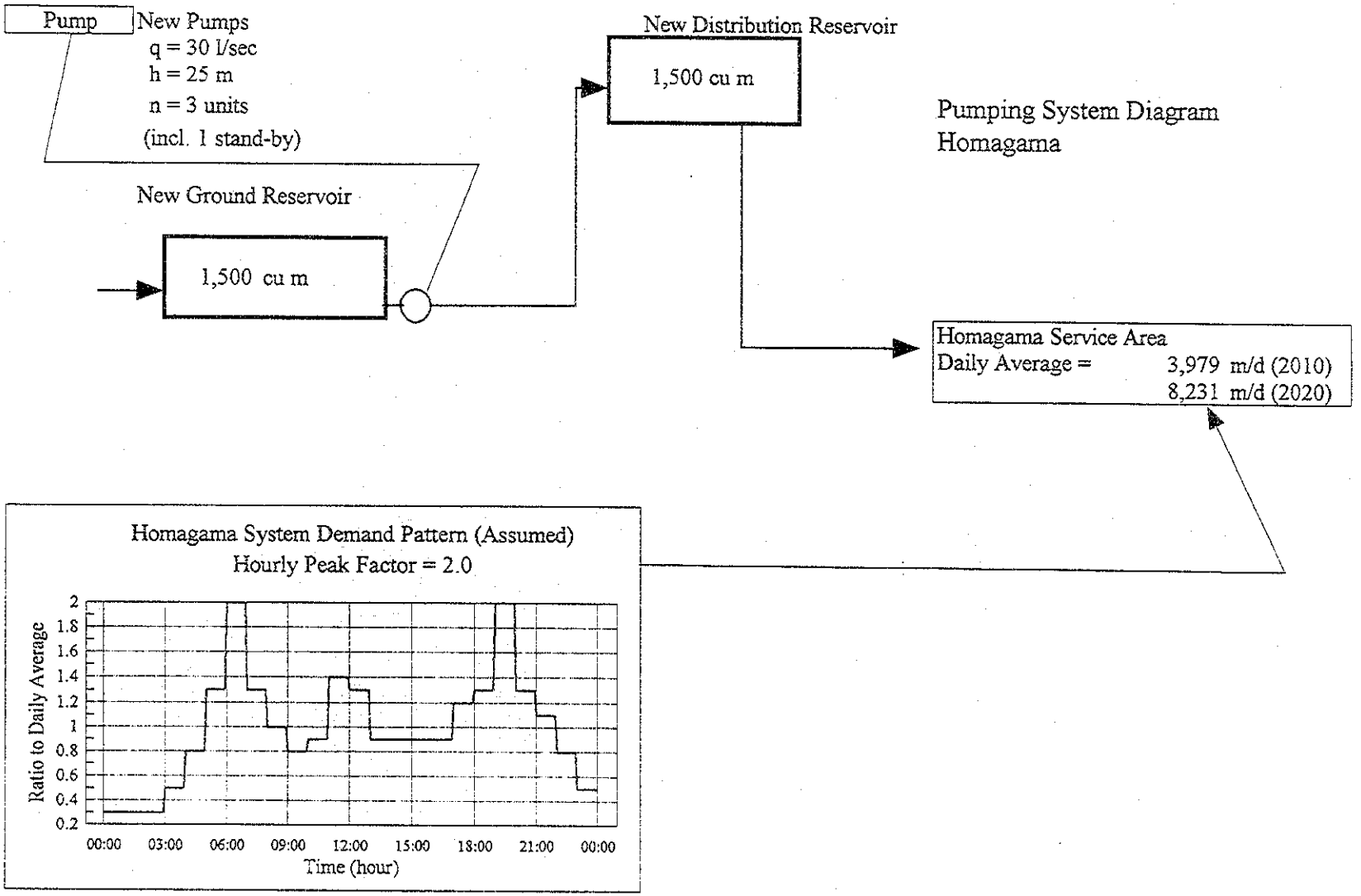
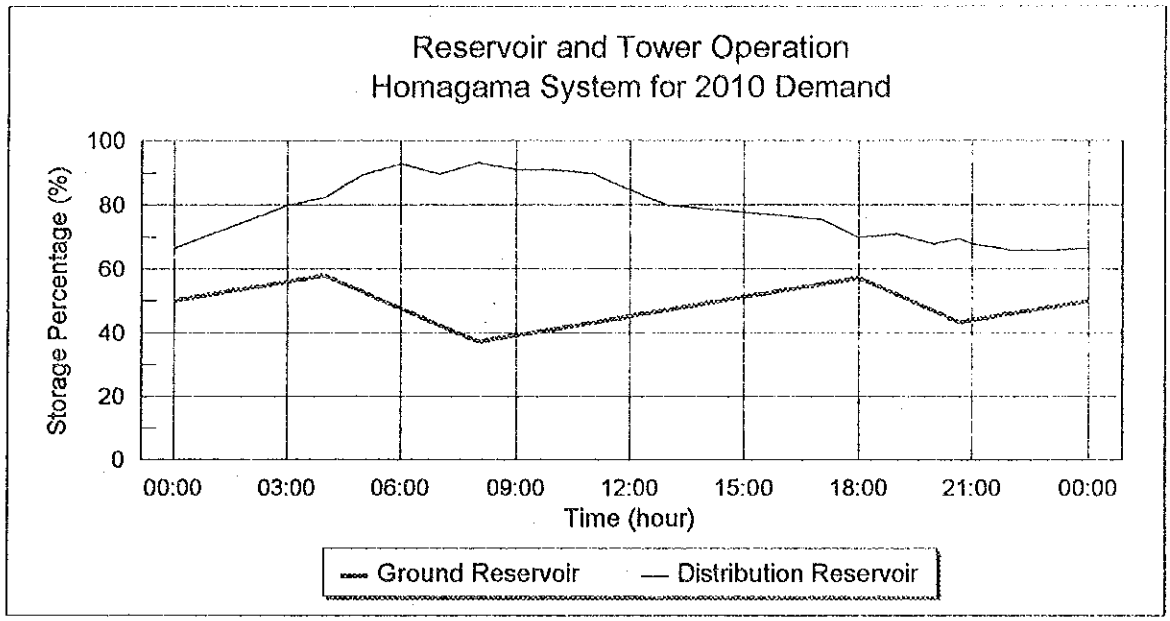
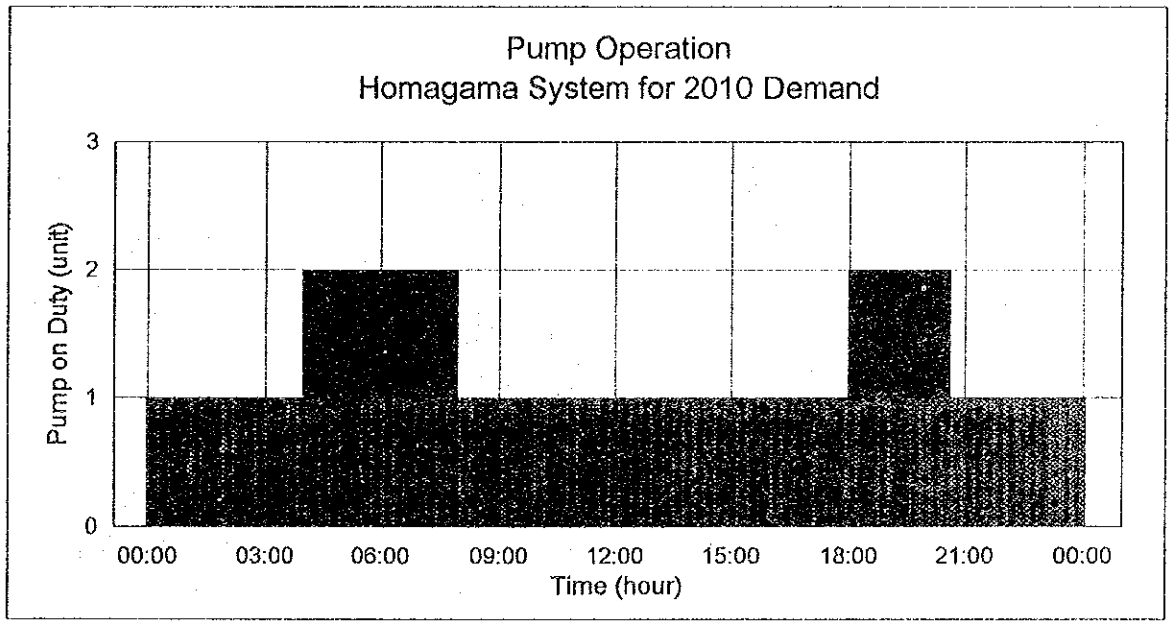

Pump
New Pumps
q = 30 l/sec
h = 25 m
n = 3 units
(incl. 1 stand-by)
New Ground Reservoir
1,500 cu m
New Distribution Reservoir
1,500 cu m
Pumping System Diagram
Homagama
Homagama Service Area
Daily Average = 3,979 m/d (2010)
8,231 m/d (2020)
Homagama System Demand Pattern (Assumed)
Hourly Peak Factor = 2.0
Ratio to Daily Average
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time (hour)



Ground Reservoir Capacity = 1,500 cu m (New Reservoir)

Distribution Reservoir Capacity = 1,500 cu m (New Reservoir)



