Table 12.2.5.4 (2) Capacity Calculation of WSP in 6,800 m^3/day,Donnybrook,2015

(3) Facultative Pond (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	6,800
Retention Time	T	day	BOD Removal = 70 %	10
Required Volume	V	m^3	Q x T	68,000
Depth	H	m	1.2 to 1.5 m	1.50
Required Surface Area	RSA	m^2	V / H	45,333
Width	W	m	-	110.00
Length	L1	m	RSA / W	412.12
Therefore	L2	m	-	420.00
Basin Number	BN	basin	-	2
(Dimension)				
Width	W	m	-	110.00
Length	L2	m	L2 / BN	210.00
Depth	H	m	-	1.50
Basin Number	BN	-	-	2

(4) Maturation Pond (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	6,800
Basin Number	BN	basin	-	6
Retention Time	T1	day	6 days at 3 ponds	6
Therefore	T2	day/basin	T1 / BN	1
Required Volume	V	m^3	Q x T2	6,800
Depth	H	m	1.2 to 1.5 m	1.50
Required Surface Area	RSA	m^2	V / H	4,533
Width	W	m	-	50.00
Length	L1	m	RSA / W	90.67
Therefore	L2	m	-	90.00
(Dimension)				
Width	W	m	-	50.00
Length	L2	m	-	90.00
Depth	H	m	-	1.50
Basin Number	BN	-	-	6

(5) Required Land Area

Grit Chamber and Screen	A1	m^2	W2 x L2 x BN	28
Anaerobic Pond	A2	m^2	W x L2 x BN	11,250
Facultative Pond	A3	m^2	W x L2 x BN	46,200
Maturation Pond	A4	m^2	W x L2 x BN	27,000
Sub-Total	A5	m^2	A1 + A2 + A3 + A4	84,478
Maintenance and Green Belt	A6	m^2	Same as A5	84,478
Total	A	m^2	A5 + A6	168,956

Table 12.2.5.5 (1) Capacity Calculation of BNR in 92,100 m^3/day,Harare South,2015

(1) Grit Chamber and Screen (Peak Wet Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Type	-	-	Parallel Flow Type	
Design Sewage Quantity	Q1	m^3/day	92,100 x 3.00	276,300
	Q2	m^3/sec	Q1 / 86,400	3.198
Water Surface Load	WSL	m^3/m^2/day	-	1,800
Required Surface Area	RSA	m^2	Q1 / WSL	153.50
Basin Number	BN	basin	-	8
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.50
Width	W1	m	Q2 / (V x H)	21.32
Therefore	W2	m	-	21.60
Length	L1	m	RSA / W2	7.11
Therefore	L2	m	-	7.10
Screen Type	-	-	Manual Removal Type Bar Screen	
(Dimension)				
Width	W2	m	W2 / BN	2.70
Length	L2	m	-	7.10
Depth	H	m	-	0.50
Basin Number	BN	-	-	8

(2) Primary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	92,100
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	29
Required Surface Area	RSA	m^2	Q / WSL	3175.86
Basin Number	BN	basin	-	24
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	12.98
Therefore	D2	m	-	13.00
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	13.00
Depth	H	m	-	3.00
Basin Number	BN	-	-	24

(cont'd)

Table 12.2.5.5. (2) Capacity Calculation of BNR in 92,100 m^3/day,Harare South,2015

(3) Biological Reactor (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	92,100
Retention Time	T1	day	Anaerobic Tank	0.1
	T2	day	Anoxic Tank	0.2
	T3	day	Aerobic Tank	1.4
	T4	day	Total	1.7
Required Volume	RV	m^3	Q x T4	156,570
Depth	H	m	-	4.00
MLSS	MLSS	mg/l	3,000 to 3,600	3,500
Required Surface Area	RSA	m^2	RV / H	39,143
Basin Number	BN	basin	-	8
Width	W	m	-	400.00
Length	L1	m	RSA / W	97.86
Therefore	L2	m	-	100.00
(Dimension)				
Width	W	m	W / BN	50.00
Length	L2	m	-	100.00
Depth	H	m	-	4.00
Basin Number	BN	-	-	8

(4) Secondary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	92,100
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	10
Required Surface Area	RSA	m^2	Q / WSL	9210.00
Basin Number	BN	basin	-	16
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	27.08
Therefore	D2	m	-	27.00
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	27.00
Depth	H	m	-	3.00
Basin Number	BN	-	-	16

(cont'd)

Table 12.2.5.5. (3) Capacity Calculation of BNR in 92,100 m^3/day,Harare South,2015

(5) Sludge Thickening Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	92,100
Inlet BOD Water Quality	WQ	mg/l	800-10	790
Inlet BOD	B	kg/day	Q x WQ / 1000	72,759
Solid Matter Load	SML	kg/m2/day	60 to 90	60
Required Volume	RV	m^3		
Depth	H	m	-	4.00
Required Surface Area	RSA	m^2	B / SML	1212.65
Basin Number	BN	basin		8
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	13.90
Therefore	D2	m	-	14.00
(Dimension)				
Diameter	D2	m	-	14.00
Depth	H	m	-	4.00
Basin Number	BN	-	(Including 1 Standby)	8

(6) Sludge Drying Bed (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	92,100
Unit Sewage Quantity	USQ	l/capita/day	Assumption	100
Served Population	SP	person	$Q \times 10^3$ / USQ	921,000
Unit Required Bed Area	URBA	m^2/person	-	0.08
Required Bed Area	RBA	m^2	SP x URBA	73,680
Width	W	m	-	100.00
Length	L1	m	RBA / W	736.80
Therefore	L2	m	-	740.00
(Dimension)				
Width	W	m	-	100.00
Length	L2	m	-	740.00

(7) Required Land Area

Grit Chamber and Screen	A1	m^2	W2 x L2 x BN	153
Primary Sedimentation Tank	A2	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	3,184
Biological Reactor	A3	m^2	W x L2 x BN	40,000
Secondary Sedimentation Tank	A4	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	9,156
Sludge Thickening Tank	A5	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	1230.88
Sludge Drying Bed	A6	m^2	W x L2	74,000
Sub-Total	A7	m^2	A1 + A2 + A3 + A4 A5 + A6	127,724
Maintenance and Green Belt	A8	m^2	A7 x 1.5	191,587
Total	A	m^2	A7 + A8	319,311

Table 12.2.5.6 (1) Capacity Calculation of BNR in 37,600 m^3/day,Harare East,2015

(1) Grit Chamber and Screen (Peak Wet Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Type	-	-	Parallel Flow Type	
Design Sewage Quantity	Q1	m^3/day	37,600 x 3.00	112,800
	Q2	m^3/sec	Q1 / 86,400	1.306
Water Surface Load	WSL	m^3/m^2/day	-	1,800
Required Surface Area	RSA	m^2	Q1 / WSL	62.67
Basin Number	BN	basin	-	8
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.50
Width	W1	m	Q2 / (V x H)	8.70
Therefore	W2	m	-	8.80
Length	L1	m	RSA / W2	7.12
Therefore	L2	m	-	7.10
Screen Type	-	-	Manual Removal Type Bar Screen	
(Dimension)				
Width	W2	m	W2 / BN	1.10
Length	L2	m	-	7.10
Depth	H	m	-	0.50
Basin Number	BN	-	-	8

(2) Primary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,600
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	29
Required Surface Area	RSA	m^2	Q / WSL	1296.55
Basin Number	BN	basin	-	8
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	14.37
Therefore	D2	m	-	14.50
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	14.50
Depth	H	m	-	3.00
Basin Number	BN	-	-	8

(cont'd)

Table 12.2.5.6 (2) Capacity Calculation of BNR in 37,600 m^3/day,Harare East,2015

(3) Biological Reactor (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,600
Retention Time	T1	day	Anaerobic Tank	0.1
	T2	day	Anoxic Tank	0.2
	T3	day	Aerobic Tank	1.4
	T4	day	Total	1.7
Required Volume	RV	m^3	Q x T4	63,920
Depth	H	m	-	4.00
MLSS	MLSS	mg/l	3,000 to 3,600	3,500
Required Surface Area	RSA	m^2	RV / H	15,980
Basin Number	BN	basin	-	4
Width	W	m	-	200.00
Length	L1	m	RSA / W	79.90
Therefore	L2	m	-	80.00
(Dimension)				
Width	W	m	W / BN	50.00
Length	L2	m	-	80.00
Depth	H	m	-	4.00
Basin Number	BN	-	-	4

(4) Secondary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,600
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	10
Required Surface Area	RSA	m^2	Q / WSL	3760.00
Basin Number	BN	basin	-	8
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	24.47
Therefore	D2	m	-	25.00
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	25.00
Depth	H	m	-	3.00
Basin Number	BN	-	-	8

Table 12.2.5.6 (3) Capacity Calculation of BNR in 37,600 m^3/day,Harare East,2015

(5) Sludge Thickening Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,600
Inlet BOD Water Quality	WQ	mg/l	900-10	890
Inlet BOD	B	kg/day	Q x WQ / 1000	33,464
Solid Matter Load	SML	kg/m2/day	60 to 90	60
Required Volume	RV	m^3		
Depth	H	m	-	4.00
Required Surface Area	RSA	m^2	B / SML	557.73
Basin Number	BN	basin		4
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	13.33
Therefore	D2	m	-	13.50
(Dimension)				
Diameter	D2	m	-	13.50
Depth	H	m	-	4.00
Basin Number	BN	-		4

(6) Sludge Drying Bed (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,600
Unit Sewage Quantity	USQ	l/capita/day	Assumption	100
Served Population	SP	person	$Q \times 10^3 / USQ$	376,000
Unit Required Bed Area	URBA	m^2/person	-	0.08
Required Bed Area	RBA	m^2	SP x URBA	30,080
Width	W	m	-	100.00
Length	L1	m	RBA / W	300.80
Therefore	L2	m	-	300.00
(Dimension)				
Width	W	m	-	100.00
Length	L2	m	-	300.00

(7) Required Land Area

Grit Chamber and Screen	A1	m^2	W2 x L2 x BN	62
Primary Sedimentation Tank	A2	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	1,320
Biological Reactor	A3	m^2	W x L2 x BN	16,000
Secondary Sedimentation Tank	A4	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	3,925
Sludge Thickening Tank	A5	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	572.265
Sludge Drying Bed	A6	m^2	W x L2	30,000
Sub-Total	A7	m^2	A1 + A2 + A3 + A4 A5 + A6	51,880
Maintenance and Green Belt	A8	m^2	A7 x 1.5	77,820
Total	A	m^2	A7 + A8	129,700

Table 12.2.5.7 (1) Capacity Calculation of BNR in 49,800 m^3/day,Zengeza,2015

(1) Grit Chamber and Screen (Peak Wet Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Type	-	-	Parallel Flow Type	
Design Sewage Quantity	Q1	m^3/day	49,800 x 3.00	149,400
	Q2	m^3/sec	Q1 / 86,400	1.729
Water Surface Load	WSL	m^3/m^2/day	-	1,800
Required Surface Area	RSA	m^2	Q1 / WSL	83.00
Basin Number	BN	basin	-	8
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.50
Width	W1	m	Q2 / (V x H)	11.53
Therefore	W2	m	-	12.00
Length	L1	m	RSA / W2	6.92
Therefore	L2	m	-	7.00
Screen Type	-	-	Manual Removal Type Bar Screen	
(Dimension)				
Width	W2	m	W2 / BN	1.50
Length	L2	m	-	7.00
Depth	H	m	-	0.50
Basin Number	BN	-	-	8

(2) Primary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	49,800
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	29
Required Surface Area	RSA	m^2	Q / WSL	1717.24
Basin Number	BN	basin	-	12
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	13.50
Therefore	D2	m	-	13.50
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	13.50
Depth	H	m	-	3.00
Basin Number	BN	-	-	12

Table 12.2.5.7 (2) Capacity Calculation of BNR in 49,800 m^3/day,Zengeza,2015

(3) Biological Reactor (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	49,800
Retention Time	T1	day	Anaerobic Tank	0.1
	T2	day	Anoxic Tank	0.2
	T3	day	Aerobic Tank	1.4
	T4	day	Total	1.7
Required Volume	RV	m^3	Q x T4	84,660
Depth	H	m	-	4.00
MLSS	MLSS	mg/l	3,000 to 3,600	3,500
Required Surface Area	RSA	m^2	RV / H	21,165
Basin Number	BN	basin	-	4
Width	W	m	-	200.00
Length	L1	m	RSA / W	105.83
Therefore	L2	m	-	110.00
(Dimension)				
Width	W	m	W / BN	50.00
Length	L2	m	-	110.00
Depth	H	m	-	4.00
Basin Number	BN	-	-	4

(4) Secondary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	49,800
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	10
Required Surface Area	RSA	m^2	Q / WSL	4980.00
Basin Number	BN	basin	-	8
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	28.16
Therefore	D2	m	-	28.00
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	28.00
Depth	H	m	-	3.00
Basin Number	BN	-	-	8

(cont'd)

Table 12.2.5.7 (3) Capacity Calculation of BNR in 49,800 m^3/day,Zengeza,2015

(5) Sludge Thickening Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	49,800
Inlet BOD Water Quality	WQ	mg/l	600-10	590
Inlet BOD	B	kg/day	Q x WQ / 1000	29,382
Solid Matter Load	SML	kg/m2/day	60 to 90	60
Required Volume	RV	m^3		
Depth	H	m	-	4.00
Required Surface Area	RSA	m^2	B / SML	489.70
Basin Number	BN	basin		4
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	12.49
Therefore	D2	m	-	12.50
(Dimension)				
Diameter	D2	m	-	12.50
Depth	H	m	-	4.00
Basin Number	BN	-		4

(6) Sludge Drying Bed (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	49,800
Unit Sewage Quantity	USQ	l/capita/day	Assumption	100
Served Population	SP	person	$Q \times 10^3$ / USQ	498,000
Unit Required Bed Area	URBA	m^2/person	-	0.08
Required Bed Area	RBA	m^2	SP x URBA	39,840
Width	W	m	-	140.00
Length	L1	m	RBA / W	284.57
Therefore	L2	m	-	290.00
(Dimension)				
Width	W	m	-	140.00
Length	L2	m	-	290.00

(7) Required Land Area

Grit Chamber and Screen	A1	m^2	W2 x L2 x BN	84
Primary Sedimentation Tank	A2	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	1,717
Biological Reactor	A3	m^2	W x L2 x BN	22,000
Secondary Sedimentation Tank	A4	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	4,924
Sludge Thickening Tank	A5	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	490.625
Sludge Drying Bed	A6	m^2	W x L2	40,600
Sub-Total	A7	m^2	A1 + A2 + A3 + A4 A5 + A6	69,815
Maintenance and Green Belt	A8	m^2	A7 x 1.5	104,722
Total	A	m^2	A7 + A8	174,537

Table 12.2.5.8 (1) Capacity Calculation of TF in 37,900 m^3/day,Norton,2015

(1) Grit Chamber and Screen (Peak Wet Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Type	-	-	Parallel Flow Type	
Design Sewage Quantity	Q1	m^3/day	37,900 x 3.00	113,700
	Q2	m^3/sec	Q1 / 86,400	1.316
Water Surface Load	WSL	m^3/m^2/day	-	1,800
Required Surface Area	RSA	m^2	Q1 / WSL	63.17
Basin Number	BN	basin	(Including 1 By-pass)	8
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.50
Width	W1	m	Q2 / (V x H)	8.77
Therefore	W2	m	-	8.80
Length	L1	m	RSA / W2	7.18
Therefore	L2	m	-	7.00
Screen Type	-	-	Manual Removal Type Bar Screen	
(Dimension)				
Width	W2	m	-	1.10
Length	L2	m	-	7.00
Depth	H	m	-	0.50
Basin Number	BN	-		8

(2) Primary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,900
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	29
Required Surface Area	RSA	m^2	Q / WSL	1306.90
Basin Number	BN	basin	-	12
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	11.78
Therefore	D2	m	-	12.00
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	12.00
Depth	H	m	-	3.00
Basin Number	BN	-	-	12

(cont'd)

Table 12.2.5.8 (2) Capacity Calculation of TF in 37,900 m^3/day,Norton,2015

(3) Trickling Filter (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,900
Inlet BOD Water Quality	WQ	mg/l	1000x0.50	500
Inlet BOD	B	kg/day	Q x WQ / 1000	18950
BOD Loading	BL	kg/m^3/day	-	0.2
Required Volume	RV	m^3	B / BL	94,750
Depth	H	m	3 to 4 m	4.00
Required Surface Area	RSA	m^2	RV / H	23687.5
Basin Number	BN	basin	-	24
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	35.46
Therefore	D2	m	-	36.00
(Dimension)				
Diameter	D2	m	-	36.00
Depth	H	m	-	4.00
Basin Number	BN	-	-	24
(Check)				
Surface Area	A	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	24416.64
Water Surface Load	WSL	m^3/m^2/day	Q / A	1.55

(4) Secondary Sedimentation Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,900
Retention Time	T	hr	-	1.5
Water Surface Load	WSL	m^3/m^2/day	-	29
Required Surface Area	RSA	m^2	Q / WSL	1306.90
Basin Number	BN	basin	-	12
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	11.78
Therefore	D2	m	-	12
Depth	H	m	-	3.00
(Dimension)				
Diameter	D2	m	-	12.00
Depth	H	m	-	3.00
Basin Number	BN	-	-	12

(cont'd)

Table 12.2.5.8 (3) Capacity Calculation of TF in 37,900 m^3/day,Norton,2015

(5) Sludge Thickening Tank (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,900
Inlet BOD Water Quality	WQ	mg/l	1000-70	930
Inlet BOD	B	kg/day	Q x WQ / 1000	35247
Solid Matter Load	SML	kg/m2/day	60 to 90	60
Required Volume	RV	m^3		
Depth	H	m	-	4.00
Required Surface Area	RSA	m^2	B / SML	587.45
Basin Number	BN	basin		4
Diameter	D1	m	$(RSA / (BN \times 3.14))^{1/2} \times 2$	13.68
Therefore	D2	m	-	14.00
(Dimension)				
Diameter	D2	m	-	14.00
Depth	H	m	-	4.00
Basin Number	BN	-		4

(6) Sludge Drying Bed

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	37,900
Unit Sewage Quantity	USQ	l/capita/day	Assumption	100
Served Population	SP	person	$Q \times 10^3 / USQ$	379,000
Unit Required Bed Area	URBA	m^2/person	-	0.08
Required Bed Area	RBA	m^2	SP x URBA	30,320
Width	W	m	-	150.00
Length	L1	m	RBA / W	202.13
Therefore	L2	m	-	200.00
(Dimension)				
Width	W	m	-	150.00
Length	L2	m	-	200.00

(7) Required Land Area

Grit Chamber and Screen	A1	m^2	W2 x L2 x BN	62
Primary Sedimentation Tank	A2	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	1,356
Trikling Filter	A3	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	24,417
Secondary Sedimentation Tank	A4	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	1,356
Sludge Thickening Tank	A5	m^2	$(D2 / 2)^2 \times 3.14 \times BN$	6.28
Sludge Drying Bed	A6	m^2	W x L2	30,000
Sub-Total	A7	m^2	A1 + A2 + A3 + A4 A5 + A6	57,197
Maintenance and Green Belt	A8	m^2	A7 x 1.5	85,796
Total	A	m^2	A7 + A8	142,994

Table 12.2.5.9 (1) Capacity Calculation of WSP in 13,100 m^3/day,Ruwa,2015

(1) Grit Chamber and Screen (Peak Wet Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Type	-	-	Parallel Flow Type	
Design Sewage Quantity	Q1	m^3/day	13,100 x 3.75	49,125
	Q2	m^3/sec	Q1 / 86,400	0.569
Water Surface Load	WSL	m^3/m^2/day	-	1,800
Required Surface Area	RSA	m^2	Q1 / WSL	27.29
Basin Number	BN	basin	-	4
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.50
Width	W1	m	Q2 / (V x H)	3.79
Therefore	W2	m	-	4.00
Length	L1	m	RSA / W2	6.82
Therefore	L2	m	-	7.00
Screen Type	-	-	Manual Removal Type Bar Screen	
(Dimension)				
Width	W2	m	W2 / BN	1.00
Length	L2	m	-	7.00
Depth	H	m	-	0.50
Basin Number	BN	-	-	4

(2) Anaerobic Pond (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	13,100
Retention Time	T	day	BOD Removal = 60 %	5
Required Volume	V	m^3	Q x T	65,500
Depth	H	m	At least 3 m	3.00
Required Surface Area	RSA	m^2	V / H	21,833
Width	W	m	-	105.00
Length	L1	m	RSA / W	207.94
Therefore	L2	m	-	210.00
Basin Number	BN	basin	-	2
(Dimension)				
Width	W	m	-	105.00
Length	L2	m	L2 / BN	105.00
Depth	H	m	-	3.00
Basin Number	BN	-	-	2

(cont'd)

Table 12.2.5.9 (2) Capacity Calculation of WSP in 13,100 m^3/day,Ruwa,2015

(3) Facultative Pond (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	13,100
Retention Time	T	day	BOD Removal = 70 %	10
Required Volume	V	m^3	Q x T	131,000
Depth	H	m	1.2 to 1.5 m	1.50
Required Surface Area	RSA	m^2	V / H	87,333
Width	W	m	-	105.00
Length	L1	m	RSA / W	831.75
Therefore	L2	m	-	840.00
Basin Number	BN	basin	-	4
(Dimension)				
Width	W	m	-	105.00
Length	L2	m	L2 / BN	210.00
Depth	H	m	-	1.50
Basin Number	BN	-	-	4

(4) Maturation Pond (Average Dry Weather Flow)

Item	Symbol	Unit	Calculation	Adoption
Design Sewage Quantity	Q	m^3/day	-	13,100
Basin Number	BN	basin	-	12
Retention Time	T1	day	6 days at 3 ponds	6
Therefore	T2	day/basin	T1 / BN	0.5
Required Volume	V	m^3	Q x T2	6,550
Depth	H	m	1.2 to 1.5 m	1.50
Required Surface Area	RSA	m^2	V / H	4,367
Width	W	m	-	105.00
Length	L1	m	RSA / W	41.59
Therefore	L2	m	-	40.00
(Dimension)				
Width	W	m	-	105.00
Length	L2	m	-	40.00
Depth	H	m	-	1.50
Basin Number	BN	-	-	12

(5) Required Land Area

Grit Chamber and Screen	A1	m^2	W2 x L2 x BN	28
Anaerobic Pond	A2	m^2	W x L2 x BN	22,050
Facultative Pond	A3	m^2	W x L2 x BN	88,200
Maturation Pond	A4	m^2	W x L2 x BN	50,400
Sub-Total	A5	m^2	A1 + A2 + A3 + A4	160,678
Maintenance and Green Belt	A6	m^2	Same as A5	160,678
Total	A	m^2	A5 + A6	221,226

Table 12.7.1 Trade Effluent Standards for Discharge into Public Sewers

(Unit: mg/l)

Item	Concentration
Total Suspended Solids	600
Total Non-volatile Dissolved Solids	3,000
BOD_5 at 20°C	1,000
COD	2,000
Phenols (total at connection point)	10
Detergents	15
Soaping oils and fats	10
Hydro carbons	20
Silver (Ag)	0.02
Arsenic (As)	0.02
Barium (Ba)	0.5
Cadmium (Cd)	0.01
Chloride (Cl)	1,000
Cyanide (CN^-)	0.02
Cyanide (CN) total	1
Cobalt (Co)	0.05
Hexavalent Chromium (Cr^{6+})	0.05
Total Chromium	3
Copper (Cu)	0.5
Mercury (Hg)	0.01
Ammonical Nitrogen	20
Nickel (Ni)	0.5
Free Ammonia	10
Total Kjeldahi Nitrogen	Nil
Nitrite	0.5
Lead (Pb)	2
Total Phosphate	30
Selenium (Se)	0.5
Tin (Sn)	0.5
Sulphite (SO_3)	2
Sulphate (SO_4)	1,000
Zinc (Zn)	0.5
Total Nonferrous Metals	0.5
Total Soluble Nonferrous Metals	30
Pesticides	Nil
pH	6.5 - 8.0
Temperature	Not exceeding 35°C
In addition, effluent should not contain any toxic matter or any matter that will cause blockage and damage to sewers. Inflammable material and tar should not be present in the final effluent entering the sewer.	

