311	31,371	31,431	31,491	31,551	31,611	31,671	31,731	31,791	31,851	31,911	31,971	32,031	32,091	32,151	32,211	32,271	32,331	32,391	32,451	32,511	32,571	32,631	32,691	32,751	32,811	32,871	32,931	32,991	33,051	33,111	33,171	33,231	33,291	33,351	33,411	33,471	33,531	33,591	33,651	33,711	33,771	33,831	33,891	33,951	34,011	34,071	34,131	34,191	34,251	34,311	34,371	34,431	34,491	34,551	34,611	34,671	34,731	34,791	34,851	34,911	34,971	35,031	35,091	35,151	35,211	35,271	35,331	35,391	35,451	35,511	35,571	35,631	35,691	35,751	35,811	35,871	35,931	35,991	36,051	36,111	36,171	36,231	36,291	36,351	36,411	36,471	36,531	36,591	36,651	36,711	36,771	36,831	36,891	36,951	37,011	37,071	37,131	37,191	37,251	37,311	37,371	37,431	37,491	37,551	37,611	37,671	37,731	37,791	37,851	37,911	37,971	38,031	38,091	38,151	38,211	38,271	38,331	38,391	38,451	38,511	38,571	38,631	38,691	38,751	38,811	38,871	38,931	38,991	39,051	39,111	39,171	39,231	39,291	39,351	39,411	39,471	39,531	39,591	39,651	39,711	39,771	39,831	39,891	39,951	40,011	40,071	40,131	40,191	40,251	40,311	40,371	40,431	40,491	40,551	40,611	40,671	40,731	40,791	40,851	40,911	40,971	41,031	41,091	41,151	41,211	41,271	41,331	41,391	41,451	41,511	41,571	41,631	41,691	41,751	41,811	41,871	41,931	41,991	42,051	42,111	42,171	42,231	42,291	42,351	42,411	42,471	42,531	42,591	42,651	42,711	42,771	42,831	42,891	42,951	43,011	43,071	43,131	43,191	43,251	43,311	43,371	43,431	43,491	43,551	43,611	43,671	43,731	43,791	43,851	43,911	43,971	44,031	44,091	44,151	44,211	44,271	44,331	44,391	44,451	44,511	44,571	44,631	44,691	44,751	44,811	44,871	44,931	44,991	45,051	45,111	45,171	

**OPTION B**

(1) GAS-STEAM COMBINED CYCLE POWER PLANT



ELECTRIC SUPPLY FROM ABOVE GENERATORS

- D - 31,820 m<sup>3</sup>/d
- D - 31,820 m<sup>3</sup>/d
- D - 31,820 m<sup>3</sup>/d
- D - 31,820 m<sup>3</sup>/d
- D - 31,820 m<sup>3</sup>/d
- D - 31,820 m<sup>3</sup>/d
- D - 31,820 m<sup>3</sup>/d
- D - 31,820 m<sup>3</sup>/d

DESALINATION PLANT (RO TYPE)



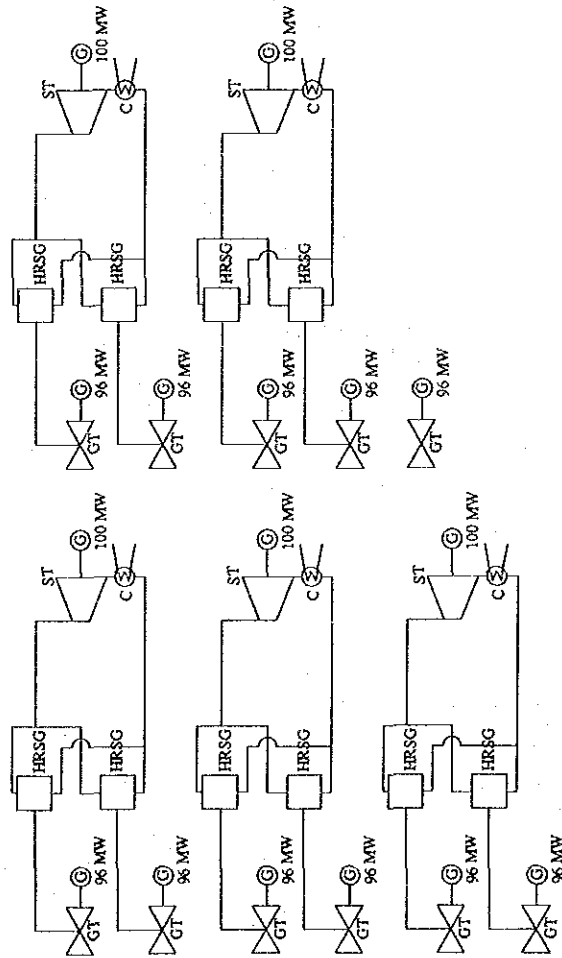
**TOTAL OUTPUT**

• Power Plant  
 • Desalination Plant

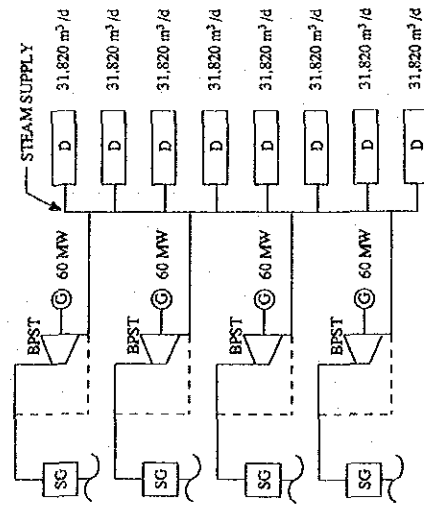
Combined Cycle 292 MW x 6 = 1,752 MW  
 Gas Turbine (open cycle) 96 MW x 1 = 96 MW } 1,848 MW  
 31,820 m<sup>3</sup>/d x 8 = 254,560 m<sup>3</sup>/d

**OPTION A**

(1) GAS-STEAM COMBINED CYCLE POWER PLANT



(2) BACK PRESSURE STEAM TURBINE CYCLE POWER PLANT AND DESALINATION PLANT (MSF TYPE)



**TOTAL OUTPUT**

• Power Plant  
 • Desalination Plant

Combined Cycle 292 MW x 5 = 1,460 MW  
 Gas Turbine (open cycle) 96 MW x 1 = 96 MW } 1,796 MW  
 Back Pressure Turbine 60 MW x 4 = 240 MW  
 31,820 m<sup>3</sup>/d x 8 = 254,560 m<sup>3</sup>/d

**ABBREVIATIONS**

- GT : Gas Turbine
- ST : Steam Turbine
- BPST : Back Pressure Steam Turbine
- HRSG : Heat Recovery Steam Generator (Boiler)
- G : Electric Generator
- SG : Steam Generator (Boiler)
- D : Desalination Plant (MSF or RO type)
- C : Condenser

**NOTES**

1. This system diagram indicates major part of the power and desalination plant for a comparison of Options A and B. Details are omitted for clarity.

**Figure 3.3 System Diagram of Power and Desalination Plant**

## APPENDIX 4

### Table of Contents

Table 4.1	Operation Record of Ghubrah No. 5 Plant in 1993 -----	4 - 1
Table 4.2	Comparison of Annual Operation Cost for MSF and RO Types -----	4 - 1
Table 4.3	Comparison of Water Production Cost by Desalination Process -----	4 - 2
Figure 4.1	Transmission Pipeline Route-----	4 - 3
Figure 4.2	Transmission Pipeline Route to South Batina-----	4 - 4



Appendix Table 4.1 Operation Record of Ghubrah No. 5 Plant in 1993

	Description	Unit	Ghubrah No. 5 Plant
1	Operation Hrs	hrs	7314.9
2	Water Production	m <sup>3</sup> /y	8,106,140
3	Load Factor	%	82.54
4	Average Water Production	m <sup>3</sup> /d	26,596
5	Power Generation	MWH/y	223,522
6	Power Generation (Output)	MW	30.56
7	Fuel Gas Consumption	Nm <sup>3</sup> /y	110,287,396
8	Per m <sup>3</sup> Fuel Gas Consumption	Nm <sup>3</sup> /m <sup>3</sup>	13.61
9	Per kwh Fuel Gas Consumption	Nm <sup>3</sup> /kW	0.493
10	Efficiency	%	24.2
11	Aux. Power Consumption	MWH/y	44,987
12	Aux. Power Consumption	MW	6.15
13	Power Consumption for Water Production	kWh/m <sup>3</sup>	5.55
14	Fuel Gas Cost	R.O./Nm <sup>3</sup>	0.0283
15	Fuel Gas Caloric Value	Kcal/Nm <sup>3</sup>	7,209
16	Fuel Oil Cost	R.O./l	0.108
17	Cost of Power Used	R.O./MWH	14.00

(Source: MEW MONTHLY REPORT)

Appendix Table 4.2 Comparison of Annual Operation Cost for MSF and RO Types

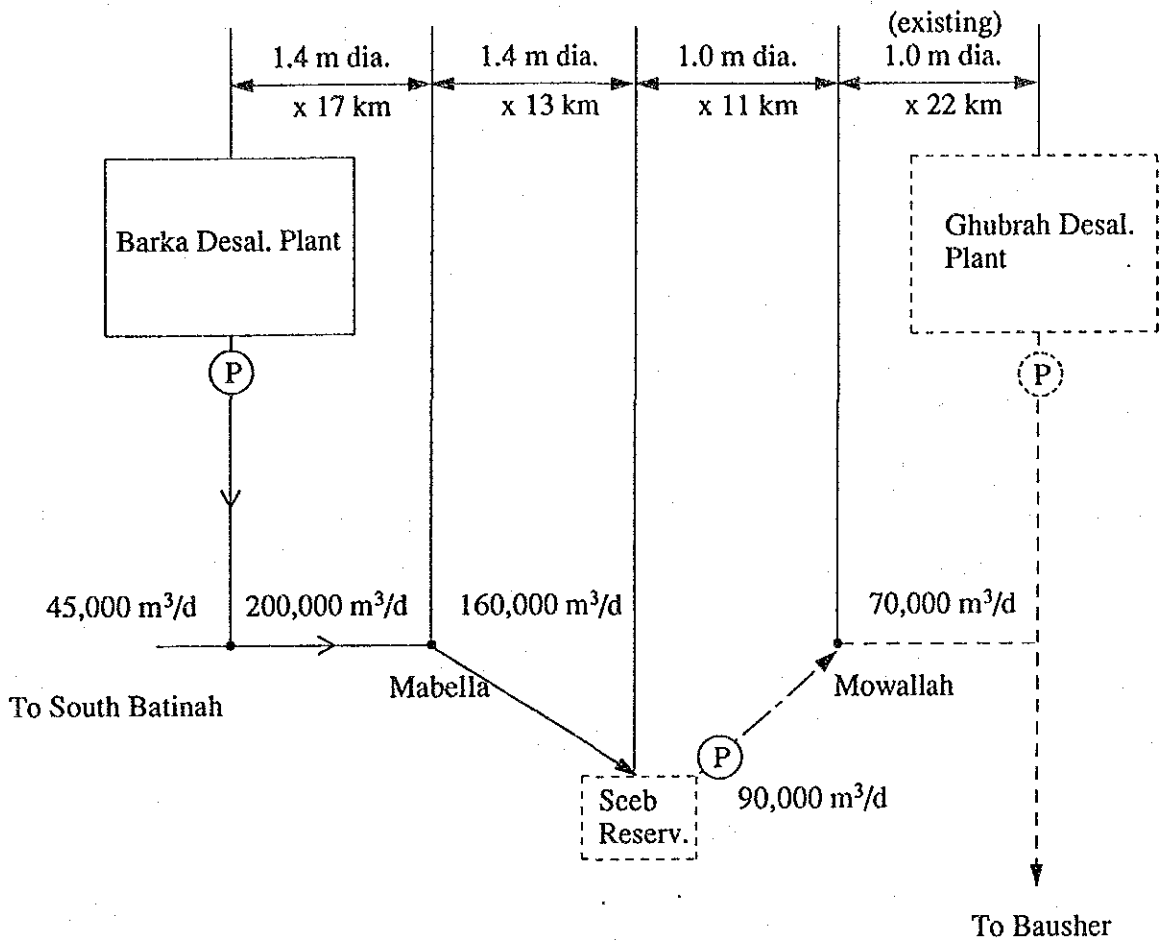
DESCRIPTION	MSF			RO	
	STANDARD MONTHLY COST 1993 (A)	STANDARD MONTHLY COST 1992 (B)	GHUBRAH NO. 5 COST (C)	CORRECTION FACTOR (D)	ASSUMED COST (E)
UNIT	R.O./M	R.O./M	R.O./Y	R.O./Y	R.O./Y
COST OF MAN POWER	111,305	99,804	138,012	0.50	69,006
COST OF CHEMICALS USED	37,514	30,880	79,608	1.30	103,490
COST OF CONSUMABLES	31,699	26,798	58,812	1.00	58,812
COST OF SPARES USED	52,284	31,330	251,448	1.00	251,448
COST OF MEMBRANE REPLACEMENT	0	0	0		548,000
COST OF EQUIP. DEPRECIATION	579,937	400,931	2,148,072		1,030,756

Notes 1. (C) = {(A) - (B)} x 12  
2. (E) = (C) x (D)

Source: MEW MONTHLY REPORT FOR ITEMS (A) & (B)

Appendix Table 4.3 Comparison of Water Production Cost by Desalination Process

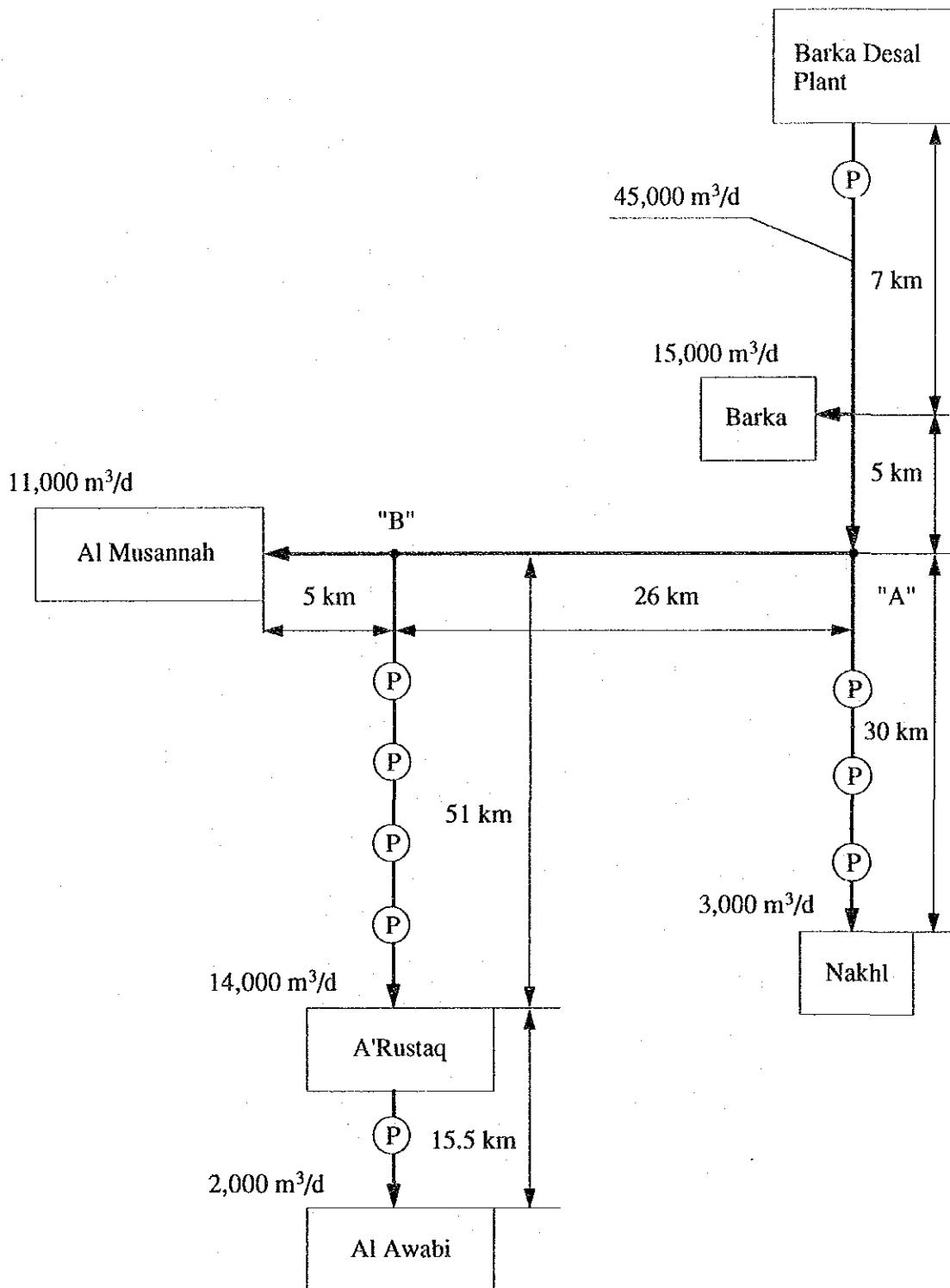
DISCRIPTION		UNIT	CASE1	CASE2	CASE3
			DUAL PURPOSE (GUBRAH NO.5)	6 MGPD RO PLANT	
			MSF	DESAL.ONLY	DESAL.&POWER
DATA ( PER YEAR )					
	INSTALLATION COST	R.O.	49,000,000	28,770,000	38,770,000
	EXPORTED WATER	CUB.MTRS	8,108,140	8,108,140	8,108,140
	FUEL GAS CONSUMP(PDO FIG)	CUB.MTRS	110,287,398	0	62,338,217
	FUEL OIL CONSUMP	LITRES	1,092,960	0	0
	POWER CONSUMED	M.W.HR	44,987	58,384	58,384
	POWER GENERATED	M.W.HR	223,522	0	238,900
EXPENCES IN R.O. PER YEAR					
1	FUEL GAS COST	R.O./Y	3,121,133	0	1,768,540
2	FUEL OIL COST	R.O./Y	118,040	0	0
3	COST OF POWER USED	R.O./Y	-2,489,494	817,099	-2,489,494
4	COST OF MAN POWER	R.O./Y	138,012	69,008	69,008
5	COST OF CHEMICAL USED	R.O./Y	79,808	103,490	103,490
6	COST OF CONSUMABLES	R.O./Y	58,812	58,812	58,812
7	COST OF SPARES USED	R.O./Y	251,448	828,848	828,848
8	COST OF EQUIP. DEPRECIATION	R.O./Y	3,920,000	2,301,800	3,101,800
9	TOTAL COST	R.O./Y	5,187,558	4,178,855	3,428,802
COST PER ONE CUB.MTR EXPORT					
1	FUEL GAS COST	BAIZA/m3	385.0	0.0	217.9
2	FUEL OIL COST	BAIZA/m3	14.8	0.0	0.0
3	COST OF POWER USED	BAIZA/m3	-308.3	100.8	-308.3
4	COST OF MAN POWER	BAIZA/m3	17.0	8.5	8.5
5	COST OF CHEMICAL USED	BAIZA/m3	9.8	12.8	12.8
6	COST OF CONSUMABLES	BAIZA/m3	7.3	7.3	7.3
7	COST OF SPARES USED	BAIZA/m3	31.0	102.0	102.0
8	COST OF EQUIP. DEPRECIATION	BAIZA/m3	483.8	283.9	382.8
9	TOTAL COST	BAIZA/m3	640.0	515.3	422.7
10	EXPORT WATER COST	BAIZA/GAL	2.82	2.35	1.93