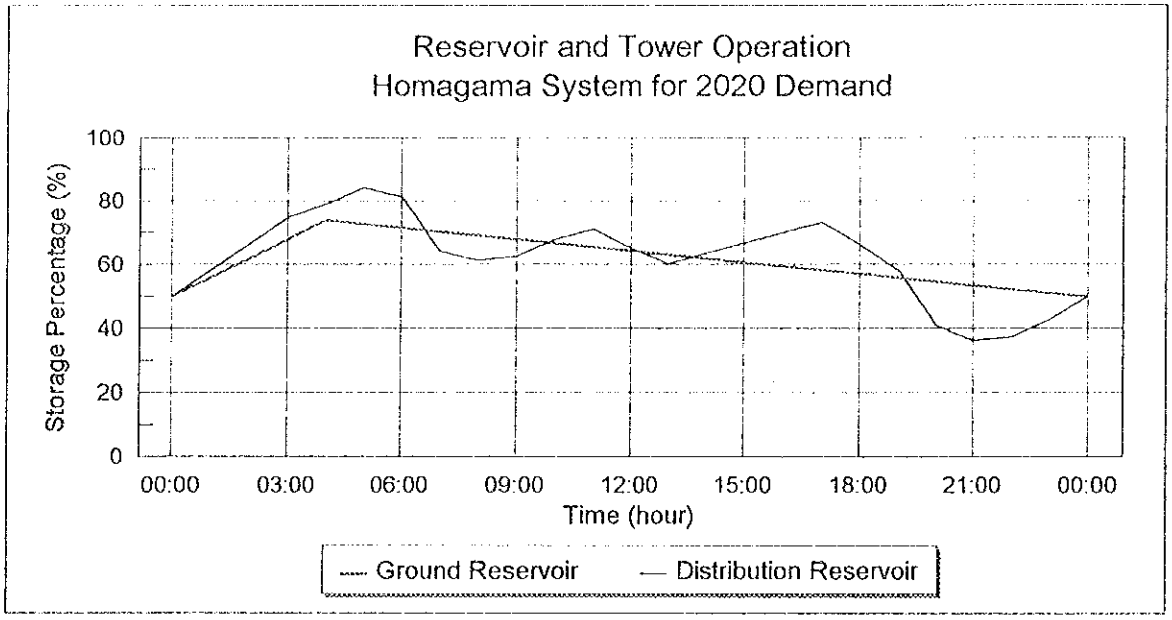
Pump Specifications

New Pumps

q = 30 l/sec

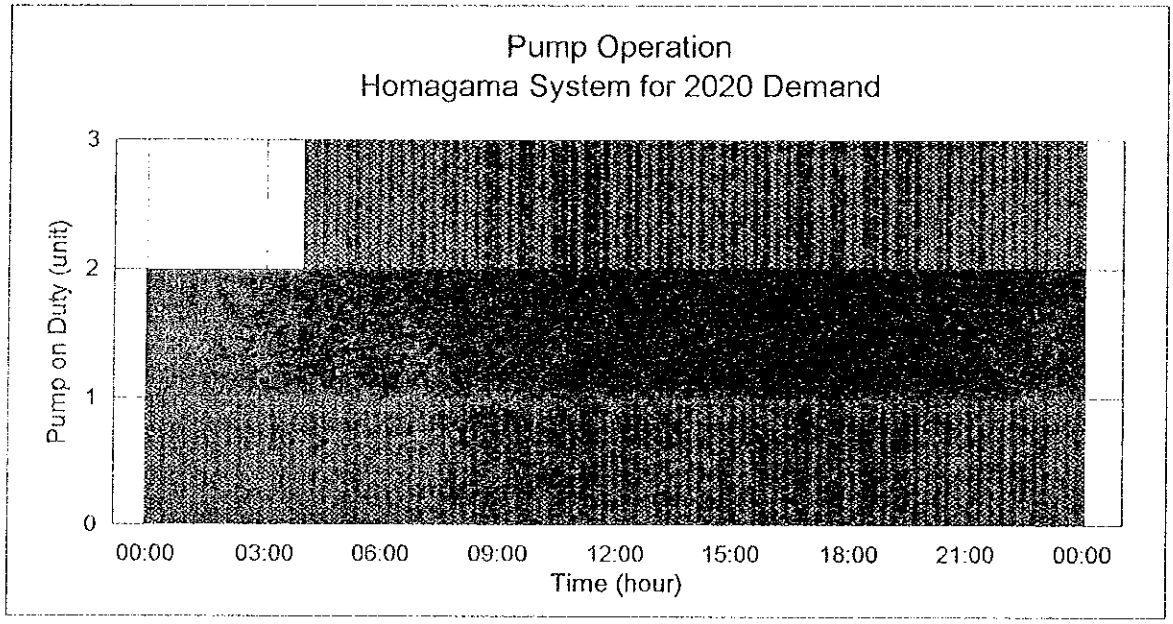
h = 25 m

3 units (incl. 1 stand-by)



Ground Reservoir Capacity = 1,500 cu m

Distribution Reservoir Capacity = 1,500 cu m



Pump Specifications

New Pumps

q = 30 l/sec

h = 25 m

4 units (incl. 1 stand-by)

CHAPTER 12

Ref. No. 12.1

Subject : Project Cost Estimates

Title : Unit Construction Cost

Contents : Unit Construction Cost for Each Item of Construction Works

Unit Construction Cost

Construction Items	unit	unit cost (Rs)	Foreign Portion ratio (%)	Foreign Portion cost (Y)	Local Portion ratio (%)	Local Portion cost (Rs)
Intake facilities						
1) excavation, common including coffering	m3	800	65	1,144	35	280
2) excavation, rock including coffering	m3	2,000	65	2,860	35	700
3) excavation, common	m3	350	65	501	35	123
4) excavation, rock	m3	1,500	65	2,145	35	525
5) embankment	m3	450	65	644	35	158
6) concrete w/form and re-bar, 210 kg/cm2	m3	13,000	65	18,590	35	4,550
7) concrete w/form and re-bar, 180 kg/cm2	m3	11,000	65	15,730	35	3,850
8) re-bar	t	60,000	90	118,800	10	6,000
9) backfilling	m3	300	65	429	35	105
10) office building	m2	25,000	50	27,500	50	12,500
11) steel sheet piling	m2	10,000	90	19,800	10	1,000
Raw water transmission facilities						
1) steel pipe,DN1500 mm, w/fittings, supply & delivery	m	101,580	75	167,607	25	25,395
2) -do-, laying cost 15 % of 1) above	m	15,237	30	10,056	70	10,666
3) road reinstatement 5 % of 1) above (3.0 m2/m)	m	5,079	30	3,352	70	3,555
4) DIP,DN1500 mm, w/fittings,	m	108,000	75	178,200	25	27,000
Treatment facilities						
1) excavation, common	m3	350	65	501	35	123
2) excavation, rock	m3	1,200	65	1,716	35	420
3) embankment	m3	450	65	644	35	158
4) concrete w/form & re-bar, 210 kg/cm2	m3	13,000	65	18,590	35	4,550
5) re-bar	t	70,000	90	138,600	10	7,000
6) backfilling	m3	300	65	429	35	105
7) control building	m2	25,000	50	27,500	50	12,500
8) staff house	m2	13,840	50	15,224	50	6,920
9) in-situ pile,400 dia.	m	9,000	65	12,870	35	3,150
Clear water transmission & distribution facilities						
1) steel pipe,DN1650 mm, w/fittings, supply & delivery	m	117,650	75	194,123	25	29,413
2) -do-, laying cost 15 % of 1) above	m	17,648	30	11,647	70	12,353
3) road reinstatement 5 % of 1) above (3.3 m2/m)	m	5,883	30	3,882	70	4,118
4) DIP,DN1650 mm, w/fittings, supply & delivery	m	125,000	75	206,250	25	31,250
High level reservoir						
1) excavation, common	m3	400	65	572	35	140
2) excavation, rock	m3	1,500	65	2,145	35	525
3) excess soil treat	m3	300	65	429	35	105
4) embankment	m3	450	65	644	35	158
5) backfill	m3	380	65	543	35	133
6) concrete, 180 kg/cm2	m3	11,000	65	15,730	35	3,850
7) concrete, 210 kg/cm2	m3	13,000	65	18,590	35	4,550

Unit Construction Cost

Construction Items	unit	unit cost (Rs)	Foreign Portion ratio (%)	Foreign Portion cost (Y)	Local Portion ratio (%)	Local Portion cost (Rs)
8) re-bar	t	60,000	90	118,800	10	6,000
9) access road, W=10m	m	5,000	65	7,150	35	1,750
10) concrete pile 400*400, l=20 m	m	9,000	65	12,870	35	3,150
(1) pipe and fittings (supply & delivery cost to cover C	F colombo	custom duty,	inland treansportation and fitting	cost)		
1) D.I pipe, 1200 dia.	m	70,000	75	115,500	25	17,500
2) D.I pipe, 1000 dia.	m	52,500	75	86,625	25	13,125
3) D.I pipe, 900 dia.	m	42,000	75	69,300	25	10,500
4) D.I pipe, 800 dia.	m	34,500	75	56,925	25	8,625
5) D.I pipe, 600 dia.	m	17,600	75	29,040	25	4,400
6) D.I pipe, 500 dia.	m	13,600	75	22,440	25	3,400
7) D.I pipe, 400 dia.	m	11,000	75	18,150	25	2,750
8) D.I pipe, 350 dia.	m	9,000	75	14,850	25	2,250
9) D.I pipe, 200 dia.	m	5,000	75	8,250	25	1,250
10) PVC pipe, 200 dia.	m	2,400	0	0	100	2,400
11) PVC pipe, 150 dia.	m	2,000	0	0	100	2,000
12) PVC pipe, 100 dia.	m	1,600	0	0	100	1,600
13) PVC pipe, 90 dia.	m	800	0	0	100	800
14) PVC pipe, 63 dia.	m	500	0	0	100	500
(laying cost, 15 % of suply & delivery cost)						
1) D.I pipe, 1200 dia.	m	10,500	30	6,930	70	7,350
2) D.I pipe, 1000 dia.	m	7,875	30	5,198	70	5,513
3) D.I pipe, 900 dia.	m	6,300	30	4,158	70	4,410
4) D.I pipe, 800 dia.	m	5,175	30	3,416	70	3,623
5) D.I pipe, 600 dia.	m	2,640	30	1,742	70	1,848
6) D.I pipe, 500 dia.	m	2,040	30	1,346	70	1,428
7) D.I pipe, 400 dia.	m	1,650	30	1,089	70	1,155
8) D.I pipe, 350 dia.	m	1,350	30	891	70	945
9) D.I pipe, 200 dia.	m	750	30	495	70	525
10) PVC pipe, 200 dia.	m	360	30	238	70	252
11) PVC pipe, 150 dia.	m	300	30	198	70	210
12) PVC pipe, 100 dia.	m	240	30	158	70	168
13) PVC pipe, 90 dia.	m	150	30	99	70	105
14) PVC pipe, 80 dia.	m	120	30	79	70	84
(road reinstatement cost, 5 % of supply & delivery cost)						
1) D.I pipe, 1200 dia.	m	3,500	30	2,310	70	2,450
2) D.I pipe, 1000 dia.	m	2,625	30	1,733	70	1,838
3) D.I pipe, 900 dia.	m	2,100	30	1,386	70	1,470
4) D.I pipe, 800 dia.	m	1,725	30	1,139	70	1,208
5) D.I pipe, 600 dia.	m	880	30	581	70	616
6) D.I pipe, 500 dia.	m	680	30	449	70	476
7) D.I pipe, 400 dia.	m	550	30	363	70	385
8) D.I pipe, 350 dia.	m	450	30	297	70	315
9) D.I pipe, 200 dia.	m	250	30	165	70	175
10) PVC pipe, 200 dia.	m	120	30	79	70	84
11) PVC pipe, 150 dia.	m	100	30	66	70	70
12) PVC pipe, 100 dia.	m	80	30	53	70	56
13) PVC pipe, 90 dia.	m	50	30	33	70	35
14) PVC pipe, 80 dia.	m	40	30	26	70	28
(2) ground reservoir 1500 m3	m3	10,000	65	14,300	35	3,500
(3) ground reservoir, 2000 m3	m3	5,000	65	7,150	35	1,750
(4) pump station	kw	10,000	80	17,600	20	2,000
(5) water tower, 1000 m3	m3	15,000	65	21,450	35	5,250
(6) water tower, 2000 m3	m3	14,000	65	20,020	35	4,900
(7) public utilities	l.s	-	50	-	50	-