Source: JICA Study Team

SECTION 13 COST ESTIMATE BY PUBLIC AND PRIVATE INVESTMENT AND FINANCIAL STUDY

13.3 Unit Cost and Cost functions for Construction/Rehabilitation of Facilities

Table 13.3.1(1) Construction Cost of Trickling Filter Process

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	2,500 m3/day Quantity	2,500 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$
Preliminary and General					234422.78		364565.06		649045.62		1194378.16
Bulk Excavation					68862.75		137083.91		282084.05		562649.57
Grit Chamber					54139.55		54139.55		69393.84		87568.01
Pump Pit					47954.27		80355.18		117060.48		194310.59
Primary Sedimentation Tank					53234.85		103873.65		212194.74		423887.81
Distribution Tank					6146.38		10586.94		16695.42		23957.38
Trickling Filter					515555.42		1025978.07		1603977.84		3242476.76
Split Box for Clarifier					1480.93		2960.56		5379.22		8160.12
Secondary Sedimentation Tank					223196.90		253619.71		461512.72		922360.32
WAS Pump Station (STT - TT)					16668.64		16668.64		16668.64		16668.64
Sludge Thickening Tank					92059.16		92059.16		99837.80		110852.41
Pump Station (TT - DB)					16668.64		16668.64		16668.64		16668.64
Sludge Drying Pond					171713.24		327553.14		598054.14		1150016.48
Electric Control House					25858.96		25858.96		43227.99		78737.56
Pipe Work					45810.95		100784.08		152513.05		246834.00
Site Work					223467.89		424451.79		631702.21		877372.74
Plant/Equipment					53917.24		91119.24		149280.49		274706.98
Electrical Work					179724.13		303730.80		497601.64		915689.92
Total construction Cost					2030882.72		3432158.09		5622898.52		10347296.09
Unit Cost per m3 (Treated water)					812.35		686.43		562.29		517.36

Table 13.3.1(2) Construction Cost of Trickling Filter Process

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	2,500 m3/day Quantity	2,500 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$
Preliminary and General (15%)					234422.78		364665.06		649045.62		1194378.16
Bulk Excavation											
Site clearance	1	0 11	m2	7059	743.05	14053	1479.26	28919	3044.11	57684	6072.00
Excavation,topsoil	15	1 58	m3	1059	1672.11	2108	3328.42	4338	6849.47	8653	13662.63
Excavation,common	30	3.16	m3	3530	11147.37	7027	22190.53	14460	45663.16	28842	91089.00
Excavation,intermediate	100	10.53	m3	2118	22294.74	4216	44378.95	8676	91326.32	17305	182157.89
Excavation,hard rock	200	21.05	m3	1412	29726.32	2811	59178.95	5784	121768.42	11537	242884.21
Others (5%)			L S.		3279.18		6527.81		13432.57		26792.84
Subtotal					68862.76		137083.91		282084.05		562649.57
Grit Chamber											
Excavation,common	50	5.26	m3	47	247.37	47	247.37	76	400.00	123	647.37
Excavation,intermediate	150	15.79	m3	14	221.05	14	221.05	23	363.16	37	584.21
Excavation,hard rock	250	26.32	m3	9	236.84	9	236.84	15	394.74	25	657.89
Concrete,10MPA	35	3.68	m2	12	44.21	12	44.21	20	73.68	32	117.89
Concrete,25-30MPA	750	78 95	m3	22	1736.84	22	1736.84	35	2763.16	56	4421.05
Shuttering	120	12 63	m2	74	934.74	74	934.74	118	1490.53	189	2387.37
Reinforcement	7.5	0.79	kg	2508	1980.00	2508	1980.00	3990	3150.00	6384	5040.00
Concrete ancillary (5%)			L S.		270.05		270.05		431.76		692.79
Metal work (25%)			L.S.		1350.26		1350.26		2158.82		3463.95
Building work (7%)			L.S.		378.07		378.07		604.47		969.91
PIpe work (3%)			L.S.		162.03		162 03		259.06		415.67
Air compressor,air lift pump			L.S.	2.5m3x2	24000.00	2.5m3x2	24000.00	2 5m3x2	24000.00	2 5m3x2	24000.00
Flow recorder			L S	2nos.	20000.00	2nos.	20000.00	3nos.	30000.00	4nos.	40000.00
Others (5%)			L S.		2578.07		2578.07		3304.47		4169.91
Subtotal					54139.55		54139.55		69393.84		87568.01
Pump Pit											
Excavation,common	50	5.26	m3	48	252 63	62	326.32	80	421.05	131	689.47
Excavation,intermediate	150	15.79	m3	28	442 11	37	584.21	48	757.89	79	1247.37
Excavation,hard rock	250	26.32	m3	19	500.00	25	657.89	32	842.11	52	1368.42
Load haul	20	2.11	m3	95	200.00	124	261.05	160	336.84	262	551.58
Trimming	8	0.84	m2	48	40.42	62	52 21	161	135.58	132	111.16
Concrete,10MPA	35	3.68	m2	13	47.89	17	62.63	22	81.05	36	132.63
Concrete,25-30MPA	750	78.95	m3	34	2684 21	44	3473.68	57	4500.00	94	7421 05
Shuttering	120	12 63	m2	142	1793.68	186	2349.47	241	3044.21	393	4964.21
Reinforcement	7.5	0.79	kg	3752	2962 11	4906	3873.16	6349	5012 37	10390	8202.63
Concrete,ancillary (13%)			L S.		1160.00		1513.28		1967.04		3209.51
Architecture (22%)			L.S.		1963.07		2560.94		3328.84		5431.48
Metal work (7%)			L.S.		624.61		814.84		1059.18		1728.20
Pump			L.S.	7.5kw,3	33000.00	18 5kw,3	60000.00	37kw,3	90000.00	37kw,5	150000.00
Others (5%)			L.S.		2283.54		3826.48		5574.31		9252 89
Subtotal					47954.27		80356.18		117060.48		194310.59
Primary Sedimentation Tank											
Excavation,common	50	5.26	m3	1139	5994.74	2233	11752.63	4558	23989.47	9114	47968.42
Excavation,intermediate	150	15.79	m3	228	3600.00	447	7057.89	912	14400.00	1823	28784 21
Excavation,hard rock	250	26.32	m3	114	3000.00	223	5868.42	456	12000.00	911	23973.68
Trimming	8	0.84	m2	192	161.68	376	316.63	767	645.89	1533	1290.95
Load haul	20	2.11	m3	671	1412.63	1316	2770.53	2685	5652.63	5369	11303.16
Concrete,10MPA	35	3.68	m2	192	707.37	376	1385.26	767	2825.79	1533	5647.89
Concrete,25-30MPA	750	78.95	m3	125	9868.42	243	19184 21	497	39236.84	992	78315.79
Shuttering	120	12.63	m2	572	7225.26	1114	14071.58	2275	28736.84	4544	57397.89
Reinforcement	7.5	0.79	kg	9598	7577.37	18695	14759.21	38189	30149.21	76277	60218.68
Finishing (0.2%)			L.S.		79.09		154.33		315.27		629.80
Concrete ancillary (13%)			L S.		5141.17		10031.63		20492.77		40937.09
Metal work (5%)			L.S.		1977.37		3858 32		7881.83		15745.03
Pipe work (10%)			L S.		3954.75		7716.64		15763.67		31490.07
Others (5%)			L.S.		2534.99		4946.36		10104.51		20185.13
Subtotal					53234.85		103873.65		212194.74		423887.81
Distribution Tank											
Excavation,common	50	5 26	m3	9	47.37	16	84.21	25	131.58	36	189.47
Excavation,intermediate	150	15.79	m3	2	31.58	4	63.16	5	78.95	8	126 32
Excavation,hard rock	250	26.32	m3	1	26.32	2	52 63	3	78.95	4	105.26
Concrete,10MPA	35	3.68	m2	9	33.16	15	55.26	24	88.42	35	128.95
Concrete,25-30MPA	750	78.95	m3	20	1578.95	34	2684.21	54	4263.16	77	6078.95
Shuttering	120	12.63	m2	90	1136 84	155	1957.89	241	3082.11	351	4433.68
Reinforcement	7.5	0.79	kg	2223	1755.00	3853	3041.84	6076	4796.84	8744	6903.16
Concrete ancillary (13%)			L.S.		599.20		1032.10		1627.60		2335.55
Metal work (5%)			L S.		230.46		396.96		626.00		898.29

Table 13.3.1(3) Construction Cost of Trickling Filter Process

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	2,500 m3/day Quantity	2,500 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$
Pipe work (9%)			L.S.		414.83		714.53		1126.80		1616.92
Others (5%)			L.S.		292.68		504.14		795.02		1140.83
Subtotal					6146.38		10586.94		16695.42		23957.38
Trickling Filter											
Excavation,common	50	5.26	m3	1413	7436.84	2826	14873.68	6359	33468.42	12717	66931.58
Excavation,intermediate	150	15.79	m3	283	4468.42	565	8921.05	1272	20084.21	2544	40168.42
Excavation,hard rock	250	26.32	m3	142	3736.84	283	7447.37	636	16736.84	1272	33473.68
Concrete,10MPA	35	3.68	m2	628	2313.68	1256	4627.37	2826	10411.58	5652	20823.16
Concrete,25-30MPA	750	78.95	m3	670	52894.74	1316	103894.74	2269	179131.58	4515	356447.37
Shuttering	120	12.63	m2	1699	21461.05	3380	42694.74	5062	63941.05	10108	127680.00
Reinforcement	7.5	0.79	kg	82348	65011.58	161819	127751.84	279026	220283.68	598506	472504.74
Concrete ancillary (10%)			L.S.		15732.32		31021.08		54405.74		111802.89
Steel pipe,450mm	2000	210.53	m	34	7157.89	67	14105.26	87	18315.79	174	36631.58
AC pipe,450mm	1916	201.68	m	40	8067.37	80	16134.74	80	16134.74	160	32269.47
Concrete filter drain,150mm	239	25.16	m	938	23598.11	1884	47397.47	4239	106644.32	8478	213288.63
70mm stone	260	27.37	m3	257	7033.68	515	14094.74	1159	31720.00	2318	63440.00
50mm stone	260	27.37	m3	2343	64124.21	4685	128221.05	10541	288490.53	21082	576981.05
Bottom subgrade,compactio	260	27.37	m2	628	17187.37	1256	34374.74	2826	77343.16	5652	154686.32
Bottom crusher run	270	28.42	m3	126	3581.05	252	7162.11	566	16086.32	1131	32144.21
Distribution arm			L.S.	(2 nos.)	187200.00	(4 nos.)	374400.00	(4 nos.)	374400.00	(8 nos.)	748800.00
Others (5%)			L.S.		24550.26		48856.10		76379.90		154403.66
Subtotal					515555.42		1025978.07		1603977.84		3242476.76
Split Box for Clarifier											
Excavation,common	50	5.26	m3	2	10.53	4	21.05	7	36.84	11	57.89
Excavation,intermediate	150	15.79	m3	1	15.79	2	31.58	3	47.37	5	78.95
Excavation,hard rock	250	26.32	m3	1	26.32	1	26.32	2	52.63	3	78.95
Concrete,10MPA	35	3.68	m2	5	18.42	10	36.84	18	66.32	27	99.47
Concrete,25-30MPA	750	78.95	m3	5	394.74	10	789.47	18	1421.05	27	2131.58
Shuttering	120	12.63	m2	22	277.89	46	581.05	90	1136.84	140	1768.42
Reinforcement	7.5	0.79	kg	572	451.58	1144	903.16	2002	1580.53	3003	2370.79
Concrete ancillary (13%)			L.S.		155.38		310.63		564.41		856.19
Metal work (5%)			L.S.		59.76		119.47		217.08		329.30
Others (5%)			L.S.		70.52		140.98		256.15		388.58
Subtotal					1480.93		2960.56		5379.22		8160.12
Secondary Sedimentation Tank (Clarifier)											
Excavation,common	50	5.26	m3	408	2147.37	799	4205.26	1629	8573.68	3257	17142.11
Excavation,intermediate	150	15.79	m3	82	1294.74	160	2526.32	326	5147.37	652	10294.74
Excavation,hard rock	250	26.32	m3	41	1078.95	80	2105.26	163	4289.47	326	8578.95
Trimming	8	0.84	m2	98	82.53	191	160.84	389	327.58	777	654.32
Load haul	20	2.11	m3	379	797.89	743	1564.21	1516	3191.58	3031	6381.05
Concrete,10MPA	35	3.68	m2	96	353.68	187	688.95	382	1407.37	763	2811.05
Concrete,25-30MPA	750	78.95	m3	96	7578.95	187	14763.16	382	30157.89	762	60157.89
Shuttering	120	12.63	m2	415	5242.11	806	10181.05	1645	20778.95	3276	41381.05
Reinforcement	7.5	0.79	kg	7696	6075.79	14976	11823.16	30576	24138.95	60944	48113.68
Concrete ancillary (12%)			L.S.		2958.24		5762.19		11761.54		23461.78
Metal work (3%)			L.S.		739.56		1440.55		2940.39		5865.45
Pipe work (9%)			L.S.		2218.68		4321.64		8821.16		17596.34
Mechanical bridge			L.S.	(2 nos.)	182000.00	(2 nos.)	182000.00	(2 nos.)	318000.00	(4nos.)	636000.00
Others (5%)			L.S.		10628.42		12077.13		21976.80		43921.92
Subtotal					223196.90		253619.71		461512.72		922360.32
WAS Pump Station (STT - TT)											
Excavation,common	50	5.26	m3	47	247.37	47	247.37	47	247.37	47	247.37
Excavation,intermediate	150	15.79	m3	10	157.89	10	157.89	10	157.89	10	157.89
Excavation,hard rock	250	26.32	m3	5	131.58	5	131.58	5	131.58	5	131.58
Trimming	8	0.84	m2	13	10.95	13	10.95	13	10.95	13	10.95
Load haul	20	2.11	m3	47	98.95	47	98.95	47	98.95	47	98.95
Concrete,10MPA	35	3.68	m2	13	47.89	13	47.89	13	47.89	13	47.89
Concrete,25-30MPA	750	78.95	m3	27	2131.58	27	2131.58	27	2131.58	27	2131.58
Shuttering	120	12.63	m2	91	1149.47	91	1149.47	91	1149.47	91	1149.47
Reinforcement	7.5	0.79	kg	2757	2176.58	2757	2176.58	2757	2176.58	2757	2176.58
Concrete ancillary (10%)			L.S.		615.23		615.23		615.23		615.23
Metal work (18%)			L.S.		1107.41		1107.41		1107.41		1107.41
Pump			L.S.	1.5kw,2	8000.00	1.5kw,2	8000.00	1.5kw,2	8000.00	1.5kw,2	8000.00
Others (5%)			L.S.		793.74		793.74		793.74		793.74
Subtotal					16668.64		16668.64		16668.64		16668.64
Sludge Thickening Tank											

Table 13.3.1(4) Construction Cost of Trickling Filter Process

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	2,500 m3/day Quantity	2,500 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$
Excavation,common	50	5.26	m3	49	257.89	49	257.89	110	578.95	195	1026.32
Excavation,intermediate	150	15.79	m3	10	157.89	10	157.89	22	347.37	39	615.79
Excavation,hard rock	250	26.32	m3	5	131.58	5	131.58	11	289.47	20	526.32
Trimming	8	0.84	m2	17	14.32	17	14.32	38	32.00	67	56.42
Load/haul	20	2.11	m3	39	82.11	39	82.11	87	183.16	155	326.32
Concrete,10MPA	35	3.68	m2	18	66.32	18	66.32	39	143.68	69	254.21
Concrete,25-30MPA	750	78.95	m3	16	1263.16	16	1263.16	35	2763.16	62	4894.74
Shuttering	120	12.63	m2	69	871.58	69	871.58	153	1932.63	273	3448.42
Reinforcement	7.5	0.79	kg	1778	1403.68	1778	1403.68	4001	3158.68	7114	5616.32
Concrete ancillary (16%)			L.S.		679.76		679.76		1508.66		2682.37
Metal work (5%)			L.S.		212.43		212.43		471.46		838.24
Pipe work (22%)			L.S.		934.68		934.68		2074.40		3688.27
Thickening bridge/scraper			L.S.	(2nos)	81600.00	(2nos.)	81600.00	(2nos)	81600.00	(2nos)	81600.00
Others (5%)			L.S.		4383.77		4383.77		4754.18		5278.69
Subtotal					92059.16		92059.16		99837.80		110852.41
Pump Station (TT - DB)											
Excavation,common	50	5.26	m3	47	247.37	47	247.37	47	247.37	47	247.37
Excavation,intermediate	150	15.79	m3	10	157.89	10	157.89	10	157.89	10	157.89
Excavation,hard rock	250	26.32	m3	5	131.58	5	131.58	5	131.58	5	131.58
Trimming	8	0.84	m2	13	10.95	13	10.95	13	10.95	13	10.95
Load/haul	20	2.11	m3	47	98.95	47	98.95	47	98.95	47	98.95
Concrete,10MPA	35	3.68	m2	13	47.89	13	47.89	13	47.89	13	47.89
Concrete,25-30MPA	750	78.95	m3	27	2131.58	27	2131.58	27	2131.58	27	2131.58
Shuttering	120	12.63	m2	91	1149.47	91	1149.47	91	1149.47	91	1149.47
Reinforcement	7.5	0.79	kg	2757	2176.58	2757	2176.58	2757	2176.58	2757	2176.58
Concrete ancillary (10%)			L.S.		615.23		615.23		615.23		615.23
Metal work (18%)			L.S.		1107.41		1107.41		1107.41		1107.41
Pump			L.S.	1.5kw,2	8000.00	1.5kw,2	8000.00	1.5kw,2	8000.00	1.5kw,2	8000.00
Others (5%)			L.S.		793.74		793.74		793.74		793.74
Subtotal					16668.64		16668.64		16668.64		16668.64
Sludge Drying Pond											
Excavation,common	50	5.26	m3	3000	15789.47	6000	31578.95	12000	63157.89	23925	125921.05
Excavation,intermediate	150	15.79	m3	600	9473.68	1200	18947.37	2400	37894.74	4785	75552.63
Excavation,hard rock	250	26.32	m3	300	7894.74	600	15789.47	1200	31578.95	2393	62973.68
Concrete,10MPA	35	3.68	m2	2000	7368.42	4000	14736.84	8000	29473.68	15950	58763.16
Concrete,15MPA	700	73.68	m3	520	38315.79	1040	76631.58	2080	153263.16	4147	305568.42
Concrete,25-30MPA	750	78.95	m3	135	10657.89	222	17526.32	257	20289.47	384	30315.79
Shuttering	120	12.63	m2	897	11330.53	1482	18720.00	1716	21675.79	2555	32273.68
Channel concrete,25MPA	750	78.95	m3	29	2289.47	44	3473.68	57	4500.00	81	6394.74
Shuttering,channel	120	12.63	m2	187	2362.11	291	3675.79	374	4724.21	530	6694.74
Reinforcement	7.5	0.79	kg	54704	43187.37	104520	82515.79	191568	151237.89	368888	291227.37
Concrete ancillary (10%)			L.S.		14866.95		28359.58		51779.58		99568.53
Others (5%)			L.S.		8176.82		15597.77		28478.77		54762.69
Subtotal					171713.24		327553.14		598054.14		1150016.48
Electric Control House											
Excavation,common	50	5.26	m3	25	131.58	25	131.58	42	221.05	75	394.74
Excavation,intermediate	150	15.79	m3	15	236.84	15	236.84	25	394.74	45	710.53
Excavation,hard rock	250	26.32	m3	10	263.16	10	263.16	17	447.37	30	789.47
Compaction	5	0.53	m2	27	14.21	27	14.21	45	23.68	81	42.63
Concrete,25-30MPA	750	78.95	m3	62	4894.74	62	4894.74	104	8210.53	188	14842.11
Shuttering	120	12.63	m2	270	3410.53	270	3410.53	451	5696.84	841	10623.16
Reinforcement	7.5	0.79	kg	7800	6157.89	7800	6157.89	13000	10263.16	23563	18602.37
Concrete ancillary (23%)			L.S.		3475.06		3475.06		5809.19		10581.15
Architecture (37%)			L.S.		5590.31		5590.31		9345.23		17021.85
Metal work (3%)			L.S.		453.27		453.27		757.72		1380.15
Others (5%)			L.S.		1231.38		1231.38		2058.48		3749.41
Subtotal					25858.96		25858.96		43227.99		78737.56
Pipework (Interconnecting)											
Asbestos Hume											
350mm,AC	1109	116.74	m	100	11673.68	80	9338.95	0	0.00	0	0.00
475mm,AC	1916	201.68	m	100	20168.42	120	24202.11	150	30252.63	150	30252.63
650mm,AC	3248	341.89	m	0	0.00	120	41027.37	150	51284.21	150	51284.21
900mm,Hime	1930	203.16	m	0	0.00	0	0.00	150	30473.68	150	30473.68
1350mm,Hume	4598	484.00	m	0	0.00	0	0.00	0	0.00	150	72600.00
Sludge pipe (Pressure)											
150mm,AC	429	45.16	m	100	4515.79	120	5418.95	200	9031.58	250	11289.47
Pipe fitting (10%)			L.S.		3635.79		7998.74		12104.21		19590.00
Box/manhole (10%)			L.S.		3635.79		7998.74		12104.21		19590.00

Table 13 3.1(5) Construction Cost of Trickling Filter Process

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	2,500 m3/day Quantity	2,500 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$
Others (5%)			L. S.		2181.47		4799 24		7262 53		11754 00
Subtotal					45810.95		100784.08		152513.05		246834.00
Site Work											
Topsoil/Turfing	10	1.05	m2	4235	4457.89	8432	8875.79	17357	18270.53	34611	36432.63
Fencing	200	21.05	m	340	7157.89	510	10736.84	686	14442 11	1080	22736.84
Read work	160	16.84	m2	1360	22905.26	2040	34357.89	2744	46214.74	4320	72757.89
Stormwater	150	15.79	m	680	10736.84	1020	16105.26	1372	21663.16	2160	34105.26
Staff house	300000	31578.95	no	5	157894.74	10	315789.47	15	473684.21	20	631578.95
Others (10%)			L.S.		20315.26		38586.53		57427.47		79761.16
Subtotal					223467.89		424451.79		631702 21		877372.74
Plant Equipment (3%) Computer, Dump trailer, Tractor tow, Tractor, Submergible pump, Dumper, etc.			L.S.		53917.24		91119.24		149280.49		274706.98
Electrical Works (10%) Switchgear, Transformer, Control Panel, Distribution line, Diesel generator, etc.			L.S.		179724.13		303730.80		497601.64		915689.92
Total Construction Cost					2030882.72		3432158.09		5622898.52		10347296.09
Unit Cost per m3(Treated water)					2500m3/day		5000m3/day		10000m3/day		20000m3/da
					812.35		686.43		562.29		517.36

Table 13.3.2 (1) Construction Cost of Biological Nutrient Removal process (BNR)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$	50,000 m3/day Quantity	50,000 m3/day Amount US$
Preliminary and General					450361.34		753511.03		1367509.32		2891361.37
Bulk Excavation					129045.55		259300.04		510588.25		1299038.67
Grit Chamber					54139.55		64639.55		79893.84		108568.01
Pump Pit					80357.44		116922 36		193713.02		427273.67
Primary Sedimentation Tank					103856.65		156046.86		423907.29		1089122.64
Inlet Work for Biological Reactor					80092.56		82121.16		160241.17		160241.17
Biological Reactor					1118178.10		1966963.54		3537218.99		6998962 34
Split Box for Clarifier					2960.56		5379.22		8160.12		8160.12
Secondary Sedimentation Tank					440843.61		843292.01		1686550.86		3952391.27
RAS and WASPump Station					55935.81		76460.69		127851.89		332063.25
Sludge Thickening Tank					92059.16		99837.80		110852.41		162827.78
Pump Station (IT - DB)					20862.98		20862.98		28813.80		35475.13
Sludge Drying Pond					300369.30		557203.61		1081721.94		2653449.58
Electric Control House					25858.96		25858.96		43227.99		78872.68
Pipe Work					74180.84		114394.74		273546.00		627002.53
Site Work					423667.89		634123.37		850441.26		1342290.63
Plant/Equipment					103583.11		173307.54		314527.14		665013.11
Electrical work					345277.03		577691.79		1048423.82		2216710.38
Total Construction Cost					3901630.45		6527917.26		11847189.12		25048827.33
Unit Cost per m3 (Treated water)					780.33		652.79		592 36		500.98

