

APPENDIX J
FACILITY PLAN

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As described in Chapter 5, detailed data and design calculations are showed here. The contents are as follows;

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APPENDIX J FACILITY PLAN

1 HYDRAULIC CALCULATION FOR GYOBYU PUMPING STATION

1.1 CASE-1 GYOBYU TO YEGU P/S

1. Design Flow

$$26 \text{ MGD} = 118,170 \text{ m}^3/\text{day} = 82.06 \text{ m}^3/\text{min} = 1.37 \text{ m}^3/\text{sec}$$

2. Necessary Pump Head

Friction loss will be calculated based on "Hazen - Williams Formula";

$$H = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$$

where;

H : Friction Loss Head (m)

C : Velocity Coefficient (=88 : Existing Pipe)

D : Inner Pipe Diameter (m) 1.4

Q : Flow Rate (m³/sec) = 1.37

L : Pipe Length (m) = 64,000 (to Yegu P/S)

Parameter	C	D	Q	L	H	ΣH
Dimension	None	m	m ³ /sec	m	m	m
Gyobyu	88	1.4	1.37	64,000	59.8	

$$\text{Thus, } H = 59.8 \text{ m} = 196.26 \text{ ft}$$

Natural Water Head is;

$$\begin{array}{rcl} \text{LWL of Reservoir} & 173.35 & \text{(by hydrological calculation)} \\ + & 13.7 & \text{(Pump Head)} \\ = & 218.3 & \text{ft} \end{array}$$

Remaining water head is;

$$H_R = 22.0 \text{ ft} > 19.34 \text{ ft : HWL of Yegu P/S}$$

OK

Necessary Pump No.

Design Flow	118,170	m ³ /day
Pump Capacity	3,310	m ³ /hr
Pump Efficiency	65	% (Estimated pump efficiency of existing pumps manufactured in 1962)
Pump Number	2.29	say 3 units on duty
		(Number of existing pumps is three so, No stand-by pump can be secured)

There are three pumps in Gyobyu P/S and currently, only two pumps are operated. This is because YCDC seldom operated the P/S owing to the frequent power failure and to preserve the water level of Gyobyu reservoir in high level, say around + 190 ft above mean

However, same to the other existing reservoirs, Gyobyu reservoir water must be fully optimized to relieve the current water shortage and thus, pumps will be fully operated

According to the project implementation schedule, replacement of the existing three pumps in Gyobyu P/S is planned on 2004 and proposed Terminal Reservoir will be constructed in 2006.

After the completion of Terminal Reservoir, Gyobyu water shall be pumped to this reservoir. Thus, Gyobyu P/S will pump reservoir water to Yegu P/S with the existing equipment until 2003, rehabilitated in 2004 and water will be converted to Terminal Reservoir from 2006.

Calculation of possible pump flow by the existing pumps

One stand-by pump must be secured to cope with machine accident and thus, duty pump number is two.

Pump Capacity	3,310	m ³ /hr	
Pump Efficiency	65	%	
Pump Number	2		
Pump Flow	4,303	m ³ /hr =	103,272 m ³ /day

1.2 CASE-2 GYOBYU TO TERMINAL RESERVOIR (HLAWGA WTP)

(1) Design Flow

$$26 \text{ MGD} = 118,170 \text{ m}^3/\text{day} = 82.06 \text{ m}^3/\text{min} = 1.37 \text{ m}^3/\text{sec}$$

(2) Necessary Pump Head

Friction loss will be calculated based on "Hazen - Williams Formula";

$$H = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$$

where;

- H : Friction Loss Head (m)
- C : Velocity Coefficient (=88 : Existing Pipe, =120 : New Pipe)
- D : Inner Pipe Diameter (m) 1.4
- Q : Flow Rate (m³/sec) = 1.37
- L : Pipe Length (m) = 50,680 (to Proposed Terminal Reservoir)
1,900 (Connection Pipe)

Parameter	C	D	Q	L	H	ΣH
Dimension	None	m	m ³ /sec	m	m	m
Gyobyu	88	1.4	1.37	50,680	47.4	
	120	1.4	1.37	2,950	1.6	
				Total	48.9	

Thus, H = 48.9 m = 160.51 ft

By Gravity Flow

Necessary Natural Water Head is;

HWL of Reservoir 36.00 ft = 11 m

Water level in Gyobyu reservoir must be greater than;

$$W_L = 196.5 \text{ ft} \\ 173.35 \text{ (LWL by hydrological calculation)}$$

Water must be supplied to the proposed Terminal Reservoir constantly through a year and thus, supply by "gravity flow" is not applicable.

By Pumps

Natural Water Head is;

$$\begin{array}{rcl} \text{LWL of Reservoir} & 173.35 & \text{(by hydrological calculation)} \\ + & 13.7 & \text{(Pump Head)} \\ = & 218.3 & \text{ft} \end{array} = 44.95 \text{ ft}$$

Remaining water head is;

$$H_R = 57.8 \text{ ft} > 36 \text{ ft : design HWL of proposed Terminal Reservoir}$$

OK

Necessary Pump No.

Design Flow	118,170	m ³ /day
Pump Capacity	3,310	m ³ /hr
Pump Efficiency	65	% (Estimated pump efficiency of existing pumps manufactured in 1962)
Pump Number	2.29	say 3 units on duty

(Number of existing pumps is three so, No stand-by pump can be secured)

The existing three pumps including electric equipment have already been deteriorated and need immediate replacement.

In case of new pumps, 85% of pump efficiency can be expected and necessary duty pump number is;

Design Flow	118,170	m ³ /day
Pump Capacity	3,310	m ³ /hr
Pump Efficiency	85	%
Pump Number	1.75	say 2 units on duty

If three pumps are replaced, two pumps can be operated as "duty pump" and remaining one will be used as "stand-by".

2 NECESSARY PUMP NUMBER IN PHUGYI PUMPING STATION

1. Design Flow

$$54 \text{ MGD} = 245,430 \text{ m}^3/\text{day} = 170.44 \text{ m}^3/\text{min} = 2.84 \text{ m}^3/\text{sec}$$

2. Necessary Pump Number

Design Flow	245,430	m ³ /day	
Pump Capacity	5,160	m ³ /hr	
Pump Efficiency	80	%	
Pump Number	2.48		say 3 units on duty

Now there are 3 existing pumps in Phugyi P/S and they are operated alternatively.

The average pumping amount is around 50 MGD.

However, the design flow of 54 MGD is average intake amount and during rainy season, intake amount will be increased to minimize overflow amount from spilway. By hydrological calculation, possible intake peak factor was estimated at 1.2 and thus;

Necessary Pump No.

Design Flow	294,520	m ³ /day	(245,430 x 1.2)
Pump Capacity	5,160	m ³ /hr	
Pump Efficiency	80	%	
Pump Number	2.97		say 3 units on duty

So, the existing three pumps must be operated almost 24 hour/day.

At least one pump must be secured as "stand-by" to cope with accidental case.

Therefore, additional one (1) pump is needed to secure stable water supply to Hlawga Reservoir.

3 PUMP AND MOTOR SPECIFICATION OF TRANSMISSION PUMPS

Parameter	C	D	Q	L	H	ΣH
Dimension	None	m	m ³ /sec	m	m	m
Terminal Reservoir to Kokine Service Reservoir						
Existing 66'	110	1.65	2.16	16,200	10.5	
Existing 42'	85	1.05	2.16	3,200	30.1	
New 56'	120	1.4	2.16	1,350	1.7	42.3
Existing 56'	85	1.4	2.07	19,600	42.0	
Existing 42'	85	1.05	0.99	18,600	41.4	
Natural Water Head	from	to	Head (ft)	Head (m)	Allowance (m)	Total H (m)
	36	140	104	31.7	5.0	79.0
						79.0
Design Pumping Volume	423,000	m ³ /day =	293.75	m ³ /min		
Pump Number	4	units				
Pump Discharge by unit	73.44	m ³ /min =	80	m ³ /min		
Motor Out-put	1,122	kW =	1,150	kW		
Terminal Reservoir to CB Hlawga Service Reservoir						
New Pipe	120	2.2	6.4	3,900	3.9	
Natural Water Head	from	to	Head (ft)	Head (m)	Allowance (m)	Total H (m)
	36	127	91	27.7	5.0	36.7
						38.0
Design Pumping Volume	553,000	m ³ /day =	384.03	m ³ /min		
Pump Number	5	units				
Pump Discharge by unit	76.81	m ³ /min				
Motor Out-put	616	kW =	640	kW		
Terminal Reservoir to CB West Service Reservoir						
New Pipe	120	2.7	8.76	7,500	5.0	
Natural Water Head	from	to	Head (ft)	Head (m)	Allowance (m)	Total H (m)
	36	118	82	25.0	5.0	35.0
						38.0
Design Pumping Volume	757,000	m ³ /day =	525.69	m ³ /min		
Pump Number	7	units				
Pump Discharge by unit	75.10	m ³ /min				
Motor Out-put	602	kW =	640	kW		

Parameter	C	D	Q	L	H	ΣH
Dimension	None	m	m ³ /sec	m	m	m
Ngamoeyeik P/S to Hlawga Reservoir (Case 1)						
						Not Applicable
New Pipe	120	1.8	4.73	30,750	47.3	
Existing Pipe	120	1.4	4.73	13,280	69.4	116.7
Ngamoeyeik P/S to Hlawga Reservoir (Case 2)						
New Pipe	120	1.8	4.73	30,750	47.3	
New Pipe	120	1.1	1.64	13,280	31.7	Double Pipe
Existing Pipe	120	1.4	3.09	13,280	31.6	
						78.9
Natural Water Head	from	to	Head (ft)	Head (m)	Allowance (m)	Total H (m)
	81	62	-19	-5.8	5.0	78.2
						78.0
Design Pumping Volume	409,050	m ³ /day =	284.06	m ³ /min		
Pump Number	4	units				
Pump Discharge by unit	71.02	m ³ /min				
Motor Out-put	1,168	kW =	1,200	kW		

4 PUMP AND MOTOR SPECIFICATION OF DISTRIBUTION PUMPS

Parameter	C	D	Q	L	H	ΣH
Dimension	None	m	m ³ /sec	m	m	m
CB Down Town East Service Reservoir						
						Pump Head (m)
						27.0
Design Pumping Volume	456,400	m ³ /day =	316.94	m ³ /min		
Pump Number	2	units				
Pump Discharge by unit	158.47	m ³ /min				
Motor Out-put	903	kW =	900	kW		
East Block South Service Reservoir						
						Pump Head (m)
						24.0
Design Pumping Volume	203,000	m ³ /day =	140.97	m ³ /min		
Pump Number	2	units				
Pump Discharge by unit	70.49	m ³ /min				
Motor Out-put	357	kW =	350	kW		
East Block Central Service Reservoir						
						Pump Head (m)
						24.0
Design Pumping Volume	186,200	m ³ /day =	129.31	m ³ /min		
Pump Number	2	units				
Pump Discharge by unit	64.65	m ³ /min				
Motor Out-put	327	kW =	350	kW		
East Block North Service Reservoir						
						Pump Head (m)
						27.0
Design Pumping Volume	86,800	m ³ /day =	60.28	m ³ /min		
Pump Number	1	units				
Pump Discharge by unit	60.28	m ³ /min				
Motor Out-put	343	kW =	350	kW		
West Block South Service Reservoir						
						Pump Head (m)
						24.0
Design Pumping Volume	35,000	m ³ /day =	24.31	m ³ /min		
Pump Number	1	units				
Pump Discharge by unit	24.31	m ³ /min				
Motor Out-put	123	kW =	125	kW		

Parameter	C	D	Q	L	H	ΣH
Dimension	None	m	m ³ /sec	m	m	m
West Block Central Service Reservoir						
						Pump Head (m)
						27.0
Design Pumping Volume	33,600	m ³ /day =	23.33	m ³ /min		
Pump Number	1	units				
Pump Discharge by unit	23.33	m ³ /min				
Motor Out-put	133	kW =	140	kW		
West Block North Service Reservoir						
						Pump Head (m)
						27.0
Design Pumping Volume	135,800	m ³ /day =	94.31	m ³ /min		
Pump Number	1	units				
Pump Discharge by unit	94.31	m ³ /min				
Motor Out-put	537	kW =	550	kW		

5 LIST OF TRANSMISSION PUMPS

Pump Location	Name of Pump	Total Discharge per P/S (m ³ /day)	Discharge/unit	Head (m)	Motor Output (kW)	No. of Units*	Remarks
Gyobyu P/S	Transmission	118,200 (26 MGD)	3,310 m ³ /hr	13.7	184	3	Existing three pumps including electric equipment will be refurbished
Phugyi P/S	Transmission	245,400 (54 MGD)	5,160 m ³ /hr	24	450	1	One additional pump equivalent to the specification of existing ones
Terminal Res to Kokine S Res	Transmission	423,000	80 m ³ /min	79	1,150	5 (1)	
Terminal Res to CB Hlawga S Res	Transmission	553,000	80 m ³ /min	38	640	6 (1)	
Terminal Res to CB West S Res	Transmission	757,000	80 m ³ /min	38	640	8 (1)	
Ngamoeyeik P/S	Transmission	409,000 (90 MGD)	71 m ³ /min	78	1,200	5 (1)	
Hlaing WTP	Intake Pump	981,500	115 m ³ /min	30	750	7 (1)	
	Transmission	940,000	85 m ³ /min	55	1,150	9 (1)	

6 (1) = Total 6 units, including 1 unit as stand-by

6 LIST OF DISTRIBUTION PUMPS

Pump Location	No.	Name of Pump	Total Discharge (m ³ /day)	Discharge/unit (m ³ /min)	Head (m)	Motor Output (kW)	No. of Units*	Remarks
CB Down Town East		Distribution	456,400	158.00	27	900	3 (1)	
East Block South		Distribution	203,000	70.00	24	350	3 (1)	
East Block Central		Distribution	186,200	64.65	24	350	3 (1)	
East Block North		Distribution	86,800	60.28	27	350	2 (1)	
South Block South	Dala	Distribution	35,000	24.31	24	125	2 (1)	
South Block Central	SK+KY	Distribution	33,600	23.33	27	140	2 (1)	
South Block North	HT	Distribution	135,800	94.31	27	550	2 (1)	

Note) 3 (1) = Total 3 units, including 1 unit as stand-by

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7 CAPACITY CALCULATION FOR HLAING W.T.P