CHAPTER 12

Ref. No. 12.2

Subject : Project Cost Estimates

Title : Unit Cost for Land Acquisition and Compensation

Contents : Unit Cost for Land Acquisition and Compensation

Unit Cost for Land Acquisition & Compensation

Area/location	unit	unit cost (Rs)
(land acquisition)		
Intake, UDUGAMA	m2	300
Intake, UDUWARA	m2	450
Treatment plant, UDUGAMA	m2	1,000
treatment plant, REMUNA	m2	
Storage facilities	m2	1,000
Distribution facilities		
(1) distribution main	m2	1,600
POKUNUWIRA-KUMBUKE		
- PALAMORUWA		
- KUHATHUDUWA		
(2) tower	m2	
(3) reservoir	m2	
(compensation)		
house compensation		
- wooden	m2	1,500
- rubble masonry	m2	2,500
- wet masonry	m2	2,500
- reinforced concrete	m2	3,000

CHAPTER 12

Ref. No. 12.3

Subject : Project Cost Estimates

Title : Breakdown of Cost Estimates for Direct Construction Works

Contents : Construction Works for Stage 1 of Phase 1 (2010)

Construction Works for Stage 2 of Phase 1 (2010)

Priced Bill of Quantities for Direct Construction Works
Stage 1 of Phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q`ty	cost F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
101	Preliminary & general						
/01	insurances/bond	l.s	-	-	0		72,500,000
/02	temporary facilities and services	l.s	-	-	150,000,000		50,000,000
/03	all measures required for maintenance of traffic flows & access	l.s	-	-	0		36,000,000
/04	office/laboratoy	l.s	-	-	3,200,000		2,500,000
/05	other incidentals	l.s	-	-	30,000,000		20,000,000
	sub total of 101				183,200,000		181,000,000
102	Intake facilities (civil works)						
/01	excavation, common w/coffering	m3	4,100	1,114	4,567,400	280	1,148,000
/02	excavation, rock w/ coffering	m3	4,600	2,860	13,156,000	700	3,220,000
/03	excavation, common	m3	8,100	501	4,058,100	123	996,300
/04	excavation, rock	m3	9,300	2,145	19,948,500	525	4,882,500
/05	concrete w/form & re-bar, 180 kg/cm2	m3	700	15,730	11,011,000	3,850	2,695,000
/06	concrete w/form & re-bar, 210 kg/cm2	m3	9,050	18,590	168,239,500	4,550	41,177,500
/07	backfill	m3	6,600	429	2,831,400	105	693,000
/08	excess soil	m3	19,400	429	8,322,600	105	2,037,000
/09	steel grating,11-set	m2	17	15,840	269,280	800	13,600
/10	ladder,SUS304,4-set	m	212	69,300	14,691,600	3,500	742,000
/11	handrail, SUS304	m	310	69,300	21,483,000	3,500	1,085,000
/12	pipe line, SP1500 mm	m	100	207,900	20,790,000	31,500	3,150,000
/13	miscellaneous works (3 % of of above)	l.s	-	-	8,681,051	-	1,855,197
	sub total				298,049,431		63,695,097
	(mech. & elect. works)						
/14	screen/gate	l.s	-	-	160,000,000	-	8,070,000
/15	pump,4-set,22.12 m3/m.	l.s	-	-	172,725,300	-	8,723,500
/16	substation,receiving panel	l.s	-	-	207,000,000	-	10,480,000
/17	pump control panel	l.s	-	-	37,570,000	-	4,170,000
/18	miscellaneous works (1 % of above)	l.s	-	-	5,772,953	-	314,435
	sub total				583,068,253		31,757,935
	(building works)						
/19	pump house,300 m2*1	m2	300	27,500	8,250,000	12,500	3,750,000
/20	staff house,100m2*4	m2	400	15,224	6,089,600	6,920	2,768,000
	sub total				14,339,600		6,518,000
	sub total of 102				895,457,284		101,971,032
103	Raw water transmission facilities						
	(supply & delivery cost for pipe & fittings)						
/01	transmission main intake to WTP, DN1500 mm, steel p.	m	7,670	167,607	1,285,545,690	25,395	194,779,650
	(laying cost/road reinstatement cost)						
/02	laying cost, intake to WTP, DN 1500 mm	m	7,670	10,056	77,129,520	10,666	81,808,220

Priced Bill of Quantities for Direct Construction Works
Stage 1 of Phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q'ty	cost F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
/03	road reinstatement for item 103/02	m	7,670	3,352	25,709,840	3,555	27,266,850
	sub total of 103				1,388,385,050		303,854,720
104	Treatment facilities (civil works)						
	whole plant site						
/01	clearing & stripping	ha	10	1,573,000	15,730,000	385,000	3,850,000
/02	excavation, common	m3	174,000	501	87,174,000	123	21,402,000
/03	excavation, rock	m3	16,700	2,145	35,821,500	525	8,767,500
/04	embankment	m3	104,300	644	67,169,200	158	16,479,400
/05	backfill	m3	61,000	429	26,169,000	105	6,405,000
/06	piping,1500 mm dia. concrete made	m	575	1,716	986,700	420	241,500
/07	inner roads	m2	18,600	715	13,299,000	175	3,255,000
	receiving well						
/08	concrete w/form and re-bar, 210 kg/cm2	m3	27	18,590	501,930	4,550	122,850
/09	concrete w/form and re-bar, 160 kg/cm2	m3	2	15,000	30,000	3,500	7,000
/10	piping,1500 dia.steel	m	147	167,607	24,638,229	25,395	3,733,065
/11	piping,150 dia,DIP	m	322	7,000	2,254,000	1,000	322,000
/12	piping,1000 dia.DIP	m	100	86,625	8,662,500	13,125	1,312,500
	rapid mixing						
/13	concrete w/form and re-bar, 210 kg/cm2	m3	16	18,590	297,440	4,550	72,800
	flow splitting chamber						
/14	concrete w/form and re-bar, 210 kg/cm2	m3	14	18,590	260,260	4,550	63,700
/15	concrete w/form and re-bar, 160 kg/cm2	m3	3	15,000	45,000	3,500	10,500
/16	piping, 800 dia.DIP	m	232	56,925	13,206,600	8,625	2,001,000
/17	piping, 600 dia.DIP	m	87	29,040	2,526,480	4,400	382,800
	flocculation & sedimentation basin						
/18	concrete w/form and re-bar, 210 kg/cm2	m3	5,020	18,590	93,321,800	4,550	22,841,000
/19	concrete w/form and re-bar, 160 kg/cm2	m3	420	15,000	6,300,000	3,500	1,470,000
/20	cobble stone	m3	1,255	297	372,735	315	395,325
/21	piping,500 dia,DIP	m	466	22,440	10,457,040	3,400	1,584,400
/22	piping,200 dia,DIP	m	130	8,250	1,072,500	1,250	162,500
/23	piping,300 dia,DIP	m	92	13,000	1,196,000	1,800	165,600
/24	in-situ found.piling, 400 dia.,l=5 m	no.	1,905	64,350	122,586,750	15,750	30,003,750
	filter						
/25	concrete w/form and re-bar, 210 kg/cm2	m3	3,280	18,590	60,975,200	4,550	14,924,000
/26	concrete w/form and re-bar, 160 kg/cm2	m3	210	15,000	3,150,000	3,500	735,000
/27	cobble stone	m3	420	297	124,740	315	132,300
/28	filter sand	m3	515	2,310	1,189,650	2,450	1,261,750
/29	filter gravel	m3	173	1,155	199,815	1,225	211,925
/30	filter block	m3	258	6,600	1,702,800	3,000	774,000
/31	piping,1000 dia.DIP	m	200	86,625	17,325,000	13,125	2,625,000
/32	piping,1650 dia.steel	m	28	194,123	5,435,444	29,413	823,564
/33	in-situ found.piling, 400 mm dia., l=5 m	no.	847	64,350	54,504,450	15,750	13,340,250
	clear water basin						
/34	concrete w/form and re-bar, 210 kg/cm2	m3	5,110	18,590	94,994,900	4,550	23,250,500

Priced Bill of Quantities for Direct Construction Works
Stage 1 of Phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q'ty	cost F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
/35	concrete w/form and re-bar, 160 kg/cm2	m3	330	15,000	4,950,000	3,500	1,155,000
/36	cobble stone	m3	650	297	193,050	315	204,750
/37	piping,1000 dia,DIP	m	40	86,625	3,465,000	13,125	525,000
/38	piping,1650 dia.steel	m	503	194,123	97,643,869	29,413	14,794,739
/39	piping. 100 dia,DIP	m	270	5,000	1,350,000	800	216,000
/40	piping. 500 dia,DIP	m	150	22,400	3,360,000	3,400	510,000
	thickning basin						
/41	concrete w/form and re-bar, 210 kg/cm2	m3	1,820	18,590	33,833,800	4,550	8,281,000
/42	concrete w/form and re-bar, 160 kg/cm2	m3	220	15,000	3,300,000	3,500	770,000
/43	cobble stone	m3	440	297	130,680	315	138,600
/44	piping,150 dia,DIP	m	347	7,000	2,429,000	1,000	347,000
/45	piping,200 dia,DIP	m	283	8,250	2,334,750	1,250	353,750
	sludge drying bed						
/46	concrete w/form and re-bar, 210 kg/cm2	m3	4,110	18,590	76,404,900	4,550	18,700,500
/47	concrete w/form and re-bar, 160 kg/cm2	m3	1,090	15,000	16,350,000	3,500	3,815,000
/48	cobble stone	m3	1,640	297	487,080	315	516,600
/49	piping,150 dia.DIP	m	274	7,000	1,918,000	1,000	274,000
	pump sump & pump room						
/50	concrete w/form and re-bar, 210 kg/cm2	m3	80	18,590	1,487,200	4,550	364,000
/51	concrete w/form and re-bar, 160 kg/cm2	m3	10	15,000	150,000	3,500	35,000
/52	cobble stone	m3	20	297	5,940	315	6,300
/53	piping,150 dia,DIP	m	365	7,000	2,555,000	1,000	365,000
	dirty washwater balancing basin						
/54	concrete w/form and re-bar, 210 kg/cm2	m3	320	18,590	5,948,800	450	144,000
/55	concrete w/form and re-bar, 160 kg/cm2	m3	40	15,000	600,000	3,500	140,000
/56	cobble stone	m3	80	297	23,760	315	25,200
/57	piping, 1650 dia,DIP	m	56	206,250	11,550,000	31,250	1,750,000
	amount, civil works				1,044,151,492		236,560,918
/58	miscellaneous works (3 % of above)	l.s	-	-	31,324,545	-	7,096,828
	sub total, civil works				1,075,476,037		243,657,746
	(mech. & elect. works)						
/59	sedimentation tank	l.s	-	-	396,000,000	-	20,000,000
/60	filter	l.s	-	-	207,700,000	-	10,500,000
/61	chemical dosing	l.s	-	-	41,360,000	-	2,100,000
/62	sludge disposal	l.s	-	-	21,639,000	-	1,100,000
/63	transmission pump	l.s	-	-	239,200,000	-	12,080,000
/64	substation,receiving panel	l.s	-	-	240,700,000	-	12,160,000
/65	plant-control panel	l.s	-	-	461,000,000	-	23,280,000
/66	miscellaneous works (1 % of above)	l.s	-	-	16,075,990	-	812,200
	sub total, M/E works				1,623,674,990		82,032,200
	(building works)						
/67	chemical building	m2	600	1,760	1,056,000	7,200	4,320,000
/68	chlorination house	m2	200	1,760	352,000	7,200	1,440,000