Table 13.3.2(1) Construction Cost of Biological Nutrient Removal process (BNR)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$	50,000 m3/day Quantity	50,000 m3/day Amount US$
Preliminary and General (15%)					450361.34		753511.03		1367509.32		2891361.37
Bulk Excavation											
Site clearance	1	0.11	m2	13230	1392.63	26583	2798.21	52583	5535.05	133182	14019.16
Excavation,topsoil	15	1.58	m3	1985	3134.21	3987	6295.26	7851	12396.32	19973	31536.32
Excavation,common	30	3.16	m3	6615	20889.47	13292	41974.74	26172	82648.42	66591	210287.37
Excavation,intermediate	100	10.53	m3	3969	41778.95	7975	83947.37	15703	165294.74	39955	420578.95
Excavation,hard rock	200	21.05	m3	2646	55705.26	5317	111936.84	10469	220400.00	26636	560757.89
Others (5%)			L.S.		6145.03		12347.62		24313.73		61858.98
Subtotal					129045.55		259300.04		510588.25		1299038.67
Grit Chamber											
Excavation,common	50	5.26	m3	47	247.37	47	247.37	76	400.00	123	647.37
Excavation,intermediate	150	15.79	m3	14	221.05	14	221.05	23	363.16	37	584.21
Excavation,hard rock	250	26.32	m3	9	236.84	9	236.84	15	394.74	25	657.89
Concrete,10MPA	35	3.68	m2	12	44.21	12	44.21	20	73.68	32	117.89
Concrete,25-30MPA	750	78.95	m3	22	1736.84	22	1736.84	35	2763.16	56	4421.05
Shuttering	120	12.63	m2	74	934.74	74	934.74	118	1490.53	189	2387.37
Reinforcement	7.5	0.79	kg	2508	1980.00	2508	1980.00	3990	3150.00	6384	5040.00
Concrete ancillary (5%)			L.S.		270.05		270.05		431.76		692.79
Metal work (25%)			L.S.		1350.26		1350.26		2158.82		3463.95
Building work (7%)			L.S.		378.07		378.07		604.47		969.91
Pipe work (3%)			L.S.		162.03		162.03		259.06		415.67
Air compressor,air lift pump			L.S.	2.5m3x2	24000.00	2.5m3x2	24000.00	2.5m3x2	24000.00	2.5m3x2	24000.00
Flow recorder			L.S	2nos.	20000.00	3nos.	30000.00	4nos.	40000.00	6nos.	60000.00
Others (5%)			L.S.		2578.07		3078.07		3804.47		5169.91
Subtotal					54139.55		64639.55		79893.84		108568.01
Pump Pit											
Excavation,common	50	5.26	m3	62	326.32	80	421.05	121	636.84	291	1531.58
Excavation,intermediate	150	15.79	m3	37	584.21	48	757.89	79	1247.37	175	2763.16
Excavation,hard rock	250	26.32	m3	25	657.89	32	842.11	52	1368.42	116	3052.63
Load haul	20	2.11	m3	124	261.05	160	336.84	262	551.58	582	1225.26
Trimming	8	0.84	m2	63	53.05	81	68.21	132	111.16	294	247.58
Concrete,10MPA	35	3.68	m2	17	62.63	22	81.05	36	132.63	80	294.74
Concrete,25-30MPA	750	78.95	m3	44	3473.68	57	4500.00	92	7263.16	205	16184.21
Shuttering	120	12.63	m2	186	2349.47	239	3018.95	387	4888.42	861	10875.79
Reinforcement	7.5	0.79	kg	4906	3873.16	6349	5012.37	10245	8058.16	22799	17999.21
Concrete,ancillary (13%)			L.S.		1513.39		1955.00		3157.41		7042.64
Architecture (22%)			L.S.		2561.12		3308.46		5343.30		11918.31
Metal work (7%)			L.S.		814.90		1052.69		1700.14		3792.19
Pump			L.S.	18.5kw,3	60000.00	37kw,3	90000.00	37kw,5	150000.00	37kw,11	330000.00
Others (5%)			L.S.		3826.54		5567.73		9224.43		20346.37
Subtotal					80357.44		116922.36		193713.02		427273.67
Primary Sedimentation Tank											
Excavation,common	50	5.26	m3	2233	11752.63	3349	17626.32	9114	47968.42	23412	123221.05
Excavation,intermediate	150	15.79	m3	447	7057.89	670	10578.95	1823	28784.21	4682	73926.32
Excavation,hard rock	250	26.32	m3	223	5868.42	335	8815.79	912	24000.00	2341	61605.26
Trimming	8	0.84	m2	376	316.63	653	549.89	1533	1290.95	3938	3316.21
Load haul	20	2.11	m3	1316	2770.53	1973	4153.68	5369	11303.16	13793	29037.89
Concrete,10MPA	35	3.68	m2	376	1385.26	563	2074.21	1533	5647.89	3938	14508.42
Concrete,25-30MPA	750	78.95	m3	243	19184.21	365	28815.79	992	78315.79	2549	201236.84
Shuttering	120	12.63	m2	1113	14058.95	1673	21132.63	4543	57385.26	11675	147473.68
Reinforcement	7.5	0.79	kg	18695	14759.21	28092	22177.89	76278	60219.47	196041	154769.21
Finishing (0.2%)			L.S.		154.31		231.85		629.83		1618.19
Concrete ancillary (13%)			L.S.		10029.99		15070.27		40938.97		105182.34
Metal work (5%)			L.S.		3857.69		5796.26		15745.76		40454.74
Pipe work (10%)			L.S.		7715.37		11592.52		31491.52		80909.49
Others (5%)			L.S.		4945.55		7430.80		20186.06		51862.98
Subtotal					103856.65		156046.86		423907.29		1089122.64
Inlet Work for Biological Reactor											
Excavation,common	50	5.26	m3	292	1536.84	292	1536.84	585	3078.95	585	3078.95
Excavation,intermediate	150	15.79	m3	176	2778.95	176	2778.95	351	5542.11	351	5542.11
Excavation,hard rock	250	26.32	m3	117	3078.95	117	3078.95	234	6157.89	234	6157.89
Load haul	20	2.11	m3	185	389.47	185	389.47	370	778.95	370	778.95
Backfill	35	3.68	m3	380	1400.00	760	2800.00	760	2800.00	760	2800.00
Trimming	8	0.84	m3	163	137.26	163	137.26	326	274.53	326	274.53
Concrete,10MPA, slope	35	3.68	m2	163	600.53	163	600.53	326	1201.05	326	1201.05
Concrete,15MPA	700	73.68	m3	79	5821.05	79	5821.05	159	11715.79	159	11715.79
Concrete,25-30MPA	750	78.95	m3	165	13026.32	165	13026.32	330	26052.63	330	26052.63
Shuttering	120	12.63	m2	922	11646.32	922	11646.32	1842	23267.37	1842	23267.37

Table 13.3.2(3) Construction Cost of Biological Nutrient Removal process (BNR)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$	50,000 m3/day Quantity	50,000 m3/day Amount US$
Reinforcement	7.5	0.79	kg	18821	14858.68	18821	14858.68	37643	29718.16	37643	29718.16
Concrete ancillary (4%)			L.S.		2210.97		2266.97		4423.50		4423.50
Metal work (7%)			L.S.		3869.21		3967.21		7741.12		7741.12
Pipe work (27%)			L.S.		14924.08		15302.08		29858.60		29858.60
Others (5%)			L.S.		3813.93		3910.53		7630.53		7630.53
Subtotal					80092.56		82121.16		160241.17		160241.17
Biological Reactor											
Excavation,common	50	5.26	m3	4500	23684.21	9100	47894.74	17000	89473.68	22000	115789.47
Excavation,intermediate	150	15.79	m3	2700	42631.58	5460	86210.53	10200	161052.63	13200	208421.05
Excavation,hard rock	250	26.32	m3	1800	47368.42	3640	95789.47	6800	178947.37	8800	231578.95
Subgrade	5	0.53	m2	3555	1871.05	7189	3783.68	13430	7068.42	17380	9147.37
Underdrain,100-150mm	239	25.16	m	270	6792.63	546	13736.21	1020	25661.05	1320	33208.42
Geotextile	40	4.21	m	225	947.37	455	1915.79	850	3578.95	1100	4631.58
Concrete,15MPA	35	3.68	m2	2700	9947.37	5460	20115.79	10200	37578.95	13200	48631.58
Concrete,25MPA	750	78.95	m3	877	69236.84	1775	140131.58	3315	261710.53	4290	338684.21
Concrete,30MPA	750	78.95	m3	673	53131.58	1361	107447.37	2542	200684.21	3289	259657.89
Shuttering	120	12.63	m2	1699	21461.05	3380	42694.74	5062	63941.05	10107	127667.37
Reinforcement	7.5	0.79	kg	128725	101625.00	260255	205464.47	486090	383755.26	629057	496623.95
Concrete ancillary (9%)			L.S.		34082.74		68866.59		127210.69		168663.77
Metal work (13%)			L.S.		46151.68		93247.65		172117.19		228572.81
Surface aerator			L.S.	30kw,6	510000.00	30kw,10	850000.00	55kw,10	1560000.00	55kw,26	4056000.00
Mixer			L.S.	3.7kw,4	96000.00	3.7kw,4	96000.00	3.7kw,4	96000.00	7.5kw,6	338400.00
Others (5%)			L.S.		53246.58		93664.93		168439.00		333283.92
Subtotal					1118178.10		1966963.54		3537218.99		6998962.34
Split Box for Clarifier											
Excavation,common	50	5.26	m3	4	21.05	7	36.84	11	57.89	11	57.89
Excavation,intermediate	150	15.79	m3	2	31.58	3	47.37	5	78.95	5	78.95
Excavation,hard rock	250	26.32	m3	1	26.32	2	52.63	3	78.95	3	78.95
Concrete,10MPA	35	3.68	m2	10	36.84	18	66.32	27	99.47	27	99.47
Concrete,25-30MPA	750	78.95	m3	10	789.47	18	1421.05	27	2131.58	27	2131.58
Shuttering	120	12.63	m2	46	581.05	90	1136.84	140	1768.42	140	1768.42
Reinforcement	7.5	0.79	kg	1144	903.16	2002	1580.53	3003	2370.79	3003	2370.79
Concrete ancillary (13%)			L.S.		310.63		564.41		856.19		856.19
Metal work (5%)			L.S.		119.47		217.08		329.30		329.30
Others (5%)			L.S.		140.98		256.15		388.58		388.58
Subtotal					2960.56		5379.22		8160.12		8160.12
Secondary Sedimentation Tank (Clarifier)											
Excavation,common	50	5.26	m3	3193	16805.26	6514	34284.21	13028	68568.42	33467	176142.11
Excavation,intermediate	150	15.79	m3	639	10089.47	1303	20573.68	2606	41147.37	6693	105678.95
Excavation,hard rock	250	26.32	m3	319	8394.74	652	17157.89	1303	34289.47	3347	88078.95
Trimming	8	0.84	m2	762	641.68	1554	1308.63	3109	2618.11	7986	6725.05
Load haul	20	2.11	m3	2971	6254.74	6062	12762.11	12124	25524.21	31144	65566.32
Concrete,10MPA	35	3.68	m2	748	2755.79	1526	5622.11	3052	11244.21	7841	28887.89
Concrete,25-30MPA	750	78.95	m3	748	59052.63	1525	120394.74	3050	240789.47	7834	618473.68
Shuttering	120	12.63	m2	3215	40610.53	6557	82825.26	13114	165650.53	33686	425507.37
Reinforcement	7.5	0.79	kg	59800	47210.53	121992	96309.47	243984	192618.95	626704	494766.32
Concrete ancillary (12%)			L.S.		23017.84		46948.57		93894.09		241179.20
Metal work (3%)			L.S.		5754.46		11737.14		23473.52		60294.80
Pipe work (9%)			L.S.		17263.38		35211.43		70420.57		180884.40
Mechanical bridge			L.S.	(2 nos.)	182000.00	(2 nos.)	318000.00	(4 nos.)	636000.00	(8nos.)	1272000.00
Others (5%)			L.S.		20992.55		40156.76		80311.95		188209.25
Subtotal					440843.61		843292.01		1686550.86		3952394.27
RAS and WAS Pump Station											
Excavation,common	50	5.26	m3	86	452.63	113	594.74	132	694.74	280	1473.68
Excavation,intermediate	150	15.79	m3	18	284.21	23	363.16	27	426.32	56	884.21
Excavation,hard rock	250	26.32	m3	9	236.84	12	315.79	13	342.11	28	736.84
Trimming	8	0.84	m2	23	19.37	30	25.26	35	29.47	74	62.32
Load haul	20	2.11	m3	86	181.05	113	237.89	132	277.89	280	589.47
Concrete,10MPA	35	3.68	m2	23	84.74	30	110.53	35	128.95	74	272.63
Concrete,25-30MPA	750	78.95	m3	49	3868.42	65	5131.58	75	5921.05	160	12631.58
Shuttering	120	12.63	m2	165	2084.21	217	2741.05	251	3170.53	533	6732.63
Reinforcement	7.5	0.79	kg	4959	3938.68	6565	5182.89	7615	6011.84	16150	12750.00
Concrete ancillary (10%)			L.S.		1115.02		1470.29		1700.29		3613.34
Metal work (18%)			L.S.		2007.03		2646.52		3060.52		6504.01
Pump,RAS			L.S.	5.5kw,3	27000.00	11kw,3	42000.00	30kw,3	84000.00	30kw,9	252000.00
Pump,WAS			L.S.	2.2kw,2	12000.00	2.2kw,2	12000.00	3.7kw,2	16000.00	5.5kw,2	18000.00
Others (5%)			L.S.		2663.61		3640.99		6088.19		15812.54
Subtotal					55935.81		76460.69		127851.89		332063.25

Table 13.3.2(4) Construction Cost of Biological Nutrient Removal process (BNR)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$	50,000 m3/day Quantity	50,000 m3/day Amount US$
Sludge Thickening Tank											
Excavation,common	50	5.26	m3	49	257.89	110	578.95	195	1026.32	595	3131.58
Excavation,intermediate	150	15.79	m3	10	157.89	22	347.37	39	615.79	119	1878.95
Excavation,hard rock	250	26.32	m3	5	131.58	11	289.47	20	526.32	60	1578.95
Trimming	8	0.84	m2	17	14.32	38	32.00	67	56.42	204	171.79
Load haul	20	2.11	m3	39	82.11	87	183.16	155	326.32	471	991.58
Concrete,10MPA	35	3.68	m2	18	66.32	39	143.68	69	254.21	211	777.37
Concrete,25-30MPA	750	78.95	m3	16	1263.16	35	2763.16	62	4894.74	191	15078.95
Shuttering	120	12.63	m2	69	871.58	153	1932.63	273	3448.42	837	10572.63
Reinforcement	7.5	0.79	kg	1778	1403.68	4001	3158.68	7114	5616.32	21785	17198.68
Concrete ancillary (16%)			L.S.		679.76		1508.66		2682.37		8220.88
Metal work (5%)			L.S.		212.43		471.46		838.24		2569.02
Pipe work (22%)			L.S.		934.68		2074.40		3688.27		11303.70
Thickening bridge/scraper			L.S.	(2nos)	81600.00	(2nos.)	81600.00	(2nos)	81600.00	(2nos)	81600.00
Others (5%)			L.S.		4383.77		4754.18		5278.69		7753.70
Subtotal					92059.16		99837.80		110852.41		162827.78
Pump Station (TT - DB)											
Excavation,common	50	5.26	m3	33	173.68	33	173.68	48	252.63	66	347.37
Excavation,intermediate	150	15.79	m3	20	315.79	20	315.79	29	457.89	39	615.79
Excavation,hard rock	250	26.32	m3	13	342.11	13	342.11	19	500.00	26	684.21
Trimming	8	0.84	m2	33	27.79	33	27.79	48	40.42	66	55.58
Load haul	20	2.11	m3	66	138.95	66	138.95	95	200.00	131	275.79
Concrete,10MPA	35	3.68	m2	9	33.16	9	33.16	13	47.89	18	66.32
Concrete,25-30MPA	750	78.95	m3	23	1815.79	23	1815.79	34	2684.21	47	3710.53
Shuttering	120	12.63	m2	99	1250.53	99	1250.53	142	1793.68	196	2475.79
Reinforcement	7.5	0.79	kg	2597	2050.26	2597	2050.26	3752	2962.11	5195	4101.32
Concrete ancillary (10%)			L.S.		614.81		614.81		893.88		1233.27
Metal work (18%)			L.S.		1106.65		1106.65		1608.99		2219.88
Pump			L.S.	2.2kw,2	12000.00	2.2kw,2	12000.00	3.7kw,2	16000.00	5.5kw,2	18000.00
Others (5%)			L.S.		993.48		993.48		1372.09		1689.29
Subtotal					20862.98		20862.98		28813.89		35475.13
Sludge Drying Pond											
Excavation,common	50	5.26	m3	6000	31578.95	12000	63157.89	24300	127894.74	61200	322105.26
Excavation,intermediate	150	15.79	m3	1200	18947.37	2400	37894.74	4860	76736.84	12240	193263.16
Excavation,hard rock	250	26.32	m3	600	15789.47	1200	31578.95	2430	63947.37	6120	161052.63
Concrete,10MPA	35	3.68	m2	4000	14736.84	8000	29473.68	16200	59684.21	40800	150315.79
Concrete,15MPA	700	73.68	m3	800	58947.37	1600	117894.74	3240	238736.84	8160	601263.16
Concrete,25-30MPA	750	78.95	m3	199	15710.53	257	20289.47	377	29763.16	737	58184.21
Shuttering	120	12.63	m2	1326	16749.47	1716	21675.79	2516	31781.05	4914	62071.58
Channel concrete,25MPA	750	78.95	m3	42	3315.79	57	4500.00	81	6394.74	144	11368.42
Shuttering,channel	120	12.63	m2	270	3410.53	374	4724.21	530	6694.74	957	12088.42
Reinforcement	7.5	0.79	kg	102440	80873.68	191568	151237.89	373568	294922.11	919152	725646.32
Concrete ancillary (10%)			L.S.		26006.00		48242.74		93655.58		229735.89
Others (5%)			L.S.		14303.30		26533.51		51510.57		126354.74
Subtotal					300369.30		557203.61		1081721.94		2653449.58
Electric Control House											
Excavation,common	50	5.26	m3	25	131.58	25	131.58	42	221.05	75	394.74
Excavation,intermediate	150	15.79	m3	15	236.84	15	236.84	25	394.74	45	710.53
Excavation,hard rock	250	26.32	m3	10	263.16	10	263.16	17	447.37	30	789.47
Compaction	5	0.53	m2	27	14.21	27	14.21	45	23.68	81	42.63
Concrete,25-30MPA	750	78.95	m3	62	4894.74	62	4894.74	104	8210.53	189	14921.05
Shuttering	120	12.63	m2	270	3410.53	270	3410.53	451	5696.84	841	10623.16
Reinforcement	7.5	0.79	kg	7800	6157.89	7800	6157.89	13000	10263.16	23563	18602.37
Concrete ancillary (23%)			L.S.		3475.06		3475.06		5809.19		10599.31
Architecture (37%)			L.S.		5590.31		5590.31		9345.23		17051.06
Metal work (3%)			L.S.		453.27		453.27		757.72		1382.52
Others (5%)			L.S.		1231.38		1231.38		2058.48		3755.84
Subtotal					25858.96		25858.96		43227.99		78872.68
Pipework (Interconnecting)											
Asbestos Hume											
475mm,AC	1916	201.68	m	100	20168.42	0	0.00	0	0.00	0	0.00
550mm,AC	2714	285.68	m	0	0.00	0	0.00	0	0.00	300	85705.26
650mm,AC	3248	341.89	m	100	34189.47	150	51284.21	200	68378.95	0	0.00
750mm,AC	4124	434.11	m	0	0.00	0	0.00	0	0.00	300	130231.58
900mm,Hume	1930	203.16	m	0	0.00	150	30473.68	200	40631.58	0	0.00
1000mm,Hume	2687	282.84	m	0	0.00	0	0.00	0	0.00	300	84852.63
1350mmhume	4598	484.00	m	0	0.00	0	0.00	200	96800.00	0	0.00
1500mm,Hume	5518	580.84	m	0	0.00	0	0.00	0	0.00	300	174252.63

Table 13.3.2(5) Construction Cost of Biological Nutrient Removal process (BNR)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$	50,000 m3/day Quantity	50,000 m3/day Amount US$
Sludge pipe (Pressure)											
150mm,AC	429	45.16	m	100	4515.79	200	9031.58	250	11289.47	500	22578.95
Pipe fitting (10%)			L.S.		5887.37		9078.95		21710.00		49762.11
Box'manhole (10%)			L.S.		5887.37		9078.95		21710.00		49762.11
Others (5%)			L.S.		3532.42		5447.37		13026.00		29857.26
Subtotal					74180.84		114394.74		273516.00		627002.53
Site Work											
Topsoil/Turfing	10	1.05	m2	6615	6963.16	13292	13991.58	26172	27549.47	66591	70095.79
Fencing	200	21.05	m	520	10947.37	740	15578.95	950	20000.00	1690	35578.95
Road work	160	16.84	m2	2080	35031.58	2960	49852.63	3800	64000.00	6760	113852.63
Stormwater	150	15.79	m	1040	16421.05	1480	23368.42	1900	30000.00	3380	53368.42
Staff house	300000	31578.95	no	10	315789.47	15	473684.21	20	631578.95	30	947368.42
Others (10%)			L.S.		38515.26		57647.58		77312.84		122026.42
Subtotal					423667.89		634123.37		850441.26		1342290.63
Plant/Equipment (3%) Computer, Dump trailer,Tractor tow, Tractor, Submergible pump, Dumper,etc.			L.S.		103583.11		173307.54		314527.14		665013.11
Electrical Works (10%) Switchgear,Transformer,Control Panel, Distribution line, Diesel generator,etc.			L.S.		345277.03		577691.79		1048423.82		2216710.38
Total Construction Cost					3901630.45		6527917.26		11847189.12		25048827.33
Unit Cost per m3(Treated water)					5000m3/day		10000m3/day		20000m3/day		50000m3/da
					780.33		652.79		592.36		500.98

Table 13.3.3 (1) Construction Cost of Wastewater Stabilization Pond

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	1,000 m3/day Quantity	1,000 m3/day Amount US$	2,000 m3/day Quantity	2,000 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$
Preliminary and General					134870.44		296372.49		655721.36		1130994.38
Bulk Excavation					55620.38		105535.72		262849.93		525688.80
Grit Chamber					49712.53		62662.78		74538.39		100364.64
Pump Pit					32277.38		44852.21		76356.85		111752.91
Anaerobic Pond					98073.57		195984.45		457165.44		914330.88
Facultative Pond					197088.85		360796.87		898825.05		1797650.11
Matulation Pond					197547.38		721579.85		1724264.01		2521189.81
Pipe work					58060.80		136690.11		362158.48		753161.68
Site Work					210755.37		347714.63		515317.58		815823.68
Plant/Equipment (Nil)					0.00		0.00		0.00		0.00
Electrical Work					51700.33		113609.46		251359.85		433547.84
Total Construction Cost					1085707.03		2385798.58		5278556.95		9104504.74
Unit Cost per m3 (Treated water)					1085.71		1192.90		1055.71		910.45

Table 13.3.3 (2) Construction Cost of Wastewater Stabilization Pond

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	1,000 m3/day Quantity	1,000 m3/day Amount US$	2,000 m3/day Quantity	2,000 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$
Preliminary and General (15%)					134870.44		296372.49		655721.36		1130994.38
Bulk Excavation											
Site clearance	1	0.11	m2	46812	4927.58	88822	9349.68	221226	23286.95	442442	46572.84
Excavation,topsoil	15	1.58	m3	7022	11087.37	13323	21036.32	33184	52395.79	66366	104788.42
Excavation,common	30	3.16	m3	11703	36956.84	22206	70124.21	55306	174650.53	110610	349294.74
Others (5%)			L.S.		2648.59		5025.51		12516.66		25032.80
Subtotal					55620.38		105535.72		262849.93		525688.80
Grit Chamber											
Excavation,common	30	3.16	m3	22	69.47	38	120.00	46	145.26	76	240.00
Excavation,intermediate	100	10.53	m3	7	73.68	12	126.32	14	147.37	23	242.11
Excavation,hard rock	200	21.05	m3	5	105.26	8	168.42	10	210.53	15	315.79
Concrete,10MPA	35	3.68	m2	6	22.11	10	36.84	12	44.21	20	73.68
Concrete,25-30MPA	750	78.95	m3	10	789.47	17	1342.11	21	1657.89	35	2763.16
Shuttering	120	12.63	m2	34	429.47	58	732.63	71	896.84	118	1490.53
Reinforcement	7.5	0.79	kg	1140	900.00	1938	1530.00	2394	1890.00	3990	3150.00
Concrete ancillary (5%)			L.S.		119.47		202.82		249.61		413.76
Metal work (25%)			L.S.		597.37		1014.08		1248.03		2068.82
Building work (7%)			L.S.		167.26		283.94		349.45		579.27
Pipe work (3%)			L.S.		71.68		121.69		149.76		248.26
Air compressor,air lift pump			L.S.	2.5m3x2	24000.00	2.5m3x2	24000.00	2.5m3x2	24000.00	2.5m3x2	24000.00
Flow recorder			L.S	2nos.	20000.00	3nos.	30000.00	4nos.	40000.00	6nos.	60000.00
Others (5%)			L.S.		2367.26		2983.94		3549.45		4779.27
Subtotal					49712.53		62662.78		74538.39		100364.64
Pump Pit											
Excavation,common	30	3.16	m3	33	104.21	48	151.58	62	195.79	80	252.63
Excavation,intermediate	100	10.53	m3	20	210.53	28	294.74	37	389.47	48	505.26
Excavation,hard rock	200	21.05	m3	13	273.68	19	400.00	25	526.32	32	673.68
Load haul	20	2.11	m3	66	138.95	95	200.00	124	261.05	160	336.84
Trimming	8	0.84	m2	33	27.79	48	40.42	63	53.05	81	68.21
Concrete,10MPA	35	3.68	m2	9	33.16	13	47.89	17	62.63	22	81.05
Concrete,25-30MPA	750	78.95	m3	18	1421.05	26	2052.63	34	2684.21	44	3473.68
Shuttering	120	12.63	m2	76	960.00	109	1376.84	143	1806.32	184	2324.21
Reinforcement	7.5	0.79	kg	1998	1577.37	2886	2278.42	3774	2979.47	4884	3855.79
Concrete,ancillary (13%)			L.S.		617.08		889.53		1164.58		1504.28
Architecture (22%)			L.S.		1044.28		1505.36		1970.83		2545.70
Metal work (7%)			L.S.		332.27		478.98		627.08		810.00
Pump			L.S.	3.7kw,3	24000.00	7.5kw,3	33000.00	18.5kw,3	60000.00	37kw,3	90000.00
Others (5%)			L.S.		1537.02		2135.82		3636.04		5321.57
Subtotal					32277.38		44852.21		76356.85		111752.91
Anaerobic Pond											
Excavation,common	30	3.16	m3	2700	8526.32	5400	17052.63	12600	39789.47	25200	79578.95
Excavation,intermediate	100	10.53	m3	1620	17052.63	3240	34105.26	7560	79578.95	15120	159157.89
Excavation,hard rock	200	21.05	m3	1080	22736.84	2160	45473.68	5040	106105.26	10080	212210.53
Trimming	8	0.84	m2	1098	924.63	2196	1849.26	5124	4314.95	10248	8629.89
Filling	35	3.68	m3	1836	6764.21	3672	13528.42	8568	31566.32	17136	63132.63
Concrete,10MPA	35	3.68	m2	36	132.63	72	265.26	168	618.95	336	1237.89
Concrete,15MPA	700	73.68	m3	159	11715.79	317	23357.89	739	54452.63	1478	108905.26
Concrete,25-30MPA	750	78.95	m3	36	2842.11	72	5684.21	168	13263.16	336	26526.32
Shuttering	120	12.63	m2	121	1528.42	243	3069.47	566	7149.47	1132	14298.95
Reinforcement	7.5	0.79	kg	21450	16934.21	42790	33781.58	99770	78765.79	199540	157531.58
Others (10%)			L.S.		8915.78		17816.77		41560.49		83120.99
Subtotal					98073.57		195984.45		457165.44		914330.88
Facultative Pond											
Excavation,common	30	3.16	m3	5400	17052.63	10200	32210.53	26250	82894.74	52500	165789.47
Excavation,intermediate	100	10.53	m3	3240	34105.26	6120	64421.05	15750	165789.47	31500	331578.95
Excavation,hard rock	200	21.05	m3	2160	45473.68	4080	85894.74	10500	221052.63	21000	442105.26
Trimming	8	0.84	m2	4392	3698.53	8296	6986.11	21350	17978.95	42700	35957.89
Filling	35	3.68	m3	7344	27056.84	13872	51107.37	35700	131526.32	71400	263052.63
Concrete,10MPA	35	3.68	m2	144	530.53	272	1002.11	700	2578.95	1400	5157.89
Concrete,15MPA	700	73.68	m3	135	9947.37	185	13631.58	308	22694.74	616	45389.47
Concrete,25-30MPA	750	78.95	m3	144	11368.42	272	21473.68	700	55263.16	1400	110526.32
Shuttering	120	12.63	m2	452	5709.47	917	11583.16	2359	29797.89	4718	59595.79
Reinforcement	7.5	0.79	kg	30690	24228.95	50270	39686.84	110880	87536.84	221760	175073.68
Others (10%)			L.S.		17917.17		32799.72		81711.37		163422.74
Subtotal					197088.85		360796.87		898825.05		1797650.11
Matulation Pond											
Excavation,common	30	3.16	m3	5400	17052.63	20400	64421.05	50400	159157.89	58464	184623.16