Legend

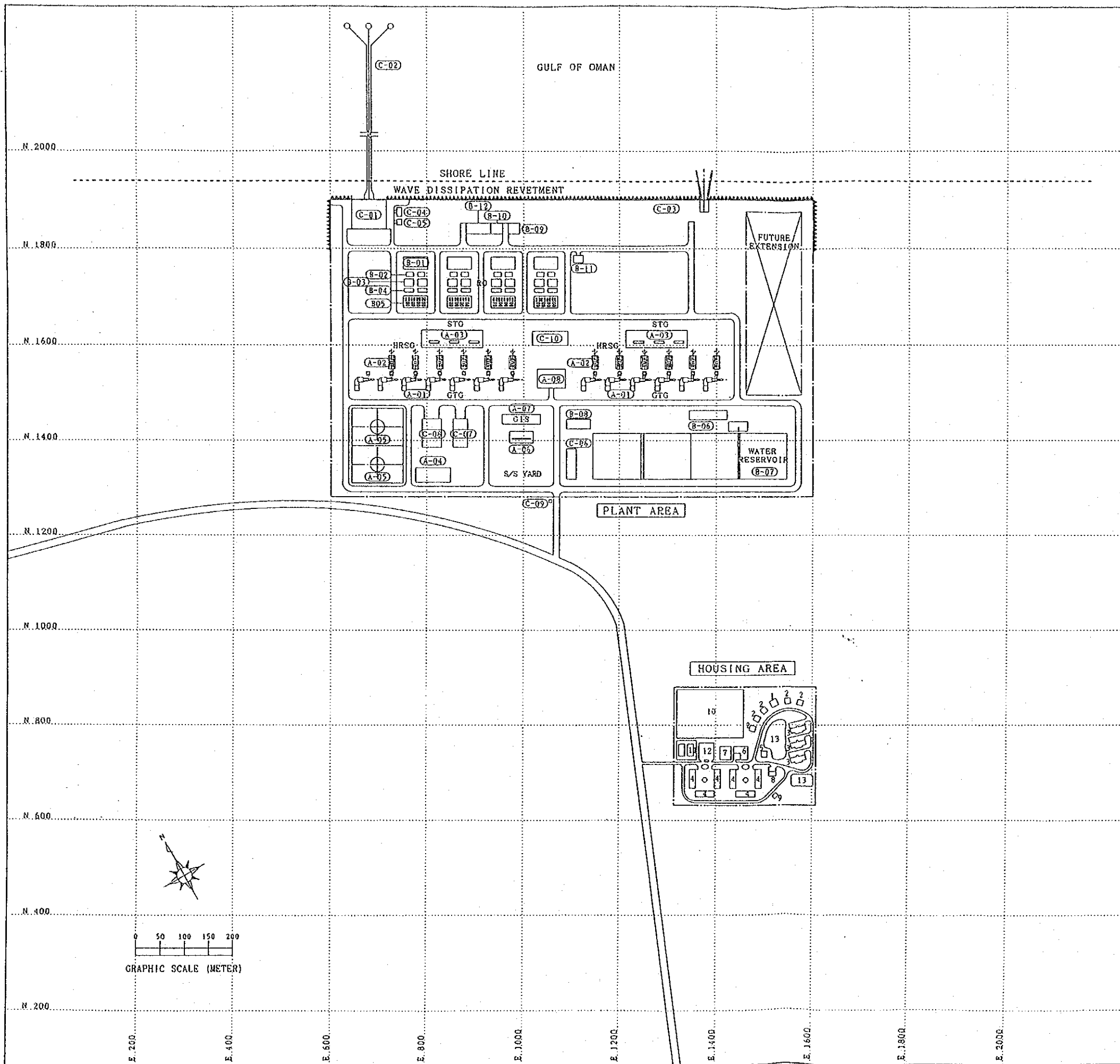
- (P) Existing Pump Station
- Existing Transmission Main
- - - Planned Transmission Main
- Proposed Transmission Main

Appendix Figure 4.1 Transmission Pipeline Route



Appendix Figure 4.2 Transmission Pipeline Route to South Batina

## APPENDIX 5.1



ITEM NO.	FACILITY	REMARKS
<b>POWER PLANT</b>		
A-01	GAS TURBINE GENERATOR (GTG)	
A-02	HEAT RECOVERY STEAM GENERATOR (HRSG)	
A-03	STEAM TURBINE GENERATOR (STG)	
A-04	FUEL GAS RECEIVING UNIT	
A-05	FUEL OIL TANK	
A-06	SENDING OUT FACILITY	
A-07	SWITCH GEAR ROOM (G(S))	
A-08	CENTRAL CONTROL BUILDING	
<b>DESALINATION PLANT</b>		
B-01	DUAL MEDIA FILTER	
B-02	BACK WASH TANK	
B-03	FILTERED WATER TANK	
B-04	CARTRIDGE FILTER	
B-05	HIGH PRESSURE PUMP	
B-06	PRODUCT WATER TREATMENT	
B-07	PRODUCT WATER RESERVOIR	
B-08	PRODUCT WATER PUMPING STATION	
B-09	DESAL CONTROL BUILDING	
B-10	DESAL CHEMICAL INJECT BUILDING	
B-11	DESAL SWITCH GEAR BUILDING	
B-12	CHEMICAL STORE HOUSE	
<b>COMMON FACILITY</b>		
C-01	SEA WATER INTAKE & PUMP PIT	
C-02	SEA WATER INTAKE PIPE LINE	
C-03	SEA WATER OUTFALL	
C-04	CHLORINATION BUILDING	
C-05	SEA WATER PUMP CONTROL ROOM	
C-06	ADMINISTRATION BUILDING	
C-07	STORE	
C-08	WORK SHOP	
C-09	GATE HOUSE	
C-10	UTILITY SPACE	

HOUSING AREA		
1	A-TYPE HOUSE	8 CLUB HOUSE
2	B-TYPE HOUSE	9 LAUNDRY ROOM
3	C-TYPE HOUSE	10 SOCCER GROUND
4	D-TYPE HOUSE	11 TENNIS COURT
5	MOSQUE	12 PARKING AREA
6	MARKET	13 PLAY GROUND
7	CANTEEN	

THE SULTANATE OF OMAN  
 MINISTRY OF ELECTRICITY AND WATER  
 BARKA POWER AND DESALINATION PLANT PROJECT

Appendix 5.1 Plant Layout

## APPENDIX 6.1





Natural Conditions of the Project Area

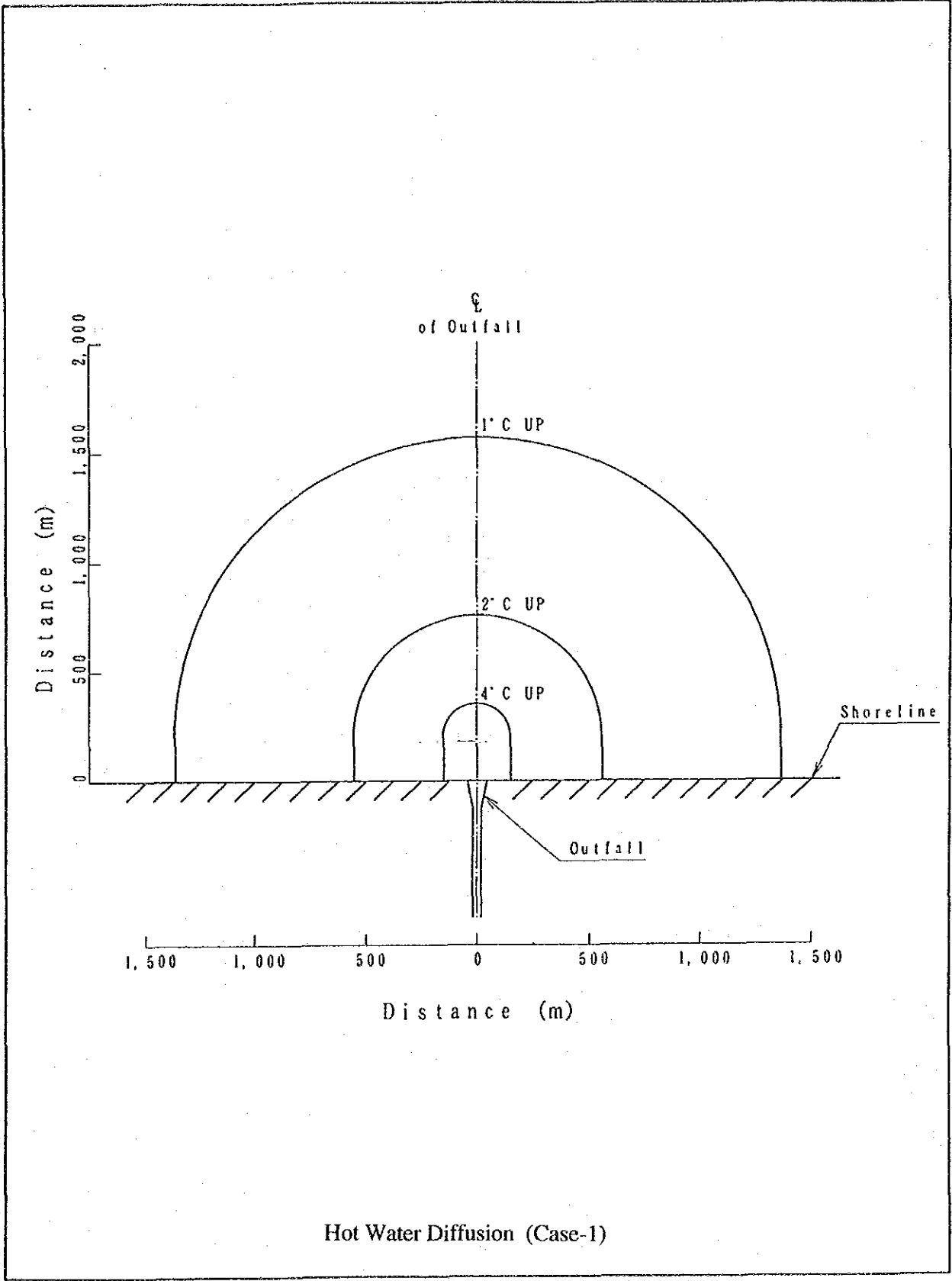
Item	Description	Source
Weather	The rainy season is generally from November to April and the annual rainfall is approx. 100 mm around the proposed site. The maximum humidity and ambient temperature in summer (June ~ August) is more than 90 % and 45°C respectively.	DCM(1)
Natural Disasters	There are records of 10 cyclones which caused some damage to the coastal area of Oman in the years from 1963 to 1993. According to the records, no cyclones have intruded the area around the site, and the courses of cyclones generally pass in the area between Masirah Island and India.	MC
Air Condition	There is no source of air pollution around the proposed site.	S
Landscape (Typical Shapes)	The proposed site is generally flat and with quite gentle undulations	S
Soil Condition (Soil Contamination)	There is a sandy layer at the surface and the firm strata with SPT-value $\geq 50$ are distributed at 5.0~11.0 m below the ground surface. The soils and underground water contain both sulphate and chloride.	S
Rivers	There is a small "wadi" about 200 m westward from the site.	S
Sea Data (Temperature, Currents)	The slope of the sea bed is gentle (1/100~1/200) and the water depth is about 7.0 m from CD at the location about 1 km offshore. The sea water temperature in December, 1993 was about 26°C. It is estimated to be about 30°C at the surface in the summer. The current velocity is estimated as 0.2 m/sec. or lower according to the measurement at Ghubrah by MEW.	DCM(2) S
Ground Water (Water Level, Uses)	The ground water table in the site was about GL-3 m (December, 1993). In Hayyasim, the ground water (saline water) is pumped up for the irrigation of plantation, but not used for drinking.	S
Vegetation	There are several kinds of trees, shrubs and other plants in and around the site.	S
Animals, Birds	There are traces of activities by some animals. Some goats and camels were seen in and around the site. Birds such as crows, sea gulls, etc. were also seen.	S
Aquatic Biota	Activities by pagurians, crabs, lugworms, etc. were observed. There are no coral reefs, breeding colonies of marine turtles or mangroves around the proposed site.	S, R, MRME
Endangered Species/Fragile Nature	No endangered species of fauna and flora exist around the site. Generally speaking, the endangered species are distributed in the mountainous area.	MRME, QU, S

DCM(1) : Statistical Year Book, 1992

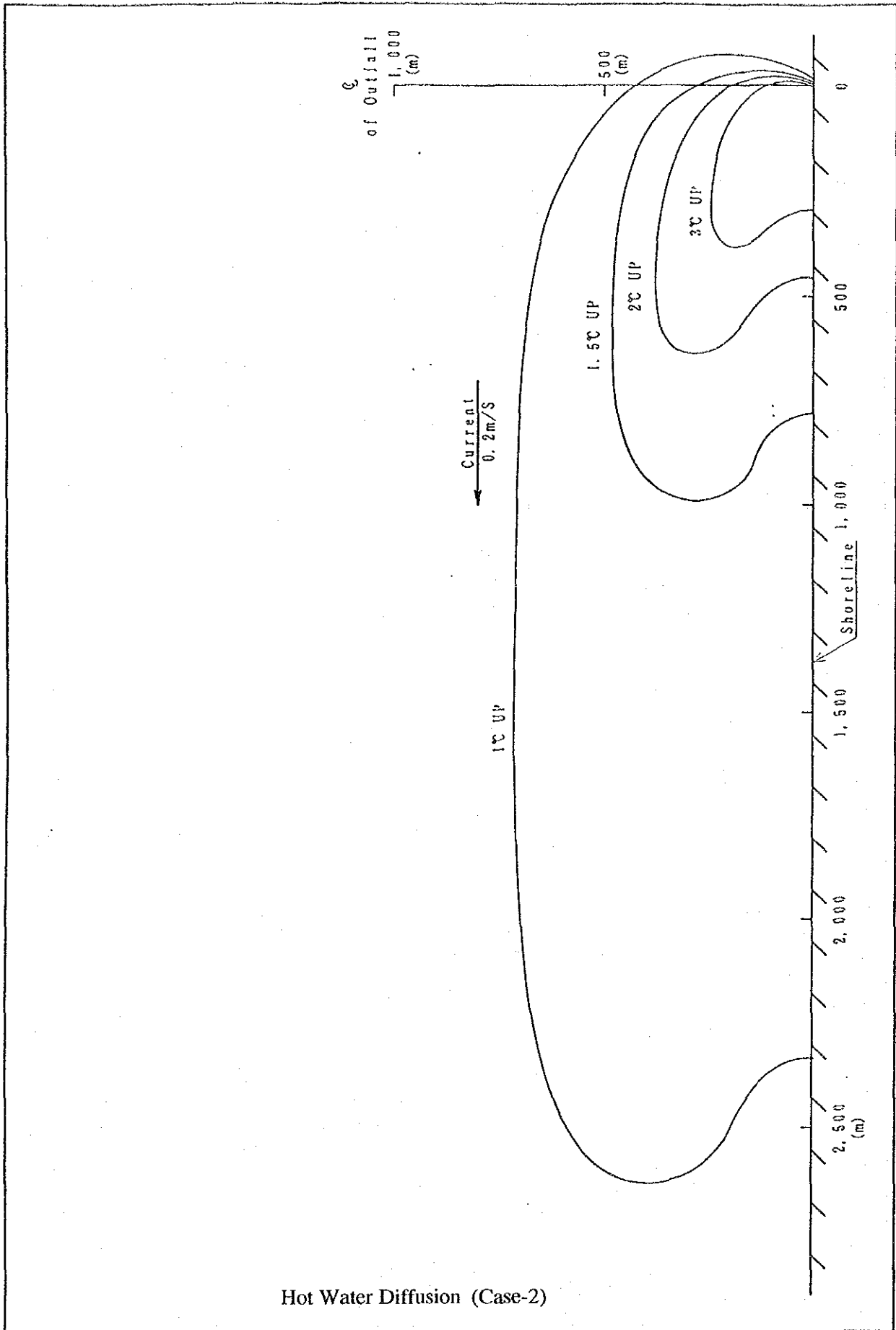
DCM(2) : Hydraulic Study for the Sea-Water Intake Ghubrah Power and Desalination Plant Extension Phase III