Priced Bill of Quantities for Direct Construction Works
Stage 1 of Phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q'ty	cost F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
/69	main building	m2	1,000	27,500	27,500,000	12,500	12,500,000
/70	work shop	m2	600	1,760	1,056,000	7,200	4,320,000
/71	staff housing,100 m2 in average	no.	45	1,522,400	68,508,000	692,000	31,140,000
	sub total, building works				98,472,000		53,720,000
	sub total of 104				2,797,623,027		379,409,946
	105 Clear water transmission facilities, 1)						
	(supply and delivery for pipe and fittings)						
/01	transmission main, WTP to H.L.reservoir DN1650 mm,steel pipe	m	3,000	194,123	582,369,000	29,413	88,239,000
	(laying cost/road reinstatement cost)						
/02	laying transmission main, WTP to HLR DN1650 mm,steel pipe	m	3,000	11,647	34,941,000	12,353	37,059,000
/03	road reinstatement for item 105/02	m	3,000	3,882	11,646,000	4,118	12,354,000
	(high level water reservoir, V=30000 m3)						
/04	excavation, rock	m3	81,960	1,716	140,643,360	420	34,423,200
/05	excess rock	m3	31,700	429	13,599,300	105	3,328,500
/06	backfill	m3	1,370	543	743,910	35	47,950
/07	embankment	m3	50,260	638	32,065,880	160	8,041,600
/08	concrete, 180 kg/cm2	m3	1,400	15,730	22,022,000	3,850	5,390,000
/09	concrete, 210 kg/cm2	m3	10,430	18,590	193,893,700	4,550	47,456,500
/10	pipe line, 1650 mm	m	200	194,123	38,824,600	29,413	5,882,600
/11	pipe line, 1200 mm	m	200	115,500	23,100,000	17,500	3,500,000
/12	pipe line, 400 mm	m	1,300	19,239	25,010,700	3,905	5,076,500
/13	valve, 1650 mm	set	2	15,000,000	30,000,000	870,000	1,740,000
/14	valve, 1200 mm	set	2	9,000,000	18,000,000	500,000	1,000,000
/15	valve, 400 mm	set	2	2,000,000	4,000,000	110,000	220,000
/16	access road, W=10 m	m	1,300	7,150	9,295,000	1,750	2,275,000
/17	landscaping	l.s	-	-	35,404,634	-	7,681,016
/18	miscellaneous works (3 % of above)	l.s	-	-	36,466,773	-	7,911,446
	sub total of 105				1,252,025,856		271,626,311
	106 Clear water transmission, 2)						
	(supply and delivery of pipe & fittings)						
/01	HLR to Pokunuwita, junction DN1200 mm, DIP	m	6,680	115,500	771,540,000	17,500	116,900,000
/02	Pokunuwita to Panadura Reservoir DN500 mm, DIP	m	15,250	22,440	342,210,000	3,400	51,850,000
/03	Moratuwa Res.to new Moratuwa TW, DN500 mm, DIP	m	300	22,440	6,732,000	3,400	1,020,000
/04	branch connection to new Piliyandara tower DN400 mm, DIP	m	30	18,150	544,500	2,750	82,500
	(laying cost/road reinstatement cost)						
/05	laying cost, Rd.A8 DN1200 mm, DIP	m	6,680	6,930	46,292,400	7,350	49,098,000
/06	road reinstatement DN1200 mm, DIP, Rd.A8	m	6,680	2,310	15,430,800	2,450	16,366,000
/07	laying & road reinstatement Costs DN500 mm, DIP	m	15,550	1,795	27,912,250	1,904	29,607,200
/08	laying & road reinstatement Costs DN400 mm, DIP	m	30	1,452	43,560	1,540	46,200

Priced Bill of Quantities for Direct Construction Works
Stage 1 of Phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q`ty	cost F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
	sub total of 106				1,210,705,510		264,969,900
	107 Distribution facilities						
	(supply and delivery cost for pipe and fittings for Moratuwa U.C. Low Zone)						
/01	DN 600 mm, DIP	m	80	29,040	2,323,200	4,400	352,000
/02	DN 500 mm, DIP	m	630	22,440	14,137,200	3,400	2,142,000
/03	DN 400 mm, DIP	m	1,330	18,150	24,139,500	2,750	3,657,500
/04	DN 300 mm, DIP	m	3,940	14,000	55,160,000	2,000	7,880,000
/05	DN 250 mm, DIP	m	860	10,000	8,600,000	1,400	1,204,000
/06	DN 200 mm, PVC	m	4,730	0	0	2,400	11,352,000
/07	DN 150 mm, PVC	m	3,820	0	0	2,000	7,640,000
/08	DN 90 mm, PVC	m	85,000	0	0	800	68,000,000
	(laying/road reinstatement costs for Moratuwa U.C. low zone)						
/09	laying cost for item 107/01 to 107/05	m	6,840	1,300	8,892,000	1,400	9,576,000
/10	laying cost for item 107/06 to 107/08	m	93,550	200	18,710,000	200	18,710,000
/11	reinstatement cost, item 107/01 to 107/05	m	6,840	450	3,078,000	450	3,078,000
/12	reinstatement cost, item 107/06 to 107/08	m	93,550	70	6,548,500	70	6,548,500
	(water tower, V=1500 m3 for Moratuwa U.C. low zone)						
/13	foundation pile 400 mm dia., l=20.0 m	no.	170	257,400	43,758,000	63,000	10,710,000
/14	gravel	m3	90	572	51,480	140	12,600
/15	concrete, 180 kg/cm2	m3	35	15,730	550,550	3,850	134,750
/16	concrete, 210 kg/cm2	m3	2,000	18,590	37,180,000	3,850	7,700,000
/17	pipe line, 400 mm	m	480	19,239	9,234,720	3,905	1,874,400
/18	valve, 400 mm	no.	3	2,178,000	6,534,000	110,000	330,000
/19	access road, W=10 m	m	200	7,150	1,430,000	1,750	350,000
/20	miscellaneous works (3 % of above)	l.s	-	-	7,209,815	-	4,837,553
	sub total of 107				247,536,965		166,089,303
	total,101 to 107				7,974,933,692		1,668,921,212
	108 B.T.T (5 %)				0		264,694,554
	Grand total				7,974,933,692		1,933,615,765

Priced Bill of Quantities for Direct Construction Works
Stage 2 of phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q'ty	F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
101	Preliminary & general						
/01	insurances	l.s	-	-	0	-	5,000,000
/02	performance bond	l.s	-	-	0	-	6,400,000
/03	temporary facilities and services	l.s	-	-	100,000,000	-	20,000,000
/04	all measures required for maintenance of traffic flows & access	l.s	-	-	0	-	7,200,000
/05	engineers office	l.s	-	-	0	-	0
/06	testing laboratory	l.s	-	-	0	-	0
/07	other incidentals	l.s	-	-	30,000,000	-	5,000,000
	sub total of 101				130,000,000	-	43,600,000
102	Intake facilities						
/01	intake pump	l.s	-	-	154,570,000	-	7,800,000
/02	pump-control panel	l.s	-	-	34,200,000	-	1,730,000
	sub total of 102				188,770,000		9,530,000
103	Raw water transmission facilities						
	sub total of 103				0		0
104	Treatment facilities (civil works) whole plant site						
/01	excavation, common	m3	30,000	501	15,030,000	123	3,690,000
/02	backfill	m3	9,100	429	3,903,900	105	955,500
	flocculation & sedimentation basin						
/03	concrete w/form and re-bar, 210 kg/cm2	m3	5,020	18,590	93,321,800	4,550	22,841,000
/04	concrete w/form and re-bar, 160 kg/cm2	m3	420	15,000	6,300,000	3,500	1,470,000
/05	coble stone	m3	1,255	297	372,735	315	395,325
	filter						
/06	concrete w/form and re-bar, 210 kg/cm2	m3	3,280	18,590	60,975,200	4,550	14,924,000
/07	concrete w/form and re-bar, 160 kg/cm2	m3	210	15,000	3,150,000	3,500	735,000
/08	coble stone	m3	420	297	124,740	315	132,300
/09	filter, sand	m3	515	2,310	1,189,650	2,450	1,261,750
/10	filter, gravel	m3	172	1,155	198,660	1,225	210,700
/11	filter, block	m3	258	6,600	1,702,800	3,000	774,000
	sub total, civil works				186,269,485		47,389,575
	(mech. & elect. works)						
/12	sedimentation tank	l.s	-	-	396,000,000	-	20,000,000
/13	filter	l.s	-	-	207,710,000	-	10,500,000
/14	sludge disposal	l.s	-	-	20,990,000	-	1,060,000
/15	transmission pump	l.s	-	-	193,000,000	-	9,750,000
/16	plant control panel	l.s	-	-	194,770,000	-	9,840,000
	sub total, M/E works				1,012,470,000		51,150,000
	sub total of 104				1,198,739,485		98,539,575
105	Clear water transmission facilities, 1						
	sub total of 105				0		0
106	Clear water transmission facilities, 2						
	(supply & delivery of pipe & fittings)						

