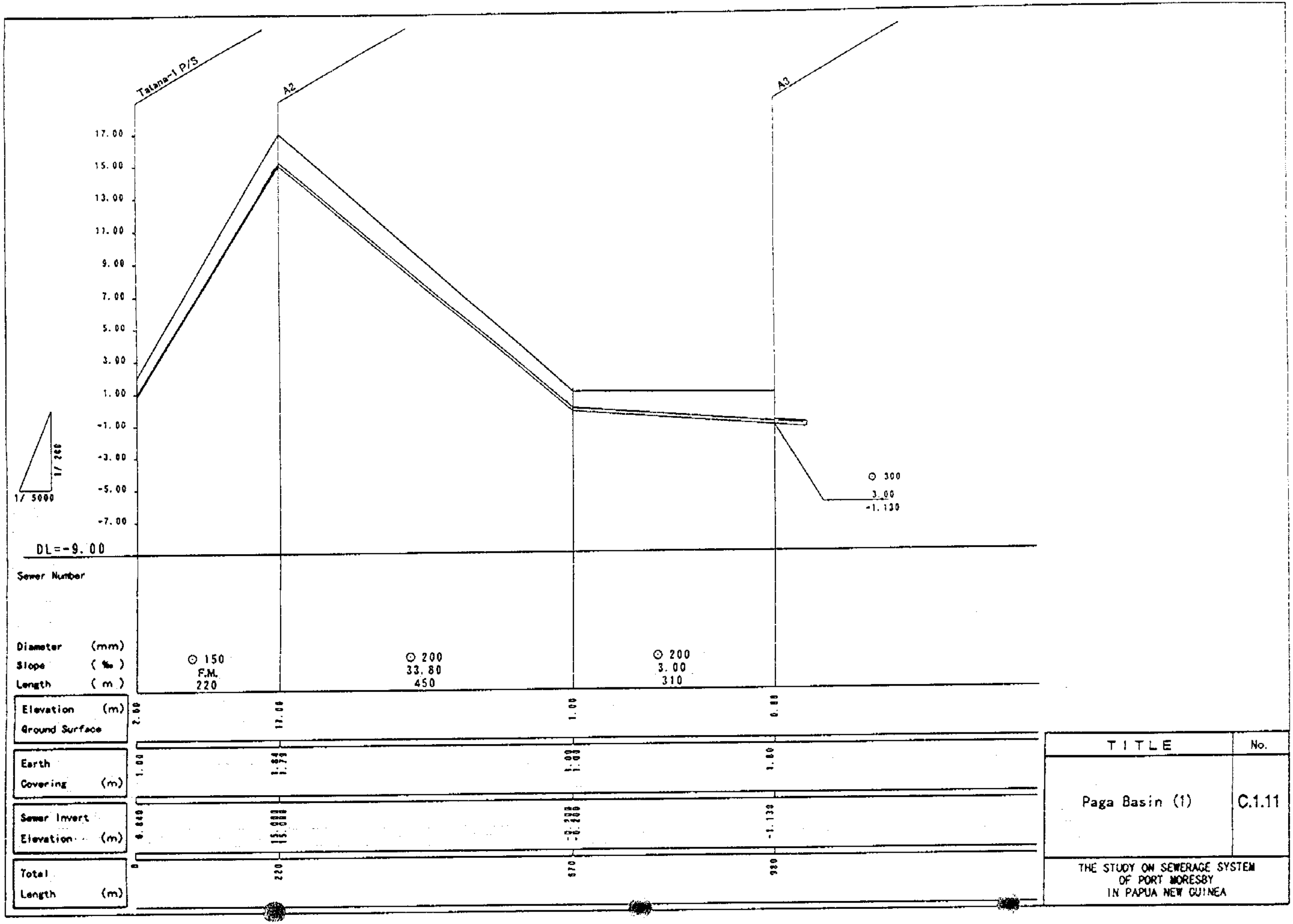
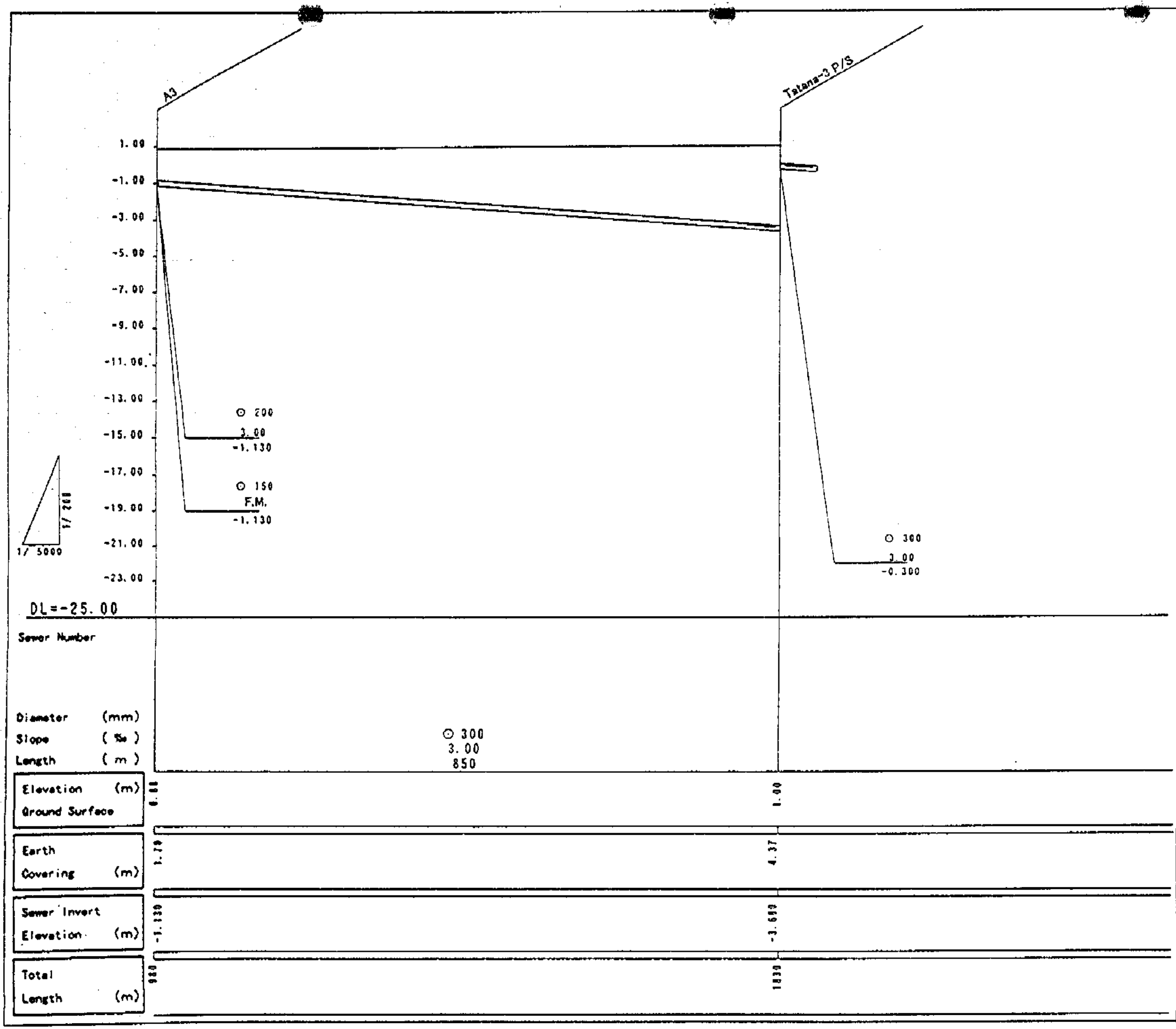
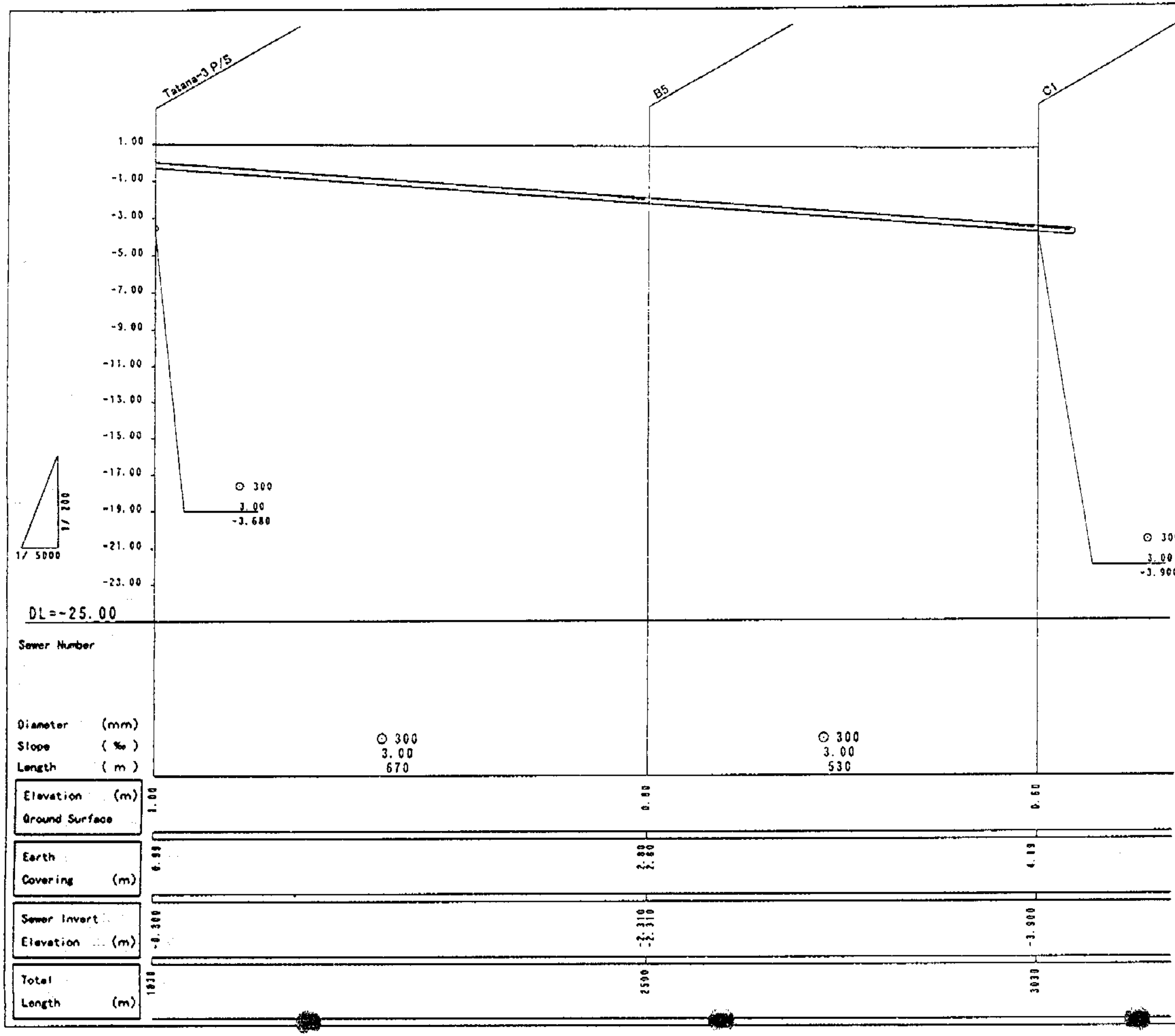

Tatana-1 P/S
A2
A3
17.00
15.00
13.00
11.00
9.00
7.00
5.00
3.00
1.00
-1.00
-3.00
-5.00
-7.00
1/200
1/5000
DL=-9.00
⊙ 300
3.00
-1.130
Sewer Number
Diameter (mm)
Slope (‰)
Length (m)
⊙ 150
F.M.
220
⊙ 200
33.80
450
⊙ 200
3.00
310
Elevation (m)
Ground Surface
Earth
Covering (m)
Sewer Invert
Elevation (m)
Total
Length (m)
TITLE
No.
Paga Basin (1)
C.1.11
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA



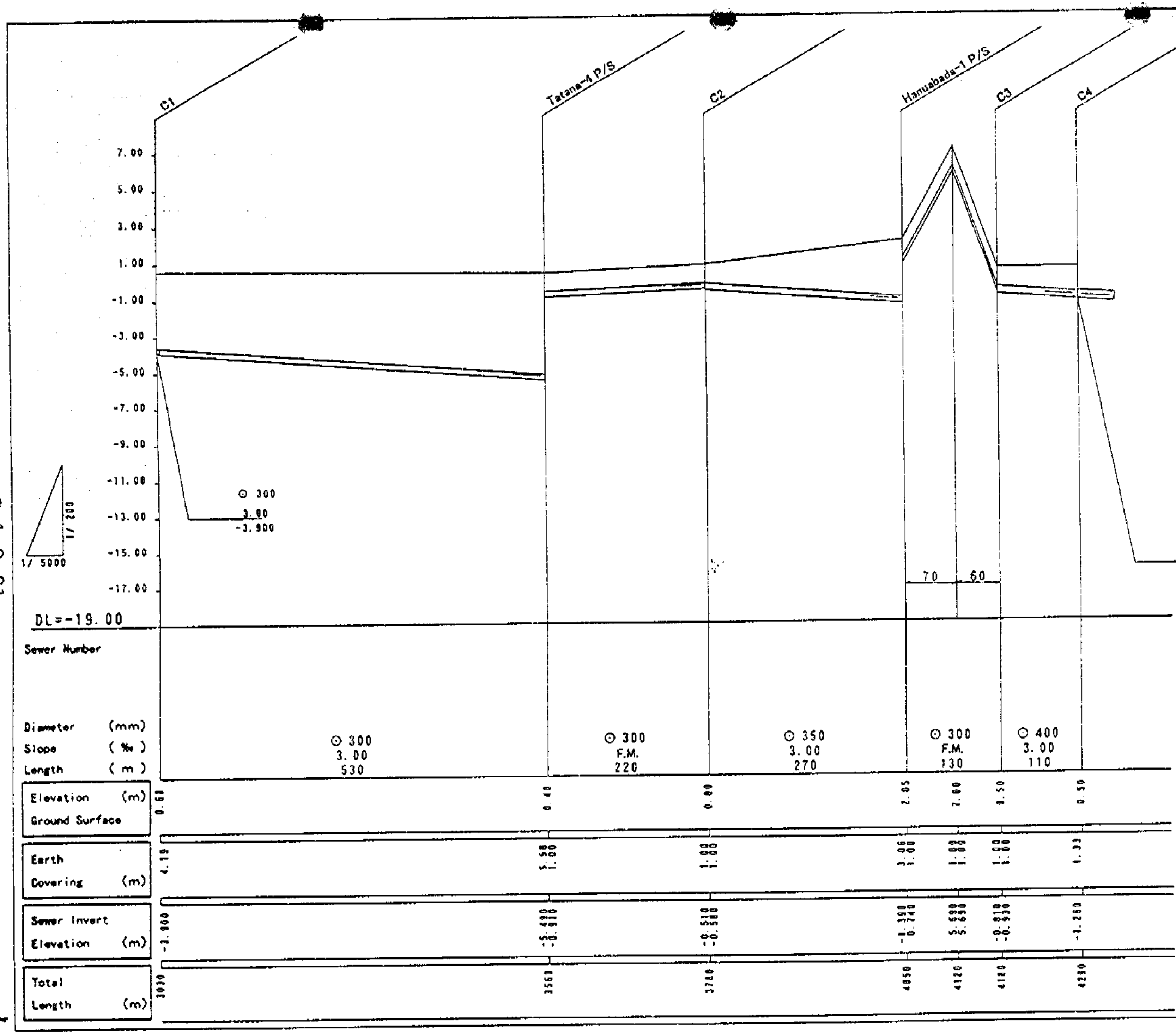
TITLE	No.
Paga Basin (2)	C.1.12
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	

2



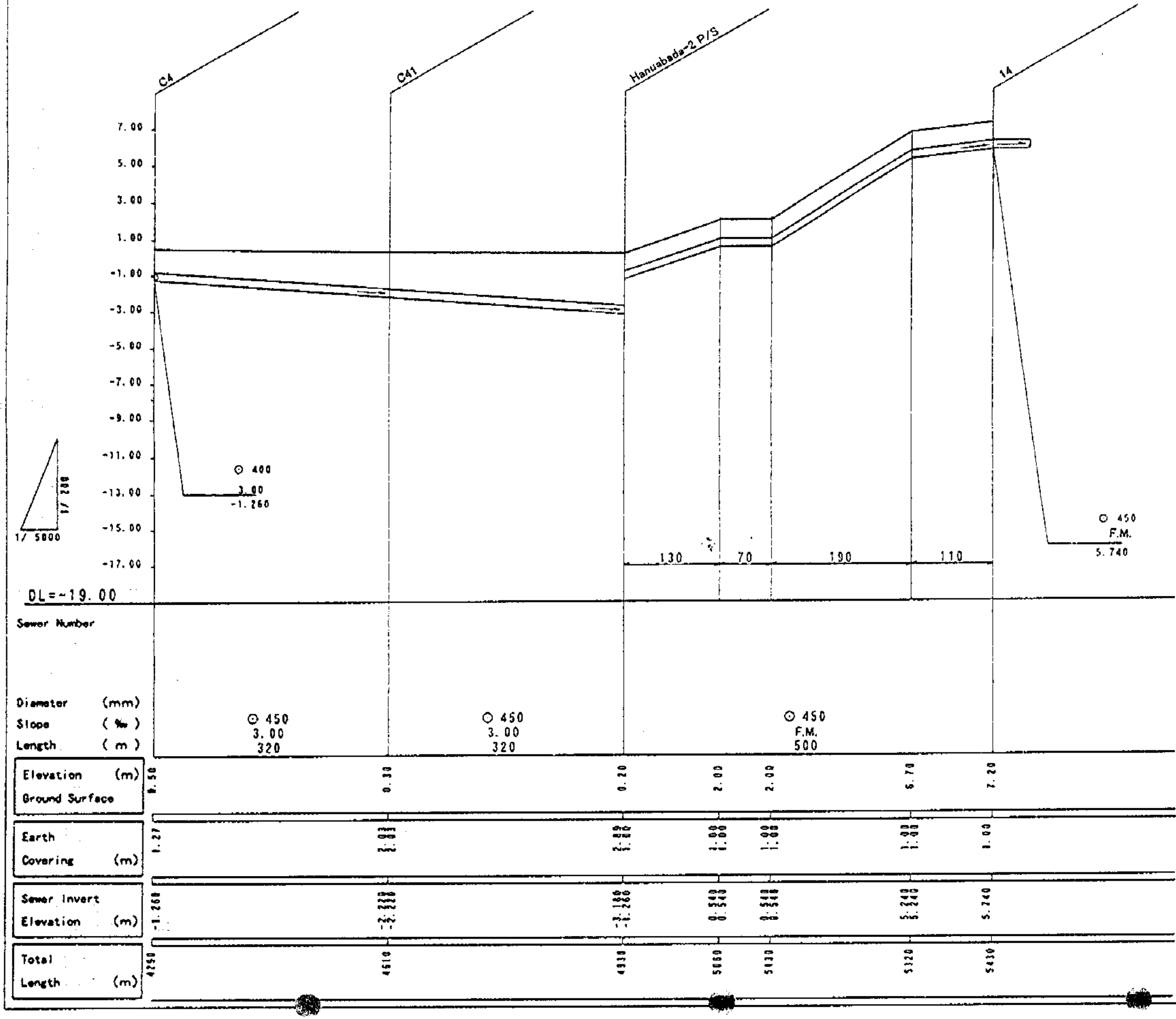
TITLE	No.
Paga Basin (3)	C.1.13

THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA



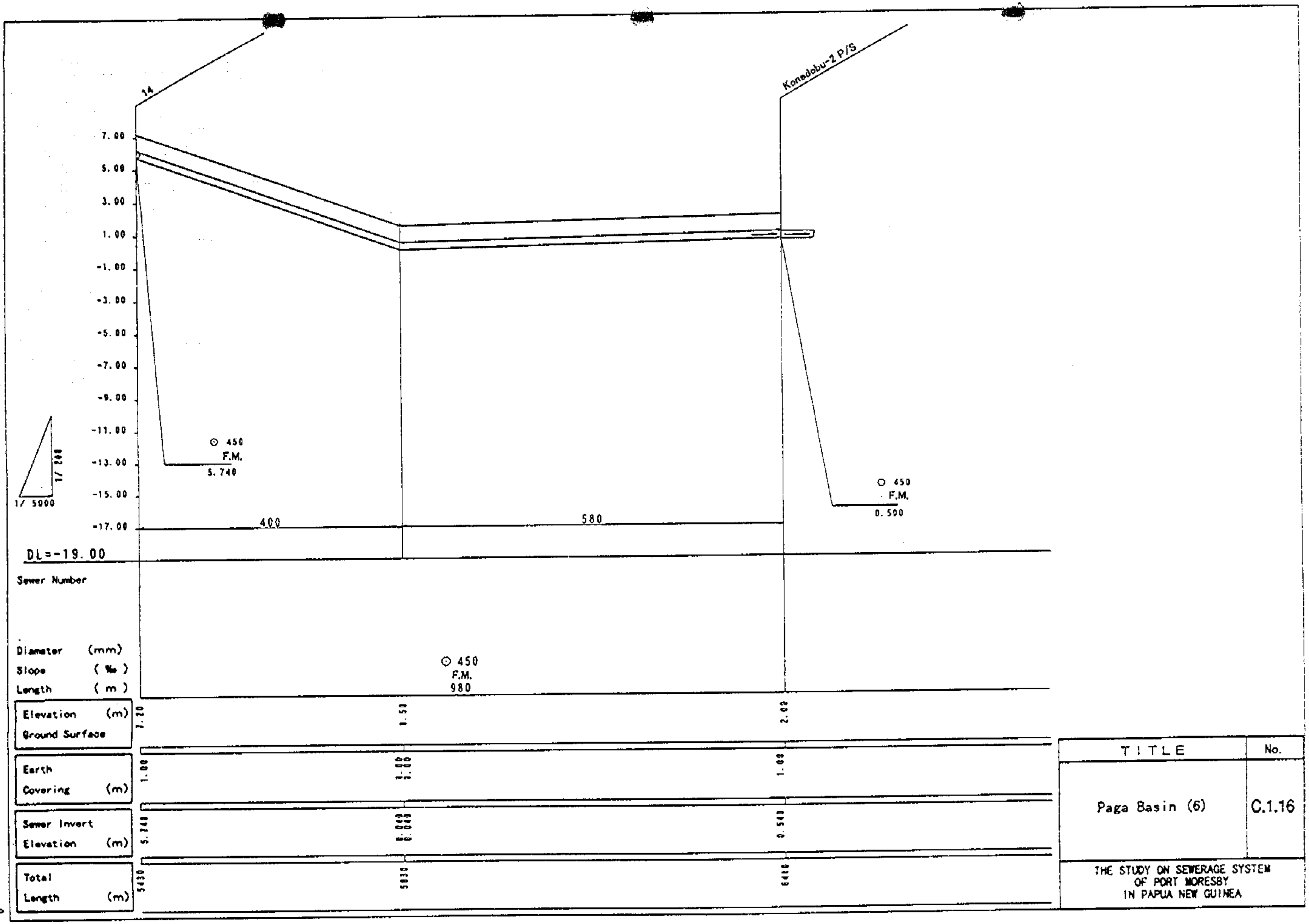
TITLE	No.
Paga Basin (4)	C.1.14

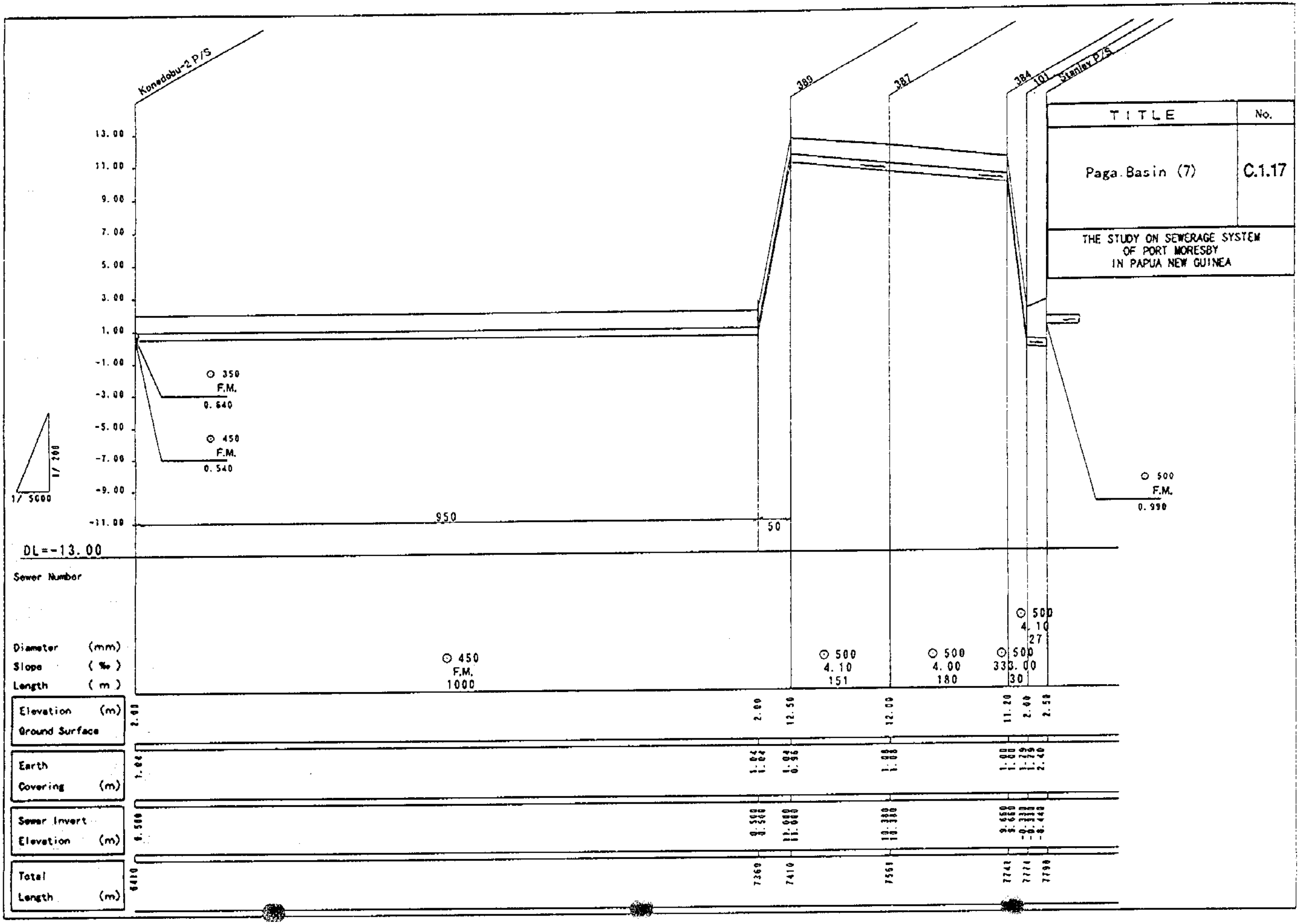
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA



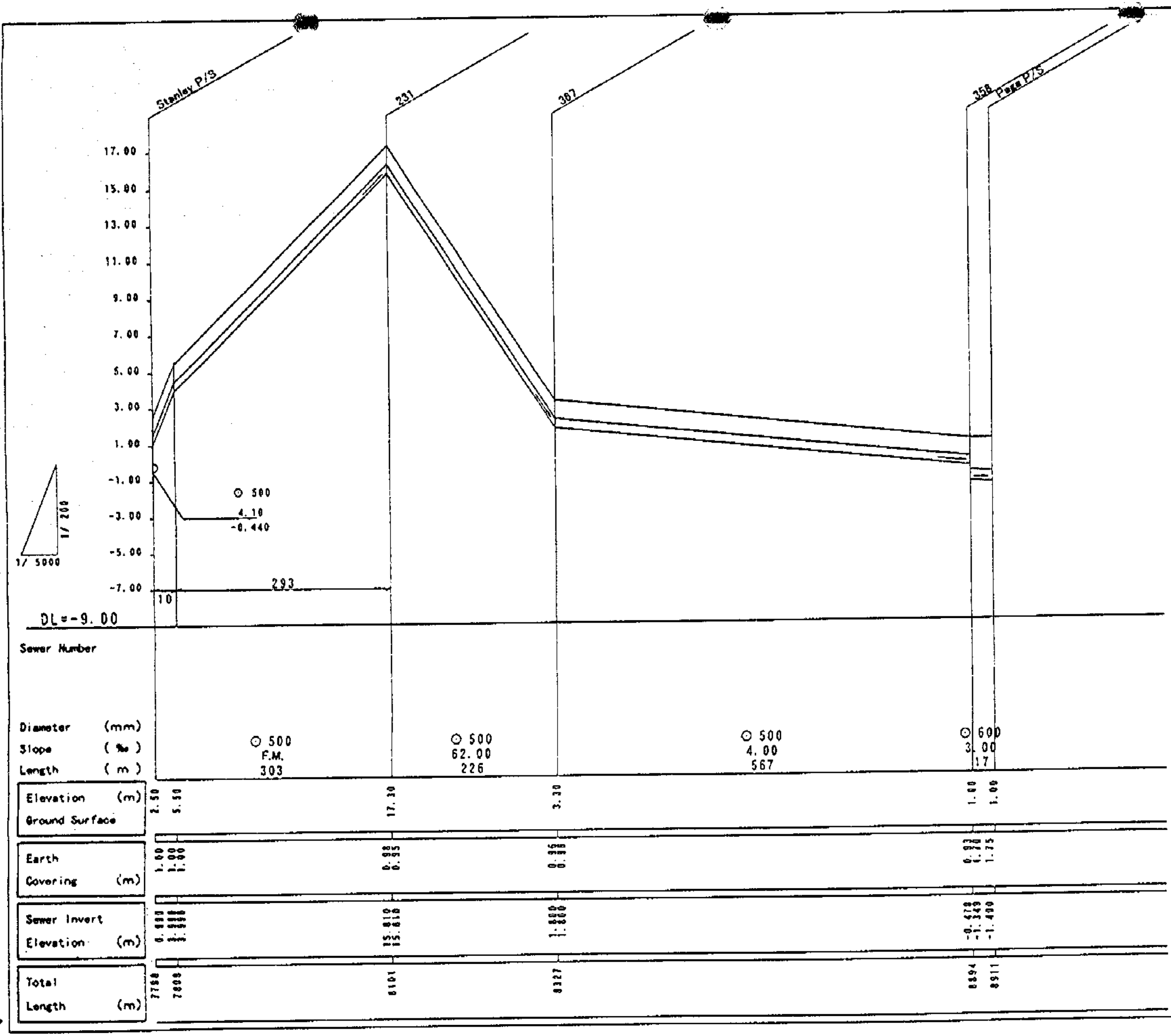
TITLE	No.
Paga Basin (5)	C.1.15

THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA


14
Konedobu-2 P/S
7.00
5.00
3.00
1.00
-1.00
-3.00
-5.00
-7.00
-9.00
-11.00
-13.00
-15.00
-17.00
1/ 200
1/ 5000
⊙ 450
F.M.
5.740
⊙ 450
F.M.
0.500
400
580
DL=-19.00
Sewer Number
Diameter (mm)
Slope (‰)
Length (m)
⊙ 450
F.M.
980
Elevation (m)
Ground Surface
7.20
1.50
2.00
Earth
Covering (m)
1.00
1.00
1.00
Sewer Invert
Elevation (m)
5.740
0.040
0.540
Total
Length (m)
5430
5830
6410
TITLE
No.
Paga Basin (6)
C.1.16
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA

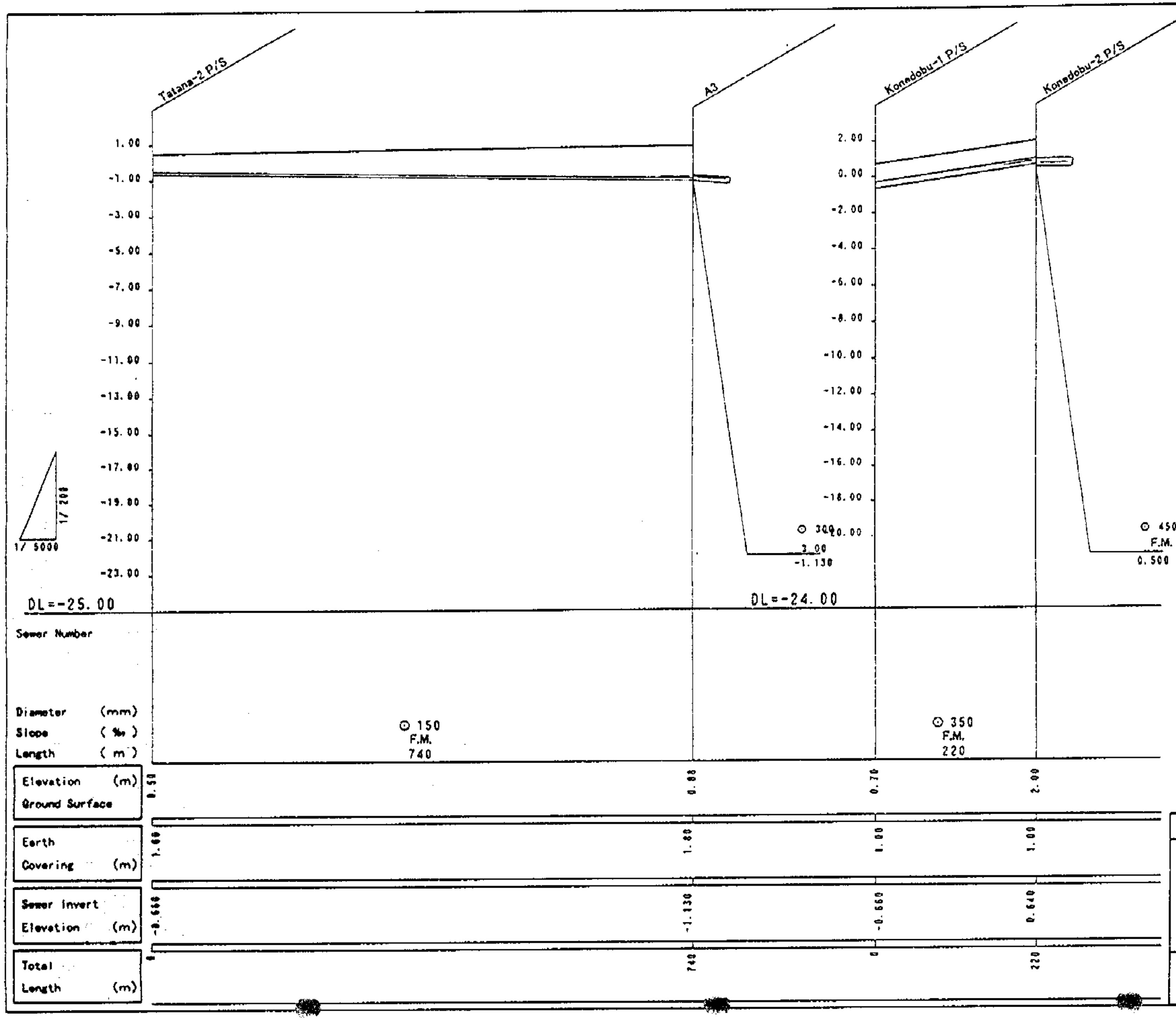


TITLE
No.
Paga Basin (7)
C.1.17
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA
Konedobu-2 P/S
389
387
384
101
Stanley P/S
1/200
1/5000
DL=-13.00
Sewer Number
Diameter (mm)
Slope (‰)
Length (m)
Elevation Ground Surface (m)
Earth Covering (m)
Sewer Invert Elevation (m)
Total Length (m)
⊙ 350 F.M. 0.640
⊙ 450 F.M. 0.540
⊙ 500 F.M. 0.990
⊙ 450 F.M. 1000
⊙ 500 4.10 151
⊙ 500 4.00 180
⊙ 500 33.00 30
⊙ 500 4.10 27
950
50