## APPENDIX 6.2





Hot Water Diffusion (Case-1)



Hot Water Diffusion (Case-2)

## APPENDIX 6.3

Table 13.3.1 Environmental Matrix

Environmental Item	Description	Survey Item	Survey Method	Evaluation		Basis of Judgement	Mitigation/Protection Measures	Monitoring	Specific Survey Items in Detailed EIA
				During Construction	During Operation				
1. Resettlement	Relocation triggered by the project	Land location, land owner	Interview Access to land use map	D	D	No resettlement is required.	-	-	-
2. Split of Societies	Split due to presence of the project	Locations of towns/villages	Interview Access to land use map	D	D	Splitting of present societies is not expected.	-	-	-
3. Aborigines	Impact to aborigines, minorities	Presence of aborigines or minorities	Site reconnaissance	D	D	No aborigines or minorities are present in the site.	-	-	-
4. Friction	Increase of friction among people	Inhabitants' opinions of project	-	C	C	Unknown.	• The outline of the project to be open to the public before implementation.	-	• Inhabitants' opinions.
5. Economic Activities	Impact to local economy, loss to the production basis	Major economic activities	Interview Examination of data	C	C	Impacts to fishing are unknown.	• Provision of an opportunity for employment. • Proper reimbursement if found necessary.	-	• Economic activities around the site, fisheries.
6. Public Facilities	Impact to schools, hospitals, etc.	Distribution of public facilities	Site reconnaissance	D	C	A housing area for plant operators will be located near the existing village.	-	-	• Use of public facilities.
7. Traffic	Increase of congestion, accidents	Road and traffic volume	Site reconnaissance Examination of data	B	C	Increase of traffic volume is expected especially during construction.	• Traffic signs to be arranged properly. • Traffic volume for construction to be well controlled.	-	• Present traffic volume, future plan for traffic system.
8. Common Rights	Loss of fishing rights, common rights	Fisheries and fishing rights	Interview Examination of data	C	C	Confirmation of the fisheries by MAF is necessary.	• The outline of the project to be open to the public before implementation. • Proper reimbursement if found necessary.	-	• Fisheries, fishing rights.
9. Cultural Heritage	Impact to historic monuments, etc.	Locations of cultural heritage sites	Interview Examination of data	C	C	Confirmation by MNHC is necessary.	• To consult MNHC and take countermeasures, if found.	-	• Site investigation with MNHC.
10. Change of Views	Drastic change of panoramic views	Present conditions in the surrounding area	Interview Examination of data Site reconnaissance	C	C	The plant will be built on the beach where the natural features are preserved.	• To maintain harmony with the surrounding views by plantation, consideration to colour of structures, etc.	-	• Inhabitants' opinions. • Opinions of the relevant authorities regarding details of the project.
11. Precious Nature	Collapse of wetlands, tropical forests, wildlands, mangroves, etc.	Present conditions in the surrounding area	Interview Examination of data Site reconnaissance	C	C	The beach around the site is designated as a "Coastal Reserve Area".	• To maintain harmony with the surrounding views by plantation, consideration to colour of structures, etc.	-	• Opinions of the relevant authorities regarding details of the project.
12. Endangered Animals, Plants	Impact to endangered species, original animals, plants, etc.	Presence of endangered species in and around the site	Interview Examination of data Site reconnaissance	C	C	It seems that there are no endangered species in the project area. However, a detailed survey is required especially for aquatic biota.	-	-	• Detailed survey for fauna, flora, aquatic biota.
13. Vegetation	Impact to vegetation	Present conditions	Site reconnaissance	B	D	Some trees and shrubs will be removed during construction.	• Plantation	-	-
14. Landscape	Change of landscape (Change of shoreline)	Geographical features	Site reconnaissance Examination of data	B	B	The natural features will change due to filling and construction of plant facilities (marine structures).	• To adopt an appropriate type of water intake (buried pipeline). • Due consideration to be taken in the detailed design of marine structures.	• Survey for change of shoreline twice a year.	• Volume of sediment flowing into the sea from the wadi (littoral transportation).
15. Groundwater	Change of groundwater level	Present conditions of groundwater	Site reconnaissance Examination of data	D	D	Groundwater around the site will not be used for the project.	-	-	-
16. Surface Water	Change of route, volume, etc.	Present conditions	Site reconnaissance	C	C	A wadi exists to the west of the site.	• Rain water drainage around the site to be considered in the design.	• Visual inspection during and after rainfall.	-
17. Surface Water	Change of temperature	Water quality, water temperature, aquatic biota	Site reconnaissance Examination of data Measurement and analysis for pollution	D	B	Hot water will be discharged into the sea.	• To design a fan-shaped outfall with proper dimensions for minimizing the impact area.	• Regular measurement of water temperature at the water intake and outfall. • Regular measurement of salinity at the outfall. • Survey for water temperature, water quality and aquatic biota in the sea around the site. (twice a year)	• Meteorological data, sea conditions. • Detailed analysis for hot water diffusion.
18. Air Pollution	Caused by factories and cars	Meteorological conditions, distribution of living facilities, standards	Examination of data Analysis for pollution	C	B	Emission of exhaust gases.	• To use natural gas for operation. • Due consideration to be taken in the design of the stack for promoting dispersion. (especially for stack height)	• Regular monitoring for concentration of NOx, SOx, etc. at the stack and at ground level.	• Meteorological and geographical data. • Detailed analysis for dispersion of pollutants.
19. Water Pollution	Caused by factories and land construction/excavation	Fisheries, water quality, recreation use	Site reconnaissance Examination of data Interview	B	D	Turbidity of sea water during construction.	• To adopt proper construction methods for minimizing contamination. (use of silt-protector, etc.)	• Monitoring at appropriate points during construction.	• Sea conditions • Fisheries.
20. Soil Contamination	Caused by toxic waste disposal	Present conditions	Site reconnaissance Interview	D	D	No disposal without treatment is expected.	• Industrial wastes to be treated if necessary. • To check chemicals in filling material.	• Regular measurement of discharged water quality.	-
21. Noise/Vibration	Caused by traffic and factories	Distribution of living facilities, standards	Site reconnaissance Examination of data	B	C	Increase of traffic volume is expected especially during construction.	• Equipment generating noise to be arranged at a sufficient distance from the site boundary or to be housed. • To adopt low-noise equipment.	• Regular measurement of noise at the boundary.	-
22. Ground Subsidence	Caused by overuse of groundwater	Underground conditions	Soil investigation	D	D	Groundwater around the site will not be used for the project.	-	-	-
23. Offensive Odor	Caused by exhaust gas, waste	Standards	Examination of data	D	D	No facilities causing offensive odor.	-	-	-

Evaluation Grade:

- A: Strong impact is expected
- B: Little impact is expected
- C: Unknown (Not clear at this moment, but needs to be examined in detail)
- D: Impact is insignificant, and no need to be a scope of EIA

## APPENDIX 7.1





Alternative B (RO Process)

		Appendix 7.1 Project Schedule for Power and Desalination Complex Plant																																																																
Activity Description	Time	Total Month	1995				1996				1997				1998				1999				2000				2001				2002				2003				2004				2005				2006				2007				2008				2009				2010			
			M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D	M	J	S	D
I. Engineering/Bidding & Contract			[Gantt bars for Engineering/Bidding & Contract]																																																															
1. Design			[Gantt bars for Design]																																																															
2. Technical Spec. & Bid Document			[Gantt bars for Technical Spec. & Bid Document]																																																															
3. Bidding			[Gantt bars for Bidding]																																																															
4. Bid Evaluation & Negotiation			[Gantt bars for Bid Evaluation & Negotiation]																																																															
5. Contract			[Gantt bars for Contract]																																																															
II. Manufacturing & Construction			[Gantt bars for Manufacturing & Construction]																																																															
IIA. Civil Works			[Gantt bars for Civil Works]																																																															
1. Field Investigation			[Gantt bars for Field Investigation]																																																															
2. Land Reclamation			[Gantt bars for Land Reclamation]																																																															
3. Sea Water Intake & Discharge Facilities			[Gantt bars for Sea Water Intake & Discharge Facilities]																																																															
4. Equipment Foundation			[Gantt bars for Equipment Foundation]																																																															
5. Building			[Gantt bars for Building]																																																															
IIB. Power Plant			[Gantt bars for Power Plant]																																																															
1. GTG Equipment 96MW	20		[Gantt bars for GTG Equipment 96MW]																																																															
2. GTG Equipment 96MW	20		[Gantt bars for GTG Equipment 96MW]																																																															
3. STG Equipment 100MW	30		[Gantt bars for STG Equipment 100MW]																																																															
4. GTG Equipment 96MW (open cycle)	20		[Gantt bars for GTG Equipment 96MW (open cycle)]																																																															
5. Power Transmission Facilities			[Gantt bars for Power Transmission Facilities]																																																															
IIC. Desalination Plant			[Gantt bars for Desalination Plant]																																																															
1. RO Equipment 31,800m3/d	24		[Gantt bars for RO Equipment 31,800m3/d]																																																															
2. RO Equipment 31,800m3/d	24		[Gantt bars for RO Equipment 31,800m3/d]																																																															
3. Water Transmission Facilities			[Gantt bars for Water Transmission Facilities]																																																															

## APPENDIX 8

## APPENDIX 8

### Table of Contents

Appendix 8.1 (1)	Capital and Operating Costs - Alternative 1 -----	8 - 1
Appendix 8.1 (2)	Capital and Operating Costs - Alternative 2 -----	8 - 2
Appendix 8.1 (3)	Capital and Operating Costs - Alternative 3 -----	8 - 3
Appendix 8.1 (4)	Capital and Operating Costs - Alternative 4 -----	8 - 4
Appendix 8.1 (5)	Unit Rate of Operating Cost-----	8 - 5
Appendix 8.2 (1)	Discounted Total Cost - Alternative 1 -----	8 - 6
Appendix 8.2 (2)	Discounted Total Cost - Alternative 2 -----	8 - 7
Appendix 8.2 (3)	Discounted Total Cost - Alternative 3 -----	8 - 8
Appendix 8.2 (4)	Discounted Total Cost - Alternative 4 -----	8 - 9
Appendix 8.3	Financial Rate of Return Analysis -----	8-10-8-12
Appendix 8.4	Sensitivity Analysis for FRR-----	8-13
Appendix 8.5	Construction Cost (Stage 1)-----	8-14
Appendix 8.6	Investment Costs Disbursement and Flow Financial Resources - Power Plant -----	8-15
Appendix 8.7	Investment Costs Disbursement and Flow Financial Resources - Desalination Plant -----	8-16
Appendix 8.8	Projected Cash Flow before Debt Service (Operation Period) 1998 - 2018-----	8-17

Appendix 8.9	Cash Flow Table for Financial Planning (Operation Period) - Stage 1 -----	8-18
Appendix 8.10	Discounted Return on Equity Invested-----	8-19
Appendix 8.11	Economic Rate of Return Analysis Revenue - Based Approach-----	8-20~8-22
Appendix 8.12	Sensitivity Analysis for ERR-----	8-23
Appendix 8.13	Key Assumptions for the Alternative-----	8-24
Appendix 8.14	Economic Cost of Alternative Scheme - Electricity-----	8-25
Appendix 8.15	Economic Rate of Return Analysis (Electricity) Comparative Method -----	8-26
Appendix 8-16	Economic Rate of Return Analysis (Water) Comparative Method -----	8-27

# Appendix 8.1 (1) Capital and operating costs--Alternative 1

Requirements	Year											Total				
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006		2007	2008	2009	2010
million R.O.																
<b>1 Requirements</b>																
<b>Power</b>																
1 Energy (MWh)	480,804	917,424	1,380,315	1,873,336	2,397,365	2,954,389	3,546,528	4,173,583	4,755,715	5,370,760	6,020,661	6,707,482	7,433,412			
2 Power (MW)	106	201	302	409	523	644	774	910	1,037	1,171	1,313	1,462	1,620			
3 Installed capacity (MW)																
C.C.	192	292	388	484	580	680	776	972	972	1,164	1,264	1,456	1,556			
BPST	0	60	60	60	120	120	120	120	180	180	180	240	240			
Total	192	352	448	544	700	800	896	1,092	1,152	1,344	1,444	1,696	1,796			
<b>Water</b>																
1 Water production (m3)	10,131	20,224	34,999	50,500	66,764	83,829	100,525	115,089	130,298	146,183	162,779	180,122				
2 Installed capacity (m3/d)																
<b>2 Capital costs</b>																
<b>Power</b>																
Foreign	16.92	127.81	19.12	3.59	36.40	45.09	12.84	47.05	37.73	9.35	62.68	27.85	62.68	7.08	0.00	516.19
Local	3.16	14.35	14.08	0.04	0.56	3.21	0.66	3.10	0.48	0.53	3.20	0.75	3.32	0.29	0.00	47.73
Sub total	20.08	142.16	33.20	3.63	36.96	48.30	13.50	50.15	38.21	9.88	65.88	28.60	66.00	7.37	0.00	563.92
<b>Water</b>																
Foreign	9.04	64.58	9.95	5.50	42.04	6.52	0.00	5.50	42.04	6.52	6.93	53.49	7.96	0.00	0.00	260.07
Local	3.80	21.05	13.15	1.02	5.39	3.81	0.00	1.02	5.39	3.81	1.38	7.52	4.86	0.00	0.00	72.20
Sub total	12.84	85.63	23.10	6.52	47.43	10.33	0.00	6.52	47.43	10.33	8.31	61.01	12.82	0.00	0.00	332.27
Total	25.96	192.39	29.07	9.09	78.44	51.61	12.84	52.55	79.77	15.87	69.61	81.34	70.64	7.08	0.00	776.26
Foreign	6.96	35.40	27.23	1.06	5.95	7.02	0.66	4.12	5.87	4.34	4.58	8.27	8.18	0.29	0.00	119.93
Local	32.92	227.79	56.30	10.15	84.39	58.63	13.50	36.67	85.64	20.21	74.19	89.61	78.82	7.37	0.00	896.19
<b>3 Operating costs</b>																
<b>Power</b>																
Foreign	0.14	0.31	0.45	0.59	0.80	0.97	1.15	1.32	1.57	1.74	1.93	2.18	2.40	2.40	2.40	15.53
Local	3.53	6.38	9.71	13.28	16.66	20.67	24.95	29.59	33.21	37.78	42.48	47.07	52.30	47.07	52.30	337.61
Sub total	3.67	6.68	10.16	13.87	17.46	21.64	26.09	30.91	34.78	39.52	44.41	49.25	54.70	49.25	54.70	353.14
<b>Water</b>																
Foreign	0.14	0.48	0.36	0.61	0.89	1.17	1.47	1.76	2.02	2.29	2.57	2.86	3.16	2.86	3.16	19.34
Local	3.53	7.55	12.06	17.34	22.52	28.43	34.68	41.26	46.58	52.91	59.46	65.97	73.21	65.97	73.21	465.52
Sub total	3.67	8.04	12.86	18.55	24.21	30.57	37.30	44.35	50.17	56.94	63.95	71.01	78.78	71.01	78.78	500.39
Total	25.96	192.39	29.21	9.57	79.24	52.82	14.53	54.69	82.39	18.96	73.20	85.36	75.14	12.12	5.56	811.13
Foreign	6.96	35.40	30.76	8.61	18.01	24.36	23.18	32.55	40.55	45.60	51.16	61.18	67.64	66.26	73.21	585.45
Local	32.92	227.79	59.97	18.19	97.25	77.18	37.71	87.24	122.94	64.56	124.56	146.55	142.77	78.38	78.78	1,396.58

