Appendix M63:

Master Plan for Sewerage Facilities

Contents for Appendix M63

Appendix M63.1 Flow Calculation Sheets (Year of 2025)

(1) Flow Calculation Sheet for Panaji Surroundings (Taleigao, Dona Paula and Caranzarem) (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m)		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
MP-1(1)	2	18.4	18.4	1,683	1,683	7.1	7.1	3.00	21.4	150	50	PM	15.00	20.97	13.270	19.240	1.50	1.50			
2	3	0.0	18.4	0	1,683	0.0	7.1	3.00	21.4	200	700	165	20.97	19.98	19.190	14.948	1.50	4.75	0.80	21.7	
3	7	18.4	36.8	1,683	3,366	7.1	14.3	3.00	42.9	300	750	280	19.98	4.17	14.848	2.290	4.75	1.50	0.81	49.0	
4	5	33.3	33.3	1,588	1,588	3.2	3.2	3.00	9.7	150	1,100	110	45.00	4.82	43.770	3.590	1.00	1.00	0.81	12.3	Branch sewer
5	MP-2(6)	0.0	33.3	0	1,588	0.0	3.2	3.00	9.7	150	400	110	4.82	4.17	3.570	-0.066	1.02	4.01	0.81	12.3	Branch sewer
MP-2(6)	7	0.0	33.3	0	1,588	0.0	3.2	3.00	9.7	75	50	PM	4.17	4.17	3.020	3.020	1.00	1.00			Branch sewer
7	8	18.4	88.5	1,683	6,637	7.1	24.7	3.00	74.0	400	650	410	4.17	4.57	2.190	0.605	1.50	3.49	0.81	87.3	
8	PS-1(9)	9.2	97.7	842	7,478	3.6	28.2	3.00	84.7	400	800	410	4.57	4.91	0.585	-1.366	3.51	5.80	0.81	87.3	
PS-1(9)	10	42.5	140.2	2,830	10,308	9.5	37.7	3.00	113.1	500	850	560	4.91	3.70	2.830	1.312	1.50	1.81	0.80	135.4	
10	STP(27)	9.2	149.4	842	11,149	3.6	41.3	3.00	123.8	500	800	560	3.70	3.11	1.292	-0.137	1.83	2.67	0.80	135.4	
MP-3(11)	12	9.3	9.3	441	441	0.9	0.9	3.00	2.7	75	500	PM	5.00	46.42	3.350	45.270	1.50	1.00			Branch sewer
12	14	0.0	9.3	0	441	0.0	0.9	3.00	2.7	150	1,100	110	46.42	39.58	45.190	35.190	1.00	4.16	0.81	12.3	Branch sewer
MP-4(13)	14	55.5	55.5	2,646	2,646	5.4	5.4	3.00	16.1	150	500	PM	3.81	39.58	2.080	37.850	1.50	1.50			
14	15	0.0	64.8	0	3,087	0.0	6.3	3.00	18.8	200	800	165	39.58	28.60	37.330	26.820	1.97	1.50	0.80	21.7	
15	16	24.1	88.9	1,147	4,234	2.3	8.6	3.00	25.8	250	500	220	28.60	4.22	24.560	2.390	3.71	1.50	0.81	34.0	
16	19	0.0	88.9	0	4,234	0.0	8.6	3.00	25.8	250	350	220	4.22	4.21	2.370	0.779	1.52	3.10	0.81	34.0	
17	MP-5(18)	25.9	25.9	1,235	1,235	2.5	2.5	3.00	7.5	150	800	110	5.70	4.21	4.470	-2.803	1.00	6.78	0.81	12.3	Branch sewer
MP-5(18)	19	0.0	25.9	0	1,235	0.0	2.5	3.00	7.5	75	50	PM	4.21	4.21	3.060	3.060	1.00	1.00			Branch sewer
19	23	22.2	137.0	1,058	6,527	2.1	13.3	3.00	39.8	300	200	280	4.21	4.44	0.729	0.015	3.10	4.05	0.81	49.0	
20	22	24.1	24.1	1,147	1,147	2.3	2.3	3.00	7.0	150	750	110	7.90	5.52	6.670	-0.148	1.00	5.44	0.81	12.3	Branch sewer
MP-6(21)	22	13.0	13.0	617	617	1.3	1.3	3.00	3.8	75	600	PM	2.27	5.52	1.120	4.370	1.00	1.00			Branch sewer
22	23	37.0	74.1	1,764	3,528	3.6	7.2	3.00	21.5	200	250	165	5.52	4.44	3.740	2.225	1.50	1.94	0.80	21.7	
23	PS-2(24)	29.6	240.7	1,411	11,467	2.9	23.3	3.00	69.8	400	400	410	4.44	4.18	-0.080	-1.056	4.04	4.76	0.81	87.3	
PS-2(24)	25	25.9	266.6	1,235	12,701	2.5	25.8	3.00	77.4	300	600	PM	4.18	7.90	2.300	6.020	1.50	1.50			
25	26	48.0	314.6	2,293	14,995	4.7	30.4	3.00	91.3	450	700	490	7.90	3.11	5.390	1.080	1.98	1.50	0.80	109.3	
26	STP(27)	0.0	314.6	0	14,995	0.0	30.4	3.00	91.3	450	550	490	3.11	3.11	1.060	-0.062	1.52	2.64	0.80	109.3	

(2) Flow Calculation Sheet for St.Crus Area (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m)		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
1	3	12.0	12.0	1,637	1,637	2.8	2.8	3.00	8.5	150	400	110	50.00	10.00	48.770	8.770	1.00	1.00	0.81	12.3	Branch Sewer
2	3	12.0	12.0	1,637	1,637	2.8	2.8	3.00	8.5	150	400	110	10.00	10.00	8.770	5.134	1.00	4.64	0.81	12.3	Branch Sewer
3	6	19.0	43.0	2,592	5,867	4.5	10.2	3.00	30.6	250	450	220	10.00	4.00	4.850	2.170	4.82	1.50	0.81	34.0	
4	MP-1(5)	9.0	9.0	1,228	1,228	2.1	2.1	3.00	6.4	150	400	110	3.00	4.00	1.770	-1.866	1.00	5.64	0.81	12.3	Branch Sewer
MP-1(5)	6	0.0	9.0	0	1,228	0.0	2.1	3.00	6.4	75	50	PM	4.00	4.00	2.850	2.850	1.00	1.00			Branch Sewer
6	9	25.0	77.0	3,411	10,506	5.9	18.2	3.00	54.7	350	650	350	4.00	3.00	2.070	0.213	1.50	2.36	0.80	66.2	
7	MP-2(8)	14.0	14.0	1,910	1,910	3.3	3.3	3.00	9.9	150	200	110	3.00	3.00	1.770	-0.048	1.00	2.82	0.81	12.3	Branch Sewer
MP-2(8)	9	0.0	14.0	0	1,910	0.0	3.3	3.00	9.9	75	50	PM	3.00	3.00	1.850	1.850	1.00	1.00			Branch Sewer
9	PS-1(12)	14.0	105.0	1,910	14,326	3.3	24.9	3.00	74.6	400	600	410	3.00	3.00	0.163	-1.300	2.36	3.82	0.81	87.3	
10	MP-3(11)	4.0	4.0	546	546	0.9	0.9	3.00	2.8	150	400	110	4.00	3.00	2.770	-0.866	1.00	3.64	0.81	12.3	Branch Sewer
MP-3(11)	PS-1(12)	15.0	19.0	2,047	2,592	3.6	4.5	3.00	13.5	200	750	165	3.00	3.00	1.220	-3.325	1.50	6.05	0.80	21.7	
PS-1(12)	STP(13)	0.0	124.0	0	16,918	0.0	29.4	3.00	88.1	450	500	490	3.00	2.00	0.970	-0.050	1.50	1.52	0.80	109.3	

(3) Flow Calculation Sheet for Porvorim (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m)		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
1	PS-1(3)	70.7	70.7	5,681	5,681	10.5	10.5	3.00	31.4	250	1,100	220	58.00	50.00	55.897	48.170	1.77	1.50	0.808	34.0	
MP-1(2)	PS-1(3)	95.9	95.9	7,709	7,709	14.2	14.2	3.00	42.6	200	1,000	PM	30.00	50.00	28.220	48.220	1.50	1.50			
PS-1(3)	8	0.0	166.6	0	13,390	0.0	24.6	3.00	73.9	250	1,100	PM	50.00	58.00	48.170	56.170	1.50	1.50			
4	MP-3(6)	18.4	18.4	1,478	1,478	2.7	2.7	3.00	8.2	150	1,100	110	58.00	50.00	56.770	48.770	1.00	1.00	0.813	12.3	Branch sewer
MP-2(5)	MP-3(6)	10.1	10.1	810	810	1.5	1.5	3.00	4.5	75	600	PM	30.00	50.00	28.850	48.850	1.00	1.00			Branch sewer
MP-3(6)	8	0.0	28.5	0	2,288	0.0	4.2	3.00	12.6	150	1,100	PM	50.00	58.00	48.270	56.270	1.50	1.50			
MP-4(7)	8	15.4	15.4	1,239	1,239	2.3	2.3	3.00	6.8	100	1,000	PM	30.00	58.00	28.820	56.820	1.00	1.00			Branch sewer
8	PS-2(18)	15.6	226.1	1,253	18,171	2.3	33.4	3.00	100.3	450	300	490	58.00	50.00	53.508	47.970	3.96	1.50	0.801	109.3	
MP-5(9)	10	25.3	25.3	2,030	2,030	3.7	3.7	3.00	11.2	100	450	PM	50.00	60.00	48.820	58.820	1.00	1.00			Branch sewer
10	11	48.0	73.3	3,857	5,887	7.1	10.8	3.00	32.5	250	450	220	60.00	57.00	57.959	55.170	1.71	1.50	0.81	34.0	
11	13	27.8	101.1	2,233	8,120	4.1	14.9	3.00	44.8	300	450	280	57.00	57.00	55.120	53.513	1.50	3.11	0.81	49.0	
MP-6(12)	13	28.5	28.5	2,292	2,292	4.2	4.2	3.00	12.7	100	650	PM	50.00	57.00	48.820	55.820	1.00	1.00			Branch sewer
13	17	22.2	151.8	1,778	12,190	3.3	22.4	3.00	67.3	400	800	410	57.00	56.00	53.413	51.462	3.11	4.06	0.81	87.3	
MP-7(14)	17	8.9	8.9	715	715	1.3	1.3	3.00	3.9	75	750	PM	50.00	56.00	48.850	54.850	1.00	1.00			Branch sewer
15	16	10.8	10.8	864	864	1.6	1.6	3.00	4.8	150	550	110	62.00	58.00	60.270	55.270	1.50	2.50	0.81	12.3	Branch sewer
16	17	45.5	56.3	3,654	4,519	6.7	8.3	3.00	24.9	250	350	220	58.00	56.00	55.170	53.579	2.50	2.09	0.81	34.0	
17	PS-2(18)	10.1	227.1	812	18,236	1.5	33.6	3.00	100.7	450	400	490	56.00	50.00	51.412	47.970	4.06	1.50	0.80	109.3	
PS-2(18)	19	7.5	460.7	597	37,003	1.1	68.1	2.50	170.2	350	1,300	PM	50.00	62.00	48.070	60.070	1.50	1.50			
19	20	8.1	468.8	643	37,646	1.2	69.3	2.50	173.2	600	350	720	62.00	60.00	59.447	57.820	1.87	1.50	0.80	194.1	
20	22	37.9	506.7	3,045	40,691	5.6	74.9	2.50	187.2	600	500	720	60.00	50.00	56.018	47.820	3.30	1.50	0.80	194.1	
MP-8(21)	22	16.3	16.3	1,332	1,332	2.5	2.5	3.00	7.4	100	600	PM	30.00	50.00	28.850	48.850	1.00	1.00			Branch sewer
22	STP(29)	0.0	523.0	0	42,023	0.0	77.3	2.50	193.3	600	550	720	50.00	5.00	43.828	2.820	5.49	1.50	0.80	194.1	
23	MP-9(24)	4.0	4.0	630	630	1.2	1.2	3.00	3.5	150	550	110	3.00	3.00	1.770	-3.230	1.00	6.00	0.81	12.3	Branch sewer
MP-9(24)	MP-10(25)	4.0	8.0	630	1,259	1.2	2.3	3.00	7.0	150	550	110	3.00	3.00	1.770	-3.230	1.00	6.00	0.81	12.3	Branch sewer
MP-10(25)	MP-11(26)	7.0	15.0	1,102	2,361	2.0	4.3	3.00	13.0	200	700	165	3.00	3.00	1.220	-3.022	1.50	5.74	0.80	21.7	
MP-11(26)	MP-12(28)	7.0	22.0	1,102	3,464	2.0	6.4	3.00	19.1	200	700	165	3.00	3.00	1.220	-3.022	1.50	5.74	0.80	21.7	
27	MP-12(28)	7.0	7.0	1,102	1,102	2.0	2.0	3.00	6.1	150	550	110	3.00	3.00	1.770	-3.230	1.00	6.00	0.81	12.3	Branch sewer
MP-12(28)	STP(29)	8.0	37.0	1,259	5,825	2.3	10.7	3.00	32.2	150	500	PM	3.00	5.00	1.270	3.270	1.50	1.50			