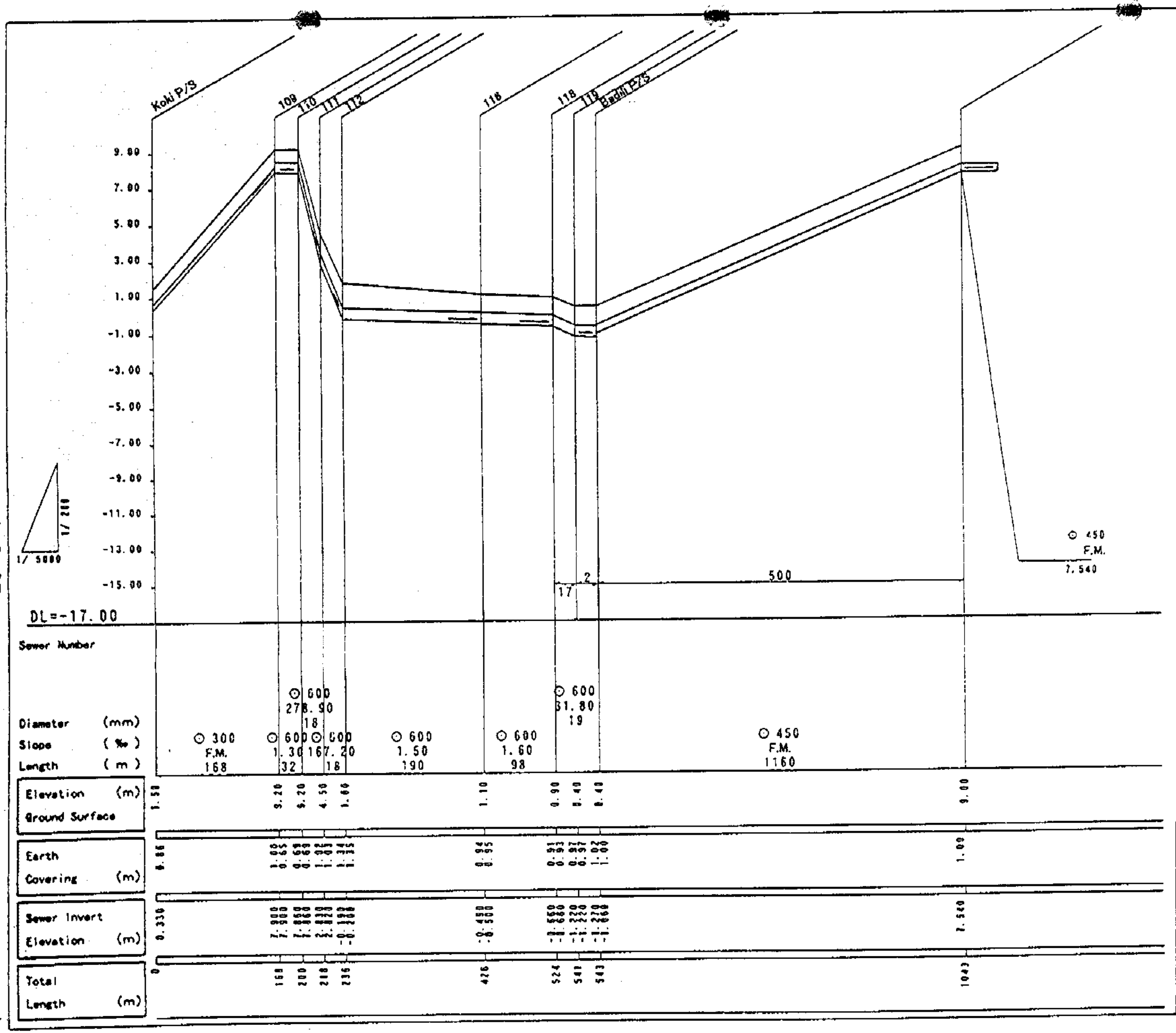
TITLE	No.
Paga Basin (8)	C.1.18

THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA



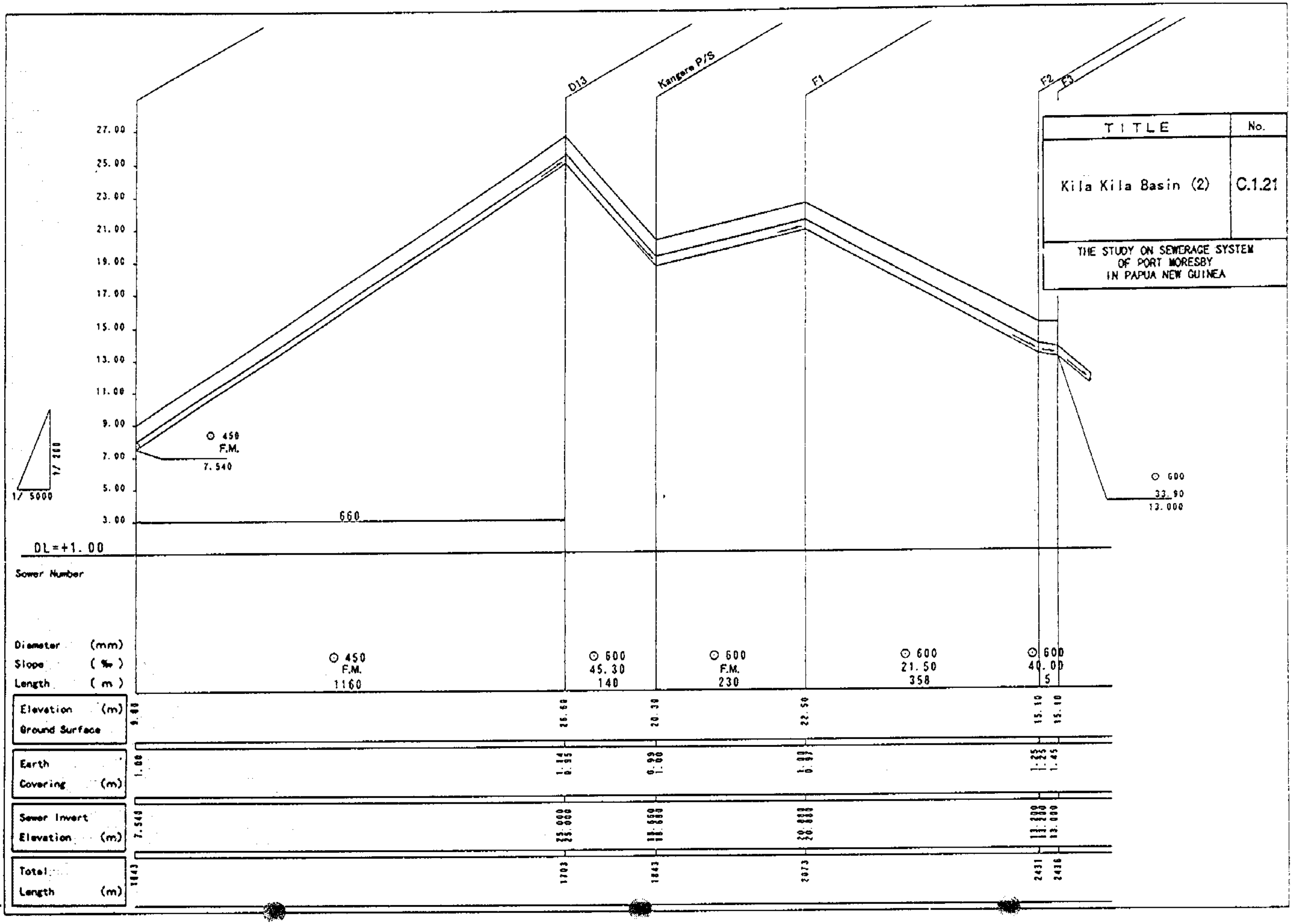
TITLE	No.
Paga Basin (9)	C.1.19

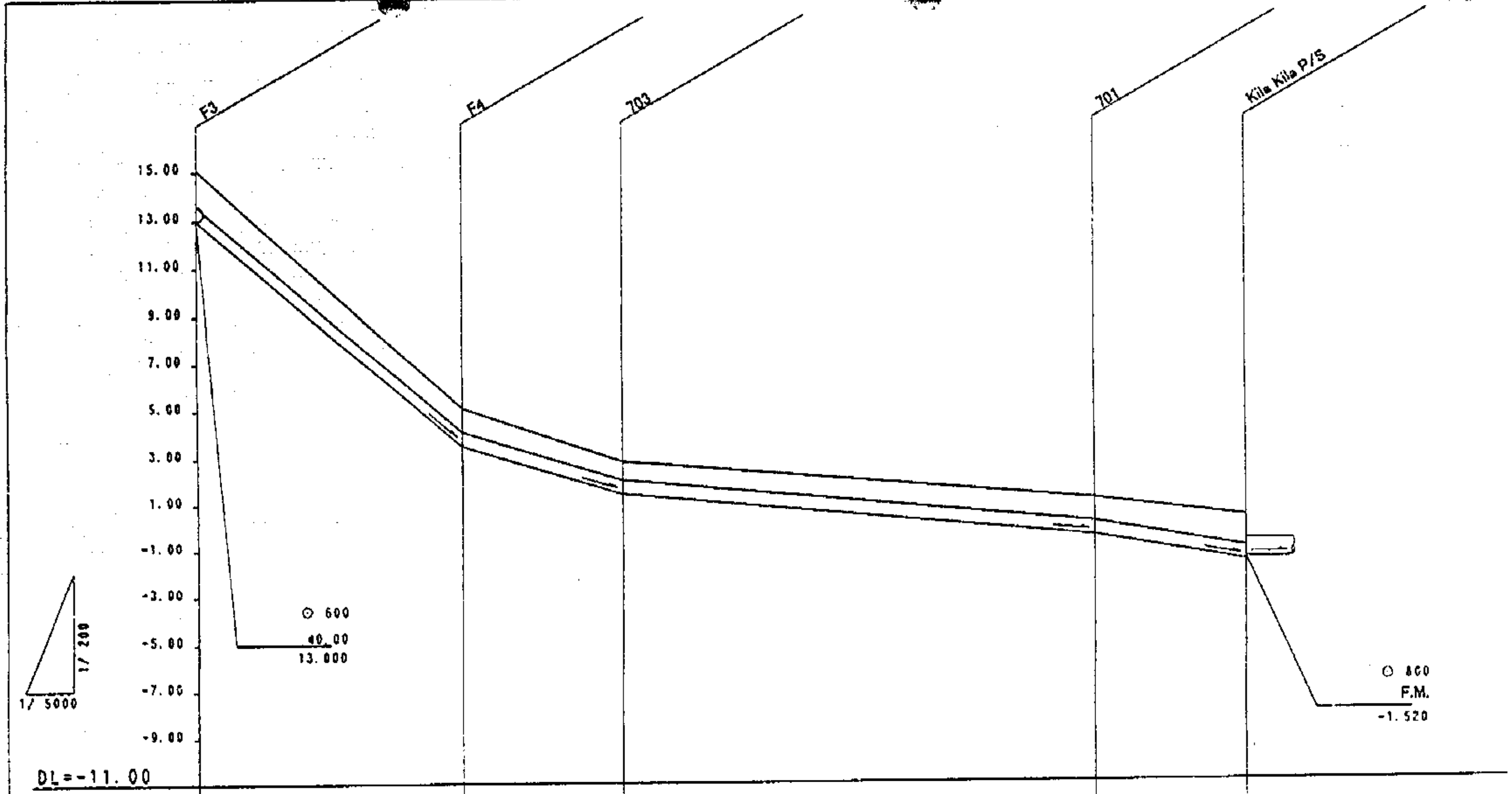
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA



TITLE	No.
Kila Kila Basin (1)	C.1.20

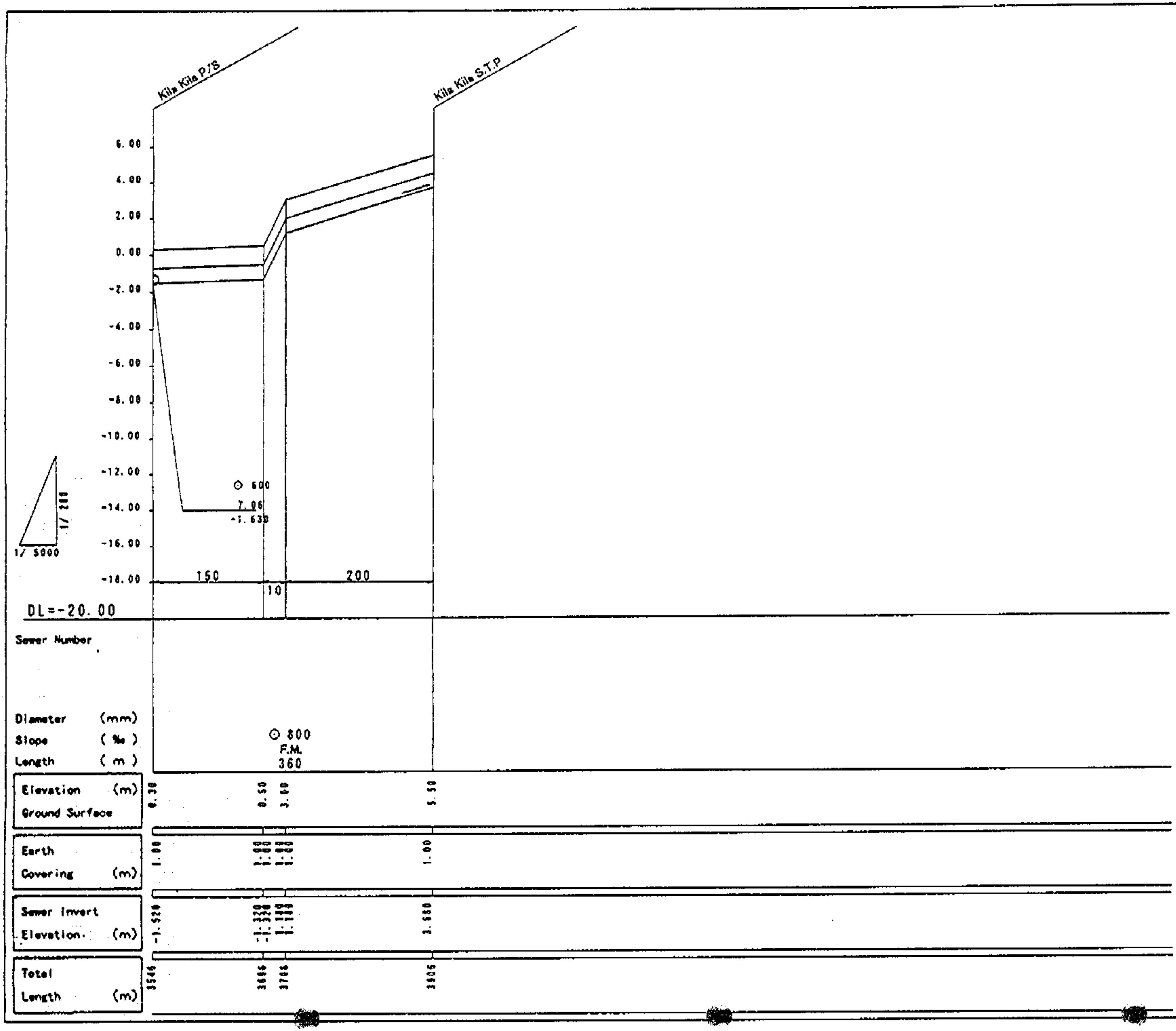
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA


TITLE
No.
Kila Kila Basin (2)
C.1.21
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA
D13
Kangere P/S
F1
F2
F3
27.00
25.00
23.00
21.00
19.00
17.00
15.00
13.00
11.00
9.00
7.00
5.00
3.00
1/ 200
1/ 5000
⊙ 450
F.M.
7.540
660
⊙ 600
33.90
13.000
DL=+1.00
Sewer Number
Diameter (mm)
Slope (‰)
Length (m)
⊙ 450
F.M.
1160
⊙ 600
45.30
140
⊙ 600
F.M.
230
⊙ 600
21.50
358
⊙ 600
40.00
5
Elevation (m)
Ground Surface
26.60
20.30
22.50
15.10
15.10
Earth
Covering (m)
1.00
Sewer Invert
Elevation (m)
7.540
Total
Length (m)
1703
1843
2073
2431
2436



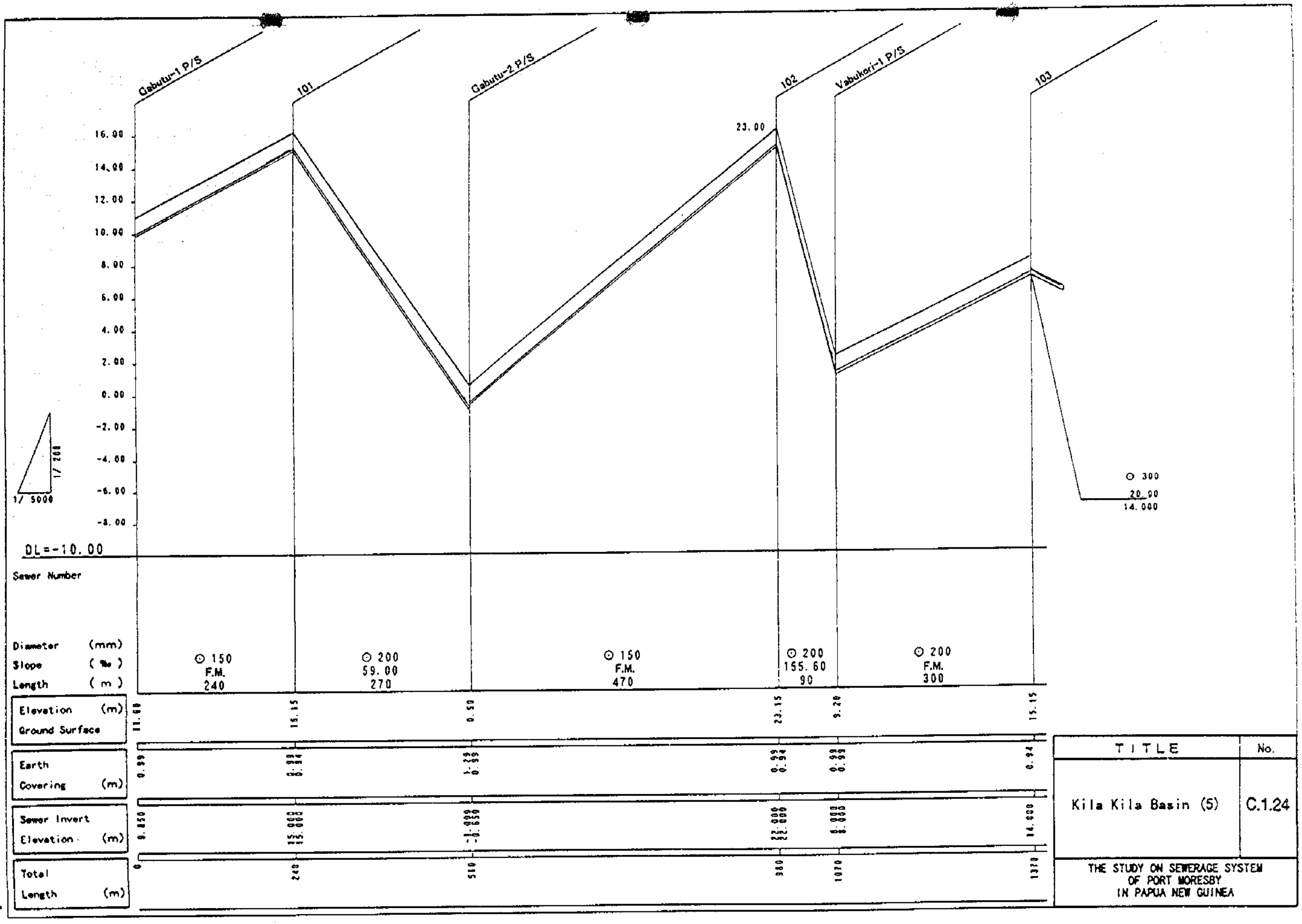
Sewer Number	F3		F4		703		701		Kila Kila P/S
Diameter (mm)		⊙ 600		⊙ 600		⊙ 600		⊙ 600	
Slope (‰)		33.90		12.35		3.80		7.06	
Length (m)		280		170		500		160	
Elevation Ground Surface (m)	15.10		5.10		2.80		1.10		0.30
Earth Covering (m)	1.45		0.93 0.95		0.75 0.75		0.95 0.95		1.20
Sewer Invert Elevation (m)	13.000		3.500 3.500		1.400 1.400		-0.500 -0.500		-1.630
Total Length (m)	2436		2716		2886		3386		3546

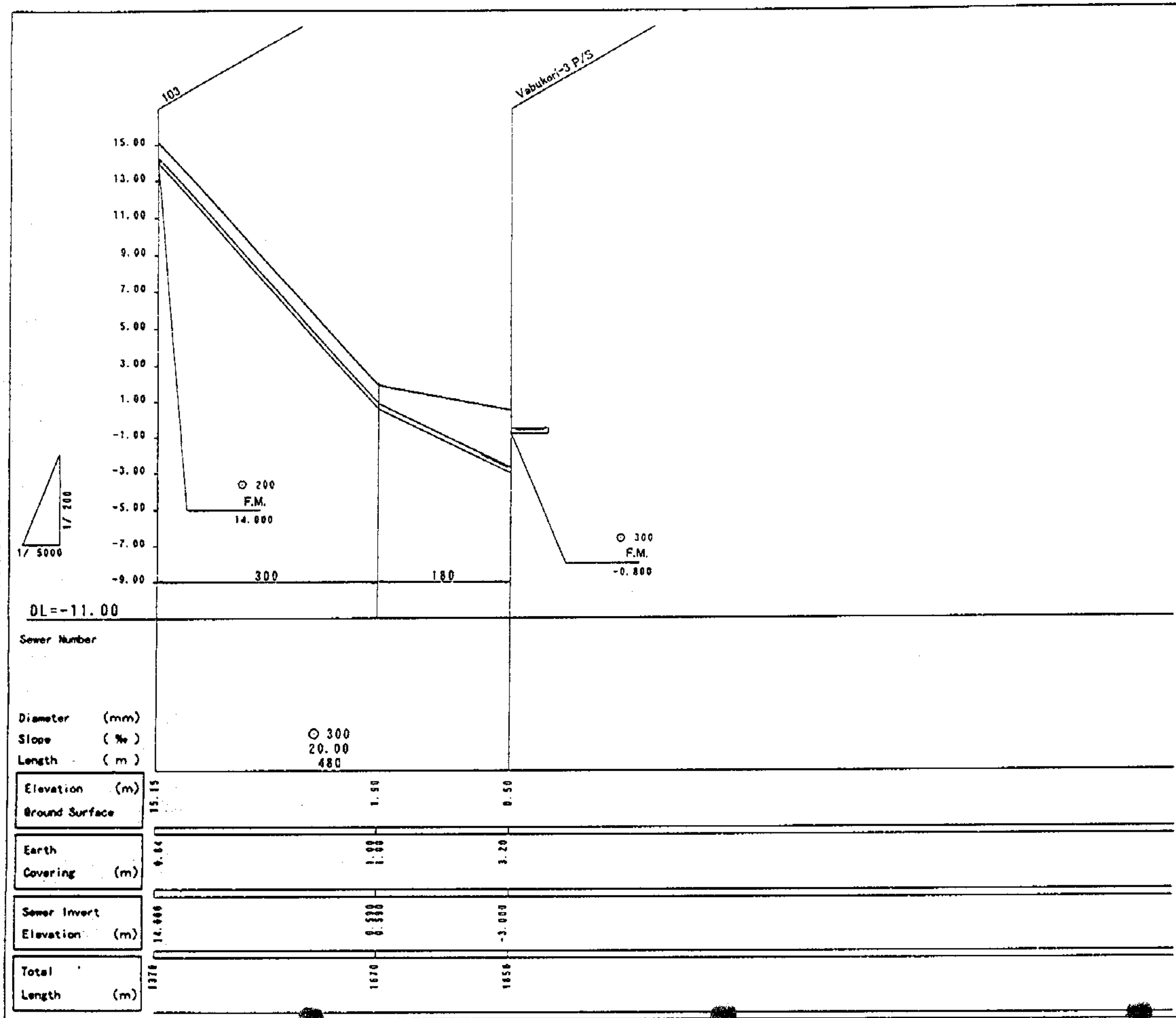
TITLE	No.
Kila Kila Basin (3)	C.1.22
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	



TITLE	No.
Kila Kila Basin (4)	C.1.23

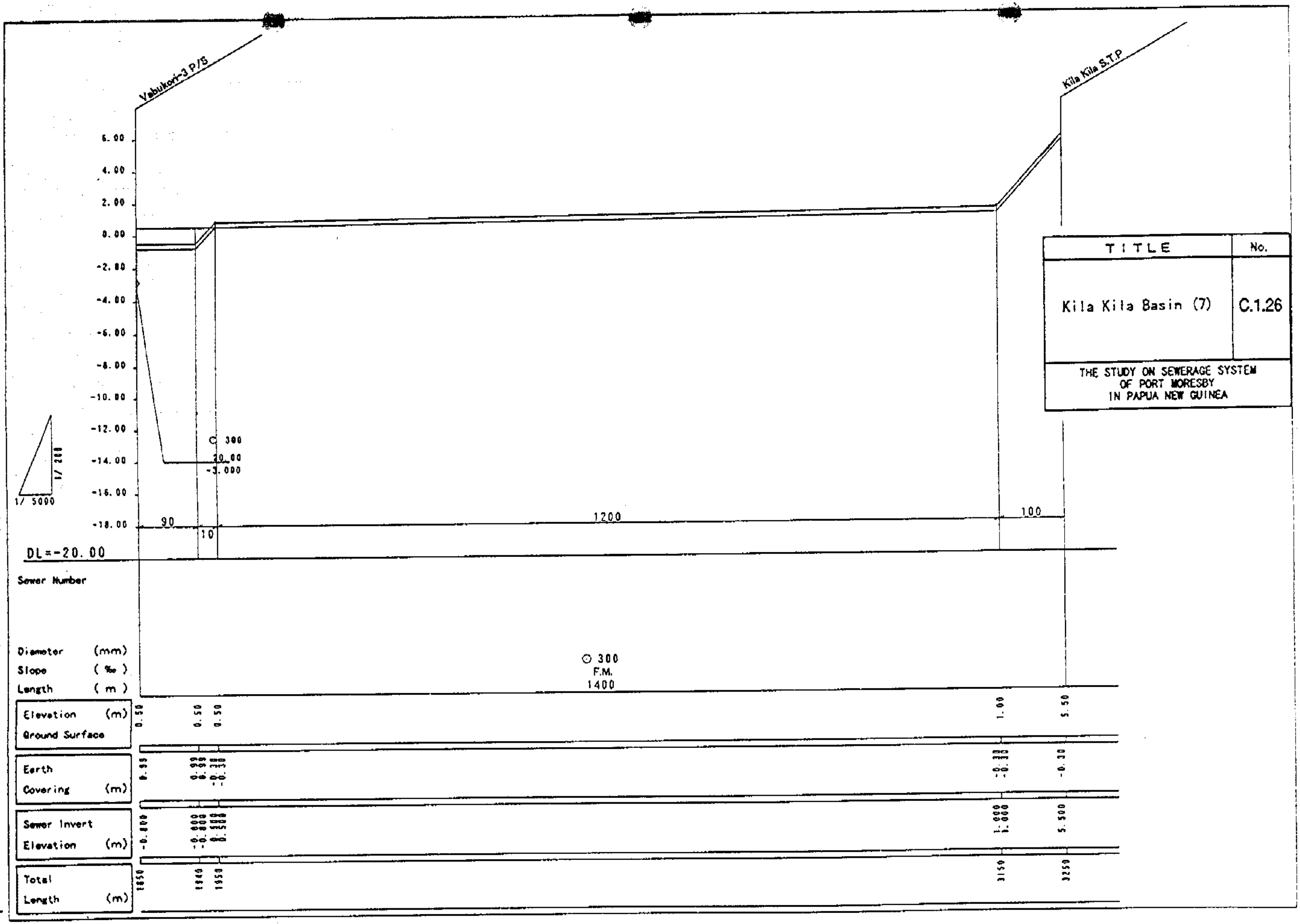
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA


Gabutu-1 P/S
101
Gabutu-2 P/S
102
Vabukori-1 P/S
103
23.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
1/ 200
1/ 5000
⊙ 300
20.00
14.000
DL=-10.00
Sewer Number
Diameter (mm)
Slope (‰)
Length (m)
⊙ 150
F.M.
240
⊙ 200
59.00
270
⊙ 150
F.M.
470
⊙ 200
155.60
90
⊙ 200
F.M.
300
Elevation (m)
Ground Surface
11.60
15.15
0.50
23.15
9.20
15.15
Earth
Covering (m)
Sewer Invert
Elevation (m)
Total
Length (m)
0
240
510
980
1070
1370
TITLE
No.
Kila Kila Basin (5)
C.1.24
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA

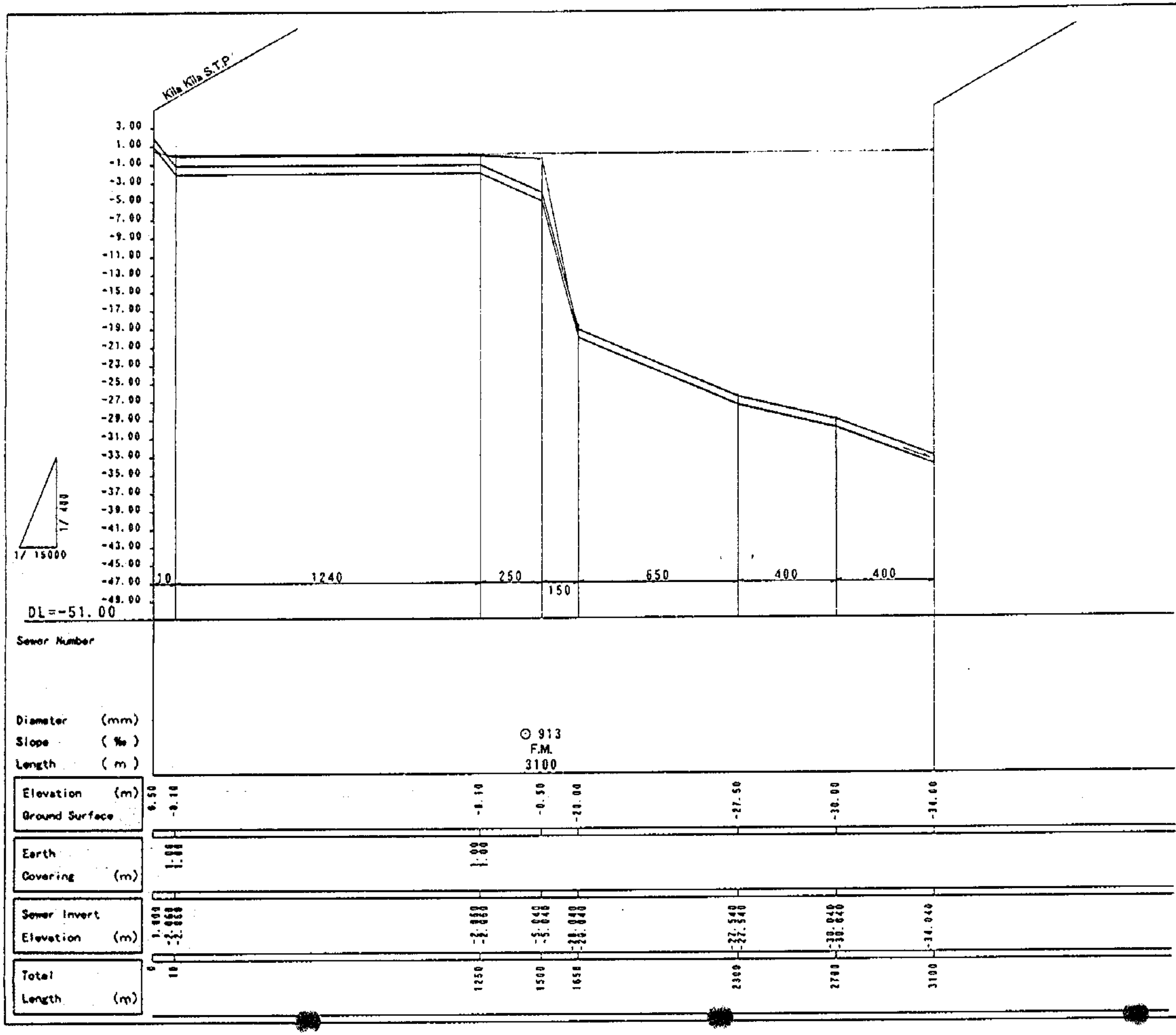


TITLE	No.
Kila Kila Basin (6)	C.1.25

THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA



Vabukori-3 P/S
Kila Kila S.T.P
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
1/ 200
1/ 5000
⊙ 300
20.00
-3.000
90
10
1200
100
DL=-20.00
Sewer Number
Diameter (mm)
Slope (‰)
Length (m)
⊙ 300
F.M.
1400
Elevation (m)
Ground Surface
0.50
0.50
0.50
1.00
5.50
Earth
Covering (m)
0.99
0.99
0.99
-0.30
-0.30
-0.30
-0.30
-0.30
Sewer Invert
Elevation (m)
-0.800
-0.800
-0.800
0.500
0.500
1.000
1.000
5.500
Total
Length (m)
1850
1940
1950
3150
3250
TITLE
No.
Kila Kila Basin (7)
C.1.26
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA



TITLE	No.
Kila Kila Ocean Outfall	C.1.27

THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA

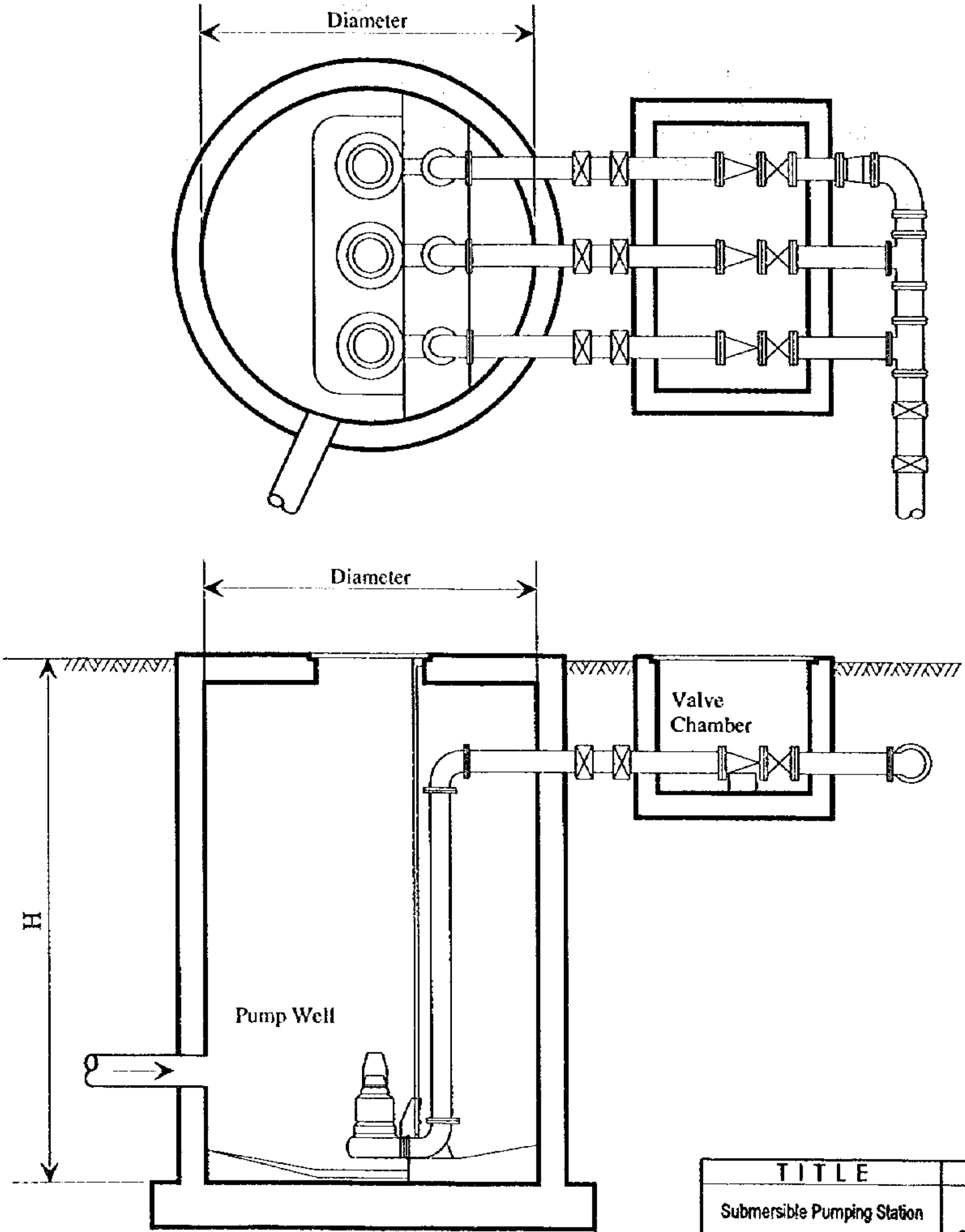
C.2 Pumping Station

There is ten working pumping stations in the study area, one is inland area and the other 9 are in coastal area. In this project, these pumping stations were utilized as much as possible. Further, 33 pumping stations are to be installed in the study area; 23 new pumping stations supplementary, and 24 pumping stations in feasibility study area, 14 new pumping stations supplementary.