Table 13.3.3 (3) Construction Cost of Wastewater Stabilization Pond

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	1,000 m3/day Quantity	1,000 m3/day Amount US$	2,000 m3/day Quantity	2,000 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$
Excavation,intermediate	100	10.53	m3	3240	34105 26	12240	128842.11	30240	318315.79	35078	369242 11
Excavation,hard rock	200	21.05	m3	2160	45473.68	8160	171789.47	20160	424421.05	21386	450231.58
Trimming	8	0.84	m2	4392	3698.53	16592	13972.21	40992	34519.58	81984	69039.16
Filling	35	3.68	m3	7344	27056.84	27744	102214.74	68544	252530.53	137088	505061.05
Concrete,10MPA	35	3.68	m2	144	530.53	544	2004 21	1344	4951.58	2688	9903.16
Concrete,15MPA	700	73.68	m3	135	9947.37	370	27263.16	583	42957.89	896	66021.05
Concrete,25-30MPA	750	78.95	m3	144	11368.42	544	42947.37	1344	106105.26	2688	212210.53
Shuttering	120	12.63	m2	485	6126 32	1833	23153.68	4529	57208.42	9058	114116.84
Reinforcement	7.5	0.79	kg	30690	24228.95	100540	79373.68	211970	167344.74	394240	311242.11
Others (10%)			L.S.		17958.85		65598.17		156751.27		229199.07
Subtotal					197547.38		721579.85		1724264.01		2521189.81
Pipework (Interconnecting)											
Asbestos Hume											
225mm,Ae	631	66.42	m	560	37195.79	0	0.00	0	0.00	0	0.00
300mm,AC	1055	111.05	m	80	8884.21	800	88842.11	0	0.00	0	0.00
400mm,AC	1555	163.68	m	0	0.00	120	19642.11	0	0.00	0	0.00
475mm,AC	1916	201.68	m	0	0.00	0	0.00	1120	225836.32	2240	451772.63
650mm,AC	3248	341.89	m	0	0.00	0	0.00	180	61541.05	320	109406.32
900mm,Hume	1930	203.16	m	0	0.00	0	0.00	0	0.00	180	36568.42
Pipe fitting (10%)			L.S.		4608.00		10848.42		28742.74		59774.74
Box/manhole (10%)			L.S.		4608.00		10848.42		28742.74		59774.74
Others (5%)			L.S.		2764.80		6509.05		17245.64		35864.84
Subtotal					58060.80		136690.11		362158.48		753161.68
Site Work											
Topsoil/Turfing	10	1.05	m2	23406	24637.89	44411	46748.42	110613	116434.74	221221	232864.21
Fencing	200	21.05	m	865	18210.53	1192	25094.74	1881	39600.00	2661	56021.05
Road work	160	16.84	m2	3460	58273.68	4768	80303.16	7524	126720.00	10644	179267.37
Stormwater	150	15.79	m	1730	27315.79	2384	37642.11	3762	59400.00	5322	84031.58
Staff house	300000	31578.95	no	2	63157.89	4	126315.79	4	126315.79	6	189473.68
Others (10%)			L.S.		19159.58		31610.42		46847.05		74165.79
Subtotal					210755.37		347714.63		515317.58		815823.68
Plant/Equipment (Nil) Computer, Dump trailer,Tractor tow, Tractor, Submergible pump, Dumper,etc.			L.S.		0.00		0.00		0.00		0.00
Electrical Works (5%) Switchgear,Transformer,Control Panel, Distribution line, Diesel generator,etc.			L.S.		51700.33		113609.46		251359.85		433547.84
Total Construction Cost					1085707.03		2385798.58		5278556.95		9104504.74
Unit Cost per m3(Treated Water)					1000m3/day		2000m3/day		5000m3/day		10000m3/da
					1085.71		1192.90		1055.71		910.45

Table 13.3.4(1) Construction Cost of Concrete Pipe (Hume Pipe)

US$1.00 = Z$9.50 = Yen 110

Dia.	Price Z$/m	Transp 10%	Tax 15%	Install 20%	Manhole 10%	Exc.M3 D=2m	Exc.Cost 30Z$/m3	Total,Z$ OH25% Prel.15%	Total US$/m
150mm	63	6.30	9.45	12.60	7.56	2.25	67.50	239.21	25.18
225mm	100	10.00	15.00	20.00	12.00	2.49	74.70	333.07	35.06
300mm	148	14.80	22.20	29.60	17.76	2.70	81.00	450.46	47.42
375mm	192	19.20	28.80	38.40	23.04	2.94	88.20	560.11	58.96
450mm	246	24.60	36.90	49.20	29.52	3.15	94.50	691.04	72.74
525mm	313	31.30	46.95	62.60	37.56	3.38	101.40	852.16	89.70
600mm	382	38.20	57.30	76.40	45.84	3.60	108.00	1017.38	107.09
675mm	427	42.70	64.05	85.40	51.24	3.83	114.90	1128.85	118.83
750mm	570	57.00	85.50	114.00	68.40	4.05	121.50	1461.08	153.80
900mm	769	76.90	115.35	153.80	92.28	4.50	135.00	1929.60	203.12
1050mm	1049	104.90	157.35	209.80	125.88	7.43	222.90	2687.88	282.93
1200mm	1332	133.20	199.80	266.40	159.84	8.10	243.00	3355.47	353.21
1350mm	1870	187.00	280.50	374.00	224.40	8.78	263.40	4598.99	484.10

Table 13.3.4(2) Construction Cost of Asbestos Fibre Cement Pipe (Sewer)

US$1.00 = Z$9.50 = Yen 110

Dia.	Price Z$/m	Transp 10%	Tax 15%	Install 20%	Manhole 10%	Exc.M3 D=2m	Exc.Cost 30Z$/m3	Total,Z$ OH25% Prel.15%	Total US$/m
150mm	45	4.50	6.75	9.00	5.40	2.25	67.50	198.59	20.90
200mm	82	8.20	12.30	16.40	9.84	2.40	72.00	288.56	30.38
250mm	110	11.00	16.50	22.00	13.20	2.55	76.50	358.23	37.71
300mm	143	14.30	21.45	28.60	17.16	2.70	81.00	439.17	46.23
400mm	322	32.20	48.30	64.40	38.64	3.00	90.00	856.09	90.11
450mm	382	38.20	57.30	76.40	45.84	3.15	94.50	997.97	105.05
525mm	436	43.60	65.40	87.20	52.32	3.39	101.70	1130.19	118.97
600mm	537	53.70	80.55	107.40	64.44	3.60	108.00	1367.19	143.91
675mm	653	65.30	97.95	130.60	78.36	3.83	114.90	1638.91	172.52
750mm	735	73.50	110.25	147.00	88.20	4.05	121.50	1833.46	193.00
825mm	870	87.00	130.50	174.00	104.40	4.29	128.70	2148.49	226.16

Table 13.3.4(3) Construction Cost of Asbestos Fibre Cement Pipe (Pressure)

US$1.00 = Z$9.50 = Yen 110

Dia.	Price Z$/m	Transp 10%	Tax 15%	Install 20%	Manhole 10%	Exc.M3 D=2m	Exc.Cost 30Z$/m3	Total,Z$ OH25% Prel.15%	Total US$/m
100mm	75	7.50	11.25	15.00	9.00	2.10	63.00	259.83	27.35
125mm	106	10.60	15.90	21.20	12.72	2.18	65.40	333.24	35.08
150mm	147	14.70	22.05	29.40	17.64	2.25	67.50	428.79	45.14
175mm	184	18.40	27.60	36.80	22.08	2.33	69.90	515.75	54.29
200mm	194	19.40	29.10	38.80	23.28	2.40	72.00	541.33	56.98
225mm	232	23.20	34.80	46.40	27.84	2.48	74.40	630.55	66.37
250mm	281	28.10	42.15	56.20	33.72	2.55	76.50	744.15	78.33
300mm	416	41.60	62.40	83.20	49.92	2.70	81.00	1055.30	111.08
350mm	437	43.70	65.55	87.40	52.44	2.85	85.50	1109.16	116.75
400mm	632	63.20	94.80	126.40	75.84	3.00	90.00	1555.72	163.76
450mm	789	78.90	118.35	157.80	94.68	3.15	94.50	1916.52	201.74
525mm	1138	113.80	170.70	227.60	136.56	3.38	101.40	2714.09	285.69
600mm	1215	121.50	182.25	243.00	145.80	3.50	105.00	2893.04	304.53
675mm	1366	136.60	204.90	273.20	163.92	3.83	114.90	3248.06	341.90
750mm	1750	175.00	262.50	350.00	210.00	4.05	121.50	4124.19	434.13

Table 13.3.4(4) Construction Cost of Polyvinyl Chloride Pipe (Pressure)

US$1.00 = Z$9.50 = Yen 110

Dia.	Price Z$/m	Transp 10%	Tax 15%	Install 20%	Manhole 10%	Exc.M3 D=2m	Exc.Cost 30Z$/m3	Total,Z$ OH25% Prel.15%	Total US$/m
4"(110)	46	4.60	6.90	9.20	5.52	2.10	63.00	194.38	20.46
6"(160)	100	10.00	15.00	20.00	12.00	2.25	67.50	322.72	33.97
8"(200)	155	15.50	23.25	31.00	18.60	2.40	72.00	453.32	47.72
10"(250)	239	23.90	35.85	47.80	28.68	2.55	76.50	649.36	68.35

Table 13.3.4(5) Construction Cost of Steel Pipe (Pumping Main)

US$1.00 = Z$9.50 = Yen 110

Dia.	Price Z$/m	Transp 10%	Tax 15%	Install 20%	Manhole 10%	Exc.M3 D=2m	Exc.Cost 30Z$/m3	Total,Z$ OH25% Prel.15%	Total US$/m
100mm	376	37.60	56.40	75.20	45.12	2.10	63.00	939.15	98.86
150mm	534	53.40	80.10	106.80	64.08	2.25	67.50	1302.20	137.07
200mm	705	70.50	105.75	141.00	84.60	2.40	72.00	1694.60	178.38
250mm	877	87.70	131.55	175.40	105.24	2.55	76.50	2089.25	219.92
300mm	1108	110.80	166.20	221.60	132.96	2.70	81.00	2617.06	275.48
350mm	1292	129.20	193.80	258.40	155.04	2.85	85.50	3038.79	319.87
400mm	1579	157.90	236.85	315.80	189.48	3.00	90.00	3692.98	388.73
450mm	1878	187.80	281.70	375.60	225.36	3.15	94.50	4374.26	460.45
500mm	2226	222.60	333.90	445.20	267.12	3.38	101.40	5169.57	544.16
600mm	2974	297.40	446.10	594.80	356.88	3.50	105.00	6862.88	722.41
700mm	3600	360.00	540.00	720.00	432.00	4.05	121.50	8299.41	873.62
800mm	4504	450.40	675.60	900.80	540.48	4.05	121.50	10339.62	1088.38
900mm	5530	553.00	829.50	1106.00	663.60	4.05	121.50	12655.18	1332.12
1000mm	6678	667.80	1001.70	1335.60	801.36	4.05	121.50	15246.07	1604.85
1100mm	7913	791.30	1186.95	1582.60	949.56	4.05	121.50	18033.31	1898.24
1200mm	9217	921.70	1382.55	1843.40	1106.04	4.05	121.50	20976.27	2208.03
1350mm	11391	1139.10	1708.65	2278.20	1366.92	4.05	121.50	25882.72	2724.50
1500mm	13791	1379.10	2068.65	2758.20	1654.92	4.05	121.50	31299.22	3294.65

Table 13.3.5(1) Construction Cost of Storage Pond
(Irrigation Area)

US$1.00 = ZS9.50 = Yen 110

Description	Unit Price ZS	Unit Price US$	Unit	1,000 m³/day Quantity	1,000 m³/day Amount US$	2,000 m³/day Quantity	2,000 m³/day Amount US$	2,500 m³/day Quantity	2,500 m³/day Amount US$	5,000 m³/day Quantity	5,000 m³/day Amount US$	10,000 m³/day Quantity	10,000 m³/day Amount US$	20,000 m³/day Quantity	20,000 m³/day Amount US$
Preliminary and General					4588.63		7558.88		10558.19		17334.76		33088.27		59106.49
Bulk Excavation					1188.16		2495.13		2910.16		5940.79		11643.95		23763.16
Inlet Pit/Outlet Pit					855.02		1961.29		1961.29		3295.02		7530.66		13125.55
Storage Pond					20178.63		37567.08		44527.54		85340.32		160165.44		315906.11
Pipe Work					8369.05		8369.05		20988.95		20988.95		41248.42		41248.42
Site Work (Nil)					0.00		0.00		0.00		0.00		0.00		0.00
Total Construction Cost					35179.49		57951.44		80946.12		132899.84		253676.74		453149.72
Unit Cost per m3 (Treated water)					35.18		28.98		32.38		26.58		25.37		22.66

Table 13.3.5(2) Construction Cost of Storage Pond
(Irrigation Area)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	1,000 m³/day Quantity	1,000 m³/day Amount US$	2,000 m³/day Quantity	2,000 m³/day Amount US$	2,500 m³/day Quantity	2,500 m³/day Amount US$	5,000 m³/day Quantity	5,000 m³/day Amount US$	10,000 m³/day Quantity	10,000 m³/day Amount US$	20,000 m³/day Quantity	20,000 m³/day Amount US$
Preliminary and General (15%)					4588.63		7558.88		10558.19		17334.76		33088.27		59106.49
Bulk Excavation															
Site clearance	1	0.11	m2	1000	105.26	2100	221.05	2450	257.89	5000	526.32	9800	1031.58	20000	2105.26
Excavation,topsoil	15	1.58	m3	150	236.84	315	497.37	368	581.05	750	1184.21	1470	2321.05	3000	4736.84
Excavation,common	30	3.16	m3	250	789.47	525	1657.89	612	1932.63	1250	3947.37	2450	7736.84	5000	15789.47
Others (5%)			L.S.		56.58		118.82		138.58		282.89		554.47		1131.58
Subtotal					1188.16		2495.13		2910.16		5940.79		11643.95		23763.16
Inlet Pit/Outlet Pit															
Excavation,common	50	5.26	m3	8	42.11	16	84.21	16	84.21	29	152.63	65	342.11	116	610.53
Excavation,intermediate	150	15.79	m3	3	47.37	5	78.95	5	78.95	9	142.11	20	315.79	35	552.63
Excavation,hard rock	250	26.32	m3	2	52.63	3	78.95	3	78.95	6	157.89	13	342.11	23	605.26
Concrete,10MPA	35	3.68	m2	2	7.37	4	14.74	4	14.74	8	29.47	17	62.63	30	110.53
Concrete,25-30MPA	750	78.95	m3	3	236.84	8	631.58	8	631.58	13	1026.32	30	2368.42	52	4105.26
Shuttering	120	12.63	m2	10	126.32	15	189.47	15	189.47	27	341.05	61	770.53	108	1364.21
Reinforcement	7.5	0.79	kg	333	262.89	888	701.05	888	701.05	1443	1139.21	3330	2628.95	5772	4556.84
Concrete ancillary (5%)			L.S.		38.78		88.95		88.95		149.43		341.53		595.26
Others (5%)			L.S.		40.72		93.39		93.39		156.91		358.60		625.03
Subtotal					855.02		1961.29		1961.29		3295.02		7530.66		13125.55
Storage Pond															
Excavation,common	30	3.16	m3	500	1578.95	1050	3315.79	1225	3868.42	2500	7894.74	4900	15473.68	10000	31578.95
Excavation,intermediate	100	10.53	m3	300	3157.89	630	6631.58	735	7736.84	1500	15789.47	2940	30947.37	6000	63157.89
Excavation,hard rock	200	21.05	m3	200	4210.53	420	8842.11	490	10315.79	1000	21052.63	1960	41263.16	4000	84210.53
Trimming	8	0.84	m2	305	256.84	641	539.79	747	629.05	1525	1284.21	2989	2517.05	6100	5136.84
Filling	35	3.68	m3	510	1878.95	1071	3945.79	1250	4605.26	2550	9394.74	4998	18413.68	10200	37578.95
Concrete,10MPA	35	3.68	m2	10	36.84	21	77.37	25	92.11	50	184.21	98	361.05	200	736.84
Concrete,15MPA	700	73.68	m3	32	2357.89	40	2947.37	50	3684.21	72	5305.26	101	7442.11	144	10610.53
Concrete,25-30MPA	750	78.95	m3	10	789.47	21	1657.89	25	1973.68	50	3947.37	98	7736.84	200	15789.47
Shuttering	120	12.63	m2	34	429.47	71	896.84	84	1061.05	169	2134.74	330	4168.42	674	8513.68
Reinforcement	7.5	0.79	kg	4620	3647.37	6710	5297.37	8250	6513.16	13420	10594.74	21890	17281.58	37840	29873.68
Others (10%)			L.S.		1834.42		3415.19		4047.96		7758.21		14560.49		28718.74
Subtotal					20178.63		37567.08		44527.54		85340.32		160165.44		315906.11
Pipework (Interconnecting)															
Asbestos/Hume															
225mm,AC	631	66.42	m	100	6642.11	100	6642.11	0	0.00	0	0.00	0	0.00	0	0.00
300mm,AC	1055	111.05	m	0	0.00	0	0.00	150	16657.89	150	16657.89	0	0.00	0	0.00
400mm,AC	1555	163.68	m	0	0.00	0	0.00	0	0.00	0	0.00	200	32736.84	200	32736.84
Pipe fitting (10%)			L.S.		664.21		664.21		1665.79		1665.79		3273.68		3273.68
Box/manhole (10%)			L.S.		664.21		664.21		1665.79		1665.79		3273.68		3273.68
Others (5%)			L.S.		398.53		398.53		999.47		999.47		1964.21		1964.21
Subtotal					8369.05		8369.05		20988.95		20988.95		41248.42		41248.42
Site Work (Nil)															
Topsoil/Turfing	10	1.05	m2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Fencing	200	21.05	m	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Road work	160	16.84	m2	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Stormwater	150	15.79	m	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Staff house	300000	31578.95	no	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Others (10%)			L.S.		0.00		0.00		0.00		0.00		0.00		0.00
Subtotal					0.00		0.00		0.00		0.00		0.00		0.00
Total Construction Cost					35179.49		57951.44		80946.12		132899.84		253676.74		453149.72
Unit Cost per m3 (Treated water)					1000m3/day		2000m3/day		2500m3/day		5000m3/day		10000m3/day		20000m3/day
					35.18		28.98		32.38		26.58		25.37		22.66

Table 13.3.6(1) Construction Cost of Pump Station (For WSP)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	1,000 m3/day Quantity	1,000 m3/day Amount US$	2,000 m3/day Quantity	2,000 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$
Civil Building 2,440 US$/m2 Pump/Motor C = 49,288 + 610 kW Electrical Work 50% Preliminary and General 15%											
Civil Building Work		2440.00	m2	18	43920.00	24	58560.00	30	73200.00	38	92720.00
Pump/Motor				5.5kW,2	105286.00	11kW,2	111996.00	30kW,2	135170.00	55kW,2	165676.00
Electrical Work					52643.00		55998.00		67585.00		82838.00
Subtotal					201849.00		226554.00		275955.00		341234.00
Preliminary and General					30277.35		33983.10		41393.25		51185.10
Total					232126.35		260537.10		317348.25		392419.10

Table 13.3.6(2) Construction Cost of Pump Station (For TF)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	2,500 m3/day Quantity	2,500 m3/day Amount US$	5,000 m3/day Quantity	5,000 m3/day Amount US$	10,000 m3/day Quantity	10,000 m3/day Amount US$	20,000 m3/day Quantity	20,000 m3/day Amount US$
Civil Building 2,440 US$/m2 Pump/Motor C = 49,288 + 610 kW Electrical Work 50% Preliminary and General 15%											
Civil Building Work		2440.00	m2	36	87840.00	42	102480.00	51	124440.00	60	146400.00
Pump Motor				15kW,4	233752.00	30kW,4	270352.00	55kW,4	331352.00	110kW,4	465552.00
Electrical Work					116876.00		135176.00		165676.00		232776.00
Subtotal					438468.00		508008.00		621468.00		844728.00
Preliminary and General					65770.20		76201.20		93220.20		126709.20
Total					504238.20		584209.20		714688.20		971437.20

Table 13.3.6(3) Construction Cost of Pump Station
(Civil and Building Works)

US$1.00 = ZS9.50 = Yen 110

Description	Unit Price ZS	Unit Price US$	Unit	Quantity	Amount US$
Preliminary and General (Nil)					0.00
Bulk Excavation					
Site clearance	1	0.11	m2	544	57.26
Excavation,topsoil	15	1.58	m3	82	129.47
Excavation,common	30	3.16	m3	272	858.95
Excavation,intermediate	100	10.53	m3	163	1715.79
Excavation,hard rock	200	21.05	m3	109	2294.74
Others (5%)			L.S.		252.81
Subtotal					5309.02
Excavation of Pump Pit					
Excavation,common	50	5.26	m3	1100	5789.47
Excavation,intermediate	150	15.79	m3	330	5210.53
Excavation,hard rock	250	26.32	m3	220	5789.47
Trimming	8	0.84	m2	1180	993.68
Compaction	5	0.53	m2	544	286.32
Crusher-run	250	26.32	m3	109	2868.42
Others (5%)			L.S.		1046.89
Subtotal					21984.79
Structure of Grit chamber/Pump Station					
Concrete,10MPA	35	3.68	m2	544	2004.21
Base concrete,15MPA	700	73.68	m3	544	40084.21
Concrete,30MPA,undergroun	750	78.95	m3	199	15710.53
Concrete,30MPA,building	750	78.95	m3	73	5763.16
Shuttering	120	12.63	m2	1246	15738.95
Reinforcement	7.5	0.79	kg	29920	23621.05
Concrete,ancillary (13%)			L.S.		13379.87
Architecture (22%)			L.S.		22642.86
Metal work (7%)			L.S.		7204.55
Others (5%)			L.S.		7307.47
Subtotal					153456.86
Site Work					
Topsoil/Turfing	10	1.05	m2	411	432.63
Fencing	200	21.05	m	98	2063.16
Road work	160	16.84	m2	272	4581.05
Stormwater	150	15.79	m	98	1547.37
Staff house	300000	31578.95	no	2	63157.89
Others (10%)			L.S.		7178.21
Subtotal					78960.32
Plant/Equipment (5%)			L.S.		12985.55
Computer, Dump trailer,Tractor tow, Tractor, Submergible pump, Dumper,etc.					
Electrical Works(20%)			L.S.		51942.20
Total Construction Cost (Exclude Preliminary and General)					324638.73
Unit Cost of Civil/Building Work for Pump Station (133m2)					2440.89

Building Area 16m x 8.3m = 133m2
Land Area 32m x 17 m = 544m2

Table 13.3.6(4) Cost of Pump Equipment including Motor and Installation

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	Quantity	Amount US$
Supply and Installation					
150 kW		140000			
100 KW		110000			
50 KW		85000			
30 KW		65000			
20 KW		60000			
(Exclude Preliminary and General)					

Table 13.3.7(1) Construction Cost of Industrial Wastewater Pretreatment Facilities (Anaerobic Pond and Facultative Pond)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	500 m3/day Quantity	500 m3/day Amount US$	1,000 m3/day Quantity	1,000 m3/day Amount US$	2,000 m3/day Quantity	2,000 m3/day Amount US$
Preliminary and General					51236.99		90164.79		149096.47
Bulk Excavation					10702.37		21401.43		40896.62
Grit Chamber					47634.41		59564.18		73026.62
Pump Pit					24239.93		39324.10		55190.17
Anaerobic Pond					49132.02		97896.99		195984.45
Facultative Pond					104696.03		197102.75		360796.87
Pipe Work					15064.29		34627.45		80735.49
Site Work					90110.84		151181.68		187346.21
Plant/Equipment					0.00		0.00		0.00
Electrical Work					19640.84		34563.17		57153.64
Total Construction Cost					412457.74		725826.54		1200226.54
(Treated water)					824.92		725.83		600.11