Priced Bill of Quantities for Direct Construction Works
Stage 2 of phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q'ty	F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
/01	Piliyandara to Dehi-wala res., Rd. B5 DN 1000 mm, DIP	m	9,580	86,625	829,867,500	13,125	125,737,500
/02	branch to Horana res. DN 200 mm, DIP	m	2,200	8,250	18,150,000	1,250	2,750,000
/03	Pokunuwita J.to Pili-yandara J. Rd. B5, DN1200 mm, DIP	m	17,000	115,500	1,963,500,000	17,500	297,500,000
/04	branch connection to exis.B'daragama tower DN 200 mm, DIP	m	180	8,250	1,485,000	1,250	225,000
	(laying/reinstatement cost)						
/05	laying cost DN 1000 mm, B5 road	m	9,580	5,198	49,796,840	5,513	52,814,540
/06	reinstatement cost DN 1000 mm, B5 road	m	9,580	1,733	16,602,140	1,838	17,608,040
/07	laying/reinstatement DN 1200 mm, DIP	m	17,000	9,240	157,080,000	9,800	166,600,000
/08	laying/reinstatement cost, DN 200 mm, DIP	m	2,380	660	1,570,800	700	1,666,000
	sub total of 106				3,038,052,280		664,901,080
107	Distribution facilities						
	(supply & delivery cost for pipe & fittings for Dehiwala M.C. High Zone						
/01	DN 300 mm, DIP	m	610	14,000	8,540,000	2,000	1,220,000
/02	DN 250 mm, DIP	m	140	10,000	1,400,000	1,400	196,000
/03	DN 200 mm, PVC	m	1,550	0	0	2,400	3,720,000
/04	DN 150 mm, PVC	m	960	0	0	2,000	1,920,000
/05	DN 110 mm, PVC	m	170	0	0	1,800	306,000
/06	DN 90 mm, PVC	m	22,500	0	0	800	18,000,000
	(laying/road reinstatement cost for Dehiwala M.C. high zone)						
/07	DN 300 mm, DIP	m	610	990	603,900	1,070	652,700
/08	DN 250 mm, DIP	m	140	784	109,760	831	116,340
/09	DN 200 mm, PVC	m	1,550	317	491,350	336	520,800
/10	DN 150 mm, PVC	m	960	264	253,440	280	268,800
/11	DN 110 mm, PVC	m	170	240	40,800	252	42,840
/12	DN 90 mm, PVC	m	22,500	132	2,970,000	140	3,150,000
	(supply & delivery cost for pipe & fittings for Dehiwala M.C. Low Zone)						
/13	DN 700 mm. DIP	m	910	41,250	37,537,500	6,250	5,687,500
/14	DN 600 mm, DIP	m	2,280	29,040	66,211,200	4,400	10,032,000
/15	DN 500 mm, DIP	m	510	22,440	11,444,400	3,400	1,734,000
/16	DN 450 mm, DIP	m	1,310	21,450	28,099,500	3,250	4,257,500
/17	DN 350 mm, DIP	m	1,530	14,850	22,720,500	2,250	3,442,500
/18	DN 250 mm, DIP	m	2,130	10,000	21,300,000	1,400	2,982,000
/19	DN 200 mm, PVC	m	2,740	0	0	2,400	6,576,000
/20	DN 150 mm, PVC	m	890	0	0	2,000	1,780,000
/21	DN 110 mm, PVC	m	390	0	0	1,800	702,000
/22	DN 90 mm, PVC	m	33,500	0	0	800	26,800,000
	(laying/road reinstatement cost for Dehiwala M.C. low zone)						
/23	DN 700 mm. DIP	m	910	3,300	3,003,000	3,500	3,185,000
/24	DN 600 mm, DIP	m	2,280	2,323	5,296,440	2,464	5,617,920
/25	DN 500 mm, DIP	m	510	1,795	915,450	1,904	971,040
/26	DN 450 mm, DIP	m	1,310	1,716	2,247,960	1,820	2,384,200
/27	DN 350 mm, DIP	m	1,530	1,188	1,817,640	1,260	1,927,800
/28	DN 250 mm, DIP	m	2,130	784	1,669,920	831	1,770,030
/29	DN 200 mm, PVC	m	2,740	317	868,580	336	920,640
/30	DN 150 mm, PVC	m	890	264	234,960	280	249,200
/31	DN 110 mm, PVC	m	390	240	93,600	252	98,280
/32	DN 90 mm, PVC	m	33,500	132	4,422,000	140	4,690,000

Priced Bill of Quantities for Direct Construction Works
Stage 2 of phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q'ty	F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
	(supply & delivery for pipe & fittings for Dehiwala M.C. North Zone)						
/33	DN 250 mm, DIP	m	360	10,000	3,600,000	1,400	504,000
/34	DN 200 mm, PVC	m	1,290	0	0	2,400	3,096,000
/35	DN 150 mm, PVC	m	2,920	0	0	2,000	5,840,000
/36	DN 90 mm, PVC	m	20,000	0	0	800	16,000,000
	(laying/road reinstatement cost for Dehiwala M.C. north zone)						
/37	DN 250 mm, DIP	m	360	784	282,240	831	299,160
/38	DN 200 mm, PVC	m	1,290	317	408,930	336	433,440
/39	DN 150 mm, PVC	m	2,920	264	770,880	280	817,600
/40	DN 90 mm, PVC	m	20,000	132	2,640,000	140	2,800,000
	(supply & delivery for pipe & fittings for Moratuwa U.C. High Zone)						
/41	DN 250 mm, DIP	m	650	10,000	6,500,000	1,400	910,000
/42	DN 200 mm, PVC	m	3,110	0	0	2,400	7,464,000
/43	DN 150 mm, PVC	m	2,450	0	0	2,000	4,900,000
/44	DN 110 mm, PVC	m	1,780	0	0	1,800	3,204,000
/45	DN 90 mm, PVC	m	71,000	0	0	800	56,800,000
	(laying/road reinstatement for Moratuwa U.C. high zone)						
/46	DN 250 mm, DIP	m	650	784	509,600	831	540,150
/47	DN 200 mm, PVC	m	3,110	317	985,870	336	1,044,960
/48	DN 150 mm, PVC	m	2,450	264	646,800	280	686,000
/49	DN 110 mm, PVC	m	1,780	240	427,200	252	448,560
/50	DN 90 mm, PVC	m	71,000	132	9,372,000	140	9,940,000
	(supply & delivery of pipe & fittings for Pandura U.C. High Zone)						
/51	DN 200 mm, PVC	m	970	0	0	2,400	2,328,000
/52	DN 150 mm, PVC	m	710	0	0	2,000	1,420,000
/53	DN 100 mm, PVC	m	910	0	0	1,600	1,456,000
/54	DN 90 mm, PVC	m	22,000	0	0	800	17,600,000
	(laying/road reinstatement cost for Pandura U.C. high zone)						
/55	DN 200 mm, PVC	m	970	317	307,490	336	325,920
/56	DN 150 mm, PVC	m	710	264	187,440	280	198,800
/57	DN 100 mm, PVC	m	910	211	192,010	224	203,840
/58	DN 90 mm, PVC	m	22,000	132	2,904,000	140	3,080,000
	(supply & delivery of pipe & fittings for Panadura U.C. Low Zone)						
/59	DN 400 mm, DIP	m	500	18,150	9,075,000	2,750	1,375,000
/60	DN 250 mm, DIP	m	440	10,000	4,400,000	1,400	616,000
/61	DN 200 mm, PVC	m	2,460	0	0	2,400	5,904,000
/62	DN 100 mm, PVC	m	580	0	0	1,600	928,000
/63	DN 90 mm, PVC	m	43,000	0	0	800	34,400,000
	(laying/road reinstatement for Panadura U.C. low zone)						
/64	DN 400 mm, DIP	m	500	1,452	726,000	1,540	770,000
/65	DN 250 mm, DIP	m	440	784	344,960	831	365,640
/66	DN 200 mm, PVC	m	2,460	317	779,820	336	826,560
/67	DN 100 mm, PVC	m	580	211	122,380	224	129,920
/68	DN 90 mm, PVC	m	43,000	132	5,676,000	140	6,020,000
	(supply & delivery of pipe & fittings for Horana)						
/69	DN 150 mm, PVC	m	1,010	0	0	2,000	2,020,000
/70	DN 110 mm, PVC	m	2,530	0	0	1,800	4,554,000
/71	DN 90 mm, PVC	m	5,000	0	0	800	4,000,000
	(laying/road reinstatement for Horana)						
/72	DN 150 mm, PVC	m	1,010	264	266,640	280	282,800
/73	DN 110 mm, PVC	m	2,530	240	607,200	252	637,560
/74	DN 90 mm, PVc	m	5,000	132	660,000	140	700,000
	(supply & delivery of pipe & fittings for Bandaragama east)						
/75	DN 110 mm, PVC	m	1,340	0	0	2,000	2,680,000
/76	DN 90 mm, PVC	m	12,250	0	0	800	9,800,000

Priced Bill of Quantities for Direct Construction Works
Stage 2 of phase 1 (cost code : 100)

Cost item no.	Work items	unit	Q'ty	F.C portion unit rate (Y)	F.C portion amount (Y)	L.C portion unit rate (Rs)	L.C portion amount (Rs)
/77 DN 63 mm, PVC		m	3,340	0	0	500	1,670,000
	(laying/road reinstatement for Bandaragama east)						
/78 DN 110 mm, PVC		m	1,340	240	321,600	252	337,680
/79 DN 90 mm, PVC		m	12,250	132	1,617,000	140	1,715,000
/80 DN 63 mm, PVC		m	3,340	106	354,040	112	374,080
	sub total of 107				276,977,000		338,367,760
	Total, 101 to 107				4,832,538,765		1,154,938,415
108 B.T.T (5 %)					0		167,577,347
	G. Total				4,832,538,765		1,322,515,762

CHAPTER 12

Ref. No. 12.4

Subject : Project Cost Estimates

Title : Cost for Land Acquisition and Compensation

Contents : Cost for Land Acquisition and Compensation

Land Acquisition & Compensation Cost
(cost code : 200)

code no.	cost items	unit	Q'ty	unit cost (Rs)	amount (Rs)
201	land acquisition				
	(1) intake facilities	m2	13,000	450	5,850,000
	(2) raw water transmssion facilities	m2	0	-	0
	(3) treatment facilities	m2	10,000	1,000	10,000,000
	(4) clear water transmission facilities	m2	0	-	0
	(5) high level reservoir	m2	25,000	1,000	25,000,000
	(6) distribution facilities	m2	0	-	0
	sub total				40,850,000
202	compensation				
	(1) intake facilities	l.s	-	-	300,000
	(2) raw water transmssion facilities	l.s	-	-	500,000
	(3) treatment facilities				
	1) wooden house,30 m2	no.	36	45,000	1,620,000
	2) blick house,30 m2	no.	31	75,000	2,325,000
	3) public facilities (temples, schools)	l.s	2	500,000	1,000,000
	4) land (67-house x 100 m2)	m2	6,700	1,000	6,700,000
	(4) clear water transmission facilities	l.s	-	-	300,000
	(5) storage facilities				
	1) house on access road 30 m2	no.	2	45,000	90,000
	(6) distribution facilities	l.s	-	-	5,000,000
	sub total				17,835,000
	Total				58,685,000

CHAPTER 12

Ref. No. 12.5

Subject : Project Cost Estimates

Title : Cost Comparison for Ductile Iron Pipe and Steel Pipe

Contents : Cost Comparison for Ductile Iron Pipe and Steel Pipe

Cost Comparison, Ductitile Iron Pipe and Steel Pipe

Unit: Rs./m

Description	Diameter						
	800mm	900mm	1000mm	1200mm	1350mm	1500mm	1650mm
Ductile iron Pipe (JIS G 5526)							
CIF Colombo	23,000	28,000	35,000	47,000	65,000	75,000	94,000
Fittings, 25% of CIF	5,750	7,000	8,750	11,750	16,250	18,750	23,500
Total	28,750	35,000	43,750	58,750	81,250	93,750	117,500
Steel pipe (JIS 3443)							
CIF Colombo	23,500	26,000	33,000	45,000	52,000	60,000	73,000
Fittings, 5% of CIF	1,175	1,300	1,650	2,250	2,600	3,000	3,650
Welding 30% of CIF	7,050	7,800	9,900	13,500	15,600	18,000	21,900
	31,725	35,100	44,550	60,750	70,200	81,000	98,550

Note : 1) figure [ ] is prefer by cost

: 2) Excluding custom duty, inland transportation cost, laying and road reinstatement costs which were applied as the same price respectively.