These pumping stations are classified into 5 types according to the scale.

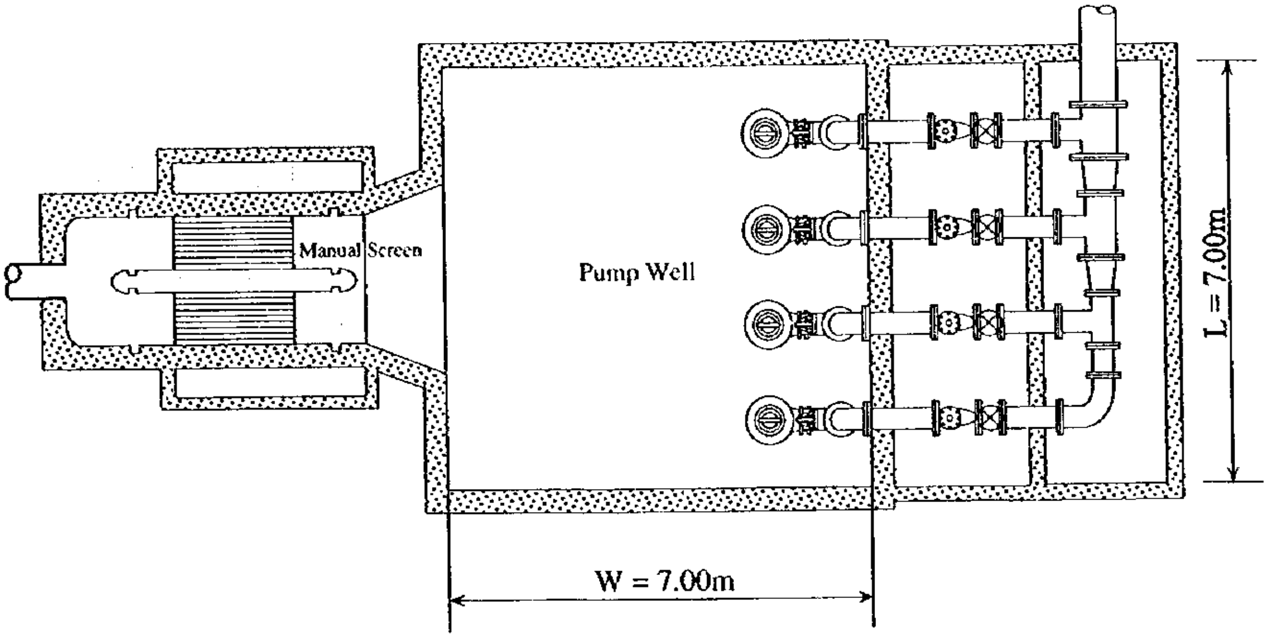
Type I:	Submersible circular type and diameter of 1.5 m
Type II:	Submersible circular type and diameter of 1.8 m
Type III:	Submersible circular type and diameter of 4.0 m
Type IV:	Simplified rectangular type, width is 7.0 m with manual screen
Type V:	Simplified rectangular type, width is 14.0 m with mechanical screen

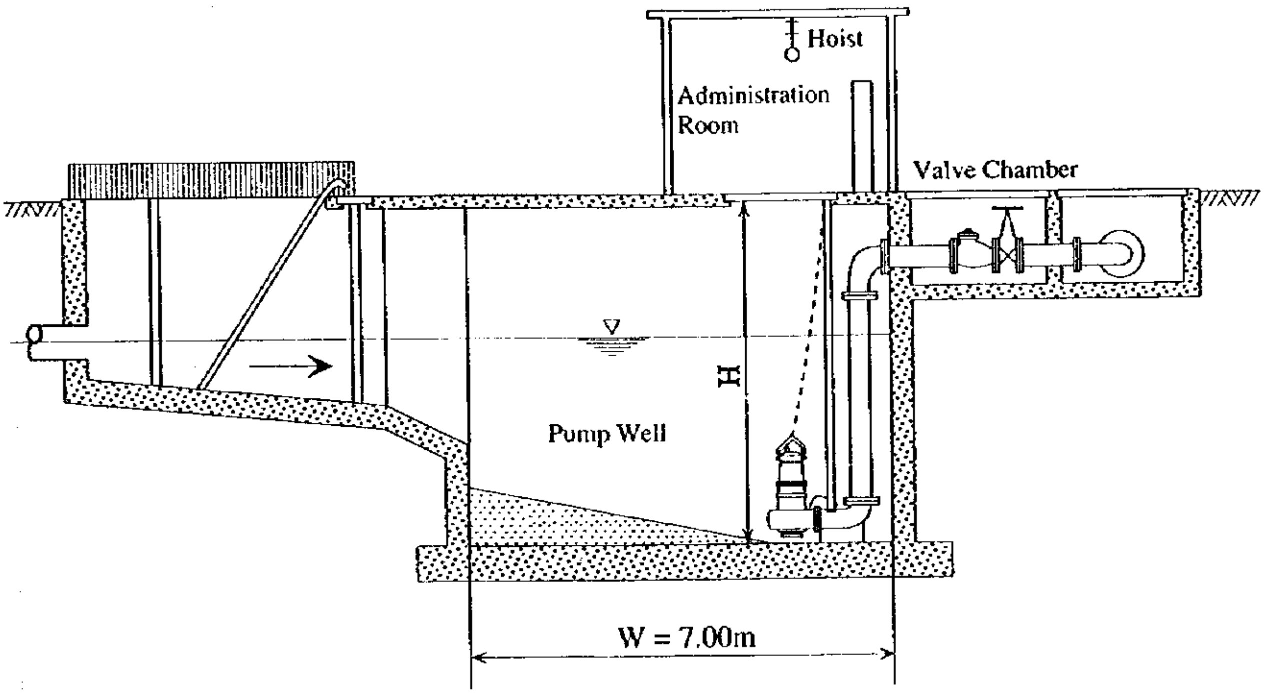
Submersible Pumping Station
Circular TYPE I, II, III



TITLE	No.
Submersible Pumping Station	C.2.1
Circular TYPE I, II, III	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	

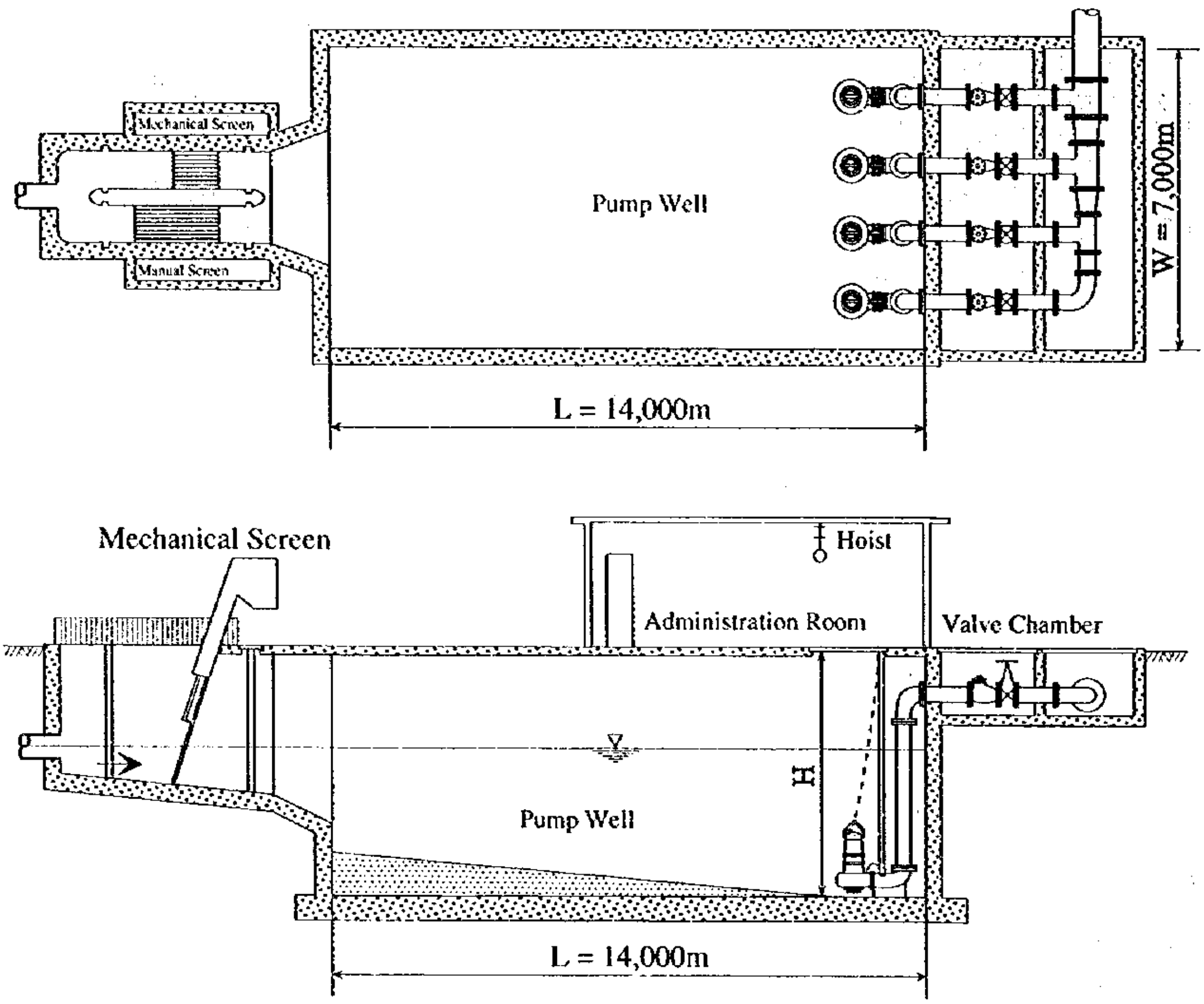
Simplified Type Pumping Station
TYPE IV





TITLE	No.
Submersible Pumping Station	C.2.2
Rectangular TYPE IV	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	

Standard Type Pumping Station
TYPE V



TITLE	No.
Submersible Pumping Station	C.2.3
Rectangular TYPE V	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	

Table C.2.1 Cost Estimation for the Pumping Facilities

TYPE I Q = 0.01 ~ 1.50 (m^3/min)

Name			Gabutu No.1	Gabutu No.3
Q (m^3/min)			0.62	0.39
Structure	Circular Type	Dia (m)	1.5	1.5
		Wall W (m)	0.25	0.25
		Depth (m)	5.1	8.0
	Site	W (m)	5.0	5.0
		L (m)	5.0	5.0
		A (m^2)	25.0	25.0
	Conc rate	r	2.8	2.3
Bill of Quantity	1. Site Grading	A (m^2)	25.0	25.0
	2. Banking/Compunction	H (m)	1.0	1.0
		V (m^3)	25.0	25.0
	3. Excavation	V (m^3)	158.5	240.6
	4. Compaction	A (m^2)	12.6	12.6
	5. Gravelling	V (m^3)	0.6	0.6
	6. Level Concrete	V (m^3)	0.3	0.3
	7. R. Concrete	V (m^3)	16.9	21.7
	8. S.R. Bar	W (t)	0.8	1.1
	9. Forming	A (m^2)	101.1	130.3
	10.Cover	V (m^3)	1.7	1.7
	11.Dump Soil	V (m^3)	17.2	27.0
	12.Back Filling	V (m^3)	141.3	213.6
	13.Fence	L (m)	20.0	20.0

Table C.2.2 Cost Estimation for the Pumping Facilities

TYPE II Q = 1.51 ~ 3.00 (m^3/min)

Name			Gabutu No.2	Vabukori No.2
Q (m^3/min)			1.67	1.14
Structure	Circular Type	Dia (m)	1.8	1.8
		Wall W (m)	0.25	0.25
		Depth (m)	8.1	6.0
	Site	W (m)	5.0	5.0
		L (m)	5.0	5.0
		A (m^2)	25.0	25.0
	Conc rate	r	2.1	2.5
Bill of Quantity	1. Site Grading	A (m^2)	25.0	25.0
	2. Banking/Compunction	H (m)	1.0	1.0
		V (m^3)	25.0	25.0
	3. Excavation	V (m^3)	268.3	202.8
	4. Compaction	A (m^2)	14.5	14.5
	5. Gravelling	V (m^3)	0.8	0.8
	6. Level Concrete	V (m^3)	0.4	0.4
	7. R. Concrete	V (m^3)	24.0	21.2
	8. S.R. Bar	W (t)	1.2	1.1
	9. Forming	A (m^2)	143.9	126.9
	10.Cover	V (m^3)	2.4	2.4
	11.Dump Soil	V (m^3)	27.3	20.2
	12.Back Filling	V (m^3)	241.0	182.6
	13.Fence	L (m)	20.0	20.0

Table C.2.3 Cost Estimation for the Pumping Facilities

TYPE III Q = 3.01 ~ 6.00 (m^3/min)

Name			Tatana No.1	Tatana No.2	Tatana No.3	Tatana No.4	Hanuabada No.1	Konedobu	Pari	Vabukori No.1	Dogura No.1	Dogura No.2	Dogura No.3	Vetor No.1	Vetor No.2	Morata
Q (m^3/min)			1.72	1.77	3.12	3.63	4.65	4.86	1.52	2.89	1.86	1.86	3.36	3.36	4.98	3.78
Structure	Circular Type	Dia (m)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1.5	1.5	4.0	4.0	4.0	4.0
		Wall W (m)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.25	0.25	0.30	0.30	0.30	0.30
		Depth (m)	3.0	5.1	4.7	8.5	5.1	5.4	2.8	3.8	3.0	3.0	4.3	5.5	4.2	4.5
	Site	W (m)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		L (m)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		A (m^2)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Conc rate	r	3.0	2.7	2.7	2.0	2.7	2.6	3.1	2.9	3.0	3.0	2.8	2.6	2.8	2.8
Bill of	1. Site Grading	A (m^2)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Quantity	2. Banking	H (m)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	/Compunction	V (m^3)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	3. Excavation	V (m^3)	203.3	325.3	302.1	522.8	325.3	342.7	191.7	249.8	203.3	203.3	278.8	348.5	273.0	290.5
	4. Compaction	A (m^2)	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	12.6	12.6	34.2	34.2	34.2	34.2
	5. Gravelling	V (m^3)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	0.6	0.6	3.3	3.3	3.3	3.3
	6. Level Concrete	V (m^3)	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	0.3	0.3	1.7	1.7	1.7	1.7
	7. R. Concrete	V (m^3)	33.9	51.9	47.8	64.1	51.9	52.9	32.7	41.5	33.9	33.9	45.4	53.9	44.3	47.5
	8. S.R. Bar	W (t)	1.7	2.6	2.4	3.2	2.6	2.6	1.6	2.1	1.7	1.7	2.3	2.7	2.2	2.4
	9. Forming	A (m^2)	203.6	311.5	287.0	384.5	311.5	317.6	196.3	249.3	203.6	203.6	272.3	323.5	266.0	285.0
	10.Cover	V (m^3)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	11.Dump Soil	V (m^3)	59.8	101.7	93.7	169.5	101.7	107.7	55.8	75.8	59.8	59.8	85.7	109.7	83.7	89.7
	12.Back Filling	V (m^3)	143.5	223.6	208.4	353.3	223.6	235.1	135.9	174.0	143.5	143.5	193.1	238.9	189.3	200.7
	13.Fence	L (m)	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

Table C.2.4 Cost Estimation for the Pumping Facilities

TYPE IV Q = 6.01 ~ 15.00 (m^3/min)

Name			Hanuabada No.2	Konedobu No.2	Badili	Kaugere	Vabukori No.3	Dogra No.4	Dogura No.5
Q (m^3/min)			8.73	12.81	9.54	13.33	8.26	6.06	9.48
	Rectanglar Type	W (m)	7.0	7.0	7.0	7.0	7.0	7.0	7.0
		L (m)	7.0	7.0	7.0	7.0	7.0	7.0	7.0
		1F Wall (m)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
		BF Wall (m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		Hight (m)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
		Depth (m)	5.2	4.2	5.3	5.7	5.5	2.9	3.5
	Site	W (m)	17.0	17.0	17.0	17.0	17.0	17.0	17.0
		L (m)	17.0	17.0	17.0	17.0	17.0	17.0	17.0
		A (m^2)	289	289	289	289	289	289	289
	Concrete	r	1.2	1.4	1.2	1.2	1.2	1.6	1.5
Bill of Quantity	1. Site Grading	A (m^2)	289.0	289	289	289	289	289	289
	2. Banking	H (m)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	/Compunction	V (m^3)	289.0	289	289	289	289	289	289
	3. Excavation	V (m^3)	689.7	568.7	701.8	750.2	726.0	411.4	484.0
	4. Compaction	A (m^2)	81.0	81.0	81.0	81.0	81.0	81.0	81.0
	5. Gravelling	V (m^3)	9.8	9.8	9.8	9.8	9.8	9.8	9.8
	6. Level Concrete	V (m^3)	4.9	4.9	4.9	4.9	4.9	4.9	4.9
	7. R. Concrete	V (m^3)	87.4	82.3	89.0	95.8	92.4	65.0	73.5
	8. S.R. Bar	W (t)	10.5	9.9	10.7	11.5	11.1	7.8	8.8
	9. Forming	A (m^2)	524.2	493.9	534.2	574.6	554.4	389.8	441.0
	10.Cover	A (m$^{3)}$	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	11.Room	A (m$^{4)}$	25.0	25.0	25.0	25.0	25.0	25.0	25.0
	12.Dump Soil	V (m^3)	399.4	322.6	407.0	437.8	422.4	222.7	268.8
	13.Back Filling	V (m^3)	290.3	246.1	294.8	312.4	303.6	188.7	215.2
	14.Fence	L (m)	68.0	68.0	68.0	68.0	68.0	68.0	68.0

Table C.2.5 Cost Estimation for the Pumping Facilities

TYPE V Q = 6.01 ~ 15.00 (m^3/min)

Name			Stanley	Paga	Kila Kila	Dogura No.6
Q (m^3/min)			15.08	16.59	25.14	17.88
	Rectanglar Type	W (m)	7.0	7.0	7.0	7.0
		L (m)	14.0	14.0	14.0	14.0
		1F Wall (m)	0.2	0.2	0.2	0.2
		BF Wall (m)	0.5	0.5	0.5	0.5
		Hight (m)	4.0	4.0	4.0	4.0
		Depth (m)	3.9	4.4	5.5	3.4
	Site	W (m)	17.0	17.0	17.0	17.0
		L (m)	24.0	24.0	24.0	24.0
		A (m^2)	408	408	408	408
	Conc rate	r	1.4	1.4	1.2	1.5
Bill of Quantity	1. Site Grading	A (m^2)	408.0	408.0	408.0	408.0
	2. Banking	H (m)	1.0	2.0	3.0	4.0
	/Compunction	V (m^3)	408.0	816.0	1224.0	1632.0
	3. Excavation	V (m^3)	871.2	970.2	1188.0	772.2
	4. Compaction	A (m^2)	144.0	144.0	144.0	144.0
	5. Gravelling	V (m^3)	19.6	19.6	19.6	19.6
	6. Level Concrete	V (m^3)	9.8	9.8	9.8	9.8
	7. R. Concrete	V (m^3)	152.9	172.5	184.8	142.8
	8. S.R. Bar	W (t)	18.3	20.7	22.2	17.1
	9. Forming	A (m^2)	917.3	1034.9	1108.8	856.8
	10.Cover	A (m$^{3)}$	36.0	36.0	36.0	36.0
	11.Room	A (m$^{4)}$	50.0	50.0	50.0	50.0
	12.Dump Soil	V (m^3)	599.0	675.8	844.8	522.2
	13.Back Filling	V (m^3)	272.2	294.4	343.2	250.0
	14.Fence	L (m)	82.0	82.0	82.0	82.0

Table 2.6 Cost Estimation for the Pumping Facilities

Pumping Station		Planned Sewage Flow						Force Main				Pump Head (Hazen's Formula, C=110)						Pump Specification					Cost (x1000Kina)				
		Population	Qd_{ave}	Peak Factor	Qb_{max}		Type	Dia	V	i	L	Suction WL	Discharge WL	H_{actual}	H_{loss}	H_{pump}	Total	Nos.	Q	Dia	Output Calc.	Output STD.	Land	Construction			O&M
		Person	m^3/day	-	m^3/day	m^3/min		mm	m/sec	-	m	M	M	m	m	m	m	-	m^3/min	mm	Kw	Kw		Civil	M&E	Total	
Tatana	No.1	2,750	1,238	2.0	2,475	1.72	III	150	1.62	0.0257	220	-0.5	10.0	10.5	5.65	1.5	17.65	2 (+1)	0.86	100	4.4	5.5	2.5	70	50	120	8.9
	No.2	2,825	1,271	2.0	2,543	1.77	III	150	1.67	0.0270	740	-2.6	-0.5	2.1	19.97	1.5	23.57	2 (+1)	0.88	100	6.0	7.5	2.5	70	55	125	12.
	No.3	5,547	2,496	1.8	4,493	3.12	III	250	1.06	0.0064	1,000	0.0	10.0	10.0	6.43	1.5	17.93	2 (+1)	1.56	100	8.1	11.0	2.5	70	62	131	19.7
	No.4	6,453	2,904	1.8	5,227	3.63	III	300	0.86	0.0035	220	-9.4	1.0	10.4	0.77	1.5	12.67	2 (+1)	1.81	100	6.6	7.5	2.5	70	57	127	13.4
Hanuabada	No.1	8,264	3,719	1.8	6,694	4.65	III	300	1.10	0.0055	130	-1.0	5.2	6.2	0.72	1.5	8.42	2 (+1)	2.32	150	5.6	7.5	2.5	70	54	124	13.4
	No.2	17,464	7,859	1.6	12,574	8.73	IV	450	0.92	0.0025	1,480	-4.5	9.0	13.5	3.65	1.5	18.65	3 (+1)	2.91	150	15.7	18.5	7.2	168	102	269	55.9
Yacht Club		545	245	2.0	491	0.34	I	150	0.32	0.0013	98	1.5	13.6	12.1	0.13	1.5	13.73	1 (+1)	0.34	100	1.3	0.0	0.6	29	40	69	0.0
Konedobu	No.1	8,659	3,888	1.8	6,998	4.86	III	350	0.84	0.0028	220	-0.4	0.0	0.4	0.62	1.5	2.52	2 (+1)	2.43	150	1.8	0.0	2.5	70	42	112	0.0
	No.2	27,330	12,299	1.5	18,448	12.81	IV	450	1.34	0.0050	1,000	-0.1	10.9	11.0	5.01	1.5	17.51	3 (+1)	4.27	200	21.6	22.0	7.2	168	126	294	70.9
Stanley		32,160	14,472	1.5	21,708	15.08	V	500	1.28	0.0041	303	-1.0	15.9	16.9	1.23	1.5	19.63	3 (+1)	5.03	200	28.4	30.0	10.2	267	155	421	96.7
Lawes		1,713	771	2.0	1,542	1.07	II	150	1.01	0.0107	50	-0.3	0.7	1.0	0.53	2.5	4.03	1 (+1)	1.07	100	1.2	0.0	0.6	29	39	69	0.0
Davara		2,592	1,166	2.0	2,333	1.62	III	150	1.53	0.0230	50	-1.4	1.8	3.2	1.15	3.5	7.85	2 (+1)	0.81	100	1.8	0.0	2.5	70	42	112	0.0
Paga		35,384	15,923	1.5	23,884	16.59	V	400	2.20	0.0143	50	-1.9	5.0	6.9	0.72	1.5	9.12	3 (+1)	5.53	200	13.5	15.0	10.2	267	97	364	48.4
Koki		4,634	2,085	2.0	4,171	2.90	III	300	0.68	0.0023	336	-2.1	8.0	10.1	0.77	1.5	12.37	2 (+1)	1.45	100	5.2	0.0	2.5	70	53	122	0.0
Badili		20,348	9,157	1.5	13,735	9.54	IV	450	1.00	0.0029	1,160	-1.8	25.0	26.8	3.37	1.5	31.67	3 (+1)	3.18	150	29.0	30.0	7.2	168	157	325	96.7
Kaugere		28,436	12,796	1.5	19,194	13.33	IV	600	0.79	0.0013	230	11.0	20.9	9.9	0.31	1.5	11.71	3 (+1)	4.44	200	15.0	15.0	7.2	168	99	267	48.4
Pari		2,430	1,094	2.0	2,187	1.52	III	200	0.81	0.0050	3,200	-0.3	9.0	9.3	16.10	1.5	26.90	2 (+1)	0.76	100	5.9	7.5	2.5	70	55	125	12.1
Gabutu	No.1	999	450	2.0	899	0.62	I	150	0.59	0.0039	240	-3.5	15.0	18.5	0.95	1.5	20.95	1 (+1)	0.62	100	3.8	5.5	0.6	29	45	74	4.4
	No.2	2,668	1,201	2.0	2,401	1.67	II	150	1.57	0.0243	120	-1.5	22.0	23.5	2.91	1.5	27.91	2 (+1)	0.83	100	6.7	7.5	2.5	70	58	127	12.1
	No.3	629	283	2.0	566	0.39	I	150	0.37	0.0017	160	-3.5	22.0	25.5	0.27	1.5	27.27	1 (+1)	0.39	100	3.1	5.5	0.6	29	43	73	4.4
Vabukori	No.1	5,135	2,311	1.8	4,159	2.89	III	200	1.53	0.0165	240	-13.5	14.0	27.5	3.97	1.5	32.97	2 (+1)	1.44	100	13.7	15.0	2.5	70	79	149	26.9
	No.2	1,819	819	2.0	1,637	1.14	II	150	1.07	0.0119	360	-3.5	14.0	17.5	4.30	1.5	23.30	1 (+1)	1.14	100	7.6	11.0	0.6	29	53	82	8.9
	No.3	16,511	7,430	1.6	11,888	8.26	IV	300	1.95	0.0160	1,400	-3.5	5.5	9.0	22.41	1.5	32.91	3 (+1)	2.75	150	26.1	30.0	7.2	168	145	313	90.7
Kila kila		53,629	24,133	1.5	36,200	25.14	V	800	0.83	0.0011	360	-2.1	5.5	7.6	0.38	1.5	9.48	3 (+1)	8.38	250	21.3	22.0	10.2	267	132	399	70.9
Dogurakohu	No.1	3,000	1,350	2.0	2,700	1.88	III	200	1.00	0.0074	500	0.0	15.0	15.0	3.71	1.5	20.21	2 (+1)	0.94	100	5.5	5.5	2.5	70	54	123	8.9
	No.2	3,000	1,350	2.0	2,700	1.88	III	200	1.00	0.0074	1,200	0.0	13.0	13.0	8.91	1.5	23.41	2 (+1)	0.94	100	6.3	7.5	2.5	70	56	126	12.1
	No.3	6,000	2,700	1.8	4,860	3.38	III	300	0.80	0.0031	1,500	0.0	14.0	14.0	4.59	1.5	20.09	2 (+1)	1.69	100	9.8	11.0	2.5	70	67	137	19.7
	No.4	12,100	5,445	1.6	8,712	6.05	IV	350	1.05	0.0043	2,000	0.0	22.0	22.0	8.50	1.5	32.00	3 (+1)	2.02	100	18.6	22.0	7.2	168	114	282	66.5
	No.5	20,200	9,090	1.5	13,635	9.47	IV	450	0.99	0.0029	1,200	0.0	5.0	5.0	3.44	1.5	9.94	3 (+1)	3.16	150	9.0	11.0	7.2	168	74	242	35.5
	No.6	38,200	17,190	1.5	25,785	17.91	V	600	1.06	0.0023	2,000	0.0	5.0	5.0	4.58	1.5	11.08	3 (+1)	5.97	200	19.1	22.0	10.2	267	116	383	70.9
Vetorogo	No.1	6,000	2,700	1.8	4,860	3.38	III	250	1.15	0.0074	500	0.0	5.0	5.0	3.72	1.5	10.22	2 (+1)	1.69	100	5.0	5.5	2.5	70	52	122	9.9
	No.2	10,000	4,500	1.6	7,200	5.00	III	300	1.18	0.0063	500	0.0	5.0	5.0	3.16	1.5	9.66	2 (+1)	2.50	150	7.0	7.5	2.5	70	58	128	15.1
Morata		6,720	3,024	1.8	5,443	3.78	III	250	1.28	0.0092	500	0.0	5.0	5.0	4.58	1.5	11.08	2 (+1)	1.89	100	6.0	7.5	2.5	70	56	125	13.4

Auxiliary Design Consideration for Pumping Station

1. Water Hammer in Pumping Facilities

Water hammer is a phenomenon that a large pressure fluctuation may occur in the water feed pipeline, when a pump used in a long water feed line is suddenly stopped by power failure or mechanical failure.

Examining by the preliminary water hammer study, some pumping stations with a long pipeline are potentially dangerous conditions to cause water hammer.

As the measures against the water hammer, the following methods are recommended:

a. Flywheel
b. Conventional surge tank, or
c. Multistage pumping station

At this stage of study, locations of pumping stations are tentative and it is difficult to examine water hammer in detail. Location of pumping stations should be finalized in detailed design stage, as well as countermeasures against water hammer, if necessary.

2. Diesel Engine Generator

In this section, costs of diesel engine generators are examined and the necessity of them are discussed.

The initial and operation costs for typical three pumping stations are calculated in the following table. The initial costs or installation costs are widely fluctuated by the capacity, And smaller generator requires higher per kW cost, for instance generator in Koki (25 kVA) is about 2.28 times than Stanley (150 kVA) in each kW. The average initial cost per kW is Kina 1,065, subject to generator life of 10 years and 480 hours/year (8 hours/day x 60 days) operation. Total power requirement for all 24 pumping stations is 705.2 kW so that the total cost for generators reaches to Kina 750,980. This equals to approximately 40 % of all mechanical and electrical equipment in pumping stations.