Total Capacity = 940,000 cu m/day

Item	Phase 1		Phase 2(total)	
	Total 470,000cu m/day (235,000cu m/day x 2units)		Total 940,000cu m/day (235,000cu m/day x 4units)	
Plant Capacity	Daily Max	470,000 cu m/day	Daily Max	940,000 cu m/day
Planned Flow	Daily Max	493,500 cu m/day 20,563 cu m/hour 342.7 cu m/min 5.712 cu m/sec	Daily Max	987,000 cu m/day 41,125 cu m/hour 685.4 cu m/min 11.424 cu m/sec
1.Intake Facilities	987000 cu m/day			
(1) Grit Chamber				
Design Criteria	Retention Time	T = 10 - 20 min		
	Surface Load	a = 200 - 500 mm/min		
	Hor. Flow Velocity	v < 2 - 7 cm/sec		
	L/W Ratio	L/W = 3 - 8 times		
	Depth	D = 3 - 4 m		
	Depth of 0.5m or 1.0m is provided for sludge settlement.			
Dimension	No.	4 basins	the same to the left	
	W m x L m	x D m x N units		
	42 x 14	3.0 x 4		
Volume	V =	1,764 cu m/basin		
Retention Time	T =	10.3 min		
L/W Ratio	L/W =	3.0 times		
Surface Load	a =	0 mm/min		
Hor. Flow Velocity	v =	0.0 cm/sec		
2.WTP Facilities				
(1) Receiving Well-A	493,500 cu m/day		987,000 cu m/day	
Criteria	Retention Time	T > 1 - 5 min	Retention Time	T > 1 - 5 min
Dimension	Rectangular	1 units	Rectangular	2 units
	L m x W m	x D m x N units	L m x W m	x D m x N units
	10.0 x 6.0	6.0 x 1.0	10.0 x 6.0	6.0 x 2.0
Unit Volume	UV =	360.0 cu m/unit	UV =	360.0 cu m/unit
	V =	360.0 cu m	V =	720.0 cu m
	T =	1.1 min	T =	1.1 min
	Gravity Mixing		Gravity Mixing	
(2) Flocculation Basin	493,500 cu m/day		987,000 cu m/day	
Type				
Criteria	Retention Time	T = 20 - 40 min	Retention Time	T = 20 - 40 min
	Required Volume	V = 6,854 cu.m to 13,708 cu.m	Required Volume	V = 13,708 cu.m to 27,417 cu.m
Unit Flow	q =	28.6 cu m/min/basin	q =	28.6 cu m/min/basin
Dimension	12 units		24 units	
Step 1	L m x W m	x D m x No.of Channel	L m x W m	x D m x No.of Channel
	22.0 x 1.3	3.3 x 2	22.0 x 1.3	3.3 x 2
Step 2	L m x W m	x D m x No.of Channel	L m x W m	x D m x No.of Channel
	22.0 x 1.8	3.3 x 2	22.0 x 1.8	3.3 x 2
Step 3	L m x W m	x D m x No.of Channel	L m x W m	x D m x No.of Channel
	22.0 x 2.4	3.3 x 2	22.0 x 2.4	3.3 x 2
Volume	Step 1	188.8 cu m/unit	Step 1	188.8 cu m/unit
	Step 2	261.4 cu m/unit	Step 2	261.4 cu m/unit
	Step 3	348.5 cu m/unit	Step 3	348.5 cu m/unit
	Volume / Unit	798.6 cu m/unit	Volume / Unit	798.6 cu m/unit
Total Volume	V =	9,583 cu m	V =	19,166 cu m
Retention Time	T =	28.0 min	T =	28.0 min

Item	Phase 1		Phase 2 (total)	
	Total 470,000cu m/day (235,000cu m/day x 2units)		Total 940,000cu m/day (235,000cu m/day x 4units)	
(3) Sedimentation Basin	493,500 cu m/day		987,000 cu m/day	
Type	Rectangular, Horizontal Flow		Rectangular, Horizontal Flow	
Unit Flow	q = 1,714 cu m/hr/basin		q = 1,714 cu m/hr/basin	
Criteria	Retention Time T = 2.5-4 hours	Surface Load a = 15-30 mm/min	Hor. Flow Velocity v < 0.40 m/min	L/W Ratio L/W = 3-8 times
	Depth D = 3-4 m	Depth of 30 cm or more is provided for sludge settlement.		
Dimension	No. 12 basins	W m x L m x D m x N units	No. 24 basins	W m x L m x D m x N units
	22 80 3.8 12		22 80 3.8 24	
Volume	V = 6,688 cu m/basin		V = 6,688 cu m/basin	
Retention Time	T = 3.9 hours		T = 3.9 hours	
L/W Ratio	L/W = 3.6		L/W = 3.6	
Surface Load	a = 16.2 mm/min		a = 16.2 mm/min	
Hor. Flow Velocity	v = 0.34 m/min		v = 0.34 m/min	
Overflow Weir	Load = 350 m ³ /m/day		Load = 350 m ³ /m/day	
Trough Length	L = 118 m or longer		L = 118 m or longer	
	No. 14 troughs	L m x N units	No. 28 troughs	L m x N units
	4.4 14		4.4 28	
	L = 123.2 m		L = 246.4 m	
Sludge Removal	Cable-operated underwater bogie sludge collector or Travelling bridge sludge collector		Cable-operated underwater bogie sludge collector or Travelling bridge sludge collector	
Sludge Amount Solid Amount (ton-DS)	$So = Q * (K * (T1 - T2) + B * C * 156 / 102) * 10^{-6}$ where So: Sludge dry weight (ton) Q: Treated water amount (m ³ /d) K: Coefficient converting turbidity to SS (0.8-1.5 -> 1.2) T1: Turbidity in raw water (ave = 154) T2: Turbidity after Sedimentation (ave = 5) B: Alum dosage rate (ave = 50) $B = 4 + 2 * (T1)^{0.5} = 28.8$ C: Concentration of AL ₂ O ₃ (8%)		$So = Q * (K * (T1 - T2) + B * C * 156 / 102) * 10^{-6}$ where So: Sludge dry weight (ton) Q: Treated water amount (m ³ /d) K: Coefficient converting turbidity to SS (0.8-1.5 -> 1.2) T1: Turbidity in raw water (ave = 154) T2: Turbidity after Sedimentation (ave = 5) B: Alum dosage rate (ave = 50) $B = 4 + 2 * (T1)^{0.5} = 28.8$ C: Concentration of AL ₂ O ₃ (8%)	
	So = 91.26 ton-DS/day		So = 182.51 ton-DS/day	
	Water Contents of Drained Sludge (with wash-out water) w = 99.0 %		Water Contents of Drained Sludge (with wash-out water) w = 99.0 %	
	Frequency of Cleaning : Continuous		Frequency of Cleaning : Continuous	
Sludge Volume	Total v = 9,126 cu.m/day	So = 91.26 ton-DS/day	Total v = 18,251 cu.m/day	So = 182.51 ton-DS/day

Item	Phase 1		Phase 2(total)	
	Total 470,000cu m ³ /day (235,000cu m ³ /day x 2units)		Total 940,000cu m ³ /day (235,000cu m ³ /day x 4units)	
(4) Rapid Sand Filter	493,500 cu m ³ /day		987,000 cu m ³ /day	
Type	Down Flow, Single Media		Down Flow, Single Media	
No.	44 units	4 stand by	88 units	8 stand by
Unit Flow	q = 11,216 cu m ³ /day/unit		q = 11,216 cu m ³ /day/unit	
Criteria	Filtration Rate	Fr = 120 - 150 m ³ /day = 5.0 - 6.25 m ³ /hour	Filtration Rate	Fr = 120 - 150 m ³ /day = 5.0 - 6.25 m ³ /hour
	Filter Area per Unit	A < 90 sq m	Filter Area per Unit	A < 90 sq m
Dimension	W m x L m x N units	5.8 14.8 44 40 4 stand by	W m x L m x N units	5.8 14.8 88 80 8 stand by
	A =	85.8 sq m/unit	A =	85.8 sq m/unit
Filtration Rate	Fr =	130.7 m ³ /day	Fr =	130.7 m ³ /day
Filtration Rate during washing	Fr' =	143.7 m ³ /day 4 units out of 40units /2days = 20 units are washing	Fr' =	143.7 m ³ /day 8 units out of 88units /2days = 40 units are washing
Filters for Backwashing	Once a day for each filter		Once a day for each filter	
Filter Washing Frequency	Once a day for each filter		Once a day for each filter	
Rate	Surface Washing	rate = 0.20 m ³ /m ² /min duration = 6 min	Surface Washing	rate = 0.20 m ³ /m ² /min duration = 6 min
	Backwashing	rate = 0.70 m ³ /m ² /min duration = 8 min	Backwashing	rate = 0.70 m ³ /m ² /min duration = 8 min
Water Amount for washing	Surface Washing	Vs = 103.0 cu m/unit	Surface Washing	Vs = 103.0 cu m/unit
	Backwashing	Vb = 480.7 cu m/unit	Backwashing	Vb = 480.7 cu m/unit
		Vs + Vb = 583.7 cu m/unit		Vs + Vb = 583.7 cu m/unit
for Total Units	Total Amount for Washing	25,683 cu m ³ /day	Total Amount for Washing	51,367 cu m ³ /day
	Percentage for Planned Flow	5.2 %	Percentage for Planned Flow	5.2 %
Solid Amount in Wastewater (ton-DS)	So = Q*K*(T1-T2)*10 ⁻⁶ where So:Sludge dry weight(ton) Q :Treated water amount(m ³ /d) K :Coefficient converting turbidity to SS (0.8-1.5 ->1.2) T1 :Turbidity before filter(ave = 5 T2 :Turbidity after filter(ave = 1		So = Q*K*(T1-T2)*10 ⁻⁶ where So:Sludge dry weight(ton) Q :Treated water amount(m ³ /d) K :Coefficient converting turbidity to SS (0.8-1.5 ->1.2) T1 :Turbidity before filter(ave = 5 T2 :Turbidity after filter(ave = 1	
	So =	2.37 ton-DS/day	So =	4.74 ton-DS/day
SS Contents	s =	92 mg/l	s =	92 mg/l

Item	Phase 1		Phase 2 (total)	
	Total 470,000 cu m/day (235,000 cu m/day x 2 units)		Total 940,000 cu m/day (235,000 cu m/day x 4 units)	
(5) Chlorination Mixing Channel	470,000 cu m/day		987,000 cu m/day	
Location	at the Inlet of the Clear Water Reservoir		at the Inlet of the Clear Water Reservoir	
Criteria	Contact Time T > 2 minutes		Contact Time T > 2 minutes	
Required Volume	V = 653 cu m		V = 1306 cu m	
Dimension	No. 2 units L m x W m x D m x N units 36.0 6.0 3.0 2		No. 4 units L m x W m x D m x N units 36.0 6.0 3.0 4	
Total Volume	v = 1,296 cu m		v = 2,592 cu m	
Retention Time	t = 2.0 min		t = 2.0 min	
(6) Clear Water Reservoir	470,000 cu m/day		987,000 cu m/day	
Criteria	Retention Time T > 1 hours		Retention Time T > 1 hours	
Required Volume	V = 19,583 cu m		V = 39,167 cu m	
Dimension	No. 2 units L m x W m x D m x N units 84.0 42.0 3.0 2		No. 4 units L m x W m x D m x N units 84.0 42.0 3.0 4	
Total Volume	V = 21,168 cu m		V = 42,336 cu m	
Retention Time	T = 1.08 hours		T = 1.03 hours	
(7) Backwash Water Storage Tank	470,000 cu m/day		987,000 cu m/day	
Retention Time	1 hours		1 hours	
Backwash Water	Vs + Vb = 584 cu.m/filter unit		Vs + Vb = 584 cu.m/filter unit	
Required Volume	2 filters 1,167 cu.m		2 filters 1,167 cu.m	
No.	N = 2 units one Stand-by		N = 4 units one Stand-by	
Dimension	L m x W m x D m x N units 36.0 12.0 3.0 1		L m x W m x D m x N units 36.0 12.0 3.0 3	
Total Volume	v = 1,296 cu m		v = 3,888 cu m	
Frequency of Wash	Once a day = 20 filters/day		Once a day = 40 filters/day	
8. Sludge Lagoon	470,000 cu m/day		987,000 cu m/day	
Water Contents of Drain Sludge	W = 99.0 %		W = 99.0 %	
Sludge Amount	v = 9,363 cu.m/day So = 93.6 ton-DS/day		v = 18,725 cu.m/day So = 187.3 ton-DS/day	
Sludge Amount(6 months)	Q = 17,087 ton-DS for all Sed.Basin and Filter		Q = 34,173 ton-DS for all Sed.Basin and Filter	
Drying Period	for 1.5 years 65 %		for 1.5 years 65 %	
Dried Volume	v = 48,819 cu m < 51,840 cu m		v = 97,638 cu m < 51,840 cu m	
Dimension	Rectangular 3 L m x W m x D m x N units 180.0 48.0 3.0 3		Rectangular 6 L m x W m x D m x N units 180.0 48.0 3.0 6	
Volume	v = 77,760 cu m		v = 155,520 cu m	

Alum - Specific Gravity (% as Al ₂ (SO ₄) ₃ -18H ₂ O)		Lime - Specific Gravity (% as Ca (OH) ₂)		Alum - Specific Gravity (% as Al ₂ (SO ₄) ₃ -18H ₂ O)		Lime - Specific Gravity (% as Ca (OH) ₂)	
5	1.0254	5	1.0308	5	1.0254	5	1.0308
10	1.0525	10	1.0607	10	1.0525	10	1.0607
15	1.0804	15	1.0923	15	1.0804	15	1.0923

8 CAPACITY CALCULATION FOR FLWGA W.T.P

Total Capacity = 820,000 cu m/day

Item	Phase 1		Phase 2 (total)	
	Total 820,000 cu m/day		Total 820,000 cu m/day (205,000 cu m/day x 4 units)	
Plant Capacity	Daily Max	820,000 cu m/day	Daily Max	820,000 cu m/day
Planned Flow	Daily Max	861,000 cu m/day 35,875 cu m/hour 597.9 cu m/min 9.965 cu m/sec	Daily Max	861,000 cu m/day 35,875 cu m/hour 597.9 cu m/min 9.965 cu m/sec
1.(1) Receiving Well-A	861,000 cu m/day			
Criteria	Retention Time	T >	1 - 5 min	
Dimension	Circular	1 units		the same to the left
	DIA m	x Dm	x Nm	
	36.0	3.0	1.0	
	V=	3052.1 cu m		
	T=	5.1 min		
1.(2) Receiving Well-B	1,760,000 cu m/day			
Criteria	Retention Time	T >	1 - 5 min	
Dimension	Rectangular	1 units		the same to the left
	L m	x Wm	x Dm	
	30.0	14.0	6.0	
Unit Volume	UV =	2520.0 cu m/unit		
	V =	2520.0 cu m		
	T =	2.1 min		
	Gravity Mixing			
1.(3) Receiving Well-C	861,000 cu m/day			
Criteria	Retention Time	T >	1 - 5 min	
Dimension	Rectangular	2 units		the same to the left
	L m	x Wm	x Dm	
	16.0	8.0	6.0	
Unit Volume	UV =	768.0 cu m/unit		
	V =	1536.0 cu m		
	T =	2.6 min		
	Gravity Mixing			
2. Rapid Sand Filter	861,000 cu m/day			
Type	Down Flow, Single Media			
No.	112 units		8 stand by	
Unit Flow	q = 7,688 cu m/day/unit			
Design Criteria	Filtration Rate	Fr =	80-100 m/day	
		=	3.3-4.2 m/hour	
	Filter Area per Unit	A <	90 sq m	
Dimension	W m	x L m	x N units	
	5.8	14.8	112	
			104	8 stand by
	A =	85.8 sq m/unit		
Filtration Rate	Fr =	89.6 m/day		
Filtration Rate during washing	Fr' =	96.4 m/day		
Filters for Backwashing	8 units out of 104 units / 2 days = 52 units are washing			
Filter Washing Frequency	Once a day for each filter			
Rate	Surface Washing	rate =	0.20 m ³ /m ² /min	
		duration =	6 min	
	Backwashing	rate =	0.70 m ³ /m ² /min	
		duration =	8 min	
Water Amount for washing	Surface Washing	Vs =	103.0 cu m/unit	
	Backwashing	Vb =	480.7 cu m/unit	
		Vs + Vb =	583.7 cu m/unit	