(4) Flow Calculation Sheet for Margao (South Sewerage Zone) (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m)		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
MP-1(1)	2			4,672	4,672	9.5	9.5	3.00	28.6	150	450	PM	31.66	39.83	29.930	38.100	1.50	1.50			
2	PS-1(3)			5,730	10,402	11.7	21.2	3.00	63.7	350	1,200	350	39.83	17.28	36.307	15.350	3.09	1.50	0.802	66.2	
PS-1(3)	4			2,860	13,262	5.8	27.1	3.00	81.3	400	50	410	17.28	12.82	10.960	10.840	5.84	1.50			
4	5			2,436	15,698	5.0	32.1	3.00	96.2	450	250	490	12.82	11.00	10.266	8.970	2.02	1.50	0.801	109.3	
5	6			609	16,307	1.2	33.3	3.00	99.9	450	400	490	11.00	10.32	8.950	8.134	1.52	1.66	0.801	109.3	
6	11			9,913	26,220	20.2	53.6	2.50	133.9	500	600	560	10.32	6.33	7.629	4.250	2.11	1.50	0.804	135.4	
7	8			1,491	1,491	3.0	3.0	3.00	9.1	200	300	165	10.72	9.46	8.940	7.122	1.50	2.06	0.804	21.7	Trenchless
8	9			3,159	4,650	6.5	9.5	3.00	28.5	250	600	220	9.46	7.40	7.072	4.345	2.06	2.73	0.808	34.0	Trenchless
9	10			1,339	5,989	2.7	12.2	3.00	36.7	300	500	280	7.40	6.36	4.295	2.509	2.73	3.47	0.809	49.0	
10	11			6,645	12,634	13.6	25.8	3.00	77.4	400	700	410	6.36	6.33	2.409	0.702	3.47	5.15	0.810	87.3	
11	12			926	39,780	1.9	81.3	2.50	203.1	700	100	880	6.33	6.33	0.402	0.288	5.15	5.26	0.802	264.8	Trenchless Crossing Railway Track
12	13			0	39,780	0.0	81.3	2.50	203.1	700	1,250	880	6.33	3.58	0.268	-1.152	5.28	3.95	0.802	264.8	
13	PS-2(14)			1,738	41,518	3.6	84.8	2.50	212.0	700	200	880	3.58	2.72	-1.172	-1.399	3.97	3.34	0.802	264.8	
PS-2(14)	15			3,725	45,243	7.6	92.4	2.50	231.0	400	650	PM	2.72	6.67	0.740	4.690	1.50	1.50			
15	16			3,579	48,822	7.3	99.7	2.50	249.3	700	1,000	880	6.67	3.75	4.212	1.470	1.68	1.50	0.802	264.8	
16	17			437	49,259	0.9	100.6	2.50	251.5	700	400	880	3.75	3.92	1.450	0.995	1.52	2.15	0.802	264.8	
17	STP(18)			1,744	51,003	3.6	104.2	2.25	234.4	700	350	880	3.92	2.00	0.975	-0.280	2.17	1.50	0.802	264.8	
To STP trough North Trunk				5,904	5,904	12.1	12.1	3.00	36.2												

(5) Flow Calculation Sheet for Ponda (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m)		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
Left Bank Main																					
1	2	56.6	56.6	4,703	4,703	9.7	9.7	3.00	29.1	250	300	220	109.90	102.80	107.077	100.970	2.49	1.50	0.81	34.0	
2	MP-1(3)	37.5	94.2	3,070	7,773	6.3	16.0	3.00	48.1	300	50	280	102.80	100.00	98.290	98.120	4.13	1.50	0.81	49.0	
MP-1(3)	4	1.7	95.9	148	7,921	0.3	16.3	3.00	49.0	200	250	PM	100.00	104.50	98.220	102.720	1.50	1.50			
4	5	1.3	97.2	139	8,060	0.3	16.6	3.00	49.9	350	100	350	104.50	103.00	101.965	101.070	2.11	1.50	0.80	66.2	
5	6	16.9	114.1	1,808	9,868	3.7	20.3	3.00	61.0	350	100	350	103.00	100.00	99.715	98.070	2.86	1.50	0.80	66.2	
6	7	7.8	121.9	835	10,703	1.7	22.1	3.00	66.2	400	100	410	100.00	99.50	97.890	97.520	1.63	1.50	0.81	87.3	
7	PS-1(8)	5.2	127.1	556	11,259	1.1	23.2	3.00	69.6	400	50	410	99.50	99.20	97.340	97.220	1.68	1.50	0.81	87.3	
PS-1(8)	9	0.0	127.1	0	11,259	0.0	23.2	3.00	69.6	250	450	PM	99.20	102.95	97.370	101.120	1.50	1.50			
9	10	1.7	128.8	138	11,397	0.3	23.5	3.00	70.5	400	300	410	102.95	102.00	100.957	100.020	1.51	1.50	0.81	87.3	
10	11	6.7	135.5	552	11,949	1.1	24.6	3.00	73.9	400	50	410	102.00	101.83	99.995	99.850	1.53	1.50	0.81	87.3	
11	12	16.8	152.4	1,381	13,330	2.8	27.5	3.00	82.5	400	100	410	101.83	100.98	99.570	99.000	1.78	1.50	0.81	87.3	
12	13	3.4	155.7	276	13,606	0.6	28.1	3.00	84.2	400	150	410	100.98	101.90	98.980	98.614	1.52	2.81	0.81	87.3	
13	14	1.7	157.4	138	13,745	0.3	28.3	3.00	85.0	400	200	410	101.90	101.90	98.594	98.106	2.83	3.31	0.81	87.3	
14	15	6.7	164.1	552	14,297	1.1	29.5	3.00	88.4	450	250	490	101.90	97.00	98.086	94.970	3.28	1.50	0.80	109.3	
15	STP(22)	0.0	164.1	0	14,297	0.0	29.5	3.00	88.4	450	250	490	97.00	96.00	94.872	93.970	1.60	1.50	0.80	109.3	
Branch	STP(22)	3.4	3.4	276	276	0.6	0.6														
Right Bank Main																					
16	17	25.2	25.2	3,377	3,377	7.0	7.0	3.00	20.9	250	200	220	101.53	101.53	99.700	98.791	1.50	2.41	0.81	34.0	
17	18	2.4	27.6	415	3,791	0.9	7.8	3.00	23.4	250	150	220	101.53	102.00	98.771	98.089	2.43	3.58	0.81	34.0	
18	19	1.2	28.7	207	3,999	0.4	8.2	3.00	24.7	250	100	220	102.00	103.30	98.069	97.614	3.60	5.36	0.81	34.0	
19	20	1.2	29.9	207	4,206	0.4	8.7	3.00	26.0	250	50	220	103.30	101.40	97.594	97.367	5.38	3.70	0.81	34.0	
20	21	3.6	33.5	622	4,828	1.3	10.0	3.00	29.9	250	100	220	101.40	96.50	97.347	94.670	3.72	1.50	0.81	34.0	
21	STP(22)	0.0	33.5	0	4,828	0.0	10.0	3.00	29.9	250	50	220	96.50	96.00	92.670	92.443	3.50	3.23	0.81	34.0	

(6) Flow Calculation Sheet for Mapusa (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m)		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
1	2	29.7	29.7	7,673	7,673	14.0	14.0	3.00	42.1	300	400	280	125.00	108.00	121.174	106.120	3.45	1.50	0.81	49.0	
2	3	38.3	68.0	11,918	19,591	21.8	35.8	3.00	107.4	450	550	490	108.00	103.00	105.265	100.970	2.21	1.50	0.80	109.3	
3	4	21.3	89.3	4,224	23,815	7.7	43.5	2.50	108.8	450	450	490	103.00	100.00	100.507	97.970	1.96	1.50	0.80	109.3	
4	5	16.5	105.8	4,674	28,489	8.5	52.0	2.50	130.1	500	400	560	100.00	98.50	97.729	96.420	1.69	1.50	0.80	135.4	Trenchless
5	11	35.3	141.1	6,756	35,245	12.3	64.4	2.50	161.0	600	400	720	98.50	97.00	96.084	94.820	1.74	1.50	0.80	194.1	Trenchless
MP-1(6)	7	5.8	5.8	739	739	1.4	1.4	3.00	4.1	75	600	PM	102.00	115.00	100.850	113.850	1.00	1.00			Branch Sewer
7	8	46.1	51.9	5,910	6,649	10.8	12.1	3.00	36.4	300	750	280	115.00	110.00	112.811	108.120	1.81	1.50	0.81	49.0	
8	PS-1(9)	4.2	56.1	620	7,269	1.1	13.3	3.00	39.8	300	400	280	110.00	104.50	107.102	102.620	2.52	1.50	0.81	49.0	
PS-1(9)	10	61.3	117.4	11,468	18,737	21.0	34.2	3.00	102.7	300	950	PM	104.50	135.00	102.620	133.120	1.50	1.50			
10	11	17.0	134.4	2,822	21,559	5.2	39.4	2.50	98.5	450	700	490	135.00	97.00	130.358	94.970	4.11	1.50	0.80	109.3	
11	12	17.3	292.8	3,175	59,979	5.8	109.6	2.25	246.6	700	1,000	880	97.00	99.50	94.720	93.584	1.50	5.14	0.80	264.8	
12	13	0.0	292.8	0	59,979	0.0	109.6	2.25	246.6	700	250	880	99.50	98.50	93.564	93.280	5.16	4.44	0.80	264.8	
13	STP(19)	4.9	297.7	2,482	62,461	4.5	114.1	2.25	256.8	700	550	880	98.50	96.00	93.260	92.635	4.46	2.58	0.80	264.8	
MP-2(14)	15	3.2	3.2	1,655	1,655	3.0	3.0	3.00	9.1	100	650	PM	103.00	125.00	101.820	123.820	1.00	1.00			Branch Sewer
15	16	0.0	3.2	0	1,655	0.0	3.0	3.00	9.1	150	250	110	125.00	122.50	123.770	121.270	1.00	1.00	0.81	12.3	Branch Sewer
16	17	4.9	8.1	2,482	4,137	4.5	7.6	3.00	22.7	250	400	220	122.50	100.00	118.085	98.170	4.09	1.50	0.81	34.0	
17	18	0.0	8.1	0	4,137	0.0	7.6	3.00	22.7	250	800	220	100.00	100.00	98.150	94.514	1.52	5.16	0.81	34.0	
18	STP(19)	3.2	11.3	1,655	5,792	3.0	10.6	3.00	31.7	250	700	220	100.00	96.00	94.494	91.312	5.18	4.36	0.81	34.0	

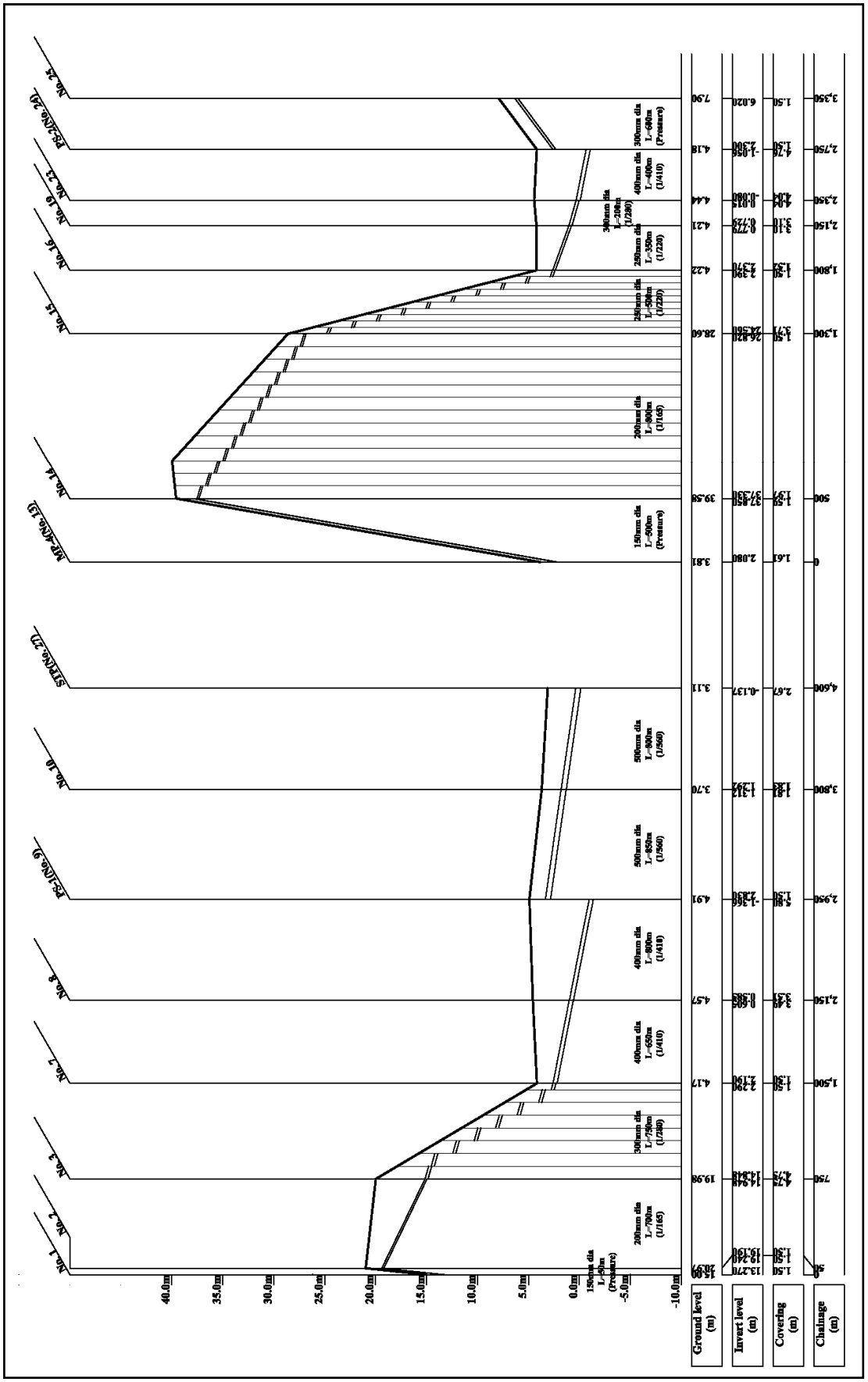
(7) Flow Calculation Sheet for South Coastal Belt (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	Length (m)	C-Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m9		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
1	2	5.1	5.1	200	200	0.9	0.9	3.00	2.8	300		110	3.00	3.00							Branch Sewer
2	3	17.0	22.1	667	867	3.1	4.1	3.00	12.3	450		110	3.00	2.50							Branch Sewer
3	MP-1(4)	17.0	39.1	667	1,533	3.1	7.2	3.00	21.7	500	500	165	2.50	2.00	0.720	-2.310	1.50	4.03	0.80	21.7	
MP-1(4)	5	9.8	48.9	384	1,918	1.8	9.1	3.00	27.2	300	800	PM	2.00	4.00	0.270	2.270	1.50	1.50			
5	6	26.3	75.2	1,031	2,949	4.9	13.9	3.00	41.8	500	1,300	280	4.00	4.00	2.120	0.334	1.50	3.29	0.81	49.0	
6	PS-1(10)	10.2	85.4	400	3,349	1.9	15.8	3.00	47.5	500	1,800	280	4.00	4.00	0.314	-1.472	3.31	5.09	0.81	49.0	
7	MP-2(8)	15.3	15.3	1,200	1,200	5.7	5.7	3.00	17.0	500	1,000	165	4.00	3.00	2.220	-0.810	1.50	3.53	0.80	21.7	
MP-2(8)	9	0.0	15.3	0	1,200	0.0	5.7	3.00	17.0	500	500	PM	3.00	4.00	1.270	2.270	1.50	1.50			
9	PS-1(10)	9.3	24.6	729	1,930	3.4	9.1	3.00	27.3	350		220	4.00	4.00	2.170	0.579	1.50	3.09	0.81	34.0	
PS-1(10)	STP(11)	0.0	110.0	0	5,279	0.0	24.9	3.00	74.8	500	2,300	410	4.00	3.00	2.020	0.800	1.50	1.72	0.81	87.3	