Running cost consists of depreciation of generators, spare parts and fuel, but not personal cost for operation/maintenance. Electricity cost per kWH is Kina 0.184 by ELCOM and Kina 0.579 by generators, which is 3.15 times higher than that of ELCOM. In case of 480 hours/year generators operation, annual running cost in total is Kina 259,334, and it is Kina 72,484 or 39 % higher than single power supply by ELCOM.

In technical view point, maintenance of 24 generators spread over city is not easy and they would not work without proper monthly maintenance, since diesel engines are assembles many and precise parts.

Power failure was very severe and it occurred everyday during dry season in 1997, Electricity Commission (ELCOM), however, mentioned that in ordinary years power failure had occurred only 2 to 3 times a month and each duration had been only 3 minutes to 30 minutes.

Taking ELCOM's comment in to consideration, it is not recommended to install a generator set to each pumping station, due to high initial and maintenance costs, difficulty of operation/maintenance and less reliability.

A. Typical Generator Costs for 3 Pumping Stations

			Stanley	Paga	Koki
Pump	Power	kW	120	45	18
Generator	Capacity	kVA	150	60	25
		PS	187.5	75.6	31.3
	Cost	Kina	82,657	41,919	28,339
		Kina/Year*[1]	12,318	6,247	4,223
		Kina/kW	689	932	1,574
	Spare Parts	%/year	5.0	5.0	5.0
		Kina/Year	4,133	2,096	1,417
	Fuel	L/PS-h	0.127	0.127	0.127
		L/h	23.8	9.6	4.0
		Kina/L	0.65	0.65	0.65
Running Cost	Operation	hours/year	480	480	480
	Depreciation	Kina/h	25.66	13.01	8.80
	Spare Parts	Kina/h	8.61	4.37	2.95
	Fuel	Kina/h	15.48	6.24	2.58
	Total Cost	Kina/h	49.75	23.62	14.33
	Cost	Kina/kWh	0.41	0.52	0.80
Generator - Initial Cost		Kina/kW	1,064.9		
Electricity Cost	Generator	Kina/kWh	0.579		
	ELCOM	Kina/kWh	0.184		

B. Generator Costs for All Pumping Stations vs. ELCOM

1. Initial Cost					
Power requirement of 24 pumping stations				705.2	kW
Average initial cost for generator				1,064.9	Kina/kW
Total initial cost for generator				750,980	Kina
2. Running Cost					
Power requirement of 24 pumping stations				705.2	kW
Operation hours/year		hours	0	480	1,440
Generator	(0.579 Kina/kWh)		0	195,865	587,595
ELCOM	(0.184 Kina/kWh)		186,850	62,283	0
Total running cost		Kina	186,850	259,334	589,035

C.3 Treatment Plant

1. Master Plan (M/P)

Ten (10) sewage treatment plants (STPs) in total are established for the M/P stage.

Four (4) STPs, including three (3) existing STPs, are located at inland area and the others are located at coastal area.

Table C.3.1 shows an outline of the established STPs.

Table C.3.1 Outline of the proposed STPs

STP Name	Location	Treatment Method	Remark
Waigani	Inland area	Stabilization pond method	Existing
Morata			- do -
Gerehu			- do -
Bomanai			
Paga	Coastal area	Sedimentation method	
Kila kila			
Tatana		Stabilization pond method	
Pari			
Vetorogo			
Dogura Kohu			

Among the above STPs, Tatana and Pari STP were denied as an element for the optimum sewerage system of the coastal area, through the comprehensive alternative study (cf. Appendix D).

Brief descriptions on capacity calculation and structure design related to the mentioned STPs for M/P are indicated in Table C.3.2 and Table C.3.3

2. Feasibility Study (F/S)

Two (2) STPs, Paga point STP and Kila kila STP, are proposed for the feasibility study (F/S) of the coastal area.

Capacity calculations of both STP are attached later and drawings are attached in a clause "DRAWING".

Table C.3.2 Proposed STPs for M/P (1) : Stabilization Pond Method
(1) Capacity Calculation & Structure Design

STP			Inland Area				Coastal Area			
			Waigani	Morata	Gerehu	Bomana	Tatana	Pari	Vetorogo	Dogura
Sewage Flow	QU_{AVE}	(m^3/day)	86,741	15,225	18,018	39,887	2,509	1,094	13,115	18,209
Stabilization Pond Method	Anaerobic Pond	V (m^3)				79,774	5,018	2,188	26,230	36,418
		Train				6	2	2	4	4
		H (m)				3.0	3.0	3.0	3.0	3.0
		UpperW(m)				90.0	40.0	25.0	65.0	75.0
		LowerW(m)				78.0	28.0	13.0	53.0	63.0
		UpperL(m)				58.6	30.2	24.6	42.8	49.8
		LowerL(m)				46.6	18.2	12.6	30.8	37.8
	Facultative Pond	V (m^3)	118,264	60,900	72,072	159,548	10,036	4,376	52,460	72,836
		Train	1	2	2	6	2	2	4	4
		H (m)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
		UpperW(m)	334.0	100.0	100.0	90.0	40.0	25.0	65.0	75.0
		LowerW(m)	326.8	92.8	92.8	82.8	32.8	17.8	57.8	67.8
		UpperL(m)	202.4	179.0	211.2	174.5	80.1	60.2	122.2	145.2
		LowerL(m)	195.0	171.8	204.0	167.3	72.9	53.0	115.0	138.0
	Site Area	(ha)	10.1	5.4	6.3	18.9	1.3	0.6	6.4	8.8
Aerated Lagoon Method (Reference)	Complete Mixing Aerated Laggon	V (m^3)				59,831	3,764	1,641	19,673	27,314
		Train				4	2	2	4	4
		H (m)				3.0	3.0	3.0	3.0	3.0
		UpperW(m)				80.0	25.0	20.0	45.0	55.0
		LowerW(m)				68.0	13.0	8.0	33.0	43.0
		UpperL(m)				73.2	38.4	24.7	47.7	52.2
		LowerL(m)				61.2	26.4	12.7	35.7	40.2
	Partial Mixing Aerated Laggon	V (m^3)				79,774	5,018	2,188	26,230	36,418
		Train				4	2	2	4	4
		H (m)				3.0	3.0	3.0	3.0	3.0
		UpperW(m)				80.0	25.0	20.0	45.0	55.0
		LowerW(m)				68.0	13.0	8.0	33.0	43.0
		UpperL(m)				95.7	49.4	31.2	61.7	67.7
		LowerL(m)				83.7	37.4	19.2	49.7	55.7
	Site Area	(ha)				8.1	0.7	0.3	3.0	4.0

Table C.3.3 Proposed STPs for M/P (1) : Stabilization Pond Method
(2) Construction Cost

STP			Inland Area				Coastal Area			
			Waigani	Morata	Gerehu	Bomana	Tatana	Pari	Vetorogo	Dogura
Structure	Anaerobic Pond	Train				6	2	2	4	4
		H (m)				3.5	3.5	3.5	3.5	3.5
		UpperW(m)				92.0	42.0	27.0	67.0	77.0
		LowerW(m)				78.0	28.0	13.0	53.0	63.0
		UpperL(m)				60.6	32.2	26.6	44.8	51.8
		LowerL(m)				46.6	18.2	12.6	30.8	37.8
	Facultative Pond	Train	1	2	2	6	2	2	4	4
		H (m)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
		UpperW(m)	336.0	102.0	102.0	92.0	42.0	27.0	67.0	77.0
		LowerW(m)	326.8	92.8	92.8	82.8	32.8	17.8	57.8	67.8
		UpperL(m)	204.4	181.0	213.2	176.5	82.1	62.2	124.2	147.2
		LowerL(m)	195.0	171.8	204.0	167.3	72.9	53.0	115.0	138.0
	Site	W (m)	356.0	229.0	229.0	574.0	106.0	76.0	290.0	330.0
		L (m)	224.4	201.0	233.2	292.2	169.3	143.8	224.0	254.0
		A (m^2)	79,902	46,038	53,410	167,695	17,947	10,926	64,972	83,830
Bill of Quantity	1. Site Grading	A (m^2)	79,902	46,038	53,410	167,695	17,947	10,926	64,972	83,830
	2. Avrage Grade Level	H (m)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
		V (m^3)	183,775	105,887	122,843	385,698	41,279	25,129	149,435	192,809
	3. Pond Volume	Anaerobic	0	0	0	96,051	6,299	2,853	32,018	44,142
		Facultative	152,341	79,084	93,508	207,470	13,360	5,968	68,723	95,062
		Total (Vm^3)	152,341	79,084	93,508	303,520	19,660	8,820	100,741	139,204
	4. Banking/Compaction	2 - 3 (m^3)	31,434	26,803	29,335	82,178	21,619	16,309	48,694	53,605
	5. Soil Cement (w/ Compaction)	Anaerobic	0	0	0	6,509	943	619	3,063	3,594
		Facultative	0	0	0	8,002	1,182	823	3,744	4,423
		Total (Vm^3)	0	0	0	14,512	2,125	1,442	6,807	8,017
	6. Asphalt Pave Recover	A (m^2)	0	0	0	6,929	2,203	1,758	4,112	4,672
	7. Fence	L (m)	0	0	0	1,732	551	440	1,028	1,168
	8. Shore Protection	A (m^2)	0	0	0	0	0	0	0	0
	9. Administration BLDG.	A (m^2)	0	0	0	50	50	50	50	50
	Gate	(nos.)	2	4	4	14	6	6	10	10

Freeboard 0.5 m
Slope of Surface 1 : 2.0

Table C.3.4 Proposed STPs for M/P (1) : Stabilization Pond Method

(3) O&M Cost

STP			Inland Area				Coastal Area			
			Waigani	Morata	Gerehu	Bomana	Tatana	Pari	Vetorogo	Dogura
Sewage Flow	Qd_{AVE}	(m^3/day)	86,741	15,225	18,018	39,887	2,509	1,094	13,115	18,209
Disinfection	Cl Volume	(mg/L)				4	4	4	4	4
	Cl Volume	(kg/year)				58,235	3,663	1,597	19,148	26,585
	Unit Cost	(kina/kg)				6.47	7.47	8.47	7.47	8.47
	Cost	(1000Kina)				90.0	27.4	13.5	143.0	225.2
Sludge Transfer	Figure		Dryed	Dryed	Dryed	Dryed	Dryed	Dryed	Dryed	Dryed
	Volume	(m^3/year)	4,337	761	901	1,994	125	55	656	910
	Unit Cost	(kina/m^3)	6.70	6.70	6.70	6.70	6.70	6.70	6.70	6.70
	Cost	(1000Kina)	29.1	5.1	6.0	13.4	0.8	0.4	4.4	6.1
Total	Cost	(1000kina)	29.1	5.1	6.0	103.4	28.2	13.9	147.4	231.3
						143.6				420.8

Table C.3.5 Proposed STPs for M/P (2) : Sedimentation Method

(1) Capacity Calculation & Structure Design

Item		Paga STP				KilaKila STP			
		Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D
Qd_{AVE}	(m^3/day)	22,571	25,079	13,414	15,923	21,313	22,406	30,470	31,563
Qd_{MAX}	(m^3/day)	29,342	32,603	17,438	20,700	27,707	29,128	39,611	41,032
Sedimentation Tank	A (m^2)	587	652	349	414	554	583	792	821
	Nos.	4	4	2	2	4	4	4	4
	Dia (m)	13.7	14.4	14.9	16.2	13.3	13.6	15.9	16.2
	H (m)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Thickener	A (m^2)	30.1	33.4	17.9	21.2	28.4	29.9	40.6	42.1
	Nos.	2	2	1	1	2	2	2	2
	Dia (m)	4.4	4.6	4.8	5.2	4.3	4.4	5.1	5.2
	H (m)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Digestion Tank	V (m^3)	1,354	1,505	805	955	1,279	1,344	1,828	1,894
	Nos.	2	2	1	1	2	2	2	2
	Dia (m)	11.1	11.5	11.8	12.5	10.9	11.1	12.3	12.4
	H (m)	5.6	5.8	5.9	6.2	5.5	5.6	6.2	6.2
Sludge Drying Bed	V (m^3)					1,229	1,330	1,229	1,330
	Nos.					20.5	22.2	20.5	22.2
	W (m)					10.0	10.0	10.0	10.0
	L (m)					15.0	15.0	15.0	15.0
	H (m)					0.4	0.4	0.4	0.4

Table C.3.6 Proposed STPs for M/P (2) : Sedimentation Method
(2) Construction Cost

Item			Paga STP				KilaKila STP			
			Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D
Structure	Sedimentation Tank	Nos.	4	4	2	2	4	4	4	4
		Dia (m)	13.7	14.4	14.9	16.2	13.3	13.6	15.9	16.2
		H (m)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
		Thickness(m)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	Thickener	Nos.	2	2	1	1	2	2	2	2
		Dia (m)	4.4	4.6	4.8	5.2	4.3	4.4	5.1	5.2
		H_1 (m)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
		H_2 (m)	3.8	4.0	4.1	4.5	3.7	3.8	4.4	4.5
		Thickness(m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Digestion Tank	Nos.	2	2	1	1	2	2	2	2
		Dia (m)	11.1	11.5	11.8	12.5	10.9	11.1	12.3	12.4
		H_1 (m)	6.6	6.8	6.9	7.2	6.5	6.6	7.2	7.2
		H_2 (m)	5.6	5.8	5.9	6.2	5.5	5.6	6.2	6.2
		Thickness(m)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	Sludge Drying Bed	Nos.					20.5	22.2	20.5	22.2
		W (m)					10.0	10.0	10.0	10.0
		L (m)					15.0	15.0	15.0	15.0
		H (m)					1.0	1.0	1.0	1.0
		Thickness(m)					0.2	0.2	0.2	0.2
	Site	W (m)	57.3	58.8	34.9	36.2	70.0	70.0	70.0	70.0
		L (m)	77.9	80.0	91.4	95.2	161.7	162.7	169.2	170.0
		A (m^2)	4,464	4,704	3,189	3,449	11,322	11,390	11,841	11,897
Bill of Quantity	1. Site Grading	A (m^2)	4,464	4,704	3,189	3,449	11,322	11,390	11,841	11,897
	2. Banking/Compaction	H (m)	3.5	3.5	3.5	3.5	3.0	3.0	3.0	3.0
		V (m^3)	15,625	16,463	11,163	12,070	33,966	34,169	35,523	35,691
	3. Excavation	Sedimentation	3,937.8	4,256.7	2,238.7	2,552.1	3,776.5	3,916.7	4,933.1	5,069.0
		Thickener	592.8	628.4	326.6	361.6	574.7	590.4	704.1	719.4
		Digestion	967.2	1,043.2	547.7	621.0	928.5	962.1	1,202.2	1,233.8
		Sludge Drying					4,546.1	4,923.1	4,546.1	4,923.1
		Total (Vm^3)	5,497.7	5,928.4	3,113.0	3,534.7	9,825.8	10,392.3	11,385.5	11,945.2
	4. Gravelling	Sedimentation	131.6	145.4	77.5	91.2	124.6	130.7	174.9	180.9
		Thickener	7.8	8.5	4.5	5.3	7.4	7.7	10.2	10.5
		Digestion	44.7	47.8	24.9	27.7	43.2	44.5	53.9	55.1
		Sludge Drying					656.7	711.1	656.7	711.1
		Total (Vm^3)	184.1	201.7	106.9	124.2	831.9	894.0	895.7	957.6
	5. Level Concrete	Sedimentation	65.8	72.7	38.7	45.6	62.3	65.3	87.5	90.4
		Thickener	3.9	4.3	2.3	2.6	3.7	3.9	5.1	5.2
		Digestion	22.4	23.9	12.5	13.9	21.6	22.3	27.0	27.6
		Sludge Drying					328.3	355.6	328.3	355.6
		Total (Vm^3)	92.0	100.8	53.5	62.1	415.9	447.0	447.8	478.8
	6. R. Concrete	Sedimentation	622.5	672.5	353.4	401.7	597.1	619.2	777.2	798.1
		Thickener	74.5	80.1	42.0	47.4	71.7	74.2	91.8	94.1
		Digestion	347.2	370.4	193.0	214.6	335.2	345.6	417.6	426.8
		Sludge Drying					680.9	737.4	680.9	737.4
		Total (Vm^3)	1,044.2	1,123.0	588.4	663.7	1,684.9	1,776.4	1,967.6	2,056.4
	7. S.R. Bar	Total (t)	156.6	168.4	88.3	99.6	252.7	266.5	295.1	308.5
	8. Forming	Total (Am^2)	4,176.9	4,492.0	2,353.7	2,654.7	6,739.5	7,105.4	7,870.3	8,225.6
	9. Dump Soil	Total (Vm^3)	2,058.9	2,289.1	1,225.1	1,457.6	5,817.4	6,238.7	6,661.0	7,083.8
	10. Back Filling	Sedimentation	1,627.8	1,697.5	872.0	934.9	1,591.4	1,623.1	1,836.4	1,863.0
		Thickener	1,684.0	1,810.9	949.1	1,072.2	1,619.5	1,675.5	2,077.6	2,130.8
		Digestion	127.1	130.9	66.7	69.9	125.1	126.9	138.2	139.5
		Sludge Drying					672.4	728.2	672.4	728.2
		Total (Am^2)	3,438.9	3,639.2	1,887.8	2,077.1	4,008.4	4,153.6	4,724.5	4,861.4
	11. Asphalt Pave Recover	A (m^2)	1,081.6	1,110.3	1,010.2	1,051.2	1,854.0	1,861.7	1,913.3	1,919.7
	12. Fence	L (m)	270.4	277.6	252.6	262.8	463.5	465.4	478.3	479.9
	13. Shore Protection	A (m^2)	1,506.8	1,546.5	1,261.5	1,312.0	2,024.2	2,030.6	2,073.9	2,079.3
	14. Filter Gravel	V (m^3)					1,537.5	1,665.0	1,537.5	1,665.0
	15. Admini. BLDG.	A (m^2)	25.0	25.0	25.0	25.0	50.0	50.0	50.0	50.0
	Sludge Pump	(nos.)	10	10	5	5	10	10	10	10
	Disinfection	(set)	1	1	1	1	1	1	1	1

Table C.3.7 Proposed STPs for M/P (2) : Sedimentation Method

(3) O&M Cost

			Paga STP				KilaKila STP			
			Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D
Sewage Flow	Qd_{AVE}	(m^3/day)	22,571	25,079	13,414	15,923	21,313	22,406	30,470	31,563
Disinfection	Cl Volume	(mg/L)	10	10	10	10	10	10	10	10
	Cl Volume	(kg/year)	82,384	91,538	48,961	58,119	77,792	81,782	111,216	115,205
	Unit Cost	(kina/kg)	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
	Cost	(1000Kina)	285.9	317.6	169.9	201.7	269.9	283.8	385.9	399.8
Offshore Discharge	Pump	(kw)	90.0	111.0	30.0	37.0	-	-	-	-
		(hour/year)	5,840	5,840	5,840	5,840	-	-	-	-
	Unit Cost	(kina/kwh)	0.184	0.184	0.184	0.184	-	-	-	-
	Cost	(1000Kina)	96.7	119.3	32.2	39.8	-	-	-	-
Sludge pumpl	Pump	(kw)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
		(hour/year)	824	915	490	581	778	818	1,112	1,152
	Unit Cost	(kina/kwh)	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184
	Cost	(1000Kina)	0.8	0.9	0.5	0.6	0.8	0.8	1.1	1.2
Digestion tank	Pump	(kw)	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
		(hour/year)	365	365	365	365	365	365	365	365
	Unit Cost	(kina/kwh)	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184
	Cost	(1000Kina)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Sludge Transfer	Figure		Digested	Digested	Digested	Digested	Dryed	Dryed	Dryed	Dryed
	Volume	(m^3/year)	11,534	12,815	6,855	8,137	2,242	2,426	2,242	2,427
	Unit Cost	(kina/m^3)	14.10	14.10	14.10	14.10	14.10	14.10	14.10	14.10
	Cost	(1000Kina)	162.6	180.7	96.6	114.7	31.6	34.2	31.6	34.2
Total	Cost	(1000kina)	546.8	619.3	300.0	357.5	303.1	319.6	419.4	435.9

Table C.3.8 Proposed STPs for M/P (2) : Sedimentation Method

(4) Effluent Discharge Pump

Case			Paga STP				Kila kila STP			
			Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D
Planned Sewage Flow	ADWF	m^3/day	22,571	25,079	13,414	15,923	21,313	22,406	30,470	31,563
	Peak Factor	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	PDWF	m^3/day	33,857	37,619	20,121	23,885	31,970	33,609	45,705	47,345
Discharge Pipe	Dia	mm	560	560	560	560	750	750	900	900
	V	m/sec	1.59	1.77	0.95	1.12	0.84	0.88	0.83	0.86
	i	-	0.0035	0.0043	0.0012	0.0017	0.0007	0.0007	0.0005	0.0005
	L	m	2,920	2,920	2,920	2,920	3,650	3,650	3,650	3,650
Head Loss	H_{Loss}	m	10.18	12.57	3.59	5.07	2.39	2.64	1.85	1.98
	H_{in}	m	0.06	0.08	0.02	0.03	0.02	0.02	0.02	0.02
	H_{out}	m	0.13	0.16	0.05	0.06	0.04	0.04	0.04	0.04
	H_{pump}	m	1.50	1.50	1.50	1.50	-	-	-	-
	$H_{saltwater}$	m	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	H Total	m	12.77	15.20	6.06	7.56	3.34	3.60	2.80	2.94
Pump Specification	Nos.	-	3 (+1)	3 (+1)	2 (+1)	2 (+1)	-	-	-	-
	Q	m^3/min	7.84	8.71	6.99	8.29	-	-	-	-
	Dia	mm	250	250	200	250	-	-	-	-
	Required Power	Kw	26.8	35.5	11.3	16.8	-	-	-	-
	Std. Power	Kw	30.0	37.0	15.0	18.5	-	-	-	-
Cost	Initial	Civil	42	47	26	31	-	-	-	-
		M&E	535	618	293	390	-	-	-	-
(x1000Kina)		Total	577	665	319	421	-	-	-	-
	O&M (per year)		97	119	32	40	-	-	-	-

3. Paga Point Sewage Treatment Plant

1). Design Criteria

(1) Basic Items

Location:	Paga point, Port Moresby
Ground elevation:	+4.5M
Land use:	Onshore reclamation, National park
Type of sewer:	Separate type
Treatment method:	Primary treatment (Sedimentation)
Sludge treatment method:	Thickening, Digestion
Sludge disposal:	Transfer to Kilakila STP in order to treat (dry) the sludge
Effluent point and water level:	Offshore Discharge, Mean High High Water +2.24M
Lowest monthly temperature:	26℃ (monthly average)

(2) Design sewage flow (m^3/day)

Daily average (Q_1)	Daily maximum (Q_2)	Hourly maximum (Q_3)
15,923	20,700	23,828

(3) Design water quality (mg/L)

Item	Influent	Primary treatment	
		Removal ratio (%)	Effluent
BOD	170	40	102
COD		40	
S S	200	40	120

(4) Moisture content of the sludge (%)

Sludge	Generated	Thickened	Digested	Dried
Moisture content	98.0	96.0	96.0	60.0

(5) Design sludge volume

Item	Generated	Thickened	Digested	Dried
Sludge weight	15,923x(200-120) x 1/1,000 =1,274kg/day	1,274kg/day	1,274 x (1-0.7x0.50) =828kg/day	(Sludge is treated at the Kilakila STP) 828kg/day
Sludge volume	1,274 x 1/1,000 x 100/(100-98) =63.7m^3/day	1,274 x 1/1,000 x 100/(100-96) =31.9m^3/day	828 x 1/1,000 x 100/(100-96) =21.5m^3/day	828 x 1/1,000 x 100/(100-60) =2.1m^3/day

2). Capacity calculation

(1) Sewage treatment facilities

Item		Calculation
1.Sedimentation Tank		
Type		Circular tank
Sewage flow	Q_2	20,700m^3/day
Water surface load	WL	35 - 70 m^3/day/m^2
Required surface area	A	20,700÷(35 - 70)=295.7 - 591.4m^2
No. of tank	N	2 tanks
Diameter of tank	D	16.0m (A=201.0m^2)
Effective depth	H	3.5m
Dimension		16.0m^W×3.5m^H×2tanks
Check		
Water surface load	WL	20,700÷(201.0×2)=51.5m^3/m^2/day
Retention time	T	(201.0×3.5×2)÷(20,700/24)=1.63hours
2.Disinfection Facility		
Chlorine requirement		Dosage : 10mg/L Design sewage flow : 15,923m^3/day (Q_1) Chlorine weight : 159.2kg/day (4,776kg/30days)
Storage facility		Storage period 30days, 1ton gas cylinder×5
3. Offshore Discharge		
Sewage flow	Q_3	23,885m^3/day=16.59m^3/min.=0.2764m^3/sec.
Pipe		Dia.=560mm, High density polyethylene (HDPE) Pipe (Existing)
Length	L	2,920m
Velocity	V	1.12m/sec.
Pumping head	WH	Seawater specific gravity: (1.03-1.00)×30m^D=0.90m Discharging head loss: 0.06m Friction head loss: I×L= $(n\times V\div R^{2/3})^2\times L$ $=(0.010\times 1.12\div 0.14^{2/3})^2\times 2,920$ =5.07m Pumping head loss: 1.50m Total: 7.53m Discharging pumping head: +2.24M(seawater level) +7.53=9.77M
Pump specification		Dia.250mm×8.30m^3/min.×7.6m^H×18.5Kw×2nos.(+1stand-by)

(2) Sludge treatment facilities

Item		Calculation
1. Thickener		
Type		Circular tank
Sludge volume	SV	1,274kg/day, 63.7m^3/day (Water content ratio: 98.0%)
Solid surface load	SL	60 - 90 kg/day/m^2
Required surface area	A	1,274÷(60 - 90)=14.2 - 21.2m^2
No. of tank	N	1 tank
Diameter of tank	D	5.0m (A=19.6m^2)
Effective depth	H	3.5m
Dimension		$5.0m^D \times 3.5m^H \times$ 1tank
Check		
Solid surface load	SL	1,274÷(19.6×1)=65.0kg /day/m^2
Retention time	T	(19.6×3.5×1)÷(63.7/24)=25.8hours
2. Digestion tank		
Type		Anaerobic digestion, No-heating with recirculation
Sludge volume	SV	1,274kg/day, 31.9m^3/day (Water content ratio: 96.0%)
Retention time	T	30days
Required capacity	V	31.9×30=957m^3
No. of tank	N	1tanks
Capacity per tank	V'	957÷1=957m^3
Diameter	D	13.0m
Side depth	H_1	6.5m V_1=862.8m^3
Corn depth	H_2	6.5×(1/3)=2.2m V_2=202.4m^3 V_1+ V_2= 1,065.2m^3
Dimension		$13.0m^D \times (6.5m^{H1}+2.2m^{H2}) \times$ 2 tanks
Sludge volume	SV'	Organic matter content ratio : 70%
through digestion		Digestion efficiency : 50%
		∴ 1,274×(1-0.7×0.5)=828kg/day, 21.5m^3/day (96%)
Check		
Retention time	T	1,065.2×1÷31.9=33.4days
3. Sludge transport		
Working days		5 days per week
Sludge volume	SV	21.5m^3/day×(7days/5days)=30.1m^3/working day
Vacuum truck		8.0m^3
Frequency		30.1÷8.0=3.76=4times/working day

4. Kila kila Sewage Treatment Plant

1). Design Criteria

(1) Basic Items

Location:	Kila kila, Port Moresby
Ground elevation:	+5.5M
Land use:	Uncultivated land
Type of sewer:	Separate type
Treatment method:	Primary treatment (Sedimentation)
Sludge treatment method:	Digestion and Drying
Sludge disposal:	Reuse of the sludge for land application (fertilizer)
Effluent point and water level:	Offshore Discharge, Mean High High Water +2.24M
Lowest monthly temperature:	26℃ (monthly average)

(2) Design sewage flow (m^3/day)

Daily average (Q_1)	Daily maximum (Q_2)	Hourly maximum (Q_3)
31,563	41,032	47,345

(3) Design water quality (mg/L)

Item	Influent	Primary treatment	
		Removal ratio (%)	Effluent
BOD	170	40	102
COD		40	
S S	200	40	120

(4) Moisture content of the sludge (%)

Sludge	Settled	Thickened	Digested	Dried
Moisture content	98.0	96.0	96.0	60.0

(5) Design sludge volume

Item	Generated	Thickened	Digested	Dried
Sludge weight	31,563x(200-120) x 1/1,000 =2,525kg/day	2,525kg/day	2,525 x (1-0.7x0.50) =1,641kg/day	1,641kg/day
Sludge volume	2,525 x 1/1,000 x 100/(100-98) =126.3m^3/day	2,525 x 1/1,000 x 100/(100-96) =63.1m^3/day	1,641 x 1/1,000 x 100/(100-96) =41.0m^3/day	1,641 x 1/1,000 x 100/(100-60) =4.1m^3/day

2). Capacity calculation

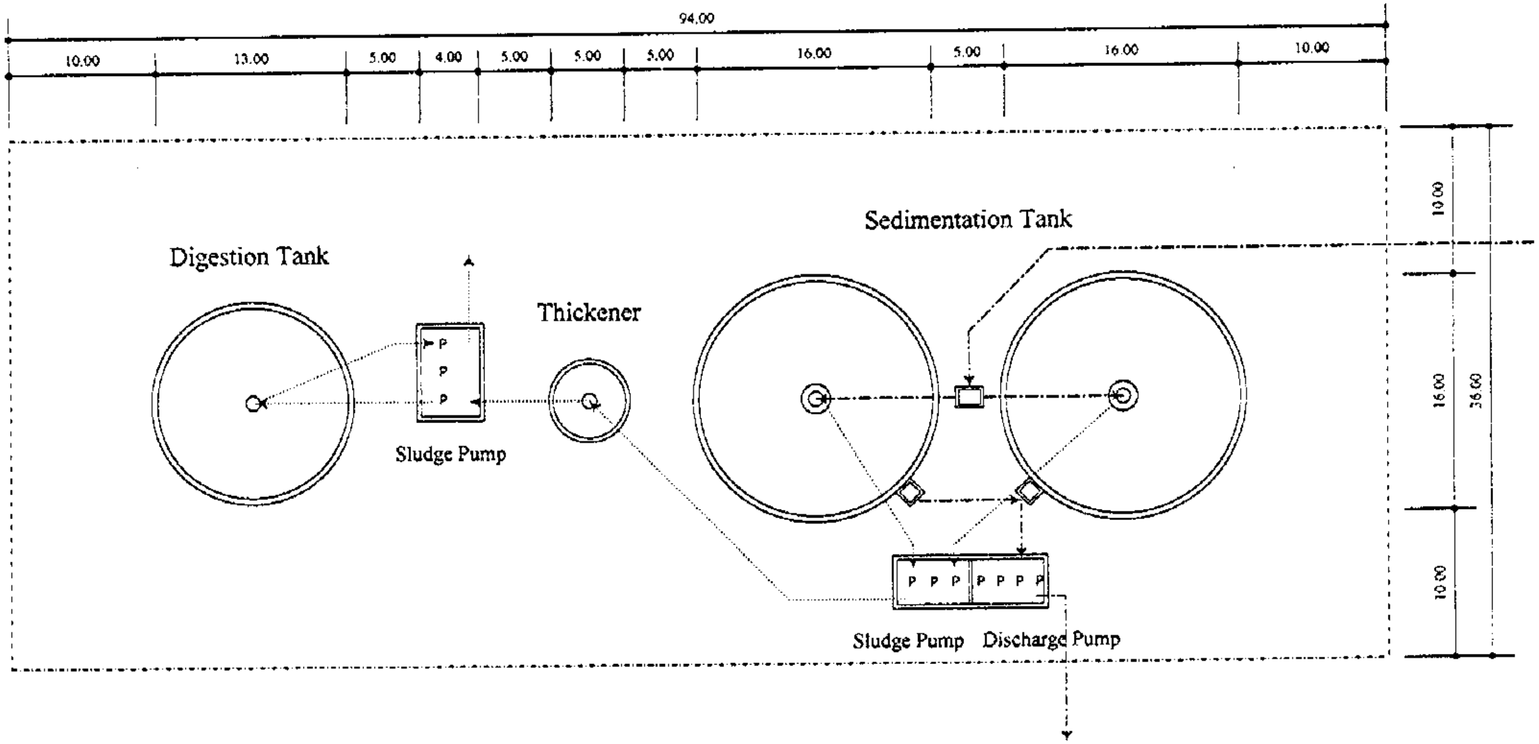
(1) Sewage treatment facilities

Item		Calculation
1.Sedimentation Tank		
Type		Circular tank
Sewage flow	Q_2	41,032m^3/day
Water surface load	WL	35 - 70 $m^3/day/m^2$
Required surface area	A	41,032÷(35 - 70)=586.2 - 1,172.3m^2
No. of tank	N	4 tanks
Diameter of tank	D	16.0m (A=201.0m^2)
Effective depth	H	3.5m
Dimension		$16.0m^W \times 3.5m^H \times$ 4tanks
Check		
Water surface load	WL	41,032÷(201.0×4)=51.0m^3/m^2/day
Retention time	T	(201.0×3.5×4)÷(41,032/24)=1.65hours
2.Disinfection Facility		
Chlorine requirement		Dosage : 10mg/L Design sewage flow : 31,563m^3/day (Q_1) Chlorine weight : 315.6kg/day (9,468kg/30days)
Storage facility		Storage period 30days, 1ton gas cylinder×10
3. Offshore Discharge		
Sewage flow	Q_3	47,345m^3/day=32.88m^3/min.=0.5480m^3/sec.
Pipe		Dia.=900mm, High density polyethylene (HDPE) Pipe
Length	L	3,650m
Velocity	V	0.86m/sec.
Effluent pit head	WH	Seawater specific gravity: (1.03-1.00)×30m^D=0.90m Discharging head loss: 0.04m Friction head loss: $I \times L = (n \times V \div R^{2/3})^2 \times L$ $= (0.010 \times 0.86 \div 0.225^{2/3})^2 \times 3{,}650 = 1.98m$ Effluent pit head loss: 0.02m Total: 2.94m Effluent pit WL: +2.24M(seawater level) +2.98=5.18M < 5.50M (GL)