Item	Phase 1	Phase 2 (total)
	Total 820,000 cu m/day	Total 820,000 cu m/day (205,000 cu m/day x 4 units)
for Total Units		Total Amount for Washing 32,688 cu m/day Percentage for Planned Flow 3.80 %
Solid Amount in Wastewater (ton-DS)		So = Q * K * (T1 - T2) * 10 ⁻⁶ where So: Sludge dry weight (ton) Q: Treated water amount (m ³ /d) K: Coefficient converting turbidity to SS (0.8-1.5 -> 1.2) T1: Turbidity before filter (ave =) T2: Turbidity after filter (ave =)
SS Contents		So = 4.13 ton-DS/day s = 126 mg/l
3. Chlorination Mixing Channel	1,760,000 cu m/day	1,760,000 cu m/day
Location Criteria	at the Inlet of the Clear Water Reservoir Contact Time T > 2 minutes	at the Inlet of the Clear Water Reservoir Contact Time T > 2 minutes
Required Volume	V = 2444 cu m	V = 2444 cu m
Dimension	No. 6 units L m x W m x D m x N units 36.0 6.0 3.0 6	No. 8 units L m x W m x D m x N units 36.0 6.0 3.0 8
Total Volume	v = 3,888 cu m	v = 5,184 cu m
Retention Time	t = 1.6 min	t = 2.1 min
4. Clear Water Reservoir	1,760,000 cu m/day	1,760,000 cu m/day
Criteria	Retention Time T > 1 hours	Retention Time T > 1 hours
Required Volume	V = 73,333 cu m	V = 73,333 cu m
Dimension	No. 6 units L m x W m x D m x N units 84.0 42.0 3.0 6	No. 8 units L m x W m x D m x N units 84.0 42.0 3.0 8
Total Volume	V = 63,504 cu m	V = 84,672 cu m
Retention Time	T = 0.87 hours	T = 1.15 hours
5. Backwash Water Storage Tank		1,760,000 cu m/day
Retention Time		1 hours
Backwash Water		V _s + V _b = 584 cu m/filter unit
Required Volume		4 filters 2,335 cu m
No.		N = 2 units one Stand-by
Dimension		L m x W m x D m x N units 50.0 16.0 3.0 1
Total Volume		v = 2,400 cu m
Frequency of Wash		Once a day = 52 filters/day
6. Sludge Lagoon	1,760,000 cu m/day	1,760,000 cu m/day
Water Contents of Drain Sludge	W = 99.0 %	W = 99.0 %
Sludge Amount	So = 0.0 ton-DS/day	So = 4.1 ton-DS/day
Sludge Amount (6 months)	Q = 0 ton-DS for all Sed. Basin and Filter	Q = 754 ton-DS for all Sed. Basin and Filter
Drying Period	for 1.5 year 65 %	for 1.5 year 65 %
Dryed Volume	v = 0 cu m < 4,315 cu m	v = 2,155 cu m < 4,315 cu m
Dimension	Rectangular 1 L m x W m x D m x N units 48.0 29.0 3.1 1	Rectangular 3 L m x W m x D m x N units 48.0 29.0 3.1 3
Volume	v = 4,315 cu m	v = 12,946 cu m

**9 Water Balance
(Summary)**

Items	unit	2000	2005	2010	2015	2020	Remarks
Water Demand	m ³ /day	615,100	1,080,300	1,466,000	1,792,100	1,912,700	Daily Maximum
Reservoirs (Total)	m ³ /day	395,500	847,600	847,600	847,600		
Gyobyu	m ³ /day	93,200	118,200	118,200	118,200		20.5 to 26 MGD
Phugyi	m ³ /day	227,300	245,400	245,400	245,400	Diverted to	50 to 54 MGD
Hlawga	m ³ /day	75,000	75,000	75,000	75,000	Hlawga WTP	16.5 MGD
Ngamoeyeik	m ³ /day	0	409,000	409,000	409,000		90 MGD
Groundwater (Total)	m ³ /day	43,900	66,600	132,300	158,200	161,600	
Left Bank	m ³ /day	41,700	64,700	54,400	39,200	33,600	
Rigt Bank (Total)	m ³ /day	2,200	1,900	77,900	119,000	128,000	
Hlaingthaya	m ³ /day	200	200	76,400	78,600	79,000	
KY + SK	m ³ /day	0	0	0	20,200	24,500	
Dala	m ³ /day	2,000	1,700	1,500	20,200	24,500	
Hlaing WTP							
Implementation Phasing		0	0	50%	50%	100%	
Treated Water Amount	m ³ /day	0	0	470,000	470,000	940,000	
Hlawga WTP	m ³ /day	0	0	0	0	820,000	
Total Available Water Amount	m ³ /day	439,400	914,200	1,449,900	1,475,800	1,921,600	
Water Balance	m ³ /day	-175,700	-166,100	-16,100	-316,300	8,900	

(Groundwater)

	2000	2005	2010	2015	2020	Remarks
Right Bank (m ³ /day)	2,246	1,920	77,865	118,908	128,051	GW Total
Hlaingthaya	0	0	75,748	96,035	97,006	Water deamand including Industry
Well Production	219	188	76,378	78,558	78,989	
No.of well newly drilled	0	0	59	10	9	
Sub-total of well No.	0	0	59	69	78	
SW Introduction	0	0	0	0	18,017	
KY + SK	1,956	7,418	14,449	20,125	23,645	Water Demand
Well Production	0	0	0	20,175	24,531	
No.of well newly drilled	0	0	0	15	6	
Sub-total of well No.	0	0	0	15	21	
Dala	2,150	7,841	12,994	19,495	24,515	Water Demand
Well Production	2,027	1,732	1,487	20,175	24,531	
No.of well newly drilled	0	0	0	15	6	
Sub-total of well No.	0	0	0	15	21	
No.of well newly drilled	0	0	59	40	21	Total of Right Bank
Sub-total of well No.	0	0	59	99	120	
Left Bank						
MCM/Y	15.20	23.62	19.84	14.29	12.27	
m ³ /day	41,644	64,712	54,356	39,151	33,616	
Total	43,890	66,632	132,221	158,059	161,667	GW Total

APPENDIX K
**INSTITUTION
AND
ORGANIZATIONS
FOR SYSTEM
MANAGEMENT**

APPNDIX K INSTITUTION AND ORGANIZATIONS FOR SYSTEM MANAGEMENT

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APPENDIX K INSTITUTION AND ORGANIZATIONS FOR SYSTEM MANAGEMENT

1 ROLE AND FUNCTIONS OF THE ENGINEERING DEPARTMENT (WATER & SANITATION)

- (a) Maintaining reservoirs, pressure machines, pumps and tube-wells and to supply water for the city dwellers to get clean water.
- (b) Disposing of water and organic waste matter using sewerage and sanitation equipment.
- (c) Constructing, maintaining, repairing water supply system and sewerage.
- (d) Installing water meters and collecting water tax.
- (e) Issuing permit to install water pipes, pumps, and to construct septic tanks after thorough inspection.
- (f) Cleaning water pipelines, replacing old pipes with new ones and supply water rotationally to those wards which receive less water so as to obtain more water.
- (g) Cleaning, mending, inspecting pipe joints of the transmission main pipes from Gyophyu, Hlawga and Phugyi reservoirs.
- (h) Constructing tanks in suitable places so as to have a good flow of water to the city.
- (i) Transporting drinking water for those people residing at the other side of the Yangon River and constructing water tanks or ponds in suburban areas and satellite towns.
- (j) Putting alum into filter tanks to have sediment settled and putting chlorine into pipe lines.
- (k) Finding ways and means to prevent wastage of water; repairing and mending of pipes that leak water.
- (l) Importing pipes and machinery spare parts, pumps, chlorine and alum, and giving necessary instruction for the use of these materials.
- (m) Planning and managing to run daily hydraulic power plant, for the east and west Yangon, to remove excrements, discarded by the city dwellers, into the river by using air pressure.
- (n) Planning and managing not to block the sewerage and to protect the environmental pollution.
- (o) Planning to use toilets requiring manual flushing instead of using toilets requiring four cornered wooden vessels as receptacles in suburban areas.
- (p) Ordering and storing machinery and spare parts for pressure plant.
- (q) Maintaining pressure machines at Yegu, Hlawga and Phugyi water pumps stations.
- (r) Repairing pumps promptly whenever they become out of order and spare parts for these pumps are manufactured at the workshop.

- (s) Ordering and storing alum and mineral salt in time not to become out of stock.
- (t) Managing sanitary machines and pressure machines to run 24 hrs.
- (u) Measuring the rate of water producing at the existing tube wells and digging new wells installing pumps and laying pipe lines.
- (v) Undertaking security of Gyophyu pipe line, Phugyi pipe line, and Hlawga pipe line and constructing cross-bridges over these pipe lines.
- (w) Maintaining hydrants, building water tanks for fire dept.
- (x) Taking action to those who illegally connect to water pipes.
- (y) In executing the above tasks and to have progress yearly the Dept draws up short and long term plans and yearly budget, providing budget and expending and supervising taxes received.

2 DUTIES OF THE CHIEF ENGINEER, ASSISTANT CHIEF ENGINEER AND BRANCH DEPARTMENT HEAD

- (a) To give guidance to accomplish the work of the Department.
- (b) To manage and do the work of the Department in accordance with law, rules and regulations instructions and committee's policy.
- (c) To distribute work to the officers of the Dept and to do the staff administration and to look after welfare of the staff.
- (d) To supervise the departmental work and its employees.
- (e) To take responsibility of the committee, with its approval, regarding committee's instructions.
- (f) To give instructions, assign duties and supervise work done by Deputy Dept officer, Assist. Dept Officers, Engineers, and other Officers.
- (g) To supervise and control the work done within the budget limit approved by the committee.
- (h) To inspect water supply stations, workshops, reservoirs, pressure machines and whether these are in systematic order.
- (i) To draw up plan and implement it regarding the sufficient supply of drinking water for the city dwellers. To manage the work regarding connecting of water pipe lines according to the rules and regulations.
- (j) Townships where water supply from main reservoirs can not be made, tube-wells are dug and supply of water is managed.
- (k) To install new large and small pipes and to maintain such pipe lines.
- (l) To find ways and means to prevent wastage of water and to supervise to collect water tax fully.
- (m) To make requisition for the machinery spare parts and water pipes so as to run the work smoothly.
- (n) To make systematic arrangement when disposing of excrement from septic tanks, sanitary pipes so as not to pollute environment.
- (o) To draw plans and submit such plans to the committee for approval regarding

new water supply project for the capital, the search for new water sources, building new reservoirs, construction of new sanitary pipes and septic tanks.

- (p) General Supervision for the systematic expenditure of departmental implementing projects, ordinary/ lot capital expense, claims for the estimate budget related matters. All these cases are being implemented by the respective departments concerned.
- (q) Besides the water supply work to the regular seasonal festivals, routine respective work's have to be done in the line of duty.

3 DUTIES OF THE DEPUTY HEAD OF DEPARTMENT /ENGINEERING DEPARTMENT (WATER AND SANITATION)

3.1 DUTIES ASSIGNED TO THE HEAD OF DEPARTMENT

- (a) Fully responsible for the implementation of the Head of Dept's duties in coordination with the Deputy Head's work supervisions, and support.
- (b) Taking charge of the department during the absence of the Head of Dept
- (c) Other special assigned duties given by the Head of Department
- (d) Co-ordination and success of works in dealing with relevant departments placed under the committee.

3.2 DUTIES OF ASST. HEAD OF DEPT

- (a) Shall be responsible to comply with the directions given by Head of Department and Deputy Head of Dept
- (b) Constant supervision and accomplishments to the works of Head of Branches, Head of Sections and Engineers, by giving additional assignments and directives as necessary from time to time.
- (c) Long run perpetuity of the major water reservoirs, conservation of the water resource forests, maintenance and repair and upkeep of the water pipes projected works for the procurement of drinking and potable water, cleaning of lakes water volume survey works, records compilation, exploration of new water resources, general supervision and reports submissions to Head of Dept, and Deputy Heads.
- (d) Diggings of tube wells, mechanised artisan wells, repair and maintenance, brick water storage ponds construction and supervisory works.
- (e) Scrutinizing & legal action takings to prevent water wastages, water pipe joining permit, sanitary tank buildings, sanitary pipes layout, permit, works supervision.
- (f) Proper flow and non-blocking of human wastage disposal works, underground sanitary cubes cleaning, and their management.

- (g) Air compressor mechanical stations, sanitary boiler driving, storage and fill up matters, & necessary management and work-implementation.
- (h) Planning and supervision for the progress and execution of assignments by branch sections for the responsible works concerned under one's management.
- (i) Co-ordination and supervision for the success of branch departments under one's charge.
- (j) Other duties assigned by Senior authorities emergency cases and special duties as directed by the Head of Dept. up to full completion.

3.3 DUTIES OF BRANCH HEAD OF DEPARTMENT

- (a) Branch Head of Department, Asst. Head of dept's directions to comply and taking full responsibility to implement it. Level to level supervision of the branch engineer's under his supervision, inspection and additional directions.
- (b) For the smooth success of the assignments, undertaking necessary supportive measures, inspection, supervision and works performances though the different levels of senior officials concerned.
- (c) Welfare matters of the staffs under his charge, planning administration by offering rewards, serve actively, in the line of duty.

Table K.1 Grouping of Townships by Districts

District Name	Township Name
District (East)	Dagon Myothit East
	Dagon Myothit North
	Dagon Myothit Seikkan
	Dagon Myothit South
	North Okkalapa
	South Okkalapa
	Thingangyun
District (North)	Hlaing
	Hlaingthaya
	Insein
	Kamayut
	Mayangone
	Mingalardon
	Shwepyitha
District (South)	Botataung
	Dala
	Dawbon
	Mingalartaungnyunt
	Pazundaung
	Seikan Port
	Seikkyi Kanaungto
	Tamwe
	Thaketa
Yankin	
District (West)	Ahlonge
	Bahan
	Dagon
	Kyauktada
	Kyeemyindaing
	Lanmadaw
	Latha
	Pabedan
Sanchaung	

Table K.2 List of Plumbers Registered with YCDC

Type	Description	Number	Annual Registration Fee (Ks.)
Licensed Water & Sanitation Engineer	Permitted to undertake designs and plumbing work	12	10,000
Licensed Master Plumber	Permitted to do all plumbing work	261	6,500
Working Plumber	Permitted to work only under the supervision of the above two types. Not permitted to by self.	164	4,000

Source: YCDC

Note: Passing of a departmental examination is required for the first two categories. Registration for the last category is by recommendation of either of the first two.