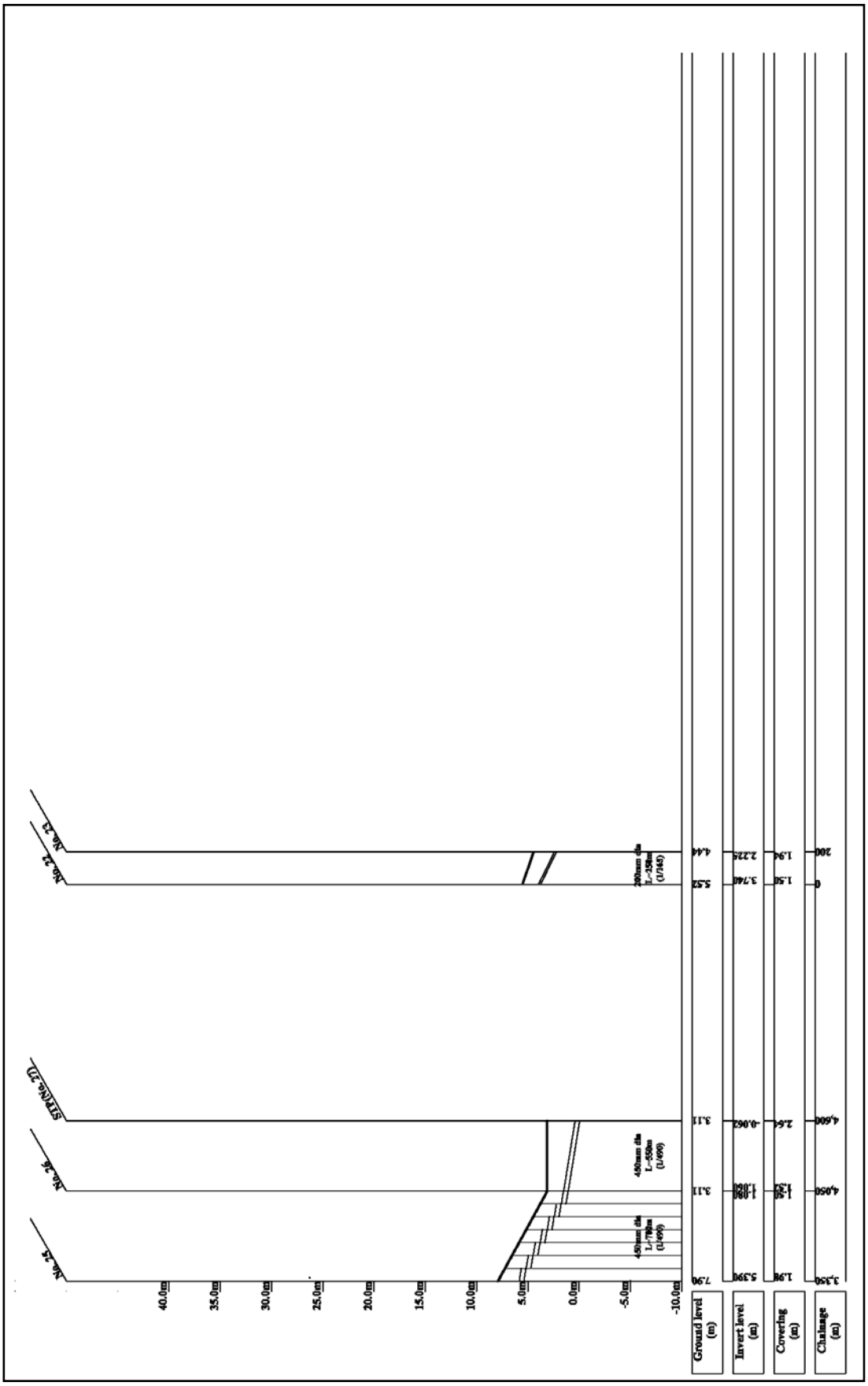
(8) Flow Calculation Sheet for North Coastal Belt (Year of 2025)

Node		Area (ha)		Population		Average Flow (lps)		Peak Factor	Peak Flow (lps)	C-Length (m)	C-Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Covering (m9		Velocity at 80% depth (m/sec)	Flow Capacity at 80% depth (lps)	Remarks
From	To	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream			
Candolim																					
1	2	77.4	77.4	5,306	5,306	19.2	19.2	3.00	57.5	1,100	13.750	350	17.04	13.99	15.110	11.967	1.50	1.59	0.80	66.2	
2	PS-1(3)	40.5	117.9	2,775	8,081	10.0	29.2	3.00	87.6	2,500	31.250	490	13.99	9.53	11.846	7.500	1.61	1.50	0.80	109.3	
PS-1(3)	4	0.0	117.9	0	8,081	0.0	29.2	3.00	87.6	5,000	62.500	PM	9.53	17.06	7.700	15.230	1.50	1.50			
4	5	39.3	157.3	2,694	10,775	9.7	38.9	3.00	116.8	5,700	71.250	560	17.06	17.27	14.980	13.730	1.50	2.96	0.80	135.4	
5	6	35.7	193.0	2,449	13,224	8.8	47.8	3.00	143.3	6,100	76.250	720	17.27	16.50	13.630	13.074	2.96	2.75	0.80	194.1	
Calangute																					
6	8	89.8	282.8	5,868	19,092	18.3	66.1	3.00	198.3	7,000	87.500	880	16.50	16.36	12.974	11.951	2.75	3.63	0.80	564.7	
7	8	35.9	35.9	2,347	2,347	7.3	7.3	3.00	22.0	700	8.750	220	19.41	16.36	17.580	14.398	1.50	1.63	0.81	34.0	
8	PS-2(9)	33.5	352.3	2,191	23,631	6.8	80.2	2.50	200.6	7,700	96.250	880	16.36	13.41	11.925	11.130	3.66	1.50	0.80	264.8	
PS-2(9)	10	28.7	381.0	1,878	25,509	5.9	86.1	2.50	215.3	8,200	102.500	PM	13.41	19.00	11.430	17.020	1.50	1.50			
10	13	67.1	448.1	4,382	29,890	13.7	99.8	2.50	249.4	9,100	113.750	880	19.00	16.30	16.534	14.020	1.69	1.50	0.80	264.8	
11	MP-1(12)	76.6	76.6	5,008	5,008	15.6	15.6	3.00	46.9	1,300	16.250	280	17.63	6.89	15.281	5.010	1.97	1.50	0.81	49.0	
MP-1(12)	13	0.0	76.6	0	5,008	0.0	15.6	3.00	46.9	2,500	31.250	PM	6.89	16.30	5.110	14.520	1.50	1.50			
13	14	68.3	593.0	4,460	39,358	13.9	129.3	2.50	323.3	10,300	128.750	1,050	16.30	8.27	13.346	5.890	2.07	1.50	0.80	346.1	
14	STP(15)	0.0	593.0	0	39,358	0.0	129.3	2.50	323.3	10,900	136.250	1,050	8.27	7.00	5.774	4.620	1.62	1.50	0.80	346.1	

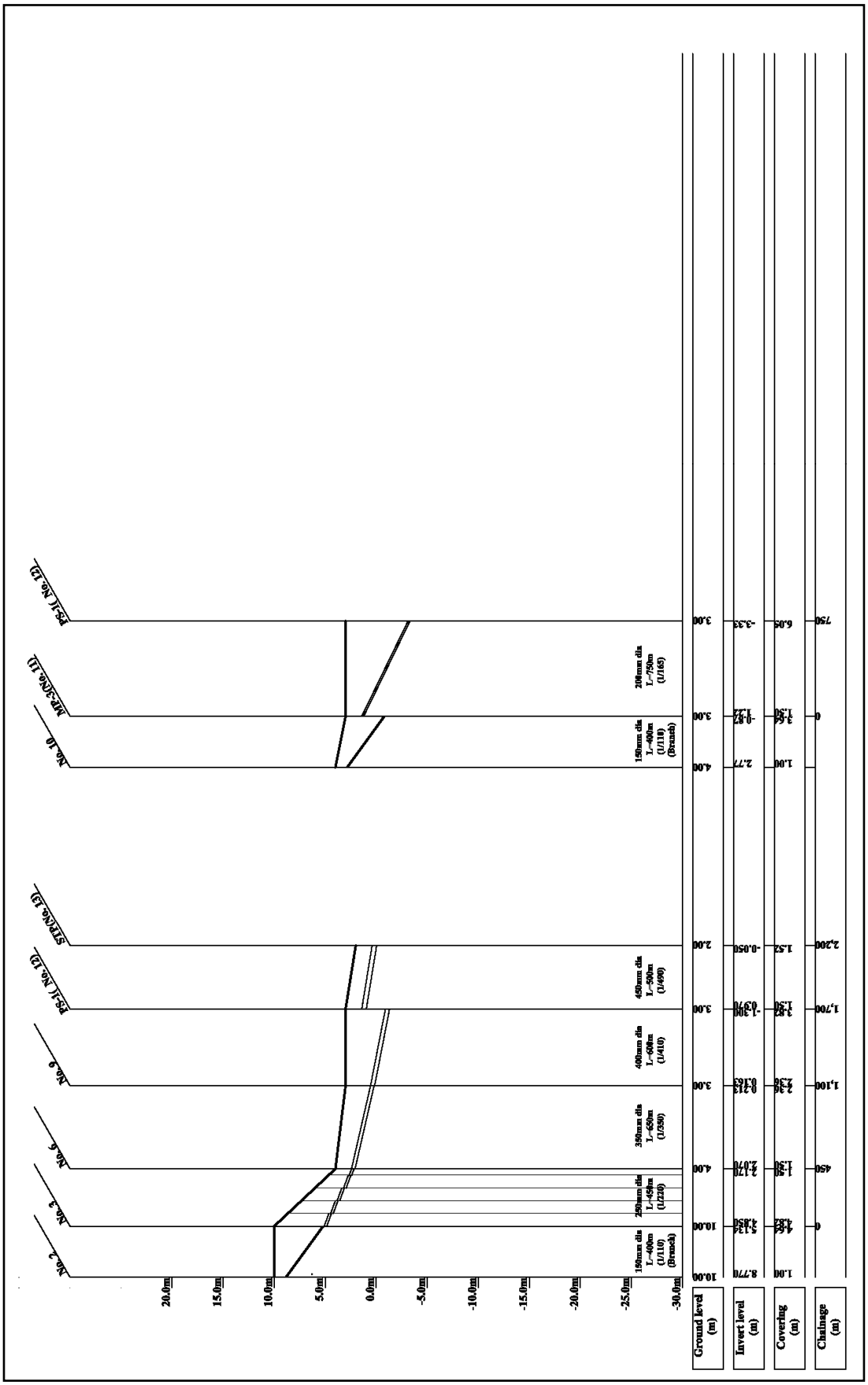
Appendix M63.2 Longitudinal Profile of Trunk Sewer (Year of 2025) (1) Panaji Surrounding (1/2)