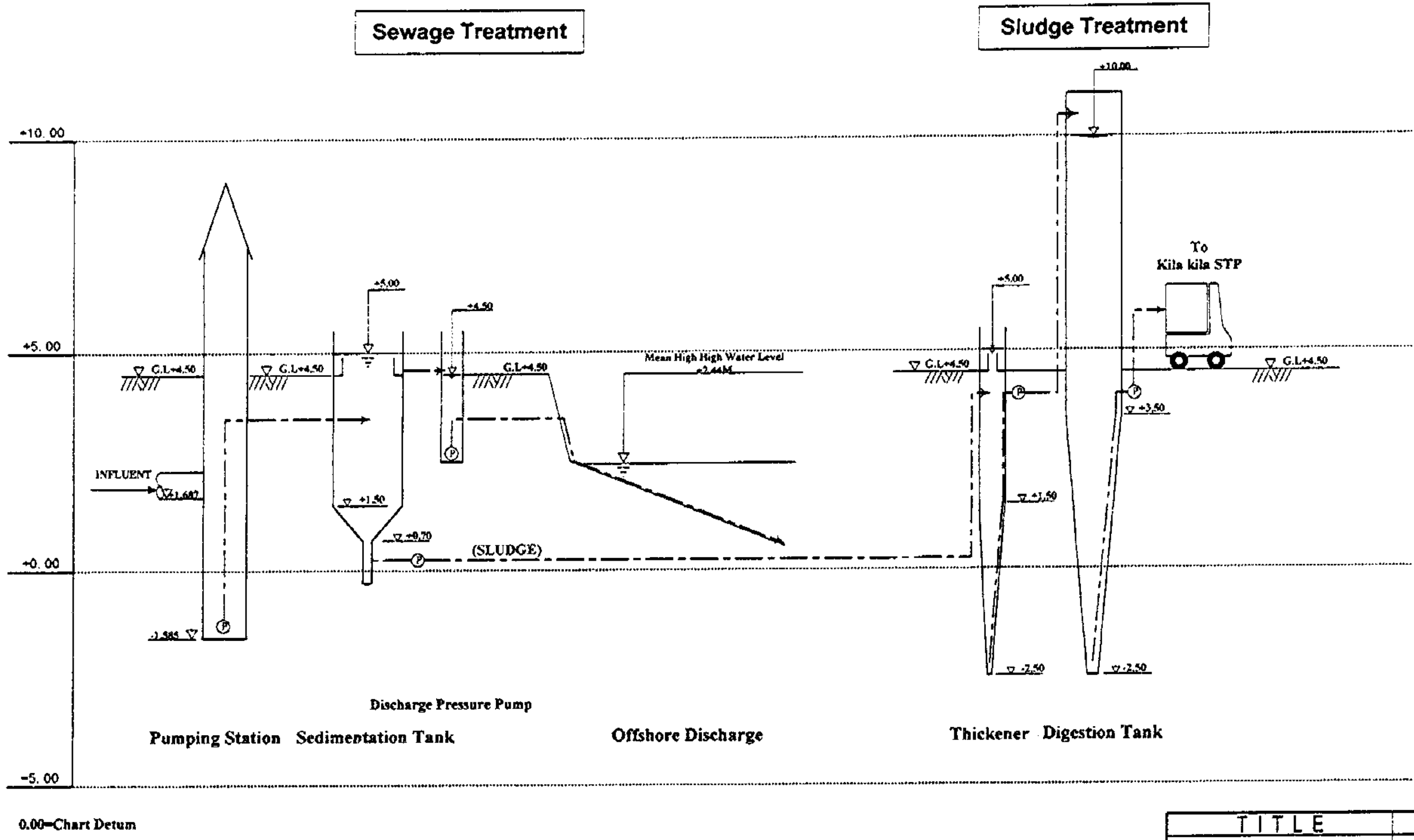
(2) Sludge treatment facilities

Item		Calculation
1. Thickener		
Type		Circular tank
Sludge volume	SV	2,525kg/day, 126.3m^3/day (Water content ratio: 98.0%)
Solid surface load	SL	60 - 90 kg/day/m^2
Required surface area	A	2,525 ÷ (60 - 90) = 28.1 - 42.1m^2
No. of tank	N	2 tank
Diameter of tank	D	5.0m (A=19.6m^2)
Effective depth	H	3.5m
Dimension		5.0m^D × 3.5m^H × 2tank
Check		
Solid surface load	SL	2,525 ÷ (19.6 × 2)=64.4 kg/day/m^2
Retention time	T	(19.6 × 3.5 × 2) ÷ (126.3/24)=26.1hours
2. Digestion tank		
Type		Anaerobic digestion, No-heating with recirculation
Sludge volume	SV	2,525kg/day, 63.1m^3/day (Water content ratio: 96.0%)
Retention time	T	30days
Required capacity	V	63.1 × 30 = 1,893m^3
No. of tank	N	2tanks
Capacity per tank	V'	1,893 ÷ 2=946.5m^3
Diameter	D	13.0m
Side depth	H_1	6.5m V_1=862.8m^3
Corn depth	H_2	6.5 × (1/3)=2.2m V_2=202.4m^3 V_1+ V_2= 1,065.2m^3
Dimension		13.0m^D × (6.5m^{H1}+2.2m^{H2}) × 2 tanks
Sludge volume through digestion	V'	Organic matter content ratio : 70% Digestion efficiency : 50% ∴ 2,525 × (1-0.7 × 0.5)=1,641kg/day, 41.0m^3/day (96%)
Check		
Retention time	T	1,065.2 × 2 ÷ 63.1=33.8days

Item		Calculation
3. Sludge drying beds		
Type		Sand drying bed utilizing evaporation and percolation
Digested sludge volume	SV	Kilakila STP : 1,641kg/day, 41.0m³/day Paga STP : 828kg/day, 21.5m³/day Total : 2,469kg/day, 62.5m³/day
Retention time	T	20days
Required capacity	V	62.5×20=1,250m³
Sludge thickness	H	40cm
Required bed area	A	1,250÷0.40=3,125m²
Dimension		10.0m^W × 15.0m^L × 20beds (3,000m²)
Check		
Retention time	T	(10.0×15.0×0.4×20)÷62.5=19.2days



TITLE	No.
Paga Point STP	C.3.1
General Layout	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	



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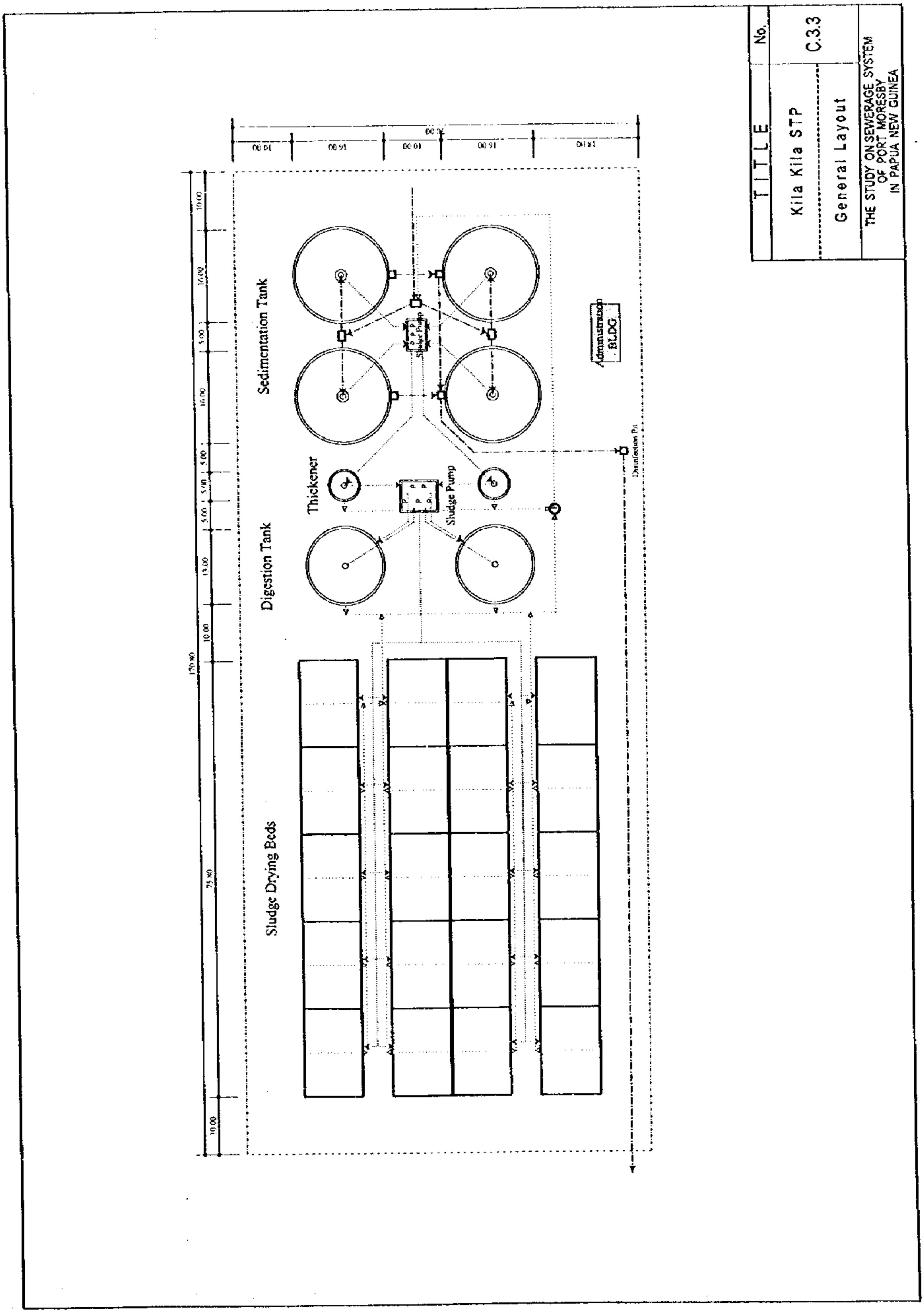
TITLE
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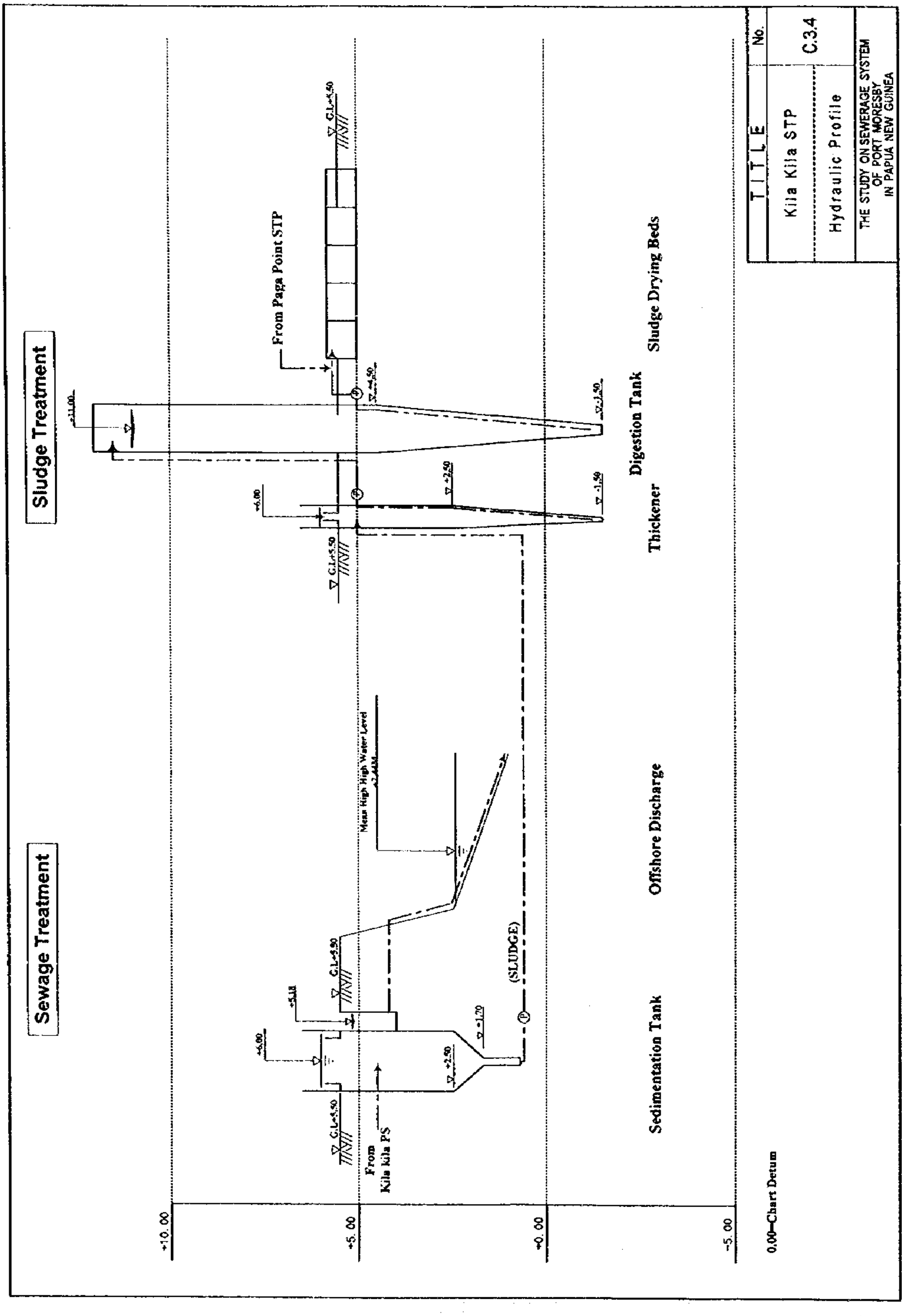
Kila Kila STP
C.3.3
General Layout
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA
Sedimentation Tank
Administration BLDG
Thickener
Sludge Pump
Digestion Tank
Disinfection Pit
Sludge Drying Beds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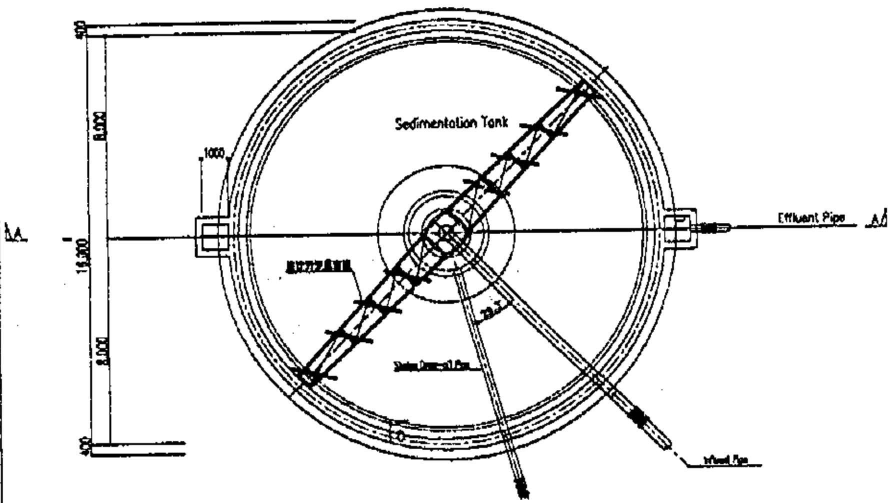
Sludge Treatment
+10.00
+5.00
+0.00
-5.00
0.00—Chart Detum
From
Kila kila PS
Sedimentation Tank
(SLUDGE)
Offshore Discharge
Mean High High Water Level
Thickener
Digestion Tank
From Paga Point STP
Sludge Drying Beds
+11.00
TITLE
No.
Kila Kila STP
Hydraulic Profile
C.3.4
THE STUDY ON SEWERAGE SYSTEM
OF PORT MORESBY
IN PAPUA NEW GUINEA

Sedimentation Tank



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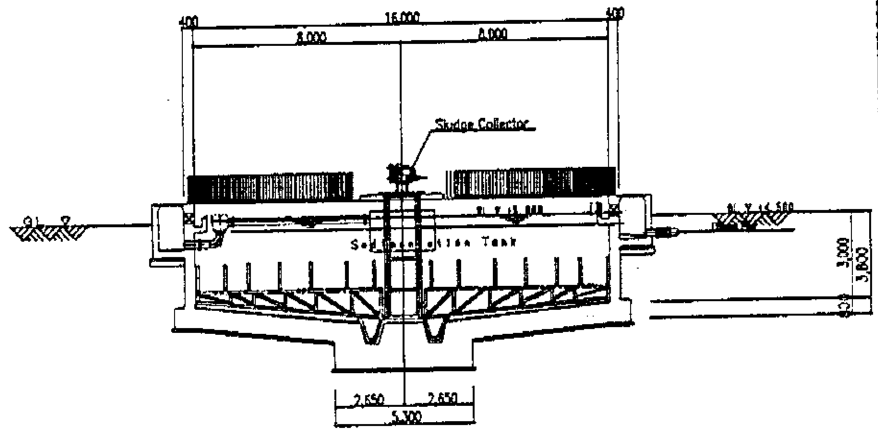

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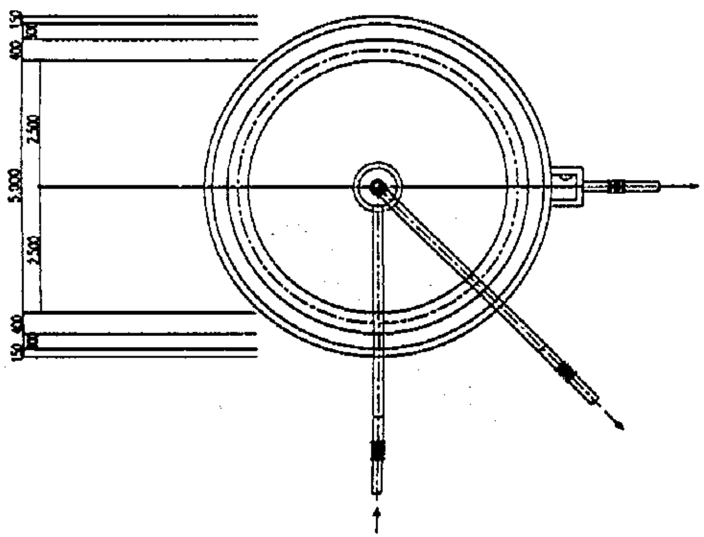
Paga Point & Kila Kila STP	C.3.5
Sedimentation Tank	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	

Thickener



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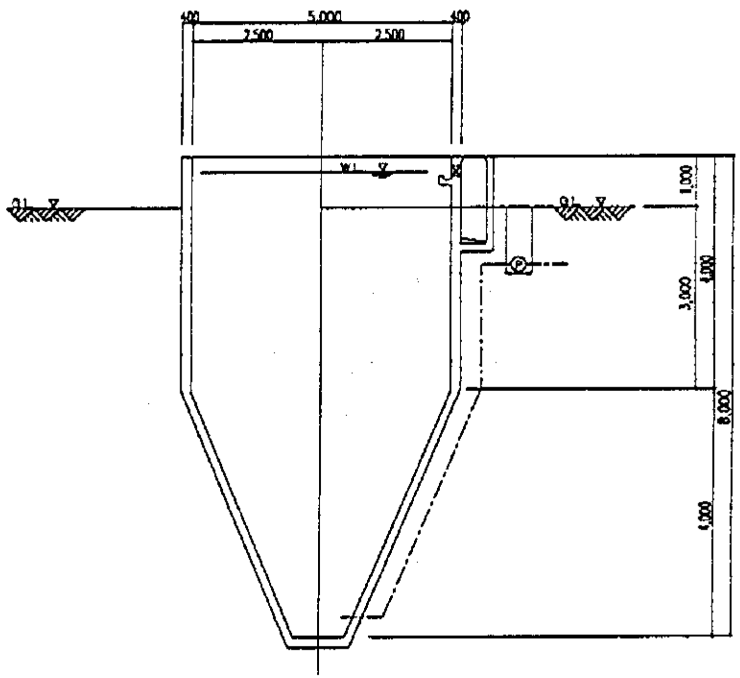

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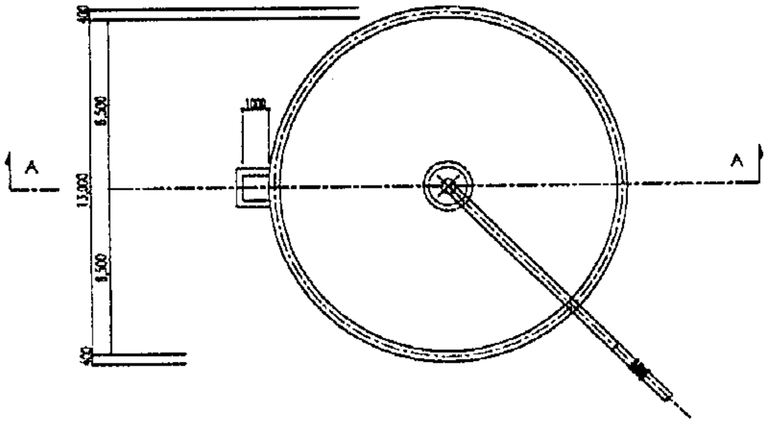
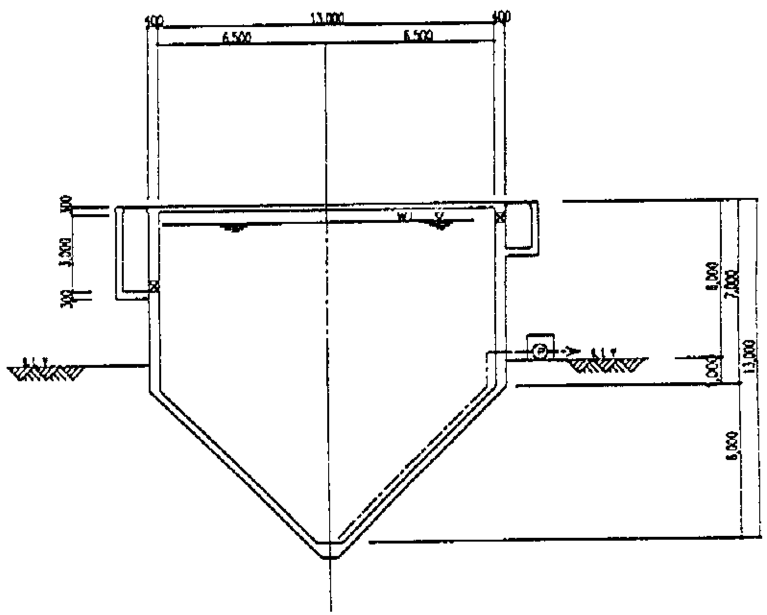
Paga Point & Kila Kila STP	C.3.6
Thickener	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	

Digestion Tank



Section A-A



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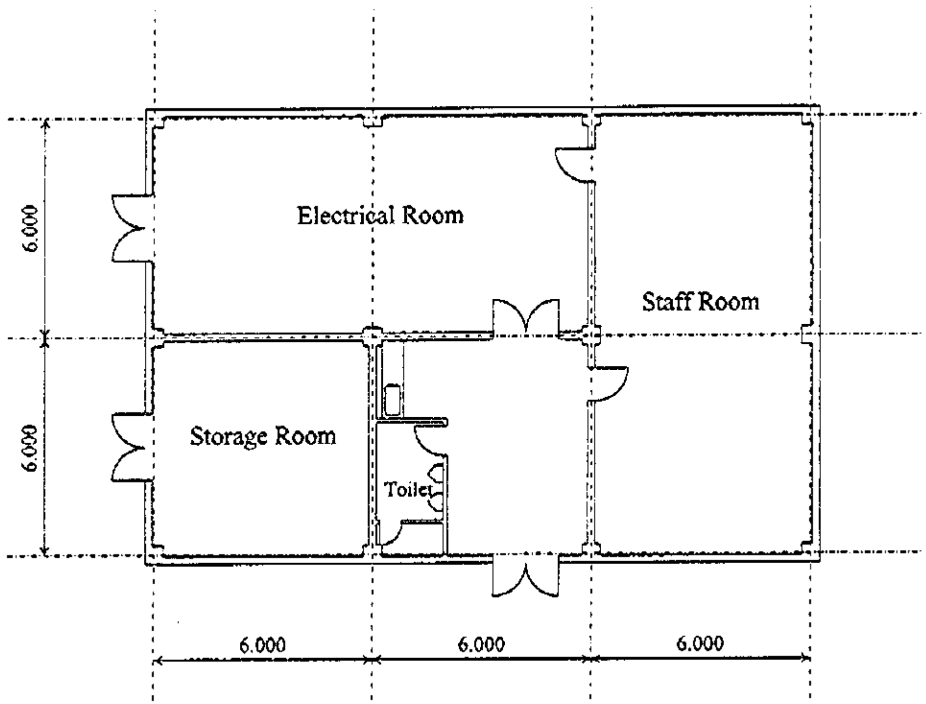
Paga Point & Kila Kila STP	C.3.7
Digestion Tank	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	



TITLE	No.
Paga Point & Kila Kila STP	C.3.8
Administration Building	
THE STUDY ON SEWERAGE SYSTEM OF PORT MORESBY IN PAPUA NEW GUINEA	

APPENDIX D ALTERNATIVE STUDY FOR COASTAL REGION SEWERAGE SYSTEM

LIST OF TABLES

APPENDIX D ALTERNATIVE STUDY FOR COASTAL REGION SEWERAGE SYSTEMS

Table below shows the Alternatives and comparison results of the Sewerage System for coastal region.

Table D.1 Comparison of Alternatives for Coastal Area

Alternative	1-A	1-B	1-C	1-D	2-A	2-B	2-C	2-D
Unit	Tatana Paga ↑ Koki Kila Kila Pari	Tatana ↓ Paga ↑ Koki Kila Kila Pari	Tatana Paga ↑ Koki Kila Kila ↑ Pari	Tatana ↓ Paga ↑ Koki Kila Kila ↑ Pari	Tatana Paga Koki ↓ Kila Kila Pari	Tatana ↓ Paga Koki ↓ Kila Kila Pari	Tatana Paga Koki ↓ Kila Kila ↑ Pari	Tatana ↓ Paga Koki ↓ Kila Kila ↑ Pari
Construction Cost	C	B	C	A	C	B	C	A
O & M Cost	A	C	B	C	A	C	B	C
Impact on the Environment	C	A	C	A	C	A	C	A
Flexibility for Future development	A	B	B	C	A	B	B	C
Ease of Land Acquisition	C	B	B	A	C	B	B	A
OVERALL	**C**	**B**	**B**	**A**	**C**	**B**	**B**	**A**

Note: A-good or less expensive; B-satisfactory; C-poor or expensive

As a result of comparison for the eight alternatives, we propose Case 2-D, consisting of two basins; Paga and Kila Kila.

Table below is an at-a-glance chart of the cost estimation.

Table D.2 Breakdown of Construction and O&M Costs

(Unit: Kina 1,000)

Alternative		1-A	1-B	1-C	1-D	2-A	2-B	2-C	2-D
Construction Cost	Sewer	8,225	8,662	8,929	9,366	8,239	8,676	8,943	9,380
	Pump station	2,647	2,941	2,766	3,060	3,146	3,438	3,163	3,455
	STP	13,022	10,586	11,232	8,797	12,186	9,835	10,393	8,042
	Outfall	4,290	4,290	3,650	3,650	4,918	4,918	4,278	4,278
	Total	28,183	26,479	26,577	**24,873**	28,489	26,867	26,777	**25,155**
O & M cost	Pump station	540	614	555	628	695	755	721	780
	STP	853	912	862	921	722	766	731	775
	Total	**1,393**	1,526	1,417	1,549	**1,418**	1,521	1,453	1,556

Note; The above costs are for comparison only and do not cover entire project costs.

Table D.3 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 1-A)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH (m)	1. Sewer Network		70 ha 9,800	168 ha 23,520	94 ha -	134 ha 18,760	14 ha 1,960	160 ha 22,400	9 ha 1,260		649 ha 67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,041	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	1,290	380	-	-	360	-	-	2,030	
		250	-	-	-	-	-	-	-	0	
		300	1,520	320	-	-	480	-	-	2,320	
		350	-	320	-	-	-	-	-	320	
		400	-	-	-	-	-	1,473	-	1,473	
		450	-	-	1,181	-	-	-	-	1,181	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	7,324
	4. Force Main	150	960	130	-	-	1,160	-	-	2,250	
		200	-	-	-	-	300	-	-	300	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	-	1,400	230	-	1,630	
		350	-	1,480	220	-	-	-	-	1,700	
		400	-	-	1,000	709	-	-	-	1,709	
		450	-	-	303	3,100	-	-	-	3,403	
		500	-	-	-	-	-	360	-	360	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	11,352
	4. Ocean Outfall	200	-	-	-	-	-	-	800	800	
		300	1,000	-	-	-	-	-	-	1,000	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	5,450
COST (x1000Kina)	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	346	102	-	-	97	-	-	198	
		250	-	-	-	-	-	-	-	0	
		300	575	121	-	-	182	-	-	303	
		350	-	125	-	-	-	-	-	125	
		400	-	-	-	-	-	637	-	637	
		450	-	-	617	-	-	-	-	617	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	1,880
	4. Force Main	150	182	25	-	-	220	-	-	245	
		200	-	-	-	-	66	-	-	66	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	-	406	67	-	473	
		350	-	518	77	-	-	-	-	595	
		400	-	-	390	277	-	-	-	667	
		450	-	-	133	1,364	-	-	-	1,497	
		500	-	-	-	-	-	180	-	180	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	3,723
	4. Ocean Outfall	200	-	-	-	-	-	-	640	640	
		300	850	-	-	-	-	-	-	0	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	4,290
	Total		1,953 (4,729)	891 (7,900)	1,217 (1,297)	1,641 (7,507)	970 (1,496)	4,533 (11,407)	640 (1,117)		12,515 (33,352)

Table D.4 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 1-B)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH (m)	1. Sewer Network		70 ha 9,800	168 ha 23,520	94 ha -	134 ha 18,760	14 ha 1,960	160 ha 22,400	9 ha 1,260		649 ha 67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,041	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	760	-	-	-	360	-	-	1,120	
		250	-	-	-	-	-	-	-	0	
		300	2,580	-	-	-	480	-	-	3,060	
		350	-	270	-	-	-	-	-	270	
		400	-	110	-	-	-	1,473	-	1,583	
		450	-	640	-	-	-	-	-	640	
		500	-	-	1,181	-	-	-	-	1,181	
		600	-	-	-	-	-	-	-	0	7,854
	4. Force Main	150	960	-	-	-	1,160	-	-	2,120	
		200	-	-	-	-	300	-	-	300	
		250	-	-	-	-	-	-	-	0	
		300	220	130	-	-	1,400	230	-	1,980	
		350	-	-	220	-	-	-	-	220	
		400	-	-	-	709	-	-	-	709	
		450	-	1,480	1,000	3,100	-	-	-	5,580	
		500	-	-	303	-	-	360	-	663	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	11,572
	4. Ocean Outfall	200	-	-	-	-	-	-	800	800	
		300	1,000	-	-	-	-	-	-	1,000	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	5,450
COST (x1000Kina)	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	204	-	-	-	97	-	-	97	
		250	-	-	-	-	-	-	-	0	
		300	976	-	-	-	182	-	-	182	
		350	-	106	-	-	-	-	-	106	
		400	-	48	-	-	-	637	-	684	
		450	-	334	-	-	-	-	-	334	
		500	-	-	700	-	-	-	-	700	
		600	-	-	-	-	-	-	-	0	2,102
	4. Force Main	150	182	-	-	-	220	-	-	220	
		200	-	-	-	-	66	-	-	66	
		250	-	-	-	-	-	-	-	0	
		300	64	38	-	-	406	67	-	510	
		350	-	-	77	-	-	-	-	77	
		400	-	-	-	277	-	-	-	277	
		450	-	651	440	1,364	-	-	-	2,455	
		500	-	-	152	-	-	180	-	332	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	3,937
	4. Ocean Outfall	200	-	-	-	-	-	-	640	640	
		300	850	-	-	-	-	-	-	0	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	4,290
	Total		2,276 (5,051)	1,176 (8,185)	1,369 (1,448)	1,641 (7,507)	970 (1,496)	4,533 (11,407)	640 (1,117)		12,952 (33,789)

Table D.5 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 1-C)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH	1. Sewer Network		70 ha	168 ha	94 ha	134 ha	14 ha	160 ha	9 ha		649 ha
(m)			9,800	23,520	-	18,760	1,960	22,400	1,260		67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,041	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	1,290	380	-	-	360	-	-	2,030	
		250	-	-	-	-	-	-	-	0	
		300	1,520	320	-	-	480	-	-	2,320	
		350	-	320	-	-	-	-	-	320	
		400	-	-	-	-	-	1,473	-	1,473	
		450	-	-	1,181	-	-	-	-	1,181	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	7,324
	4. Force Main	150	960	130	-	-	1,160	-	-	2,250	
		200	-	-	-	-	300	-	3,200	3,500	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	-	1,400	230	-	1,630	
		350	-	1,480	220	-	-	-	-	1,700	
		400	-	-	1,000	709	-	-	-	1,709	
		450	-	-	303	3,100	-	-	-	3,403	
		500	-	-	-	-	-	360	-	360	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	14,552
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	3,650
COST	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
(x1000Kina)	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	346	102	-	-	97	-	-	198	
		250	-	-	-	-	-	-	-	0	
		300	575	121	-	-	182	-	-	303	
		350	-	125	-	-	-	-	-	125	
		400	-	-	-	-	-	637	-	637	
		450	-	-	617	-	-	-	-	617	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	1,880
	4. Force Main	150	182	25	-	-	220	-	-	245	
		200	-	-	-	-	66	-	704	770	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	-	406	67	-	473	
		350	-	518	77	-	-	-	-	595	
		400	-	-	390	277	-	-	-	667	
		450	-	-	133	1,364	-	-	-	1,497	
		500	-	-	-	-	-	180	-	180	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	4,427
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	3,650
	Total		1,103 (3,879)	891 (7,900)	1,217 (1,297)	1,641 (7,507)	970 (1,496)	4,533 (11,407)	704 (1,181)		12,579 (33,416)