Note: C.C.: Combined cycle  
BPST: Back pressure steam turbine

## Appendix 8.1 (2) Capital and operating costs--Alternative 2

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
1 Requirements																
Power																
1 Energy (MWH)			475,898	913,345	1,376,776	1,872,470	2,399,234	2,959,055	3,554,049	4,183,412	4,767,198	5,383,898	6,035,450	6,723,916	7,451,482	
2 Power (MW)			106	202	304	413	529	652	783	921	1,050	1,185	1,329	1,480	1,640	
3 Installed capacity (MW)			192	388	484	580	680	776	972	1,068	1,164	1,360	1,456	1,652	1,848	
Total																
Water																
1 Water production (m <sup>3</sup> )				10,131	20,224	34,999	50,500	66,764	83,829	100,525	115,089	130,298	146,183	162,779	180,122	
2 Installed capacity (m <sup>3</sup> /d)																
2 Capital costs																
Power																
Foreign	15.16	114.11	19.54	23.65	42.35	12.57	44.46	27.19	23.23	44.87	30.31	48.57	51.95	24.66	0.00	522.62
Local	2.95	12.89	13.80	1.65	0.30	0.36	0.47	1.89	0.34	1.78	0.64	2.00	2.08	0.41	0.00	41.56
Sub total	18.11	127.00	33.34	25.30	42.65	12.93	44.93	29.08	23.57	46.65	30.95	50.57	54.03	25.07	0.00	564.18
Water																
Foreign	0.93	12.75	65.98	0.00	5.56	33.03	0.00	0.00	5.56	33.03	0.00	5.56	33.03	0.00	0.00	195.43
Local	1.14	8.63	23.75	0.00	1.11	9.92	0.00	0.00	1.11	9.92	0.00	1.11	9.92	0.00	0.00	66.61
Sub total	2.07	21.38	89.73	0.00	6.67	42.95	0.00	0.00	6.67	42.95	0.00	6.67	42.95	0.00	0.00	262.04
Total	16.09	126.86	85.52	23.65	47.91	45.60	44.46	27.19	28.79	77.90	30.31	54.13	84.98	24.66	0.00	718.05
Foreign	4.09	21.52	37.55	1.65	1.41	10.28	0.47	1.89	1.45	11.70	0.64	3.11	12.00	0.41	0.00	108.17
Local	20.18	148.38	123.07	25.30	49.32	55.88	44.93	29.08	30.24	89.60	30.95	57.24	96.98	25.07	0.00	836.22
3 Operating costs																
Power																
Foreign	0.14	0.26	0.14	0.26	0.39	0.53	0.68	0.84	1.01	1.19	1.36	1.53	1.72	1.92	2.12	13.71
Local	3.49	6.70	3.49	6.70	10.11	13.74	17.61	21.72	26.09	30.71	34.99	39.52	44.30	49.35	54.69	353.03
Sub total	3.63	6.96	3.63	6.96	10.50	14.28	18.29	22.56	27.10	31.90	36.35	41.05	46.02	51.27	56.82	366.73
Water																
Foreign					0.84	1.46	2.10	2.78	3.49	4.19	4.80	5.43	6.09	6.78	7.51	45.91
Local					0.74	1.28	1.85	2.45	3.08	3.69	4.23	4.78	5.37	5.98	6.61	40.44
Sub total					1.59	2.74	3.96	5.23	6.57	7.88	9.02	10.21	11.46	12.76	14.12	86.34
Total					1.24	1.99	2.79	3.63	4.51	5.38	6.16	6.97	7.81	8.70	9.63	59.61
Foreign					7.08	10.85	15.03	19.46	24.17	29.16	34.40	39.22	44.30	49.67	55.33	393.46
Local					7.76	12.08	17.02	22.25	27.80	33.67	39.78	45.37	51.27	57.48	64.03	70.94
Total					24.33	49.15	47.59	47.25	30.82	83.28	36.47	61.10	92.79	107.81	119.37	464.37
4 Capital/Operating cost																
Foreign	16.09	126.86	85.66	24.33	49.15	47.59	47.25	30.82	33.30	83.28	36.47	61.10	92.79	107.81	119.37	777.66
Local	4.09	21.52	41.04	8.73	12.26	25.31	19.93	26.06	30.61	46.10	39.86	47.41	61.67	55.74	61.31	501.63
Grand total	20.18	148.38	126.70	33.06	61.40	72.90	67.18	56.88	63.91	129.38	76.32	108.51	154.46	89.10	70.94	1,279.30

### Appendix 8.1 (3) Capital and operating costs--Alternative 3

	Year												Total				
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007		2008	2009	2010	
1 Requirements																	
Power																	
1 Energy (MWH)	480,804	917,424	1,380,315	1,873,336	2,397,365	2,954,389	3,546,528	4,173,583	4,755,715	5,370,760	6,020,661	6,707,482	7,433,412				
2 Power (MW)	106	201	302	409	523	644	774	910	1,037	1,171	1,313	1,462	1,620				
3 Installed capacity (MW)																	
C.C.	480	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680
BPST	480	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Total	480	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800
Water																	
1 Water production (m3)	10,131	20,224	34,999	50,500	66,764	83,829	100,525	115,089	130,298	146,183	162,779	180,122					
2 Installed capacity (m3/d)																	
2 Capital costs																	
Power																	
Foreign	24.89	191.02	26.71	0.00	0.00	0.00	3.65	46.56	104.11	88.72	0.00	0.00	0.00	0.00	0.00	0.00	485.66
Local	3.45	16.67	14.39	0.00	0.00	0.00	0.02	1.17	7.74	1.41	0.00	0.00	0.00	0.00	0.00	0.00	44.85
Sub total	28.34	207.69	41.10	0.00	0.00	0.00	3.67	47.73	111.85	90.13	0.00	0.00	0.00	0.00	0.00	0.00	530.51
Water																	
Foreign	13.81	101.61	15.47	0.00	0.00	0.00	0.00	10.31	79.17	12.04	1.43	11.45	1.44	0.00	0.00	0.00	246.73
Local	4.49	24.59	15.82	0.00	0.00	0.00	0.00	1.74	9.19	6.48	0.35	2.13	1.05	0.00	0.00	0.00	65.84
Sub total	18.30	126.20	31.29	0.00	0.00	0.00	0.00	12.05	88.36	18.52	1.78	13.58	2.49	0.00	0.00	0.00	312.57
Total	38.70	292.63	42.18	0.00	0.00	0.00	3.65	56.87	183.28	100.76	1.43	11.45	1.44	0.00	0.00	0.00	752.39
Local	7.94	41.26	30.21	0.00	0.00	0.00	0.02	2.91	16.93	7.89	0.35	2.13	1.05	0.00	0.00	0.00	110.69
Total	46.64	333.89	72.39	0.00	0.00	0.00	3.67	59.78	200.21	108.65	1.78	13.58	2.49	0.00	0.00	0.00	843.08
3 Operating costs																	
Power																	
Foreign	0.14	0.30	0.42	0.30	0.45	0.61	0.79	0.97	1.13	1.33	1.54	1.74	1.95	2.17	2.40	2.40	15.51
Local	3.53	6.42	9.66	13.11	16.78	20.67	25.05	29.48	33.46	37.79	42.36	47.19	52.30	57.30	62.30	67.30	337.79
Sub total	3.67	6.72	10.11	13.72	17.56	21.64	26.19	30.82	34.99	39.52	44.30	49.36	54.70	59.70	64.70	69.70	353.30
Water																	
Foreign	0.18	0.36	0.54	0.61	0.81	1.23	1.67	2.14	2.60	3.10	3.56	4.02	4.51	5.02	5.56	6.06	34.85
Local	1.18	2.35	3.53	4.06	5.86	7.75	9.74	11.67	13.37	15.13	16.98	18.90	20.92	22.91	24.91	26.91	127.91
Sub total	1.35	2.70	4.06	4.68	6.75	8.93	11.21	13.44	15.39	17.42	19.54	21.76	24.08	26.40	28.40	30.40	147.25
Total	0.48	0.81	1.23	1.23	1.67	2.14	2.60	3.10	3.56	4.02	4.51	5.02	5.56	6.06	6.56	7.06	34.85
Local	7.60	12.01	17.17	17.17	22.64	28.43	34.79	41.16	46.82	52.92	59.33	66.09	73.21	80.61	88.01	95.41	465.71
Total	8.08	12.82	18.40	18.40	24.31	30.57	37.39	44.26	50.38	56.94	63.85	71.12	78.78	86.57	94.41	102.25	500.55
4 Capital/Operating costs																	
Foreign	38.70	292.63	42.32	0.48	0.81	1.23	5.32	59.01	183.88	103.86	4.99	15.47	5.95	5.02	5.56	6.06	767.24
Local	7.94	41.26	33.74	7.60	12.01	17.17	22.66	31.34	51.72	49.05	47.17	55.05	60.38	66.09	73.21	80.61	576.40
Grand total	46.64	333.89	76.06	8.08	12.82	18.40	27.98	90.35	237.60	152.91	52.16	70.52	66.34	71.12	78.78	86.67	1,343.63



### Appendix 8.1 (4) Capital and operating costs--Alternative 4

Requirements	Year											Total			
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006		2007	2008	2009
million R.O.															
1 Requirements															
Power															
1 Energy (MWH)			475,898	913,345	1,376,776	1,872,470	2,399,234	2,959,055	3,554,049	4,183,412	4,767,198	5,383,898	6,035,450	6,723,916	7,451,482
2 Power (MW)			106	202	304	413	529	652	783	921	1,050	1,185	1,329	1,480	1,640
3 Installed capacity (MW)			480	680	680	680	680	872	872	1,064	1,848	1,848	1,848	1,848	1,848
Total			480	680	680	680	680	872	872	1,064	1,848	1,848	1,848	1,848	1,848
Water															
1 Water production (m3)				10,131	20,224	34,999	50,500	66,764	83,829	100,525	115,089	130,298	146,183	162,779	180,122
2 Installed capacity (m3/d)															
2 Capital costs															
Power															
Foreign	21.63	165.57	23.60	0.00	0.00	3.65	32.89	17.43	134.85	92.28	0.00	0.00	0.00	0.00	491.90
Local	3.12	14.25	13.84	0.00	0.00	0.02	0.20	0.77	5.93	1.42	0.00	0.00	0.00	0.00	39.55
Sub total	24.75	179.82	37.44	0.00	0.00	3.67	33.09	18.20	140.78	93.70	0.00	0.00	0.00	0.00	531.45
Water															
Foreign	0.92	17.63	94.62	0.00	0.00	0.00	0.00	0.00	10.40	61.30	0.00	0.00	0.00	0.00	184.87
Local	1.14	9.31	29.74	0.00	0.00	0.00	0.00	0.00	1.63	14.52	0.00	0.00	0.00	0.00	56.34
Sub total	2.06	26.94	124.36	0.00	0.00	0.00	0.00	0.00	12.03	75.82	0.00	0.00	0.00	0.00	241.21
Total	22.55	183.20	118.22	0.00	0.00	3.65	32.89	17.43	145.25	153.58	0.00	0.00	0.00	0.00	676.77
Local	4.26	23.56	43.58	0.00	0.00	0.02	0.20	0.77	7.56	15.94	0.00	0.00	0.00	0.00	95.89
Total	26.81	206.76	161.80	0.00	0.00	3.67	33.09	18.20	152.81	169.52	0.00	0.00	0.00	0.00	772.66
3 Operating costs															
Power															
Foreign	0.14	0.26	0.14	0.26	0.39	0.53	0.68	0.84	1.01	1.19	1.36	1.53	1.72	1.92	2.12
Local	3.49	6.70	3.49	6.70	10.11	13.74	17.61	21.72	26.09	30.71	34.99	39.52	44.30	49.35	54.69
Sub total	3.63	6.96	3.63	6.96	10.50	14.28	18.29	22.56	27.10	31.90	36.35	41.05	46.02	51.27	56.82
Water															
Foreign	0.42	0.42	0.84	0.42	0.84	1.46	2.10	2.78	3.49	4.19	4.80	5.43	6.09	6.78	7.51
Local	0.37	0.37	0.74	0.37	0.74	1.28	1.85	2.45	3.08	3.69	4.23	4.78	5.37	5.98	6.61
Sub total	0.79	0.79	1.59	0.79	1.59	2.74	3.96	5.23	6.57	7.88	9.02	10.21	11.46	12.76	14.12
Total	0.14	0.68	0.14	0.68	1.24	1.99	2.79	3.63	4.51	5.38	6.16	6.97	7.81	8.70	9.63
Local	3.49	7.08	3.49	7.08	10.85	15.03	19.46	24.17	29.16	34.40	39.22	44.30	49.67	55.33	61.31
Total	3.63	7.76	3.63	7.76	12.08	17.02	22.25	27.80	33.67	39.78	45.37	51.27	57.48	64.03	70.94
4 Capital/Operating costs															
Foreign	22.55	183.20	118.36	0.68	1.24	5.64	35.68	21.06	149.76	158.96	6.16	6.97	7.81	8.70	9.63
Local	4.26	23.56	47.07	7.08	10.85	15.05	19.66	24.94	36.72	50.34	39.22	44.30	49.67	55.33	61.31
Grand total	26.81	206.76	165.43	7.76	12.08	20.69	55.34	46.00	186.48	209.30	45.37	51.27	57.48	64.03	70.94

Appendix 8.1 (5) Unit rate of operating cost

Electricity				
Item	Unit	BPST	C.C.	
Fuel cost	R.O./kWh	0.00444	0.00703	
Manpower	R.O./kWh	0.00042	0.00021	
Spares	R.O./kWh	0.00057	0.00029	
Others	R.O./kWh	0.00020	0.00010	
Sub total	R.O./kWh	0.00563	0.00763	
Water				
Item	Unit	MSF	RO	
Fuel cost	R.O./m3	0.30114		
Electric. cost	R.O./m3		0.09520	
Manpower	R.O./m3	0.01703	0.00538	
Chemicals & consumables	R.O./m3	0.01708	0.02061	
Spares & membrane replacement	R.O./m3	0.03102	0.09358	
Sub total	R.O./m3	0.36627	0.21477	
Unit rate of energy consumption				
Item	Unit	BPST/MSF	CC/RO	
Calorific value of NG	kcal/m3N	7210	7210	
Gene. effic.	%	19	48	
NG consumption per kWh	m3N/kWh	0.62778305	0.24849746	
NG cost	R.O./m3N	0.0283	0.0283	
Power energy cost	R.O./kWh	0.01777	0.00703	
Cost shear				
	Elec.	0.25	1	
	Water	0.75		
NG cost per elect.	R.O./kWh	0.00444		
Power gene. per water	kWh/m3	22.6		
Power consumption per water	kWh/m3	5.4	6.8	
Power export per water	kWh/m3	17.2		
Energy cost per water	R.O./m3	0.30114		
Export rate				
Item	Unit	C.C.	BPST	Water
Inplant consumption	%	2.0	24.2	2.0
Export rate		0.98	0.758	0.98

Note: CC: Combined cycle  
BPST: Back pressure steam turbine

## Appendix 8.2 (1) Discounted total cost--Alternative 1

1994 constant, million of R.O.

Year	Foreign (1)	Local (2)	Not shadow priced, total (3) = (1) + (2)	Shadow priced, local (4) = (2) x (0.9)	Shadow priced, total (5) = (1) + (4)	Discount factor (8%) (6)	Not shadow priced, discounted total (7) = (3) x (6)	Shadow priced, discounted total (BP) (8) = (5) x (6)
<b>Capital costs</b>						1.00		
1994						1.00		
1995						0.93		
1996	25.96	6.96	32.92	6.26	32.22	0.86	28.22	27.63
1997	192.39	35.40	227.79	31.86	224.25	0.79	180.83	178.02
1998	29.07	27.23	56.30	24.51	53.58	0.74	41.38	39.38
1999	9.09	1.06	10.15	0.95	10.04	0.68	6.91	6.84
2000	78.44	5.95	84.39	5.36	83.80	0.63	53.18	52.81
2001	51.61	7.02	58.63	6.32	57.93	0.58	34.21	33.80
2002	12.84	0.66	13.50	0.59	13.43	0.54	7.29	7.26
2003	52.55	4.12	56.67	3.71	56.26	0.50	28.35	28.14
2004	79.77	5.87	85.64	5.28	85.05	0.46	39.67	39.40
2005	15.87	4.34	20.21	3.91	19.78	0.43	8.67	8.48
2006	69.61	4.58	74.19	4.12	73.73	0.40	29.46	29.28
2007	81.34	8.27	89.61	7.44	88.78	0.37	32.95	32.65
2008	70.64	8.18	78.82	7.36	78.00	0.34	26.84	26.56
2009	7.08	0.29	7.37	0.26	7.34	0.32	2.32	2.31
2010	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
Sub-total	776.26	119.93	896.19	107.94	884.20	9.85	520.28	512.54
<b>Operating costs</b>						1.00		
1994						1.00		
1995						0.93		
1996						0.86		
1997						0.79		
1998	0.14	3.53	3.67	3.18	3.31	0.74	2.69	2.44
1999	0.48	7.55	8.04	6.80	7.28	0.68	5.47	4.96
2000	0.80	12.06	12.86	10.85	11.65	0.63	8.10	7.34
2001	1.21	17.34	18.55	15.61	16.82	0.58	10.82	9.81
2002	1.69	22.52	24.21	20.27	21.96	0.54	13.08	11.86
2003	2.14	28.43	30.57	25.59	27.73	0.50	15.29	13.87
2004	2.62	34.68	37.30	31.22	33.83	0.46	17.28	15.67
2005	3.09	41.26	44.35	37.14	40.22	0.43	19.02	17.25
2006	3.59	46.58	50.17	41.92	45.51	0.40	19.92	18.07
2007	4.02	52.91	56.94	47.62	51.65	0.37	20.94	18.99
2008	4.50	59.46	63.95	53.51	58.01	0.34	21.77	19.75
2009	5.04	65.97	71.01	59.38	64.42	0.32	22.39	20.31
2010	5.56	73.21	78.78	65.89	71.46	0.29	22.99	20.86
Sub-total	34.87	465.52	500.39	418.97	453.84	9.85	199.78	181.18
<b>Total</b>						1.00		
1994						1.00		
1995						0.93		
1996	25.96	6.96	32.92	6.26	32.22	0.86	28.22	27.63
1997	192.39	35.40	227.79	31.86	224.25	0.79	180.83	178.02
1998	29.21	30.76	59.97	27.68	56.89	0.74	44.08	41.82
1999	9.57	8.61	18.19	7.75	17.33	0.68	12.38	11.79
2000	79.24	18.01	97.25	16.21	95.45	0.63	61.28	60.15
2001	52.82	24.36	77.18	21.93	74.74	0.58	45.03	43.61
2002	14.53	23.18	37.71	20.87	35.39	0.54	20.37	19.12
2003	54.69	32.55	87.24	29.29	83.98	0.50	43.64	42.01
2004	82.39	40.55	122.94	36.50	118.89	0.46	56.95	55.07
2005	18.96	45.60	64.56	41.04	60.00	0.43	27.69	25.73
2006	73.20	51.16	124.36	46.04	119.24	0.40	49.38	47.35
2007	85.36	61.18	146.55	55.06	140.43	0.37	53.88	51.64
2008	75.14	67.64	142.77	60.87	136.01	0.34	48.61	46.31
2009	12.12	66.26	78.38	59.64	71.76	0.32	24.71	22.62
2010	5.56	73.21	78.78	65.89	71.46	0.29	22.99	20.86
Grand total	811.13	585.45	1,396.58	526.91	1,338.04	9.85	720.05	693.72

Note: An average conversion factor (estimated) of 0.9 was applied to the local cost components.