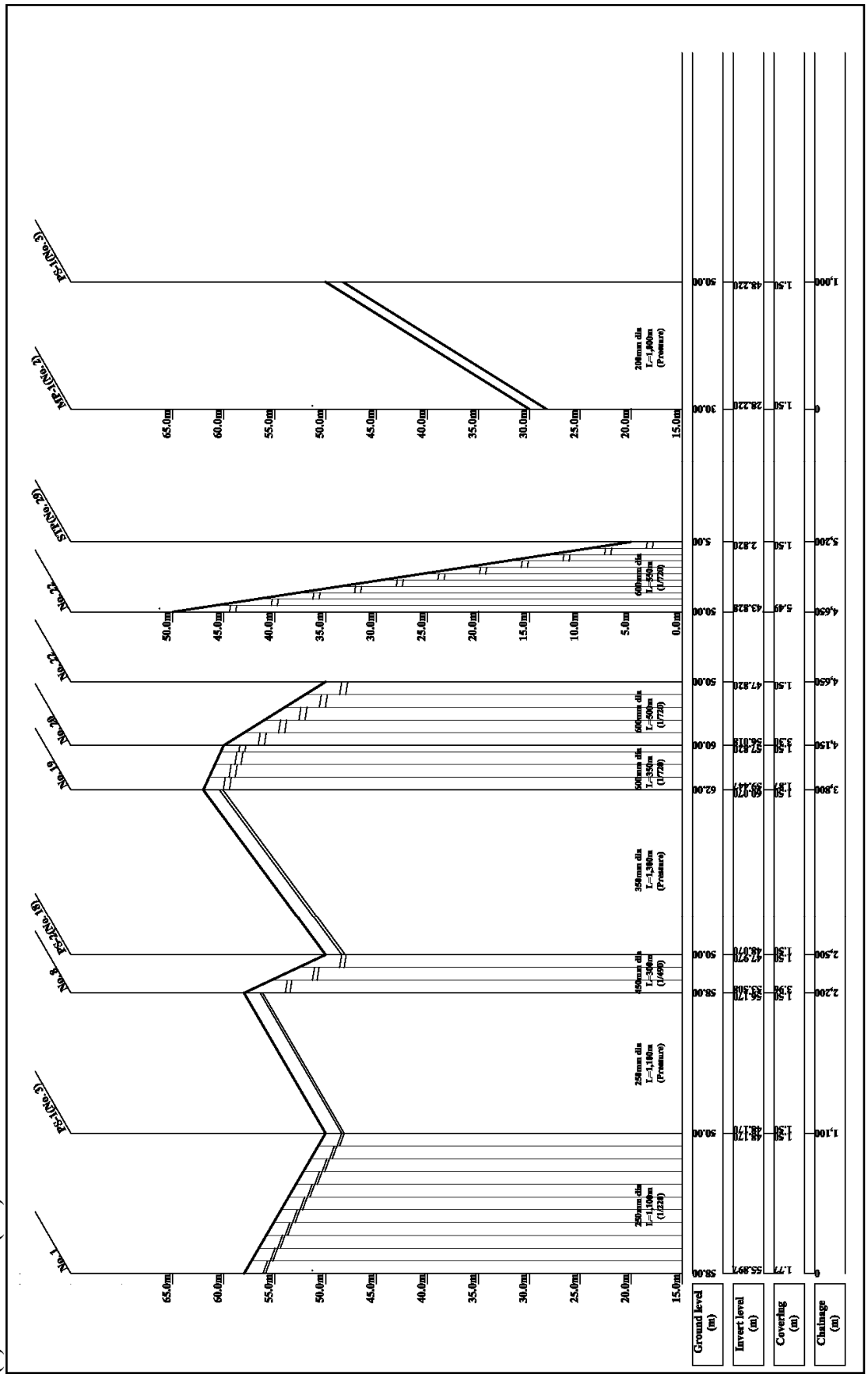
(1) Panaji Surrounding (2/2)



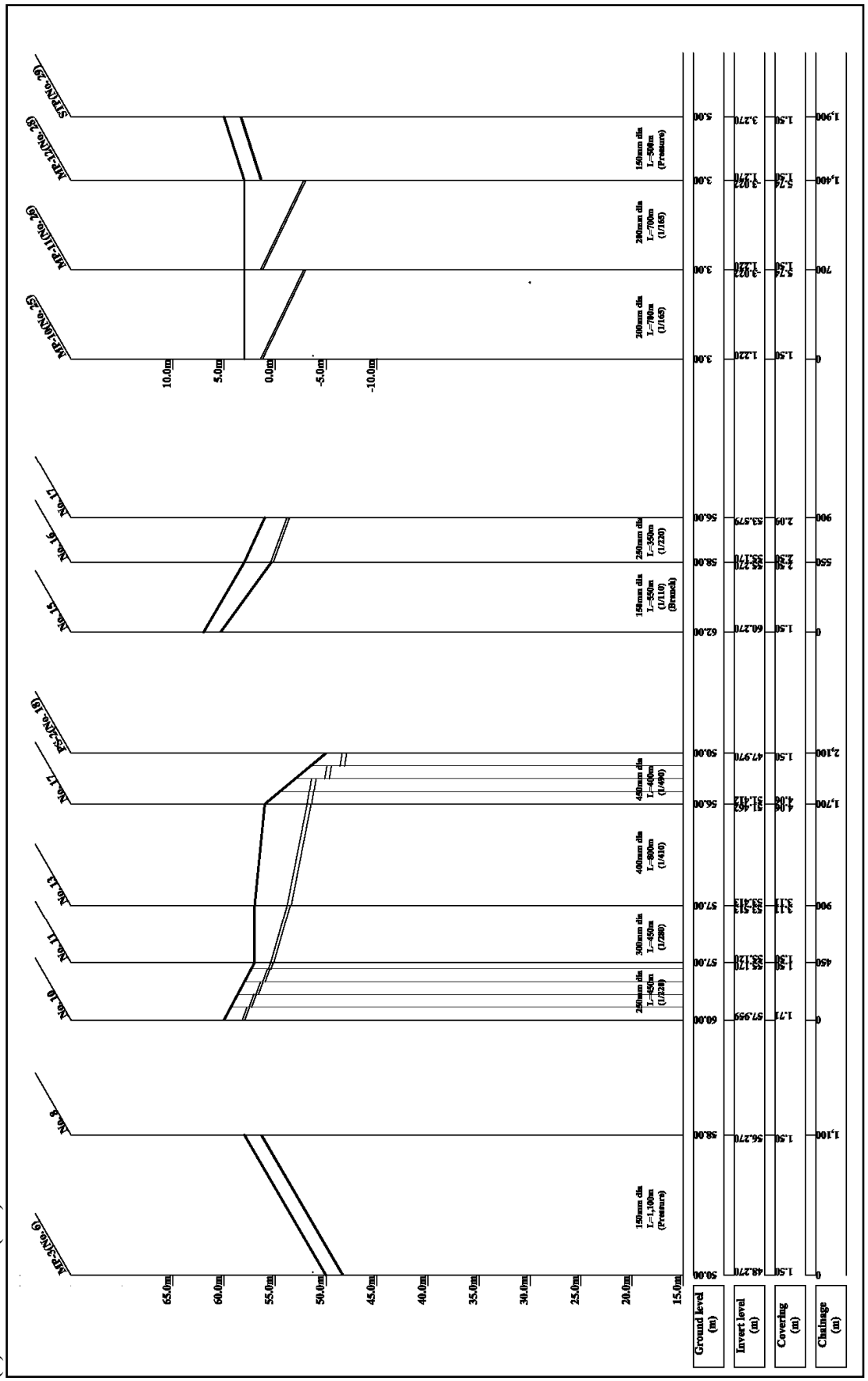
(2) St. Cruz (1/1)


No.2
No.3
No.6
No.9
PSJ(No.13)
STRNo.13)
No.10
MP-3(No.13)
PSJ(No.13)
150mm dia L=400m (1/110) (Bracnch)
250mm dia L=450m (1/220)
350mm dia L=650m (1/350)
400mm dia L=600m (1/410)
450mm dia L=500m (1/490)
150mm dia L=400m (1/110) (Bracnch)
200mm dia L=750m (1/165)
20.0m
15.0m
10.0m
5.0m
0.0m
-5.0m
-10.0m
-15.0m
-20.0m
-25.0m
-30.0m
Ground level (m)
Invert level (m)
Coverlug (m)
Chainage (m)

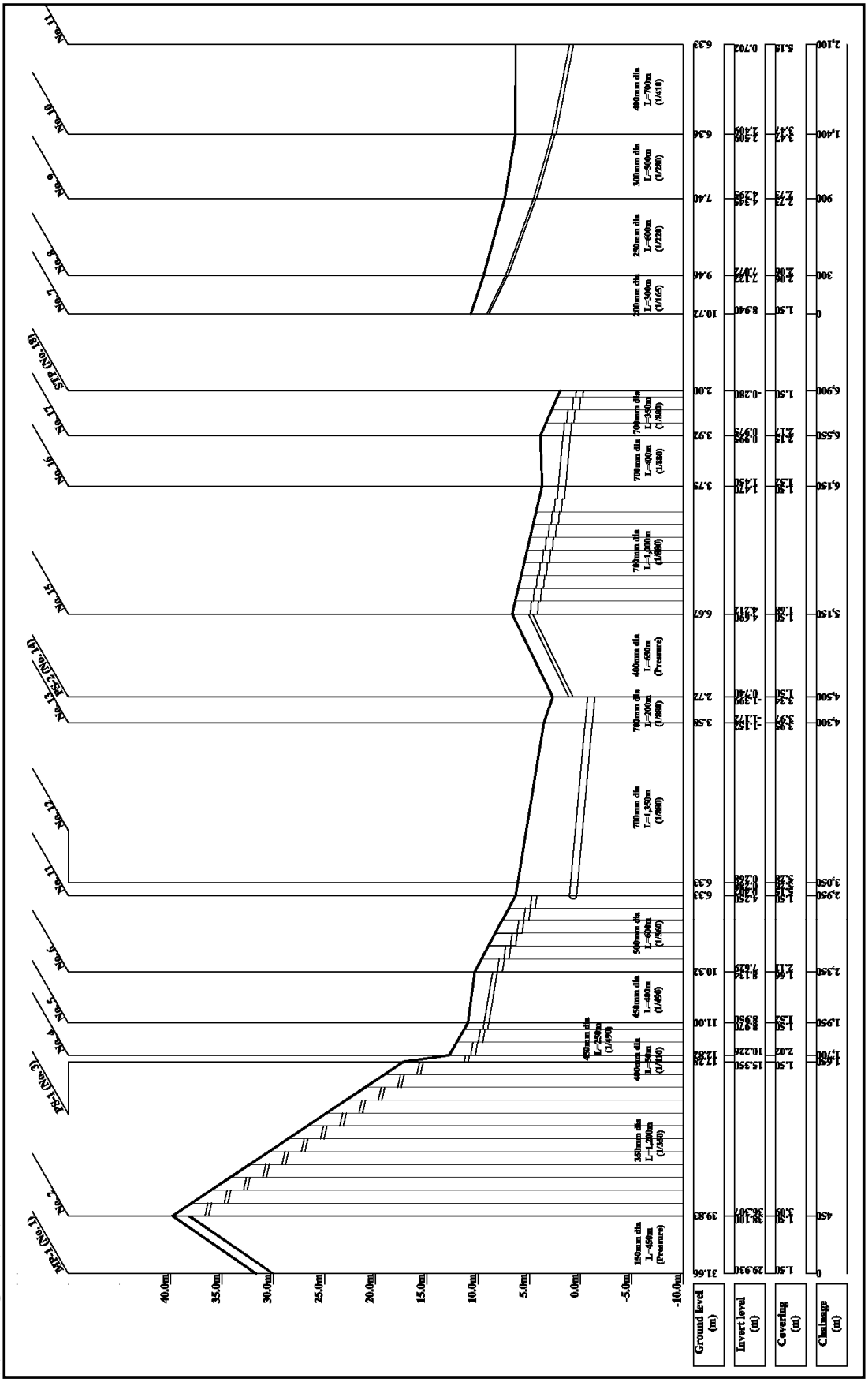
(3) Porvorim (1/2)