Table D.6 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 1-D)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH (m)	1. Sewer Network		70 ha 9,800	168 ha 23,520	94 ha -	134 ha 18,760	14 ha 1,960	160 ha 22,400	9 ha 1,260		649 ha 67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,011	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	760	-	-	-	360	-	-	1,120	
		250	-	-	-	-	-	-	-	0	
		300	2,580	-	-	-	480	-	-	3,060	
		350	-	270	-	-	-	-	-	270	
		400	-	110	-	-	-	1,473	-	1,583	
		450	-	640	-	-	-	-	-	640	
		500	-	-	1,181	-	-	-	-	1,181	
		600	-	-	-	-	-	-	-	0	7,854
	4. Force Main	150	960	-	-	-	1,160	-	-	2,120	
		200	-	-	-	-	300	-	3,200	3,500	
		250	-	-	-	-	-	-	-	0	
		300	220	130	-	-	1,400	230	-	1,980	
		350	-	-	220	-	-	-	-	220	
		400	-	-	-	709	-	-	-	709	
		450	-	1,480	1,000	3,100	-	-	-	5,580	
		500	-	-	303	-	-	360	-	663	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	14,772
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	3,650
COST (x1000Kina)	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	204	-	-	-	97	-	-	97	
		250	-	-	-	-	-	-	-	0	
		300	976	-	-	-	182	-	-	182	
		350	-	106	-	-	-	-	-	106	
		400	-	48	-	-	-	637	-	684	
		450	-	334	-	-	-	-	-	334	
		500	-	-	700	-	-	-	-	700	
		600	-	-	-	-	-	-	-	0	2,102
	4. Force Main	150	182	-	-	-	220	-	-	220	
		200	-	-	-	-	66	-	704	770	
		250	-	-	-	-	-	-	-	0	
		300	64	38	-	-	406	67	-	510	
		350	-	-	77	-	-	-	-	77	
		400	-	-	-	277	-	-	-	277	
		450	-	651	440	1,364	-	-	-	2,455	
		500	-	-	152	-	-	180	-	332	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	-	-	0	4,641
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	3,650	-	3,650	
		900	-	-	-	-	-	-	-	0	3,650
	Total		1,426 (4,201)	1,176 (8,185)	1,369 (1,448)	1,641 (7,507)	970 (1,496)	4,533 (11,407)	704 (1,181)		13,016 (33,853)

Table D.7 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 2-A)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH (m)	1. Sewer Network		70 ha 9,800	168 ha 23,520	94 ha -	134 ha 18,760	14 ha 1,960	160 ha 22,400	9 ha 1,260		649 ha 67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,041	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	1,290	380	-	-	360	-	-	2,030	
		250	-	-	-	-	-	-	-	0	
		300	1,520	320	-	-	480	-	-	2,320	
		350	-	320	-	-	-	-	-	320	
		400	-	-	-	-	-	-	-	0	
		450	-	-	1,181	-	-	-	-	1,181	
		500	-	-	-	-	-	52	-	52	
		600	-	-	-	373	-	1,843	-	2,216	8,119
	4. Force Main	150	960	130	-	-	1,160	-	-	2,250	
		200	-	-	-	-	300	-	-	300	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	336	1,400	-	-	1,736	
		350	-	1,480	220	-	-	-	-	1,700	
		400	-	-	1,000	-	-	-	-	1,000	
		450	-	-	303	1,160	-	-	-	1,463	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	360	-	360	8,809
	4. Ocean Outfall	200	-	-	-	-	-	-	800	800	
		300	1,000	-	-	-	-	-	-	1,000	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	3,650	-	3,650	5,450
COST (x1000Kina)	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	346	102	-	-	97	-	-	198	
		250	-	-	-	-	-	-	-	0	
		300	575	121	-	-	182	-	-	303	
		350	-	125	-	-	-	-	-	125	
		400	-	-	-	-	-	-	-	0	
		450	-	-	617	-	-	-	-	617	
		500	-	-	-	-	-	31	-	31	
		600	-	-	-	262	-	1,295	-	1,557	2,831
	4. Force Main	150	182	25	-	-	220	-	-	245	
		200	-	-	-	-	66	-	-	66	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	97	406	-	-	503	
		350	-	518	77	-	-	-	-	595	
		400	-	-	390	-	-	-	-	390	
		450	-	-	133	510	-	-	-	644	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	342	-	342	2,785
	4. Ocean Outfall	200	-	-	-	-	-	-	640	640	
		300	850	-	-	-	-	-	-	0	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	4,278	-	4,278	4,918
	Total		1,953 (4,729)	891 (7,900)	1,217 (1,297)	870 (6,737)	970 (1,496)	5,946 (12,819)	640 (1,117)		13,157 (33,994)

Table D.8 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 2-B)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Koncdobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH (m)	1. Sewer Network		70 ha 9,800	168 ha 23,520	94 ha -	134 ha 18,760	14 ha 1,960	160 ha 22,400	9 ha 1,260		649 ha 67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,041	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	760	-	-	-	360	-	-	1,120	
		250	-	-	-	-	-	-	-	0	
		300	2,580	-	-	-	480	-	-	3,060	
		350	-	270	-	-	-	-	-	270	
		400	-	110	-	-	-	-	-	110	
		450	-	640	-	-	-	-	-	640	
		500	-	-	1,181	-	-	52	-	1,233	
		600	-	-	-	373	-	1,843	-	2,216	8,649
	4. Force Main	150	960	-	-	-	1,160	-	-	2,120	
		200	-	-	-	-	300	-	-	300	
		250	-	-	-	-	-	-	-	0	
		300	220	130	-	336	1,400	-	-	2,086	
		350	-	-	220	-	-	-	-	220	
		400	-	-	-	-	-	-	-	0	
		450	-	1,480	1,000	1,160	-	-	-	3,640	
		500	-	-	303	-	-	-	-	303	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	360	-	360	9,029
	4. Ocean Outfall	200	-	-	-	-	-	-	800	800	
		300	1,000	-	-	-	-	-	-	1,000	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	3,650	-	3,650	5,450
COST (x1000Kina)	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	204	-	-	-	97	-	-	97	
		250	-	-	-	-	-	-	-	0	
		300	976	-	-	-	182	-	-	182	
		350	-	106	-	-	-	-	-	106	
		400	-	48	-	-	-	-	-	48	
		450	-	334	-	-	-	-	-	334	
		500	-	-	700	-	-	31	-	731	
		600	-	-	-	262	-	1,295	-	1,557	3,054
	4. Force Main	150	182	-	-	-	220	-	-	220	
		200	-	-	-	-	66	-	-	66	
		250	-	-	-	-	-	-	-	0	
		300	64	38	-	97	406	-	-	541	
		350	-	-	77	-	-	-	-	77	
		400	-	-	-	-	-	-	-	0	
		450	-	651	440	510	-	-	-	1,602	
		500	-	-	152	-	-	-	-	152	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	342	-	342	3,000
	4. Ocean Outfall	200	-	-	-	-	-	-	640	640	
		300	850	-	-	-	-	-	-	0	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	4,278	-	4,278	4,918
	Total		2,276 (5,051)	1,176 (8,185)	1,369 (1,448)	870 (6,737)	970 (1,496)	5,946 (12,819)	640 (1,117)		13,594 (34,431)

Table D.9 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 2-C)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH (m)	1. Sewer Network		70 ha	168 ha	94 ha	134 ha	14 ha	160 ha	9 ha		649 ha
			9,800	23,520	-	18,760	1,960	22,400	1,260		67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,041	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	1,290	380	-	-	360	-	-	2,030	
		250	-	-	-	-	-	-	-	0	
		300	1,520	320	-	-	480	-	-	2,320	
		350	-	320	-	-	-	-	-	320	
		400	-	-	-	-	-	-	-	0	
		450	-	-	1,181	-	-	-	-	1,181	
		500	-	-	-	-	-	52	-	52	
		600	-	-	-	373	-	1,843	-	2,216	8,119
	4. Force Main	150	960	130	-	-	1,160	-	-	2,250	
		200	-	-	-	-	300	-	3,200	3,500	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	336	1,400	-	-	1,736	
		350	-	1,480	220	-	-	-	-	1,700	
		400	-	-	1,000	-	-	-	-	1,000	
		450	-	-	303	1,160	-	-	-	1,463	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	360	-	360	12,009
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	3,650	-	3,650	3,650
COST (x1000Kina)	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	346	102	-	-	97	-	-	198	
		250	-	-	-	-	-	-	-	0	
		300	575	121	-	-	182	-	-	303	
		350	-	125	-	-	-	-	-	125	
		400	-	-	-	-	-	-	-	0	
		450	-	-	617	-	-	-	-	617	
		500	-	-	-	-	-	31	-	31	
		600	-	-	-	262	-	1,295	-	1,557	2,831
	4. Force Main	150	182	25	-	-	220	-	-	245	
		200	-	-	-	-	66	-	704	770	
		250	-	-	-	-	-	-	-	0	
		300	-	-	-	97	406	-	-	503	
		350	-	518	77	-	-	-	-	595	
		400	-	-	390	-	-	-	-	390	
		450	-	-	133	510	-	-	-	644	
		500	-	-	-	-	-	-	-	0	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	342	-	342	3,489
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	4,278	-	4,278	4,278
	Total		1,103	891	1,217	870	970	5,946	704		13,221
			(3,879)	(7,900)	(1,297)	(6,737)	(1,496)	(12,819)	(1,181)		(34,058)

Table D.10 Cost Estimation for Trunk Sewers, Force Mains and Ocean Outfalls (Case 2-D)

Item	Breakdown	Dia. (mm)	Baruni/ Tatana	Idubada/ Hanuabada	Konedobu/ Town	Koki/ Badili	Gabutu/ Vabukori	Kila Kila	Pari	Total	
LENGTH (m)	1. Sewer Network		70 ha 9,800	168 ha 23,520	94 ha -	134 ha 18,760	14 ha 1,960	160 ha 22,400	9 ha 1,260		649 ha 67,900
	2. Sub-trunk Sewer	200	550	2,460	160	3,049	-	2,302	520	9,041	
		250	-	130	116	57	-	-	-	303	
		300	-	-	-	-	-	430	-	430	
		400	-	-	-	-	-	200	-	200	9,974
	3. Trunk Sewer	200	760	-	-	-	360	-	-	1,120	
		250	-	-	-	-	-	-	-	0	
		300	2,580	-	-	-	480	-	-	3,060	
		350	-	270	-	-	-	-	-	270	
		400	-	110	-	-	-	-	-	110	
		450	-	640	-	-	-	-	-	640	
		500	-	-	1,181	-	-	52	-	1,233	
		600	-	-	-	373	-	1,843	-	2,216	8,649
	4. Force Main	150	960	-	-	-	1,160	-	-	2,120	
		200	-	-	-	-	300	-	3,200	3,500	
		250	-	-	-	-	-	-	-	0	
		300	220	130	-	336	1,400	-	-	2,086	
		350	-	-	220	-	-	-	-	220	
		400	-	-	-	-	-	-	-	0	
		450	-	1,480	1,000	1,160	-	-	-	3,640	
		500	-	-	303	-	-	-	-	303	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	360	-	360	12,229
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	3,650	-	3,650	3,650
COST (x1000Kina)	1. Sewer Network		(2,628)	(6,308)	-	(5,031)	(526)	(6,007)	(338)		(20,838)
	2. Sub-trunk Sewer	200	147	660	43	818	-	617	139	2,277	
		250	-	41	37	18	-	-	-	96	
		300	-	-	-	-	-	163	-	163	
		400	-	-	-	-	-	86	-	86	2,623
	3. Trunk Sewer	200	204	-	-	-	97	-	-	97	
		250	-	-	-	-	-	-	-	0	
		300	976	-	-	-	182	-	-	182	
		350	-	106	-	-	-	-	-	106	
		400	-	48	-	-	-	-	-	48	
		450	-	334	-	-	-	-	-	334	
		500	-	-	700	-	-	31	-	731	
		600	-	-	-	262	-	1,295	-	1,557	3,054
	4. Force Main	150	182	-	-	-	220	-	-	220	
		200	-	-	-	-	66	-	704	770	
		250	-	-	-	-	-	-	-	0	
		300	64	38	-	97	406	-	-	541	
		350	-	-	77	-	-	-	-	77	
		400	-	-	-	-	-	-	-	0	
		450	-	651	440	510	-	-	-	1,602	
		500	-	-	152	-	-	-	-	152	
		600	-	-	-	-	-	-	-	0	
		700	-	-	-	-	-	-	-	0	
		800	-	-	-	-	-	342	-	342	3,704
	4. Ocean Outfall	200	-	-	-	-	-	-	-	0	
		300	-	-	-	-	-	-	-	0	
		750	-	-	-	-	-	-	-	0	
		900	-	-	-	-	-	4,278	-	4,278	4,278
	Total		1,426 (4,201)	1,176 (8,185)	1,369 (1,448)	870 (6,737)	970 (1,496)	5,946 (12,819)	704 (1,181)		13,658 (34,495)

Table D.11 Cost Estimation for the Pumping Facilities

Pumping Station		Planned Sewage Flow						Force Main				Pump Head (Hazen's Formula, C=110)						Pump Specification					Cost (x1000Kina)				
		Population	Qd_{ave}	Peak Factor	Qh_{max}		Type	Dia	V	i	L	Suction WL	Discharge WL	H_{actual}	H_{loss}	H_{pump}	Total	Nos.	Q	Dia	Output Calc.	Output STD.	Land	Construction			O&M
		Person	m³/day	-	m³/day	m³/min		mm	m/sec	-	m	M	M	m	m	m	m	-	m³/min	mm	Kw	Kw		Civil	M&E	Total	
Tatana	No.1	2,750	1,238	2.0	2,475	1.72	III	150	1.62	0.0257	220	-0.5	10.0	10.5	5.65	1.5	17.65	2 (+1)	0.86	100	4.4	5.5	2.5	70	50	120	8.9
	No.2	2,825	1,271	2.0	2,543	1.77	III	150	1.67	0.0270	740	-2.6	-0.5	2.1	19.97	1.5	23.57	2 (+1)	0.88	100	6.0	7.5	2.5	70	55	125	12.1
	No.3	5,547	2,496	1.8	4,493	3.12	III	250	1.06	0.0064	1,000	0.0	10.0	10.0	6.43	1.5	17.93	2 (+1)	1.56	100	8.1	11.0	2.5	70	62	131	19.7
	No.4	6,453	2,904	1.8	5,227	3.63	III	300	0.86	0.0035	220	-9.4	1.0	10.4	0.77	1.5	12.67	2 (+1)	1.81	100	6.6	7.5	2.5	70	57	127	13.4
Hanuabada	No.1	8,264	3,719	1.8	6,694	4.65	III	300	1.10	0.0055	130	-1.0	5.2	6.2	0.72	1.5	8.42	2 (+1)	2.32	150	5.6	7.5	2.5	70	54	124	13.4
	No.2	17,464	7,859	1.6	12,574	8.73	IV	450	0.92	0.0025	1,480	-4.5	9.0	13.5	3.65	1.5	18.65	3 (+1)	2.91	150	15.7	18.5	7.2	168	102	269	55.9
Yacht Club		545	245	2.0	491	0.34	I	150	0.32	0.0013	98	1.5	13.6	12.1	0.13	1.5	13.73	1 (+1)	0.34	100	1.3	0.0	0.6	29	40	69	0.0
Konedobu	No.1	8,639	3,888	1.8	6,998	4.86	III	350	0.84	0.0028	220	-0.4	0.0	0.4	0.62	1.5	2.52	2 (+1)	2.43	150	1.8	0.0	2.5	70	42	112	0.0
	No.2	27,330	12,299	1.5	18,448	12.81	IV	450	1.34	0.0050	1,000	-0.1	10.9	11.0	5.01	1.5	17.51	3 (+1)	4.27	200	21.6	22.0	7.2	168	126	294	70.9
Stanley		32,160	14,472	1.5	21,708	15.08	V	500	1.28	0.0041	303	-1.0	15.9	16.9	1.23	1.5	19.63	3 (+1)	5.03	200	28.4	30.0	10.2	267	155	421	96.7
Lawes		1,713	771	2.0	1,542	1.07	II	150	1.01	0.0107	50	-0.3	0.7	1.0	0.53	2.5	4.03	1 (+1)	1.07	100	1.2	0.0	0.6	29	39	69	0.0
Davara		2,592	1,166	2.0	2,333	1.62	III	150	1.53	0.0230	50	-1.4	1.8	3.2	1.15	3.5	7.85	2 (+1)	0.81	100	1.8	0.0	2.5	70	42	112	0.0
Paga		35,384	15,923	1.5	23,884	16.59	V	400	2.20	0.0143	50	-1.9	5.0	6.9	0.72	1.5	9.12	3 (+1)	5.53	200	13.5	15.0	10.2	267	97	364	48.4
Koki		4,634	2,085	2.0	4,171	2.90	III	300	0.68	0.0023	336	-2.1	8.0	10.1	0.77	1.5	12.37	2 (+1)	1.45	100	5.2	0.0	2.5	70	53	122	0.0
Badili		20,348	9,157	1.5	13,735	9.54	IV	450	1.00	0.0029	1,160	-1.8	25.0	26.8	3.37	1.5	31.67	3 (+1)	3.18	150	29.0	30.0	7.2	168	157	325	96.7
Kaugere		28,436	12,796	1.5	19,194	13.33	IV	600	0.79	0.0013	230	11.0	20.9	9.9	0.31	1.5	11.71	3 (+1)	4.44	200	15.0	15.0	7.2	168	99	267	48.4
Pari		2,430	1,094	2.0	2,187	1.52	III	200	0.81	0.0050	3,200	-0.3	9.0	9.3	16.10	1.5	26.90	2 (+1)	0.76	100	5.9	7.5	2.5	70	55	125	12.1
Gabutu	No.1	999	450	2.0	899	0.62	I	150	0.59	0.0039	240	-3.5	15.0	18.5	0.95	1.5	20.95	1 (+1)	0.62	100	3.8	5.5	0.6	29	45	74	4.4
	No.2	2,668	1,201	2.0	2,401	1.67	II	150	1.57	0.0243	120	-1.5	22.0	23.5	2.91	1.5	27.91	2 (+1)	0.83	100	6.7	7.5	2.5	70	58	127	12.1
	No.3	629	283	2.0	566	0.39	I	150	0.37	0.0017	160	-3.5	22.0	25.5	0.27	1.5	27.27	1 (+1)	0.39	100	3.1	5.5	0.6	29	43	73	4.4
Vabukori	No.1	5,135	2,311	1.8	4,159	2.89	III	200	1.53	0.0165	240	-13.5	14.0	27.5	3.97	1.5	32.97	2 (+1)	1.44	100	13.7	15.0	2.5	70	79	149	26.9
	No.2	1,819	819	2.0	1,637	1.14	II	150	1.07	0.0119	360	-3.5	14.0	17.5	4.30	1.5	23.30	1 (+1)	1.14	100	7.6	11.0	0.6	29	53	82	8.9
	No.3	16,511	7,430	1.6	11,888	8.26	IV	300	1.95	0.0160	1,400	-3.5	5.5	9.0	22.41	1.5	32.91	3 (+1)	2.75	150	26.1	30.0	7.2	168	145	313	90.7
Kila kila		53,629	24,133	1.5	36,200	25.14	V	800	0.83	0.0011	360	-2.1	5.5	7.6	0.38	1.5	9.48	3 (+1)	8.38	250	21.3	22.0	10.2	267	132	399	70.9
Dogurakohu	No.1	3,000	1,350	2.0	2,700	1.88	III	200	1.00	0.0074	500	0.0	15.0	15.0	3.71	1.5	20.21	2 (+1)	0.94	100	5.5	5.5	2.5	70	54	123	8.9
	No.2	3,000	1,350	2.0	2,700	1.88	III	200	1.00	0.0074	1,200	0.0	13.0	13.0	8.91	1.5	23.41	2 (+1)	0.94	100	6.3	7.5	2.5	70	56	126	12.1
	No.3	6,000	2,700	1.8	4,860	3.38	III	300	0.80	0.0031	1,500	0.0	14.0	14.0	4.59	1.5	20.09	2 (+1)	1.69	100	9.8	11.0	2.5	70	67	137	19.7
	No.4	12,100	5,445	1.6	8,712	6.05	IV	350	1.05	0.0043	2,000	0.0	22.0	22.0	8.50	1.5	32.00	3 (+1)	2.02	100	18.6	22.0	7.2	168	114	282	66.5
	No.5	20,200	9,090	1.5	13,635	9.47	IV	450	0.99	0.0029	1,200	0.0	5.0	5.0	3.44	1.5	9.94	3 (+1)	3.16	150	9.0	11.0	7.2	168	74	242	35.5
	No.6	38,200	17,190	1.5	25,785	17.91	V	600	1.06	0.0023	2,000	0.0	5.0	5.0	4.58	1.5	11.08	3 (+1)	5.97	200	19.1	22.0	10.2	267	116	383	70.9
Vetorogo	No.1	6,000	2,700	1.8	4,860	3.38	III	250	1.15	0.0074	500	0.0	5.0	5.0	3.72	1.5	10.22	2 (+1)	1.69	100	5.0	5.5	2.3	70	52	122	9.9
	No.2	10,000	4,500	1.6	7,200	5.00	III	300	1.18	0.0063	500	0.0	5.0	5.0	3.16	1.5	9.66	2 (+1)	2.50	150	7.0	7.5	2.5	70	58	128	15.1
Morata		6,720	3,024	1.8	5,443	3.78	III	250	1.28	0.0092	500	0.0	5.0	5.0	4.58	1.5	11.08	2 (+1)	1.89	100	6.0	7.5	2.5	70	56	125	13.4

Table D.12 Construction and O & M Cost for the Pumping Stations

(Unit : 1000kina)

Cost	PS	Case 1-A	Case 1-B	Case 1-C	Case 1-D	Case 2-A	Case 2-B	Case 2-C	Case 2-D
Construction	Tatana No.1	125	125	125	125	125	125	125	125
	Tatana No.2	87	87	87	87	87	87	87	87
	Tatana No.3	124	135	124	135	124	135	124	135
	Hanuabada	75	136	75	136	75	136	75	136
	Hanuabada	171	279	171	279	171	279	171	279
	Konedobu	287	266	287	266	287	266	287	266
	Stanley	324	448	324	448	324	448	324	448
	Paga	128	141	128	141	93	104	93	104
	Koki	264	264	264	264	-	-	-	-
	Badili	-	-	-	-	341	341	341	341
	Kaugere	-	-	-	-	308	308	308	308
	Kila kila	292	292	405	405	441	441	451	451
	Gabutu	74	74	74	74	74	74	74	74
	Gabutu	90	90	90	90	90	90	90	90
	Gabutu	73	73	73	73	73	73	73	73
	Vabukori	85	85	85	85	85	85	85	85
	Vabukori	82	82	82	82	82	82	82	82
	Vabukori	281	281	281	281	281	281	281	281
	Pari	83	83	90	90	83	83	90	90
	Total	2,647	2,941	2,766	3,060	3,146	3,438	3,163	3,455
O&M	Tatana No.1	9	9	9	9	9	9	9	9
	Tatana No.2	9	9	9	9	9	9	9	9
	Tatana No.3	10	20	10	20	10	20	10	20
	Hanuabada	4	20	4	20	4	20	4	20
	Hanuabada	44	56	44	56	44	56	44	56
	Konedobu	60	48	60	48	60	48	60	48
	Stanley	97	119	97	119	97	119	97	119
	Paga	71	97	71	97	48	60	48	60
	Koki	48	48	48	48	-	-	-	-
	Badili	-	-	-	-	119	119	119	119
	Kaugere	27	27	27	27	97	97	97	97
	Kila kila	60	60	71	71	97	97	119	119
	Gabutu	4	4	4	4	4	4	4	4
	Gabutu	12	12	12	12	12	12	12	12
	Gabutu	4	4	4	4	4	4	4	4
	Vabukori	10	10	10	10	10	10	10	10
	Vabukori	6	6	6	6	6	6	6	6
	Vabukori	56	56	56	56	56	56	56	56
	Pari	9	9	12	12	9	9	12	12
	Total	540	614	555	628	695	755	721	780

Table D.13 Cost Estimation for the STPs (1)

Item			Paga STP				KilaKila STP			
			Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D
Structure	Sedimentation Tank	Nos.	4	4	2	2	4	4	4	4
		Dia (m)	13.7	14.4	14.9	16.2	13.3	13.6	15.9	16.2
		H (m)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
		Thickness(m)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	Thickener	Nos.	2	2	1	1	2	2	2	2
		Dia (m)	4.4	4.6	4.8	5.2	4.3	4.4	5.1	5.2
		H_1 (m)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
		H_2 (m)	3.8	4.0	4.1	4.5	3.7	3.8	4.4	4.5
		Thickness(m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Digestion Tank	Nos.	2	2	1	1	2	2	2	2
		Dia (m)	11.1	11.5	11.8	12.5	10.9	11.1	12.3	12.4
		H_1 (m)	6.6	6.8	6.9	7.2	6.5	6.6	7.2	7.2
		H_2 (m)	5.6	5.8	5.9	6.2	5.5	5.6	6.2	6.2
		Thickness(m)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	Sludge Drying Bed	Nos.					20.5	22.2	20.5	22.2
		W (m)					10.0	10.0	10.0	10.0
		L (m)					15.0	15.0	15.0	15.0
		H (m)					1.0	1.0	1.0	1.0
		Thickness(m)					0.2	0.2	0.2	0.2
	Site	W (m)	57.3	58.8	34.9	36.2	70.0	70.0	70.0	70.0
		L (m)	77.9	80.0	91.4	95.2	161.7	162.7	169.2	170.0
		A (m^2)	4,464	4,704	3,189	3,449	11,322	11,390	11,841	11,897
Bill of Quantity	1. Site Grading	A (m^2)	4,464	4,704	3,189	3,449	11,322	11,390	11,841	11,897
	2. Banking/Compacti	H (m)	3.5	3.5	3.5	3.5	3.0	3.0	3.0	3.0
		V (m^3)	15,625	16,463	11,163	12,070	33,966	34,169	35,523	35,691
	3. Excavation	Sedimentation	3,937.7	4,256.8	2,238.7	2,552.0	3,776.5	3,916.7	4,933.0	5,069.0
		Thickener	592.8	628.5	326.6	361.6	574.7	590.4	704.1	719.4
		Digestion	967.2	1,043.2	547.7	621.0	928.5	962.1	1,202.2	1,233.8
		Sludge Drying					4,546.1	4,923.1	4,546.1	4,923.1
		Total (Vm^3)	5,497.7	5,928.4	3,113.0	3,534.6	9,825.8	10,392.4	11,385.4	11,945.2
	4. Gravelling	Sedimentation	131.6	145.4	77.5	91.2	124.6	130.7	174.9	180.9
		Thickener	7.8	8.5	4.5	5.3	7.4	7.7	10.2	10.5
		Digestion	44.7	47.8	24.9	27.7	43.2	44.5	53.9	55.1
		Sludge Drying					656.7	711.1	656.7	711.1
		Total (Vm^3)	184.1	201.7	106.9	124.2	831.9	894.0	895.7	957.6
	5. Level Concrete	Sedimentation	65.8	72.7	38.7	45.6	62.3	65.3	87.5	90.4
		Thickener	3.9	4.3	2.3	2.6	3.7	3.9	5.1	5.2
		Digestion	22.4	23.9	12.5	13.9	21.6	22.3	27.0	27.6
		Sludge Drying					328.3	355.6	328.3	355.6
		Total (Vm^3)	92.0	100.8	53.5	62.1	415.9	447.0	447.8	478.8
	6. R. Concrete	Sedimentation	622.5	672.5	353.4	401.7	597.1	619.2	777.2	798.1
		Thickener	74.5	80.1	42.0	47.4	71.7	74.2	91.8	94.1
		Digestion	347.2	370.4	193.0	214.6	335.2	345.6	417.6	426.8
		Sludge Drying					680.9	737.4	680.9	737.4
		Total (Vm^3)	1,044.2	1,123.0	588.4	663.7	1,684.9	1,776.4	1,967.6	2,056.4
	7. S.R. Bar	Total (t)	156.6	168.5	88.3	99.6	252.7	266.5	295.1	308.5
	8. Forming	Total (Am^2)	4,176.8	4,492.0	2,353.8	2,654.7	6,739.5	7,105.5	7,870.2	8,225.6
	9. Dump Soil	Total (Vm^3)	2,058.8	2,289.2	1,225.1	1,457.6	5,817.4	6,238.7	6,661.0	7,083.8
	10. Back Filling	Sedimentation	1,627.8	1,697.5	872.0	934.9	1,591.4	1,623.1	1,836.4	1,863.0
		Thickener	1,683.9	1,810.9	949.1	1,072.2	1,619.5	1,675.6	2,077.5	2,130.8
		Digestion	127.1	130.9	66.7	69.9	125.1	126.9	138.2	139.5
		Sludge Drying					672.4	728.2	672.4	728.2
		Total (Am^2)	3,438.8	3,639.3	1,887.8	2,077.1	4,008.4	4,153.7	4,724.4	4,861.4

Table D.13 Cost Estimation for the STPs (1)

Item			Paga STP				KilaKila STP			
			Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D
	11.Asphalt Pave Rec	A (m^2)	1,081.6	1,110.3	1,010.2	1,051.2	1,854.0	1,861.7	1,913.3	1,919.7
	12.Fence	L (m)	270.4	277.6	252.6	262.8	463.5	465.4	478.3	479.9
	13.Shore Protection	A (m^2)	1,506.8	1,546.5	1,261.5	1,312.0	2,024.2	2,030.6	2,073.9	2,079.3
	14.Filter Gravel	V (m^3)					1,537.5	1,665.0	1,537.5	1,665.0
	15.Admini. BLDG.	A (m^2)	25.0	25.0	25.0	25.0	50.0	50.0	50.0	50.0
	Sludge Pump	(nos.)	10	10	5	5	10	10	10	10
	Disinfection	(set)	1	1	1	1	1	1	1	1
Cost	0. Land Acquisition	25.0	0	0	0	0	283,054	284,742	296,027	297,429
Estimation	1. Site Grading	5.0	22,321	23,519	15,947	17,243	56,611	56,948	59,205	59,486
	2. Cutting/Hauling	35.0	546,870	576,216	390,706	422,459				
	2. Cutting/Hauling	15.0					509,497	512,535	532,848	535,372
unit : Kina	2. Banking/Compacti	10.0	156,248	164,633	111,630	120,703	339,665	341,690	355,232	356,914
	3. Excavation	20.0	109,953	118,569	62,259	70,693	196,515	207,847	227,708	238,904
	4. Gravelling	50.0	9,205	10,084	5,346	6,211	41,593	44,702	44,783	47,881
	5. Level Concrete	300.0	27,614	30,252	16,039	18,633	124,780	134,107	134,348	143,642
	6. R. Concrete	300.0	313,261	336,903	176,532	199,101	505,460	532,911	590,266	616,921
	7. S.R. Bar	2,000.0	313,261	336,903	176,532	199,101	505,460	532,911	590,266	616,921
	8. Forming	50.0	208,841	224,602	117,688	132,734	336,973	355,274	393,511	411,281
	9.Disposal	12.0	24,706	27,470	14,702	17,491	69,809	74,864	79,932	85,005
	10.Back Filling	10.0	34,388	36,393	18,878	20,771	40,084	41,537	47,244	48,614
	11.Asphalt Pave Rec	60.0	64,893	66,619	60,614	63,073	111,238	111,701	114,796	115,180
	12.Fence	200.0	54,078	55,516	50,512	52,561	92,698	93,084	95,663	95,984
	13.Shore Protection	50.0	75,342	77,327	63,074	65,600	101,208	101,532	103,695	103,963
	14.Filter Gravel	50.0					76,875	83,250	76,875	83,250
	15.Admini. BLDG.	500.0	12,500	12,500	12,500	12,500	25,000	25,000	25,000	25,000
	16.Discharge Pit		41,637	46,707	26,427	31,497				
	17.Discharge Pump	M&E	535,000	618,000	292,500	390,000				
	Mech. (Clarifier)		813,571	859,714	429,857	532,810	813,571	813,571	1,065,619	1,065,619
	Mech. (Sludge Pump)	15,000.0	150,000	150,000	75,000	75,000	150,000	150,000	150,000	150,000
	Mech. (Disinfection)		55,000	55,001	55,002	55,003	55,004	55,005	55,006	55,007
	Electric	Mech. x 20%	203,714	212,943	111,972	132,563	203,715	203,715	254,125	254,125
	Total		3,772,404	4,039,871	2,283,717	2,635,745	4,638,810	4,756,927	5,292,150	5,406,499

Table D.14 Cost Estimation for the STPs (2)

			Tatana STP	Pari STP
Structure	Anaerobic Pond	Train	2	2
		H (m)	3.5	3.5
		UpperW(m)	42.0	27.0
		LowerW(m)	28.0	13.0
		UpperL(m)	32.2	26.6
		LowerL(m)	18.2	12.6
	Facultative Pond	Train	2	2
		H (m)	2.3	2.3
		UpperW(m)	42.0	27.0
		LowerW(m)	32.8	17.8
		UpperL(m)	82.1	62.2
		LowerL(m)	72.9	53.0
	Site	W (m)	106.0	76.0
		L (m)	169.3	143.7
		A (m^2)	17,946	10,923
Bill of Quantity	1. Site Grading	A (m^2)	17,946	10,923
	2. Avrage Grade Level	H (m)	3.5	3.5
		V (m^3)	62,812	38,231
	3. Pond Volume	Anaerobic	6,299	2,852
		Facultative	13,359	5,965
		Total (Vm^3)	19,658	8,817
	4. Banking/Compaction	2 - 3 (m^3)	43,154	29,415
	5. Soil Cement (w/ Compaction)	Anaerobic	943	619
		Facultative	1,181	823
		Total (Vm^3)	2,124	1,442
	6. Asphalt Pave Recover	A (m^2)	2,202	1,758
	7. Fence	L (m)	551	439
	8. Shore Protection	A (m^2)	2,984	2,314
	9. Administration BLDG.	A (m^2)	25	25
	Gate	(nos.)	6	6
Cost Estimation	0. Land Acquisition	25.0	0	0
	1. Site Grading	5.0	89,731	54,616
	2. Cutting/Hauling-Rock, (	35.0	1,510,391	1,029,514
	2. Cutting/Hauling-Soil	20.0		
	3. Banking/Compaction	10.0	431,540	294,147
unit : Kina	4. Soil Cement	75.0	159,330	108,128
	5 Asphalt Pave Recover	60.0	132,146	105,469
	6 Fence	200.0	110,121	87,891
	7. Shore Protection	50.0	149,209	115,721
	8. Administration BLDG.	500.0	12,500	12,500
	Mech. (Gate)	10,000.0	60,000	60,000
	Mech. (Disinfection)		30,000	23,000
	Electric	Mech. x 20%	18,000	16,600
	Total		2,702,968	1,907,585

Table D.15 Pumping Facility for the Offshore Discharge Pipe (Manning's Formula, n=0.010)