CHAPTER 12

Ref. No. 12.6

Subject : Project Cost Estimates

Title : Base Unit Costs

Contents : Daily Wage of Labor

Unit Price of Materials

Equipment Cost

Chemical Cost for Operation (2010)

Electricity Cost for Operation (2010)

Daily Wage of Labor

Description	Unit	Foreign Currency (US$)	Local Currency (Rs.)
Foreman A	Day		497
Foreman B	Day		398
Operator A	Day		363
Operator B	Day		290
Driver A	Day		311
Driver B	Day		249
Mechanic A	Day		363
Mechanic B	Day		290
Electrician A	Day		363
Electrician B	Day		290
Carpenter	Day		311
Form Worker	Day		311
Reinforcement Worker	Day		311
Concrete Worker	Day		311
Driller	Day		311
Powder Man	Day		373
Common Labor, Tunnel	Day		249
Plumber	Day		311
Welder	Day		363
Mason	Day		311
Boring Worker	Day		311
Grout Worker	Day		311
Rigger	Day		363
Skilled Labor	Day		311
Common Labor	Day		207
Foreign Technician A	Day	300.00	
Foreign Technician B	Day	200.00	

Unit Price of Materials (1/2)

Description	Price at Site		Allocation		Unit Price	
	Unit	(Rs.) (1)	F.C. (2)	L.C. (3)	F.C. ($) (4)	L.C. ($) (5)
Light oil (diesel)	lit.	13	80%	20%	0.21	2
Gasoline	lit.	36	80%	20%	0.58	7
Kelosine	lit.	13	80%	20%	0.21	2
Engine oil	lit.	44	80%	20%	0.70	8
Grease	kg	122	80%	20%	1.95	24
Asphalt	lit.	24	80%	20%	0.38	4
Porland cement	ton	5,158	70%	30%	82.53	1,031
Detonator	p.c.	152	90%	10%	2.43	30
Dynamite	kg	383	90%	10%	6.13	76
Wiremesh 12' x 7', 50 x 50 mm	p.c.	748	70%	30%	11.97	149
Nail	kg	41	70%	30%	0.66	8
plywood 8' x 4', 6 mm	p.c.	911	90%	10%	14.58	182
ploywood 8' x 4', 9 mm	p.c.	1,313	90%	10%	21.01	262
ploywood 8' x 4', 12 mm	p.c.	1,515	90%	10%	24.24	303
ploywood 8' x 4', 15 mm	p.c.	1,716	90%	10%	27.46	343
ploywood 8' x 4', 18 mm	p.c.	1,867	90%	10%	29.87	373
Concrete pipe, 450 mm x 1 m	p.c.	1,873	70%	30%	29.97	374
Concrete pipe, 600 mm x 1 m	p.c.	2,746	70%	30%	43.94	549
Concrete pipe, 900 mm x 1 m	p.c.	4,999	70%	30%	79.98	999
Concrete pipe, 1200 mm x 1 m	p.c.	9,098	70%	30%	145.57	1,819
Air entraining agent	kg	120	90%	10%	1.92	24
Water reducing arent	kg	140	90%	10%	2.24	28
Quick setting agent	kg	100	90%	10%	1.60	20
Reinforcement bar, deformed	ton	29,137	90%	10%	466.19	5,827
Reinforcement bar, round	ton	29,137	90%	10%	466.19	5,827
H-shape steel	ton	33,074	90%	10%	529.18	6,614
Channel steel	ton	33,074	90%	10%	529.18	6,614
Steel plate	ton	31,192	90%	10%	499.07	6,238
Annealed iron wire	kg	44	70%	30%	0.70	8
Steel wire	kg	40	70%	30%	0.64	8
Anfo	kg	171	90%	10%	2.74	34
Timber	m3	33,518	90%	10%	536.29	6,703
Steel sheet pile (type III)	m	3,089	90%	10%	49.42	617
Steel sheet pile (type IV)	m	3,918	90%	10%	62.69	783
Bentonite	kg	14	90%	10%	0.22	2
PVC water stop CF200	m	619	80%	20%	9.90	123
PVC water stop CF300	m	1,209	80%	20%	19.34	241
PVC water stop UC300	m	1,318	80%	20%	21.09	263

Unit Price of Materials (2/2)

Description	Price at Site		Allocation		Unit Price	
	Unit	(Rs.) (1)	F.C. (2)	L.C. (3)	F.C. ($) (4)	L.C. ($) (5)
Flastic joint filler, 20 mm	m	409	80%	20%	6.54	81
Flastic joint filler, 25 mm	m	491	80%	20%	7.86	98
Perforated PVC pipe, 150 mm	m	572	80%	20%	9.15	114
Perforated PVC pipe, 200 mm	m	940	80%	20%	15.04	188
Metal form 300 x 1,500	p.c.	1,551	80%	20%	24.82	310
Metal form 200 x 1,500	p.c.	1,551	80%	20%	24.82	310
Metal form 100 x 1,500	p.c.	1,200	80%	20%	19.20	240
Steel pipe 100 mm x 5.5 m	m	613	80%	20%	9.81	122
Steel pipe 150 mm x 5.5 m	m	1,057	80%	20%	16.91	211
Rockbolt 25 mm	m	378	90%	10%	6.05	75
Regin 24 mm x 320 mm	p.c.	307	90%	10%	4.91	61
Electricity	kWh	4	50%	50%	0.06	0
Masonry stone	m3	471	40%	60%	7.54	94
Clamp	p.c.	49	90%	10%	0.78	9
cone	p.c.	15	90%	10%	0.24	3
Separator, 8 - 10 mm	m	30	90%	10%	0.48	6
Form oil	lit	169	80%	20%	2.70	33
Form tie, 250 mm	p.c.	42	90%	10%	0.67	8
Wire mesh welded 150 x 150 x 5	m2	113	90%	10%	1.81	22
Tire for 4 t Dump Truck	set	72,850	90%	10%	1,165.60	14,570
Tire for 8 t Dump Truck	set	131,850	90%	10%	2,109.60	26,370
Tire for 11 t Dump Truck	set	228,450	90%	10%	3,655.20	45,690
Cement	t	5000	60%	40%	80.00	1,000

Equipment Cost (1/2)

Description	Capacity	Unit	F.C. ($) (1)	L.C. (Rs.) (2)	Total (Rs.) (3)
Bulldozer	11 ton	Hour	14.12	220	926
Bulldozer	15 ton	Hour	18.79	292	1231
Bulldozer	21 ton	Hour	33.18	510	2169
Bulldozer	32 ton	Hour	47.29	727	3091
Bulldozer W/ripper	21 ton	Hour	36.13	556	2362
Bulldozer W/ripper	32 ton	Hour	51.32	789	3355
Backhoe	0.35 m3	Hour	10.58	164	693
Backhoe	0.70 m3	Hour	22.70	353	1488
Backhoe	0.80 m3	Hour	23.72	369	1555
Backhoe	1.20 m3	Hour	34.56	538	2266
Crawler loader	1.40 m3	Hour	14.88	232	976
Crawler loader	2.20 m3	Hour	23.72	369	1555
Crawler loader	3.20 m3	Hour	35.32	550	2316
Wheel loader	1.40 m3	Hour	12.32	192	808
Wheel loader	2.30 m3	Hour	20.55	320	1347
Wheel loader	3.20 m3	Hour	28.74	447	1884
Crawler loader, side	1.50 m3	Hour	32.85	505	2147
Crawler loader, side	1.80 m3	Hour	43.13	663	2819
Dump truck	4 t	Hour	7.47	125	498
Dump truck	8 t	Hour	12.37	208	826
Dump truck	11 t	Hour	17.58	295	1174
Cargo truck	4 t	Hour	6.71	116	451
Cargo truck	8 t	Hour	9.08	157	611
Cargo truck	11 5	Hour	13.70	237	922
Truck crane	20 t	Hour	18.57	379	1307
Truck crane	32 t	Hour	43.74	895	3082
Grout pump	30 lit/min.	Hour	1.20	20	80
Grout pump	100 lit/min..	Hour	2.24	38	150
Grout pump	200 lit/min.	Hour	2.79	47	186
Grout mixer	100 lit x 1	Hour	0.51	8	33
Grout mixer	200 lit x 2	Hour	1.20	20	80
Grout mixer	400 lit x 2	Hour	1.92	33	129
Boring machine	5.5 kW	Hour	4.23	72	283
Leg hammer	30 kg	Hour	0.75	8	45
Leg hammer	40 kg	Hour	0.84	9	51
Pick hammer	7 kg	Hour	0.10	1	6
Rock breaker	800 kg	Hour	9.07	103	556
Crawler drill	100 kg	Hour	53.83	838	3529
Crawler drill	150 kg	Hour	60.91	948	3993
Dust collector	150 m3/min.	Hour	26.47	309	1632
Motor grader	3.1 m	Hour	17.10	304	1159
Motor grader	3.7 m	Hour	22.26	396	1509
Macadum roller	10/12 t	Hour	11.27	200	763
Tire roller	8/20 t	Hour	12.73	227	863
Tamping roller	13.5/20 t	Hour	13.45	238	910
Tractor for above	211 ps	Hour	28.63	446	1877
Vibration roller	4 t	Hour	7.28	129	493
Vibration roller	10 t	Hour	20.84	371	1413
Vibration roller	17 t	Hour	32.61	580	2210
Tamper	80 kg	Hour	0.64	6	38

Equipment Cost (2/2)