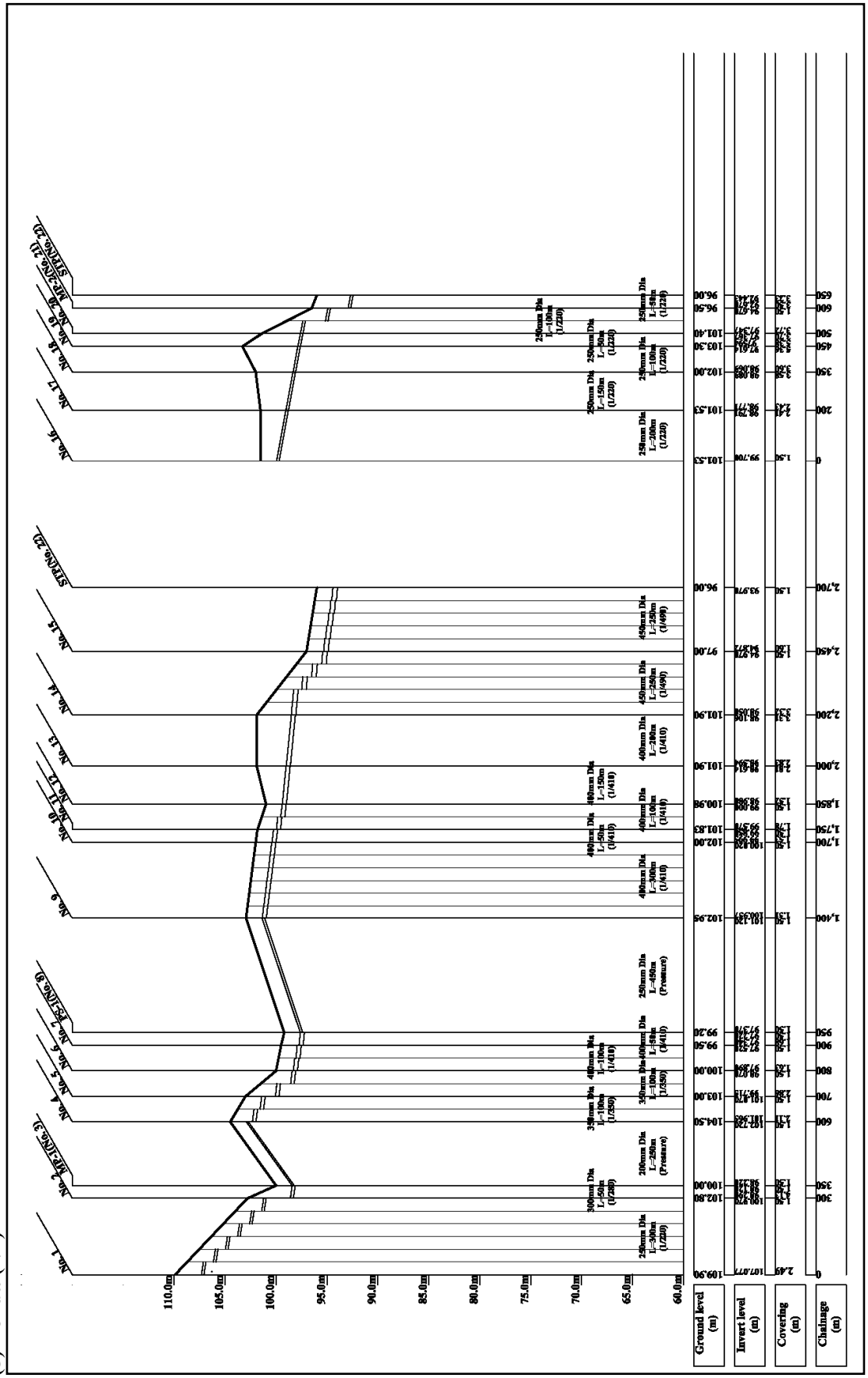
(3) Porvorim (2/2)



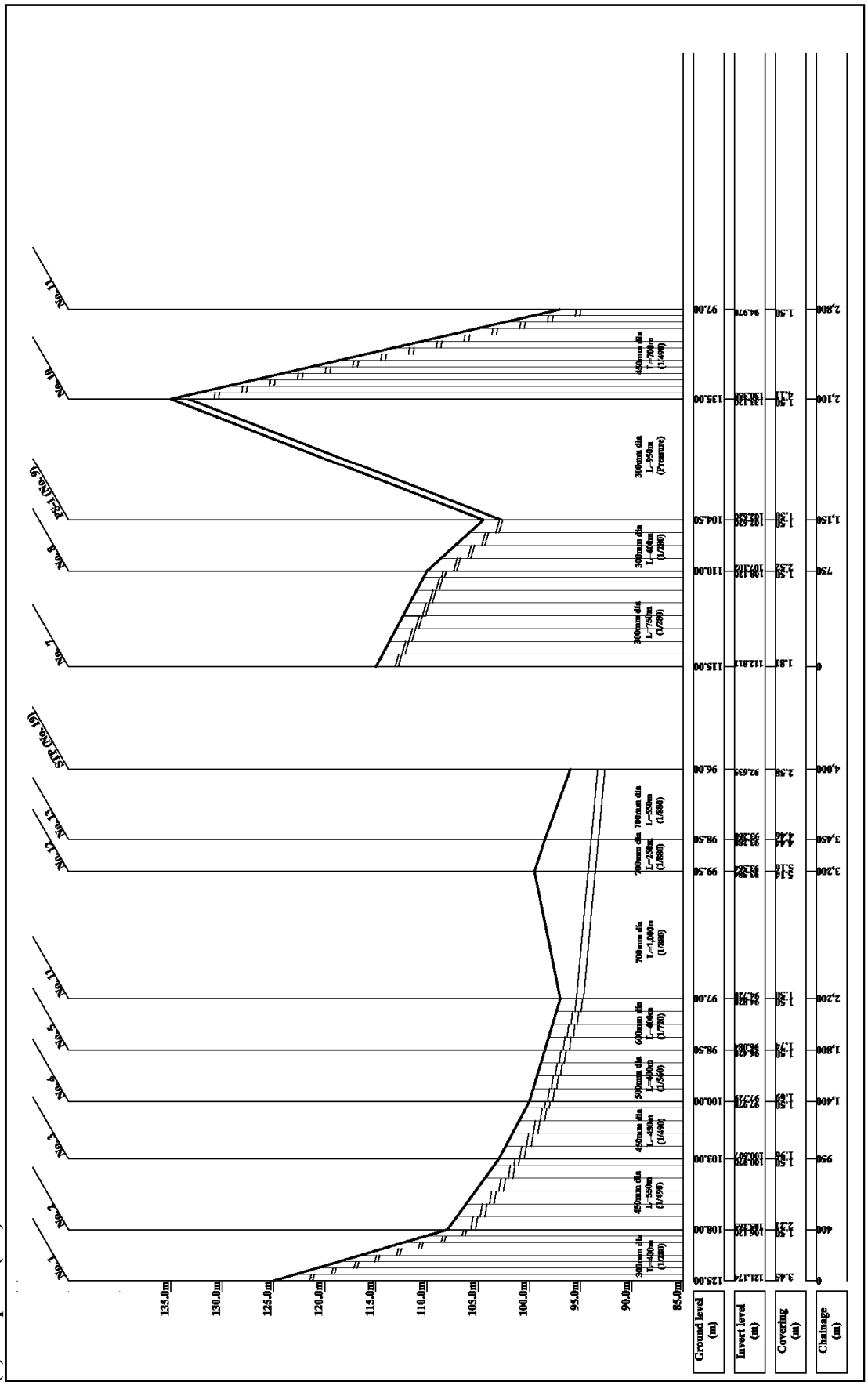
(4) Margao (1/1)


MP-1 (No. 1)
No. 2
PS-1 (No. 3)
No. 4
No. 5
No. 6
No. 11
No. 12
PS-2 (No. 13)
No. 14
No. 15
No. 16
No. 17
STP (No. 18)
No. 7
No. 8
No. 9
No. 10
No. 11
40.0m
35.0m
30.0m
25.0m
20.0m
15.0m
10.0m
5.0m
0.0m
-5.0m
-10.0m
Ground level (m)
Invert level (m)
Covering (m)
Chainage (m)

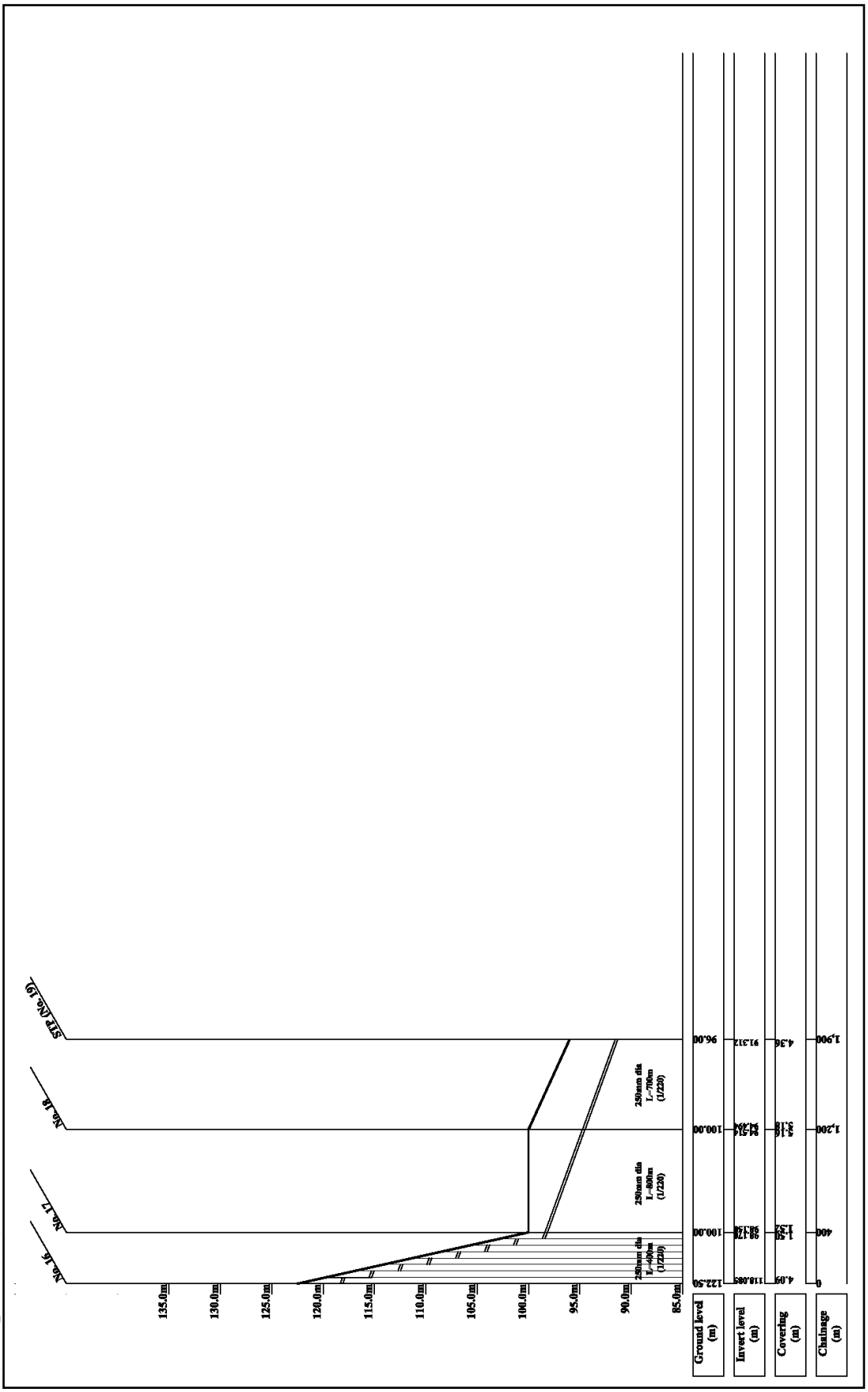
(5) Ponda (1/1)


No.1
No.2
MH-2(No.3)
No.4
No.5
No.6
No.7
FC-1(No.8)
No.9
No.10
No.11
No.12
No.13
No.14
No.15
STR(No.23)
No.16
No.17
No.18
No.19
MH-3(No.21)
STR(No.22)
110.0m
105.0m
100.0m
95.0m
90.0m
85.0m
80.0m
75.0m
70.0m
65.0m
60.0m
Ground level (m)
Invert level (m)
Covering (m)
Chainage (m)

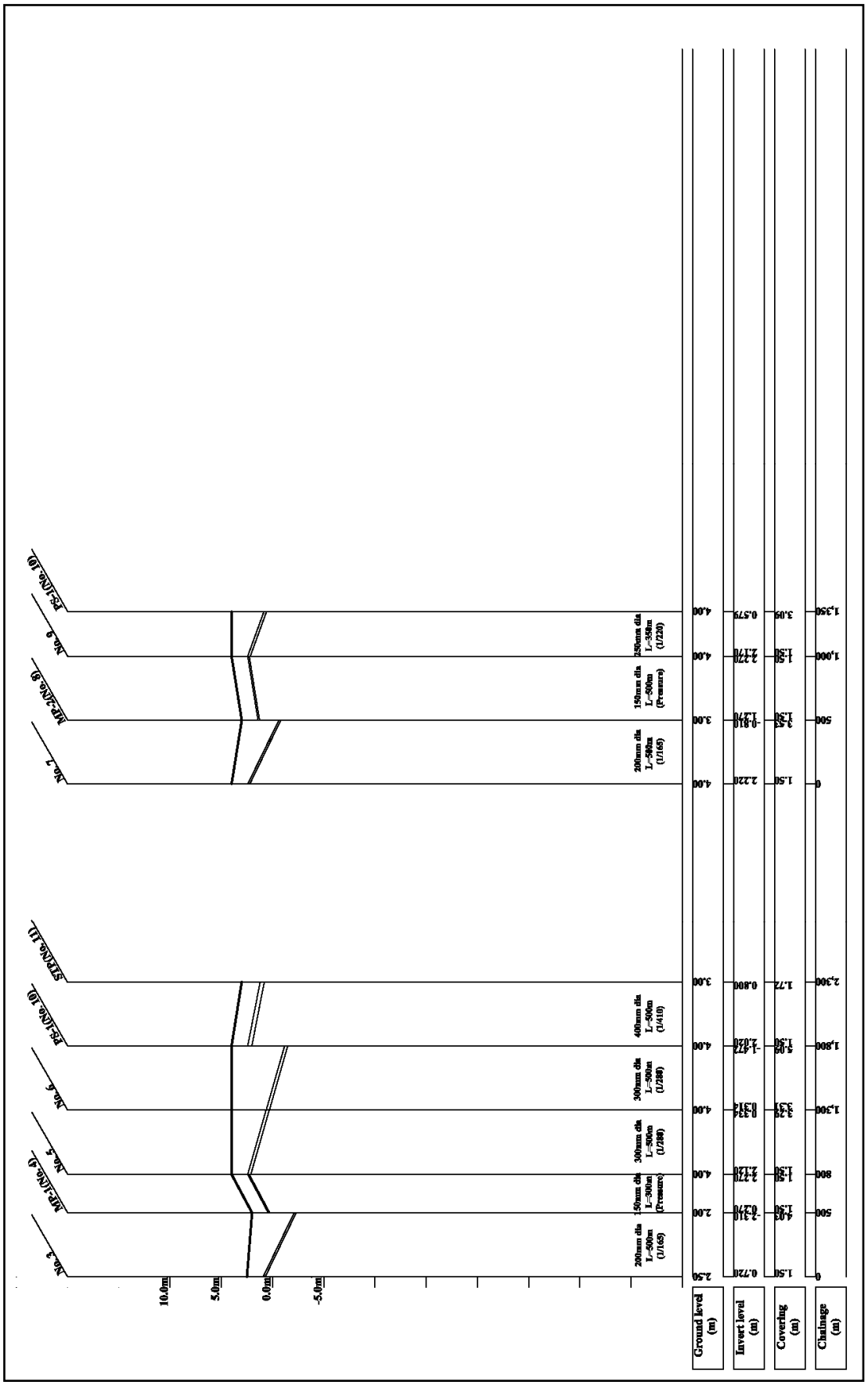
(6) Mapusa (1/2)