Appendix 8.2 (2) Discounted total cost--Alternative 2

1994 constant, million of R.O.

Year	Foreign	Local	Not shadow priced, total	Shadow priced, local	Shadow priced, total	Discount factor (8%)	Not shadow priced, discounted total	Shadow priced, discounted total (BP)
	(1)	(2)	(3) = (1) + (2)	(4) = (2) x (0.9)	(5) = (1) + (4)	(6)	(7) = (3) x (6)	(8) = (5) x (6)
<b>Capital costs</b>						1.00		
1994						0.93		
1995						0.86		
1996	16.09	4.09	20.18	3.68	19.77	0.79	17.30	16.95
1997	126.86	21.52	148.38	19.37	146.23	0.74	117.79	116.08
1998	85.52	37.55	123.07	33.80	119.32	0.68	90.46	87.70
1999	23.65	1.65	25.30	1.49	25.14	0.63	17.22	17.11
2000	47.91	1.41	49.32	1.27	49.18	0.58	31.08	30.99
2001	45.60	10.28	55.88	9.25	54.85	0.54	32.61	32.01
2002	44.46	0.47	44.93	0.42	44.88	0.50	24.27	24.25
2003	27.19	1.89	29.08	1.70	28.89	0.46	14.55	14.45
2004	28.79	1.45	30.24	1.31	30.10	0.43	14.01	13.94
2005	77.90	11.70	89.60	10.53	88.43	0.40	38.43	37.93
2006	30.31	0.64	30.95	0.58	30.89	0.37	12.29	12.27
2007	54.13	3.11	57.24	2.80	56.93	0.34	21.05	20.93
2008	84.98	12.00	96.98	10.80	95.78	0.32	33.02	32.61
2009	24.66	0.41	25.07	0.37	25.03	0.29	7.90	7.89
2010	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
Sub-total	718.05	108.17	826.22	97.35	815.40	9.85	471.97	465.10
<b>Operating costs</b>						1.00		
1994						0.93		
1995						0.86		
1996						0.79		
1997						0.74		
1998	0.14	3.49	3.63	3.14	3.28	0.68	2.67	2.41
1999	0.68	7.08	7.76	6.37	7.05	0.63	5.28	4.80
2000	1.24	10.85	12.08	9.76	11.00	0.58	7.61	6.93
2001	1.99	15.03	17.02	13.53	15.52	0.54	9.93	9.05
2002	2.79	19.46	22.25	17.52	20.31	0.50	12.02	10.97
2003	3.63	24.17	27.80	21.75	25.38	0.46	13.91	12.70
2004	4.51	29.16	33.67	26.25	30.75	0.43	15.60	14.25
2005	5.38	34.40	39.78	30.96	36.34	0.40	17.06	15.59
2006	6.16	39.22	45.37	35.29	41.45	0.37	18.02	16.46
2007	6.97	44.30	51.27	39.87	46.84	0.34	18.85	17.22
2008	7.81	49.67	57.48	44.70	52.51	0.32	19.57	17.88
2009	8.70	55.33	64.03	49.80	58.50	0.29	20.19	18.44
2010	9.63	61.31	70.94	55.18	64.81	0.29	20.71	18.92
Sub-total	59.61	393.46	453.08	354.12	413.73	9.85	181.41	165.61
<b>Total</b>						1.00		
1994						0.93		
1995						0.86		
1996	16.09	4.09	20.18	3.68	19.77	0.79	17.30	16.95
1997	126.86	21.52	148.38	19.37	146.23	0.74	117.79	116.08
1998	85.66	41.04	126.70	36.94	122.59	0.68	93.13	90.11
1999	24.33	8.73	33.06	7.85	32.19	0.63	22.50	21.91
2000	49.15	12.26	61.40	11.03	60.18	0.58	38.69	37.92
2001	47.59	25.31	72.90	22.78	70.37	0.54	42.54	41.06
2002	47.25	19.93	67.18	17.94	65.19	0.50	36.30	35.22
2003	30.82	26.06	56.88	23.45	54.27	0.46	28.45	27.15
2004	33.30	30.61	63.91	27.55	60.85	0.43	29.60	28.19
2005	83.28	46.10	129.38	41.49	124.77	0.40	55.49	53.51
2006	36.47	39.86	76.32	35.87	72.34	0.37	30.31	28.73
2007	61.10	47.41	108.51	42.67	103.77	0.34	39.90	38.15
2008	92.79	61.67	154.46	55.50	148.29	0.32	52.59	50.49
2009	33.36	55.74	89.10	50.17	83.53	0.29	28.09	26.33
2010	9.63	61.31	70.94	55.18	64.81	0.29	20.71	18.92
Grand total	777.66	501.63	1,279.30	451.47	1,229.13	9.85	653.38	630.71

### Appendix 8.2 (3) Discounted total cost--Alternative 3

1994 constant, million of R.O.

Year	Foreign	Local	Not shadow priced, total	Shadow priced, local	Shadow priced, total	Discount factor (8%)	Not shadow priced, discounted total	Shadow priced, discounted total (BP)
	(1)	(2)	(3) = (1) + (2)	(4) = (2) x (0.9)	(5) = (1) + (4)	(6)	(7) = (3) x (6)	(8) = (5) x (6)
<b>Capital costs</b>								
1994						1.00		
1995						0.93		
1996	38.70	7.94	46.64	7.15	45.85	0.86	39.99	39.31
1997	292.63	41.26	333.89	37.13	329.76	0.79	265.05	261.78
1998	42.18	30.21	72.39	27.19	69.37	0.74	53.21	50.99
1999	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00
2000	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00
2001	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00
2002	3.65	0.02	3.67	0.02	3.67	0.54	1.98	1.98
2003	56.87	2.91	59.78	2.62	59.49	0.50	29.90	29.76
2004	183.28	16.93	200.21	15.24	198.52	0.46	92.74	91.95
2005	100.76	7.89	108.65	7.10	107.86	0.43	46.60	46.26
2006	1.43	0.35	1.78	0.32	1.75	0.40	0.71	0.69
2007	11.45	2.13	13.58	1.92	13.37	0.37	4.99	4.92
2008	1.44	1.05	2.49	0.95	2.39	0.34	0.85	0.81
2009	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
Sub-total	732.39	110.69	843.08	99.62	832.01	9.85	536.02	528.44
<b>Operating costs</b>								
1994						1.00		
1995						0.93		
1996						0.86		
1997						0.79		
1998	0.14	3.53	3.67	3.18	3.31	0.74	2.69	2.44
1999	0.48	7.60	8.08	6.84	7.32	0.68	5.50	4.98
2000	0.81	12.01	12.82	10.81	11.61	0.63	8.08	7.32
2001	1.23	17.17	18.40	15.46	16.69	0.58	10.74	9.74
2002	1.67	22.64	24.31	20.38	22.05	0.54	13.14	11.91
2003	2.14	28.43	30.57	25.59	27.73	0.50	15.29	13.87
2004	2.60	34.79	37.39	31.31	33.91	0.46	17.32	15.71
2005	3.10	41.16	44.26	37.04	40.14	0.43	18.98	17.22
2006	3.56	46.82	50.38	42.14	45.70	0.40	20.01	18.15
2007	4.02	52.92	56.94	47.63	51.65	0.37	20.94	18.99
2008	4.51	59.33	63.85	53.40	57.91	0.34	21.74	19.72
2009	5.02	66.09	71.12	59.48	64.51	0.32	22.42	20.34
2010	5.56	73.21	78.78	65.89	71.46	0.29	22.99	20.86
Sub-total	34.85	465.71	500.55	419.13	453.98	9.85	199.83	181.22
<b>Total</b>								
1994						1.00		
1995						0.93		
1996	38.70	7.94	46.64	7.15	45.85	0.86	39.99	39.31
1997	292.63	41.26	333.89	37.13	329.76	0.79	265.05	261.78
1998	42.32	33.74	76.06	30.37	72.68	0.74	55.90	53.42
1999	0.48	7.60	8.08	6.84	7.32	0.68	5.50	4.98
2000	0.81	12.01	12.82	10.81	11.61	0.63	8.08	7.32
2001	1.23	17.17	18.40	15.46	16.69	0.58	10.74	9.74
2002	5.32	22.66	27.98	20.40	25.72	0.54	15.12	13.89
2003	59.01	31.34	90.35	28.20	87.21	0.50	45.20	43.63
2004	185.88	51.72	237.60	46.55	232.43	0.46	110.06	107.66
2005	103.86	49.05	152.91	44.14	148.00	0.43	65.58	63.47
2006	4.99	47.17	52.16	42.46	47.44	0.40	20.71	18.84
2007	15.47	55.05	70.52	49.54	65.01	0.37	25.93	23.91
2008	5.95	60.38	66.34	54.35	60.30	0.34	22.58	20.53
2009	5.02	66.09	71.12	59.48	64.51	0.32	22.42	20.34
2010	5.56	73.21	78.78	65.89	71.46	0.29	22.99	20.86
Grand total	767.24	576.40	1,343.63	518.76	1,285.99	9.85	735.84	709.67

## Appendix 8.2 (4) Discounted total cost--Alternative 4

1994 constant, million of R.O.

Year	Foreign	Local	Not shadow priced, total	Shadow priced, local	Shadow priced, total	Discount factor (8%)	Not shadow priced, discounted total	Shadow priced, discounted total (BP)
	(1)	(2)	(3) = (1) + (2)	(4) = (2) x (0.9)	(5) = (1) + (4)	(6)	(7) = (3) x (6)	(8) = (5) x (6)
<b>Capital costs</b>						1.00		
1994						0.93		
1995						0.86		
1996	22.55	4.26	26.81	3.83	26.38	0.79	22.99	22.62
1997	183.20	23.56	206.76	21.20	204.40	0.74	164.13	162.26
1998	118.22	43.58	161.80	39.22	157.44	0.68	118.93	115.72
1999	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00
2000	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00
2001	3.65	0.02	3.67	0.02	3.67	0.54	2.14	2.14
2002	32.89	0.20	33.09	0.18	33.07	0.50	17.88	17.87
2003	17.43	0.77	18.20	0.69	18.12	0.46	9.10	9.07
2004	145.25	7.56	152.81	6.80	152.05	0.43	70.78	70.43
2005	153.58	15.94	169.52	14.35	167.93	0.40	72.70	72.02
2006	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	9.85	0.00	0.00
Sub-total	676.77	95.89	772.66	86.30	763.07		478.65	472.13
<b>Operating costs</b>						1.00		
1994						0.93		
1995						0.86		
1996						0.79		
1997						0.74		
1998	0.14	3.49	3.63	3.14	3.28	0.68	2.67	2.41
1999	0.68	7.08	7.76	6.37	7.05	0.63	5.28	4.80
2000	1.24	10.85	12.08	9.76	11.00	0.58	7.61	6.93
2001	1.99	15.03	17.02	13.53	15.52	0.54	9.93	9.05
2002	2.79	19.46	22.25	17.52	20.31	0.50	12.02	10.97
2003	3.63	24.17	27.80	21.75	25.38	0.46	13.91	12.70
2004	4.51	29.16	33.67	26.25	30.75	0.43	15.60	14.25
2005	5.38	34.40	39.78	30.96	36.34	0.40	17.06	15.59
2006	6.16	39.22	45.37	35.29	41.45	0.37	18.02	16.46
2007	6.97	44.30	51.27	39.87	46.84	0.34	18.85	17.22
2008	7.81	49.67	57.48	44.70	52.51	0.32	19.57	17.88
2009	8.70	55.33	64.03	49.80	58.50	0.29	20.19	18.44
2010	9.63	61.31	70.94	55.18	64.81	9.85	20.71	18.92
Sub-total	59.61	393.46	453.08	354.12	413.73		181.41	165.61
<b>Total</b>						1.00		
1994						0.93		
1995						0.86		
1996	22.55	4.26	26.81	3.83	26.38	0.79	22.99	22.62
1997	183.20	23.56	206.76	21.20	204.40	0.74	164.13	162.26
1998	118.36	47.07	165.43	42.37	160.72	0.68	121.60	118.14
1999	0.68	7.08	7.76	6.37	7.05	0.63	5.28	4.80
2000	1.24	10.85	12.08	9.76	11.00	0.58	7.61	6.93
2001	5.64	15.05	20.69	13.54	19.19	0.54	12.07	11.20
2002	35.68	19.66	55.34	17.70	53.38	0.50	29.90	28.84
2003	21.06	24.94	46.00	22.45	43.50	0.46	23.01	21.76
2004	149.76	36.72	186.48	33.05	182.81	0.43	86.38	84.68
2005	158.96	50.34	209.30	45.30	204.27	0.40	89.76	87.61
2006	6.16	39.22	45.37	35.29	41.45	0.37	18.02	16.46
2007	6.97	44.30	51.27	39.87	46.84	0.34	18.85	17.22
2008	7.81	49.67	57.48	44.70	52.51	0.32	19.57	17.88
2009	8.70	55.33	64.03	49.80	58.50	0.29	20.19	18.44
2010	9.63	61.31	70.94	55.18	64.81	9.85	20.71	18.92
Grand total	736.38	489.35	1,225.74	440.42	1,176.80		660.06	637.74

### Appendix 8.3 Financial rate of return analysis

Project year	Thousand R.O.																		
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
<b>I. Electricity</b>																			
<b>A. Benefit (Revenue)</b>																			
<b>(a) Capacity</b>																			
1 Power requirement at generation (MW)																			
2 Power requirement at sending-end (2% loss)																			
3 Power requirement at transmission-end (3% loss)																			
4 Total benefit at transmission-end @ 34.63 R.O./KW																			
<b>(b) Energy</b>																			
1 Energy requirement at generation (MWh)																			
2 Energy requirement at sending-end (2% loss)																			
3 Energy requirement at transmission-end (3% loss)																			
4 Total benefit at transmission-end @ 0.01145 R.O./KWh																			
<b>Sub-total</b>																			
<b>B. Cost</b>																			
<b>(a) Capital cost</b>																			
Foreign																			
Local																			
Total																			
<b>(b) Operating cost</b>																			
Foreign																			
Local																			
Total																			
<b>C. Net benefit (A - B)</b>																			
<b>D. Net present value</b>																			
8% discount rate																			
<b>E. Cumulative NPV</b>																			
10%																			
<b>II. Gas</b>																			
<b>A. Benefit (Revenue)</b>																			
<b>(a) Capacity</b>																			
1 Power requirement at generation (MW)																			
2 Power requirement at sending-end (2% loss)																			
3 Power requirement at transmission-end (3% loss)																			
4 Total benefit at transmission-end @ 34.63 R.O./KW																			
<b>(b) Energy</b>																			
1 Energy requirement at generation (MWh)																			
2 Energy requirement at sending-end (2% loss)																			
3 Energy requirement at transmission-end (3% loss)																			
4 Total benefit at transmission-end @ 0.01145 R.O./KWh																			
<b>Sub-total</b>																			
<b>B. Cost</b>																			
<b>(a) Capital cost</b>																			
Foreign																			
Local																			
Total																			
<b>(b) Operating cost</b>																			
Foreign																			
Local																			
Total																			
<b>C. Net benefit (A - B)</b>																			
<b>D. Net present value</b>																			
8% discount rate																			
<b>E. Cumulative NPV</b>																			