Table K.3 List of Co-operative Societies involved in Water Supply in the City

Township	No. Societies	Members Benefited	No. Tubewells	Year Built	Water Cost (cents/50 gl)
Ahlon	1	345	1	1985/86	10
Dawbon	3	450	1	1990/91	30
			1	1991/92	
			1	1993/94	
Mayangone	2	67	6	1977-89	35
Mingalardon	1	20	1	1994/95	35
North Okklapa	4	450	4	89-99	25
South Okklapa	2	255	2	88-90	20
Thaketa	2	550	2	75-87	20
Thingangyun	5	1767	5	89-98	30

Source: Ministry of Co-operatives

Table K.4 Revenue Forecasts and Actuals, Water Supply & Sanitation Department

Year	Total Revenue Forecast (mil Kyats)	Actual (million Kyats)				
		Govt Depts	Private customers	Connection fee	Other	Total
1991/92		20.87	27.75	8.34	1.09	58.05
1992/93		27.87	35.77	10.34	3.09	77.07
1993/94		28.42	44.4	11.02	1.25	85.09
1994/95		44.63	96.77	19.55	2.68	163.63
1995/96		48.77	193.61	59.52	9.39	311.29
1996/97	405	58.45	206.86	74.39	8.95	348.65
1997/98	500	58.02	282.41	125.7	6.64	472.77
1998/99	600	63.4	244.81	104.34	13.18	425.73
1999/00	600	74.44	259.47	201.02	17.59	552.52
2000/01	660	69.44	249.47	194.02	16.63	529.56

Source: Finance and Administrative Division

Table K.5 Expenditure Forecasts and Actuals, Water Supply & Sanitation Department

Year	Expenditure Forecast (million Kyats)				Actual Expenditure (million Kyats)			
	Salary & Wages	Overhead Charges	Maintenance	Total	Salary & Wages	Overhead Charges	Maintenance	Total
1991/92	16.07	19.83	13.22	49.12	10.2	19.19	19.75	49.14
1992/93	15.75	29.23	16.2	61.18	13.3	22.9	18.55	54.75
1993/94	17.8	27.48	17.7	62.98	15.95	25.44	16.58	57.97
1994/95	18.3	33.12	20.7	72.12	15.62	32.38	15.14	63.14
1995/96	19.1	36.22	22.2	77.52	14.85	34.55	17.63	67.03
1996/97	18.8	37.65	23.2	79.65	14.54	35.16	23.96	73.66
1997/98	18.8	37.56	23.5	79.86	14.66	52.65	31.27	98.58
1998/99	18.8	47.56	31.6	97.96	15.6	84.34	43.64	143.58
1999/00	18.8	60.5	32.3	111.6	18.01	92	47.34	157.35
2000/01	18.8	76.1	30.3	125.2	73.00	108.02	59.91	240.93

Source: Finance & Administrative Division, YCDC

Table K.6 Components for Training Needs Assessment

Component	Description
Participants	Corporate staff; senior managers and professionals; junior professionals; township professional and other rank staff; administrative and account staff; staff doing minor role; new recruits
Subject	Determine subjects for training considering the new and existing functions of staff throughout the department. Include engineering, other subjects (planning, monitoring, data collection and analysis, customer education, etc.) and administrative and accounting subjects.
Training types	Pre-service, in-service; on-the-job; short and long-term in-country and overseas;
Training facility	Assessment of current hardware and software facilities prevail in and around the City, investigate quality, adequacy and availability; cost
Syllabus	Assess syllabus and course contents for different types of training; examine the extent to which they address to current needs; identify strengths and areas for improvement
Resources	Evaluate current allocation, adequacy and problems
Evaluation of training	Present evaluation of training; formats; identify data needs and develop new formats

Table K.7 Education and Awareness Needs by Customer Types

Customer Type	Aim
Customers with water connections and especially free water customers	Education and training on proper water use, reduction of waste, control of UfW use, basic knowledge on O&M tasks etc. Educate paid customers on cost of water, the calculation of water bills and of the need for prompt payment of bills
Free water customers	Educate free water customers on the value of water and solicit their cooperation to use this resource effectively and economically
All customers	Awareness on water production, distribution costs and cost of maintenance of the supply network
Customers of communal tanks, and lakes and ponds	Sanitary and hygienic education on water use, safe drinking water, treatment methods etc.
Customers of communal tanks, ponds and lakes	Secure the participation of users for cleaning of tanks, ponds and lakes, and adding chemicals to clean / purify water.
School children	General awareness about City water supply and water sanitation
Community organizations	Value of drinking water; water conservation, sanitary and hygienic education
All water users	Status of City water supply and planned improvements

Table K.8 Project Cost by Main Institutional Element

Activity Area	Unit	Approximate Cost
Planning, Programming & Monitoring	\$	31,500
Human Resources Strengthening	\$	794,500
Department staff cost	Ks.	50,420,000
Operation, Maintenance & Repairs	\$	255,000
Strengthening Legislative & Regulatory Matters	\$	3,500
Information & Education Materials	\$	5,500
Building Customer/Client Relations	\$	55,800
Training	\$	32,400
	\$	1,178,200
Grand Total	Ks.	50,420,000

Note: All cost items are to be reviewed when more reliable data of the proposed development work is known

Table K-9 Distribution of Institutional Development Cost by Project Year

Item	Project Cost	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Personal services (Cost in:	794,500	109,000	587,500	53,000		15,000				30,000						
Local staff cost (Ks.)	50,420,000	308,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	#####	#####
Equipment (\$)	225,000		30,000	195,000												
Buildings (\$)	85,000		20,000	65,000												
Training workshops (\$)	11,900	200	2,400	2,900	400	400	400	400	400	400	400	400	400	400	400	
IE materials (\$)	6,000			6,000												
NGO contracts (\$)	55,800		3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	
Total (\$)	1,178,200	109,200	643,000	325,000	3,500	18,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	
Total (Ks.)	50,420,000	308,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	2,784,000	#####	#####

APPENDIX L

INITIAL ENVIRONMENTAL EXAMINATION

APPNDIX L INITIAL ENVIRONMENTAL EXAMINATION

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APPENDIX L INITIAL ENVIRONMENTAL EXAMINATION

1 MYANMAR LAWS RELATING TO ENVIRONMENT

1.1 ADMINISTRATIVE SECTOR

1. The Territorial Sea and Maritime Zones Law, 1977
2. The Emergency Provisions Act, 1950
3. The Essential Supplies and Services Act, 1947
4. The Police Act, 1945
5. The Poison Act, 1919
6. The Explosive Substances Act, 1908
7. The Town Act, 1907
8. The Village Act, 1907
9. The Yangon Police Act, 1899
10. The Explosives Act, 1887
11. The Panel Code, 1861 of Offence Affecting the Public Health, Safety, Convenience, Decency and Morals.

1.2 AGRICULTURE AND IRRIGATION SECTOR

12. The Plant Pest Quarantine Law, 1993
13. The Pesticide Law, 1990
14. The Embankment Act, 1909

1.3 CULTURE SECTOR

15. The Protection and Preservation of Cultural Heritage Region Law, 1998

1.4 CITY DEVELOPMENT SECTOR

16. The Development Committees Law, 1993
17. The Mandalay City Development Law, 1992
18. The City of Yangon Development Law, 1990 (Amended in 1995 and again in 1996)
19. The Underground Water Act, 1930
20. The Water Power Act, 1927
21. The City of Yangon Municipal Act, 1992
22. The Yangon Water-works Act, 1885

1.5 FINANCE & REVENUE SECTOR

23. The Myanmar Insurance Law, 1993

1.6 FORESTRY SECTOR

24. The Protection of Wild Life and Wild Plants and Conservation of Natural Areas Law, 1994
25. The Forest Law, 1992

1.7 HEALTH SECTOR

26. The National Food Law, 1997
27. The Traditional Drug Law, 1996
28. The Prevention and Control of Communicable Diseases Law, 1995
29. The National Drug Law, 1992
30. The Union of Myanmar Public Health Law, 1972

1.8 HOTEL AND TOURISM SECTOR

31. The Myanmar Hotel and Tourism Law, 1993

1.9 INDUSTRIAL SECTOR

32. The Private Industrial Enterprise Law, 1990
33. The Factories Act, 1951
34. The Oilfield (Worker and Welfare) Act, 1951
35. The Petroleum Act, 1934
36. The Oilfields Act, 1918

1.10 LIVESTOCK AND FISHERIES SECTOR

37. The Animal Health and Development Law, 1993
38. The Freshwater Fisheries Law, 1992
39. The Myanmar Marine Fisheries Law, 1990 (Amended in 1993)
40. The Law Relating to Aquaculture, 1989
41. The Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1989 (Amended in 1993)

1.11 MINING SECTOR

42. The Myanmar Gemstone Law, 1995
43. The Myanmar Pearl Law, 1995
44. The Myanmar Mines Law, 1994
45. The Salt Enterprise Law, 1992
46. The Land Acquisition (Mines) Act, 1885

1.12 SCIENCE AND TECHNOLOGY SECTOR

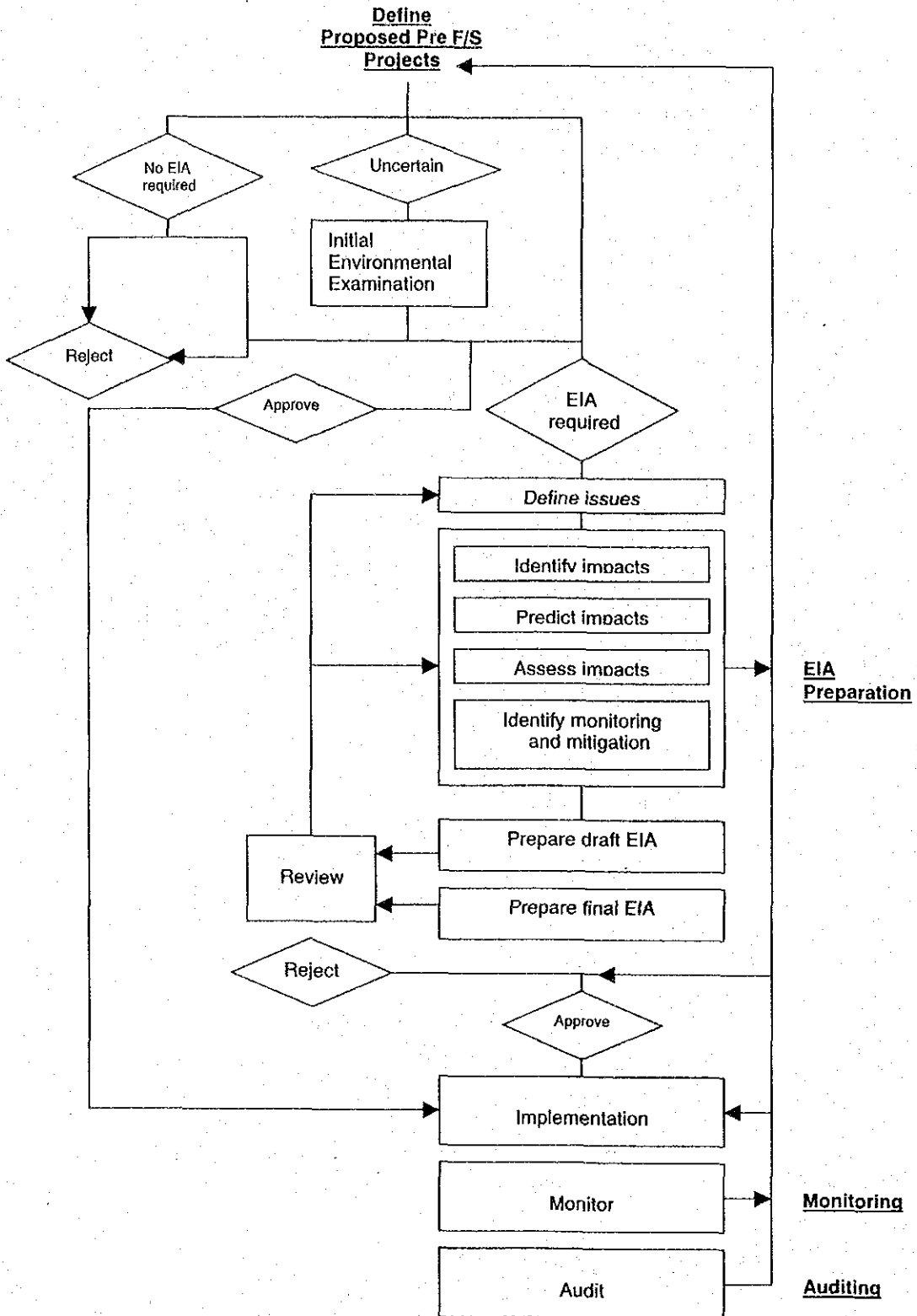
47. The Science and Technology Development Law, 1994

1.13 TRANSPORTATION SECTOR

48. The Highway Law, 2000
49. The Motor Vehicle Law, 1964
(The Law amending the Motor Vehicle Law of 1964 enacted in 1989)

50. The Myanmar Aircraft Act, 1934
51. The Inland Steam Vessels Act, 1917
52. The Port Act, 1908
53. The Defile Traffic Act, 1907
54. The Yangon Port Act, 1905
55. The Canal Act, 1905
56. The Obstruction in Fairways Act, 1881

2 FLOW DIAGRAM SHOWING THE COMPONENT OF AN EIA PROCEDURE



3 SAMPLE OF SCOPING CHECKLIST OF EIA

Project name/location

Enumerator's name

Assessment: 1st /2nd/

Date
Sheet 1 of 3

For each potential Environmental effect place (X)	Positive Impacts			Negative Impacts		
	Non	Minor	Major	Non	Minor	Major
Hydrology						
● Low flow regime						
● Flood regime						
● Operation of dam						
● Water table level						
● Surface water quality						
● Ground water quality						
● Eutrophication						
Pollution						
● Noise						
● Agrochemicals						
● Organic pollution						
● Anaerobic effects						
● Gas emission						
Soils						
● Salinization						
● Soil properties						
● Water logging						
● Erosion						
● Soil Fertility						
● Soil Productivity						
Sediments						
● Local erosion						
● Hinterland effect						
● River morphology						
● Channel engine						
● Sedimentation						
● Estuary erosion						

For each potential Environmental effect place (X)	Positive Impacts			Negative Impacts		
	Non	Minor	Majar	Non	Minor	Majar
Ecology						
● Projects lands						
● Water bodies						
● Surrounding area						
● Valleys and slopes						
● Wetlands and plains						
● Wildlife						
● Vegetation						
● Climate						
Socio-Economic						
● Population change						
● Income						
● Employment						
● Arable agriculture						
● Settlement						
● Recreational sites						
● Historical and archaeology site						
● Livestock raising						
● Tourism						
● Infrastructure						
● Fishing						
● Land tenure						
Health						
● Water and sanitation						
● Nutrition						
● Relocation effect						
● Disease effect						
● Disease ecology						
● Disease control						
● Disease hazards						

For each potential Environmental effect place (X)	Positive Impacts			Negative Impacts		
	Non	Minor	Majar	Non	Minor	Majar
Imbalances						
● Pests and weeds						
● Animal disease						
● Aquatic weeds						
● Structural damages						
● Animal imbalances						

APPENDIX M

ECONOMIC AND FINANCIAL ANALYSIS

APPNDIX M ECONOMIC AND FINANCIAL ANALYSIS

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Appendix M.1 Average Household Income and Expenditure by Township