No.1
No.2
No.3
No.4
No.5
No.11
No.12
No.13
SFT (No.19)
No.7
No.8
PS-1 (No.9)
No.10
No.11
300mm dia L=400m (1/280)
450mm dia L=550m (1/490)
450mm dia L=450m (1/490)
500mm dia L=400m (1/560)
600mm dia L=400m (1/700)
700mm dia L=1,000m (1/880)
700mm dia L=250m (1/880)
700mm dia L=550m (1/880)
300mm dia L=750m (1/280)
300mm dia L=400m (1/280)
300mm dia L=950m (Pressure)
450mm dia L=700m (1/490)
135.0m
130.0m
125.0m
120.0m
115.0m
110.0m
105.0m
100.0m
95.0m
90.0m
85.0m
Ground level (m)
Invert level (m)
Covering (m)
Chainage (m)

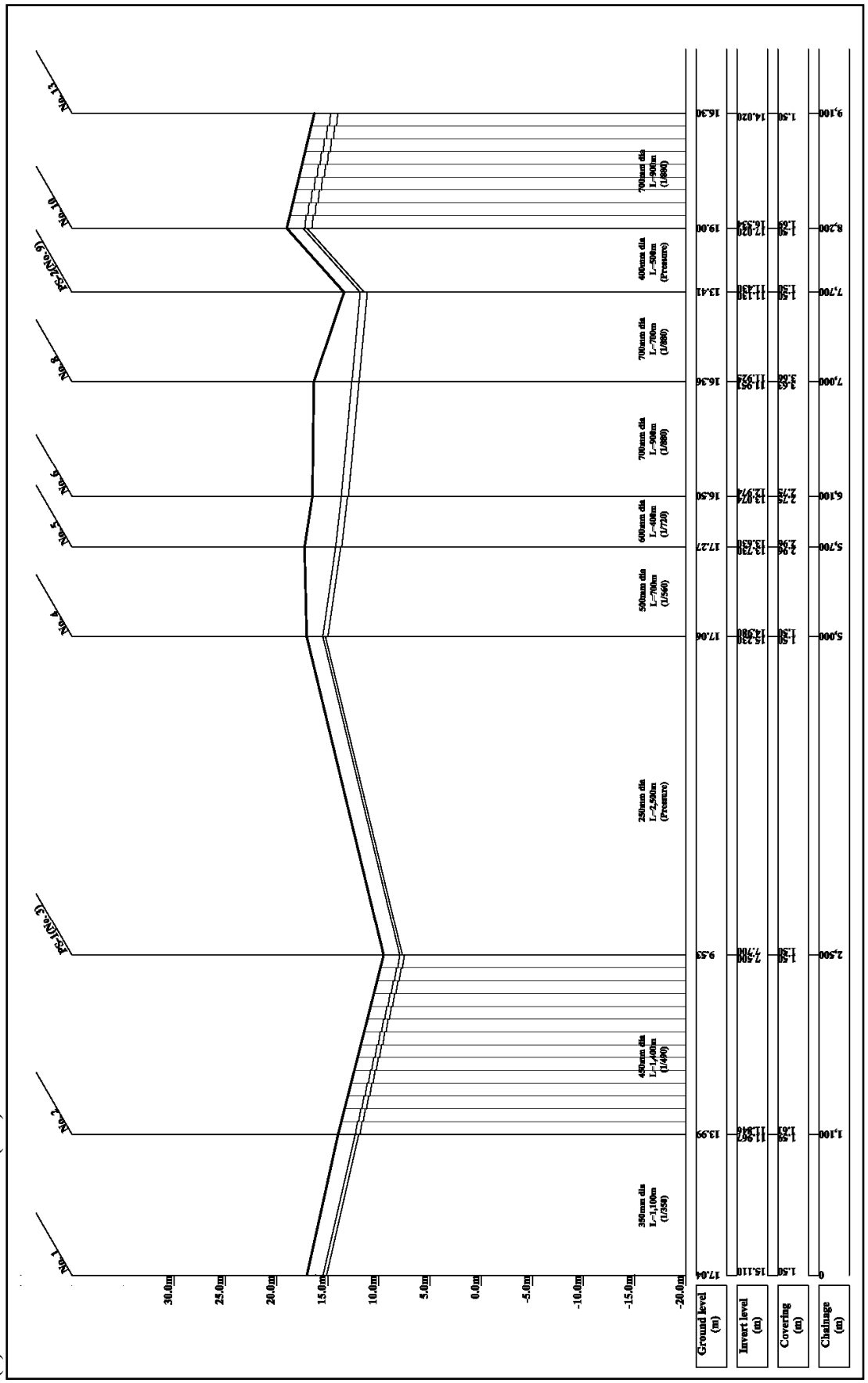
(6) Mapusa (2/2)


Site No. 19
No. 18
No. 17
No. 16
250mm dia L=700m (1/220)
250mm dia L=400m (1/220)
250mm dia L=400m (1/220)
135.0m
130.0m
125.0m
120.0m
115.0m
110.0m
105.0m
100.0m
95.0m
90.0m
85.0m
Ground level (m)
122.50
100.00
100.00
96.00
Invert level (m)
118.085
91.312
Covering (m)
4.09
4.36
Chainage (m)
0
400
1,200
1,900

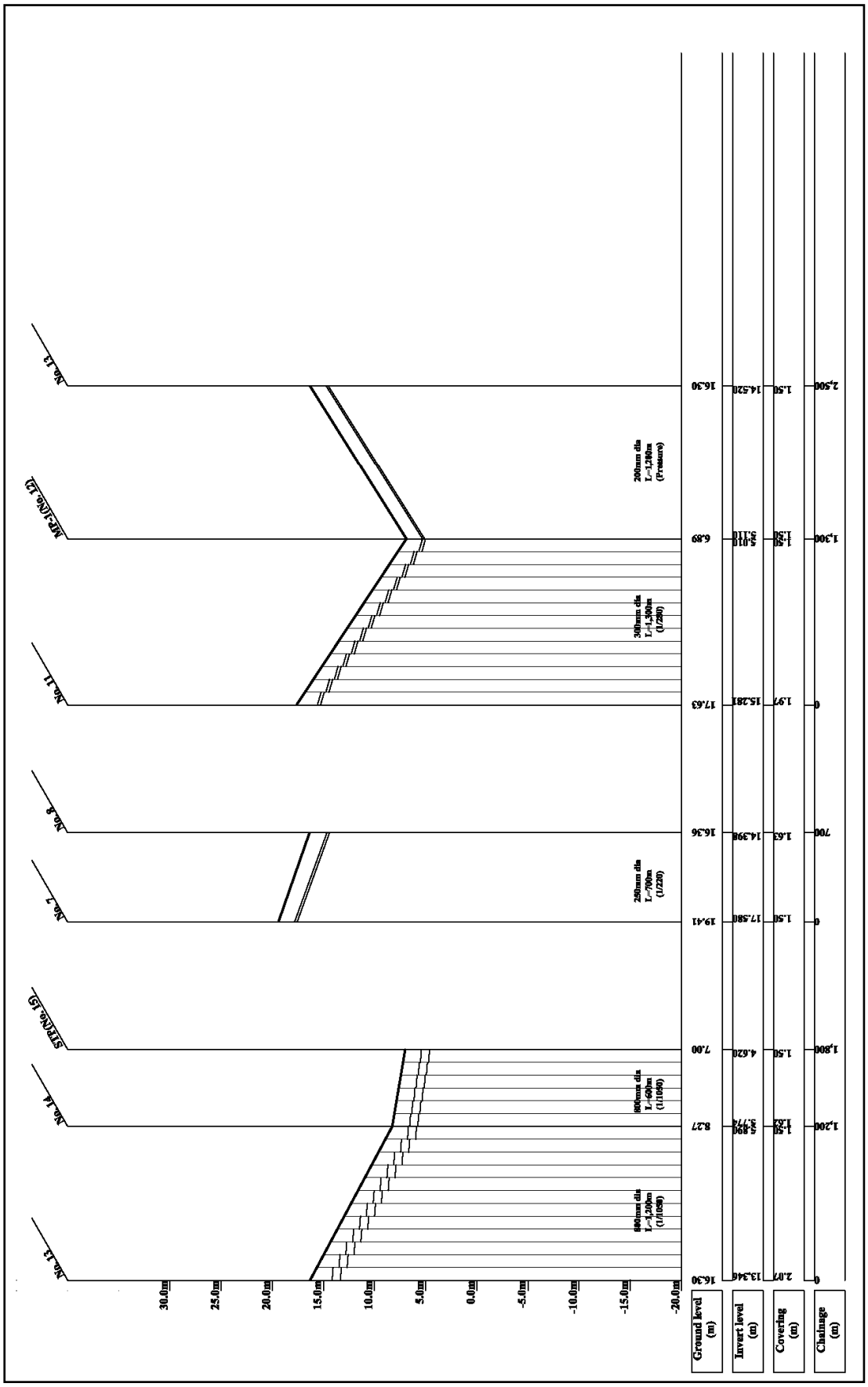
(7) South Coastal Belt (1/1)



(8) North Coastal Belt (1/2)



(8) North Coastal Belt (2/2)



Appendix M63.3 Capacity Calculation of Sewerage Treatment Facilities

(1) Panaji

(2) St. Cruz

(3) Porvorim

(4) Ponda

(5) Colva (South Coastal Belt)

See Volume V Appendix for Chapter 5 for the F/S areas such as Margao, Mapusa, North Coastal Belt.

(1) Panaji

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name	:	**Panaji (Tonca) Sewage Treatment Plant**	
(2) Land Area	:	Approximately	30,000 m^2
(3) Elevation	:	+ 3.00	m
(4) Inlet Pipe Level	:	-	m
(5) Pipe Diameter	:	-	mm
(6) Land Use	:	Exclusively for Sewage Treatment Plant	
(7) Collection System	:	Combined System ・ (Separate System)	
(8) Treatment Method	:		
Sewage Treatment	:	Pre-treatment + SBR Tank + Sand Filtration (future) + Disinfection Tank	
Sludge Treatment	:	Sludge Thickening Tank + Sludge Digestion Tank + Dewatering (Drying Beds as stand-by)	
(9) Effluent Point	:	Mandovi river	
(10) Effluent Point Water Level	:	High Level = + 2.50m	
(11) Target Year	:	2025	Year

1-2 Design Population and Area

Design Population	:	56,600	Persons (Residents)
Design Area	:	943 ha	Panaji City, Taleigao, Dona Paula and Caranzalem