Case			Paga STP				Kila kila STP			
			Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D
Planned Sewage Flow	ADWF	m^3/day	22,571	25,079	13,414	15,923	21,313	22,406	30,470	31,563
	Peak Factor	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	PDWF	m^3/day	33,856	37,619	20,121	23,884	31,969	33,610	45,704	47,345
Discharge Pipe	Dia	mm	560	560	560	560	750	750	900	900
	V	m/sec	1.59	1.77	0.95	1.12	0.84	0.88	0.83	0.86
	i	-	0.0035	0.0043	0.0012	0.0017	0.0007	0.0007	0.0005	0.0005
	L	m	2,920	2,920	2,920	2,920	3,650	3,650	3,650	3,650
Head Loss	H_{loss}	m	10.18	12.57	3.59	5.07	2.39	2.64	1.85	1.98
	H_{in}	m	0.06	0.08	0.02	0.03	0.02	0.02	0.02	0.02
	H_{out}	m	0.13	0.16	0.05	0.06	0.04	0.04	0.04	0.04
	H_{pump}	m	1.50	1.50	1.50	1.50	-	-	-	-
	$H_{saltwater}$	m	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	H Total	m	12.77	15.20	6.06	7.56	3.34	3.60	2.80	2.94
Pump Specification	Nos.	-	3 (+1)	3 (+1)	2 (+1)	2 (+1)	-	-	-	-
	Q	m^3/min	7.84	8.71	6.99	8.29	-	-	-	-
	Dia	mm	250	250	200	250	-	-	-	-
	Required	Kw	26.8	35.5	11.3	16.8	-	-	-	-
	Std.	Kw	30.0	37.0	15.0	18.5	-	-	-	-
Cost (x1000Kina)	Initial	Civil	42	47	26	31	-	-	-	-
		M&E	535	618	293	390	-	-	-	-
		Total	577	665	319	421	-	-	-	-
	O&M (per year)		97	119	32	40	-	-	-	-

Table D.16 Operation & Maintenance Cost for the STPs

			Tatana	Paga STP				KilaKila STP				Pari
			STP	Case 1-A Case 1-C	Case 1-B Case 1-D	Case 2-A Case 2-C	Case 2-B Case 2-D	Case 1-A Case 1-B	Case 1-C Case 1-D	Case 2-A Case 2-B	Case 2-C Case 2-D	STP
Sewage Flow	Qd_{AVE}	(m^3/day)	2,509	22,571	25,079	13,414	15,923	21,313	22,406	30,470	31,563	1,094
Disinfection	Cl Volume	(mg/L)	4	10	10	10	10	10	10	10	10	4
	Cl Volume	(kg/year)	3,663	82,383	91,540	48,961	58,118	77,792	81,783	111,214	115,205	1,597
	Unit Cost	(kina/kg)	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47
	Cost	(1000Kina)	12.7	285.9	317.6	169.9	201.7	269.9	283.8	385.9	399.8	5.5
Offshore Discharge	Pump	(kw)	-	90.0	111.0	30.0	37.0	-	-	-	-	-
		(hour/year)	-	5,840	5,840	5,840	5,840	-	-	-	-	-
	Unit Cost	(kina/kwh)	-	0.184	0.184	0.184	0.184	-	-	-	-	-
	Cost	(1000Kina)	-	96.7	119.3	32.2	39.8	-	-	-	-	-
Sludge pumpl	Pump	(kw)	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	-
		(hour/year)	-	824	915	490	581	778	818	1,112	1,152	-
	Unit Cost	(kina/kwh)	-	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	-
	Cost	(1000Kina)	-	0.8	0.9	0.5	0.6	0.8	0.8	1.1	1.2	-
Digestion tank	Pump	(kw)	-	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	-
		(hour/year)	-	365	365	365	365	365	365	365	365	-
	Unit Cost	(kina/kwh)	-	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	-
	Cost	(1000Kina)	-	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	-
Sludge Transfer	Figure		Dryed	Digested	Digested	Digested	Digested	Dryed	Dryed	Dryed	Dryed	Dryed
	Volume	(m^3/year)	125	11,534	12,816	6,855	8,137	2,242	2,427	2,242	2,427	55
	Unit Cost	(kina/m^3)	6.70	14.10	14.10	14.10	14.10	6.70	6.70	6.70	6.70	6.70
	Cost	(1000Kina)	0.8	162.6	180.7	96.6	114.7	15.0	16.3	15.0	16.3	0.4
Total	Cost	(1000kina)	13.6	546.8	619.3	300.0	357.5	286.5	301.6	402.8	417.9	5.9

Table D.17 Cost Estimation Result for the STPs

(Unit : 1000kina)

Cost	STP	Case 1-A	Case 1-B	Case 1-C	Case 1-D	Case 2-A	Case 2-B	Case 2-C	Case 2-D
Construction	Tatana	2,703	↓	2,703	↓	2,703	↓	2,703	↓
	Paga	3,772	4,040	3,772	4,040	2,284	2,636	2,284	2,636
	Kila Kila	4,639	4,639	4,757	4,757	5,292	5,292	5,406	5,406
	Pari	1,908	1,908	↑	↑	1,908	1,908	↑	↑
	Total	*13,022*	10,586	11,232	**8,797**	*12,186*	9,835	10,393	**8,042**
O&M	Tatana	14	↓	14	↓	14	↓	14	↓
	Paga	547	619	547	619	300	357	300	357
	Kila Kila	286	286	302	302	403	403	418	418
	Pari	6	6	↑	↑	6	6	↑	↑
	Total	853	*912*	862	*921*	**722**	766	**731**	775

Note: Bold means "the BEST", Italic means "the WORST"

APPENDIX E COST ESTIMATION

APPENDIX E COST ESTIMATION

LIST OF TABLES

LIST OF FIGURES

1. CIVIL WORK UNIT PRICE BACK DATA

Table E.1.1 PNG Civil Work Unit Price (as of Jan.15th,1998)

PRICE IN KINA

Work Item			Quotation						Conclusion	
			1. Company "K"		2. Company "H"		3. Company "C"		No.1 Survey	No 2 Survey
Kind of work	Specification	Dimension	Day	Month	Day	Month	Day	Month	Day	Day
SCHEDULE-1 MANNING CHARGE										
1. Civil work										
Civil field engineer (Manager)			800	16,000	396	10,357	750	22,500	550	650
assistant manager			650	13,500	257	6,732	450	13,500	450	450
Surveyor			600	12,000	257	6,732	350	10,500		400
Supervior/Foreman			600	12,000	257	6,732	350	10,500	300	400
assistant			180	3,600	78	2,040	60	1,800		100
Special worker			100	1,950	48	1,248	60	1,800	200	80
Skill almighty carpenter			100	1,950	48	1,248	40	1,200	50	60
Steel bar bender			100	1,950	48	1,248	25	750	50	50
Rigger			100	1,950	48	1,248	40	1,200	50	50
Concrete worker			100	1,950	48	1,248	25	750	50	50
Masonary			100	1,950	34	902	25	750	50	50
Plasterer			100	1,950	48	1,248	25	750	50	50
Concrete block layer			100	1,950	48	1,248	25	750	50	50
Unskill									20	25
2. Mechanical work										
Mechanical engineer			800	16,000	396	10,357	450	13,500		650
Assistant mechanical engineer			650	13,500	257	6,732	400	12,000		450
Foreman			600	12,000	180	4,708	350	10,500		400
Assitant foreman			180	3,600	78	2,040	60	1,800		100
Rigger			100	1,950	58	1,515	40	1,200		50
Pipe fitter			100	1,950	48	1,248	40	1,200		50
Welder (Manual)			100	1,950	78	2,048	40	1,200		70
Welder (Pressure vessel)			100	1,950	99	2,601	360	10,800		150
Painter			100	1,950	48	1,248	25	750		60
Common skilled mechanical worker					46	1,200	25	750		50
3. Electrical work										
Electrical enginner			800	16,000			450	13,500		650
assistant			650	13,500			400	12,000		450
Foreman			600	12,000			120	3,600		400
assistant			180	3,600			45	1,350		100
High voltage electrician (>6.6kv)			150	2,900			120	3,600		130
High voltage electrician (,>3.3kv)			150	2,900			120	3,600		130
Common skilled electrician			110	2,200			45	1,350		80
4. Common work										
Construction machine operater (Licence grade A)			100	12,850	48	1,267	70	2,100		80
(Licence grade B)			90	1,800	48	1,267	45	1,350		60
(Licence grade C)			80	1,600	48	1,267	30	900		50
Strore keeper			70	1,400	33	875	20	600		40
Securetary guard			70	1,400	33	875	16	480		40
Unskilled worker			55	1,100	28	734	16	480		25
5. Office worker										
Secretary (Carrier more than 3 years)			110	2,100	33	732	45	1,350		50
Computer input operater			95	1,900	33	875	25	750		40
Typist			95	1,900	33	875	25	750		40
Car driver			70	1,400	48	1,248	20	600		50
Office boy			55	1,150	28	734	15	450		30
Cook (Carrier more than 3 years)			95	1,900	28	734	30	900		50
House keeper			95	1,150	28	734	15	450		25

Work description			Quotation						Conclusion	
			1. Company "K"		2. Company "H"		3. Company "C"		No.1 Survey	No.2 Survey
Kind of work	Specification	Dimension	Condition	Excess	Condition	Excess	Condition	Excess		
Schedule-1 Manning charge working condition										
1 Normal working houres in a day				8 Hours		8.50 Hours		10 Hours		
2 ditto in a week (Month)			Week	42 Hours	Week	42.5 Hours	Month	300 Hours		
3 Over time charge 1			17 to 22	20%		50%		50%		
4 2			22	50%		75%		Blank		
5 3						100%		Blank		
6 Holiday working charge				50%		100%		100%		
Schedule-2 Material unit price for civil and sewerage work			Unit price	Remarks	Unit price	Remarks	Unit price	Remarks	Unit price	Remarks
6. Civil material										
Buble stone	Dia 200-300	m^3	85		48		45			60
Cruched stone (Concrete)	Dia 15-20	m^3	45		43		45			45
Crushed stone (Pavement)	Dia 15-20	m^3	50		43		55			50
Sand for concrete	River sand	m^3	45		40		55			50
Sand for backfilling		m^3	40		35		35			40
Cement (Poltland cement)	Bulk	ton	375		348		370			360
ditto	Pack	ton	400		369		370			380
Cement (Sulfa resist)	Bulk	ton	N/A		402		400			400
ditto	Pack	ton	N/A		412		400			410
Ready mixed concrete	240-12-25 class	m^3	280		265	without tr	225			260
ditto	210-12-25 class	m^3	265		255	without tr				170
ditto	175-12-25 class	m^3	260		245	without tr				170
Water reduction conrete admixture		Lit or kg	2	Lit or kg	1.9	litter	2.54	Kg		2
Steel round bar	Dia < 13mm	ton	1500		1488		1250			1400
ditto	Dia > 13mm	ton	1500		1560		1250			1400
Deformed steel bar	Dia < 13mm	ton	1500		1600		1185			1400
ditto	Dia > 13mm	ton	1500		1620		1185			1400
Ply wood	t=6mm	m^2	N/A		9		10			10
ditto	t=12mm	m^2	33		23		18			25
Timber plate	t=10mm	m^2	N/A		15		Not avail			15
ditto	t=25mm	m^2	13		38		Not avail			26
Timber rod	Dia 200-300mm	m^3	470		1500		800			900
Brick		m^3	N/A		N/A		Not avail			Not available
Concrte hollow block	thickness 150mm	m^2	34		34		28			32
ditto	thickness 200mm	m^2	38		56		31			42
Structual stiel	angle	ton	1700		1811	L-75 class	1350	L-75 class		1600
ditto	channel	ton	1700		1906	W-100 class	1380	W-100 class		1700
ditto	H-beam	ton	1700		2084	H-250 class	1700	H-250 class		1800
ditto	Flat-bar	ton	1700		1921	F-50 call	1200	F-50 call		1600
Corrugated asbestos cement sheet		m^2			N/A			Not avail		
Oil paint		Litter	6		N/A		8			7
Vinyl Paint		Litter	10		N/A		8			9
Emulsion paint		Litter	6		N/A		8			7
					Transportation charge					
					Quarry Material 0.81 m^3/km					
					All other material 37.5 ton					

Work Item			Quotation				Aust Syd cost,1995		Conclusion	
			1. Company "K"		2. Company "H"		*F=1.23		No.1 Survey	No.2 Survey
Kind of work	Specification	Dimension	Unit price	Remarks	Unit price	Remarks	Unit price	Unit price	Unit price	Unit price
Schedule-3 Unit price for civil and sewerage piping general work Civil work for sewerage facility							Aust $	kina		
7. Excavation										
Except trench										
Rock-Hard rock	Blasting	m^3	250		180		75	92	50	180
Rock-Soft rock	Machine	m^3	200		200		47.5	58	15	120
Soil-Light soil	Machine	m^3					14	17		20
Soil-Clay	Machine	m^3	60		25		20	25	6.5	20
Trench										
Rock-Hard rock	Blasting	m^3					225	276	50	220
Rock-Soft rock	Machine	m^3					150	184	15	150
Soil-Light soil	Machine	m^3					45	55		30
Soil-Clay	Machine	m^3					37	46	6.5	30
8. Compaction		m^2								2
9. Disposal										
Rock-Hard & Soft rock		m^3	190		14		17	21		15
Soil,Light soil		m^3	60		12		12.5	15	6.5	12
10. Backfilling										
Excaveted material		m^3	65		6		6	7	6.5	10
Clean sand to convey within 2km		m^3	70		58		30	37	6.5	20
11. Rubble and leveling concrete										
Sand mat laying and compaction		m^3	65				30	37	50	40
Crushed stone		m^3	70				70	86	50	70
Lean/Leveling concrete		m^3			640		187	230	300	270
12. Form work										
Under ground foundation flat face		m^2	60		70		48	59	40	50
ditto caved face		m^2	75		85		72	88	40	80
13.										
Re-bar round/deformed <9mm		ton	1700		2150		1435	1765	2400	2000
>10mm		ton	1700		2150		1420	1747	2400	2000
14. Concrete work										
Ready mixed con. Placing only	Leveling concrete	m^3	25	ex. Con.	145	ex. Con	-	-		50
ditto	Structual cocrete	m^3	30	ex. Con.	175	ex. Con	-	-		60
Concrete with material/placing	240-12-25	m^3	295	with con.	464	with con.	178	219	300	300
ditto	210-12-25	m^3	275	with con.	450	with con.	-	-	300	280
ditto	175-12-25	m^3	270	with con.	436	with con.	-	-	300	270
ditto	140-12-25	m^3	245	with con.	422	with con.	-	-	300	260
15. Others										
Concrete demolish	St.re-bar struct.	m^3	250		175		96	118		200
ditto	No steel re-bar	m^3	220		75		45	55		120
Asphalt road re-pavement	Ex. To cut/pave	m^2	50		9		-	-	60	60
Fence around sewerage facility	Eq.exist p.station	m	100		6	/m^2	178	218	100/m	200
Scafolding W=1m H=10m by steel pipe		m^3	80		N/A		-	-		80
Pipe support H=3m for floor concrete placing		m^3	30		N/A		-	-		30
Dewatering		m^3	15 k/m^3	10Lit/m^3/min	N/A		45$/$m^2$ (Area)	55K/m^2 (Area)		15K*Excavation Volume
Land acquisition		m^2					-	-	25	25
Site grading/Leveling		m^2					5	6	3	5
Banking/Compaction	use cut material	m^3							6.5	10
Rock cut/hauling	fill by conveyed soil	m^3								35
Cut and fill	fill by cut soil	m^3								15
Embankment protection by rock	Rock within 2km	m^3					70	86	50	50
Landscaping	Wood chips spred	m^2					54	66	50	50
New asphalt pavement	200mm thick	m^2					18	22	50	40
Soil cement work	Cement 0.06t/m^3	m^3					-	-	75	75
Operation building		m^2					300-400	370-492		500

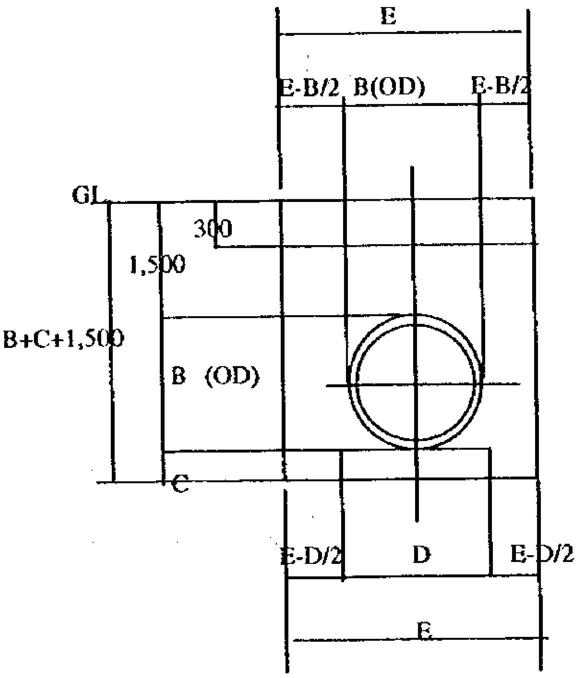
* F=Ex.change rate1.10*Escalation1.12=1.23

2. UNDER GROUND PIPING UNIT PRICE BACK DATA

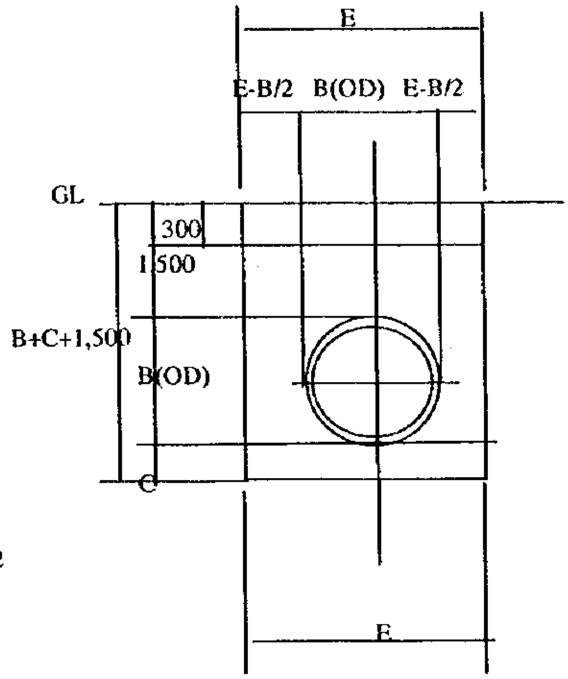
2.1 Unit cost

2.1.1 Calculation section

Section-1
Concrete bed for Cocrete hume pipe



Section-2
Sandbed for Ductile and Pvc Pressure pipe



Pipe size for calculation

ID(mm)	OD(mm)		
	Concrete Hume	Ductile pipe	Pvc pressure
150	202	169	162
200	254	220	214
250	306	272	265
300	360	323	316
350	414	374	367
400	470	426	418
450	526	477	469
500	584	528	520
600	700	631	624
700	816	733	728
800	920	850	840

Table E.2.1 Dimension

Unit:mm

ID	150	200	250	300	350	400	450	500	600	700	800
Sec.1 for Concrte bed											
OD	202	254	306	360	414	470	526	584	700	816	920
B	210	260	310	360	420	480	530	590	700	820	950
C	100	100	100	100	130	130	150	150	150	150	150
D	400	400	500	500	600	600	800	800	900	1000	1100
E	700	750	800	850	900	1000	1200	1300	1400	1600	1800
Sec.2 for Ductile											
OD	169	220	272	323	374	426	477	528	631	733	850
B	170	220	280	330	380	430	480	530	640	740	850
C	100	100	100	100	130	130	150	150	150	150	150
D											
E	700	750	800	850	900	1000	1200	1300	1400	1600	1800
Sec.2 for Pvc Pressure											
OD	162	214	265	316	367	418	469	520	624	728	840
B	170	220	270	320	370	420	470	520	630	730	840
C	100	100	100	100	130	130	150	150	150	150	150
D											
E	700	750	800	850	900	1000	1200	1300	1400	1600	1800

Table E.2.2 Main Civil Work Quantity

Main civil work		ID										
Item	Unit	150	200	250	300	350	400	450	500	600	700	800
Sec.-1 Concrete Hume												
Excavation	m^3	1.267	1.395	1.528	1.666	1.845	2.110	2.616	2.912	3.290	3.952	4.680
Bed leveling	m^2	0.700	0.750	0.800	0.850	0.900	1.000	1.200	1.300	1.400	1.600	1.800
Bed concrete	m^3	0.040	0.040	0.050	0.050	0.078	0.078	0.120	0.120	0.135	0.150	0.165
Bed form work	m^2	0.200	0.200	0.200	0.200	0.260	0.260	0.300	0.300	0.300	0.300	0.300
Backfill-1	m^3	0.982	1.077	1.163	1.259	1.359	1.551	1.915	2.129	2.350	2.794	3.267
Backfill-2	m^3	0.210	0.225	0.240	0.255	0.270	0.300	0.360	0.390	0.420	0.480	0.540
Backfill-3	m^3	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Disposal	m^3	1.192	1.302	1.403	1.514	1.629	1.851	2.275	2.519	2.770	3.274	3.807
Grading	m^2	1.200	1.250	1.300	1.350	1.400	1.500	1.700	1.800	1.900	2.100	2.300
Sec.-2 Ductile pipe												
Excavation	m^3	1.239	1.365	1.504	1.641	1.809	2.060	2.556	2.834	3.206	3.824	4.500
Bed leveling	m^2	0.700	0.750	0.800	0.850	0.900	1.000	1.200	1.300	1.400	1.600	1.800
Bed concrete	m^3	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Bed form work	m^2	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Backfill-1	m^3	0.936	1.027	1.122	1.215	1.309	1.485	1.835	2.028	2.254	2.674	3.123
Backfill-2	m^3	0.210	0.225	0.240	0.255	1.400	0.300	0.360	0.390	0.420	0.480	0.540
Backfill-3	m^3	0.070	0.075	0.080	0.085	0.117	0.130	0.180	0.195	0.210	0.240	0.270
Disposal	m^3	1.216	1.327	1.442	1.555	1.696	1.915	2.375	2.613	2.884	3.394	3.933
Grading	m^2	1.200	1.250	1.300	1.350	1.400	1.500	1.700	1.800	1.900	2.100	2.300
Sec.-2 Pvc Pressure												
Excavation	m^3	1.239	1.365	1.496	1.632	1.800	2.050	2.544	2.821	3.192	3.808	4.482
Bed leveling	m^2	0.700	0.750	0.800	0.850	0.900	1.000	1.200	1.300	1.400	1.600	1.800
Bed concrete	m^3	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Bed form work	m^2	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Backfill-1	m^3	0.936	1.027	1.119	1.212	1.306	1.482	1.831	2.024	2.250	2.670	3.118
Backfill-2	m^3	0.210	0.225	0.240	0.255	0.270	0.300	0.360	0.390	0.420	0.480	0.540
Backfill-3	m^3	0.070	0.075	0.080	0.085	0.117	0.130	0.180	0.195	0.210	0.240	0.270
Disposal	m^3	1.216	1.327	1.439	1.552	1.693	1.912	2.371	2.609	2.880	3.390	3.928
Grading	m^2	1.200	1.250	1.300	1.350	1.400	1.500	1.700	1.800	1.900	2.100	2.300

Table E.2.3 Main Civil Work Cost (Price in Kina)

Main civil work		Unit	ID										
Item	Unit	price	150	200	250	300	350	400	450	500	600	700	800
Sec.-1 Concrete Hume													
Excavation	m^3	30.0	38	42	46	50	55	63	78	87	99	119	140
Bed leveling	m^2	5.0	4	4	4	4	5	5	6	7	7	8	9
Bed concrete	m^3	270.0	11	11	14	14	21	21	32	32	36	41	45
Bed form work	m^2	50.0	10	10	10	10	13	13	15	15	15	15	15
Backfill-1	m^3	20.0	20	22	23	25	27	31	38	43	47	56	65
Backfill-2	m^3	10.0	2	2	2	3	3	3	4	4	4	5	5
Backfill-3	m^3	20.0											
Disposal	m^3	12.0	14	16	17	18	20	22	27	30	33	39	46
Grading	m^2	5.0	6	6	7	7	7	8	9	9	10	11	12
Total			104	112	122	130	150	166	210	227	251	293	337
Sec.-2 Ductile pipe													
Excavation	m^3	30.0	37	41	45	49	54	62	77	85	96	115	135
Bed leveling	m^2	5.0	4	3	2	2	2	2	2	3	4	6	10
Bed concrete	m^3	270.0											
Bed form work	m^2	50.0											
Backfill-1	m^3	20.0	19	21	22	24	26	30	37	41	45	53	62
Backfill-2	m^3	10.0	2	2	2	3	14	3	4	4	4	5	5
Backfill-3	m^3	20.0	1	2	2	2	2	3	4	4	4	5	5
Disposal	m^3	12.0	15	16	17	19	20	23	29	31	35	41	47
Grading	m^2	5.0	6	6	7	7	7	8	9	9	10	11	12
Total			83	90	97	105	126	129	160	176	197	235	277
Sec.-2 Pvc Pressure													
Excavation	m^3	30.0	37	41	45	49	54	62	76	85	96	114	134
Bed leveling	m^2	5.0	4	3	2	2	2	2	2	3	4	6	10
Bed concrete	m^3	270.0											
Bed form work	m^2	50.0											
Backfill-1	m^3	20.0	19	21	22	24	26	30	37	40	45	53	62
Backfill-2	m^3	10.0	2	2	2	3	3	3	4	4	4	5	5
Backfill-3	m^3	20.0	1	2	2	2	2	3	4	4	4	5	5
Disposal	m^3	12.0	15	16	17	19	20	23	28	31	35	41	47
Grading	m^2	5.0	6	6	7	7	7	8	9	9	10	11	12
Total			83	90	97	105	114	129	159	176	197	234	276

2.2 Pipe installation cost

Table E.2.4 Concrete Hume Pipe

Cost Item		ID											
Work	Remarks	150	200	250	300	350	400	450	500	600	700	800	Remarks
0. Installation method		Manual		Crane									
1. Manning cost	(per 10m)												
1.1 Foreman		0.32	0.33	0.32	0.33	0.33	0.34	0.35	0.36	0.38	0.40	0.42	400K/day
1.2 Skill		0.65	0.66	0.64	0.66	0.66	0.68	0.70	0.72	0.76	0.80	0.84	50K/day
1.3 Unskill		0.90	0.99	0.64	0.66	0.99	1.02	1.05	1.08	1.52	1.60	1.68	20K/day
1.4 Cost(1.1+1.2+1.3)		179	185	173	178	185	190	196	202	220	232	244	
1.5 Item 1.4*F	Efficiency	536	554	518	535	554	571	588	605	661	696	731	F=3.0
1.6 Other expence	1.5*%	0	0	0	0	0	0	0	0	0	0	0	
1.7 Manning cost	Kina	616	638	612	631	654	674	694	714	780	821	862	
2. Crane cost	(per 10m)												
2.1 Crane /day		0	0	0.32	0.33	0.33	0.34	0.35	0.36	0.38	0.40	0.42	
2.2 Crane cost		0	0	38	40	40	41	42	43	46	48	50	120k/day
2.3 Item 2.2*F	Efficiency	0	0	115	119	119	122	126	130	137	144	151	F=3.0
3. Item(1.7+2.3)	(per 10m)	616	638	727	750	773	796	820	843	917	965	1014	
4. Joint work													
5. Consumable Material													
6. Contingency													
7. Cost													
7.1 Cost/10m		616	638	727	750	773	796	820	843	917	965	1014	
7.2 Cost/meter		62	64	73	75	77	80	82	84	92	97	101	

Table E.2.5 Ductile Pipe

Cost Item		ID											
Work	Remarks	150	200	250	300	350	400	450	500	600	700	800	Remarks
0. Installation method		Crane											
1. Manning cost	(per 10m)												
1.1 Foreman	man/day	0.05	0.05	0.06	0.06	0.09	0.11	0.12	0.15	0.18	0.22	0.26	400K/day
1.2 Skill	man/day	0.09	0.10	0.11	0.13	0.17	0.21	0.25	0.29	0.36	0.44	0.52	50K/day
1.3 Unskill	man/day	0.15	0.16	0.17	0.19	0.25	0.31	0.37	0.43	0.55	0.66	0.8	25K/day
1.4 Cost(1.1+1.2+1.3)		28	29	34	35	51	62	70	85	104	127	150	
1.5 Item 1.4*F	Efficiency	85	87	101	106	152	187	209	256	311	380	450	F=3.0
1.6 Other expence	Item1.5*G	15	16	18	19	27	34	38	46	56	68	81	G=18%
1.7 Manning cost	Kina	100	103	119	125	180	220	247	302	367	448	531	
2. Crane cost	(per 10m)												
2.1 Crane/day	work/day	1.34	1.41	1.47	1.54	1.61	1.68	1.74	1.81	1.94	2.08	2.21	
2.2 Crane cost	Kina	161	169	176	185	193	202	209	217	233	250	265	120k/day
2.3 Item2.2*F	Efficiency	482	508	529	554	580	605	626	652	698	749	796	F=3.0
3. Item(1.7+2.3)	(per 10m)	582	610	649	679	759	825	873	953	1066	1197	1327	
4. Joint work	(per 1 joint)												
4.1 Foreman	man/day	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.07	0.08	0.11	400K/day
4.2 Skill	man/day	0.06	0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.14	0.16	0.21	50K/day
4.3 Unskill	man/day	0.06	0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.14	0.16	0.21	25K/day
4.4 Cost(4.1+4.2+4.3)		17	21	22	27	27	28	32	33	39	44	60	
4.5 Item 4.4*F	Efficiency	50	64	66	80	80	83	97	99	116	132	179	F=3.0
4.6 Pipe unit length	m	5	5	5	6	6	6	6	6	6	6	6	
4.7 Item 4.5/10m		10	13	13	13	13	14	16	17	19	22	30	
4.8 Other expence Item4.7@H		1	1	1	1	1	1	2	2	2	2	3	H=10%
4.9 Joint cost per 10m		11	14	15	15	15	15	18	18	21	24	33	
5. Consumable material													
6. Contingency													
7. Cost													
7.1 Cost/10m		593	624	663	694	774	840	891	972	1087	1221	1359	
7.2 Cost/m		59	62	66	69	77	84	89	97	109	122	136	

Cost Item		ID											
Work	Remarks	150	200	250	300	350	400	450	500	600	700	800	Remarks
0. Installation method		Manual											
1. Manning cost	(per meter)												
1.1 Foreman	man/day	0.015	0.017	0.018	0.020	0.022	0.024	0.026	0.028	0.030	0.032	0.034	400k/day
1.2 Skill	man/day	0.031	0.034	0.037	0.040	0.044	0.047	0.051	0.055	0.059	0.063	0.067	50k/day
1.3 Unskill	man/day	0.057	0.070	0.083	0.096	0.109	0.121	0.134	0.147	0.160	0.173	0.187	25k/day
1.4 Total (1+2+3)	man/day	9	10	11	12	14	15	16	18	19	20	22	
1.5 Item 1.4*F	Efficiency	27	31	33	37	41	45	49	53	57	61	65	F=3.0
1.6 Other expence	Item1.5*5%	1	1	1	1	1	1	1	2	2	2	2	
1.7 Manning total		28	32	34	38	42	46	50	54	59	63	67	
2. Crane cost													
3. Item (1.7+2.3)	Cost/m												
4. Joint work													
5. Consumable Material													
5.1 Bond+Lubricant	g/1 joint	50	80	125	175	240	310	390	490	715	940	1200	
5.2 Pipe unit length	m	4	4	4	4	4	4	4	4	4	4	4	
5.3 Bond+Lubricant	g/m	13	20	31	44	60	78	98	123	179	235	300	
5.4 Bond cost	kina/m	6	10	16	22	30	39	49	61	89	118	150	Cost0.5k/g
6. Contingency													
7. Cost/m		34	42	50	60	72	85	99	116	148	180	217	

2.3 Under ground pipe material unit cost

Table E.2.6 Under Ground Pipe Material Unit Cost

Kind of Pipe	Country	Supply	Unit	pipe inner size 150	200	250	300	350	400	450	500	600	700		800	Remarks
Concrete Hume	Japan	Ken-bukka 97/12	1 Pipe price in ¥	4,620	5,030	6,120	7,340	8,840	13,900	16,500	19,500	27,600	36,700		46,900	Jis A 5303
		Import	Exchanged to Kina	56	61	75	90	108	170	201	238	337	448		572	1K=¥82
			2.One unit length	2	2	2	2	2	2.43	2.43	2.43	2.43	2.43		2.43	
			3 Price/m	28	32	38	45	54	70	83	98	139	184		235	
			4.Trans charege	8	14	23	32	44	58	73	90	130	176		230	
			5. Duty 10%	4	5	6	8	10	13	16	19	27	36		47	
			6. 3+4+5	40	51	67	85	108	141	172	207	296	396		512	
	PNG	Monier	1.One pipe price				152	188 (375)		274	344 (525)	418	482 (675)	573 (750)		No coating
		Domestic	2 One unit length				2.44	2.44		2.44	2.44	2.44	2.44	2.44		
			3.Price/m				62	77		112	141	171	198	235		
			4.Trans charege				0	0		0	0	0	0	0		
			5.Tax 3%				2	2		3	4	5	6	7		
			6. 3+4+5				64	79		115	145	176	204	242		
	Australia	PNG PIPES	1.One pipe price	Not clear												
		Import	2.One unit length	Not clear												
			3 Price/m	59	89 (225)	132		191 (375)		261	330 (525)	432	515 (675)			CIF price
			4.Trans charege	0	0	0		0		0	0	0	0			
			5.Duty 10%+3%	8	12	17		25		34	43	56	67			
			6. 3+4+5	67	101	149		216		295	373	488	582			
		Steam Ship	1.One pipe price		81 (225)		174	215 (375)		314	393 (525)	478		655 (750)		
		Data-1	2.One unit length		2.44		2.44	2.44		2.44	2.44	2.44		2.44		
		Import	3.Price/m		33		71	88		129	161	196		268		
			4.Trans.charege		10		23	31		51	63	90		123		
			5.Duty 10%+3%		4		12	15		23	29	37		51		
			6. 3+4+5		47		106	134		203	253	323		442		
	unit cost		pipe net cost	40	47	67	80	90	100	115	145	176	242		350	
			Above*1.15	46	54	77	92	104	115	132	167	202	278		403	
Ductile pipe	Japan	Ken-bukka 97/12	1 Pipe cost in ¥	25,600	33,800	42,000	63,700	74,300	90,800	108,000	12,800	171,000	207,000		259,000	Jis G 5526
		Import	Exchande to Kina	312	412	512	777	906	1107	1317	156	2085	2524		3159	1K=¥82
			2 One unit length	5	5	5	6	6	6	6	6	6	6		6	
			3 Price/m	62	82	102	129	151	185	220	26	348	421		526	
			4.Trans.charege	8	14	23	32	44	58	73	90	130	176		230	
			5 Duty 10%+3%	9	13	16	21	25	32	38	15	62	78		98	
			6. 3+4+5	80	109	142	182	220	274	331	131	540	674	0	855	
	Australia	EDA RANU	1.One pipe price	200	220	555	795		280	300						stocked
			2 One unit length	6	6	6	6		6	6						material
			3.Price/m	33	37	40	43		47	50						purchased
			4.Trans charege	0	0	0	0		0	0						
			5.Tax Not clesr	0	0	0	0		0	0						
			6. 3+4+5	33	37	40	43		47	50						
		PNG PIPES	1.One pipe price	713	996	1350	1693	3075 (375)		3920	5065	6639	9415 (750)			CIF Price
		Import	2.One unit length	5.5	5.5	5.5	5.5	5.5		5.5	5.5	5.5	5.5			
			3 Price/m	130	181	245	308	559		713	921	1207	1712			
			4.Trans charege	0	0	0	0	0		0	0	0	0			Included in 1
			%.Duty 10%+3%	4	5	7	9	17		21	28	36	51			
			6. 3+4+5	134	186	252	317	576		734	949	1243	1763			
		Steam Ships	1.One pipe price													
		Import	2.One unit length													
			3 Price/m													
			4.Trans charege													
			5 Duty 10%+3%													
			6. 3+4+5													
		Tubemakers	1.One pipe price													D1 K9 CIpipe
		Import	2 One unit length													
			3 Price/m	40	55	69	89	125 (375)		152	178	236	340 (750)			CIF
			4.Trans charege	0	0	0	0	0		0	0	0	0			
			5 Duty 10%+3%	5	7	9	12	16		20	23	31	44			
			6. 3+4+5	45	62	78	101	141		172	201	267	384			
	unit cost	pipe net cost		45	62	78	101	141	160	172	201	267	384		500	
		Above*1.15		52	71	90	116	162	184	198	231	307	442		575	