Name of township	Average family size (persons)	Working member (persons)	Average HH income (Kyat/month)	Household expenditure										Detail of expenditures on utilities							Balance	
				Food and beverage	Clothing	House rent and repairs	Utilities	Charity and ceremonies	Education / School	Transportation	Medical care	Tax	Total	Potable water	Waste water disposal	Solid waste disposal	Telephone	Gas	Electricity	Fuel		Total
01. Ahlone	5.00	1.71	29,586	23,571	1,571	343	2,919	2,171	3,957	3,214	1,286	0	39,034	179	0	45	657	24	1,657	357	2,919	-9,448
02. Bahan	4.91	1.73	55,464	25,091	3,545	327	10,583	1,773	7,864	3,773	1,909	0	54,365	204	0	37	2,218	183	7,941	0	#####	30,599
03. Botataung	4.63	1.63	47,125	11,938	738	0	3,344	675	1,188	3,313	813	0	22,007	127	0	180	975	0	2,063	0	3,344	25,118
04. Dagon	6.43	1.14	24,971	40,071	639	186	9,099	2,500	4,357	2,443	1,514	552	61,361	439	0	51	1,186	226	7,000	197	9,099	-36,390
05. Dagon Myothit East	6.44	2.33	48,144	21,839	711	433	3,764	583	5,822	3,173	1,156	0	37,532	1,009	46	22	756	422	736	772	3,764	10,613
06. Dagon Myothit North	5.23	2.69	49,947	20,154	338	415	3,466	1,692	2,308	2,892	562	2,054	33,882	1,035	60	32	715	172	615	838	3,466	16,065
07. Dagon Myothit Seikkan	5.20	1.60	70,240	24,200	1,000	1,660	3,740	1,600	4,800	1,740	2,200	80	41,020	1,360	85	30	400	150	959	756	3,740	29,220
08. Dagon Myothit South	6.11	2.64	28,404	16,304	429	354	2,660	546	1,204	1,786	836	60	24,177	857	24	16	214	54	184	1,311	2,660	4,227
09. Dala	5.13	2.06	13,844	8,875	531	0	2,389	225	1,219	706	456	0	14,402	152	0	0	0	0	513	1,725	2,389	-558
10. Dawson	6.00	1.27	32,055	24,182	1,009	564	3,526	1,255	3,641	2,473	1,341	226	38,216	1,053	0	30	182	227	513	1,518	3,526	-6,161
11. Hlaing	4.83	1.43	31,841	26,565	1,437	1,253	3,461	1,739	3,357	3,548	2,430	891	44,681	711	0	48	298	111	1,471	822	3,461	-12,840
12. Hlaingthaya	6.71	2.29	29,492	16,730	375	254	3,178	558	1,717	1,577	463	20	24,891	175	0	0	38	7	338	2,621	3,178	4,601
13. Insein	5.93	1.93	40,413	28,696	1,267	254	3,598	1,374	5,707	2,957	3,872	920	48,643	289	0	40	698	429	1,355	787	3,598	-8,230
14. Kamayut	6.36	2.07	34,321	8,643	757	21	2,342	371	2,964	2,150	1,329	91	18,669	212	15	90	538	119	775	595	2,342	15,653
15. Kyauktada	5.17	1.33	45,233	41,667	1,217	317	3,889	1,750	2,567	1,717	933	0	54,056	146	0	60	1,217	0	1,867	600	3,889	-8,822
16. Kyeemyindang	5.81	1.25	39,088	20,000	606	87	3,616	1,194	7,344	3,713	5,406	0	41,965	148	0	70	538	448	1,894	519	3,616	-2,978
17. Lanmadaw	4.14	1.14	69,443	25,000	2,557	229	2,957	1,671	10,714	9,600	2,357	7,471	62,557	262	0	51	943	486	1,100	114	2,957	6,886
18. Latha	3.20	1.60	30,400	13,700	1,000	114	3,799	900	1,600	1,500	1,400	448	24,461	149	0	196	554	200	2,700	0	3,799	-5,939
19. Mayangone	5.17	1.00	37,079	23,483	610	234	3,419	1,621	4,310	2,400	914	121	37,112	198	0	30	297	100	1,357	1,438	3,419	-35
20. Mingalardon	5.30	2.00	34,257	15,938	615	63	2,473	479	2,096	2,048	174	85	23,970	146	1	33	882	21	407	983	2,473	10,286
21. Mingalartaungnyunt	5.56	1.56	31,125	15,375	425	24	1,776	356	1,219	2,219	469	0	21,863	148	0	135	563	0	931	0	1,776	9,263
22. North Okkalapa	6.27	2.16	45,876	20,722	622	123	2,258	444	2,184	1,760	650	928	29,693	354	14	25	138	62	385	1,364	2,258	16,184
23. Pabedan	5.25	2.50	39,350	18,000	1,100	198	1,920	500	625	250	1,250	1,300	25,143	210	100	60	325	0	1,225	0	1,920	14,208
24. Pazundaung	4.29	1.57	18,100	9,643	586	1,500	2,241	471	429	1,786	343	0	16,998	132	0	180	1,071	0	857	0	2,241	1,102
25. Sanchaung	3.62	1.08	42,615	15,538	854	831	3,019	1,577	1,485	2,608	1,731	846	28,488	140	15	45	880	615	1,140	182	3,019	14,127
26. Seikkan Port																						
27. Seikkyi Kanaungro	6.67	1.33	19,575	19,333	1,200	267	2,742	6,733	7,500	2,433	2,067	0	42,275	0	0	0	100	0	275	2,367	2,742	-22,700
28. Shwepyitha	4.67	1.48	30,715	10,824	299	1,627	2,825	350	1,495	857	576	375	19,228	117	2	50	310	199	400	1,748	2,825	11,487
29. South Okkalapa	5.58	2.17	19,541	10,942	1,046	59	1,825	523	1,354	810	722	334	17,616	226	48	88	202	73	500	687	1,825	1,925
30. Tamwe	5.67	2.00	36,461	19,389	311	0	2,395	378	667	3,472	467	0	27,079	179	0	144	389	0	1,183	500	2,395	-9,383
31. Thaketa	6.05	1.74	19,861	12,474	221	13	707	276	934	2,046	200	0	16,872	119	4	89	71	0	332	92	707	2,989
32. Thingangyun	5.97	1.72	83,015	28,017	2,424	3,610	5,813	3,328	6,428	4,738	2,305	1,167	57,830	635	136	120	470	524	3,076	850	5,813	25,185
33. Yankin	6.50	2.00	48,750	21,917	675	0	4,008	1,083	792	2,792	683	0	31,949	264	0	135	900	0	2,083	625	4,008	16,801
Overall average	5.44	1.76	39,260	19,965	960	480	3,430	1,272	3,245	2,578	1,338	562	33,829	367	17	67	585	152	1,492	761	3,430	5,431
Average in HHs who connect with YCDC water supply systems	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average in HHs who do not connect with YCDC water supply	6.01	1.95	38,692	19,343	819	1,026	3,620	959	3,017	2,184	1,392	503	32,862	579	23	38	411	163	1,079	1,393	3,686	5,830
Per capita income in overall average			22,364																			

(Note 1)			(Note 2)		
	Average in HHs who connect with YCDC water supply systems.	Average in HHs who do not connect with YCDC water supply systems.	Average in HHs who do not connect with YCDC water supply systems	Expenditure (Kyat/mth)	No. of samples
Private piped water				841	6
Common Tube Well				827	9
Protected dug well				13	3
Private water tanker				1,025	2
Neighbor's tap/well				1,512	31
Bottled water				1,052	24

Sources: Result of Consumer Survey made by JICA Study Team, July 2001.

Appendix M.2 Basic Unit for Estimation of Saved Amount of Medical Expenditure

A. Estimation of Saving Amount of Medicament

(As of 1998)

Number of cases in overall diseases	Outpatients*	Inpatients incl. death*			Total patients	Share rate to populatio	Percentage (%)
		Inpatients	Death	Total			
Population in total in Yangon(as of 1998)					3,691,941		
Total administration	241,871	227,218	10,355	237,573	469,089	12.71 %	100.00%
Water borne disease in total					34,701		7.40%
Others					434,388		92.60%
Revenue of hospitals received consisting of treatment charges, and subsidies (Million Kyats)**							
1998/99					33.90		
1999/00					368.40		
2000/01					600.00	Amount of medical expenditure to be saved by clean water supply:	
2001/02					620.00		
Annual average since 1999/00					529.47		
Average amount allocated to water borne diseases (Thousand Kyats/annum)					39,168		5,875

Source: * Hospital Statistics Annual Report 1998, Ministry of Health.

** Ministry of Health.

(Note 1)

Water Borne Diseases in Yangon

Year	Diarrhoea	Dysentery	Viral hepatitis	Typhoid	Total
1991	28,808	19,686	749	244	49,487
1992	24,552	15,355	657	161	40,725
1993	26,433	14,649	660	236	41,978
1994	30,711	11,826	821	193	43,551
1995	28,349	10,380	670	224	39,623
1996	24,649	8,209	444	210	33,512
1997	20,253	8,112	489	196	29,050
1998	17,988	7,040	386	161	25,575
1999	15,615	5,787	300	156	21,858
2000	14,721	6,399	338	194	21,652
Average per year	23,208	10,744	551	198	34,701

Source: Ministry of Health.

(Note) ** In Myammer, they have no health insurance systems until present time.

B. Saved Amount of Income to be decreased by water borne disease

Average duration of stay of inpatients:

Total number of patient days: 1,903,482

Number of discharges and deaths: 237,573

Average duration of stay of inpatie 8.01 (days/annum)

Average number of days of outpatients visited to hospitals:

Total number of outpatient attendances: 576,756

Average number of outpatients per day: 2,383

Total number of outpatient attendances caused by water borne disease 241,871

Average number of days of outpatients visited to hospitals: 2.38 (days/annum)

Basic unit of saved amount of income to be decreased caused by water borne diseases:

Basic unit of income per person*: 22,364 (Kyats/month) = 1,017 (Kyats/day) (22 working days/month)

Total income loss of inpatient per annum: 8,145 (Kyats/working person per annum)

Total income loss of outpatient per annum: 2,424 (Kyats/working person per annum)

Share rate of working persons per HH*(%): 32.29%

Sources: * Result of Consumer Survey made by JICA Study Team, July 2001.

Appendix M.3 Annual Disbursement of Construction Cost and Estimation of Its Economic Cost

(Note)

FC = Foreign currency portion

LC = Local currency portion

(US\$1,000)

Cost item	Annual disbursement (Phase-1)																								Total								
	2001			2002			2003			2004			2005			2006			2007			2008				2009			2010				
	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total			
Construction works																																	
Direct cost	0	0	0	0	0	0	0	0	0	24,194	1,810	26,004	25,086	2,218	27,304	90,528	9,946	100,574	63,506	5,998	69,504	110,790	22,539	133,329	86,400	16,594	102,994	110,979	19,088	130,067	511,583	78,193	589,776
Indirect cost	0	0	0	0	0	0	0	0	0	5,565	416	5,981	5,770	510	6,280	20,844	2,288	23,132	14,606	1,380	15,986	25,482	5,184	30,666	19,872	3,817	23,689	26,525	4,390	29,915	117,664	17,984	135,648
Sub-total	0	0	0	0	0	0	0	0	0	29,759	2,226	31,985	30,856	2,728	33,584	111,472	12,234	123,706	78,112	7,378	85,490	136,272	27,723	163,995	106,272	20,411	126,683	136,504	23,478	159,982	629,247	96,177	725,424
Engineering cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,694	0	7,694	14,760	0	14,760	11,401	0	11,401	14,398	0	14,398	48,253	0	48,253
Compensation cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub total	0	0	0	0	0	0	0	0	0	29,759	2,226	31,985	30,856	2,728	33,584	111,472	12,234	123,706	78,112	7,378	85,490	136,272	27,723	163,995	106,272	20,411	126,683	136,504	23,478	159,982	629,247	96,177	725,424
Administration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
Sub total	0	0	0	0	0	0	0	0	0	29,759	2,227	31,985	30,856	2,729	33,584	111,472	12,234	123,706	78,113	7,379	85,491	136,273	27,724	163,996	106,273	20,412	126,684	136,505	23,479	159,983	629,248	96,178	725,425
Physical contingency	0	0	0	0	0	0	0	0	0	1,488	111	1,599	1,543	136	1,679	5,474	612	6,086	4,290	369	4,659	7,552	1,386	8,938	5,884	1,021	6,904	7,545	1,174	8,719	33,875	4,809	38,684
Financial cost	0	0	0	0	0	0	0	0	0	31,247	2,338	33,585	32,399	2,865	35,264	117,046	12,846	129,892	90,097	7,747	97,844	158,583	29,110	187,693	123,557	21,432	144,989	158,448	24,653	183,101	711,376	100,990	812,366
Economic cost	0	0	0	0	0	0	0	0	0	28,122	1,171	29,293	29,159	1,435	30,594	105,341	6,433	111,774	81,087	3,880	84,967	142,725	14,578	157,302	111,201	10,733	121,934	142,603	12,346	154,949	640,238	50,575	690,813

(US\$1,000)

M-3

Cost item	Annual disbursement (Phase-2)																								Total								
	2011			2012			2013			2014			2015			2016			2017			2018				2019			2020				
	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total			
Construction works																																	
Direct cost	31,851	6,560	38,411	29,333	6,627	35,960	20,798	2,645	23,443	6,961	1,818	8,779	15,438	4,021	19,459	15,299	4,674	19,973	59,462	11,345	70,807	83,915	18,872	102,787	114,456	21,033	135,489	6,851	1,758	8,609	384,364	79,353	463,717
Indirect cost	7,326	1,509	8,835	6,747	1,524	8,271	4,784	608	5,392	1,601	418	2,019	3,551	925	4,476	3,519	1,075	4,594	13,676	2,609	16,286	19,300	4,341	23,641	26,325	4,838	31,162	1,576	405	1,980	88,404	18,251	106,655
Sub-total	39,177	8,069	47,246	36,080	8,151	44,231	25,582	3,253	28,835	8,562	2,236	10,798	18,989	4,946	23,935	18,818	5,749	24,567	73,138	13,954	87,093	103,215	23,213	126,428	140,781	25,871	166,651	8,427	2,162	10,589	472,768	97,604	570,372
Engineering cost	4,252	0	4,252	3,981	0	3,981	2,395	0	2,395	972	0	972	2,154	0	2,154	2,211	0	2,211	7,838	0	7,838	11,379	0	11,379	14,999	0	14,999	953	0	953	51,333	0	51,333
Compensation cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub total	43,429	8,069	51,498	40,060	8,151	48,212	28,177	3,253	31,430	9,534	2,236	11,770	21,143	4,946	26,089	21,029	5,749	26,778	80,977	13,954	94,931	114,594	23,213	137,807	155,780	25,871	181,651	9,380	2,162	11,542	524,101	97,604	621,705
Administration	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
Sub total	43,429	8,069	51,498	40,060	8,152	48,212	28,177	3,254	31,430	9,534	2,236	11,770	21,143	4,946	26,089	21,029	5,749	26,778	80,977	13,955	94,931	114,594	23,213	137,807	155,780	25,871	181,651	9,380	2,163	11,543	524,101	97,609	621,710
Physical contingency	2,171	403	2,575	2,003	408	2,411	1,409	163	1,572	477	112	589	1,027	247	1,274	1,051	287	1,339	4,049	698	4,747	5,730	1,161	6,890	7,789	1,294	9,083	469	108	577	26,205	4,880	31,085
Financial cost	45,600	8,473	54,073	42,063	8,559	50,622	29,586	3,416	33,002	10,011	2,348	12,359	22,300	5,193	27,393	22,080	6,037	28,117	85,025	14,653	99,678	120,324	24,374	144,697	163,568	27,165	190,733	9,849	2,271	12,120	550,306	102,489	652,795
Economic cost	41,040	4,243	45,284	37,857	4,286	42,143	26,627	1,711	28,338	9,010	1,176	10,186	19,980	2,601	22,581	19,872	3,023	22,895	76,523	7,338	83,861	108,291	12,506	120,797	147,212	13,604	160,815	8,864	1,138	10,001	495,276	51,326	546,602

Remarks:

1. Price share rates:

- Labour	FC	LC
- Equipment and	0.0%	80.0%
	100.0%	20.0%
2. Tax for construction and engineering services: 10%
3. Contractor's overhead & profit: 10%
4. Standard conversion factor: 0.95195
5. Shadow wage rate (economic wage rate): 50%

6. Operation & Maintenance cost:

DM work items	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Personal cost	5	5	5	5	6	6	6	6	7	7	7	7	7	7	7	9	9
Electricity cost	10	10	89	117	144	144	216	216	216	233	233	233	239	239	239	239	295
Chemical cost	192	192	606	600	928	928	8,666	8,666	8,666	8,666	8,666	8,677	8,677	8,677	8,677	8,677	16,324
Inspection/repairing cost				791			345	1,076		989	401	1,076	989			7,301	14,289
Financial total	207	207	694	722	1,869	1,078	8,838	9,233	9,964	8,906	9,894	9,318	9,999	8,923	9,911	16,225	30,916
Economic cost	104	104	348	362	936	540	4,451	4,624	4,990	4,460	4,955	4,666	5,007	4,468	4,964	8,126	15,483

(US\$1,000)

7. Price: As of November 2001.
8. Exchange rate: US\$ 1.00 = 900 Kyats = Japanese Yen 120.00.
9. Physical contingency: 5.00% (of total of the above)
10. Indirect cost: 23% (of direct cost)
11. (Equivalent to million Kyats) 36.50 (in financial cost)
12. Engineering cost: 9% (of direct and indirect cost)

Remarks:

Gyohyu:	167	Phugyi:	400	Terminal-Kokine:	7,042	Terminal CBW:	8,217	Ngamoyeik:	6,900	CBDT East:	4,708
East Block S:	983	Terminal to CB:	6,517	Hlaing WTP:	5,342	Transmission:	7,042	West Block N:	875	East Block N:	558
West Block S:	225	East Block C:	900	West Block C:	217						

Appendix M.4 Calculation of Economic Internal Rate of Return in Phase-1

(Note) Sunk cost is assumed at 0.5 % of replacement cost until the end of works.
(US\$1,000)