1-3 Design Sewage Flow

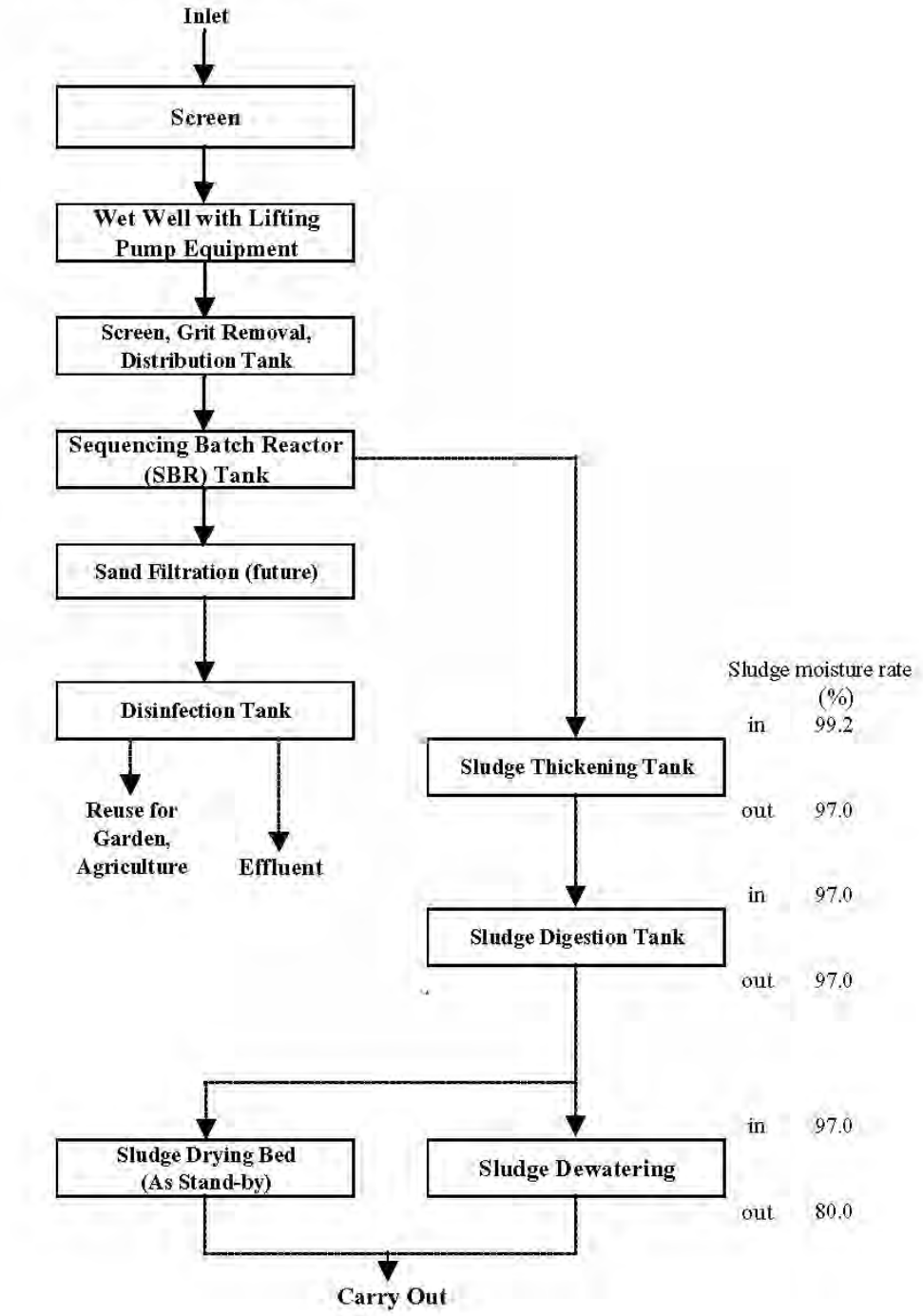
Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average	21,400	891.7	14.86	0.248	
Peak Flow	48,150	2,006.3	33.44	0.557	Peak factor = 2.25

1-4 Design Sewage Quality

Item	Influent (mg/L)	T.R.R (%)	Effluent (mg/L)	Remarks
BOD	210	86	30	Effluent Quality Regulation = 30 mg/l
SS	180	72	50	Effluent Quality Regulation = 100 mg/l

T.R.R. : Total Removal Ratio

1-5 Flow Chart (SBR Method)



1-6 Design Criteria for SBR Method

Items	Unit	Figure *1	Figure *2	Adoption
1-6-1 Grit Chamber				
(1) Water surface load	m3/m2/sec	1,800	2,160	2,160
(2) Average velocity	m/sec	0.3	0.15 - 0.30	0.3
1-6-2 Wet Well with Pump Facilities				
(1) Pump inflow velocity	m/sec	1.5 - 3.0	-	1.5 - 3.0
(2) Retention time in wet well	min	-	>5.0	9.0
1-6-3 SBR Tank				
(1) BOD-SS load	kgBOD/kgSS・day	0.2 - 0.4	-	0.3
(2) MLSS concentration	mg/L	1,500 - 2,000	-	1,750
(3) Cycle	cycle/day	3 - 4	-	4
(4) Hydraulic retention time	hour	12 - 24	-	12.0
(5) Water depth	m	4 - 6	-	4.0
(6) Pull-out ratio	1/P	2 - 4	-	3
1-6-4 Disinfection Tank				
(1) Retention time	min	15.0	-	15.0
(2) Dosage	mg/L	2 - 8	-	3.0
1-6-5 Sludge Thickening Tank				
(1) Sludge surface load	kg/m2/day	60 - 90	25 - 30	30.0
(2) Depth	m	4.0	3.0	3.0
1-6-6 Sludge Digestion Tank				
(1) Solids retention time	days	15 0 - 20.0	14.0	14.0
(2) Operating temperature	℃	-	30.0	30.0
(3) Depth	m	>7.5	6.0 - 12.0	8.0
(4) Digestion rate	%	35.0	-	35.0
1-6-7 Sludge Dewatering				
(1) Operation time	hr/day	-	-	8.0
1-6-8 Sludge Drying Bed				
(1) Retention time	day	10 - 15	< 2 weeks	10
(2) Depth of sludge bed	m	0.20 - 0.30	max 0.30	0.3
1-6-9 Sand Filtration (future)				
(1) Filtration rate	m/day	max 300	-	200

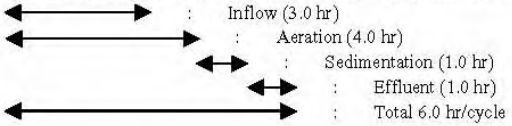
*1: Design Criteria in Japanese standard and "Wastewater Engineering" by Metcalf & Eddy

*2: Design Criteria in India named "Manual on Sewerage and Sewage Treatment"

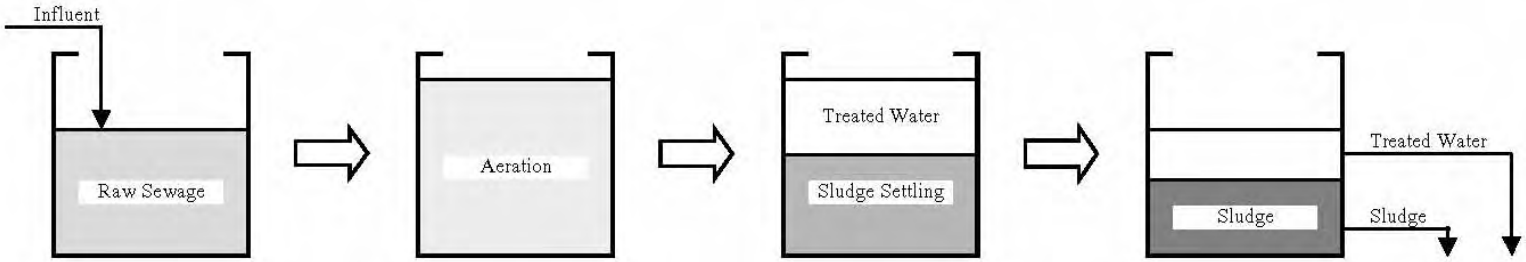
1-7 SBR Tank Cycle Time Schedule per Day

Cycle	Basin	1st day																						2nd day					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6
1	NO.1	←						→																		←					→
	NO.2				←						→																		←		
2	NO.1							←						→																	
	NO.2										←						→														
3	NO.1													←						→											
	NO.2																←					→									
4	NO.1																			←					→						
	NO.2																						←						→		

Note: Breakdown schedule of one cycle of SBR method is shown below.



Time Schedule of SBR Method



Stage-1:
Inflow and Aeration

(3.0 hrs/cycle)

Stage-2:
Aeration

(4.0 hrs/cycle)

Stage-3:
Stop the aeration and settling

(1.0 hr/cycle)

Stage-4:
Discharge the treated water and draw the excess sludge

(1.0 hr/cycle)

2 CAPACITY CALCULATION

2-1 Wet Well with Pump Equipment

Item	Sign	Unit	Calculation	Result
2-1-1 Wet Well				
Design sewage flow	Q1	m^3/day	Peak Flow	48,150
	Q2	m^3/min	Peak Flow	33.44
Basin number	BN	basin		1
Retention time	RT	min		9.0
Required volume	RV	m^3	Q2×RT	300.9
Depth	H	m		5.0
Required area	RA	m^2	RV/H	60.19
Well diameter	D1	m	$(4\times RA/3.14)^{0.5}$	8.8
Diameter of existing well	D2	m		15.0
Area of existing well	A	m^2	$D2^2\times 3.14/4$	176.6
Area of existing well = 176.6 m^2 > Required area = 60.19 m^2 Therefore, the existing wet well is useful against the design flow (= 48,150 m3/day, peak flow)				
2-1-2 Pump Equipment				
Design sewage flow	Q1	m^3/day	Peak flow	48,150
	Q2	m^3/min	Peak flow	33.44
Specification of the existing pump equipment 150mm × 261.0m3/hr = 4.35m3/min × 16.0m × 22kw × 2units 200mm × 586.0m3/hr = 9.77m3/min × 16.0m × 55kw × 3(1)units				
Pump discharging flow	DF1	m^3/min/unit		4.35
	DF2	m^3/min/unit		9.77
Pump discharging flow total	DFT	m^3/min	(DF1×2)+(DF2×2)	28.24
Discharging flow of existing pump = 28.24m3/min < Design flow = 33.44m3/min. Required additional discharging capacity = 33.44 - 28.24 = 5.20 m3/min				
Design sewage flow	Q3	m^3/min	Q2-DFT	5.20
Pump unit number	UN	unit		1
Pump discharging flow	DF3	m^3/min/unit	=Q3	5.20
Pump inflow velocity	PV	m/sec		1.5 - 3.0
Required pump diameter	D3-1	mm	$146\times(DF1/3.0)^{0.5}$	192
	D3-2	mm	$146\times(DF1/1.5)^{0.5}$	272
	D3	mm	*Therefore*	200
Pump total head	H	m		16.0
Pump efficiency	PE	-		0.60
Axis power	AP	kw	0.163×DF3×H/PE	22.59
Motor allowance	MA	-		0.15
Pump power	P	kw	AP1×(1+MA)	25.98
		kw	*Therefore*	26.0
Pump Specification (New Facility)	**200 mmdia × 5.20 m3/min × 16.0 m × 26.0 kW × 1 unit**			

2-2 Screen and Grit Chamber

Item	Sign	Unit	Calculation	Result
2-2-1 Grit Chamber				
Type	-	-	Parallel flow type	
Design sewage flow	Q1	m^3/day	Peak flow	48,150
	Q2	m^3/sec	Peak flow	0.557
Water surface load	SL	m^3/m^2/day		2,160

Required surface area	RA	m^2	Q1/SL	22.3
Number of existing chamber	BN	basin		1
Width of existing chamber	W	m		4.80
Length of existing chamber	L	m		4.80
Surface area of existing	A	m^2	W×L	23.0
Area of existing grit chamber = 23.0 m^2 > Required area = 22.3 m^2 Therefore, the existing grit chamber is useful against the design flow (= 48,150 m3/day, peak flow)				
2-2-2 Fine Screen				
Type	-	-	One rake type intermittent rake-up	
Set number	SSN	set	1 set = Manual screen	1
Screen opening	-	mm	10 to 20	20
The existing screens are useful for the design flow (= 45,700 m3/day, peak flow)				
Unit removed screenings	RS	m^3/1,000m^3		0.010
Design sewage flow	Q	m^3/day	Daily average	21,400
Volume of screenings	VS	m^3/day	Q×RS/1,000	0.214
				▼
				Carry out

2-3 SBR Tank

Item	Sign	Unit	Calculation	Result
Type			Sequencing Batch Aeration Tank	
Design sewage flow	Q1	m^3/day	Daily average	21,400
	Q2	m^3/hr	Daily average	891.7
BOD-SS load	BS	kgBOD/kgSS·day		0.30
Inlet BOD	BD	mg/l		210
MLSS concentration	MLSS	mg/l		1,750
Cycle	CY	cycle/day		4
Pull-out ratio	PR	-		3
Aeration time	AT	hr/cycle	24×BD/(BS×PR×MLSS)	3.2
Water depth	H	m		4.0
Clearance depth of tank	H1	m		0.5
Settling velocity	SV	m/hr		3.0
Settling time	ST	hr/cycle	(H×(1/PR)+H1)/SV	0.61
Aeration time ratio	e	-	CY×AT/24	0.53
Required volume	RV	m^3	Q1×BD/(e×MLSS×BS)	16,050
Width of existing tank	W	m		22.0
Length of existing tank	L	m		40.0
Basin number	EBN	basin		2
Volume of existing tank	EV	m^3	W×L×H×EBN	7,040
Required additional tank volume = 16,050 - 7,040 = 9,010 m^3				
Required additional tank	RA	m^3	RV-EV	9,010
Basin number of new tank	NBN	basin		2
Water depth of new tank	NH	m		4.0
Width of new tank	NW	m		24.0
Length of new tank	NL	m	RA/(NH×NW×NBN)	46.9
	L2	m	*Therefore*	47.0
Dimension (width)	W	m	**New Facility**	**24.0**
(Depth)	H	m		**4.0**
(Length)	L2	m		**47.0**
(Basin)	BN	basin		**2**

2-4 Sand Filtration Tank (future)

Item	Sign	Unit	Calculation	Result
Type	-	-	Gravity Upflow Filter Type	
Design sewage flow	Q1	m^3/day	Daily average	21,400
	Q2	m^3/sec	Daily average	0.248
Filtration rate	FR	m/day		200.0
Required surface area	RA	m^2	Q1/FR	107.0
Basin number	BN	basin		4
Width	W	m		5.0
Length	L1	m	RA/(W×BN)	5.35
	L2	m	*Therefore*	5.5
Dimension (Width)	W	m	**New Facility**	**5.0**
(Length)	L	m		**5.5**
(Basin)	N	basin		**4**