Project Year	Year																	
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>2. Water</b>																		
<b>A. Benefit (Revenue)</b>																		
(a) Capacity																		
1. Production requirement (m <sup>3</sup> /d)	10,111	20,224	34,999	50,600	66,764	83,829	100,525	115,089	130,298	146,183	162,779	180,122	180,122	180,122	180,122	180,122	180,122	180,122
2. Capacity requirement (20% for peak demand)	12,157	24,269	41,999	60,600	80,117	100,595	126,630	138,107	156,357	175,420	195,335	216,147	216,147	216,147	216,147	216,147	216,147	216,147
3. Capacity requirement at sending-end (2% loss)	11,914	23,784	41,159	59,388	78,515	98,583	118,217	135,345	153,250	171,912	191,429	211,824	211,824	211,824	211,824	211,824	211,824	211,824
4. Capacity requirement at transmission-end (0% loss)	11,914	23,784	41,159	59,388	78,515	98,583	118,217	135,345	153,250	171,912	191,429	211,824	211,824	211,824	211,824	211,824	211,824	211,824
5. Total benefit at transmission-end @ 219.34 R.O./m <sup>3</sup> /d	2,613	5,217	9,028	13,026	17,221	21,623	25,930	29,887	33,610	37,107	40,461	43,685	46,788	49,771	52,634	55,376	58,000	60,513
(b) Production																		
1. Production requirement (m <sup>3</sup> )	3,697,646	7,381,897	12,744,673	18,432,633	24,368,973	30,597,635	36,691,625	42,007,505	47,538,693	53,266,893	59,145,511	65,144,704	71,348,972	77,849,972	84,649,972	91,749,972	99,149,972	106,949,972
2. Production requirement at sending-end (-2%)	3,623,693	7,245,299	12,519,179	18,063,981	23,881,591	29,985,682	35,957,793	41,167,355	46,607,519	52,289,255	58,226,221	64,429,809	70,949,972	77,849,972	85,049,972	92,549,972	100,349,972	108,449,972
3. Production requirement at transmission-end (-0.4%)	3,623,693	7,245,299	12,519,179	18,063,981	23,881,591	29,985,682	35,957,793	41,167,355	46,607,519	52,289,255	58,226,221	64,429,809	70,949,972	77,849,972	85,049,972	92,549,972	100,349,972	108,449,972
4. Total benefit at transmission-end @ 0.443 R.O./m <sup>3</sup>	1,605	3,205	5,546	8,002	10,580	13,284	15,929	18,237	20,647	23,164	25,794	28,542	31,400	34,368	37,446	40,634	43,932	47,340
<b>Sub-total</b>	4,218	8,422	14,574	21,029	27,801	34,907	41,859	47,924	54,257	60,871	67,782	75,004	79,000	79,000	79,000	79,000	79,000	79,000
<b>B. Cost</b>																		
(a) Capital cost																		
Foreign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local	930	12,740	65,980	0	5,560	33,030	0	5,560	33,030	0	5,560	33,030	0	5,560	33,030	0	5,560	33,030
Total	2,070	12,740	65,980	0	5,560	33,030	0	5,560	33,030	0	5,560	33,030	0	5,560	33,030	0	5,560	33,030
(b) Operating cost																		
Foreign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local	432	843	1,459	2,105	2,783	3,494	4,190	4,797	5,431	6,093	6,785	7,507	8,258	9,037	9,844	10,680	11,546	12,442
Total	794	1,585	2,744	3,959	5,234	6,571	7,880	9,022	10,214	11,459	12,760	14,120	15,548	16,997	18,564	20,154	21,776	23,426
<b>Sub-total</b>	2,070	21,380	89,720	8,255	45,694	3,959	5,234	13,241	50,830	9,022	16,884	54,409	12,760	14,120	16,097	16,097	16,097	16,097
<b>C. Net benefit (A - B)</b>	-2,070	-21,380	-89,720	3,424	1,666	-31,120	17,070	22,567	21,665	-8,971	38,902	37,372	6,462	55,022	60,884	62,903	62,903	62,903
<b>D. Net present value</b>	-2,070	-19,796	-76,929	2,718	1,22	-31,380	10,757	13,168	11,705	-4,438	18,019	16,028	2,566	20,231	20,779	19,830	18,361	17,001
8% discount rate	1,000	0.93	0.86	0.79	0.74	0.68	0.63	0.58	0.54	0.50	0.46	0.43	0.40	0.37	0.34	0.32	0.29	0.27
<b>E. Cumulative NPV</b>	-2,070	-21,866	-98,795	-96,077	-95,955	-117,135	-106,378	-93,210	-81,505	-85,993	-67,974	-51,945	-49,379	-29,148	-8,419	11,411	29,771	46,772
<b>F. FPK</b>																		
<b>2. Water</b>																		
<b>A. Benefit (Revenue)</b>																		
(a) Capacity																		
1. Production requirement (m <sup>3</sup> /d)	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122	180,122
2. Capacity requirement (20% for peak demand)	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147	216,147
3. Capacity requirement at sending-end (2% loss)	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824
4. Capacity requirement at transmission-end (0% loss)	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824	211,824
5. Total benefit at transmission-end @ 219.34 R.O./m <sup>3</sup> /d	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461	46,461
(b) Production																		
1. Production requirement (m <sup>3</sup> )	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972	74,948,972
2. Production requirement at sending-end (-2%)	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993
3. Production requirement at transmission-end (-0.4%)	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993	73,449,993
4. Total benefit at transmission-end @ 0.443 R.O./m <sup>3</sup>	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538	32,538
<b>Sub-total</b>	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000
<b>B. Cost</b>																		
(a) Capital cost																		
Foreign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(b) Operating cost																		
Foreign	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558	8,558
Local	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538	7,538
Total	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097
<b>Sub-total</b>	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097
<b>C. Net benefit (A - B)</b>	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903	62,903
<b>D. Net present value</b>	15,741	14,575	13,496	12,496	11,570	7,966	7,376	6,830	42,159	39,016	36,144	1,673	1,549	1,435	1,238	0	0	0
8% discount rate	0.25	0.23	0.21	0.20	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.08
<b>E. Cumulative NPV</b>	62,514	77,089	90,585	103,081	114,651	122,617	129,993	136,823	178,982	218,017	254,162	255,835	257,884	258,819	260,147	260,147	260,147	260,147



Project Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
<b>3. Total (Electricity and Water)</b>																			
<b>A. Total benefit</b>																			
B. Total cost																			
(a) Capital cost																			
Foreign	16,000	126,860	85,520	21,650	47,910	45,600	44,460	27,190	29,790	71,900	30,110	54,110	84,980	24,660	0	0	0	0	0
Local	1,000	21,520	37,550	1,410	10,380	1,410	1,800	1,800	1,800	11,700	640	1,110	13,000	410	0	0	0	0	0
Total	20,180	148,380	123,070	25,500	49,330	55,880	44,930	29,080	30,240	89,600	30,950	57,240	96,980	25,070	0	0	0	0	0
(b) Operating cost																			
Foreign	0	0	138	697	1,242	2,002	2,801	3,641	4,525	5,303	6,179	6,982	7,843	8,734	9,668	10,604	10,804	10,804	10,804
Local	0	0	3,403	7,076	15,848	15,029	19,664	24,170	29,164	34,397	39,216	44,301	49,667	55,329	61,306	64,384	64,384	64,384	64,384
Total	0	0	3,541	7,773	17,090	17,031	22,265	27,811	33,689	39,800	45,396	51,283	57,510	64,064	70,975	75,188	75,188	75,188	75,188
Sub-total	20,180	148,380	126,701	33,063	61,410	72,911	67,195	56,891	63,929	129,400	76,346	108,533	154,490	89,134	70,975	75,188	75,188	75,188	75,188
C. Net benefit (A - B)																			
D. Net present value																			
8% discount rate	-20,180	-137,389	-101,206	-9,733	-20,584	-16,584	-1,699	14,339	19,141	-3,844	26,874	18,589	6,279	36,975	47,367	45,418	42,041	38,939	38,939
8% discount rate	1.00	0.93	0.86	0.79	0.74	0.68	0.63	0.58	0.54	0.50	0.46	0.43	0.40	0.37	0.34	0.32	0.30	0.27	0.27
E. Cumulative NPV	-20,180	-157,569	-258,775	-268,508	-289,092	-305,676	-307,345	-293,003	-273,864	-279,708	-252,834	-234,245	-227,966	-190,591	-143,623	-98,205	-56,151	-17,212	-17,212
<b>F. FRM 13%</b>																			
<b>3. Total (Electricity and Water)</b>																			
<b>A. Total benefit</b>																			
B. Total cost																			
(a) Capital cost																			
Foreign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(b) Operating cost																			
Foreign	10,804	10,804	10,804	10,804	10,571	9,032	8,915	8,798	8,801	49,684	49,446	3,367	3,250	3,012	2,895	2,88	2,88	2,88	2,88
Local	64,384	64,384	64,384	64,384	58,778	51,302	48,349	45,396	43,543	75,590	69,461	26,124	23,171	17,142	14,189	14,189	14,189	14,189	14,189
Total	75,188	75,188	75,188	75,188	69,049	60,334	57,264	54,195	52,344	125,274	119,007	29,491	26,421	20,154	17,084	17,084	17,084	17,084	17,084
Sub-total	75,188	75,188	75,188	75,188	69,049	60,334	57,264	54,195	52,344	125,274	119,007	29,491	26,421	20,154	17,084	17,084	17,084	17,084	17,084
C. Net benefit (A - B)																			
D. Net present value																			
8% discount rate	36,055	33,384	30,911	28,621	24,950	18,888	16,824	14,982	49,095	44,930	40,604	5,360	4,335	3,407	2,795	2,795	2,795	2,795	2,795
8% discount rate	0.25	0.25	0.21	0.20	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.08	0.08
E. Cumulative NPV	18,843	52,226	83,137	111,759	136,709	155,597	172,421	187,383	236,478	291,409	322,013	327,363	331,898	334,506	338,101	338,780	338,780	338,780	338,780

Note: The salvage value at the end of the economic life is minimum, and therefore is disregarded.

Appendix 8.4 Sensitivity analysis for FRR

	Discount rate		
	7%	9%	10%
<b>Power (R.O.)</b>			
LRMC at generation	28.27	32.74	35.25
LRMC at transmission-end	31.97	37.26	40.19
<b>Water (R.O.)</b>			
LRMC at production	180.86	210.62	205.98
LRMC at transmission-end	201.99	237.2	255.35
<b>Net benefit (Thousand R.O.)</b>			
Electricity	926,737	1,092,608	1,184,480
Water	1,636,561	1,870,079	1,990,453
Total	2,563,299	2,962,688	3,174,933
<b>FRR</b>			
Electricity	10%	11%	11%
Water	16%	17%	18%
Total	13%	13%	14%

Appendix 8.5 Construction Costs (Stage I)

Million R.O.

Item	Year											
	1996			1997			1998			Total		
	FC	LC	TC	FC	LC	TC	FC	LC	TC	FC	LC	TC
<b>A Power Plant</b>												
1. Civil Work--Stage 1 share (excluding foundations and power)	0.21 (0.56)	0.29 (0.76)	0.51 (1.32)	0.85 (2.21)	1.46 (3.79)	2.31 (5.99)	0.24 (0.61)	1.18 (3.08)	1.42 (3.69)	1.30 (3.37)	2.94 (7.63)	4.23 (11.01)
2. Foundation and power house	0.15 (0.39)	0.17 (0.44)	0.32 (0.83)	0.58 (1.51)	1.47 (3.82)	2.05 (5.33)				0.73 (1.90)	1.64 (4.27)	2.37 (6.16)
3. Equipment & erection	9.40 (24.45)	0.08 (0.20)	9.48 (24.64)	77.52 (201.61)	0.52 (1.36)	78.04 (202.98)	7.07 (18.39)	0.30 (0.78)	7.37 (19.17)	93.99 (244.45)	0.90 (2.34)	94.89 (246.79)
4. Transmission facilities--Stage 1 share	0.96 (2.50)	0.27 (0.71)	1.24 (3.21)	6.71 (17.46)	0.83 (2.17)	7.55 (19.63)	1.94 (5.04)	1.62 (4.20)	3.55 (9.24)	9.61 (25.00)	2.72 (7.08)	12.34 (32.08)
5. Total cost for Stage 1	10.73 (27.90)	0.81 (2.11)	11.54 (30.01)	85.66 (222.79)	4.29 (11.14)	89.95 (233.93)	9.24 (24.04)	3.10 (8.06)	12.34 (32.10)	105.63 (274.72)	8.20 (21.32)	113.83 (296.04)
<b>B Desalination Plant</b>												
1. Civil work stage--1 share (excluding foundations)	0.23 (0.60)	0.28 (0.73)	0.51 (1.33)	0.93 (2.42)	1.67 (4.34)	2.60 (6.76)	0.39 (1.01)	1.50 (3.90)	1.89 (4.92)	1.55 (4.03)	3.45 (8.97)	5.00 (13.00)
2. Foundation				0.20 (0.52)	0.44 (1.14)	0.64 (1.66)	1.79 (4.66)	4.02 (10.46)	5.81 (15.11)	1.99 (5.18)	4.46 (11.60)	6.45 (16.78)
3. Equipment and erection				5.33 (13.86)	0.51 (1.33)	5.84 (15.19)	30.87 (80.29)	4.50 (11.70)	35.37 (91.99)	36.20 (94.15)	5.01 (13.03)	41.21 (107.18)
4. Transmission facilities--Stage 1 share				0.92 (2.39)	0.37 (0.96)	1.29 (3.36)	8.23 (21.40)	3.35 (8.71)	11.58 (30.12)	9.15 (23.80)	3.72 (9.67)	12.87 (33.47)
5. Total cost for Stage 1	0.23 (0.60)	0.28 (0.73)	0.51 (1.33)	7.38 (19.19)	2.99 (7.78)	10.37 (26.97)	41.28 (107.36)	13.37 (34.77)	54.65 (142.13)	48.89 (127.15)	16.64 (43.28)	65.53 (170.43)
C Total construction cost	10.96 (28.49)	1.09 (2.84)	12.05 (31.33)	93.04 (241.98)	7.28 (18.92)	100.32 (260.90)	50.52 (131.40)	16.47 (42.83)	66.99 (174.23)	154.52 (401.88)	24.84 (64.59)	179.36 (466.47)

Note: 1 ( ) Million US\$  
US\$= 0.3845 O.R.

2 Costs include physical contingencies, engineering fees and administration expenses.

Appendix 8.6 Investment costs disbursement and flow financial resources--power plant

Million US\$

	Project year												Total		
	0			1			2			1998					
	1996			1997			1998			1998					
	FC	LC	TC	FC	LC	TC	FC	LC	TC	FC	LC	TC	FC	LC	TC
A Fixed assets															
(1) Construction costs (including physical contingencies, engineering fees and administration costs)	27.90	2.11	30.01	222.79	11.14	233.93	24.04	8.06	32.10	274.72	21.32	296.04			
(2) Interest on loan accrued 8%	0.59	0.04	0.63	5.88	0.32	6.21	11.32	0.74	12.06	17.79	1.11	18.90			
Sub-total	28.48	2.16	30.64	228.67	11.47	240.14	35.36	8.80	44.16	292.51	22.43	314.94			
B Net working capital	0	0	0	0	0	0	0	0	0	0	0	0			
C Total initial investment (A + B)	28.48	2.16	30.64	228.67	11.47	240.14	35.36	8.80	44.16	292.51	22.43	314.94			
D Total price contingencies 3%	0.85	0.06	0.92	6.86	0.34	7.20	1.06	0.26	1.32	8.78	0.67	9.45			
E Total finance required (C + D)	29.34	2.22	31.56	235.53	11.81	247.34	36.42	9.07	45.48	301.28	23.10	324.39			
(Financial resources)															
F Equity capital	14.67	1.11	15.78	117.76	5.91	123.67	18.21	4.53	22.74	150.64	11.55	162.19			
Cumulative	14.67	1.11	15.78	132.43	7.02	139.45	150.64	11.55	162.19						
G Commercial bank loan Interest 8%	14.67	1.11	15.78	117.76	5.91	123.67	18.21	4.53	22.74	150.64	11.55	162.19			
Cumulative	14.67	1.11	15.78	132.43	7.02	139.45	150.64	11.55	162.19						
H Total finance Cumulative	29.34	2.22	31.56	235.53	11.81	247.34	36.42	9.07	45.48	301.28	23.10	324.39			

Note: 1 Equity-loan ratio  
 Equity: 50%  
 Loan: 50%

2 Computation of interest  
 Cumulative debt x 8% + new debt x 4%

3 No working capital nor pre-operation expenditures assumed.

Appendix 8.7 Investment costs disbursement and flow of financial resources--desalination plant

Million US\$

	Project year											
	0			1			2			Total		
	1996			1997			1998					
Year	FC	LC	TC	FC	LC	TC	FC	LC	TC	FC	LC	TC
A Fixed assets												
(1) Construction costs (including physical contingencies, engineering fees and administration costs)	0.60	0.73	1.33	19.19	7.78	26.97	107.36	34.77	142.13	127.15	43.28	170.43
(2) Interest on loan accrued 8%	0.01	0.02	0.03	0.43	0.19	0.62	3.11	1.10	4.21	3.55	1.31	4.86
Sub-total	0.61	0.74	1.35	19.62	7.97	27.59	110.47	35.87	146.34	130.70	44.58	175.29
B Net working capital	0	0	0	0	0	0	0	0	0	0	0	0
C Total initial investment (A + B)	0.61	0.74	1.35	19.62	7.97	27.59	110.47	35.87	146.34	130.70	44.58	175.29
D Total price contingencies 3%	0.02	0.02	0.04	0.59	0.24	0.83	3.31	1.08	4.39	3.92	1.34	5.26
E Total finance required (C + D)	0.63	0.77	1.39	20.21	8.21	28.42	113.78	36.95	150.73	134.62	45.92	180.55
(Financial resources)												
F Equity capital	0.31	0.38	0.70	10.11	4.11	14.21	56.89	18.47	75.36	67.31	22.96	90.27
Cumulative	0.31	0.38	0.70	10.42	4.49	14.91	67.31	22.96	90.27			
G Commercial bank loan	0.31	0.38	0.70	10.11	4.11	14.21	56.89	18.47	75.36	67.31	22.96	90.27
Interest 8%												
Cumulative	0.31	0.38	0.70	10.42	4.49	14.91	67.31	22.96	90.27			
H Total finance	0.63	0.77	1.39	20.21	8.21	28.42	113.78	36.95	150.73	134.62	45.92	180.55
Cumulative	0.63	0.77	1.39	20.84	8.98	29.82	134.62	45.92	180.55			

Note: 1 Equity-loan ratio  
Equity: 50%  
Loan: 50%

2 Computation of interest

Cumulative debt x 8% + new debt x 4%  
3 No working capital nor pre-operation expenditures assumed.