Year in order	Year	Economic cost					Economic benefit				Cash balance
		Construction cost		OM cost	Replace ment cost	Total	Potable water supply	Saving of medical expenditur	Saving of income loss	Total	
		F/C portion	L/C portion								
-1	2001	0	0	0	0	0	0	0	0	0	0
0	2002	0	0	0	0	0	0	0	0	0	0
1	2003	0	0	0	0	0	0	0	0	0	0
2	2004	28,122	1,171	104	0	29,397	8,705	3	6	8,713	-20,684
3	2005	29,159	1,435	104	0	30,698	11,631	3	8	11,643	-19,055
4	2006	105,341	6,433	348	0	112,122	24,635	7	17	24,659	-87,463
5	2007	81,087	3,880	362	0	85,329	25,648	8	17	25,673	-59,656
6	2008	142,725	14,578	936	0	158,238	26,660	8	18	26,686	-131,552
7	2009	111,201	10,733	540	0	122,474	27,678	8	19	27,705	-94,769
8	2010	142,603	12,346	4,451	0	159,400	43,318	13	29	43,361	-116,039
9	2011	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
10	2012	0	0	4,847	0	4,847	43,318	13	29	43,361	38,513
11	2013	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
12	2014	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
13	2015	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
14	2016	0	0	4,847	0	4,847	43,318	13	29	43,361	38,513
15	2017	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
16	2018	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
17	2019	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
18	2020	0	0	4,847	0	4,847	43,318	13	29	43,361	38,513
19	2021	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
20	2022	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
21	2023	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
22	2024	0	0	4,847	0	4,847	43,318	13	29	43,361	38,513
23	2025	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
24	2026	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
25	2027	0	0	4,451	0	4,451	43,318	13	29	43,361	38,910
26	2028			4,847	0	4,847	43,318	13	29	43,361	38,513
27	2029			4,451	0	4,451	43,318	13	29	43,361	38,910
28	2030			4,451	241,785	246,235	43,318	13	29	43,361	-202,875
29	2031			4,451	0	4,451	43,318	13	29	43,361	38,910
30	2032			4,847	0	4,847	43,318	13	29	43,361	38,513
31	2033			4,451	0	4,451	43,318	13	29	43,361	38,910
32	2034			4,451	0	4,451	43,318	13	29	43,361	38,910
33	2035			4,451	0	4,451	43,318	13	29	43,361	38,910
34	2036			4,847	0	4,847	43,318	13	29	43,361	38,513
35	2037			4,451	0	4,451	43,318	13	29	43,361	38,910
36	2038			4,451	0	4,451	43,318	13	29	43,361	38,910
37	2039			4,451	0	4,451	43,318	13	29	43,361	38,910
38	2040			4,847	0	4,847	43,318	13	29	43,361	38,513
39	2041			4,451	0	4,451	43,318	13	29	43,361	38,910
40	2042			4,451	0	4,451	43,318	13	29	43,361	38,910
41	2043			4,451	0	4,451	43,318	13	29	43,361	38,910
42	2044			4,847	0	4,847	43,318	13	29	43,361	38,513
43	2045			4,451	0	4,451	43,318	13	29	43,361	38,910
44	2046			4,451	0	4,451	43,318	13	29	43,361	38,910
45	2047			4,451	0	4,451	43,318	13	29	43,361	38,910
46	2048			4,847	0	4,847	43,318	13	29	43,361	38,513
47	2049			4,451	0	4,451	43,318	13	29	43,361	38,910
48	2050			4,451	241,785	246,235	43,318	13	29	43,361	-202,875
49	2051			4,451	0	4,451	43,318	13	29	43,361	38,910
50	2052			4,847	0	4,847	43,318	13	29	43,361	38,513
51	2053			4,451	0	4,451	43,318	13	29	43,361	38,910
52	2054			4,451	0	4,451	43,318	13	29	43,361	38,910
53	2055			4,451	0	4,451	43,318	13	29	43,361	38,910
54	2056			4,847	0	4,847	43,318	13	29	43,361	38,513
55	2057			4,451	0	4,451	43,318	13	29	43,361	38,910
56	2058			4,451	0	4,451	43,318	13	29	43,361	38,910
57	2059			4,451	0	4,451	43,318	13	29	43,361	38,910
58	2060			4,847	0	4,847	43,318	13	29	43,361	38,513
Total		640,238	50,575	234,538	483,569	1,408,920	2,334,193	691	1,584	2,336,467	927,547

In the condition of discount rate at 10%:

Present value:	366,758	246,940	-119,818
Internal rate of return (EIRR):			4.95%
B/C:			0.67

Appendix M.5 Calculation of Economic Internal Rate of Return in Phase-2

(Note) Sunk cost is assumed at 0.5 % of replacement cost until the year 2020.
(US\$1,000)

Year in order	Year	Economic cost				Economic benefit				Cash balance	
		Construction cost		OM cost	Replace- ment cost	Total	Potable water supply	Saving of medical expenditur	Saving of income loss		Total
		I/C portion	L/C portion								
-1	2001	0	0	0	0	0	0	0	0	0	
0	2002	0	0	0	0	0	0	0	0	0	
1	2003	0	0	0	0	0	0	0	0	0	
2	2004	0	0	0	0	0	0	0	0	0	
3	2005	0	0	0	0	0	0	0	0	0	
4	2006	0	0	0	0	0	0	0	0	0	
5	2007	0	0	0	0	0	0	0	0	0	
6	2008	0	0	0	0	0	0	0	0	0	
7	2009	0	0	0	0	0	0	0	0	0	
8	2010	0	0	0	0	0	0	0	0	0	
9	2011	41,040	4,243	173	0	45,457	1,257	0	1	1,258	-44,199
10	2012	37,857	4,286	143	0	42,286	2,514	1	1	2,516	-39,771
11	2013	26,627	1,711	9	0	28,347	3,770	1	2	3,773	-24,574
12	2014	9,010	1,176	504	0	10,690	5,027	1	3	5,030	-5,660
13	2015	19,980	2,601	216	0	22,796	7,183	2	4	7,189	-15,608
14	2016	19,872	3,023	160	0	23,056	9,196	2	5	9,203	-13,853
15	2017	76,523	7,338	18	0	83,878	11,213	3	6	11,222	-72,657
16	2018	108,291	12,206	513	0	121,010	13,225	3	7	13,235	-107,775
17	2019	147,212	13,604	3,675	0	164,490	15,242	4	8	15,254	-149,236
18	2020	8,864	1,138	10,635	0	20,637	26,478	6	14	26,498	5,861
19	2021	0	0	8,327	0	8,327	26,478	6	14	26,498	18,172
20	2022	0	0	8,822	0	8,822	26,478	6	14	26,498	17,676
21	2023	0	0	11,983	0	11,983	26,478	6	14	26,498	14,515
22	2024	0	0	10,635	0	10,635	26,478	6	14	26,498	15,863
23	2025	0	0	8,327	0	8,327	26,478	6	14	26,498	18,172
24	2026	0	0	8,822	0	8,822	26,478	6	14	26,498	17,676
25	2027	0	0	11,983	0	11,983	26,478	6	14	26,498	14,515
26	2028			10,635	0	10,635	26,478	6	14	26,498	15,863
27	2029			8,327	0	8,327	26,478	6	14	26,498	18,172
28	2030			8,822	0	8,822	26,478	6	14	26,498	17,676
29	2031			11,983	0	11,983	26,478	6	14	26,498	14,515
30	2032			10,635	0	10,635	26,478	6	14	26,498	15,863
31	2033			8,327	0	8,327	26,478	6	14	26,498	18,172
32	2034			8,822	0	8,822	26,478	6	14	26,498	17,676
33	2035			11,983	0	11,983	26,478	6	14	26,498	14,515
34	2036			10,635	0	10,635	26,478	6	14	26,498	15,863
35	2037			8,327	0	8,327	26,478	6	14	26,498	18,172
36	2038			8,822	0	8,822	26,478	6	14	26,498	17,676
37	2039			11,983	0	11,983	26,478	6	14	26,498	14,515
38	2040			10,635	191,311	201,946	26,478	6	14	26,498	-175,448
39	2041			8,327	0	8,327	26,478	6	14	26,498	18,172
40	2042			8,822	0	8,822	26,478	6	14	26,498	17,676
41	2043			11,983	0	11,983	26,478	6	14	26,498	14,515
42	2044			10,635	0	10,635	26,478	6	14	26,498	15,863
43	2045			8,327	0	8,327	26,478	6	14	26,498	18,172
44	2046			8,822	0	8,822	26,478	6	14	26,498	17,676
45	2047			11,983	0	11,983	26,478	6	14	26,498	14,515
46	2048			10,635	0	10,635	26,478	6	14	26,498	15,863
47	2049			8,327	0	8,327	26,478	6	14	26,498	18,172
48	2050			8,822	0	8,822	26,478	6	14	26,498	17,676
49	2051			11,983	0	11,983	26,478	6	14	26,498	14,515
50	2052			10,635	0	10,635	26,478	6	14	26,498	15,863
51	2053			8,327	0	8,327	26,478	6	14	26,498	18,172
52	2054			8,822	0	8,822	26,478	6	14	26,498	17,676
53	2055			11,983	0	11,983	26,478	6	14	26,498	14,515
54	2056			10,635	0	10,635	26,478	6	14	26,498	15,863
55	2057			8,327	0	8,327	26,478	6	14	26,498	18,172
56	2058			8,822	0	8,822	26,478	6	14	26,498	17,676
57	2059			11,983	0	11,983	26,478	6	14	26,498	14,515
58	2060			10,635	191,311	201,946	26,478	6	14	26,498	-175,448
59	2061			8,327	0	8,327	26,478	6	14	26,498	18,172
60	2062			8,822	0	8,822	26,478	6	14	26,498	17,676
61	2063			11,983	0	11,983	26,478	6	14	26,498	14,515
62	2064			10,635	0	10,635	26,478	6	14	26,498	15,863
63	2065			8,327	0	8,327	26,478	6	14	26,498	18,172
64	2066			8,822	0	8,822	26,478	6	14	26,498	17,676
65	2067			11,983	0	11,983	26,478	6	14	26,498	14,515
66	2068			10,635	0	10,635	26,478	6	14	26,498	15,863
67	2069			8,327	0	8,327	26,478	6	14	26,498	18,172
68	2070			8,822	0	8,822	26,478	6	14	26,498	17,676
Total		495,276	51,326	#####	382,621	1,439,625	1,419,000	332	762	1,420,094	-19,531

In the condition of discount rate at 10%:

Present value: 138,554 57,470 -81,084
 Internal rate of return (EIRR): -0.17%
 B/C: 0.41

Appendix M.6 Calculation of Economic Internal Rate of Return for Overall Project

(US\$1,000)

Year in order	Year	Economic cost				Economic benefit			Cash balance		
		Construction cost		OM cost	Replace- ment cost	Total	Potable water supply	Saving of medical expenditur		Saving of income loss	Total
		I/C portion	L/C portion								
-1	2001	0	0	0	0	0	0	0	0	0	
0	2002	0	0	0	0	0	0	0	0	0	
1	2003	0	0	0	0	0	0	0	0	0	
2	2004	28,122	1,171	104	0	29,397	8,705	2	5	8,712	-20,684
3	2005	29,159	1,435	104	0	30,698	11,631	3	7	11,642	-19,056
4	2006	105,341	6,433	348	0	112,122	24,635	7	15	24,657	-87,465
5	2007	81,087	3,880	362	0	85,329	25,648	7	16	25,671	-59,658
6	2008	142,725	14,578	936	0	158,238	26,660	7	17	26,684	-131,554
7	2009	111,201	10,733	540	0	122,474	27,678	8	17	27,703	-94,771
8	2010	142,603	12,346	4,451	0	159,400	43,318	12	27	43,357	-116,042
9	2011	41,040	4,243	4,624	0	49,907	44,575	12	28	44,615	-5,292
10	2012	37,857	4,286	4,990	0	47,134	45,832	12	29	45,873	-1,260
11	2013	26,627	1,711	4,460	0	32,798	47,089	13	29	47,131	14,333
12	2014	9,010	1,176	4,955	0	15,141	48,345	13	30	48,388	33,248
13	2015	19,980	2,601	4,666	0	27,247	50,501	14	32	50,547	23,300
14	2016	19,872	3,023	5,007	0	27,903	52,514	14	33	52,561	24,658
15	2017	76,523	7,338	4,468	0	88,329	54,531	15	34	54,580	-33,749
16	2018	108,291	12,206	4,964	0	125,461	56,543	15	35	56,594	-68,867
17	2019	147,212	13,604	8,126	0	168,941	58,560	16	37	58,613	-110,328
18	2020	8,864	1,138	15,483	0	25,484	69,796	19	44	69,859	44,375
19	2021	0	0	8,327	0	8,327	69,796	19	44	69,859	61,532
20	2022	0	0	8,822	0	8,822	69,796	19	44	69,859	61,037
21	2023	0	0	11,983	0	11,983	69,796	19	44	69,859	57,876
22	2024	0	0	15,483	0	15,483	69,796	19	44	69,859	54,376
23	2025	0	0	8,327	0	8,327	69,796	19	44	69,859	61,532
24	2026	0	0	8,822	0	8,822	69,796	19	44	69,859	61,037
25	2027	0	0	11,983	0	11,983	69,796	19	44	69,859	57,876
26	2028			15,483	0	15,483	69,796	19	44	69,859	54,376
27	2029			8,327	0	8,327	69,796	19	44	69,859	61,532
28	2030			8,822	243,565	252,387	69,796	19	44	69,859	-182,528
29	2031			11,983	0	11,983	69,796	19	44	69,859	57,876
30	2032			15,483	0	15,483	69,796	19	44	69,859	54,376
31	2033			8,327	0	8,327	69,796	19	44	69,859	61,532
32	2034			8,822	0	8,822	69,796	19	44	69,859	61,037
33	2035			11,983	0	11,983	69,796	19	44	69,859	57,876
34	2036			15,483	0	15,483	69,796	19	44	69,859	54,376
35	2037			8,327	0	8,327	69,796	19	44	69,859	61,532
36	2038			8,822	0	8,822	69,796	19	44	69,859	61,037
37	2039			11,983	0	11,983	69,796	19	44	69,859	57,876
38	2040			15,483	191,311	206,793	69,796	19	44	69,859	-136,934
39	2041			8,327	0	8,327	69,796	19	44	69,859	61,532
40	2042			8,822	0	8,822	69,796	19	44	69,859	61,037
41	2043			11,983	0	11,983	69,796	19	44	69,859	57,876
42	2044			15,483	0	15,483	69,796	19	44	69,859	54,376
43	2045			8,327	0	8,327	69,796	19	44	69,859	61,532
44	2046			8,822	0	8,822	69,796	19	44	69,859	61,037
45	2047			11,983	0	11,983	69,796	19	44	69,859	57,876
46	2048			15,483	0	15,483	69,796	19	44	69,859	54,376
47	2049			8,327	0	8,327	69,796	19	44	69,859	61,532
48	2050			8,822	241,785	250,607	69,796	19	44	69,859	-180,748
49	2051			11,983	0	11,983	69,796	19	44	69,859	57,876
50	2052			15,483	0	15,483	69,796	19	44	69,859	54,376
51	2053			8,327	0	8,327	69,796	19	44	69,859	61,532
52	2054			8,822	0	8,822	69,796	19	44	69,859	61,037
53	2055			11,983	0	11,983	69,796	19	44	69,859	57,876
54	2056			15,483	0	15,483	69,796	19	44	69,859	54,376
55	2057			8,327	0	8,327	69,796	19	44	69,859	61,532
56	2058			8,822	0	8,822	69,796	19	44	69,859	61,037
57	2059			11,983	0	11,983	69,796	19	44	69,859	57,876
58	2060			15,483	191,311	206,793	69,796	19	44	69,859	-136,934
59	2061			8,327	0	8,327	69,796	19	44	69,859	61,532
60	2062			8,822	0	8,822	69,796	19	44	69,859	61,037
61	2063			11,983	0	11,983	69,796	19	44	69,859	57,876
62	2064			15,483	0	15,483	69,796	19	44	69,859	54,376
63	2065			8,327	0	8,327	69,796	19	44	69,859	61,532
64	2066			8,822	0	8,822	69,796	19	44	69,859	61,037
65	2067			11,983	0	11,983	69,796	19	44	69,859	57,876
66	2068			15,483	0	15,483	69,796	19	44	69,859	54,376
67	2069			8,327	0	8,327	69,796	19	44	69,859	61,532
68	2070			8,822	241,785	250,607	69,796	19	44	69,859	-180,748
Total		#####	101,901	621,109	1,109,755	2,968,279	4,186,376	1,141	2,616	4,190,133	1,221,854