Table 13.3.7(2) Construction Cost of Industrial Wastewater Pretreatment Facilities (Anaerobic Pond and Facultative Pond)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	500 m3/day Quantity	500 m3/day Amount US$	1,000 m3/day Quantity	1,000 m3/day Amount US$	2,000 m3/day Quantity	2,000 m3/day Amount US$
Preliminary and General (15%)					51236.99		90164.79		149096.47
Bulk Excavation									
Site clearance	1	0.11	m2	9006	948.00	18012	1896.00	34422	3623.37
Excavation,topsoil	15	1.58	m3	1351	2133.16	2702	4266.32	5163	8152.11
Excavation,common	30	3.16	m3	2252	7111.58	4503	14220.00	8605	27173.68
Others (5%)			L.S.		509.64		1019.12		1947.46
Subtotal					10702.37		21401.43		40896.62
Grit Chamber									
Excavation,common	50	5.26	m3	11	57.89	22	115.79	38	200.00
Excavation,intermediate	150	15.79	m3	4	63.16	7	110.53	12	189.47
Excavation,hard rock	250	26.32	m3	2	52.63	4	105.26	8	210.53
Concrete,10MPA	35	3.68	m2	3	11.05	6	22.11	10	36.84
Concrete,25-30MPA	750	78.95	m3	5	394.74	10	789.47	17	1342.11
Shuttering	120	12.63	m2	10	126.32	21	265.26	36	454.74
Reinforcement	7.5	0.79	kg	342	270.00	684	540.00	1938	1530.00
Concrete ancillary (5%)			L.S.		48.79		97.42		198.18
Metal work (25%)			L.S.		243.95		487.11		990.92
Building work (7%)			L.S.		68.31		136.39		277.46
Pipe work (3%)			L.S.		29.27		58.45		118.91
Air compressor,air lift pump			L.S.	2.5m3x2	24000.00	2.5m3x2	24000.00	2.5m3x2	24000.00
Flow recorder			L.S	2nos.	20000.00	3nos.	30000.00	4nos.	40000.00
Others (5%)			L.S.		2268.31		2836.39		3477.46
Subtotal					47634.41		59564.18		73026.62
Pump Pit									
Excavation,common	50	5.26	m3	33	173.68	44	231.58	59	310.53
Excavation,intermediate	150	15.79	m3	20	315.79	26	410.53	35	552.63
Excavation,hard rock	250	26.32	m3	13	342.11	18	473.68	23	605.26
Load haul	20	2.11	m3	66	138.95	88	185.26	117	246.32
Trimming	8	0.84	m2	33	27.79	44	37.05	59	49.68
Concrete,10MPA	35	3.68	m2	9	33.16	12	44.21	16	58.95
Concrete,25-30MPA	750	78.95	m3	18	1421.05	24	1894.74	32	2526.32
Shuttering	120	12.63	m2	76	960.00	101	1275.79	134	1692.63
Reinforcement	7.5	0.79	kg	1998	1577.37	2664	2103.16	3552	2804.21
Concrete,ancillary (13%)			L.S.		648.69		865.28		1150.05
Architecture (22%)			L.S.		1097.78		1464.32		1946.24
Metal work (7%)			L.S.		349.29		465.92		619.26
Pump			L.S.	3.7kw,2	16000.00	11kw,2	28000.00	18.5kw,2	40000.00
Others (5%)			L.S.		1154.28		1872.58		2628.10
Subtotal					24239.93		39324.10		55190.17
Anaerobic Pond									
Excavation,common	30	3.16	m3	1350	4263.16	2700	8526.32	5400	17052.63
Excavation,intermediate	100	10.53	m3	810	8526.32	1620	17052.63	3240	34105.26
Excavation,hard rock	200	21.05	m3	540	11368.42	1080	22736.84	2160	45473.68
Trimming	8	0.84	m2	549	462.32	1098	924.63	2196	1849.26
Filling	35	3.68	m3	918	3382.11	1836	6764.21	3672	13528.42
Concrete,10MPA	35	3.68	m2	18	66.32	36	132.63	72	265.26
Concrete,15MPA	700	73.68	m3	80	5894.74	158	11642.11	317	23357.89
Concrete,25-30MPA	750	78.95	m3	18	1421.05	36	2842.11	72	5684.21
Shuttering	120	12.63	m2	61	770.53	121	1528.42	243	3069.47
Reinforcement	7.5	0.79	kg	10780	8510.53	21340	16847.37	42790	33781.58
Others (10%)			L.S.		4466.55		8899.73		17816.77
Subtotal					49132.02		97896.99		195984.45
Facultative Pond									
Excavation,common	30	3.16	m3	2700	8526.32	5400	17052.63	10200	32210.53
Excavation,intermediate	100	10.53	m3	1620	17052.63	3240	34105.26	6120	64421.05
Excavation,hard rock	200	21.05	m3	1080	22736.84	2160	45473.68	4080	85894.74
Trimming	8	0.84	m2	2196	1849.26	4392	3698.53	8296	6986.11
Filling	35	3.68	m3	3672	13528.42	7344	27056.84	13872	51107.37
Concrete,10MPA	35	3.68	m2	72	265.26	144	530.53	272	1002.11
Concrete,15MPA	700	73.68	m3	101	7442.11	135	9947.37	185	13631.58
Concrete,25-30MPA	750	78.95	m3	72	5684.21	144	11368.42	272	21473.68
Shuttering	120	12.63	m2	243	3069.47	453	5722.11	917	11583.16

Table 13.3.7(3) Construction Cost of Industrial Wastewater Pretreatment Facilities (Anaerobic Pond and Facultative Pond)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	500 m3/day Quantity	500 m3/day Amount US$	1,000 m3/day Quantity	1,000 m3/day Amount US$	2,000 m3/day Quantity	2,000 m3/day Amount US$
Reinforcement	7.5	0.79	kg	19030	15023.68	30690	24228.95	50270	39686.84
Others (10%)			L.S.		9517.82		17918.43		32799.72
Subtotal					104696.03		197102.75		360796.87
Pipework (Interconnecting)									
Asbestos Hume									
225mm,AC	631	66.42	m	180	11955.79	280	18597.89	0	0.00
300mm,AC	1055	111.05	m	0	0.00	80	8884.21	400	44421.05
400mm,AC	1556	163.79	m	0	0.00	0	0.00	120	19654.74
Pipe fitting (10%)			L.S.		1195.58		2748.21		6407.58
Box/manhole (10%)			L.S.		1195.58		2748.21		6407.58
Others (5%)			L.S.		717.35		1648.93		3844.55
Subtotal					15064.29		34627.45		80735.49
Site Work									
Topsoil/Turfing	10	1.05	m2	4503	4740.00	9006	9480.00	17211	18116.84
Fencing	200	21.05	m	380	8000.00	540	11368.42	742	15621.05
Road work	160	16.84	m2	1520	25600.00	2160	36378.95	2968	49987.37
Stormwater	150	15.79	m	760	12000.00	1080	17052.63	1484	23431.58
Staff house	300000	31578.95	no	1	31578.95	2	63157.89	2	63157.89
Others (10%)			L.S.		8191.89		13743.79		17031.47
Subtotal					90110.84		151181.68		187346.21
Plant Equipment (Nil)			L.S.		0.00		0.00		0.00
Computer, Dump trailer,Tractor tow, Tractor, Submergible pump, Dumper,etc.									
Electrical Works (5%)			L.S.		19640.84		34563.17		57153.64
Switchgear,Transformer,Control Panel, Distribution line, Diesel generator,etc.									
Total Construction Cost					412457.74		725826.54		1200226.54
Unit Cost per m3 (Treated water)					500m3/day		1000m3/day		2000m3/day
					824.92		725.83		600.11

Table 13.3.8(1) Construction Cost of Solid Waste Leachate Treatment Facilities (WSP)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	100 m3/day Quantity	100 m3/day Amount US$	500 m3/day Quantity	500 m3/day Amount US$	1,000 m3/day Quantity	1,000 m3/day Amount US$
Preliminary and General					37518.12		78643.66		146440.39
Bulk Excavation					5822.19		27811.85		55620.38
Grit Chamber					46736.94		58134.41		70064.18
Pump Pit					20032.09		24232.09		40145.24
Anaerobic Pond					10949.75		49132.02		97896.99
Facultative Pond					26573.57		104696.03		221863.17
Matulation Pond					52080.95		104696.03		221863.17
Pipe Work					13390.48		26789.97		58060.80
Site Work					74534.84		128807.68		210755.37
Plant Equipment					0.00		0.00		0.00
Electrical Work					14381.95		30146.74		56135.48
Total Construction Cost					302020.87		633081.48		1178845.18
Unit Cost per m3 (Treated water)					3020.21		1266.16		1178.85

Table 13.3.8(1) Construction Cost of Solid Waste Leachate Treatment Facilities (WSP)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Price Z$	Unit Price US$	Unit	100 m3/day Quantity	100 m3/day Amount US$	500 m3/day Quantity	500 m3/day Amount US$	1,000 m3/day Quantity	1,000 m3/day Amount US$
Preliminary and General (15%)					37518.12		78643.66		146440.39
Bulk Excavation									
Site clearance	1	0.11	m2	4902	516.00	23406	2463.79	46812	4927.58
Excavation,topsoil	15	1.58	m3	735	1160.53	3511	5543.68	7022	11087.37
Excavation,common	30	3.16	m3	1225	3868.42	5852	18480.00	11703	36956.84
Others (5%)			L.S.		277.25		1324.37		2648.59
Subtotal					5822.19		27811.85		55620.38
Grit Chamber									
Excavation,common	50	5.26	m3	4	21.05	11	57.89	22	115.79
Excavation,intermediate	150	15.79	m3	1	15.79	4	63.16	7	110.53
Excavation,hard rock	250	26.32	m3	1	26.32	2	52.63	4	105.26
Concrete,10MPA	35	3.68	m2	1	3.68	3	11.05	6	22.11
Concrete,25-30MPA	750	78.95	m3	2	157.89	5	394.74	10	789.47
Shuttering	120	12.63	m2	4	50.53	10	126.32	21	265.26
Reinforcement	7.5	0.79	kg	114	90.00	342	270.00	684	540.00
Concrete ancillary (5%)			L.S.		18.26		48.79		97.42
Metal work (25%)			L.S.		91.32		243.95		487.11
Building work (7%)			L.S.		25.57		68.31		136.39
Pipe work (3%)			L.S.		10.96		29.27		58.45
Air compressor,air lift pump			L.S.	2.5m3x2	24000.00	2.5m3x2	24000.00	2.5m3x2	24000.00
Flow recorder			L.S	2nos.	20000.00	3nos.	30000.00	4nos.	40000.00
Others (5%)			L.S.		2225.57		2768.31		3336.39
Subtotal					46736.94		58134.41		70064.18
Pump Pit									
Excavation,common	50	5.26	m3	32	168.42	32	168.42	48	252.63
Excavation,intermediate	150	15.79	m3	20	315.79	20	315.79	29	457.89
Excavation,hard rock	250	26.32	m3	13	342.11	13	342.11	19	500.00
Load haul	20	2.11	m3	66	138.95	66	138.95	95	200.00
Trimming	8	0.84	m2	33	27.79	33	27.79	48	40.42
Concrete,10MPA	35	3.68	m2	9	33.16	9	33.16	13	47.89
Concrete,25-30MPA	750	78.95	m3	18	1421.05	18	1421.05	26	2052.63
Shuttering	120	12.63	m2	76	960.00	76	960.00	109	1376.84
Reinforcement	7.5	0.79	kg	1998	1577.37	1998	1577.37	2886	2278.42
Concrete,ancillary (13%)			L.S.		648.00		648.00		936.88
Architecture (22%)			L.S.		1096.62		1096.62		1585.48
Metal work (7%)			L.S.		348.92		348.92		504.47
Pump			L.S.	2.2kw,2	12000.00	3.7kw,2	16000.00	11kw,2	28000.00
Others (5%)			L.S.		953.91		1153.91		1911.68
Subtotal					20032.09		24232.09		40145.24
Anaerobic Pond									
Excavation,common	30	3.16	m3	300	947.37	1350	4263.16	2700	8526.32
Excavation,intermediate	100	10.53	m3	180	1894.74	810	8526.32	1620	17052.63
Excavation,hard rock	200	21.05	m3	120	2526.32	540	11368.42	1080	22736.84
Trimming	8	0.84	m2	122	102.74	549	462.32	1098	924.63
Filling	35	3.68	m3	204	751.58	918	3382.11	1836	6764.21
Concrete,10MPA	35	3.68	m2	4	14.74	18	66.32	36	132.63
Concrete,15MPA	700	73.68	m3	18	1326.32	80	5894.74	158	11642.11
Concrete,25-30MPA	750	78.95	m3	4	315.79	18	1421.05	36	2842.11
Shuttering	120	12.63	m2	13	164.21	61	770.53	121	1528.42
Reinforcement	7.5	0.79	kg	2420	1910.53	10780	8510.53	21340	16847.37
Others (10%)			L.S.		995.43		4466.55		8899.73
Subtotal					10949.75		49132.02		97896.99
Facultative Pond									
Excavation,common	30	3.16	m3	563	1777.89	2700	8526.32	5400	17052.63
Excavation,intermediate	100	10.53	m3	337	3547.37	1620	17052.63	3240	34105.26
Excavation,hard rock	200	21.05	m3	225	4736.84	1080	22736.84	2160	45473.68
Trimming	8	0.84	m2	458	385.68	2196	1849.26	4392	3698.53
Filling	35	3.68	m3	765	2818.42	3672	13528.42	7344	27056.84
Concrete,10MPA	35	3.68	m2	15	55.26	72	265.26	144	530.53
Concrete,15MPA	700	73.68	m3	48	3536.84	101	7442.11	435	32052.63
Concrete,25-30MPA	750	78.95	m3	15	1184.21	72	5684.21	144	11368.42
Shuttering	120	12.63	m2	51	644.21	243	3069.47	485	6126.32
Reinforcement	7.5	0.79	kg	6930	5471.05	19030	15023.68	30690	24228.95
Others (10%)			L.S.		2415.78		9517.82		20169.38
Subtotal					26573.57		104696.03		221863.17

Table 13.3.8(3) Construction Cost of Solid Waste Leachate Treatment Facilities (WSP)

US$1.00 = Z$9.50 = Yen 110

Description	Unit Pric Z$	Unit Pric US$	Unit	100 m3/day Quantity	100 m3/day Amount US$	500 m3/day Quantity	500 m3/day Amount US$	1,000 m3/day Quantity	1,000 m3/day Amount US$
Matulation Pond									
Excavation,common	30	3.16	m3	1125	3552.63	2700	8526.32	5400	17052.63
Excavation,intermediate	100	10.53	m3	675	7105.26	1620	17052.63	3240	34105.26
Excavation,hard rock	200	21.05	m3	450	9473.68	1080	22736.84	2160	45473.68
Trimming	8	0.84	m2	915	770.53	2196	1849.26	4392	3698.53
Filling	35	3.68	m3	1530	5636.84	3672	13528.42	7344	27056.84
Concrete,10MPA	35	3.68	m2	30	110.53	72	265.26	144	530.53
Concrete,15MPA	700	73.68	m3	90	6631.58	101	7442.11	435	32052.63
Concrete,25-30MPA	750	78.95	m3	30	2368.42	72	5684.21	144	11368.42
Shuttering	120	12.63	m2	101	1275.79	243	3069.47	485	6126.32
Reinforcement	7.5	0.79	kg	13200	10421.05	19030	15023.68	30690	24228.95
Others (10%)			L.S.		4734.63		9517.82		20169.38
Subtotal					52080.95		104696.03		221863.17
Pipework (Interconnecting)									
Asbestos/Hume									
225mm,AC	631	66.42	m	160	10627.37	320	21254.74	560	37195.79
300mm,AC	1055	111.05	m	0	0.00	0	0.00	80	8884.21
Pipe fitting (10%)			L.S.		1062.74		2125.47		4608.00
Box'manhole (10%)			L.S.		1062.74		2125.47		4608.00
Others (5%)			L.S.		637.64		1275.28		2764.80
Subtotal					13390.48		26780.97		58060.80
Site Work									
Topsoil/Turfing	10	1.05	m2	2451	2580.00	11703	12318.95	23406	24637.89
Fencing	200	21.05	m	280	5894.74	610	12842.11	865	18210.53
Road work	160	16.84	m2	1120	18863.16	2440	41094.74	3460	58273.68
Stormwater	150	15.79	m	560	8842.11	1220	19263.16	1730	27315.79
Staff house	300000	31578.95	no	1	31578.95	1	31578.95	2	63157.89
Others (10%)			L.S.		6775.89		11709.79		19159.58
Subtotal					74534.84		128807.68		210755.37
Plant Equipment (Nil) Computer, Dump trailer,Tractor tow, Tractor, Submergible pump, Dumper,etc.			L.S.		0.00		0.00		0.00
Electrical Works (5%) Switchgear,Transformer,Control Panel, Distribution line, Diesel generator,etc.			L.S.		14381.95		30146.74		56135.48
Total Construction Cost					302020.87		633081.48		1178845.18
Unit Cost per m3 (treated water)					100m3/day		500m3/day		1000m3/day
					3020.21		1266.16		1178.85

13.4 Cost Requirements for Expansion of Sewerage Facilities

Table 13.4.1 (1) Construction Cost for Sewage Treatment Works (Scenario-1)

Crowborough Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detailed Construction Cost Description	(US$)
Harare	Crowborough	BNR, 94,100m3/d	2005	66.46	1) Direct Cost	
					BNR	47,338,257
					Subtotal	47,338,257
					2) Contingency (20%)	9,467,651
					Total of Construction Cost	56,805,908
					3) Engineering Cost (17%) (D/D and Supervision)	9,657,004
					Total	66,462,912
		BNR, 30,800m3/d	2015	23.56	1) Direct Cost	
					BNR	16,777,660
					Subtotal	16,777,660
					2) Contingency (20%)	3,355,532
					Total of Construction Cost	20,133,192
					3) Engineering Cost (17%) (D/D and Supervision)	3,422,643
					Total	23,555,835
		Sewer, 6.75km2	2000	3.30	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	2,347,650
					Pump Station	0
					Subtotal	2,347,650
					2) Contingency (20%)	469,530
					Total of Construction Cost	2,817,180
					3) Engineering Cost (17%) (D/D and Supervision)	478,921
					Total	3,296,101
		Sewer, 39.31km2	2005	35.99	1) Direct Cost	
					Trunk Sewer	11,081,198
					Collection Sewer	13,672,018
					Pump Station	877,927
					Subtotal	25,631,143
					2) Contingency (20%)	5,126,229
					Total of Construction Cost	30,757,372
					3) Engineering Cost (17%) (D/D and Supervision)	5,228,753
					Total	35,986,125
		Sewer, 12.78km2	2015	6.24	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	4,444,884
					Pump Station	0
					Subtotal	4,444,884
					2) Contingency (20%)	888,977
					Total of Construction Cost	5,333,861
					3) Engineering Cost (17%) (D/D and Supervision)	906,756
					Total	6,240,617
		Total Cost		135.55		135,541,590

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.1 (2) Construction Cost for Sewage Treatment Works (Scenario-1)

Firle Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare	Firle	BNR, 176,100m3/d	2005	125.37	1) Direct Cost	
					BNR	89,292,898
					Subtotal	89,292,898
					2) Contingency (20%)	17,858,580
					Total of Construction Cost	107,151,478
					3) Engineering Cost (17%) (D/D and Supervision)	18,215,751
					Total	125,367,229
		BNR, 61,600m3/d	2015	45.58	1) Direct Cost	
					BNR	32,461,577
					Subtotal	32,461,577
					2) Contingency (20%)	6,492,315
					Total of Construction Cost	38,953,892
					3) Engineering Cost (17%) (D/D and Supervision)	6,622,162
					Total	45,576,054
		Sewer, 13.11km2	2000	6.40	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	4,559,658
					Pump Station	0
					Subtotal	4,559,658
					2) Contingency (20%)	911,932
					Total of Construction Cost	5,471,590
					3) Engineering Cost (17%) (D/D and Supervision)	930,170
					Total	6,401,760
		Sewer, 12.48km2	2005	21.50	1) Direct Cost	
					Trunk Sewer	9,782,692
					Collection Sewer	4,340,544
					Pump Station	1,187,499
					Subtotal	15,310,735
					2) Contingency (20%)	3,062,147
					Total of Construction Cost	18,372,882
					3) Engineering Cost (17%) (D/D and Supervision)	3,123,390
					Total	21,496,272
		Sewer, 6.55km2	2015	4.79	1) Direct Cost	
					Trunk Sewer	732,224
					Collection Sewer	2,278,090
					Pump Station	401,539
					Subtotal	3,411,853
					2) Contingency (20%)	682,371
					Total of Construction Cost	4,094,224
					3) Engineering Cost (17%) (D/D and Supervision)	696,018
					Total	4,790,242
		Total Cost		203.64		203,631,557

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.1 (3) Construction Cost for Sewage Treatment Works (Scenario-1)

Marlborough Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detailed Construction Cost Description	(US$)
Harare	Marlborough	WSP, 2,800m3/d	2015	5.31	1) Direct Cost	
					WSP	2,988,498
					Pump Station	286,691
					Pumping Main	420,240
					Storage Pond	83,361
					Subtotal	3,778,790
					2) Contingency (20%)	755,758
					Total of Construction Co	4,534,548
					3) Engineering Cost (17%) (D/D and Supervision)	770,873
					Total	5,305,421
		Sewer, 7.29km2	2015	3.56	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	2,535,462
					Pump Station	0
					Subtotal	2,535,462
					2) Contingency (20%)	507,092
					Total of Construction Co	3,042,554
					3) Engineering Cost (17%) (D/D and Supervision)	517,234
					Total	3,559,788
		Total Cost		8.87		8,865,209

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.1 (4) Construction Cost for Sewage Treatment Works (Scenario-1)

Donnybrook Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare	Donnybrook	WSP, 2,400m3/d	2005	4.72	1) Direct Cost	
					WSP	2,595,074
					Pump Station	276,850
					Pumping Main	420,240
					Storage Pond	72,996
					Subtotal	3,365,160
					2) Contingency (20%)	673,032
					Total of Construction Co	4,038,192
					3) Engineering Cost (17%) (D/D and Supervision)	686,493
					Total	4,724,685
		WSP, 4,400m3/d	2015	7.74	1) Direct Cost	
					WSP	4,520,640
					Pump Station	317,611
					Pumping Main	551,220
					Storage Pond	123,036
					Subtotal	5,512,507
					2) Contingency (20%)	1,102,501
					Total of Construction Co	6,615,008
					3) Engineering Cost (17%) (D/D and Supervision)	1,124,551
					Total	7,739,559
		Sewer, 2.36km2	2015	1.15	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	820,808
					Pump Station	0
					Subtotal	820,808
					2) Contingency (20%)	164,162
					Total of Construction Co	984,970
					3) Engineering Cost (17%) (D/D and Supervision)	167,445
					Total	1,152,415
		Total Cost		13.61		13,616,659

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.1 (5) Construction Cost for Sewage Treatment Works (Scenario-1)

Harare South Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare Expansion	Harare South	BNR, 63,600m3/d	2005	47.05	1) Direct Cost	
					BNR	33,508,652
					Subtotal	33,508,652
					2) Contingency (20%)	6,701,730
					Total of Construction Co	40,210,382
					3) Engineering Cost (17%) (D/D and Supervision)	6,835,765
					Total	47,046,147
		BNR, 28,500m3/d	2015	22.12	1) Direct Cost	
					BNR	15,751,862
					Subtotal	15,751,862
					2) Contingency (20%)	3,150,372
					Total of Construction Co	18,902,234
					3) Engineering Cost (17%) (D/D and Supervision)	3,213,380
					Total	22,115,614
		Sewer, 27.36km2	2000	13.36	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	9,515,808
					Pump Station	0
					Subtotal	9,515,808
					2) Contingency (20%)	1,903,162
					Total of Construction Co	11,418,970
					3) Engineering Cost (17%) (D/D and Supervision)	1,941,225
					Total	13,360,195
		Sewer, 28.63km2	2005	28.42	1) Direct Cost	
					Trunk Sewer	9,408,376
					Collection Sewer	9,957,514
					Pump Station	877,927
					Subtotal	20,243,817
					2) Contingency (20%)	4,048,763
					Total of Construction Co	24,292,580
					3) Engineering Cost (17%) (D/D and Supervision)	4,129,739
					Total	28,422,319
		Sewer, 31.51km2	2015	15.39	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	10,959,178
					Pump Station	0
					Subtotal	10,959,178
					2) Contingency (20%)	2,191,836
					Total of Construction Co	13,151,014
					3) Engineering Cost (17%) (D/D and Supervision)	2,235,672
					Total	15,386,686
		Total Cost		126.34		126,330,961

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.1 (6) Construction Cost for Sewage Treatment Works (Scenario-1)

Harare East Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare Expansion	Harare East	BNR, 6,300m3/d	2005	6.48	1) Direct Cost	
					BNR	4,618,197
					Subtotal	4,618,197
					2) Contingency (20%)	923,639
					Total of Construction Co	5,541,836
					3) Engineering Cost (17%) (D/D and Supervision)	942,112
					Total	6,483,948
		BNR, 31,300m3/d	2015	23.87	1) Direct Cost	
					BNR	16,998,731
					Subtotal	16,998,731
					2) Contingency (20%)	3,399,746
					Total of Construction Co	20,398,477
					3) Engineering Cost (17%) (D/D and Supervision)	3,467,741
					Total	23,866,218
		Sewer, 11.10km2	2000	5.42	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	3,860,580
					Pump Station	0
					Subtotal	3,860,580
					2) Contingency (20%)	772,116
					Total of Construction Co	4,632,696
					3) Engineering Cost (17%) (D/D and Supervision)	787,558
					Total	5,420,254
		Sewer	2005	4.54	1) Direct Cost	
					Trunk Sewer	3,233,190
					Collection Sewer	0
					Pump Station	0
					Subtotal	3,233,190
					2) Contingency (20%)	646,638
					Total of Construction Co	3,879,828
					3) Engineering Cost (17%) (D/D and Supervision)	659,571
					Total	4,539,399
		Sewer, 14.76km2	2015	10.09	1) Direct Cost	
					Trunk Sewer	2,052,009
					Collection Sewer	5,133,528
					Pump Station	0
					Subtotal	7,185,537
					2) Contingency (20%)	1,437,107
					Total of Construction Co	8,622,644
					3) Engineering Cost (17%) (D/D and Supervision)	1,465,849
					Total	10,088,493
		Total Cost		50.40		50,398,312