Kind of Pipe	Country	Supply	Unit	pipe inner size 150	200	250	300	350	400	450	500	600	700		800	Remarks
PVC PRESSURE	Japan	Ken-bukka 97/12	1.Pipe cost in ¥	Nil	24,700	28,500	38,200	47,900	55,400	63,800	71,100	90,100	108,000		127,000	AS350 10kg/cm²
		Import	Exchanged to Kina		301	348	466	584	676	778	867	1099	1317		1549	1 Kina=¥82
			2.One unit length		4	4	4	4	4	4	4	4	4		4	
			3.Price/m		75	87	116	146	169	195	217	275	329		387	
			4.Trans.charege		14	23	32	44	58	73	90	130	176		230	
			5.Duty 30%		27	33	45	57	68	80	92	121	152	0	185	
			6. 3+4+5		102	120	161	203	237	275	309	396	481	0	572	
	PNG	Pipe Makers	1.One pipe price	190.9												
		Domestic	2.One unit length	5.8												
			3.Price/m	33												
			4.Trans.charege	0												
			5.Tax 3%	1												
			6. 3+4+5	34												
	Australia	EDA-RANU	1.One pipe price	285	400	585										stocked
			2.One unit length	6	6	6										material
			3.Price/m	48	67	98										purchased
			4.Trans.charege	0	0	0										price
			5.Not clear	0	0	0										
			6. 3+4+5	48	67	98										
		PNG PIPES	1.One pipe price	Not clear												
		Import	2.One unit length	Not clear												
			3.Price/m	65	101	155	225	345 (375)		490						CIF
			4.Trans.charege	0	0	0	0	0		0						
			5.Duty 30%+3%	2	3	5	7	10		15						
			6. 3+4+5	67	104	160	232	355		505						
		PNG PIPES	1.One pipe price	70												CIF
		Import	2.One unit length	5.8												
			3.Price/m	12*	30 (225)*		60*	100 (375)*		156 (475)*		310	526			*UPVC
			4.Trans.charege	0	0		0	0		0		0	0			
			5.Duty 30%+3%	4	10		20	33		51		102	174			
			6. 3+4+5	16	40		80	133		207		412	700			
		Vindex	1.One pipe price													AS CL16
			2.One unit length													
			3.Price/m	20	32	51	74	114 (375)								Work shop
			4.Trans.charege	6	10	16	23	31								
			Duty 30%	8	13	20	29	44								
			6. 3+4+5	34	55	87	126	189								
		pipe net cost		34	55	87	126	189	237	275	309	396	481		572	
		Above*1.15		39	63	100	145	217	273	316	355	455	553		658	

2.4 Manhole

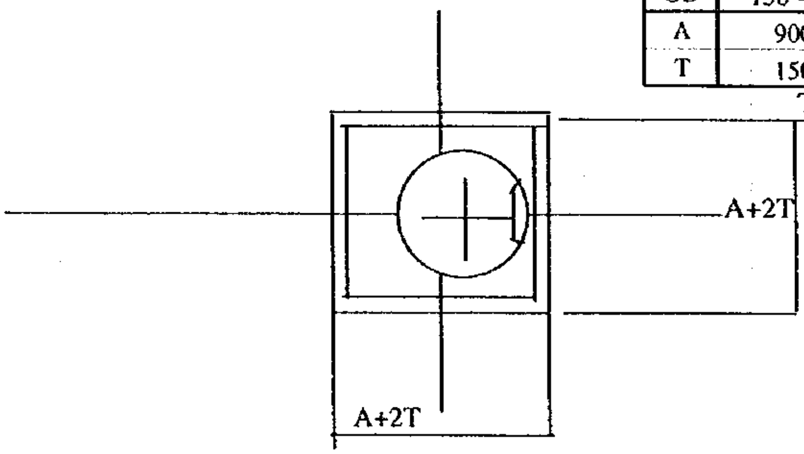
2.4.1 Manhole size for calculation

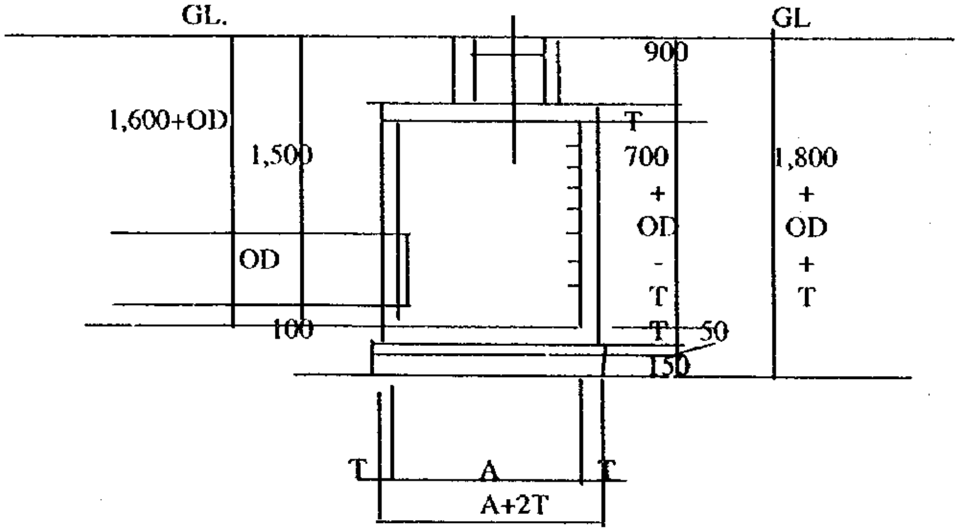
Manhole Size

OD	150-450	500-800
A	900	1,200
T	150	200

T: Wall thickness

Section





ID		150	200	250	300	350	400	450	500	600	700	800
Calculation OD	(mm)	210	260	310	360	420	480	530	590	700	820	950
Width A	(mm)	900	900	900	900	900	900	900	1200	1200	1200	1200
Wall thickness T	(mm)	150	150	150	150	150	150	150	200	200	200	200
Calculation OD	(m)	0.21	0.26	0.25	0.36	0.42	0.48	0.53	0.59	0.70	0.82	0.95
Width A	(m)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	1.20	1.20	1.20	1.20
Wall thickness T	(m)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.20	0.20	0.20	0.20

Table E.2.7 Manhole Civil Work and Cost

Work Item	Unit	Unit price	ID 150	200	250	300	350	400	450	500	600	700	800
1. Quantity													
Excavation	m^3		10.45	10.70	10.65	11.18	11.47	11.76	12.00	17.51	18.25	19.06	19.94
Rubble	m^3		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.43	0.43	0.43	0.43
Lean concrete	m^3		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.09	0.09	0.09	0.09
Concrete 1	m^3		0.91	0.94	0.94	1.01	1.04	1.08	1.11	2.24	2.37	2.50	2.65
Concrete 2	m^3		0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
Form work 1	m^2		5.09	5.33	5.28	5.81	6.10	6.38	6.62	9.54	10.24	11.01	11.84
Form work 2	m^2		2.74	2.92	2.88	3.28	3.49	3.71	3.89	5.23	5.76	6.34	6.96
Form work 3	m^2		0.81	0.81	0.81	0.81	0.81	0.81	0.81	1.44	1.44	1.44	1.44
Form work 4	m^2		0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Re-bar	ton		0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.17	0.18	0.18	0.19
Disposal	m^3		2.42	2.49	2.47	2.63	2.72	2.81	2.88	4.91	5.19	5.49	5.83
Backfill	m^3		8.04	8.21	8.17	8.55	8.75	8.96	9.13	12.60	13.07	13.57	14.12
Grading	m^2		4.84	4.84	4.84	4.84	4.84	4.84	4.84	6.76	6.76	6.76	6.76
2. Cost													
Excavation		30	314	321	319	335	344	353	360	525	548	572	598
Rubble		70	18	18	18	18	18	18	18	30	30	30	30
Lean concrete		270	18	18	18	18	18	18	18	23	23	23	23
Concrete(1+2)		280	415	424	422	442	452	463	472	789	823	861	902
Form work(1+2+3+4)		50	474	495	491	537	562	587	608	853	914	982	1054
Re-bar		2000	178	182	181	189	194	198	202	338	353	369	386
Disposal		12	29	30	30	32	33	34	35	59	62	66	70
Backfill		10	80	82	82	85	88	90	91	126	131	136	141
Grading		5	24	24	24	24	24	24	24	34	34	34	34
Manhole cover		225	225	225	225	225	225	225	225	225	225	225	225
Step		100	100	100	100	100	100	100	100	100	100	100	100
Total cost		set	1875	1918	1910	2005	2057	2109	2153	3102	3243	3397	3564
Pitch		m	50	50	50	50	50	75	75	75	75	75	75
Manhole cost/m		k/m	37	38	38	40	41	28	29	41	43	45	48

2.5 Under ground piping work total unit cost (in Kina)

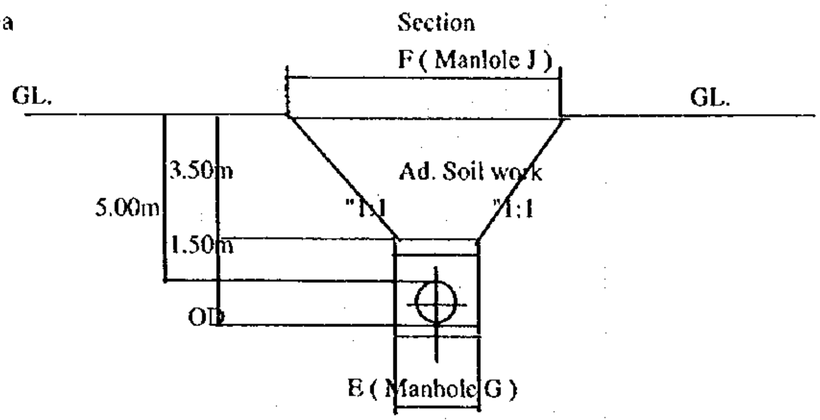
Table E.2.8 Under Ground Piping Work Total Unit Cost

Under ground piping total unit cost	ID 150	200	250	300	350	400	450	500	600	700	800	Remarks
1. Concrete Hume pipe												
A. Piping												
A1 Civil work	104	112	122	130	150	166	210	227	251	293	337	
A2 Pipe installation	62	64	73	75	77	80	82	84	92	97	101	
A3 Pipe material	46	54	77	92	104	115	132	167	202	278	403	
A. Total	212	230	272	297	332	361	424	478	545	667	841	
B.Manhole cost	37	38	38	40	41	28	29	41	43	45	48	
A+B	249	268	310	337	373	389	452	520	588	712	889	
2. Ductile pipe												
A. Piping												
A1 Civil work	83	90	97	105	126	129	160	176	197	235	277	
A2 Pipe installation	59	62	66	69	77	84	89	97	109	122	136	
A3 Pipe material	52	71	90	116	162	184	198	231	307	442	575	
A. Total	195	223	254	290	365	397	447	504	613	799	988	
B. Manhole cost	37	38	38	40	41	28	29	41	43	45	48	
A+B	232	262	292	330	406	425	475	546	656	844	1,036	
3. PVC Pressure pipe												
A. Piping												
A1 Civil work	83	90	97	105	114	129	159	176	197	234	276	
A2 Pipe installation	34	42	50	60	72	85	99	116	148	180	217	
A3 Pipe material	39	63	100	145	217	273	316	355	455	553	658	
A. Total	156	195	247	310	403	487	574	646	800	967	1,151	
B. Manhole cost	37	38	38	40	41	28	29	41	43	45	48	
A+B	194	233	285	350	445	515	603	688	843	1,012	1,199	

2.6 Special Case

Covering thickness 5.00m

for Tatana area

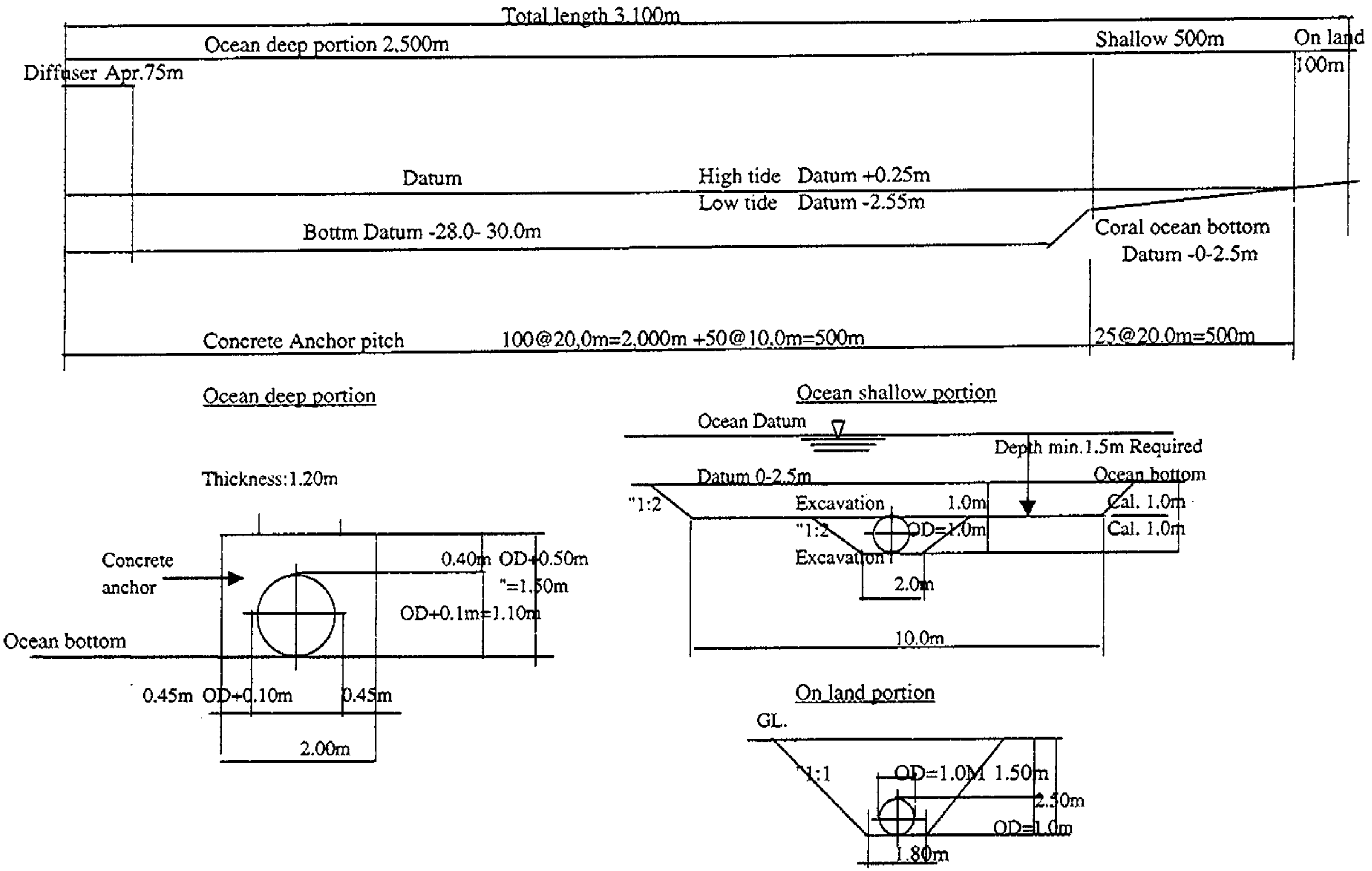


	OD	150	200	250	300	350	400	450	500	600	700	800
Work quantity												
A. Piping work												
E	m	0.70	0.75	0.80	0.85	0.90	1.00	1.20	1.30	1.40	1.60	1.80
F	m	7.70	7.75	7.80	7.85	7.90	8.00	8.20	8.30	8.40	8.60	8.80
Ad. Excavation	m^3	14.70	14.88	15.05	15.23	15.40	15.75	16.45	16.80	17.15	17.85	18.55
Ad. Backfill	m^3	14.70	14.88	15.05	15.23	15.40	15.75	16.45	16.80	17.15	17.85	18.55
Ad. Grading	m^2	7.70	7.75	7.80	7.85	7.90	8.00	8.20	8.30	8.40	8.60	8.80
B. Manhole work												
G	m	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.6	2.6	2.6	2.6
J	m	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.6	9.6	9.6	9.6
Ad. Excavation	m^3	156.6	156.6	156.6	156.6	156.6	156.6	156.6	173.1	173.1	173.1	173.1
Ad.Backfill	m^3	156.6	156.6	156.6	156.6	156.6	156.6	156.6	173.1	173.1	173.1	173.1
Ad. Grading	m^2	35.6	35.6	35.6	35.6	35.6	43.2	43.2	43.2	43.2	15.0	15.0
Work cost												
A. Piping work												
Ad. Excavation	$30k/m^3$	441	446	452	457	462	473	494	504	515	536	557
Ad.Backfill	$10k/m^3$	147	149	151	152	154	158	165	168	172	179	186
Ad.Grading	$5k/m^2$	39	39	39	39	40	40	41	42	42	43	44
Pipe civil ad. cost	k/m	627	634	641	648	656	670	699	714	728	757	786
PVC stand+Ad.	k/m	783	828	888	958	1059	1157	1273	1360	1528	1724	1937
B Manhole												
Ad. Excavation	$30k/m^3$	4698	4698	4698	4698	4698	4698	4698	5193	5193	5193	5193
Ad.backfill	$10k/m^3$	1566	1566	1566	1566	1566	1566	1566	1731	1731	1731	1731
Ad.Grading	$5k/m^2$	193	194	195	196	198	200	205	208	210	215	220
Pitch	m	50	50	50	50	50	75	75	75	75	75	75
cost/m	k/m	129	129	129	129	129	86	86	95	95	95	95
PVC stand +Ad	k/m	167	168	167	169	170	114	115	136	138	140	143
PVC (A+B) stan+Ad	k/m	950	996	1055	1127	1229	1271	1388	1496	1666	1864	2080

3. OCEAN OUTFALL COST BACK DATA

3.1 Ocean outfall planning for Joice bay

Pipe: Material High density polythelene,ID=913mm,OD=1,000mm,Class 4.5
Thickness=43.5mm,Unit weight=138.4kg/m, One unit=Normal 15.0m Suppied

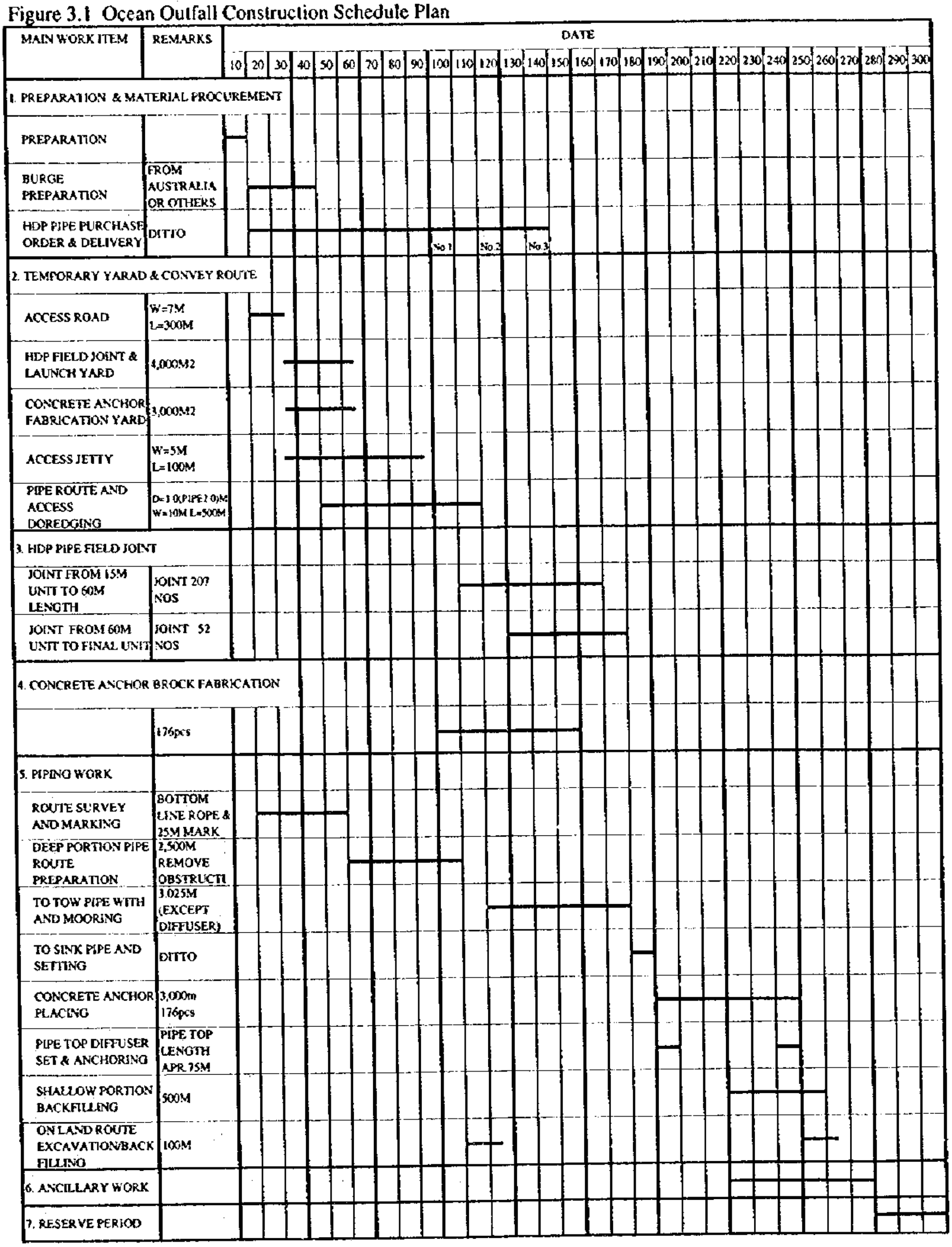


3.2 Ocean Outfall Construction Schedule Plan

PIPING OUTLINE: TOTAL 3,100M(ONLAND 100M +SHALLOW 500M+OCEAN DEEP 3,000M)

(R5,Jan.22,98) PIPE:HIGH DENSITY POLYTHELENE(HDP),CLASS 4.5,OD=1,000MM,ID=913MM,W=138.4KG/M

Figure 3.1 Ocean Outfall Construction Schedule Plan



3.3 Ocean outfall for Joice bay, Cost calculation

Table E.3.1 Ocean Outfall for Joyce Bay, Cost Calculation

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
Cost total						
1. Common work						
1.1 Construction yard and temporary facility						
1.1.1 HDP storage and field joint yard		W*L=50*80m =4,000m²			106,350	See sheet 3
1.1.2 Anchor fabrication yard and others		W*L=50*80m =4,000m²			Included in Item 1.1.1	ditto
1.1.3 Access Jetty		W*L=5*100m =500m²			138,250	See sheet 3
1.1.4 Shallow Pipe route & access excavation		Excavation 7,440m³, Backfilling 7,048m³			148,500	See sheet 4
1.1.5 Transportation road to site		W*L=7*300m =2,100m²			31,500	ditto
	Item 1.1 Total				424,600	
1.2 Ocean vessel cost					422,700	See sheet 5
	Item 1 Total				847,300	
2. Direct work cost						
2.1 Concrete anchor field fabrication					282,426	See sheet 6
2.2 HDP pipe cost						
2.2.1 Material(Pipe and diffuser)					1,669,300	CIF Port Moresby. See sheet 7
2.2.2 Port duty +Consumtion Tax					217,009	Item 2.2.1*(10%+3%), ditto
2.2.3 Inner transportation					13,200	See sheet 7
2.2.4 Field joint cost					159,700	See sheet 7
	Item 2.2 Total				2,059,209	

PRICE CALCULATION SHEET

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
2.3 Civil work and pipe installation						
2.3.1 Onland and ocean shallow portion civil work					77,455	See sheet 8
2.3.2 Supplementaray facility					10,000	See sheet 8
2.3.3 Deep ocean anchor base grading					450,000	See sheet 8
2.3.4 Pipe toing, moring and setting					Included in Item 2.3.3	
2.3.5 Concrete anchor setting					Included in Item 2.3.3	
	Item 2.3 Total				537,455	
	Item 2 Total				2,879,090	
	Item 1+2				3,726,390	
3. Indirect cost						
3.1 Contractor's fileld supervisionary cost		Item (1+2) *15%			558,959	
3.2 Contractor's head office charge and over head		Item (1+2) *5%			186,320	
	Item 1+2+3 total				4,471,669	/3,100m=1,442kina/m

PRICE CALCULATION SHEET

Cost breakdown

SHEET 3

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
1.1.1 Pipe storage yard and field joint yard						
1.1.2 Anchor field fabrication yard and others		Item1.1.1+1.1.2=Total 8,000m², 30days				
Buldozer	D6 class	1*30day*1/3 =10days	day	135	1,350	
Tireroller	SP1151 class	10days	day	100	1,000	
Supervisor		1*30*1.0=30days	day	400	12,000	
Skill		2*30*1.0=60days	day	50	6,000	
Unskill		4*30*1.0=120days	day	25	6,000	
Temporary fence		500m	m	50	25,000	
Tool/Consumable/Miscellaneous		30days	day	500	15,000	
Land hire cost		8,000m²	m²	5	40,000	
		Item 1.1.2 Total			106,350	/8,000m²=13.29kina/m²
1.1.3 Access Jetty	D*W*L=1.5*5 *100m =750m³	60days				
Backfill rock		750m³	m³	60	45,000	
Overlay soil		750m³*0.3=225m³	m³	30	6,750	
Bulldozer		1*60*1.0=60days	day	135	8,100	
Dumpcar		2*60*1.0=120days	day	100	12,000	
Tireroller		1*60*0.4=24days	day	100	2,400	
Supervisor		1*60*1.0=60days	day	400	24,000	
Skill		2*60*1.0=120days	day	50	6,000	
Unskill		6*60*1.0=360days	day	25	9,000	
Tool/Consumable/Miscellaneous		50days	day	500	25,000	
		Item 1.1.3 Total			138,250	/500m²=276.5kina/m²

PRICE CALCULATION SHEET

SHEET 4

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
1.1.4 Ocean pipe route and	access doredging	Excavation 8,000m³	70days			/70days=114m³/day
		Backfilling 7,608m³	40days			/40days=190m³/day
Vessel					Included in Item 1.2	
Backhoe		1*110*1.0 =110days	day	150	16,500	7,200m³/60days=120m³/day
Supervisor		1*110*1.0 =110days	day	400	44,000	
Skill		3*110*1.0 =330days	day	50	16,500	
Unskill		6*110*1.0 =660days	day	25	16,500	
Tool/Consumable/Miscellaneous		110days	day	500	55,000	
		Item 1.1.4 Total			148,500	/(7,440m³+7,048m³)=10.2kina/m³
1.1.5 Access road						
Temporary road cost		W*L=7*300m =2,100m²	m²	10	21,000	
Land hire cost		2,100m²	m²	5	10,000	
		Item 1.1.5 Total			31,000	

PRICE CALCULATION SHEET

SHEET 5

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
1.2 Common vessel cost and buoy,markers						
1.2.1 Juction boat		260days	day	120	31,200	with captain & fuel
1.2.2 Barge						
Purchase of second hand barge			No.	38,500	38,500	Aus.$ 3,500*1.10=38,500Kina
Towing with tag boat		Australia to PMB, 2,000km, 20days	day	2,000	40,000	with captain & fuel
Daily use	with winch 4 sets	150days	day	100	15,000	ditto
1.2.3 Tag boat		80days	day	1,000	80,000	ditto
1.2.4 Work vessel		200days	day	150	30,000	ditto
1.2.5 Crane vessel	Crane Cap. 25ton req.	80days	day	500	40,000	ditto
1.2.6 Surveyor's boat		50days	day	120	6,000	ditto
1.2.7 Vouy and markers		3,000m/50m =60sets	set	200	12,000	ditto
1.2.8 Tool/consumable material		260days	day	500	130,000	
		Item 1.2 Sub total			422,700	

PRICE CALCULATION SHEET

SHEET 6

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
2. Direct cost						
2.1 Concrete anchor field fabrication		176pcs/60days =2.93pcs/day				
Material						
Concrete		2.356m³/pc*176pcs =415m³	m³	200	83,000	one piece 5.65ton
Form work		4.380m²/pc*176pcs =771m²	m²	16.7	12,876	50kina/m²*1/3=16.7kina/m²
Anchor piece		0.200t/pc*176pcs =35.2t	ton	2,500	88,000	
Supervisor		1*60*1.0=60days	day	400	24,000	
Skill		4*60*1.0=240days	day	50	12,000	
Unskill		8*60*1.0=480days	day	25	12,000	
Wrecker	25-30ton class	1*60*0.75=45days	day	150	6,750	
Trailer		1*60*0.25=15days	day	120	1,800	
Truck		1*60*1.00=60days	day	50	3,000	
Tractive truck		1*60*0.50=30days	day	100	3,000	
Fabrication facility			LS		6,000	
Tool/comsumable material		1*60*1.00=60days	day	500	30,000	
		Item 2.1Total			282,426	/176pcs=1,605kina/pc
						/415m³=681kina/m³

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
2.2 HDP pipe cost						
	Total length 3,100m	(including diffuser)		Greade class 4.5		Joint 206pcs/50days
	Material: High density polythelene			OD= 1,000mm		=4.17pcs/day
				ID= 913mm		
	One unit : 15.0m*206pcs =3,090m 10.0m:1pc=10m total 3,100m			Thickness = 43.5mm		
	Joint : Welding, portially bolt			Weight= 138.4kg/m		
2.2.1 Pipe normal portion		3,025m	m	532	1,609,300	
2.2.1 Pipe Diffuser portion		75m	m	800	60,000	CIF Port Moresby
2.2.2 Import tax		Item *10%			166,930	
2.2.3 Consumtion tax		Item* 3%			50,079	
		Item2.2.1+2.2.1+2.2.3 +2.2.4 Total			1,886,309	
2.2.4 Inner transportation						Delivery 3 times
Toraiier		2*2days*3times =12days	day	150	1,800	207pcs/6days=34.5pcs/day
Wrecker		2*2days*3times =12days	day	150	1,800	2T*2days*3times=36pcs
Supervisor		1*12days*1.0 =12days	day	400	4,800	
Skill		8*12days*1.0 =96days	day	50	4,800	
		Item 2.2.4 Total			13,200	
2.2.5 Field joint and Launching						
Pipe maker's supervisior		1*70days*1.0 =70days	day	650	45,500	
Supervisor		1*70*1.0=70days	day	400	28,000	
Skill		4*70*1.0=70days	day	50	14,000	
Unskill		8*70*1.0 =560days	day	25	14,000	
Joint material		206part	part	200	41,200	
Field shop facility			Ls		5,000	
Tool/consumable material		70days	day	500	35,000	
		Item 2.2.5 Total			182,700	
		Item 2.2 Total			2,082,209	

PRICE CALCULATION SHEET

WORK ITEM	SPECIFICATION	QUANTITY	UNIT	UNIT PRICE	PRICE	REMARKS
2.3 Pipe installation cost						
2.3.1 On land portion civil work		100m				
Excavation		684	m^3	40	27,360	
Dewatering		684	m^3	15	10,260	Excavation volume*Dewatering unit price
Backfilling		606	m^3	10	6,060	
Disposal		79	m^3	20	1,580	
Compaction		560	m^2	10	5,600	
		Item 2.3.1 Total			50,860	509kina/m
2.3.2 Supplementary facility			Ls		10,000	
2.3.2 Deep ocean pipe base grading		Item 2.3 Total 200days				
2.3.3. Pipe toinge, moring and setting						
2.3.4 Concrete anchor setting						
Ocean vessel					Included in Common Item	
Wrecker	25-30 class	1*200days*0.5 =100days	day	150	15,000	
Surveyor		1*200days*0.25 =50days	day	400	20,000	
ditto assistant		2*50days =100days	day	50	5,000	
Diver-1		4*200days*0.50 =400days	day	300	120,000	
Diver-2		2*200days*0.25 =100days	day	300	30,000	
Supervisor		1*200*1.0 =200days	day	400	80,000	
Skill		4*200*1.0 =800days	day	50	40,000	
Unskill		8*200*1.0 =1600days	day	25	40,000	
Anchor/bouy					Including in Common Item	
Tool/consumable material		200days	day	500	100,000	
		Item2.4.2+2.4.3+2.4.3 Total			450,000	