## Appendix 8.8 Projected cash flow before debt service (operation period) 1998-2018

Year	Thousand US\$																						
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	
<b>1. Electricity</b>																							
Installed capacity (MW)	192	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	292	160	
Available capacity (15%)	177	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	92	
<b>A. Operating income</b>																							
(a) Capacity	177	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	92	
1. Power requirement at generation (MW)	148	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	92	
2. Power requirement at sending-end (2% loss)	148	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	92	
3. Power requirement at transmission-end (3% loss)	148	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	233	92	
4. Unit charge (\$/kWh)	101.37	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	91.55	181.08	
5. Total charge at transmission-end	17,023	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	26,663	70,277	
(b) Energy																							
1. Energy requirement at generation (MWh)	1,083,156	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	564,144	
2. Energy requirement at sending-end (2% loss)	1,083,156	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	564,144	
3. Energy requirement at transmission-end (3% loss)	1,083,156	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	1,647,300	564,144	
4. Unit charge (\$/MWh)	1,029,649	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	1,565,924	3,131,677	
5. Total charge at transmission-end	34,510	54,019	55,880	57,351	59,071	60,844	62,669	64,549	66,485	68,480	70,534	72,650	74,830	77,075	79,387	81,769	84,222	86,748	89,351	92,031	32,463	1,424,759	
<b>B. Operating expenditures</b>																							
Foreign	51,531	80,722	83,144	85,638	88,207	90,853	93,579	96,386	99,278	102,256	105,324	108,483	111,728	115,090	118,563	122,099	125,702	129,353	133,042	137,424	48,475	2,127,486	
Local	1,807	2,831	2,916	3,003	3,093	3,186	3,282	3,380	3,482	3,586	3,694	3,805	3,919	4,036	4,157	4,282	4,411	4,543	4,679	4,820	1,700	74,613	
Total expenditure	53,338	83,553	86,060	88,641	91,300	93,939	96,861	100,009	102,764	105,742	108,808	111,988	115,647	119,126	122,640	126,201	129,813	133,476	137,141	141,244	49,875	2,202,100	
<b>C. Net operating income (A - B)</b>	25,469	39,896	41,093	42,326	43,596	44,903	46,250	47,638	49,067	50,539	52,055	53,617	55,225	56,882	58,589	60,346	62,157	64,021	65,942	67,920	23,958	1,051,492	
<b>2. Water</b>																							
Installed capacity (MW)	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	63,640	
Capacity requirement for average demand	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	50,912	
Available capacity (5%)	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	
<b>A. Operating income</b>																							
(a) Capacity	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	48,366	
1. Capacity requirement at sending-end (2% loss)	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	
2. Capacity requirement at transmission-end (3% loss)	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	47,399	
4. Unit charge (\$/m3)	561.32	681.16	701.59	722.64	744.32	766.65	789.65	813.34	837.74	862.87	888.76	915.42	942.88	971.17	1,000.31	1,030.31	1,061.22	1,093.06	1,125.85	1,159.63	947,981		
5. Total charge at transmission-end	31,346	32,286	33,255	34,253	35,280	36,339	37,429	38,552	39,708	40,899	42,126	43,390	44,692	46,033	47,414	48,836	50,291	51,810	53,364	54,965	842,277		
(b) Production																							
1. Production requirement at sending-end (2% loss)	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	353,074,729	
2. Production requirement at transmission-end (3% loss)	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	17,653,736	353,074,729	
4. Unit charge (\$/m3)	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	1,730,661	346,013,226	
5. Total charge at transmission-end	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	3,015,397	6,030,752	
<b>B. Operating expenditure</b>																							
Foreign	54,411	56,043	57,734	59,456	61,240	63,077	64,969	66,918	68,926	70,993	73,123	75,317	77,576	79,904	82,301	84,770	87,313	89,932	92,630	95,409	1,462,032		
Local	6,078	6,350	6,448	6,541	6,641	6,747	6,858	6,974	7,094	7,219	7,348	7,481	7,618	7,759	7,904	8,053	8,206	8,363	8,524	8,689	163,716		
Total expenditure	60,489	62,393	64,182	66,000	67,885	69,825	71,947	74,142	76,412	78,767	81,111	83,545	86,073	88,593	91,204	93,904	96,709	99,615	102,622	105,738	307,166		
<b>C. Net operating income (A - B)</b>	25,469	39,896	41,093	42,326	43,596	44,903	46,250	47,638	49,067	50,539	52,055	53,617	55,225	56,882	58,589	60,346	62,157	64,021	65,942	67,920	23,958	1,051,492	
<b>3. Total (Electricity and Water)</b>																							
A. Operating income	51,531	135,132	139,186	143,362	147,663	152,093	156,656	161,355	166,196	171,182	176,317	181,607	187,055	192,667	198,447	204,400	210,532	216,848	223,353	230,054	143,884	3,589,519	
B. Operating expenditure	1,807	9,969	9,716	10,027	10,328	10,639	10,951	11,264	11,578	11,893	12,209	12,526	12,844	13,163	13,483	13,804	14,126	14,449	14,773	15,098	15,424	237,959	
Local	24,255	48,719	48,338	48,719	49,100	49,482	49,865	50,249	50,634	51,019	51,404	51,790	52,176	52,563	52,950	53,338	53,726	54,115	54,504	54,893	55,283	1,383,161	
Total	26,062	58,257	58,055	59,438	59,819	60,369	60,914	61,463	62,013	62,562	63,111	63,660	64,209	64,758	65,307	65,856	66,405	66,954	67,503	68,052	68,601	1,621,121	
<b>C. Net operating income (A - B)</b>	28,469	82,875	85,561	87,922	90,564	93,277	96,075	98,977	101,926	104,984	108,133	111,377	114,719	118,160	121,705	125,356	129,117	132,990	136,990	141,090	99,322	2,206,358	

Note: Annual price increase (in charges and expenditures) 3%

# Appendix 8.9 Cash flow table for financial planning (operation period)--stage 1

Project year	Thousand US\$																					
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
1. Net cash flow from operations	25,469	82,875	85,361	87,922	90,560	93,277	96,075	98,957	101,926	104,984	108,133	111,377	114,719	118,160	121,705	125,356	129,117	132,990	136,980	141,090	99,322	2,206,358
2. Interest earned 3%	382	1,243	1,280	1,319	1,358	1,399	1,441	1,484	1,529	1,575	1,622	1,671	1,721	1,772	1,826	1,880	1,937	1,995	2,055	2,116	1,490	33,095
3. Working capital (net increase)	4,344	4,366	261	269	277	286	294	303	312	321	331	341	351	362	373	384	395	407	419	432	-14,827	0
4. Interest paid on debt 8%	347	20,197	18,803	17,297	15,671	13,915	12,018	9,970	7,757	5,368	2,787	0	0	0	0	0	0	0	0	0	0	124,130
5. Net income before tax	21,160	59,555	67,578	71,675	75,970	80,476	85,204	90,169	95,386	100,870	106,637	112,707	116,088	119,571	123,158	126,853	130,658	134,578	138,616	142,774	115,640	2,115,322
6. Income tax paid 0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7. Aftertax cash flow	21,160	59,555	67,578	71,675	75,970	80,476	85,204	90,169	95,386	100,870	106,637	112,707	116,088	119,571	123,158	126,853	130,658	134,578	138,616	142,774	115,640	2,115,322
8. Loan repayments																						
Outstanding principal	17,427	18,822	20,327	21,954	23,710	25,607	27,655	29,868	32,257	34,839												252,465
9. After-debt service cash flow	21,160	42,128	48,756	51,347	54,017	56,766	59,598	62,514	65,518	68,613	71,798	75,077	78,459	81,944	85,533	89,226	93,023	96,924	100,929	105,039	109,254	1,862,857
Cumulative	21,160	63,288	112,044	163,391	217,408	274,173	333,771	396,285	461,803	530,416	602,214	677,391	755,940	838,958	926,527	1,018,680	1,115,438	1,216,916	1,323,215	1,435,444	1,553,694	1,862,857
10. Debt service coverage Item 9 / (items 4 & 8)	1.12	1.30	1.36	1.44	1.51	1.58	1.66	1.74	1.82	1.91												

Note: 1. Assumptions on loan:

- 1 Principal: 252.47 million US dollars
- 2 Interest: 8%
- 3 Duration: 10 years
- 4 PPF: 0.149029
- 5 Loan ratio: 70%

- 2. Interest earned: Interest on a half of the net operating income of the year
  - 3. Working capital: 2-month operating expenditure
  - 4. Beginning of year (BOY) basis
  - 5. Interest paid in 1996 is on the working capital of that year.
- Interest on the loan in 1996 is included in the initial investment.

## Appendix 8.10 Discounted return on equity invested

Project year	Thousand US\$																								
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	
A. Cash inflow			51,913	136,376	140,467	144,681	149,021	153,492	158,097	162,840	167,725	172,756	177,939	183,277	188,776	194,439	200,272	206,280	212,469	218,843	225,408	232,170	239,127	3,622,614	
a. Operation			51,531	135,122	139,186	143,362	147,663	152,093	156,656	161,355	166,196	171,182	176,317	181,607	187,055	192,667	198,447	204,400	210,532	216,848	223,353	230,054	236,954	3,589,519	
b. Interest earned			382	1,243	1,280	1,319	1,358	1,399	1,441	1,484	1,529	1,575	1,622	1,671	1,721	1,772	1,826	1,880	1,937	1,995	2,055	2,116	1,490	33,095	
B. Cash outflow			16,476	137,883	138,860	94,248	91,711	93,333	95,005	96,735	98,499	100,325	102,206	104,144	106,141	70,570	72,687	74,868	77,114	79,427	81,810	84,265	86,792	2,012,222	
a. Equity capital paid-in			16,476	137,883	98,106																			252,465	
b. Operation			26,082	52,237	53,325	55,440	57,103	58,816	60,580	62,398	64,270	66,198	68,184	70,229	72,336	74,506	76,741	79,044	81,415	83,857	86,373	88,964	44,562	1,383,161	
c. Net working capital			4,344	4,366	261	269	277	286	294	303	312	321	331	341	351	362	373	384	395	407	419	432	445	0	
d. Interest paid on debt			347	20,197	18,803	17,297	15,671	13,915	12,018	9,970	7,757	5,268	2,787	0	0	0	0	0	0	0	0	0	0	124,130	
e. Income (expense) tax paid			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
f. Loan repayments			0	17,427	18,822	20,327	21,954	23,710	25,607	27,655	29,868	32,257	34,839	0	0	0	0	0	0	0	0	0	0	252,465	
C. Net cash flow (A - B)			-16,476	-137,883	-76,947	42,128	48,756	51,347	54,017	56,766	59,598	62,514	65,518	68,613	71,798	112,707	116,088	119,571	123,158	126,853	130,658	134,578	138,616	1,610,392	
D. Cumulative net CF			-16,476	-154,359	-231,306	-189,178	-146,422	-99,074	-55,058	21,708	81,306	143,820	209,338	277,951	349,749	462,456	578,544	698,115	821,273	948,126	1,078,785	1,213,363	1,351,978	1,494,752	1,610,392
E. Net present value			-16,476	-142,925	-199,307	-150,175	-103,214	-60,622	-22,092	12,667	43,927	71,946	96,964	119,208	138,890	170,044	196,072	220,075	239,722	256,249	269,965	281,151	290,065	296,941	2,307,189
8% discount rate			1.00	0.93	0.86	0.79	0.74	0.68	0.63	0.58	0.54	0.50	0.46	0.43	0.40	0.37	0.34	0.32	0.29	0.27	0.25	0.23	0.21	0.20	0.18
F. Cumulative NPV			-16,476	-159,401	-237,708	-207,884	-161,098	-109,812	-68,146	-29,219	-5,665	27,313	68,309	119,101	170,210	218,166	262,605	303,200	339,722	372,051	401,082	426,724	449,887	470,573	4,917,889
G. Internal rate of return on equity (IRR)			22%																						



### Appendix 8.11 Economic rate of return analysis--revenue-based approach

Electricity	Project year																	Total
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
<b>A. Benefit</b>																		
(a) Capacity																		
1 Power requirement at generation (MW)	106	202	304	413	529	652	783	931	1,050	1,185	1,329	1,480	1,640	1,698	1,698	1,698	1,698	1,698
2 Power requirement at sending-end (2% loss)	103	198	298	405	518	639	767	903	1,029	1,162	1,302	1,451	1,607	1,664	1,664	1,664	1,664	1,664
3 Power requirement at transmission-end (3% loss)	100	192	289	392	503	620	744	876	998	1,127	1,263	1,407	1,559	1,614	1,614	1,614	1,614	1,614
4 Total benefit at transmission-end @ 34.48 R.O./KW	3,459	6,614	9,956	13,530	17,328	21,365	25,656	30,194	34,404	38,850	43,549	48,513	53,760	55,655	55,655	55,655	55,655	55,655
(b) Energy																		
1 Energy requirement at generation (MWh)	475,898	911,345	1,376,776	1,874,470	2,399,234	2,959,055	3,564,049	4,183,412	4,767,198	5,383,898	6,015,450	6,723,916	7,451,483	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569
2 Energy requirement at sending-end (2% loss)	462,380	895,078	1,349,246	1,835,071	2,351,240	2,909,873	3,492,968	4,090,714	4,671,241	5,276,220	5,914,241	6,589,438	7,302,452	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677
3 Energy requirement at transmission-end (3% loss)	452,388	883,226	1,308,745	1,779,970	2,280,712	2,812,877	3,378,479	3,976,735	4,531,899	5,119,933	5,737,299	6,391,255	7,083,379	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987
4 Total benefit at transmission-end @ 0.01036 R.O./MWh	-4,087	8,595	13,559	18,440	23,628	29,141	35,001	41,199	46,948	53,022	59,458	66,219	73,384	76,270	76,270	76,270	76,270	76,270
<b>B. Cost</b>																		
(a) Capital cost																		
Foreign	15,160	114,110	19,540	23,650	42,550	44,460	37,190	44,870	30,310	48,570	51,950	24,660	6	0	0	0	0	0
Local	2,655	11,601	32,420	1,483	270	324	423	306	576	1,800	1,872	369	0	0	0	0	0	0
Total	17,815	125,711	51,960	25,135	42,820	44,884	37,613	45,176	30,886	50,370	53,822	25,029	6	0	0	0	0	0
(b) Operating cost																		
Foreign	136	360	392	534	684	843	1,013	1,192	1,359	1,534	1,720	1,916	2,124	2,207	2,207	2,207	2,207	2,207
Local	3,179	6,034	9,095	12,370	15,849	19,478	23,478	27,656	31,492	35,566	39,870	44,418	49,224	51,161	51,161	51,161	51,161	51,161
Total	3,315	6,394	9,487	12,904	16,533	20,321	24,491	28,828	32,851	37,100	41,590	46,335	51,348	53,368	53,368	53,368	53,368	53,368
<b>C. Net benefit (A - B)</b>	17,815	125,711	35,239	31,429	52,107	61,416	49,282	48,027	75,300	87,477	95,412	71,364	51,348	53,368	53,368	53,368	53,368	53,368
<b>D. Net present value</b>	-17,815	-125,711	-27,093	-15,820	-28,503	-6,173	-20,460	1,225	12,650	-3,907	17,615	4,402	43,768	75,795	78,557	78,557	78,557	78,557
8% discount rate	1.00	0.93	0.86	0.79	0.74	0.68	0.63	0.58	0.54	0.50	0.46	0.43	0.40	0.37	0.34	0.32	0.29	0.27
<b>E. Cumulative NPV</b>	-17,815	-134,214	-157,442	-170,001	-191,017	-188,816	-199,709	-198,994	-192,171	-194,125	-185,966	-184,078	-181,070	-165,124	-139,318	-114,554	-91,654	-70,392
<b>F. ERR</b>	10%																	
<b>A. Benefit</b>																		
(a) Capacity																		
1 Power requirement at generation (MW)	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698	1,698
2 Power requirement at sending-end (2% loss)	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664
3 Power requirement at transmission-end (3% loss)	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614	1,614
4 Total benefit at transmission-end @ 34.48 R.O./KW	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655	55,655
(b) Energy																		
1 Energy requirement at generation (MWh)	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569	7,744,569
2 Energy requirement at sending-end (2% loss)	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677	7,589,677
3 Energy requirement at transmission-end (3% loss)	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987	7,361,987
4 Total benefit at transmission-end @ 0.01036 R.O./MWh	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270	76,270
<b>B. Cost</b>																		
(a) Capital cost																		
Foreign	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925
Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925	131,925
(b) Operating cost																		
Foreign	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207	2,207
Local	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161	51,161
Total	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368	53,368
<b>C. Net benefit (A - B)</b>	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557	78,557
<b>D. Net present value</b>	19,659	18,203	16,834	15,606	12,949	11,063	9,600	7,853	6,713	5,705	4,666	3,559	2,890	2,175	1,420	885	60,405	60,405
8% discount rate	0.25	0.23	0.21	0.20	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.09	0.08	0.08
<b>E. Cumulative NPV</b>	-50,733	-32,531	-15,676	-70	12,878	23,941	33,541	41,394	48,107	53,811	58,477	62,035	64,925	67,100	68,530	69,405	69,405	69,405