Description	Capacity	Unit	F.C. ($) (1)	L.C. (Rs.) (2)	Total (Rs.) (3)
Compactor	90 kg	Hour	0.57	5	33
Concrete plant	1.0 m3 x 1	Hour	103.95	1799	6996
Truck mixer	3.2 m3	Hour	12.13	189	795
Truck mixer	4.4 m3	Hour	17.62	274	1155
Concrete pump truck	55 m3/h	Hour	37.34	502	2369
Concrete pump truck, boom	55 m3/h	Hour	53.72	721	3407
Concrete pump	60 m3/h	Hour	59.99	856	3855
Concrete pump	95 m3/h	Hour	75.08	1018	4772
Agitator car	3 m3	Hour	17.49	237	1111
Agitator car	4 m3	Hour	21.96	297	1395
Agitator car	6 m3	Hour	30.20	409	1919
Asphalt plant	30 t/h	Hour	105.17	1836	7094
Asphalt finisher	2.4/5 m	Hour	48.63	969	3400
Asphalt kettle	200 lit.	Hour	0.97	11	59
Asphalt distributor	3,000 lit.	Hour	11.56	204	782
Asphalt sprayer	200 lit.	Hour	0.85	8	50
Sprinkler truck	6,000 lit.	Hour	7.90	137	532
Port air compressor	7.5 m3/min.	Hour	4.49	66	290
Port air compressor	10.5 m3/min.	Hour	6.89	101	445
Port air compressor	14.3 m3/min.	Hour	7.95	117	514
Port air compressor	17 m3/min.	Hour	8.07	119	522
St. air compressor	20 m3/min.	Hour	5.48	81	355
Submersible pump	80 mm	Hour	0.39	5	24
Submersible pump	100 mm	Hour	0.64	8	40
Submersible pump	150 mm	Hour	0.91	12	57
Submersible pump	200 mm	Hour	1.36	18	86
Diesel generator	100 kVA	Hour	3.69	54	238
Winch	55 kW	Hour	11.69	176	760
Grout measuring device	1,201/min.	Hour	5.02	66	317
Concrete bucket	1.0 m3	Hour	1.00	13	63
Concrete vibrator	40 mm	Hour	0.25	2	14
Concrete vibrator	60 mm	Hour	0.37	3	21
Form vibrator	0.4 kW	Hour	0.16	1	9
Port. bert conveyer	7 m	Hour	0.65	5	37
Shotcrete	10 m3/h	Hour	30.63	409	1940
Quick agent supply	2.4 lit/min.	Hour	1.84	21	113
Cement silo	200 t	Hour	6.93	117	463
Vibrating feeder	100 t/h	Hour	3.32	60	226
Jaw crusher	600 x 900	Hour	44.14	704	2911
Vib. screen	1,200 x 2,400	Hour	7.42	112	483
Cone cursher	1,000	Hour	37.74	605	2492
Rod mill	1,500 x 3,000	Hour	64.77	1046	4284
Spiral classifier	900 x 6,500	Hour	10.70	167	702
Vib. feeder	50 t/h	Hour	0.64	11	43
Cone cursher	600	Hour	18.03	289	1190
Vib. screen	900 x 1,800	Hour	6.08	91	395
Spiral elassifier	450 x 4,000	Hour	5.15	81	338
Belt conveyor	450 x 180 m	Hour	38.83	673	2614
Screen tower	15 t	Hour	12.74	113	750

Chemicals Cost for Operation (2010)

1. Unit Prices of Chemicals (Presen 1994 Future 1994)

Item	Alum	Lime	Chlorine
Present Cost	12,000 Rs/ton	10,500 Rs/ton	27,500 Rs/ton
Escalation Ratio	0 % per year	0 % per year	0 % per year
Future Cost	12,000 Rs/ton	10,500 Rs/ton	27,500 Rs/ton

2. Alum

Stage	1st	2nd	Total
Consumption	1,365 kg/day	1,365 kg/day	2,730 kg/day
Chemical Cost	16,380 Rs/day	16,380 Rs/day	32,760 Rs/day
Annual Cost (Thousand-Rs/year)	5,979 T-Rs/year	5,979 T-Rs/year	11,958 T-Rs/year

3. Lime

Stage	1st	2nd	Total
Consumption	683 kg/day	683 kg/day	1,366 kg/day
Chemical Cost	7,166 Rs/day	7,166 Rs/day	14,332 Rs/day
Annual Cost (Thousand-Rs/year)	2,616 T-Rs/year	2,616 T-Rs/year	5,232 T-Rs/year

4. Chlorine

Stage	1st	2nd	Total
Consumption	182 kg/day	182 kg/day	364 kg/day
Chemical Cost	5,561 Rs/day	5,561 Rs/day	11,122 Rs/day
Annual Cost (Thousand-Rs/year)	2,030 T-Rs/year	2,030 T-Rs/year	4,060 T-Rs/year

5. Total

Stage	1st	2nd	Total
Production	91,000 m3/day	91,000 m3/day	182,000 m3/day
Chemical Cost	29,107 Rs/day	29,107 Rs/day	58,214 Rs/day
per m3	0.32 Rs/m3	0.32 Rs/m3	0.32 Rs/m3
Annual Cost (Thousand-Rs/year)	10,624 T-Rs/year	10,624 T-Rs/year	21,248 T-Rs/year

Electricity Cost for Operation (2010)

1. Electricity Tariff (Industrial Tariff)	
1) Rate I - 1:400/230 V, 10 to 50 kVA	
– Unit Charge	4
– Fixed Charge	205
2) Rate I - 2:>11,000 V, >50 kVA	
– Max. Demand Charge	196
– Unit Charge	3.65
– Fixed Charge	408
2. Electricity Charge	
1) Main Equipment	
– Intake Facilities **	987.4 kW
– Treatment Plant **	3,540.9 kW
– Reservoir *	20.0 kW
2) Consumption	
– Intake Facilities	23,698 kWH/day
– Treatment Plant	84,982 kWH/day
– Reservoir	480 kWH/day
Total	109,160 kWH/day
3) Monthly Charge	
– Intake Facilities	2,788,826 Rs
– Treatment Plant	9,999,910 Rs
– Reservoir	2,125 Rs
Total	12,790,861 Rs/month
4) Annual Charge	
(Thousand Rs)	153,490 Th. Rs

CHAPTER 12

Ref. No. 12.7

Subject : Project Cost Estimates

Title : Cost Estimates for Lower Demand Scenario

Contents : Cost Estimates for Lower Demand Scenario

Lower demand scenario

Cost item no.	Work items	unit	Q'ty	F.C portion		L.C portion	
				unit rate (Y)	amount (Y)	unit rate (Rs)	amount (Rs)
1. Supply & delivery costs of pipe and fittings							
1) DN 1350 mm, DIP		m	3,400	148,500	504,900,000	22,500	76,500,000
2) DN 1200 mm, DIP		m	8,200	115,500	947,100,000	17,500	143,500,000
3) DN 1000 mm, DIP		m	23,680	86,625	2,051,280,000	13,125	310,800,000
4) DN 500 mm, DIP		m	300	22,440	6,732,000	3,400	1,020,000
5) DN 400 mm, DIP		m	30	18,150	544,500	2,750	82,500
2. Laying cost							
1) DN 1350 mm, DIP		m	3,400	8,910	30,294,000	9,450	32,130,000
2) DN 1200 mm, DIP		m	8,200	6,930	56,826,000	7,350	60,270,000
3) DN 1000 mm, DIP		m	23,680	5,198	123,088,640	5,513	130,547,840
4) DN 500 mm, DIP		m	300	1,346	403,800	1,428	428,400
5) DN 400 mm, DIP		m	30	1,089	32,670	1,155	34,650
3. Road reinstatement cost							
1) DN 1350 mm, DIP		m	3,400	2,970	10,098,000	3,150	10,710,000
2) DN 1200 mm, DIP		m	8,200	2,310	18,942,000	2,450	20,090,000
3) DN 1000 mm, DIP		m	23,680	1,733	41,037,440	1,838	43,523,840
4) DN 500 mm, DIP		m	300	449	134,700	476	142,800
5) DN 400 mm, DIP		m	30	363	10,890	385	11,550
4. Total cost per diameter, 4=1+2+3							
1) DN 1350 mm, DIP		m	3,400	-	545,292,000	-	119,340,000
2) DN 1200 mm, DIP		m	8,200	-	1,022,868,000	-	223,860,000
3) DN 1000 mm, DIP		m	23,680	-	2,215,406,080	-	484,871,680
4) DN 500 mm, DIP		m	300	-	7,270,500	-	1,591,200
5) DN 400 mm, DIP		m	30	-	588,060	-	128,700
G.Total					3,791,424,640		829,791,580

CHAPTER **16**

Ref. No. **16.1**

Subject : **Environmental Impact Assessment**

Title : **Definitions from Sri Lankan Environmental Legislation**

Contents : **Definition**

DEFINITIONS FROM SRI LANKAN ENVIRONMENTAL LEGISLATION

1. Environmental Scoping.

" Environmental Scoping " means determining the range and scope of proposed actions, alternatives, and impacts to be discussed in an Initial Environmental Examination Report or Environmental Impact Assessment Report.

2. Initial Environmental Examination Report.

" Initial Environmental Examination Report " means a written report wherein possible impacts of the prescribed project on the environment shall be assessed with a view to determining whether such impacts are significant, and as such requires the preparation of an environmental impact assessment report and such report shall contain further details, descriptions, data, designs and other information and details as may be prescribed by the minister.

3 Environmental Impact Assessment Report.

" Environmental Impact Assessment Report " means a written analysis of the predicted environmental project and containing an environmental cost benefit analysis, if such an analysis has been prepared, and including a description of the project, and includes a description of the avoidable and unavoidable adverse environmental effects of the proposed proscribed project; a description of alternative to the activity which might be less harmful to the environment together with the reasons why such alternatives were rejected, and a description of any irreversible or irritrievable commitments of resources required by the prescribed project.

CHAPTER 16

Ref. No. 16.2

Subject : Environmental Impact Assessment

Title : Supplemental Assessment

Contents : Assessment of the Stream near the Proposed Treatment Plant Site

Evaluation of the Potential Environmental Effects of the Proposed Kalu Ganga Treatment Plant on the Bolgoda Lake System

ASSESSMENT OF THE STREAM NEAR THE PROPOSED TREATMENT WORKS SITE.

A visual inspection was made of the nearest significant watercourse to the proposed treatment works site on June 16 and 20.It flows from the west, looping north of the site to flow south, roughly parallel to the site's eastern boundary. The rising ground of the site is separated from the stream by approximately 300 M of flat rice paddy, most of which seemed to be abandoned on the eastern side.

Thick growths of trees and bushes are apparent along both banks of the stream restricting access to the water. On both of the inspection days the stream was about 200 mm to 400 mm deep, between 3 M to 4 M wide and flowing at about 0.5 M/s in the stretch near the eastern boundary of the site. The clarity of the water was very good on the first inspection day but quite cloudy on the second. Silt and mud deposits on the foliage beside the stream showed that the water depth had been at least 1.0 M higher in the recent past.

It would appear that the stream normally flows well below ground level and no evidence was found to suggest that the stream is used for irrigation purposes. Enquiries with local people indicated that the nearby paddy fields used only rainfall to water the crop. Some groundwater seepage from the edge of the hill forming the site is noticeable and also seems to be used as irrigation water. Hoof prints at various places on the banks of the stream show that cattle etc. frequently drink it's waters and distant noises suggested that children bathe in it.