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stsbilization Pond
TF : Trickling Filter Process

Table 13.4.1 (7) Construction Cost for Sewage Treatment Works (Scenario-1)

Norton Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Norton	Norton	TF, 9,000m3/d	2005	9.89	1) Direct Cost	
					TF	5,410,774
					Pump Station	725,407
					Pumping Main	680,310
					Storage Pond	227,884
					Subtotal	7,044,375
					2) Contingency (20%)	1,408,875
					Total of Construction Co	8,453,250
					3) Engineering Cost (17%) (D/D and Supervision)	1,437,053
					Total	9,890,303
		TF, 28,900m3/d	2015	26.88	1) Direct Cost	
					TF	15,417,906
					Pump Station	1,654,620
					Pumping Main	1,391,010
					Storage Pond	679,020
					Subtotal	19,142,556
					2) Contingency (20%)	3,828,511
					Total of Construction Co	22,971,067
					3) Engineering Cost (17%) (D/D and Supervision)	3,905,081
					Total	26,876,148
		Sewer, 2.99km2	2000	1.46	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	1,039,922
					Pump Station	0
					Subtotal	1,039,922
					2) Contingency (20%)	207,984
					Total of Construction Co	1,247,906
					3) Engineering Cost (17%) (D/D and Supervision)	212,144
					Total	1,460,050
		Sewer, 6.56km2	2005	8.25	1) Direct Cost	
					Trunk Sewer	3,159,719
					Collection Sewer	2,281,568
					Pump Station	433,106
					Subtotal	5,874,393
					2) Contingency (20%)	1,174,879
					Total of Construction Co	7,049,272
					3) Engineering Cost (17%) (D/D and Supervision)	1,198,376
					Total	8,247,648
		Sewer, 31.38km2	2015	19.30	1) Direct Cost	
					Trunk Sewer	2,162,815
					Collection Sewer	10,913,961
					Pump Station (P1)	421,672
					Pump Station (P2)	247,910
					Subtotal	13,746,361
					2) Contingency (20%)	2,749,272
					Total of Construction Co	16,495,633
					3) Engineering Cost (17%) (D/D and Supervision)	2,804,258
					Total	19,299,891
		Total Cost		65.78		65,774,040

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.1 (8) Construction Cost for Sewage Treatment Works (Scenario-1)

Ruwa Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Ruwa	Ruwa	WSP, 7,900m3/d	2005	12.60	1) Direct Cost	
					WSP	7,725,870
					Pump Station	362,653
					Pumping Main	680,310
					Storage Pond	203,682
					Subtotal	8,972,515
					2) Contingency (20%)	1,794,503
					Total of Construction Co	10,767,018
					3) Engineering Cost (17%) (D/D and Supervision)	1,830,393
					Total	12,597,411
		WSP, 5,200m3/d	2015	8.83	1) Direct Cost	
					WSP	5,267,864
					Pump Station	329,864
					Pumping Main	551,220
					Storage Pond	142,076
					Subtotal	6,291,024
					2) Contingency (20%)	1,258,205
					Total of Construction Co	7,549,229
					3) Engineering Cost (17%) (D/D and Supervision)	1,283,369
					Total	8,832,598
		Sewer, 7.02km2	2000	3.43	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	2,441,556
					Pump Station	0
					Subtotal	2,441,556
					2) Contingency (20%)	488,311
					Total of Construction Co	2,929,867
					3) Engineering Cost (17%) (D/D and Supervision)	498,077
					Total	3,427,944
		Sewer, 7.57km2	2005	15.36	1) Direct Cost	
					Trunk Sewer	5,933,979
					Collection Sewer	2,632,846
					Pump Station (P1)	411,851
					Pump Station (P2)	626,299
					Pump Station (P3)	291,403
					Pump Station (P4)	1,046,778
					Subtotal	10,943,156
					2) Contingency (20%)	2,188,631
					Total of Construction Co	13,131,787
					3) Engineering Cost (17%) (D/D and Supervision)	2,232,404
					Total	15,364,191
		Sewer, 3.86km2	2015	1.88	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	1,342,508
					Pump Station	0
					Subtotal	1,342,508
					2) Contingency (20%)	268,502
					Total of Construction Co	1,611,010
					3) Engineering Cost (17%) (D/D and Supervision)	273,872
					Total	1,884,882
		Total Cost		42.10		42,107,026

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.1(9) Construction Cost for Sewage Treatment Works (Scenario-1)

Zengeza Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Chitungwiz	Zengeza	BNR, 17,100m3/d	2000	14.60	1) Direct Cost	
					BNR	10,398,987
					Subtotal	10,398,987
					2) Contingency (20%)	2,079,797
					Total of Construction Co	12,478,784
					3) Engineering Cost (17%) (D/D and Supervision)	2,121,393
					Total	14,600,177
		BNR, 1,200m3/d	2005	1.68	1) Direct Cost	
					BNR	1,199,651
					Subtotal	1,199,651
					2) Contingency (20%)	239,930
					Total of Construction Co	1,439,581
					3) Engineering Cost (17%) (D/D and Supervision)	244,729
					Total	1,684,310
		BNR, 31,500m3/d	2015	23.99	1) Direct Cost	
					BNR	17,086,974
					Subtotal	17,086,974
					2) Contingency (20%)	3,417,395
					Total of Construction Co	20,504,369
					3) Engineering Cost (17%) (D/D and Supervision)	3,485,743
					Total	23,990,112
		Sewer, 1.75km2	2000	8.98	1) Direct Cost	
					Trunk Sewer	4,851,130
					Collection Sewer	608,650
					Pump Station (P1)	938,958
					Subtotal	6,398,738
					2) Contingency (20%)	1,279,748
					Total of Construction Co	7,678,486
					3) Engineering Cost (17%) (D/D and Supervision)	1,305,343
					Total	8,983,829
		Sewer, 20.56km2	2015	20.54	1) Direct Cost	
					Trunk Sewer	5,599,955
					Collection Sewer	7,150,768
					Pump Station (P2)	592,627
					Pump Station (P3)	1,286,691
					Subtotal	14,630,041
					2) Contingency (20%)	2,926,008
					Total of Construction Co	17,556,049
					3) Engineering Cost (17%) (D/D and Supervision)	2,984,528
					Total	20,540,577
		Total Cost		69.79		69,799,005

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.2(1) Construction Cost of Sewer
(Scenario-1)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
Harare	Crowboroug	2000	Collect Sewer		ha	675	3478.00	2347650
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					2347650
		2005	Collect Sewer		ha	3931	3478.00	13672018
			Trunk Sewer					
				800mm,AC	m	5800	215.36	1249088
				600mm,S	m	1200	707.53	849036
				900mm,RC	m	1700	202.41	344097
				1350mm,RC	m	9500	473.43	4497585
				500mm,AC	m	7600	111.49	847324
				1100mm,RC	m	5100	306.27	1561977
				1200mm,RC	m	4700	368.53	1732091
				Subtotal				11081198
			Pump Station					
				Civil/Buildin	m2	92	2440.00	224480
				Pump/Motor		37kW,5		359290
				Electrical		50%		179645
				Preliminary & general		15%		114512
				Subtotal				877927
			Total (2005)					25631143
		2015	Collect Sewer		ha	1278	3478.00	4444884
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					4444884
			Total (Crowborough)					32423677
	Firle	2000	Collect Sewer		ha	1311	3478.00	4559658
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					4559658
		2005	Collect Sewer		ha	1248	3478.00	4340544
			Trunk Sewer					
				1000mm,RC	m	9200	250.08	2300736
				1200mm,RC	m	6900	368.53	2542857
				1200mm,RC	m	4800	368.53	1768944
				1000mm,RC	m	4700	250.08	1175376
				1200mm,RC	m	400	368.53	147412
				1100mm,S	m	1700	306.27	520659
				1200mm,RC	m	3600	368.53	1326708
				Subtotal				9782692
			Pump Station					
				Civil/Buildin	m2	137	2440.00	334280
				Pump/Motor		110kW,4		465552
				Electrical		50%		232776
				Preliminary & general		15%		154891
				Subtotal				1187499
			Total (2005)					15310735
		2015	Collect Sewer		ha	655	3478.00	2278090

Table 13.4.2(2) Construction Cost of Sewer
(Scenario-1)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
			Trunk Sewer	800mm,AC	m	3400	215.36	732224
			Pump Station					
				Civil/Buildin	Nil			0
				Pump/Motor		110kW,2		232776
				Electrical		50%		116388
				Preliminary & general		15%		52375
				Subtotal				401539
			Total (2015)					3411853
			Total (Firle)					23282246
	Marlborough	2000	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					0
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2005)					0
		2015	Collect Sewer		ha	729	3478.00	2535462
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					2535462
			Total (Marlborough)					2535462
	Donnybrook	2000	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					0
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2005)					0
		2015	Collect Sewer		ha	236	3478.00	820808
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					820808
			Total (Donnybrook)					820808
Harare Expansion	Harare South	2000	Collect Sewer		ha	2736	3478.00	9515808
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					9515808
		2005	Collect Sewer		ha	2863	3478.00	9957514
			Trunk Sewer					

Table 13.4.2(3) Construction Cost of Sewer
(Scenario-I)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				1350mm,RC	m	6800	473.43	3219324
				800mm AC	m	3900	215.36	839904
				1500mm,RC	m	4000	592.32	2369280
				700mm,AC	m	3000	178.62	535860
				1800mm,RC	m	2800	872 86	2444008
				Subtotal				9408376
			Pump Station					
				Civil/Buildin	m2	92	2440.00	224480
				Pump/Motor		37kW,5		359290
				Electrical		50%		179645
				Preliminary & general		15%		114512
				Subtotal				877927
			Total (2005)					20243817
		2015	Collect Sewer		ha	3151	3478.00	10959178
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					10959178
			Total (Harare South)					40718803
	Harare East	2000	Collect Sewer		ha	1110	3478.00	3860580
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					3860580
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer					
				1100mm,RC	m	6700	306.27	2052009
				900mm,RC	m	4900	202.41	991809
				1350mm,RC	m	400	473.43	189372
				Subtotal				3233190
			Pump Station	Nil				0
			Total (2005)					3233190
		2015	Collect Sewer		ha	1476	3478.00	5133528
			Trunk Sewer	1100mm,RC	m	6700	306.27	2052009
			Pump Station	Nil				0
			Total (2015)					7185537
			Totaln (Harare East)					14279307
Norton	Norton	2000	Collect Sewer		ha	299	3478.00	1039922
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					1039922
		2005	Collect Sewer		ha	656	3478.00	2281568
			Trunk Sewer					
				900mm,RC	m	6400	202.41	1295424
				300mm,AC	m	1900	54.11	102809
				500mm,S	m	1200	541 28	649536
				700mm,AC	m	1700	178.62	303654
				450mm,AC	m	2600	98.85	257010

Table 13.4.2(4) Construction Cost of Sewer
(Scenario-1)

US$1.00 = ZS9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				1100mm,RC	m	1800	306.27	551286
				Subtotal				3159719
			Pump Station (P2)					
				Civil/Buildin	m2	66	2440.00	161040
				Pump/Motor		37kW,2		143716
				Electrical		50%		71858
				Preliminary & general		15%		56492
				Subtotal				433106
			Total (2005)					5874393
		2015	Collect Sewer		ha	3138	3478.00	10913964
			Trunk Sewer					
				350mm,S	m	1600	311.45	498320
				700mm,AC	m	2100	178.62	375102
				500mm,AC	m	2100	111.49	234129
				800mm,AC	m	4900	215.36	1055264
				Subtotal				2162815
			Pump Station (P1)					
				Civil/Buildin	m2	47	2440.00	114680
				Pump/Motor		11kW,3		167994
				Electrical		50%		83997
				Preliminary & general		15%		55001
				Subtotal				421672
			Pump Station (P2)					
				Civil/Buildin	Nil			0
				Pump/Motor		37kW,2		143716
				Electrical		50%		71858
				Preliminary & general		15%		32336
				Subtotal				247910
			Total (2015)					13746361
			Total (Norton)					20660676
Ruwa	Ruwa	2000	Collect Sewer		ha	702	3478.00	2441556
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					2441556
		2005	Collect Sewer		ha	757	3478.00	2632846
			Trunk Sewer					
				250mm,S	m	1800	226.77	408186
				350mm,AC	m	2500	68.04	170100
				400mm,S	m	2400	390.00	936000
				600mm,AC	m	700	143.93	100751
				200mm,S	m	1600	183.74	293984
				600mm,AC	m	2700	143.93	388611
				450mm,AC	m	3300	98.85	326205
				450mm,AC	m	2800	98.85	276780
				800mm,AC	m	1500	215.36	323040
				1000mm,RC	m	1300	250.08	325104
				800mm,S	m	2200	1084.19	2385218
				Subtotal				5933979
			Pump Station (P1)					
				Civil/Buildin	m2	39	2440.00	95160
				Pump/Motor		15kW,3		175314

Table 13.4.2(5) Construction Cost of Sewer
(Scenario-1)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				Electrical		50%		87657
				Preliminary & general		15%		53720
				Subtotal				411851
			Pump Station (P2)					
				Civil/Buildin	m2	57	2440.00	139080
				Pump/Motor		30kW,4		270352
				Electrical		50%		135176
				Preliminary & general		15%		81691
				Subtotal				626299
			Pump Station (P3)					
				Civil/Buildin	m2	35	2440.00	85400
				Pump/Motor		11kW,2		111996
				Electrical		50%		55998
				Preliminary & general		15%		38009
				Subtotal				291403
			Pump Station (P4)					
				Civil/Buildin	m2	108	2440.00	263520
				Pump/Motor		37kW,6		431148
				Electrical		50%		215574
				Preliminary & general		15%		136536
				Subtotal				1046778
			Total (2005)					10943156
		2015	Collect Sewer		ha	386	3478.00	1342508
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					1342508
			Total (Ruwa)					14727220
Chitungwiz	Zengeza	2000	Collect Sewer		ha	175	3478.00	608650
			Trunk Sewer					
				800mm,AC	m	6700	215.36	1442912
				600mm,S	m	3700	707.53	2617861
				800mm,AC	m	3200	215.36	689152
				900mm,RC	m	500	202.41	101205
				Subtotal				4851130
			Pump Station (P1)					
				Civil/Buildin	m2	80	2440.00	195200
				Pump/Motor		55kW,5		414190
				Electrical		50%		207095
				Preliminary & general		15%		122473
				Subtotal				938958
			Total (2000)					6398738
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2005)					0
		2015	Collect Sewer		ha	2056	3478.00	7150768
			Trunk Sewer					

Table 13.4.2(6) Construction Cost of Sewer
(Scenario-1)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				450mm,S	m	2200	463.67	1020074
				600mm,AC	m	900	143.93	129537
				600mm,AC	m	6100	143.93	877973
				600mm,AC	m	5900	143.93	849187
				700mm,AC	m	3900	178.62	696618
				1000mm,RC	m	300	250.08	75024
				800mm,S	m	1800	1084.19	1951542
				Subtotal				5599955
			Pump Station (P2)					
				Civil/Buildin	m2	57	2440.00	139080
				Pump/Motor		22kW,4		250832
				Electrical		50%		125416
				Preliminary & general		15%		77299
				Subtotal				592627
			Pump Station (P3)					
				Civil/Buildin	m2	108	2440.00	263520
				Pump/Motor		75kW,6		570228
				Electrical		50%		285114
				Preliminary & general		15%		167829
				Subtotal				1286691
			Total (2015)					14630042
			Total (Zengeza)					21028779

Table 13.4 3 (1) Construction Cost for Sewage Treatment Works (Scenario-2)

Crowborough Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare	Crowborough	BNR, 38,700m3/d	2005	28.36	1) Direct Cost	
					BNR	20,199,413
					Subtotal	20,199,413
					2) Contingency (20%)	4,039,883
					Total of Construction Co	24,239,296
					3) Engineering Cost (17%) (D/D and Supervision)	4,120,680
					Total	28,359,976
		BNR, 31,500m3/d	2015	23.99	1) Direct Cost	
					BNR	17,086,974
					Subtotal	17,086,974
					2) Contingency (20%)	3,417,395
					Total of Construction Co	20,504,369
					3) Engineering Cost (17%) (D/D and Supervision)	3,485,743
					Total	23,990,112
		Sewer, 6.75km2	2000	3.30	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	2,347,650
					Pump Station	0
					Subtotal	2,347,650
					2) Contingency (20%)	469,530
					Total of Construction Co	2,817,180
					3) Engineering Cost (17%) (D/D and Supervision)	478,921
					Total	3,296,101
		Sewer, 39.31km2	2005	32.69	1) Direct Cost	
					Trunk Sewer	8,898,204
					Collection Sewer	13,672,018
					Pump Station	711,882
					Subtotal	23,282,104
					2) Contingency (20%)	4,656,421
					Total of Construction Co	27,938,525
					3) Engineering Cost (17%) (D/D and Supervision)	4,749,549
					Total	32,688,074
		Sewer, 12.78km2	2015	6.24	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	4,444,884
					Pump Station	0
					Subtotal	4,444,884
					2) Contingency (20%)	888,977
					Total of Construction Co	5,333,861
					3) Engineering Cost (17%) (D/D and Supervision)	906,756
					Total	6,240,617
		Total Cost		94.58		94,574,880

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3 (2) Construction Cost for Sewage Treatment Works (Scenario-2)

Firle Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare	Firle	BNR, 133,300m3/	2005	94.95	1) Direct Cost	
					BNR	67,628,616
					Subtotal	67,628,616
					2) Contingency (20%)	13,525,723
					Total of Construction Co	81,154,339
					3) Engineering Cost (17%) (D/D and Supervision)	13,796,238
					Total	94,950,577
		BNR, 72,600m3/d	2015	53.24	1) Direct Cost	
					BNR	37,921,014
					Subtotal	37,921,014
					2) Contingency (20%)	7,584,203
					Total of Construction Co	45,505,217
					3) Engineering Cost (17%) (D/D and Supervision)	7,735,887
					Total	53,241,104
		Sewer, 13.11km2	2000	6.40	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	4,559,658
					Pump Station	0
					Subtotal	4,559,658
					2) Contingency (20%)	911,932
					Total of Construction Co	5,471,590
					3) Engineering Cost (17%) (D/D and Supervision)	930,170
					Total	6,401,760
		Sewer, 12.48km2	2005	24.60	1) Direct Cost	
					Trunk Sewer	11,992,964
					Collection Sewer	4,340,544
					Pump Station	1,187,499
					Subtotal	17,521,007
					2) Contingency (20%)	3,504,201
					Total of Construction Co	21,025,208
					3) Engineering Cost (17%) (D/D and Supervision)	3,574,285
					Total	24,599,493
		Sewer, 6.55km2	2015	4.79	1) Direct Cost	
					Trunk Sewer	732,224
					Collection Sewer	2,278,090
					Pump Station	401,539
					Subtotal	3,411,853
					2) Contingency (20%)	682,371
					Total of Construction Co	4,094,224
					3) Engineering Cost (17%) (D/D and Supervision)	696,018
					Total	4,790,242
		Total Cost		183.98		183,983,176

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3 (3) Construction Cost for Sewage Treatment Works (Scenario-2)

Marlborough Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detailed Construction Cost Description	(US$)
Harare	Marlborough	WSP, 600m3/d	2015	1.74	1) Direct Cost	
					WSP	729,195
					Pump Station	202,217
					Pumping Main	286,710
					Storage Pond	22,118
					Subtotal	1,240,240
					2) Contingency (20%)	248,048
					Total of Construction Co	1,488,288
					3) Engineering Cost (17%) (D/D and Supervision)	253,009
					Total	1,741,297
		Sewer, 7.29km2	2015	3.56	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	2,535,462
					Pump Station	0
					Subtotal	2,535,462
					2) Contingency (20%)	507,092
					Total of Construction Co	3,042,554
					3) Engineering Cost (17%) (D/D and Supervision)	517,234
					Total	3,559,788
		Total Cost		5.30		5,301,085

Remarks: Above construction cost includes direct cost,contingency and engineering cost.
The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3 (4) Construction Cost for Sewage Treatment Works (Scenario-2)

Donnybrook Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare	Donnybrook	WSP, 2,900m3/d	2005	5.45	1) Direct Cost	
					WSP	3,086,087
					Pump Station	288,980
					Pumping Main	420,240
					Storage Pond	85,919
					Subtotal	3,881,226
					2) Contingency (20%)	776,245
					Total of Construction Co	4,657,471
					3) Engineering Cost (17%) (D/D and Supervision)	791,770
					Total	5,449,241
		WSP, 3,300m3/d	2015	6.02	1) Direct Cost	
					WSP	3,473,710
					Pump Station	297,566
					Pumping Main	420,240
					Storage Pond	96,033
					Subtotal	4,287,549
					2) Contingency (20%)	857,510
					Total of Construction Co	5,145,059
					3) Engineering Cost (17%) (D/D and Supervision)	874,660
					Total	6,019,719
		Sewer, 2 36km2	2015	1.15	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	820,808
					Pump Station	0
					Subtotal	820,808
					2) Contingency (20%)	164,162
					Total of Construction Co	984,970
					3) Engineering Cost (17%) (D/D and Supervision)	167,445
					Total	1,152,415
		Total Cost		12.62		12,621,375

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3 (5) Construction Cost for Sewage Treatment Works (Scenario-2)

Harare South Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare Expansion	Harare South	BNR, 47,100m3/d	2005	33.27	1) Direct Cost	
					BNR	23,696,664
					Subtotal	23,696,664
					2) Contingency (20%)	4,739,333
					Total of Construction Co	28,435,997
					3) Engineering Cost (17%) (D/D and Supervision)	4,834,119
					Total	33,270,116
		BNR, 300m3/d	2015	0.55	1) Direct Cost	
					BNR	388,723
					Subtotal	388,723
					2) Contingency (20%)	77,745
					Total of Construction Co	466,468
					3) Engineering Cost (17%) (D/D and Supervision)	79,300
					Total	545,768
		Sewer, 27.36km2	2000	13.36	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	9,515,808
					Pump Station	0
					Subtotal	9,515,808
					2) Contingency (20%)	1,903,162
					Total of Construction Co	11,418,970
					3) Engineering Cost (17%) (D/D and Supervision)	1,941,225
					Total	13,360,195
		Sewer, 28.63km2	2005	23.30	1) Direct Cost	
					Trunk Sewer	5,875,477
					Collection Sewer	9,957,514
					Pump Station	765,337
					Subtotal	16,598,328
					2) Contingency (20%)	3,319,666
					Total of Construction Co	19,917,994
					3) Engineering Cost (17%) (D/D and Supervision)	3,386,059
					Total	23,304,053
		Sewer, 31.51km2	2015	15.39	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	10,959,178
					Pump Station	0
					Subtotal	10,959,178
					2) Contingency (20%)	2,191,836
					Total of Construction Co	13,151,014
					3) Engineering Cost (17%) (D/D and Supervision)	2,235,672
					Total	15,386,686
	Total Cost			85.87		85,866,818

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3 (6) Construction Cost for Sewage Treatment Works (Scenario-2)

Harare East Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Harare Expansion	Harare East	BNR, 6,300m3/d	2005	6.48	1) Direct Cost	
					BNR	4,618,197
					Subtotal	4,618,197
					2) Contingency (20%)	923,639
					Total of Construction Co	5,541,836
					3) Engineering Cost (17%) (D/D and Supervision)	942,112
					Total	6,483,948
		BNR, 31,300m3/d	2015	23.87	1) Direct Cost	
					BNR	16,998,731
					Subtotal	16,998,731
					2) Contingency (20%)	3,399,746
					Total of Construction Co	20,398,477
					3) Engineering Cost (17%) (D/D and Supervision)	3,467,741
					Total	23,866,218
		Sewer, 11.10km2	2000	5.42	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	3,860,580
					Pump Station	0
					Subtotal	3,860,580
					2) Contingency (20%)	772,116
					Total of Construction Co	4,632,696
					3) Engineering Cost (17%) (D/D and Supervision)	787,558
					Total	5,420,254
		Sewer	2005	4.54	1) Direct Cost	
					Trunk Sewer	3,233,190
					Collection Sewer	0
					Pump Station	0
					Subtotal	3,233,190
					2) Contingency (20%)	646,638
					Total of Construction Co	3,879,828
					3) Engineering Cost (17%) (D/D and Supervision)	659,571
					Total	4,539,399
		Sewer, 14.76km2	2015	10.09	1) Direct Cost	
					Trunk Sewer	2,052,009
					Collection Sewer	5,133,528
					Pump Station	0
					Subtotal	7,185,537
					2) Contingency (20%)	1,437,107
					Total of Construction Co	8,622,644
					3) Engineering Cost (17%) (D/D and Supervision)	1,465,849
					Total	10,088,493
		Total Cost		50.40		50,398,312

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3 (7) Construction Cost for Sewage Treatment Works (Scenario-2)