In the condition of discount rate at 10%:

Present value: 500,662 305,273 -195,389

Internal rate of return (EIRR): 3.73%

B/C: 0.61

Appendix M.7 Willingness of People to Pay by Case and Township

Name of township	Average family size (persons)	Working member (persons)	Average HH income (Kyat/month)	Willingness to pay of HHs who connected with YCDC water supply systems for improvement					Willingness to pay of HHs who do not connect with YCDC water supply systems	
				Clean water supply	Drinkable water supply	24 hours	24 hours	24 hours	Clean water not drinkable	Drinkable water supply
						water supply	clean water supply	drinkable water supply		
01 Ahlone	5.00	1.71	29,586	0	0	0	143	155	0	0
02 Bahan	4.91	1.73	85,464	280	290	310	243	282	200	300
03 Botataung	4.63	1.63	47,125	155	155	194	206	241	0	0
04 Dagon	6.43	1.14	24,971	0	0	0	650	720	0	0
05 Dagon Myothit East	6.44	2.33	48,144	0	0	0	0	0	1,200	1,667
06 Dagon Myothit North	5.23	2.69	49,947	0	0	0	0	0	577	1,000
07 Dagon Myothit Seikkan	5.20	1.60	70,240	0	0	0	0	0	1,300	2,100
08 Dagon Myothit South	6.11	2.64	28,404	0	0	0	0	0	589	1,082
09 Dala	5.13	2.06	13,844	0	0	0	260	0	0	200
10 Dawbon	6.00	1.27	32,055	0	0	200	0	633	0	764
11 Hlaing	4.83	1.43	31,841	0	0	0	0	655	0	944
12 Hlaingthaya	6.71	2.29	29,492	0	0	0	0	0	1,000	268
13 Insein	5.93	1.93	40,413	0	0	0	339	367	333	467
14 Kamayut	6.36	2.07	34,321	0	0	0	342	238	0	0
15 Kyauklada	5.17	1.33	45,233	0	0	0	400	460	0	0
16 Kyeemyindaing	5.81	1.25	39,088	0	0	0	160	181	250	300
17 Lanmadaw	4.14	1.14	69,443	0	500	0	640	600	0	0
18 Latha	3.20	1.60	30,400	0	0	0	283	375	0	0
19 Mayangone	5.17	1.00	37,079	0	0	0	511	450	0	560
20 Mingalardon	5.50	2.00	34,257	0	0	0	490	1,200	126	224
21 Mingalartaungnyunt	5.56	1.56	31,125	170	177	201	228	241	0	0
22 North Okkalapa	6.27	2.16	45,876	267	367	0	432	517	320	506
23 Pabedan	5.25	2.50	39,350	0	0	0	0	363	0	0
24 Pazundaung	4.29	1.57	18,100	151	159	189	200	242	0	0
25 Sanchaung	3.62	1.08	42,615	100	120	140	175	208	0	0
26 Seikan Port										
27 Seikkyi Kanaungto	6.67	1.33	19,575	0	0	0	0	0	0	800
28 Shwepyitha	4.67	1.48	30,715	0	0	0	350	0	264	414
29 South Okkalapa	5.58	2.17	19,541	100	200	0	340	150	500	520
30 Tamwe	5.67	2.00	36,461	189	194	229	246	264	0	0
31 Thaketa	6.05	1.74	19,861	150	156	194	203	253	0	0
32 Thingangyun	5.97	1.72	83,015	0	0	600	617	985	834	1,309
33 Yankin	6.50	2.00	48,750	150	150	200	200	250	0	0
Effective number of samples				73	74	72	241	175	123	169
Overall simple average	5.44	1.76	39,260	171	224	246	333	418	576	746
Average in HHs both who connect with and without YCDC water supply systems	5.41	1.78	36,404	171	185	222	321	383	150	300
Average in HHs who do not connect with YCDC water supply	6.01	1.95	38,692	0	0	0	0	0	559	797
Per capita income in overall average			22,364							

(Note 1)

- Average in HHs who connect with YCDC water supply
- Average in HHs both who connect and do not connect with
- Average in HHs who do not connect with YCDC water supply

Sources: Result of Consumer Survey made by JICA Study Team, July 2001.

**Appendix M.8 Calculation of Financial Internal Rate of Return in
Conventional Way for Phase-1**

(US\$1,000)

Year in order	Year	Financial cost					Financial benefit			Cash balance		
		Construction cost		OM cost	Replac- ment cost	Total	Option- 1	Option- 2	Option- 3	Option-1	Option-2	Option-3
		F/C portion	L/C portion									
-1	2001	0	0	0	0	0	0	0	0	0	0	0
0	2002	0	0	0	0	0	0	0	0	0	0	0
1	2003	0	0	0	0	0	0	0	0	0	0	0
2	2004	31,247	2,338	207		33,792	2,170	3,941	4,569	-31,622	-29,851	-29,223
3	2005	32,399	2,865	207		35,471	2,590	4,703	5,452	-32,881	-30,768	-30,019
4	2006	117,046	12,846	694		130,586	4,772	8,664	10,045	-125,815	-121,922	-120,541
5	2007	90,097	7,747	723		98,567	4,856	8,818	10,224	-93,711	-89,749	-88,343
6	2008	158,583	29,110	1,869		189,562	4,941	8,972	10,402	-184,621	-180,590	-179,159
7	2009	123,557	21,432	1,078		146,067	5,027	9,128	10,583	-141,040	-136,939	-135,484
8	2010	158,448	24,653	8,888		191,988	7,670	13,927	16,147	-184,318	-178,061	-175,841
9	2011	0	0	8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
10	2012	0	0	9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
11	2013	0	0	8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
12	2014			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
13	2015			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
14	2016			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
15	2017			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
16	2018			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
17	2019			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
18	2020			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
19	2021			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
20	2022			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
21	2023			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
22	2024			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
23	2025			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
24	2026			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
25	2027			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
26	2028			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
27	2029			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
28	2030			8,888	284,328	293,215	7,670	13,927	16,147	-285,546	-279,289	-277,068
29	2031			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
30	2032			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
31	2033			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
32	2034			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
33	2035			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
34	2036			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
35	2037			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
36	2038			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
37	2039			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
38	2040			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
39	2041			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
40	2042			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
41	2043			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
42	2044			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
43	2045			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
44	2046			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
45	2047			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
46	2048			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
47	2049			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
48	2050			8,888	284,328	293,215	7,670	13,927	16,147	-285,546	-279,289	-277,068
49	2051			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
50	2052			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
51	2053			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
52	2054			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
53	2055			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
54	2056			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
55	2057			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
56	2058			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
57	2059			8,888		8,888	7,670	13,927	16,147	-1,218	5,039	7,259
58	2060			9,963		9,963	7,670	13,927	16,147	-2,294	3,963	6,184
Total		711,376	100,990	472,028	568,656	1,853,049	415,517	754,492	874,773	-1,437,532	-1,098,558	-978,276

In the condition of discount rate at 10%:

Present value:

Internal rate of return (FIRR):

B/C:

447,560	44,989	81,690	94,713	-402,571	-365,870	-352,847
				#DIV/0!	#DIV/0!	#DIV/0!
				0.10	0.18	0.21

**Appendix M.9 Calculation of Financial Internal Rate of Return in
Conventional Way for Phase-2**

(US\$1,000)

Year in order	Year	Financial cost				Financial benefit			Cash balance		
		Construction cost		Replace- ment cost	Total	Option- 1	Option- 2	Option- 3	Option-1	Option-2	Option-3
		F/C portion	L/C portion								
-1	2001	0	0	0	0	0	0	0	0	0	0
0	2002	0	0	0	0	0	0	0	0	0	0
1	2003	0	0	0	0	0	0	0	0	0	0
2	2004	0	0	0	0	0	0	0	0	0	0
3	2005	0	0	0	0	0	0	0	0	0	0
4	2006	0	0	0	0	0	0	0	0	0	0
5	2007	0	0	0	0	0	0	0	0	0	0
6	2008	0	0	0	0	0	0	0	0	0	0
7	2009	0	0	0	0	0	0	0	0	0	0
8	2010	0	0	0	0	0	0	0	0	0	0
9	2011	45,600	8,473	346	54,419	3,212	5,832	6,762	-51,207	-48,586	-47,657
10	2012	42,063	8,559	286	50,908	3,265	5,928	6,873	-47,644	-44,980	-44,035
11	2013	29,586	3,416	18	33,020	3,317	6,023	6,984	-29,703	-26,997	-26,036
12	2014	10,011	2,348	1,007	13,366	3,370	6,119	7,094	-9,996	-7,247	-6,271
13	2015	22,200	5,193	430	27,824	3,487	6,332	7,342	-24,337	-21,492	-20,482
14	2016	22,080	6,037	320	28,437	3,594	6,527	7,567	-24,842	-21,910	-20,870
15	2017	85,025	14,653	35	99,713	3,702	6,722	7,793	-96,011	-92,991	-91,920
16	2018	120,324	24,374	1,024	145,721	3,809	6,916	8,019	-141,912	-138,805	-137,702
17	2019	163,568	27,165	7,338	198,071	3,916	7,111	8,245	-194,155	-190,959	-189,826
18	2020	9,849	2,271	21,237	33,357	4,688	8,513	9,870	-28,669	-24,844	-23,487
19	2021			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
20	2022			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
21	2023			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
22	2024			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
23	2025			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
24	2026			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
25	2027			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
26	2028			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
27	2029			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
28	2030			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
29	2031			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
30	2032			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
31	2033			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
32	2034			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
33	2035			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
34	2036			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
35	2037			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
36	2038			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
37	2039			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
38	2040			21,237	21,237	4,688	8,513	9,870	-245,027	-241,203	-239,846
39	2041			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
40	2042			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
41	2043			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
42	2044			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
43	2045			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
44	2046			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
45	2047			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
46	2048			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
47	2049			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
48	2050			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
49	2051			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
50	2052			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
51	2053			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
52	2054			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
53	2055			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
54	2056			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
55	2057			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
56	2058			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
57	2059			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
58	2060			21,237	21,237	4,688	8,513	9,870	-245,027	-241,203	-239,846
59	2061			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
60	2062			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
61	2063			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
62	2064			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
63	2065			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
64	2066			17,616	17,616	4,688	8,513	9,870	-12,928	-9,103	-7,746
65	2067			23,928	23,928	4,688	8,513	9,870	-19,240	-15,415	-14,058
66	2068			21,237	21,237	4,688	8,513	9,870	-16,549	-12,725	-11,367
67	2069			16,627	16,627	4,688	8,513	9,870	-11,939	-8,115	-6,757
Total	550,306	102,489	#REF!		2,111,317	266,078	483,141	560,164	-1,845,239	-1,628,175	-1,551,153

In the condition of discount rate at 10%:

Present value:	179,178	15,289	27,762	32,188	-163,889	-151,416	-146,990
Internal rate of return (FIRR):					#DIV/0!	#DIV/0!	#DIV/0!
B/C:					0.09	0.15	0.18

Appendix M.10 Calculation of Financial Internal Rate of Return in Conventional Way for Overall Project

(US\$1,000)

Year in order	Year	Financial cost				Financial benefit			Cash balance			
		Construction cost		OM cost	Replacement cost	Total	Option-1	Option-2	Option-3	Option-1	Option-2	Option-3
		F/C portion	L/C portion									
-1	2001	0	0	0	0	0	0	0	0	0	0	0
0	2002	0	0	0	0	0	0	0	0	0	0	0
1	2003	0	0	0	0	0	0	0	0	0	0	0
2	2004	31,247	2,338	207	0	33,792	2,357	4,280	4,962	-31,435	-29,513	-28,830
3	2005	32,399	2,865	207	0	35,471	2,812	5,106	5,920	-32,659	-30,365	-29,551
4	2006	117,046	12,846	694	0	130,586	5,181	9,408	10,908	-125,405	-121,178	-119,678
5	2007	90,097	7,747	723	0	98,567	5,273	9,575	11,102	-93,294	-88,992	-87,465
6	2008	158,583	29,110	1,869	0	189,562	5,365	9,742	11,295	-184,196	-179,819	-178,266
7	2009	123,557	21,432	1,078	0	146,067	5,458	9,911	11,491	-140,608	-136,155	-134,575
8	2010	158,448	24,653	8,888	0	191,988	8,328	15,123	17,533	-183,660	-176,865	-174,455
9	2011	45,600	8,473	9,233	0	63,306	8,467	15,374	17,825	-54,839	-47,932	-45,481
10	2012	42,063	8,559	9,964	0	60,587	8,606	15,626	18,117	-51,981	-44,961	-42,470
11	2013	29,586	3,416	8,906	0	41,908	8,744	15,878	18,409	-33,163	-26,030	-23,499
12	2014	10,011	2,348	9,894	0	22,253	8,883	16,129	18,701	-13,370	-6,124	-3,553
13	2015	22,200	5,193	9,318	0	36,711	9,193	16,692	19,353	-27,519	-20,020	-17,359
14	2016	22,080	6,037	9,999	0	38,116	9,475	17,204	19,947	-28,641	-20,911	-18,168
15	2017	85,025	14,653	8,923	0	108,601	9,758	17,719	20,544	-98,843	-90,882	-88,057
16	2018	120,324	24,374	9,911	0	154,609	10,041	18,232	21,138	-144,568	-136,377	-133,471
17	2019	163,568	27,165	16,225	0	206,958	10,324	18,746	21,735	-196,635	-188,212	-185,224
18	2020	9,849	2,271	30,916	0	43,036	12,358	22,439	26,017	-30,678	-20,596	-17,019
19	2021			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
20	2022			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
21	2023			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
22	2024			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
23	2025			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
24	2026			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
25	2027			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
26	2028			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
27	2029			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
28	2030			17,616	284,328	301,944	12,358	22,439	26,017	-289,586	-279,504	-275,927
29	2031			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
30	2032			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
31	2033			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
32	2034			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
33	2035			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
34	2036			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
35	2037			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
36	2038			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
37	2039			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
38	2040			30,916	228,478	259,394	12,358	22,439	26,017	-247,036	-236,955	-233,378
39	2041			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
40	2042			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
41	2043			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
42	2044			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
43	2045			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
44	2046			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
45	2047			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
46	2048			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
47	2049			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
48	2050			17,616	284,328	301,944	12,358	22,439	26,017	-289,586	-279,504	-275,927
49	2051			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
50	2052			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
51	2053			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
52	2054			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
53	2055			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
54	2056			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
55	2057			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
56	2058			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
57	2059			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
58	2060			30,916	228,478	259,394	12,358	22,439	26,017	-247,036	-236,955	-233,378
59	2061			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
60	2062			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
61	2063			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
62	2064			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
63	2065			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
64	2066			17,616	0	17,616	12,358	22,439	26,017	-5,258	4,824	8,401
65	2067			23,928	0	23,928	12,358	22,439	26,017	-11,570	-1,489	2,089
66	2068			30,916	0	30,916	12,358	22,439	26,017	-18,558	-8,476	-4,899
67	2069			23,760	0	23,760	12,358	22,439	26,017	-11,402	-1,321	2,257
Total		1,261,682	203,479	1,315,354	#####	3,806,128	736,162	1,336,715	1,549,814	-3,069,966	-2,469,413	-2,256,314
In the condition of discount rate at 10%:												
Present value:						619,374	57,318	104,078	120,670	-562,056	-515,296	-498,704
Internal rate of return (FIRR):										#DIV/0!	#DIV/0!	#DIV/0!
B/C:										0.09	0.17	0.19