Project year	Year												Total					
	0	1	2	3	4	5	6	7	8	9	10	11		12	13	14	15	16
<b>2. Water</b>																		
<b>A. Benefit</b>																		
<b>(a) Capacity</b>																		
1. Production requirement (m <sup>3</sup> /d)																		
2. Capacity requirement (20% for peak demand)																		
3. Capacity requirement at sending-end (2% loss)																		
4. Capacity requirement at transmission-end (0% loss)																		
5. Total benefit at transmission-end @ 21.4, 33 R.O./m <sup>3</sup> /d																		
<b>(b) Production</b>																		
1. Production requirement (m <sup>3</sup> )																		
2. Production requirement at sending-end (2%)																		
3. Production requirement at transmission-end (-0%)																		
4. Total benefit at transmission-end @ 0.401 R.O./m <sup>3</sup>																		
<b>B. Cost</b>																		
<b>(a) Capital cost</b>																		
Foreign																		
Local																		
Total																		
<b>(b) Operating cost</b>																		
Foreign																		
Local																		
Total																		
<b>C. Net benefit (A - B)</b>																		
<b>D. Net present value</b>																		
8% discount rate																		
<b>E. Cumulative NPV</b>																		
16%																		
<b>2. Water</b>																		
<b>A. Benefit</b>																		
<b>(a) Capacity</b>																		
1. Production requirement (m <sup>3</sup> /d)																		
2. Capacity requirement (20% for peak demand)																		
3. Capacity requirement at sending-end (2% loss)																		
4. Capacity requirement at transmission-end (0% loss)																		
5. Total benefit at transmission-end @ 21.4, 33 R.O./m <sup>3</sup> /d																		
<b>(b) Production</b>																		
1. Production requirement (m <sup>3</sup> )																		
2. Production requirement at sending-end (2%)																		
3. Production requirement at transmission-end (-0%)																		
4. Total benefit at transmission-end @ 0.401 R.O./m <sup>3</sup>																		
<b>B. Cost</b>																		
<b>(a) Capital cost</b>																		
Foreign																		
Local																		
Total																		
<b>(b) Operating cost</b>																		
Foreign																		
Local																		
Total																		
<b>C. Net benefit (A - B)</b>																		
<b>D. Net present value</b>																		
8% discount rate																		
<b>E. Cumulative NPV</b>																		

Project year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013		
<b>3. Total (Electricity and Water)</b>																				
A. Total benefit	0	0	8,146	19,615	31,513	45,812	60,929	76,911	93,810	111,150	126,868	143,404	160,801	179,109	198,380	206,779	206,779	206,779	206,779	
B. Total cost																				
(a) Capital cost																				
Foreign	16,000	126,869	85,520	23,650	47,910	45,600	44,460	27,190	28,700	71,900	30,310	54,150	84,980	24,660	0	0	0	0	0	0
Local	3,881	19,368	33,295	1,985	1,269	9,252	423	1,701	1,306	10,530	576	2,799	10,800	369	0	0	0	0	0	0
Total	19,771	146,238	119,215	25,175	49,179	54,852	44,883	28,891	30,006	82,430	30,886	56,929	95,780	25,029	0	0	0	0	0	0
(b) Operating cost																				
Foreign	0	0	1,56	683	1,235	1,992	2,789	3,626	4,507	5,382	6,155	6,965	7,813	8,701	9,631	10,766	10,766	10,766	10,766	10,766
Local	0	0	3,144	6,368	9,763	13,526	17,518	21,753	26,248	30,987	35,295	39,871	44,709	49,797	55,176	57,945	57,945	57,945	57,945	57,945
Total	0	0	3,279	7,051	10,999	15,518	20,307	25,379	30,755	36,339	41,450	46,836	52,513	58,497	64,807	68,711	68,711	68,711	68,711	68,711
Sub-total	19,771	146,228	122,594	32,186	60,178	70,370	65,190	54,270	60,850	124,769	72,336	103,765	148,293	83,526	64,807	68,711	68,711	68,711	68,711	68,711
C. Net benefit (A - B)	-19,771	-146,228	-114,448	-12,571	-28,665	-24,558	-4,261	22,641	32,961	-13,619	54,532	39,638	12,508	95,583	133,573	138,068	138,068	138,068	138,068	138,068
D. Net present value 8% discount rate	1,000	0.93	0.86	0.79	-0.979	-1.069	-1.174	-2.683	13.211	17.808	-6.813	25.259	17,000	4,967	35,146	45,476	43,525	40,701	37,315	34,215
E. Cumulative NPV	-19,771	-155,167	-253,288	-263,267	-284,336	-301,050	-308,735	-290,524	-272,717	-279,530	-254,271	-237,271	-232,304	-197,158	-151,682	-108,157	-67,856	-30,541		

Project year	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total
Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
<b>3. Total (Electricity and Water)</b>																	
A. Total benefit	306,779	306,779	306,779	306,779	193,072	164,174	157,321	147,456	463,758	456,905	445,925	74,701	67,848	56,747	47,003	16,883	4,995,695
B. Total cost																	
(a) Capital cost																	
Foreign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	718,050
Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97,353
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	815,403
(b) Operating cost																	
Foreign	10,766	10,766	10,766	10,766	10,536	9,001	8,886	8,772	49,776	49,662	49,628	3,351	3,256	3,002	2,887	2,24	333,745
Local	57,945	57,945	57,945	57,945	52,630	46,172	43,514	40,857	70,689	68,031	62,603	23,511	20,854	15,428	12,770	5,426	1,232,218
Total	68,711	68,711	68,711	68,711	63,166	55,173	52,401	49,628	120,465	117,693	112,232	26,862	24,090	18,430	15,657	5,660	1,565,963
Sub-total	68,711	68,711	68,711	68,711	63,166	55,173	52,401	49,628	120,465	117,693	112,232	26,862	24,090	18,430	15,657	5,660	2,371,366
C. Net benefit (A - B)	138,068	138,068	138,068	138,068	129,906	109,001	104,920	97,828	343,294	339,213	333,692	47,839	43,758	38,318	31,346	11,223	2,654,329
D. Net present value 8% discount rate	34,551	31,992	29,622	27,428	23,895	18,565	16,546	14,285	46,414	42,465	38,703	5,134	4,349	3,526	2,671	885	310,489
E. Cumulative NPV	4,011	36,003	65,625	93,073	116,948	135,513	152,058	166,343	312,757	255,222	293,025	299,059	303,408	306,533	309,604	310,489	

Appendix 8.12 Sensitivity analysis for ERR

	Discount rate		
	7%	9%	10%
<b>Power (R.O.)</b>			
LRMC at generation	28.21	32.74	35.13
LRMC at transmission-end	31.84	37.18	39.99
<b>Water (R.O.)</b>			
LRMC at generation	176.88	205.98	220.96
LRMC at transmission-end	197.40	231.79	249.51
<b>Net benefit (Thousand R.O.)</b>			
Electricity	988,874	1,158,407	1,247,619
Water	1,526,869	1,754,949	1,872,470
Total	2,515,744	2,913,356	3,120,089
<b>ERR</b>			
Electricity	10%	11%	12%
Water	15%	17%	17%
Total	13%	13%	14%

Appendix 8.13 Key assumptions for the Alternative

(1) Alternative scheme:	
Plant type	: oil-fired thermal plant
Capital cost (shadow-priced)	: 346.05 R.O./KW (900 US\$/KW)
Life expectancy	: 20 years
Discount factor	: 8%
(opportunity cost of capital)	
(2) KW capacity cost (benefit):*	
Annuitized value	: 346.05 R.O./KW x 0.101852 = 35.246 R.O./KW (annually)
(3) KWH energy cost (benefit):	
Price of fuel (oil)	: 0.2 \$/ℓ
Heat value	: 10,000 kcal/ℓ
Thermal efficiency	: 31%
Heat rate**	: 2,774 kcal/KWH
Fuel cost***	: $5.55 \times 10^{-2}$ \$/KWH
Operating costs excluding fuel	( $2.13 \times 10^{-2}$ R.O./KWH)
Total operating costs	: $8.77 \times 10^{-3}$ R.O./KWH
	: $3.01 \times 10^{-2}$ R.O./KWH
(4) Loss:	
Station use	: 6%
Transmission loss	: 3%

\* In this report, operation and maintenance costs are not included in the capacity cost, but in the energy (or operating) cost.

\*\* 1 KW = 1,000 joule/sec.

1 kcal = 4,185.5 joule

1 KWH =  $1,000 \times 3,600 \div 4,185.5 = 860$  (kcal/hr)

Heat rate =  $860 \div 31\% = 2,774$  (kcal/KWH)

\*\*\*  $5.55 \times 10^{-2}$  \$/KWH =  $0.2 \text{ \$/\ell} \times 2,774 \text{ kcal/KWH} \div 10,000 \text{ kcal/\ell}$

### Appendix 8.14 Economic cost of alternative scheme--electricity

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Thousand R.O.
<b>(a) Capacity</b>																			
1	106	202	304	413	529	652	783	921	1,050	1,185	1,329	1,480	1,640	1,808	1,984	2,168	2,359	2,556	2,759
2	103	198	298	405	518	639	767	903	1,039	1,185	1,342	1,508	1,684	1,868	2,059	2,256	2,459	2,668	2,881
3	100	192	289	392	503	620	744	876	1,012	1,158	1,314	1,480	1,656	1,840	2,031	2,228	2,431	2,640	2,854
4	4,189	8,008	12,055	16,383	20,982	25,870	31,065	36,560	41,657	47,042	52,731	58,742	65,095	71,789	78,826	86,219	93,970	102,081	110,554
<b>(b) Energy</b>																			
1	475,898	913,345	1,376,776	1,872,470	2,399,234	2,959,055	3,554,049	4,183,412	4,767,198	5,383,898	6,035,450	6,723,916	7,451,482	8,220,152	9,030,926	9,883,804	10,777,886	11,712,162	12,686,632
2	466,380	895,078	1,349,240	1,835,021	2,351,249	2,899,873	3,482,968	4,099,744	4,671,854	5,276,220	5,914,741	6,589,438	7,302,452	8,054,819	8,847,952	9,681,862	10,557,552	11,475,008	12,435,232
3	452,388	888,236	1,308,763	1,779,970	2,280,712	2,812,877	3,378,479	3,976,752	4,531,699	5,117,933	5,737,299	6,391,755	7,083,579	7,814,864	8,586,612	9,400,322	10,257,094	11,157,928	12,092,824
4	14,929	28,651	43,189	58,739	75,265	92,825	111,490	131,233	149,546	168,892	189,331	210,928	233,751	263,229	298,046	342,229	392,804	449,800	514,564
<b>Total cost</b>																			
	19,118	36,660	55,244	75,122	96,246	118,695	142,555	167,793	191,203	215,934	242,062	269,670	298,846	310,618	329,436	348,254	367,071	385,889	404,707
<b>(a) Capacity</b>																			
1	1,698	1,698	1,522	1,430	1,341	1,161	1,073	985	897	717	628	537	360	268	268	268	268	268	268
2	1,664	1,664	1,491	1,401	1,315	1,138	1,052	965	879	702	616	526	353	263	263	263	263	263	263
3	1,614	1,614	1,446	1,359	1,275	1,104	1,020	936	852	681	597	510	342	255	255	255	255	255	255
4	67,389	67,389	60,388	56,741	53,241	46,093	42,392	39,092	35,591	28,444	24,943	21,296	14,295	10,648	10,648	10,648	10,648	10,648	10,648
<b>(b) Energy</b>																			
1	9,553,201	10,412,136	10,412,136	9,330,356	8,766,928	8,226,038	7,121,721	6,580,831	6,039,940	5,499,050	4,394,733	3,853,843	3,390,415	2,298,635	1,645,208	1,645,208	1,645,208	1,645,208	1,645,208
2	9,362,137	10,203,893	10,203,893	9,143,749	8,591,590	8,061,517	6,979,286	6,449,214	5,919,142	5,389,069	4,306,838	3,776,766	3,224,607	2,164,462	1,612,305	1,612,305	1,612,305	1,612,305	1,612,305
3	9,081,272	9,897,776	9,897,776	8,869,436	8,333,242	7,819,872	6,769,908	6,255,738	5,741,567	5,227,397	4,177,633	3,663,463	3,127,869	2,099,528	1,563,934	1,563,934	1,563,934	1,563,934	1,563,934
4	299,682	326,627	326,627	292,691	273,017	258,049	223,407	206,439	189,472	172,504	137,862	130,894	103,230	69,284	51,610	51,610	51,610	51,610	51,610
<b>Total cost</b>																			
	367,071	394,016	394,016	353,079	331,748	311,290	269,500	249,032	228,563	208,095	166,305	145,837	124,516	83,579	62,258	62,258	62,258	62,258	62,258

Appendix 8.15 Economic rate of return analysis (electricity)--comparative method

million R.O.								
Year	Project year	Capital cost	Operating cost	Operating benefit	Net benefit	Discount factor 8%	Net present value	Cumulative NPV
		(1)	(2)	(3)	(4)=(3)-(1)-(2)	(5)	(6)=(4)x(5)	(7)
1996	0	17,815			-17,815	1.00	-17,815	-15,856
1997	1	125,711			-125,711	0.93	-116,399	-132,255
1998	2	31,960	3,279	19,118	-16,122	0.86	-13,822	-146,077
1999	3	25,135	6,294	36,660	5,231	0.79	4,153	-141,924
2000	4	42,620	9,487	55,244	3,137	0.74	2,305	-139,619
2001	5	12,894	12,903	75,122	49,325	0.68	33,569	-106,049
2002	6	44,883	16,533	96,246	34,829	0.63	21,948	-84,101
2003	7	28,891	20,391	118,695	69,413	0.58	40,502	-43,599
2004	8	23,536	24,491	142,555	94,528	0.54	51,070	7,471
2005	9	46,472	28,828	167,793	92,493	0.50	46,270	53,741
2006	10	30,886	32,851	191,203	127,467	0.46	59,042	112,783
2007	11	50,370	37,100	215,934	128,463	0.43	55,096	167,879
2008	12	53,822	41,590	242,062	146,649	0.40	58,236	226,115
2009	13	25,029	46,335	269,670	198,306	0.37	72,917	299,032
2010	14	0	51,348	298,846	247,498	0.34	84,263	383,295
2011	15	0	53,368	310,618	257,250	0.32	81,096	464,391
2012	16	0	53,368	329,436	276,068	0.29	80,582	544,973
2013	17	0	53,368	348,254	294,886	0.27	79,698	624,671
2014	18	0	53,368	367,071	313,704	0.25	78,504	703,175
2015	19	0	53,368	394,016	340,648	0.23	78,932	782,108
2016	20	0	53,368	394,016	340,648	0.21	73,085	855,193
2017	21	0	53,368	394,016	340,648	0.20	67,672	922,865
2018	22	0	47,823	353,079	305,256	0.18	56,149	979,014
2019	23	0	42,163	331,758	289,595	0.17	49,322	1,028,336
2020	24	0	39,391	311,290	271,899	0.16	42,878	1,071,215
2021	25	0	36,618	269,500	232,882	0.15	34,005	1,105,220
2022	26	0	33,730	249,032	215,301	0.14	29,109	1,134,329
2023	27	0	30,958	228,563	197,605	0.13	24,738	1,159,066
2024	28	0	25,298	208,095	182,797	0.12	21,189	1,180,255
2025	29	0	22,525	166,305	143,780	0.11	15,432	1,195,687
2026	30	0	19,753	145,837	126,084	0.10	12,530	1,208,217
2027	31	0	14,093	124,516	110,423	0.09	10,161	1,218,377
2028	32	0	11,320	83,579	72,259	0.09	6,156	1,224,534
2029	33	0	5,660	62,258	56,598	0.08	4,465	1,228,999
Total		560,024	1,034,338	7,000,387	5,406,025		1,227,040	
Economic rate of return (ERR):		29%						

### Appendix 8.16 Economic rate of return analysis (water)--comparative method

Year	Demand (m <sup>3</sup> /d) (1)	Capacity requirement (m <sup>3</sup> /d) (2)=(1)×120% for peak demand	Capacity installed (m <sup>3</sup> /d) (3)	Number of new plants installed (4)	Cumulative total installed capacity (m <sup>3</sup> /d) (5)	Benefit Capital cost (6)=(3)×@12 million R.O.	Cost (7)	Net benefit (8)=(6)-(7)	Discount factor 8% (9)	Net present value (10)=(8)×(9)	Cumulative NPV (11)	million R.O.
1996								1.86	-2	-2	-2	0
1997								19.24	-19	-18	-18	-18
1998								80.76	-45	-38	-38	-56
1999	10,131	12,157	13,650	3	13,650	36	0.00	0.00	0.79	29	-28	-28
2000	20,224	24,269	13,650	3	27,300	48	6.00	6.00	0.74	31	3	3
2001	34,999	41,999	18,200	4	45,500	48	38.66	38.66	0.68	6	10	10
2002	50,500	60,600	18,200	4	63,700	48	0.00	0.00	0.63	30	40	40
2003	66,764	80,117	18,200	4	81,900	60	0.00	0.00	0.58	35	75	75
2004	83,829	100,595	22,750	5	104,650	48	0.00	0.00	0.54	23	98	98
2005	100,525	120,630	18,200	4	122,850	48	38.66	38.66	0.50	5	102	102
2006	115,089	138,107	18,200	4	141,050	48	0.00	0.00	0.46	22	124	124
2007	130,298	156,357	18,200	4	159,250	48	6.00	6.00	0.43	18	142	142
2008	146,183	175,420	18,200	4	177,450	48	38.66	38.66	0.40	4	146	146
2009	162,779	195,335	18,200	4	195,650	60	0.00	0.00	0.37	22	168	168
2010	180,122	216,147	22,750	5	218,400	0	0.00	0.00	0.34	0	168	168
Total	1,101,445	1,321,734	218,400	48	1,351,350	576	236	340	9	166	975	975

Economic internal rate of return (EIRR):

46.01%

Note: Assume that the disbursement of the capital cost is made one year earlier, as the construction of plants is completed one year earlier.











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