Norton Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Norton	Norton	TF, 4,200m3/d	2005	5.95	1) Direct Cost	
					TF	2,995,310
					Pump Station	571,236
					Pumping Main	551,220
					Storage Pond	118,203
					Subtotal	4,235,969
					2) Contingency (20%)	847,194
					Total of Construction Co	5,083,163
					3) Engineering Cost (17%) (D/D and Supervision)	864,138
					Total	5,947,301
		TF, 18,900m3/d	2015	17.04	1) Direct Cost	
					TF	9,622,089
					Pump Station	915,371
					Pumping Main	1,170,000
					Storage Pond	431,760
					Subtotal	12,139,220
					2) Contingency (20%)	2,427,844
					Total of Construction Co	14,567,064
					3) Engineering Cost (17%) (D/D and Supervision)	2,476,401
					Total	17,043,465
		Sewer, 2.99km2	2000	1.46	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	1,039,922
					Pump Station	0
					Subtotal	1,039,922
					2) Contingency (20%)	207,984
					Total of Construction Co	1,247,906
					3) Engineering Cost (17%) (D/D and Supervision)	212,144
					Total	1,460,050
		Sewer, 6.56km2	2005	7.28	1) Direct Cost	
					Trunk Sewer	2,526,656
					Collection Sewer	2,281,568
					Pump Station (P2)	376,285
					Subtotal	5,184,509
					2) Contingency (20%)	1,036,902
					Total of Construction Co	6,221,411
					3) Engineering Cost (17%) (D/D and Supervision)	1,057,640
					Total	7,279,051
		Sewer, 31.38km2	2015	18.39	1) Direct Cost	
					Trunk Sewer	1,577,867
					Collection Sewer	10,913,964
					Pump Station (P1)	389,753
					Pump Station (P2)	216,343
					Subtotal	13,097,927
					2) Contingency (20%)	2,619,585
					Total of Construction Co	15,717,512
					3) Engineering Cost (17%) (D/D and Supervision)	2,671,977
					Total	18,389,489
	Total Cost			50.12		50,119,356

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3 (8) Construction Cost for Sewage Treatment Works (Scenario-2)

Ruwa Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Ruwa	Ruwa	WSP, 0	2005	0.00	1) Direct Cost	
					WSP	0
					Pump Station	0
					Pumping Main	0
					Storage Pond	0
					Subtotal	0
					2) Contingency (20%)	0
					Total of Construction Co	0
					3) Engineering Cost (17%) (D/D and Supervision)	0
					Total	0
		WSP, 400m3/d	2015	1.39	1) Direct Cost	
					WSP	503,033
					Pump Station	184,466
					Pumping Main	286,710
					Storage Pond	15,598
					Subtotal	989,807
					2) Contingency (20%)	197,961
					Total of Construction Co	1,187,768
					3) Engineering Cost (17%) (D/D and Supervision)	201,921
					Total	1,389,689
		Sewer, 7.02km2	2000	3.43	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	2,441,556
					Pump Station	0
					Subtotal	2,441,556
					2) Contingency (20%)	488,311
					Total of Construction Co	2,929,867
					3) Engineering Cost (17%) (D/D and Supervision)	498,077
					Total	3,427,944
		Sewer, 7.57km2	2005	10.42	1) Direct Cost	
					Trunk Sewer	3,201,137
					Collection Sewer	2,632,846
					Pump Station (P1)	277,373
					Pump Station (P2)	433,948
					Pump Station (P3)	262,010
					Pump Station (P4)	617,881
					Subtotal	7,425,195
					2) Contingency (20%)	1,485,039
					Total of Construction Co	8,910,234
					3) Engineering Cost (17%) (D/D and Supervision)	1,514,740
					Total	10,424,974
		Sewer, 3.86km2	2015	1.88	1) Direct Cost	
					Trunk Sewer	0
					Collection Sewer	1,342,508
					Pump Station	0
					Subtotal	1,342,508
					2) Contingency (20%)	268,502
					Total of Construction Co	1,611,010
					3) Engineering Cost (17%) (D/D and Supervision)	273,872
					Total	1,884,882
		Total Cost		17.12		17,127,489

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.3(9) Construction Cost for Sewage Treatment Works (Scenario-2)

Zengeza Sewage Works

Authority	Sewage Works	Treatment Facility	Target Year	Construction Cost (Mill US$)	Detaailed Construction Cost Description	(US$)
Chitungwiz	Zengeza	BNR, 25,100m3/d	2000	19.95	1) Direct Cost	
					BNR	14,206,375
					Subtotal	14,206,375
					2) Contingency (20%)	2,841,275
					Total of Construction Co	17,047,650
					3) Engineering Cost (17%) (D/D and Supervision)	2,898,101
					Total	19,945,751
		BNR, 12,600m3/d	2005	11.39	1) Direct Cost	
					BNR	8,112,967
					Subtotal	8,112,967
					2) Contingency (20%)	1,622,593
					Total of Construction Co	9,735,560
					3) Engineering Cost (17%) (D/D and Supervision)	1,655,045
					Total	11,390,605
		BNR, 49,600m3/d	2015	34.70	1) Direct Cost	
					BNR	24,714,144
					Subtotal	24,714,144
					2) Contingency (20%)	4,942,829
					Total of Construction Co	29,656,973
					3) Engineering Cost (17%) (D/D and Supervision)	5,041,685
					Total	34,698,658
		Sewer, 1.75km2	2000	11.28	1) Direct Cost	
					Trunk Sewer	6,140,402
					Collection Sewer	608,650
					Pump Station (P1)	1,286,691
					Subtotal	8,035,743
					2) Contingency (20%)	1,607,149
					Total of Construction Co	9,642,892
					3) Engineering Cost (17%) (D/D and Supervision)	1,639,292
					Total	11,282,184
		Sewer, 20.56km2	2015	23.35	1) Direct Cost	
					Trunk Sewer	7,286,546
					Collection Sewer	7,150,768
					Pump Station (P2)	651,553
					Pump Station (P3)	1,541,336
					Subtotal	16,630,203
					2) Contingency (20%)	3,326,041
					Total of Construction Co	19,956,244
					3) Engineering Cost (17%) (D/D and Supervision)	3,392,561
					Total	23,348,805
		Total Cost		100.67		100,666,003

Remarks: Above construction cost includes direct cost,contingency and engineering cost. The cost of price escalation and administration is not included.

BNR : Biological nutrient Removal Process
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process

Table 13.4.4(1) Construction Cost of Sewer
(Scenario-2)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
Harare	Crowborough	2000	Collect Sewer		ha	675	3478.00	2347650
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					2347650
		2005	Collect Sewer		ha	3931	3478.00	13672018
			Trunk Sewer					
				700mm,AC	m	5800	178.62	1035996
				500mm,S	m	1200	541.28	649536
				800mm,AC	m	1700	215.36	366112
				1200mm,RC	m	9500	368 53	3501035
				400mm,AC	m	7600	82.98	630648
				1000mm,RC	m	5100	250.08	1275408
				1100mm,RC	m	4700	306.27	1439469
				Subtotal				8898204
			Pump Station					
				Civil/Buildin	m2	77	2440.00	187880
				Pump/Motor		37kW,4		287432
				Electrical		50%		143716
				Preliminary & general		15%		92854
				Subtotal				711882
			Total (2005)					23282104
		2015	Collect Sewer		ha	1278	3478.00	4444884
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					4444884
			Total (Crowborough)					30074638
	Firle	2000	Collect Sewer		ha	1311	3478.00	4559658
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					4559658
		2005	Collect Sewer		ha	1248	3478.00	4340544
			Trunk Sewer					
				1000mm,RC	m	9200	250.08	2300736
				1200mm,RC	m	6900	368.53	2542857
				1200mm,RC	m	4800	368.53	1768944
				1000mm,RC	m	4700	250.08	1175376
				1200mm,RC	m	400	368.53	147412
				1000mm,S	m	1700	1606.43	2730931
				1200mm,RC	m	3600	368.53	1326708
				Subtotal				11992964
			Pump Station					
				Civil/Buildin	m2	137	2440.00	334280
				Pump/Motor		110kW,4		465552
				Electrical		50%		232776
				Preliminary & general		15%		154891
				Subtotal				1187499
			Total (2005)					17521007
		2015	Collect Sewer		ha	655	3478.00	2278090

Table 13.4.4(2) Construction Cost of Sewer
(Scenario-2)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
			Trunk Sewer	800mm,AC	m	3400	215.36	732224
			Pump Station					
				Civil-Buildin	Nil			0
				Pump-Motor		110kW,2		232776
				Electrical		50%		116388
				Preliminary & general		15%		52375
				Subtotal				401539
			Total (2015)					3411853
			Total (Firle)					25492518
	Marlborough	2000	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					0
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2005)					0
		2015	Collect Sewer		ha	729	3478.00	2535462
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					2535462
			Total (Marlborough)					2535462
	Donnybrook	2000	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					0
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2005)					0
		2015	Collect Sewer		ha	236	3478.00	820808
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					820808
			Total (Donnybrook)					820808
Harare Expansion	Harare South	2000	Collect Sewer		ha	2736	3478.00	9515808
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					9515808
		2005	Collect Sewer		ha	2863	3478.00	9957514
			Trunk Sewer					

Table 13.4.4(3) Construction Cost of Sewer
(Scenario-2)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				1100mm,RC	m	6800	306.27	2082636
				600mm AC	m	3900	143.93	561327
				1200mm,RC	m	4000	368.53	1474120
				600mm,AC	m	3000	143.93	431790
				1350mm,RC	m	2800	473.43	1325604
				Subtotal				5875477
			Pump Station					
				Civil/Buildin	m2	80	2440.00	195200
				Pump/Motor		22kW,5		313540
				Electrical		50%		156770
				Preliminary & general		15%		99827
				Subtotal				765337
			Total (2005)					16598328
		2015	Collect Sewer		ha	3151	3478.00	10959178
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					10959178
			Total (Harare South)					37073314
	Harare East	2000	Collect Sewer		ha	1110	3478.00	3860580
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					3860580
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer					
				1100mm,RC	m	6700	306.27	2052009
				900mm,RC	m	4900	202.41	991809
				1350mm,RC	m	400	473.43	189372
				Subtotal				3233190
			Pump Station	Nil				0
			Total (2005)					3233190
		2015	Collect Sewer		ha	1476	3478.00	5133528
			Trunk Sewer	1100mm,RC	m	6700	306.27	2052009
			Pump Station	Nil				0
			Total (2015)					7185537
			Total (Harare East)					14279307
Norton	Norton	2000	Collect Sewer		ha	299	3478.00	1039922
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					1039922
		2005	Collect Sewer		ha	656	3478.00	2281568
			Trunk Sewer					
				800mm,RC	m	6400	166.73	1067072
				250mm,AC	m	1900	41.27	78413
				450mm,S	m	1200	463.67	556404
				600mm,AC	m	1700	143.93	244681
				400mm,AC	m	2600	82.98	215748

Table 13.4.4(4) Construction Cost of Sewer
(Scenario-2)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				900mm,RC	m	1800	202.41	364338
				Subtotal				2526656
			Pump Station (P2)					
				Civil/Buildin	m2	57	2440.00	139080
				Pump/Motor		22kW,2		125416
				Electrical		50%		62708
				Preliminary & general		15%		49081
				Subtotal				376285
			Total (2005)					5184509
		2015	Collect Sewer		ha	3138	3478.00	10913964
			Trunk Sewer					
				300mm,S	m	1600	269.31	430896
				500mm,AC	m	2100	111.49	234129
				450mm,AC	m	2100	98.85	207585
				600mm,AC	m	4900	143.93	705257
				Subtotal				1577867
			Pump Station (P1)					
				Civil/Buildin	m2	39	2440.00	95160
				Pump/Motor		8kW,3		162504
				Electrical		50%		81252
				Preliminary & general		15%		50837
				Subtotal				389753
			Pump Station (P2)					0
				Civil/Buildin	Nil			0
				Pump/Motor		22kW,2		125416
				Electrical		50%		62708
				Preliminary & general		15%		28219
				Subtotal				216343
			Total (2015)					13097927
			Total (Norton)					19322358
Ruwa	Ruwa	2000	Collect Sewer		ha	702	3478.00	2441556
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2000)					2441556
		2005	Collect Sewer		ha	757	3478.00	2632846
			Trunk Sewer					
				150mm,S	m	1800	140.08	252144
				200mm,AC	m	2500	29.62	74050
				250mm,S	m	2400	226.77	544248
				350mm,AC	m	700	68.04	47628
				150mm,S	m	1600	140.08	224128
				350mm,AC	m	2700	68.04	183708
				300mm,AC	m	3300	54.11	178563
				300mm,AC	m	2800	54.11	151508
				500mm,AC	m	1500	111.49	167235
				600mm,AC	m	1300	143.93	187109
				500mm,S	m	2200	541.28	1190816
				Subtotal				3201137
			Pump Station (P1)					
				Civil/Buildin	m2	30	2440.00	73200
				Pump/Motor		11kW,2		111996

Table 13.4.4(5) Construction Cost of Sewer
(Scenario-2)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				Electrical		50%		55998
				Preliminary & general		15%		36179
				Subtotal				277373
			Pump Station (P2)					
				Civil/Buildin	m2	39	2440.00	95160
				Pump/Motor		22kW,3		188124
				Electrical		50%		94062
				Preliminary & general		15%		56602
				Subtotal				433948
			Pump Station (P3)					
				Civil/Buildin	m2	30	2440.00	73200
				Pump/Motor		3.7W,2		103090
				Electrical		50%		51545
				Preliminary & general		15%		34175
				Subtotal				262010
			Pump Station (P4)					
				Civil/Buildin	m2	66	2440.00	161040
				Pump/Motor		22kW,4		250832
				Electrical		50%		125416
				Preliminary & general		15%		80593
				Subtotal				617881
			Total (2005)					7425195
		2015	Collect Sewer		ha	386	3478.00	1342508
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2015)					1342508
			Total (Ruwa)					11209259
Chitungwiz	Zengeza	2000	Collect Sewer		ha	175	3478.00	608650
			Trunk Sewer					
				900mm,RC	m	6700	202.41	1356147
				800mm,S	m	3700	1084.19	4011503
				900mm,RC	m	3200	202.41	647712
				1000mm,RC	m	500	250.08	125040
				Subtotal				6140402
			Pump Station (P1)					
				Civil/Buildin	m2	108	2440.00	263520
				Pump/Motor		75kW,6		570228
				Electrical		50%		285114
				Preliminary & general		15%		167829
				Subtotal				1286691
			Total (2000)					8035743
		2005	Collect Sewer		ha	0	3478.00	0
			Trunk Sewer	Nil				0
			Pump Station	Nil				0
			Total (2005)					0
		2015	Collect Sewer		ha	2056	3478.00	7150768
			Trunk Sewer					

Table 13.4.4(6) Construction Cost of Sewer
(Scenario-2)

US$1.00 = Z$9.50 = Yen 110

Authority	Sewage Work	Target Year	Detailed Works	Description	Unit	Quantity	Unit Price US$	Amount US$
				500mm,S	m	2200	541.28	1190816
				700mm,AC	m	900	178.62	160758
				700mm,AC	m	6100	178.62	1089582
				700mm,AC	m	5900	178.62	1053858
				900mm,RC	m	3900	202.41	789399
				1200mm,RC	m	300	368.53	110559
				1000mm,S	m	1800	1606.43	2891574
				Subtotal				7286546
			Pump Station (P2)					
				Civil/Buildin	m2	66	2440.00	161040
				Pump/Motor		30kW,4		270352
				Electrical		50%		135176
				Preliminary & general		15%		84985
				Subtotal				651553
			Pump Station (P3)					
				Civil/Buildin	m2	120	2440.00	292800
				Pump/Motor		110kW,6		698328
				Electrical		50%		349164
				Preliminary & general		15%		201044
				Subtotal				1541336
			Total (2015)					16630203
			Total (Zengeza)					24665946

13.5 Operation and Maintenance Cost

Table13.5.1 Collection Sewer Cleaning Cost

Machine or person	No.	Unit cost Z$/person	Cost	Remarks
High pressure cleaning machir	1		200,000	annual cost
Attendant	1	20,000	20,000	
Operator	1	15,000	15,000	
Foreman	1	12,000	12,000	
General Staff	2	8,000	16,000	
Others	1		20,000	
Total(annual)			283,000	

Annual cleaning sewer length 600m/day x 240day/year
=144km/year

Unit sewer cleaning cost
(one time per each five years) Z$283,000/years / 144km/year / 5years
=Z$393/km/year

Sewer cleaning cost per ha 0.18km/ha x Z$393/km/year / 9.5Z$/US$
=US$7.45/ha/year

Table 13.5.2 Estimated Pump Station O & M Cost by Design Capacity

Cost Item		Unit	Pump Discharge (m^3/min)						Remarks
			1-3	4-10	11-20	21-40	41-60	61-	
Staff Cost		Annual cost/person							
	Superintendent	24,000	0.0	0.0	0.1	0.2	0.3	0.4	
	Attendant	20,000	0.3	0.5	0.7	1.0	1.2	1.4	
	Operator	15,000	0.9	1.5	2.1	3.0	3.6	4.2	
	Foreman	12,000	0.2	0.5	0.7	1.0	1.2	1.4	
	General Staff	8,000	0.4	1.0	1.4	2.0	2.4	2.8	
	Total		25,100	46,500	67,500	97,800	118,800	139,800	
Electricity	Total Pump Power	kW	30	90	150	350	500	600	
	Operating hours per day	hours	6	6	6	6	6	6	
	Annual Consumption	kWH/year	65,700	197,100	328,500	766,500	1,095,000	1,314,000	
	Unit cost	Z$/kW	0.45	0.45	0.45	0.45	0.45	0.45	
	Annual Cost	Z$/year	29,565	88,695	147,825	344,925	492,750	591,300	
Maintenance & Repairs		Z$/year	5,913	17,739	29,565	68,985	98,550	118,260	Electricity*0.2
Materials & Chemicals		Z$/year	2,957	8,870	14,783	34,493	49,275	59,130	Electricity*0.1
Others		Z$/year	12,550	23,250	33,750	48,900	59,400	69,900	Staff Cost*0.5
Total		Z$/year	76,085	185,054	293,423	595,103	818,775	978,390	
Administration charge		Z$/year	15,217	37,011	58,685	119,021	163,755	195,678	Total*0.2
Total cost (Z$)		Z$/year	91,301	222,064	352,107	714,123	982,530	1,174,068	
Total cost (US$)		US$/year	9,611	23,375	37,064	75,171	103,424	123,586	

Table 13.5.3 Estimated STW O & M Cost (Staff) by Design Capacity

		Unit cost Z$/person	Flow 1,000m³/d		Flow 2,000m³/d		Flow 5,000m³/d		Flow 10,000m³/d	
			No.	Cost	No.	Cost	No.	Cost	No.	Cost
WSP	S	24,000	0	0	0	0	1	24,000	1	24,000
	A	20,000	1	20,000	1	20,000	2	40,000	2	40,000
	O	15,000	3	45,000	3	45,000	6	90,000	6	90,000
	F	12,000	2	24,000	2	24,000	4	48,000	5	60,000
	G	8,000	4	32,000	4	32,000	8	64,000	10	80,000
	Total		10	121,000	10	121,000	21	266,000	24	294,000

		Unit cost Z$/person	Flow 2,500m³/d		Flow 5,000m³/d		Flow 10,000m³/d		Flow 20,000m³/d	
			No.	Cost	No.	Cost	No.	Cost	No.	Cost
TF	S	24,000	1	24,000	1	24,000	1	24,000	1	24,000
	A	20,000	3	60,000	3	60,000	6	120,000	6	120,000
	O	15,000	9	135,000	9	135,000	18	270,000	18	270,000
	F	12,000	3	36,000	4	48,000	5	60,000	8	96,000
	G	8,000	6	48,000	8	64,000	10	80,000	16	128,000
	Total		22	303,000	25	331,000	40	554,000	49	638,000

		Unit cost Z$/person	Flow 5,000m³/d		Flow 10,000m³/d		Flow 20,000m³/d		Flow 50,000m³/d	
			No.	Cost	No.	Cost	No.	Cost	No.	Cost
BNR	S	24,000	1	24,000	1	24,000	2	48,000	3	72,000
	A	20,000	3	60,000	3	60,000	6	120,000	12	240,000
	O	15,000	9	135,000	9	135,000	18	270,000	18	270,000
	F	12,000	4	48,000	5	60,000	8	96,000	10	120,000
	G	8,000	8	64,000	10	80,000	16	128,000	20	160,000
	Total		25	331,000	28	359,000	50	662,000	63	862,000

		Unit cost Z$/person	Flow 100m³/d		Flow 500m³/d		Flow 1,000m³/d		Flow 2,000m³/d	
			No.	Cost	No.	Cost	No.	Cost	No.	Cost
IWPTF	S	24,000			0	0	0	0	0	0
	A	20,000			1	20,000	1	20,000	1	20,000
	O	15,000			3	45,000	3	45,000	3	45,000
	F	12,000			1	12,000	1	12,000	1	12,000
	G	8,000			2	16,000	2	16,000	2	16,000
	Total				7	93,000	7	93,000	7	93,000

		Unit cost Z$/person	Flow 100m³/d		Flow 500m³/d		Flow 1,000m³/d		Flow 2,000m³/d	
			No.	Cost	No.	Cost	No.	Cost	No.	Cost
Solid Was	S	24,000	0	0	0	0	0	0		
	A	20,000	1	20,000	1	20,000	1	20,000		
	O	15,000	3	45,000	3	45,000	3	45,000		
	F	12,000	1	12,000	2	24,000	2	24,000		
	G	8,000	2	16,000	3	24,000	4	32,000		
	Total		7	93,000	9	113,000	10	121,000		

Note: S: Superintendent
A: Attendant
O: Operator
F: Foreman
G: General Staff

Condition: Including Irrigation pump station is included in WSP,TF.

Table 13.5.4 Estimated STW O & M Cost (Electlicity) by Design Capacity

Electlicity Unit Cost 0.45 Z$

	Item	Flow 1,000m³/d				Flow 2,000m³/d				Flow 5,000m³/d				Flow 10,000m³/d			
		kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH
WSP	Pump	3.7	1	16	21,608	7.5	1	16	43,800	18.5	1	16	108,040	37	1	16	216,080
	Irrigation pump	5.5	1	24	48,180	11	1	24	96,360	30	1	24	262,800	55	1	24	481,800
	Total				69,788				140,160				370,840				697,880
	Total cost				31,405				63,072				166,878				314,046
	Item	Flow 2,500m³/d				Flow 5,000m³/d				Flow 10,000m³/d				Flow 20,000m³/d			
		kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH
TF	Pump	7.5	1	16	43,800	18.5	1	16	108,040	37	1	16	216,080	37	2	16	432,160
	Sludge pump(ST-TT)	1.5	1	6	3,285	1.5	1	6	3,285	1.5	1	6	3,285	1.5	1	6	3,285
	Sludge pump(TT-DB)	1.5	1	6	3,285	1.5	1	6	3,285	1.5	1	6	3,285	1.5	1	6	3,285
	Irrigation pump	15	1	24	131,400	30	1	24	262,800	55	1	24	481,800	110	1	24	963,600
	Total				181,770				377,410				704,450				1,402,330
	Total cost				81,797				169,835				317,003				631,049
	Item	Flow 5,000m³/d				Flow 10,000m³/d				Flow 20,000m³/d				Flow 50,000m³/d			
		kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH
BNR	Pump	18.5	1	16	108,040	37	1	16	216,080	37	2	16	432,160	37	5	16	1,080,400
	Aerator	30	6	24	1,576,800	30	10	24	2,628,000	55	10	24	4,818,000	55	26	24	12,526,800
	Mixer	3.7	4	24	129,648	3.7	4	24	129,648	3.7	4	24	129,648	7.5	6	24	394,200
	RAS	5.5	1	24	48,180	11	1	24	96,360	30	1	24	262,800	30	1	24	262,800
	WAS	2.2	1	6	4,818	2.2	1	6	4,818	3.7	1	6	8,103	5.5	1	6	12,045
	Sludge Pump	2.2	1	6	4,818	2.2	1	6	4,818	3.7	1	6	8,103	5.5	1	6	12,045
	Total				1,872,304				3,079,724				5,658,814				14,288,290
	Total cost				842,537				1,385,876				2,546,466				6,429,731
	Item	Flow 100m³/d				Flow 500m³/d				Flow 1,000m³/d				Flow 2,000m³/d			
		kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH
IWPTF	Pump					3.7	1	8	10,804	11	1	8	32,120	18.5	1	8	54,020
	Total								10,804				32,120				54,020
	Total cost								4,862				14,454				24,309
	Item	Flow 100m³/d				Flow 500m³/d				Flow 1,000m³/d				Flow 2,000m³/d			
		kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH	kW	No.	Hours	kWH
Solid Waste	Pump	2.2	1	8	6,424	3.7	1	8	10,804	11	1	8	32,120				
	Total				6,424				10,804				32,120				
	Total cost				2,891				4,862				14,454				

Note: Conditions: Irrigation pump station is included in WSP,TF.