Appendix M.11 Levelized Cost of Capital and Necessary Expenditure for Water Supply per Household

Year	Initial investment cost in FC portion (US\$1,000)	Initial investment cost in LC portion (US\$1,000)	Cost for Operation and Maintenance (US\$1,000)	Total (US\$1,000)	Designed water volume to be supplied (m ³ /annum)
2001	0	0	0	0	0
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	31,247	2,338	207	33,792	59,620,938
2005	32,399	2,865	207	35,471	79,666,047
2006	117,046	12,846	694	130,586	168,730,851
2007	90,097	7,747	723	98,567	175,668,851
2008	158,583	29,110	1,869	189,562	182,605,050
2009	123,557	21,432	1,078	146,067	189,575,950
2010	158,448	24,653	8,888	191,988	296,701,051
2011	45,600	8,473	9,233	63,306	305,310,856
2012	42,063	8,559	9,964	60,587	313,918,867
2013	29,586	3,416	8,906	41,908	322,525,086
2014	10,011	2,348	9,894	22,253	331,129,513
2015	22,200	5,193	9,318	36,711	345,900,652
2016	22,080	6,037	9,999	38,116	359,684,503
2017	85,025	14,653	8,923	108,601	373,503,069
2018	120,324	24,374	9,911	154,609	387,283,351
2019	163,568	27,165	16,225	206,958	401,098,352
2020	9,849	2,271	30,916	43,036	478,056,572
2021			23,760	23,760	478,056,572
2022			17,616	17,616	478,056,572
2023			23,928	23,928	478,056,572
2024			30,916	30,916	478,056,572
2025			23,760	23,760	478,056,572
2026			17,616	17,616	478,056,572
2027			23,928	23,928	478,056,572
2028			30,916	30,916	478,056,572
2029			23,760	23,760	478,056,572
2030			17,616	17,616	478,056,572
2031			23,928	23,928	478,056,572
2032			30,916	30,916	478,056,572
2033			23,760	23,760	478,056,572
2034			17,616	17,616	478,056,572
2035			23,928	23,928	478,056,572
2036			30,916	30,916	478,056,572
2037			23,760	23,760	478,056,572
2038			17,616	17,616	478,056,572
2039			23,928	23,928	478,056,572
2040			30,916	30,916	478,056,572
Total				2,083,216	14,332,111,001
Present value*				589,945	1,989,462,148
Levelized cost (US\$/m³)					29.65
Equivalent to domestic currency (Kyats/m³)					148
Necessary expenditure for water (Kyats/month per HH)					4,359

(Note) Exchange rate: US\$1.00 = 500 Kyats.
Daily consumption of water: 140 l/day per capita.
Average family size: 7 persons/HH.
Discount rate: 10 %

**Appendix M.12 Calculation of Financial Internal Rate of Return in
Case of Recommended Pricing Schedule for Phase-1**

Water price to be applied (US\$/m ³):	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>	<u>Share rate</u>
Domestic sector	8.47	12.65	15.62	17.92	70%
Public sector	5.65	8.43	10.41	11.95	10%
Industrial/commercial sector	38.11	56.93	70.29	80.65	20%

(1,000 US\$)

Year in order	Year	Financial cost				Annual water volume to be supplied (m ³ /annum)	Financial benefit			Cash balance		
		Construction cost		OM cost	Replacement cost		Total	Domestic sector	Public sector		Industrial/commercial sector	
		F/C portion	L/C portion									
-1	2001	0	0	0	0	0	0	0	0	0		
0	2002	0	0	0	0	0	0	0	0	0		
1	2003	0	0	0	0	0	0	0	0	0		
2	2004	31,247	2,338	207	0	33,792	59,620,938	551	52	708	1,312	-32,481
3	2005	32,399	2,865	207	0	35,471	79,666,047	4,723	450	6,073	11,246	-24,225
4	2006	117,046	12,846	694	0	130,586	168,730,851	10,004	953	12,862	23,818	-106,768
5	2007	90,097	7,747	723	0	98,567	175,668,851	10,415	992	13,391	24,797	-73,769
6	2008	158,583	29,110	1,869	0	189,562	182,605,050	10,826	1,031	13,919	25,777	-163,785
7	2009	123,557	21,432	1,078	0	146,067	189,575,950	11,239	1,070	14,451	26,761	-119,306
8	2010	158,448	24,653	8,888	0	191,988	296,701,051	26,277	2,503	33,785	62,564	-129,424
9	2011	0	0	8,888	0	8,888	296,701,051	26,277	2,503	33,785	62,564	53,677
10	2012	0	0	9,963	0	9,963	296,701,051	26,277	2,503	33,785	62,564	52,601
11	2013	0	0	8,888	0	8,888	296,701,051	26,277	2,503	33,785	62,564	53,677
12	2014			8,888	0	8,888	296,701,051	26,277	2,503	33,785	62,564	53,677
13	2015			8,888	0	8,888	296,701,051	32,440	3,090	41,708	77,238	68,351
14	2016			9,963	0	9,963	296,701,051	32,440	3,090	41,708	77,238	67,275
15	2017			8,888	0	8,888	296,701,051	32,440	3,090	41,708	77,238	68,351
16	2018			8,888	0	8,888	296,701,051	32,440	3,090	41,708	77,238	68,351
17	2019			8,888	0	8,888	296,701,051	32,440	3,090	41,708	77,238	68,351
18	2020			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
19	2021			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
20	2022			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
21	2023			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
22	2024			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
23	2025			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
24	2026			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
25	2027			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
26	2028			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
27	2029			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
28	2030			8,888	284,328	293,215	296,701,051	37,221	3,545	47,855	88,620	-204,595
29	2031			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
30	2032			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
31	2033			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
32	2034			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
33	2035			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
34	2036			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
35	2037			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
36	2038			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
37	2039			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
38	2040			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
39	2041			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
40	2042			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
41	2043			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
42	2044			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
43	2045			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
44	2046			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
45	2047			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
46	2048			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
47	2049			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
48	2050			8,888	284,328	293,215	296,701,051	37,221	3,545	47,855	88,620	-204,595
49	2051			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
50	2052			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
51	2053			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
52	2054			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
53	2055			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
54	2056			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
55	2057			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
56	2058			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
57	2059			8,888	0	8,888	296,701,051	37,221	3,545	47,855	88,620	79,733
58	2060			9,963	0	9,963	296,701,051	37,221	3,545	47,855	88,620	78,657
Total		711,376	100,990	472,028		1,853,049		1,867,385	177,846	2,400,921	4,446,151	2,593,102

In the condition of discount rate at 10%:

Present value:	447,560	158,381	15,084	203,632	377,096	-70,463
Internal rate of return (FIRR):						8.03%
B/C:						0.84

**Appendix M.13 Calculation of Financial Internal Rate of Return in
Case of Recommended Pricing Schedule for Phase-2**

Water price to be applied (US\$/m ³):	2005	2010	2015	2020	Share rate
Domestic sector	8.47	12.65	15.62	17.92	70%
Public sector	5.65	8.43	10.41	11.95	10%
Industrial/commercial sector	38.11	56.93	70.29	80.65	20%

Year in order	Year	Financial cost				Annual water volume to be supplied (m ³ /annum)	Financial benefit			Cash balance		
		Construction cost		OM cost	Replace-ment cost		Total	Domestic sector	Public sector		Industrial/commercial sector	
		F/C portion	L/C portion									
-1	2001	0	0	0	0	0	0	0	0	0		
0	2002	0	0	0	0	0	0	0	0	0		
1	2003	0	0	0	0	0	0	0	0	0		
2	2004	0	0	0	0	0	0	0	0	0		
3	2005	0	0	0	0	0	0	0	0	0		
4	2006	0	0	0	0	0	0	0	0	0		
5	2007	0	0	0	0	0	0	0	0	0		
6	2008	0	0	0	0	0	0	0	0	0		
7	2009	0	0	0	0	0	0	0	0	0		
8	2010	0	0	0	0	0	0	0	0	0		
9	2011	45,600	8,473	346	0	54,419	8,609,805	763	73	980	1,816	-52,603
10	2012	42,063	8,559	286	0	50,908	17,217,816	1,525	145	1,961	3,631	-47,278
11	2013	29,586	3,416	18	0	33,020	25,824,035	2,287	218	2,941	5,445	-27,575
12	2014	10,011	2,348	1,007	0	13,366	34,428,462	3,049	290	3,920	7,260	-6,106
13	2015	22,200	5,193	430	0	27,824	49,199,601	5,379	512	6,916	12,808	-15,016
14	2016	22,080	6,037	320	0	28,437	62,983,452	6,886	656	8,854	16,396	-12,041
15	2017	85,025	14,653	35	0	99,713	76,802,018	8,397	800	10,796	19,993	-79,720
16	2018	120,324	24,374	1,024	0	145,721	90,582,300	9,904	943	12,734	23,581	-122,141
17	2019	163,568	27,165	7,338	0	198,071	104,397,301	11,414	1,087	14,676	27,177	-170,894
18	2020	9,849	2,271	21,237	0	33,357	181,355,521	22,751	2,167	29,251	54,168	20,811
19	2021			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
20	2022			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
21	2023			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
22	2024			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
23	2025			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
24	2026			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
25	2027			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
26	2028			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
27	2029			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
28	2030			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
29	2031			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
30	2032			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
31	2033			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
32	2034			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
33	2035			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
34	2036			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
35	2037			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
36	2038			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
37	2039			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
38	2040			21,237	228,478	249,715	181,355,521	22,751	2,167	29,251	54,168	-195,547
39	2041			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
40	2042			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
41	2043			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
42	2044			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
43	2045			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
44	2046			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
45	2047			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
46	2048			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
47	2049			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
48	2050			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
49	2051			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
50	2052			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
51	2053			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
52	2054			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
53	2055			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
54	2056			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
55	2057			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
56	2058			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
57	2059			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
58	2060			21,237	228,478	249,715	181,355,521	22,751	2,167	29,251	54,168	-195,547
59	2061			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
60	2062			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
61	2063			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
62	2064			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
63	2065			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
64	2066			17,616	0	17,616	181,355,521	22,751	2,167	29,251	54,168	36,552
65	2067			23,928	0	23,928	181,355,521	22,751	2,167	29,251	54,168	30,240
66	2068			21,237	0	21,237	181,355,521	22,751	2,167	29,251	54,168	32,931
67	2069			16,627	0	16,627	181,355,521	22,751	2,167	29,251	54,168	37,541
Total		550,306	#####	1,001,565		456,957	2,111,317	1,187,138	113,061	1,526,320	2,826,518	715,202

In the condition of discount rate at 10%:

Present value:	179,178	47,196	4,495	60,681	112,372	-66,806
Internal rate of return (FIRR):						3.89%
B/C:						0.63

Appendix M.15 Repayment Ability of Loan for Phase 1

Year in order	Year	Outflow						In flow				(US\$1,000)	(US\$1,000)
		Construction cost		Foreign borrow		OM cost	Total	Foreign borrow	Revenu e in total	In flow in total	Cash balance	Subsidy to the Project from YCDC or Central Government of Myanmar	
		Loan portion	Local portion	Interest	Principal								
-1	2001	0	0	0	0	0	0	0	0	0	0	0	0
0	2002	0	0	0	0	0	0	0	0	0	0	0	0
1	2003	0	0	0	0	0	0	0	0	0	0	0	0
2	2004	31,875	2,361	0	0	207	34,444	31,875	1,312	33,186	-1,257	1,257	
3	2005	33,380	2,908	414	0	207	36,910	33,380	11,246	44,626	7,716		
4	2006	121,799	13,105	848	0	694	136,446	121,799	23,818	145,617	9,171		
5	2007	94,693	7,943	2,432	0	723	105,790	94,693	24,797	119,490	13,700		
6	2008	168,339	29,994	3,663	0	1,869	203,865	168,339	25,777	194,115	-9,749	9,749	
7	2009	132,470	22,193	5,851	0	1,078	161,592	132,470	26,761	159,230	-2,362	2,362	
8	2010	171,576	25,656	7,573	0	8,888	213,693	171,576	62,564	234,140	20,447		
9	2011			9,804	0	8,888	18,691		62,564	62,564	43,873		
10	2012			9,804	0	9,963	19,767		62,564	62,564	42,797		
11	2013			9,804	33,260	8,888	51,951		62,564	62,564	10,613		
12	2014			9,371	33,692	8,888	51,951		62,564	62,564	10,613		
13	2015			8,933	34,130	8,888	51,951		77,238	77,238	25,287		
14	2016			8,490	34,574	9,963	53,027		77,238	77,238	24,211		
15	2017			8,040	35,024	8,888	51,951		77,238	77,238	25,287		
16	2018			7,585	35,479	8,888	51,951		77,238	77,238	25,287		
17	2019			7,124	35,940	8,888	51,951		77,238	77,238	25,287		
18	2020			6,656	36,407	9,963	53,027		88,620	88,620	35,593		
19	2021			6,183	36,881	8,888	51,951		88,620	88,620	36,669		
20	2022			5,704	37,360	8,888	51,951		88,620	88,620	36,669		
21	2023			5,218	37,846	8,888	51,951		88,620	88,620	36,669		
22	2024			4,726	38,338	9,963	53,027		88,620	88,620	35,593		
23	2025			4,228	38,836	8,888	51,951		88,620	88,620	36,669		
24	2026			3,723	39,341	8,888	51,951		88,620	88,620	36,669		
25	2027			3,211	39,852	8,888	51,951		88,620	88,620	36,669		
26	2028			2,693	40,371	9,963	53,027		88,620	88,620	35,593		
27	2029			2,168	40,895	8,888	51,951		88,620	88,620	36,669		
28	2030			1,637	41,427	8,888	51,951		88,620	88,620	36,669		
29	2031			1,098	41,966	8,888	51,951		88,620	88,620	36,669		
30	2032			553	42,511	9,963	53,027		88,620	88,620	35,593		
31	2033					8,888	8,888		88,620	88,620	79,733		
32	2034					8,888	8,888		88,620	88,620	79,733		
33	2035					8,888	8,888		88,620	88,620	79,733		
34	2036					9,963	9,963		88,620	88,620	78,657		
35	2037					8,888	8,888		88,620	88,620	79,733		
36	2038					8,888	8,888		88,620	88,620	79,733		
37	2039					8,888	8,888		88,620	88,620	79,733		
38	2040					9,963	9,963		88,620	88,620	78,657		
39	2041					8,888	8,888		88,620	88,620	79,733		
40	2042					8,888	8,888		88,620	88,620	79,733		
41	2043					8,888	8,888		88,620	88,620	79,733		
42	2044					9,963	9,963		88,620	88,620	78,657		
43	2045					8,888	8,888		88,620	88,620	79,733		
44	2046					8,888	8,888		88,620	88,620	79,733		
45	2047					8,888	8,888		88,620	88,620	79,733		
46	2048					9,963	9,963		88,620	88,620	78,657		
47	2049					8,888	8,888		88,620	88,620	79,733		
48	2050					8,888	8,888		88,620	88,620	79,733		
49	2051					8,888	8,888		88,620	88,620	79,733		
50	2052					9,963	9,963		88,620	88,620	78,657		
51	2053					8,888	8,888		88,620	88,620	79,733		
52	2054					8,888	8,888		88,620	88,620	79,733		
53	2055					8,888	8,888		88,620	88,620	79,733		
54	2056					9,963	9,963		88,620	88,620	78,657		
55	2057					8,888	8,888		88,620	88,620	79,733		
56	2058					8,888	8,888		88,620	88,620	79,733		
57	2059					8,888	8,888		88,620	88,620	79,733		
58	2060					9,963	9,963		88,620	88,620	78,657		
Total		754,131						754,131					

(Note)

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| (1) Interest rate of foreign loan: | 1.30% |
| (2) Equal annual repayment amount of capital for foreign loan (US\$1,000): | 43,064 |