It was not possible to inspect the whole length of the stream from the treatment works site to the Kalu Ganga due to the thick foliage along it's banks. However access was gained at two points, one close to a Temple about midway between the site and the river and the other at the site of a bridge and sluicegates close to the stream's estuary.
At both these locations the stream flowed between steep banks with evidence that it had recently overtopped the banks and caused flooding of surrounding land. It was difficult to make an accurate estimate as to the probable depth when the stream was in flood but it must have been about 5 M to 6 M.

Conclusions.

(i) The stream is large enough to carry the waste water flow from the treatment works.

(ii) Outside of the rainy season the normal stream flow is quite small and will be noticeably enhanced by the waste water discharge.

(iii) The quality of the water in the stream is normally

much better than that of unsettled waterworks sludge and therefore sludge lagoons or drying beds must be provided.

(iv) With properly designed sludge lagoons or drying beds the supernatant water or filtrate will be of good quality , comply with the Sri Lankan discharge regulations , and be quite suitable for discharge to the Kalu Ganga via the nearby stream.

Comment.
Mention must be made of the rubber factory found to be under construction on the north west edge of the proposed treatment works site. This factory (presumably not actually on the land that the NWSDB has the option to purchase) was said to be ready for operation in early July according to the site manager. The study team were shown the tile lined tanks to be used in the rubber production process and were informed that the spent liquid would be discharged to the stream.

It was evident that no treatment was to be given to the liquid waste and it is most unlikely that such a discharge will come close to complying with the discharge regulations.

EVALUATION OF THE POTENTIAL ENVIRONMENTAL EFFECTS OF THE PROPOSED KALU GANGA TREATMENT WORKS ON THE BOLGODA LAKE SYSTEM.

It is theoretically possible for the proposed new treatment works to affect the environment of the Bolgoda lakes in three ways:

(i) Abstraction of raw water for the treatment works may affect the flow into the Bolgoda lake system from the kalu Ganga during periods of low flow in the river.
(ii) Waste discharge from the treatment works into the river may affect the quality of the river water flowing into the lakes.
(iii) The increased volume of drinking water fed to the areas surrounding the lakes may find its way into the lake system, thereby increasing the pollutant load.

Taking these points in turn :

(i) Effect of abstraction.

Some 192,000 m3/d (2m3/s) will be required by the treatment works. Under average flow conditions this represents about 2% of the river flow and as such will make no significant difference to the conditions downstream.
The 30 year minimum at the point at which water flows into the Bolgoda lakes is approximately 11 m3/s. At such times the treatment works abstraction will lower this figure to 9 m3/s. Although this represents an 18% reduction in flow, it will not affect the flow into the Bolgoda lakes as such flows are governed by the hydraulic head in the river. The hydraulic head is directly related to the sea level as this stretch is tidal

(ii) Pollution Caused by the Treatment Works.

The only discharge from the treatment works will be the filtrate from the sludge drying beds. This waste water will be discharged to the Kalu Ganga via a small stream and will contain only a very small quantity of suspended solids. On many occasions the waste water will be of better quality than the stream water into which it is discharged.
The worst situation would occur if the drying beds were bypassed. Under this circumstance a high suspended solids load would flow into the stream.From the point of discharge to the stream to the Kalu Ganga is a distance of about one Km. Much of the suspended solids would settle out in this distance. If they should reach the main river, the inlet to the Bolgoda lakes is still some 20 Km downstream. Under these circumstances it is extremely unlikely that any deterioration in water quality will be found at the lake inlet.

(iii) Indirect Pollution of the Bolgoda Lakes.

The provision of increased supplies of drinking water to the areas surrounding the lakes will inevitably increase the quantity of sewage entering the lake system. No piped sewerage system exists in the area and many houses have no toilet facilities. Without the construction of properly designed septic tanks or sewers, increased pollution of the lakes cannot be avoided.

Conclusion.

In direct terms the operation of the treatment works will have no effect on the quality or quantity of water entering the Bolgoda lake system from the Kalu Ganga during periods of low flow in the river.

Indirectly, via increased supplies of drinking water, additional quantities of sewage may be expected to reach the lake system.

CHAPTER 16

Ref. No. 16.3

Subject : Environmental Impact Assessment

Title : Supplemental Recommendation

Contents : Countermeasures against Environmental Effects

COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	RESETTLEMENT
Contents	Land aquisition requiring resettlement of displaced persons.
Cause	1. Construction of the intake 2. Construction of the treatment works 3. Construction of the reservoir 4. Construction of the pipelines
Environmental impact	1. Displacement of the local population from the construction site areas
Elements for evaluation	1. Numbers to be resettled 2. Occupations of people affected
Countermeasures	1. Careful selection of the site areas to minimise resettlement needs 2. Minimise the land area requirements 3. Careful selection of resettlement areas 4. Full consultation with affected people
Related studies	1. Population density in the affected areas 2. Land use survey 3. Possible resettlement areas

Table 16.4
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	ECONOMIC ACTIVITIES
Contents	Economic activities that may be affected by the project
Cause	1. Construction of the intake 2. Construction of the treatment works 3. Construction of the reservoir 4. Construction of the pipelines
Environmental impact	1. Disruption or ending of the economic activities currently carried out at the construction sites
Elements for evaluation	1. Economic activities currently carried out at the proposed sites
Countermeasures	1. Careful selection of construction sites and pipeline routes 2. Minimise areas required for construction
Related studies	1. Land use survey 2. Layout of intake, treatment works, reservoir and pipeline routes

Table 16.5
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	TRANSPORTATION AND INSTITUTION
Contents	Interruption to transportation and the daily life of the community
Cause	1. Movement of site vehicles and construction plant 2. Excavation and pipelaying along roadways
Environmental impact	1. Interruption to local traffic flow
Elements for evaluation	1. Traffic density in the affected areas 2. Time period required for pipelaying activities
Countermeasures	1. Avoid roadways as far as possible for pipeline route 2. Restrict the movement of the construction vehicles 3. Avoid vehicle movements during peak traffic times
Related studies	1. Population density in construction areas

Table 16.6
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	SEPARATION OF THE COMMUNITY
Contents	Affect on the social aspects of the communities in the project areas
Cause	1. Construction site activities 2. Influx of outside construction site workers to the areas 3. Relocation of the displaced persons
Environmental impact	1. Alteration of the social structure of the communities 2. Increase in crime and disturbances 3. Creation of animosity between construction workers and the local communities
Elements for evaluation	1. Numbers of outside construction workers to be employed 2. Numbers and occupations of displaced persons 3. Possible resettlement areas
Countermeasures	1. Prepare code of conduct for workers 2. Restrict or prohibit access to certain areas 3. Careful selection of resettlement areas
Related studies	1. Population densities in the project areas 2. Possible resettlement areas

Table 16.7
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	CULTURAL ASSETS AND ARCHEOLOGY
Contents	Loss or damage to shrines, temples and archeological remains
Cause	1. Construction of the intake 2. Construction of the treatment works 3. Construction of the reservoir 4. Construction of the pipelines
Environmental impact	1. Damage or destruction of cultural assets and archeological remains
Elements for evaluation	1. Location of cultural assets and archeological remains on or near to the construction sites
Countermeasures	1. Careful selection of the construction sites and pipeline routes
Related studies	1. Land use survey

Table 16.8
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	SANITATION
Contents	Adverse effects on sanitation aspects
Cause	1. Sewage generated by the construction workers
Environmental impact	1. Spread of diseases
Elements for evaluation	1. Numbers of construction workers
Countermeasures	1. Provide an adequate number of properly designed latrines
Related studies	

Table 16.9
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	LAKE MARSH AND RIVER
Contents	Effect of abstraction on river flows
Cause	1. Abstraction of water from the Kalu Ganga during the operation of the treatment works
Environmental impact	1. Reduction in river flow
Elements for evaluation	1. Volume of water to be abstracted 2. Volume flowing in the river during low flow periods
Countermeasures	1. Locate intake where flow is highest in the required area 2. Reduce the volume abstracted during periods of low flow
Related studies	1. Flow survey of the Kalu Ganga 2. Options for intake site 3. Treatment plant design

Table 16.10

COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	WATER POLLUTION
Contents	Water pollution caused during construction and operation of the treatment plant, intake and pipelines
Cause	1. Rainfall causing disturbed soil to be washed into watercourses 2. Sewage pollution from construction site workers 3. Sludge discharge from the treatment works
Environmental impact	1. Pollution of watercourses causing siltation and damage to flora and fauna 2. Increased incidence of waterborne diseases 3. Degredation of water quality in watercourses due to sludge discharges
Elements for evaluation	1. Nature of soils on construction sites 2. Probability of sludge discharges to watercourses and possible volume 3. Flow in watercourse at probable discharge point 4. Estimate of the number of construction site workers
Countermeasures	1. Bunding to prevent soil run off during construction 2. Provide adequate latrines during construction phase 3. Provide drying beds or lagoons to prevent sludge entering watercourses
Related studies	1. Flows in the Kalu Ganga 2. Surveys of intake, Treatment plant and reservoir sites and the pipeline routes 3 Design of treatment works

Table 16.11
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	SOIL POLLUTION
Contents	Soil pollution caused by sewage, fuel and oil during construction phase
Cause	1. Sewage from construction site workers 2. Spilt fuel and oil from storage tanks
Environmental impact	1. Pollution of the ground on the construction sites causing damage to flora and fauna 2. Increased incidence of disease
Elements for evaluation	1. Number of construction site workers 2. Quantity of fuel and oil to be stored
Countermeasures	1. Provide adequate latrines 2. Provide bunded storage areas 3. Provide interceptor drains from plant maintainance areas
Related studies	

Table 16.12
COUNTERMEASURES AGAINST ENVIRONMENTAL EFFECTS

SUBJECT	NOISE AND VIBRATION
Contents	Noise and vibration caused by plant and equipment
Cause	1. Movement of large vehicles and operation of large plant 2. Piling operations 3. Operation of treatment plant after construction
Environmental impact	1. Disturbance to local population 2. Frightening of domestic animals 3. Disturbance of wild animals causing migration from the area 4. Vibration causing damage to nearby structures
Elements for evaluation	1. Population densities in the surrounding areas 2. Existance of animal rearing in the surrounding areas 3. Existance of buildings or structures liable to vibration damage near to the construction sites 4. The need for piling to be used for construction
Countermeasures	1. Use low noise producing plant and equipment where possible 2. Restrict working hours to minimise disturbance 3. Construct sound absorbing bunds or walls if possible 4. Avoid piling operations if posible 5. Careful selection of construction site areas
Related studies	1. Land use survey 2. Geological and soil mechanics surveys 3. Design of intake, treatment works, reservoir and pipeline routes