Table 13.5.5 Estimated STW O & M Cost by Design Capacity

		1,000m³/d	2,000m³/d	5,000m³/d	10,000m³/d	Remarks
WSP	Staff cost	121,000	121,000	266,000	294,000	
	Electricity	31,405	63,072	166,878	314,046	
	Maintenance & Repairs	31,405	63,072	166,878	314,046	Electricity*1.0
	Materials & Chemicals	15,703	31,536	83,439	157,023	Electricity*0.5
	Others	60,500	60,500	133,000	147,000	Staff cost*0.5
	total	260,013	339,180	816,195	1,226,115	
	Administration charge	52,003	67,836	163,239	245,223	total*0.2
	Total cost (Z$)	312,015	407,016	979,434	1,471,338	
	Total cost (US$)	32,844	42,844	103,098	154,878	
		2,500m³/d	5,000m³/d	10,000m³/d	20,000m³/d	Remarks
TF	Staff cost	303,000	331,000	554,000	638,000	
	Electricity	81,797	169,835	317,003	631,049	
	Maintenance & Repairs	81,797	169,835	317,003	631,049	Electricity*1.0
	Materials & Chemicals	40,899	84,918	158,502	315,525	Electricity*0.5
	Others	151,500	165,500	277,000	319,000	Staff cost*0.5
	total	658,993	921,088	1,623,508	2,534,623	
	Administration charge	131,799	184,218	324,702	506,925	total*0.2
	Total cost (Z$)	790,791	1,105,305	1,948,209	3,041,547	
	Total cost (US$)	83,241	116,348	205,075	320,163	
		5,000m³/d	10,000m³/d	20,000m³/d	50,000m³/d	Remarks
BNR	Staff cost	331,000	359,000	662,000	862,000	
	Electricity	842,537	1,385,876	2,546,466	6,429,731	
	Maintenance & Repairs	168,507	277,175	509,293	1,285,946	Electricity*0.2
	Materials & Chemicals	84,254	138,588	254,647	642,973	Electricity*0.1
	Others	165,500	179,500	331,000	431,000	Staff cost*0.5
	total	1,591,798	2,340,139	4,303,406	9,651,650	
	Administration charge	318,360	468,028	860,681	1,930,330	total*0.2
	Total cost (Z$)	1,910,158	2,808,167	5,164,087	11,581,980	
	Total cost (US$)	201,069	295,596	543,588	1,219,156	
		100m³/d	500m³/d	1,000m³/d	2,000m³/d	Remarks
IWPTF	Staff cost		93,000	93,000	93,000	
	Electricity		4,862	14,454	24,309	
	Maintenance & Repairs		4,862	14,454	24,309	Electricity*1.0
	Materials & Chemicals		2,431	7,227	12,155	Electricity*0.5
	Others		46,500	46,500	46,500	Staff cost*0.5
	total		151,655	175,635	200,273	
	Administration charge		30,331	35,127	40,055	total*0.2
	Total cost (Z$)		181,986	210,762	240,327	
	Total cost (US$)		19,156	22,185	25,298	
		100m³/d	500m³/d	1,000m³/d	2,000m³/d	Remarks
Solid Waste	Staff cost	93,000	113,000	121,000		
	Electricity	2,891	4,862	14,454		
	Maintenance & Repairs	2,891	4,862	14,454		Electricity*1.0
	Materials & Chemicals	1,446	2,431	7,227		Electricity*0.5
	Others	46,500	56,500	60,500		Staff cost*0.5
	total	146,728	181,655	217,635		
	Administration charge	29,346	36,331	43,527		total*0.2
	Total cost (Z$)	176,073	217,986	261,162		
	Total cost (US$)	18,534	22,946	27,491		

Conditions: Irrigation pump station is included in WSP,TF.

Table 13.5.6 Summary of O & M Cost for Sewage Treatment Works

Scenario	Authority	Sewage Works	O & M Cost Mill US$/year	Replacement Co Mill US$/year	Total Cost Mill US$/year
Scenario-1	Harare	Crowborough	2.515	2.711	5.226
		Firle	4.169	4.073	8.242
		Marlborough	0.069	0.177	0.246
		Donnybrook	0.121	0.272	0.393
		Total Cost	6.874	7.233	14.107
	Harare Expansion	Harare South	2.025	2.527	4.552
		Harare East	0.947	1.008	1.955
		Total Cost	2.972	3.535	6.507
	Norton	Norton	0.578	1.316	1.894
	Ruwa	Ruwa	0.329	0.842	1.171
	Chitungwiza	Zengeza	1.338	1.396	2.734
		Grand Total (Scenario-1)	12.091	14.322	26.413
Scenario-2	Harare	Crowborough	1.615	1.892	3.507
		Firle	3.726	3.68	7.406
		Marlborough	0.027	0.106	0.133
		Donnybrook	0.113	0.252	0.365
		Total Cost	5.481	5.93	11.411
	Harare Expansion	Harare South	1.223	1.717	2.94
		Harare East	0.947	1.008	1.955
		Total Cost	2.170	2.725	4.895
	Norton	Norton	0.425	1.002	1.427
	Ruwa	Ruwa	0.093	0.342	0.435
	Chitungwiza	Zengeza	2.046	2.013	4.059
		Grand Total (Scenario-2)	10.215	12.012	22.227

Remarks : O & M and Replacement cost at each target year

Scenario-1	2000	0.6	1.139	1.739
	2005	8.281	8.905	17.186
	2015	12.091	14.322	26.413
Scenario-2	2000	0.795	1.292	2.087
	2005	6.527	7.533	14.06
	2015	10.215	12.012	22.227

Table 13 5.7 O & M Cost for Sewage Treatment Works(Scenario-1)

Authority	Sewage Works	Treatment Facility	Target Year	O & M Cost (Mill US$)/ea	Replacement Cost (Mill US$)/ea	Total Cost (Mill US$)/year)	Remarks
Harare	Crowborough	BNR, 94,100m3/d	2005	1 924	1 329	3 253	BNR
		BNR, +30,800m3/	2015	2 410	1 800	4 210	BNR
		Sewer, 6 75km2	2000	0 065	0 066	0 071	TS,CS,FS
		Sewer, +39 31km	2005	0 096	0 786	0 882	TS,CS,FS
		Sewer, +12 78km	2015	0 105	0 911	1 016	TS,CS,FS
		Total Cost		2 515	2 711	5 226	
	Firle	BNR, 176,100m3/	2005	3 167	2 507	5 674	BNR
		BNR, +61,600m3/	2015	4 020	3 419	7 439	BNR
		Sewer, 13 11km2	2000	0 010	0 128	0 138	TS,CS,FS
		Sewer, +12 45km	2005	0 114	0 558	0 672	TS,CS,FS
		Sewer, +6 55km2	2015	0 149	0 654	0 803	TS,CS,FS
		Total Cost		4 169	4 073	8 242	
	Marlborough	WSP, 0	2005	0 000	0 000	0 000	
		WSP,+ 2,800m3/	2015	0 063	0 106	0 169	WSP,FS,FM,S
		Sewer, 7 29km2	2015	0 005	0 071	0 077	TS,CS,PS
		Total Cost		0 069	0 177	0 246	
	Derbybrook	WSP, 2,400m3/d	2005	0 057	0 094	0 151	WSP,FS,FM,S
		WSP, +4,400m3/	2015	0 119	0 249	0 368	WSP,FS,FM,S
		Sewer, 2 36km2	2015	0 002	0 023	0 025	TS,CS,FS
		Total Cost		0 121	0 272	0 393	
Harare Expansion	Harare South	BNR, 63,600m3/d	2005	1.409	0 941	2 350	BNR
		BNR, +28,500m3/	2015	1 891	1 383	3 274	BNR
		Sewer, 27 36km2	2000	0 020	0 267	0 288	TS,CS,PS
		Sewer, +28 63km	2005	0.110	0 835	0 946	TS,CS,PS
		Sewer, +31 51km	2015	0.133	1 143	1 277	TS,CS,FS
		Total Cost		2 025	2 527	4 551	
	Harare East	BNR, 6,300m3/d	2005	0 224	0 130	0 354	BNR
		BNR, +31,300m3/	2015	0 927	0 607	1 534	BNR
		Sewer, 11 10km2	2000	0.068	0 168	0 117	TS,CS,PS
		Sewer, +0km2	2005	0 068	0 199	0 207	TS,CS,PS
		Sewer, +14 76km	2015	0 019	0 401	0 420	TS,CS,PS
		Total Cost		0 947	1 008	1 955	
Norton	Norton	TF, 9,000m3/d	2005	0.186	0 198	0 384	TF,PS,FM,SP
		TF, +28,900m3/d	2015	0.485	0.735	1 220	TF,PS,FM,SP
		Sewer, 2 99km2	2000	0 002	0 029	0.031	TS,CS,PS
		Sewer, +6 56km2	2005	0 033	0 194	0 227	TS,CS,PS
		Sewer, +31 38km	2015	0.093	0 580	0 673	TS,CS,PS
		Total Cost		0 578	1 316	1 893	
Ruwa	Ruwa	WSP, 7,900m3/d	2005	0.132	0 252	0 384	WSP,FS,FM,S
		WSP, +5,200m3/	2015	0.190	0.429	0 618	WSP,PS,FM,S
		Sewer, 7 02km2	2000	0 005	0 069	0 074	TS,CS,PS
		Sewer, +7.57km2	2005	0 137	0 376	0 513	TS,CS,PS
		Sewer, +3 86km2	2015	0.140	0.413	0 553	TS,CS,PS
		Total Cost		0 329	0 842	1 171	
Chitungwi	Zengeza	BNR, 17,100m3/d	2000	0.496	0 292	0 788	BNR
		BNR, +1,200m3/	2005	0 523	0 326	0 849	BNR
		BNR, +31,500m3/	2015	1 160	0 805	1 965	BNR
		Sewer, 1.75km2	2000	0 054	0 180	0 233	TS,CS,PS
		Sewer, +0km2	2005	0 163	0 180	0 342	TS,CS,FS
		Sewer, +20 56km	2015	0 178	0 590	0.768	TS,CS,PS
		Total Cost		1 338	1 396	2 733	
		Grand Total		12 089	14 322	26 410	

Remarks The cost of price escalation and administration is not included

BNR : Biological nutrient Removal Process
TS : Trunk Sewer
CS : Collection Sewer
PS : Pump Station
PM : Pumping Main
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process
SP : Storage Pond

O & M and Replacement Cost at Each Target Year

2000 :	0 600	1 139	1 739
2005 :	8 281	8 905	17 186
2015 :	12 089	14 322	26 410

Table 13 5 8 O & M Cost for Sewage Treatment Works(Scenario-2)

Authority	Sewage Works	Treatment Facility	Target Year	O & M Cost (Mill US$/yea	Replacemen Cost ill US$/yea	Total Cost ill US$/year)	Remarks
Harare	Crowborough	BNR, 38,700m3/d	2005	0 949	0 567	1 516	BNR
		BNR, +31,500m3/	2015	1 524	1 047	2 571	BNR
		Sewer, 6 75km2	2000	0 005	0 066	0 071	TS,CS,FS
		Sewer, +39 31km	2005	0 082	0.720	0 802	TS,CS,FS
		Sewer, +12 78km	2015	0 092	0 815	0 936	TS,CS,FS
		Total Cost		1 615	1 892	3 507	
	Firle	BNR, 133,300m3/	2005	2 538	1 899	4 437	BNR
		BNR, +72,600m3/	2015	3 586	2 964	6 550	BNR
		Sewer, 13 11km2	2000	0 010	0 128	0 138	TS,CS,FS
		Sewer, +12 48km	2005	0 107	0 620	0 727	TS,CS,FS
		Sewer, +6 55km2	2015	0.140	0 716	0 856	TS,CS,FS
		Total Cost		3 726	3 680	7 405	
	Marlborough	WSP, 0	2005	0 000	0 000	0 000	
		WSP, +600m3/d	2015	0 021	0 035	0 056	WSP,FS,FM,S
		Sewer, 7 29km2	2015	0 005	0 071	0 077	TS,CS,FS
		Total Cost		0 027	0 106	0 133	
	Donnybrook	WSP, 2,900m3/d	2005	0 065	0 109	0 174	WSP,FS,FM,S
		WSP, +3,300m3/	2015	0 111	0 229	0 341	WSP,FS,FM,S
		Sewer, 2 35km2	2015	0 002	0 023	0 025	TS,CS,FS
		Total Cost		0 113	0 252	0 365	
Harare Expansion	Harare South	BNR, 47,100m3/d	2005	1 109	0 665	1 775	BNR
		BNR, +300m3/d	2015	1 115	0 676	1 791	BNR
		Sewer, 27 36km2	2000	0 020	0 267	0 288	TS,CS,FS
		Sewer, +28 63km	2005	0 085	0.733	0 818	TS,CS,FS
		Sewer, +31 51km	2015	0 109	1 041	1.150	TS,CS,FS
		Total Cost		1 223	1 717	2 941	
	Harare East	BNR, 6,300m3/d	2005	0 224	0 130	0 354	BNR
		BNR, +31,300m3/	2015	0 927	0 607	1 534	BNR
		Sewer, 11 10km2	2000	0 008	0 108	0 117	TS,CS,FS
		Sewer, +0km2	2005	0 008	0 199	0 207	TS,CS,FS
		Sewer, +14 7km	2015	0 019	0.401	0 420	TS,CS,FS
		Total Cost		0 947	1 008	1 955	
Norton	Norton	TF, 4,200m3/d	2005	0 112	0 119	0 231	TF,FS,FM,SP
		TF, +18,900m3/d	2015	0 349	0.460	0 809	TF,FS,FM,SP
		Sewer, 2 99km2	2000	0 002	0 029	0 031	TS,CS,FS
		Sewer, +6 56km2	2005	0 026	0.175	0 201	TS,CS,FS
		Sewer, +31 38km	2015	0 076	0 543	0 619	TS,CS,FS
		Total Cost		0 425	1.002	1 428	
Ruwa	Ruwa	WSP, 0	2005	0 000	0 000	0 000	WSP,FS,FM,S
		WSP, +400m3/d	2015	0.016	0 028	0 044	WSP,FS,FM,S
		Sewer, 7 02km2	2000	0 005	0 069	0 074	TS,CS,FS
		Sewer, +7 57km2	2005	0.074	0 277	0 351	TS,CS,FS
		Sewer, +3 86km2	2015	0 077	0 315	0 392	TS,CS,FS
		Total Cost		0 093	0 342	0 436	
Chitungwi	Zengeza	BNR, 25,100m3/d	2000	0 672	0 399	1 071	BNR
		BNR, +12,600m3/	2005	0 929	0 627	1 556	BNR
		BNR, +49,600m3/	2015	1 812	1 321	3 133	BNR
		Sewer, 1 75km2	2000	0 071	0 226	0 297	TS,CS,FS
		Sewer, +0km2	2005	0 218	0 693	0 911	TS,CS,FS
		Sewer, +20 56km	2015	0 233	0 693	0 926	TS,CS,FS
		Total Cost		2 046	2 013	4 059	
		Grand Total		10 215	12 013	22 228	

Remarks The cost of price escalation and administration is not included

BNR : Biological nutrient Removal Process
TS : Trunk Sewer
CS : Collection Sewer
FS : Pump Station
FM : Pumping Main
WSP : Wastewater Stabilization Pond
TF : Trickling Filter Process
SP : Storage Pond

O & M and Replacement Cost at Each Target Year

2000 :	0 795	1 292	2 087
2005 :	6 527	7 533	14 059
2015 :	10 215	12 013	22 228

CHAPTER 3

Study of Priority Project

CHAPTER 3 STUDY OF PRIORITY PROJECT

1. General

Periodic blooms of blue-green algae were observed in Lake Chivero from 1960 onwards. This problem was related to eutrophication (nutrient enrichment) caused by the discharge of nitrogen and phosphorus-rich wastewater/treated sewage effluent from urbanised area into the lake that was beyond its natural assimilation capacity. During the 1970s large numbers of fish were killed on several occasions. This was mainly attributed to the depletion of dissolved oxygen in parts of the lake. In addition, a massive build-up of water hyacinth was experienced and was subsequently controlled to an acceptable level through the intensive and careful spraying of the weeds with selective herbicides.

Harare (previously named Salisbury) acquired large areas of farm land for the disposal of irrigation of the treated sewage effluent, which was allowed to flow into the lake before the time. About 70% of the average dry weather flow of the effluent in the study area was pumped for irrigation in 1975. During the period, a tertiary treatment process was partially employed at sewage treatment plants to discharge effluent into rivers. Subsequently, the water quality of the lake improved greatly in the 1980s, but fell again in the 1990s.

In recent years, the water pollution in Lake Chivero, the major water source for the Harare metropolitan area, has been receiving attention in order to obtain better watershed management in the Upper Manyame River Basin. As demonstrated by the fact that thousands of fish died and that water hyacinth covered a wide area of the lake during March 1996, urgent countermeasures are expected to the pollution sources relevant to domestic sewage treatment and, industrial, farming and other possible activities that discharge nutrients. Furthermore, based on the experience of the lake's failure to provide enough water to operate the spillways of its associated dam for the past nine years, the importance of ensuring fresh water flow into the lake was realised; especially in terms of water recycling, effluent discharge and the control of rain water in the basin.

2. Previous Studies and Political Measures on Water Pollution Control

The eutrophication problem of Lake Chivero was recognised and the identified cause was the discharge of well-treated, but still nutritious sewage effluent. Accordingly, a number of

committees and similar bodies were established and tasked with finding solutions to the problem.

(1) Water Pollution Committee (established by the Ministry of Water Development in 1964)

This committee was mandated to investigate the problem, consult with all interested bodies and to recommend appropriate action and amending legislation. The committee recommended principles in legislating for and administering a water pollution control system. These were the basis of the Water Amendment Act No.7/1979, which put new sections on water pollution control into the Water Act. The following are its major recommendations.

1) "Pollution" should be defined clearly and precisely, but also comprehensively.
2) The relevant legislation should be under one act, the Water Act.
3) The legislation should provide for pollution control by effluent standards prescribed by regulations issued in terms of the Water Act, and not in the Water Act itself.
4) The legislation should provide for exemptions and relaxation where appropriate.
5) There should be penalties for all infringements of the Water Act's regulations and for continuing offences.
6) The prescribed standards should relate to the effluent discharge and not to the receiving water and should be based on a high standard of purity.
7) The prescribed standards and methods of sampling and testing should be framed in conjunction with the Standards Association of Central Africa, SACA, (now Standards Association of Zimbabwe, SAZ)
8) The Ministry of Water Development should be the responsible Ministry, and a Technical Advisory Board should be established to advise the Minister.

(2) Upper Hunyani (Manyame) River Pollution Committee (set-up in 1969 comprising representatives from Ministries of Health, Water Development and Works, Harare, Municipality, University of Zimbabwe and the Natural Resources Board)

The committee commissioned an investigation on the eutrophication of Lake Chivero and the pollution in the upper Manyame River, which was undertaken by the University of Zimbabwe and jointly funded by the City of Salisbury and Ministry of Water Development. This research identified treated sewage effluent as the major source of eutrophication. In accordance with the study's result, the City of Harare purchased four farms to divert its treated effluent to irrigation for recovery of the lake.

(3) Working party on the Reuse of Treated Sewage Effluent (set-up in 1968 by the Natural Resources Board (NRB))

This group was mandated to examine and recommend to the Government on the requirements for the use and reuse of treated sewage effluents with particular reference to:

1) the need for making best use of wastewater,
2) the forms such use could take,
3) the requirements of standards and control for the use and the reuse of effluent,
4) publicity needs to encourage best use of effluent, and
5) the need and nature, in outline only, of legislation that might be required to give effect to matters recommended upon.

The party concluded that the maximum reuse of water was essential, because although population expands in time, water availability is a closed cycle. In this connection, the reuse of treated sewage effluent to supplement urban water supply is current policy (DWD, 1993). However, at the study time, the party only recommended that any potable water produced from sewage effluent should meet WHO Drinking Water Quality Standards, since economical technology was not yet proven to produce sewage effluent suitable for potable reuse.

The party's efforts were concentrated on the reuse of effluent for agricultural and amenity irrigation. The quality guidelines recommended were subsequently reflected in the Public Health (Effluent) Regulations, 1970. Since irrigation with sewage effluent was employed largely as a countermeasure of water pollution control, the Regulations are also related to this field.

(4) Standards Association of Zimbabwe Technical Committee on Water Pollution Control (established by SACA upon Request from MWD)

The committee was mandated to draft a standard for waste or effluent water and produced Central African Standard in 1972 consisting of quality standards for effluents and methods of analysis. The proposed standards were incorporated in the Water (Effluent and Wastewater) Regulations, 1977. The review of the Regulations with reference to relaxing an excessively strict ammonia standard is taking place in parallel with the current review of the Water Act.

The quality standards in water pollution control regulations apply uniformly nation-wide with two zones (blanket standards); Zone I covering mountain streams of high purity and Zone II for the reminder of the country). It seems to be early for the country to implement effective standards based on receiving water quality standards.

(5) The Water Pollution Advisory Board

A board to advise the Ministry of Water Development concerning water pollution was recommended by the Water Pollution Committee in 1970. The Board comprises representatives of almost all concerned agencies, local governments and relevant associations. The Board meets once every three months, and is chaired by the DWD's Senior Water Pollution Control Officer. Water pollution is defined as covering both nuisance and human health aspects and all animal life.

The Water Pollution Control Section of DWD conducts investigations and takes whatever action is necessary, usually after bringing the matter to WPAB for their comments. Prosecutions were applied only as a last resort and were conducted only if the polluter proves intransigent.

3. Definition of Priority Projects

All efforts were exerted by the Government of Zimbabwe for more than last two decades to preserve the water resources, especially for Lake Chivero in the upper Manyame River basin. However, water pollution of the rivers and lakes/dams has been considerable in recent years due to rapid urbanisation and industrialisation, as well as some other reasons including agricultural chemicals and solid wastes. Under this situation, timely and adequate countermeasures focusing on the eutrophication of the water body are requisites based on an on-going comprehensive basin plan of water pollution control. In this connection, staged improvement with priority projects should be designed considering all concerned factors; technical, cost-effectiveness, financial soundness, environmental improvements, and institutional and social acceptability.

The target year for the urgent project is assumed to be the year 2000. Water pollution sources in the study basin in terms of discharge of pollution load into water bodies are identified as follows:

- treated sewage effluent from sewage treatment plants and raw sewage overflowing from deteriorated sewers
- partially treated industrial wastewater
- other pollution loads caused by livestock, farm land, solid waste disposal, street refuse and flora and fauna

Among these water pollution sources, the rehabilitation and expansion of the existing sewage works are recommended as potential urgent projects including the institutional strengthening, if necessary; these projects are justifiable under the following reasons:

(1) Contribution to the water pollution of the study basin

Domestic and industrial wastewater was identified as a major pollution source in the previous studies conducted in the country and through the review of particulars on water pollution and field confirmation by the Study team.

Sewerage services are provided for more than 60% of the people in the urban areas and industrial wastewater is, in principle, received by the sewers. In this regard, the run-off ratio of generated pollution loads derived from these pollution sources to the sewage treatment plants is high, while those of other pollution sources into the water ways are considerably lower due to no concentration of massive loads and existence of poor stream networks to connect to the main river.

(2) Cost-effectiveness

Investment can be done focusing on the specific sites/areas for the sewage treatment plants/sewered area, while other pollution sources are scattered making countermeasures costly. Furthermore, rehabilitation/expansion of existing sewage treatment plants in full use of existing facilities are more cost-effective than the construction of new sewerage systems.

(3) Pollution control measures by public works

The reinforcement of laws and regulations and the strengthening of concerned institutions are requisites, however, these should be implemented steadily and progressively to meet socio-economic conditions and government policy. It is also important to accelerate

the required countermeasures in the private sector, but, it seems to take much more time under the current socio-economic conditions. The provision of public sewerage services to ensure both water pollution control and sanitation improvement meets a basic need of human life and is being practised in the country through the application of the governmental budget.

(4) Technical experience in sewage works

The local government authorities have a great deal of experience in the operation of sewage works. Due to the insufficient treatment capacity of the existing secondary treatment facilities at most sewage works, improvements should be worked out. However, tertiary treatment for the removal of nutritious substances has been practised with well-treated effluent quality.

(5) Institutional and financial capability of concerned authorities

With reference to the sewerage project implementation, the concerned authorities have been managing with the assistance of local consultants. A continuous arrangement for financial needs, even if it was not sufficient, has been made by local governments to expand sewerage systems supported by National Government agencies.

(6) Social acceptance on the sewerage projects

The collection of sewerage charges from users is practised by all concerned sewage works. The need for sewage works and the responsibility of users are seen as a basic infrastructure in the urban area.

4. Selection of Priority Projects

4.1 Conditions for Selection of Priority Projects

Potential projects shall be selected among the existing sewage works. Physical development may be primarily considered and the strengthening of the relevant institutions in connection with the selected project(s) shall be included, as required. The current institutional arrangements by concerned local governments in the sewerage sector are almost on the same level requiring some improvements. In view of the urgent projects, a combined development of

physical and institutional components for the selected project(s) is advantageous not only with regards to the financial limitations to cover all requirements but also as a favourable model for the future reinforcement of the sewerage sector.

A comparative study among the potential sewerage projects shall be made evaluating the current conditions in terms of technical, environmental improvements, economical and financial aspects, and the implementing capacity of the concerned authorities and the sustainability of the project. The technical aspect will cover two major components: water pollution control (quality) and the reuse of treated efficient (quantity).

4.2 Reuse of Treated Effluent

(1) Reuse for potable purpose

The study area lies in the semi-arid tropics and the water resources available are therefore limited. Nevertheless, the population increase and the economic development expected in the future will require an increasing demand for water, which lead to the increased reuse of water. Recently, high-quality sewage effluent is discharged from the Firle and Crowborough Sewage Works after the application of a tertiary treatment method. This deliberate policy was employed to increase the yield of the upper Manyame River system supplemented by treated effluent from sewage works. It was reported that the effluent from sewage works contributed to the water supply by as much as 25% during the droughts of 1983 and 1984. At the present time, water intake from Lake Chivero at the Morton Jaffray WTW is more than 50% above the amount during the above drought period. In this light, the discharge of well-treated sewage effluent will become more important to replenish the water source with at least 30% of the water supply amount to make it available during the dry season, as well as for the preservation of the water environment along the upper Manyame River.

(2) Reuse for irrigation purpose

The Government of Zimbabwe introduced strict standards for nutrients and other contaminants discharged to water courses. Local authorities concerned had to switch to the disposal of treated sewage effluent for irrigation, unless their circumstances were such that they could obtain exemption from the standards according to the Public Health (Effluent) Regulations, 1972. Treated effluent reuse was intended to protect water