2-5 Disinfection Tank

Item	Sign	Unit	Calculation	Result
Chemical type	-	-	Chlorination Type	
Design sewage flow	Q1	m^3/day	Daily average	21,400
	Q2	m^3/min	Daily average	14.86
Retention time	RT	min		15.0
Required volume	RV	m^3	Q2×RT	222.9
Width of existing tank	W	m		2.6
Length of existing tank	L	m		9.5
Depth of existing tank	H	m		1.0
Pass number	PN	pass		9
Volume of existing tank	EV	m^3	W×L×H×PN	222.3
Volume of existing tank = 222.3 m3 ≒ Required volume = 222.9 m3 Therefore, the existing disinfection tank is useful against the design flow (= 21,400 m3/day, daily average)				

2-6 Sludge Thickening Tank

Item	Sign	Unit	Calculation	Result
Type	-	-	Radial Flow Circular Type	
Design sewage flow	Q1	m^3/day	Daily average	21,400
	Q2	m^3/hr	Daily average	891.7
Basin number	BN	basin		2
Influent SS quality	ISQ	mg/L		180
Effluent SS quality	ESQ	mg/L		50
Generated sludge	GS	kg/day	$Q1\times(ISQ-ESQ)\times10^{-3}$	2,782
Sludge surface load	SL	kg/m^2/day		30.0
Required surface area	RA	m^2	GS/SL	92.7
Required tank diameter	D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	7.7
	D2	m	*Therefore*	8.0
Water depth	H	m		3.0
Dimension (Diameter)	D	m	**New Facility**	**8.0**
(Depth)	H	m		**3.0**
(Basin)	BN	basin		**2**

2-7 Sludge Digestion Tank

Item	Sign	Unit	Calculation	Result
Type	-	-	Anaerobic Tank	
Design sewage flow	Q1	m^3/day	Daily average	21,400
	Q2	m^3/hr	Daily average	891.7
Generated sludge weight	GS1	kg/day	refer to 2-6	2,782
	GS2	ton/day	GS1/1000	2.78
Sludge moisture rate	MR	%	Thickened sludge	97.0
Sludge volume	SV	m^3/day	GS2×100/(100-MR)	92.7
Solid retention time	T	day		14.0
Basin number	BN	basin		2
Required tank volume	RV1	m^3/basin	SV×T/BN	649.1
Water depth	H	m		8.0
Required surface area	RA	m^2/basin	RV1/H	81.1
Required tank diameter	D1	m	$(RA\times4/3.14)^{0.5}$	10.2
	D2	m	*Therefore*	10.5
Dimension (Diameter)	D	m	**New Facility**	**10.5**
(Depth)	H	m		**8.0**
(Basin)	BN	basin		**2**

2-8 Digestion Gas Tank

Item	Sign	Unit	Calculation	Result
Generated sludge weight	GS	kg/day	refer to 2-7	2,782
Organic matter ratio	OM	%		70
Generation ratio of gas	GR	%		35
Retention time	RT	day		1
Required tank volume	RV	m^3	$GS\times OM\times GR\times RT/10^4$	341
Depth of tank	H	m		5.0
Basin number	BN	basin		1
Required tank diameter	D1	m	$2\times(RV/(3.14\times H\times BN))^{0.5}$	9.3
	D2			9.5
Dimension (Diameter)	D	m	**New Facility**	**9.5**
(Depth)	H	m		**5.0**
(Number)	BN	basin		**1**

2-9 Sludge Dewatering Equipment

Item	Sign	Unit	Calculation	Result
Type	-	-	Centrifugal type	
Digestion rate	DR	%		35.0
Thickened sludge weight	GSW	ton/day	refer to 2-7	2.78
Digested sludge weight	DSW	ton/day	GSW×(100-DR)/100	1.81
Sludge moisture rate	MR	%	digested sludge	97.0
Generated sludge volume	GSV	m^3/day	DSW×100/(100-MR)	60.3
Existing capacity	EC	m^3/hr		20.0
Existing unit number	UN	unit	including stand-by (=1 unit)	2
Operation time	OT	hr/day		8.0
Required capacity	RC	m^3/hr	GSV/((UN-1)×OT)	7.5
Treatment capacity of existing dewatering = 20.0 m^2/hr > Required capacity = 7.5 m^2 Therefore, the existing equipment is useful against the design flow (= 21,400 m3/day, daily average)				
Digested sludge weight	DSW	ton/day		1.81
Sludeg moisture ratio	DM	%	dewatered sludge	80.0
Dewatered sludge volume	DV	m^3/day	DSW×100/(100-DM)	**9.0**
				↓
				Carry out

2-9 Sludge Drying Bed

Item	Sign	Unit	Calculation	Result
Digested sludge volume	DV	m^3/day	Refer to the above 2-8	60.3
Retention time	RT	day		10.0
Sludge thickness in bed	H	m		0.3
Required area	RA	m^2	DV×RT/H	2,009.2
Width of existing bed	W	m		7.5
Length of existing bed	L	m		15.0
Number of existing bed	BN	basin		18
Area of existing facility	AE	m^2	W×L×BN	2,025.0
Existing drying bed area = 2,025 m^2 > Required area = 2,009.2 m^2 Therefore, the existing facility will be used for an additional sewage flow.				

3 SUMMARY OF STP FACILITIES

facility	Existing Facility	Additional Facility
Wet well	15.0 mdia. × 5.0 mH × 1 basin	-
Pump equipment	150mm × 261.0m3/hr = 4.35m3/min × 16.0m × 22kw × 2units	200 mmdia × 5.20 m3/min × 16.0 m × 26.0 kW × 1 unit
	200mm × 586.0m3/hr = 9.77m3/min × 16.0m × 55kw × 3(1)units	
Grit chamber	4.8 mW × 4.8 mL × 1 basin	-
Mechanical screen	Type : One rake type intermittent rake-up	-
	Mechanical screen × 1 unit with 20mm bar opening	-
SBR tank	22.0 mW × 40.0 mL × 4.0 mH × 2 basin	24.0 mW × 47.0 mL × 4.0 mH × 2 basin
Sand Filtration	-	Type : Gravity upflow filter type
(Future Plan)	-	5.0 mW × 5.5 mL × 4 basin
Disinfection tank	Type : Hypochlorite type	-
	2.6 mW × 9.5 mL × 1.0 mH × 9 pass	-
Sludge thickening tank	-	Type : Radial flow circular type
	-	8.0 mdia. × 3.0 mH × 2 basin
Sludge digestion tank	-	Type : Anaerobic digestion
	-	10.5 mdia. × 8.0 mH × 2 basin
Digestion gas tank	-	9.5 mdia. × 5.0 mH × 1 basin
Sludge dewatering	Centrifugal type 20.0 m3/hr × 2 (1) unit	-
Sludge drying bed	7.5 mW × 15.0 mL × 0.3 mH × 18 basin	-

(2) St. Cruz

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **St. Cruz Sewage Treatment Plant**

(2) Land Area : Approximately m^2

(3) Elevation : + m

(4) Inlet Pipe Level : - m

(5) Pipe Diameter : - mm

(6) Land Use :

(7) Collection System : Combined System ・ (Separate System)

(8) Treatment Method :

Sewage Treatment ; Pre-treatment + OD + Final Sedimentation + Sand Filtration (future) + Disinfection Tank

Sludge Treatment ; Sludge Thickening + Sludge Digestion + Dewatering

(9) Effluent Point :

(10) Effluent Point Water Level : + m

(11) Target Year : 2025 Year

1-2 Design Population and Area

Design Population : 16,900 Persons (Residents)

Design Area : 124 ha

1-3 Design Sewage Flow

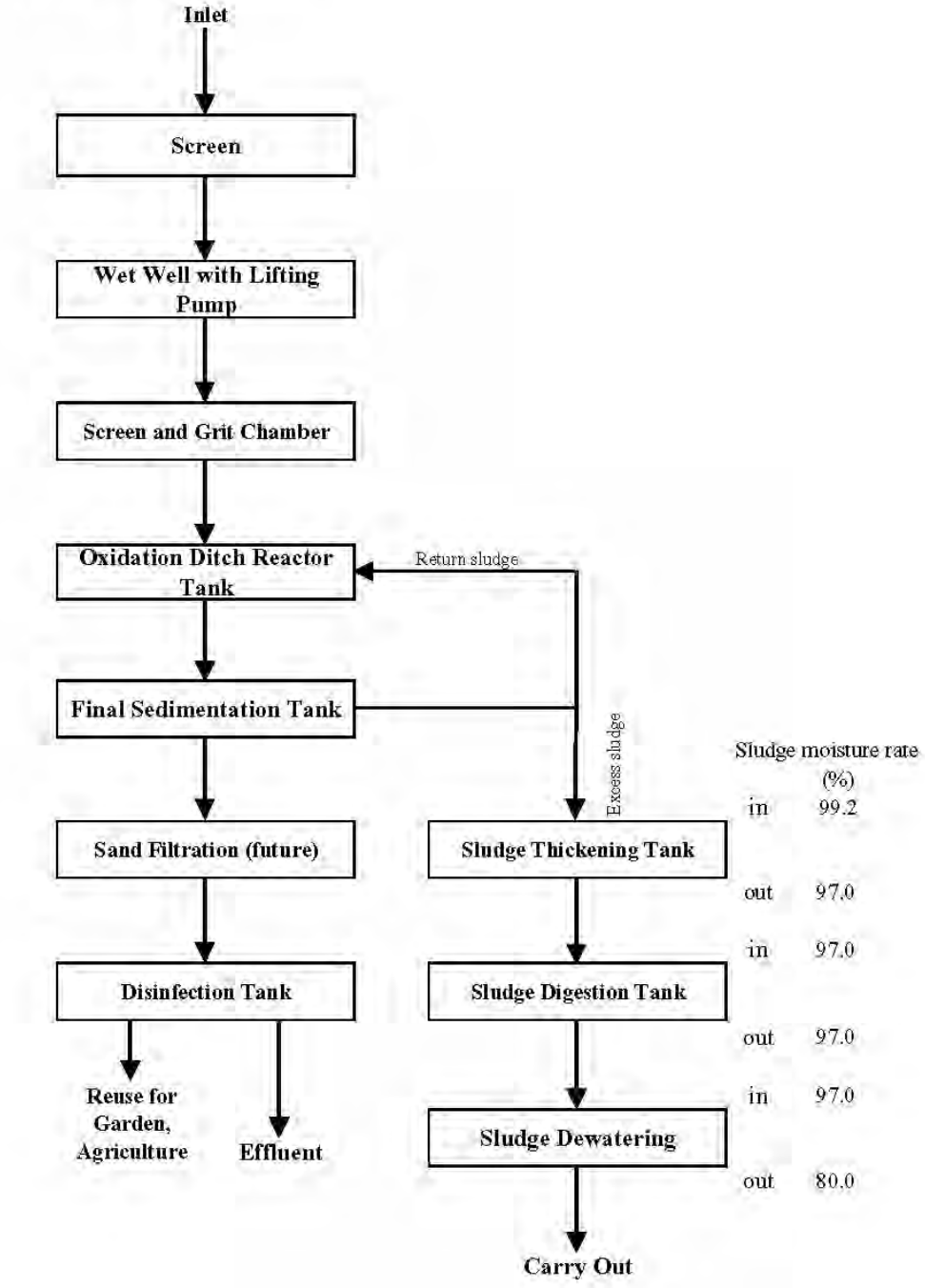
Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average	2,500	104.2	1.74	0.029	
Peak Flow	7,500	312.5	5.21	0.087	Peak factor = 3.00

1-4 Design Sewage Quality

Item	Influent (mg/L)	T.R.R (%)	Effluent (mg/L)	Remarks
BOD	300	90	30	Effluent Quality Regulation = 30 mg/l
SS	250	80	50	Effluent Quality Regulation = 100 mg/l

T.R.R. : Total Removal Ratio

1-5 Flow Chart (OD Method)



2 Design Criteria for STP

Items	Unit	CPHEEO	Japanese Standards	Metcalf&Eddy	**Adoption**
2.1 Screen and Grit Chamber					
(1) Screen					
Openings of screen bars	mm	Less than 20	-	15	20
(2) Grit Chamber					
Water surface loading	m3/m2/day	2,160	-	1,382 - 1,814	2,160
Horizontal velocity	m/sec	0.15 - 0.30	-	0.24 - 0.39	0.3
2.2 Pump Equipment					
Pump inflow velocity	m/sec	-	-	1.5 - 3.0	1.5 - 3.0
Retention time in wet well	min	> 5.0	-	-	9.0
2.3 Oxidation Ditch Reactor Tank					
Hydraulic retention time	hr	12 - 24	24 - 48	8.0 - 36.0	15.0
MLSS concentration	mg/l	3,000 - 5,000	3,000 - 4,000	3,000 - 6,000	3,500
BOD-SS load	kgBOD/kgSS/day	0.10 - 0.18	0.03 - 0.05	0.05 - 0.30	0.15
Depth	m	-	1.0 - 3.0	-	3.0
Width	m	-	2.0 - 6.0	-	4.0
2.4 Final Sedimentation Tank					
Overflow rate	m3/m2/day	8.0 - 15.0	8.0 - 12.0	16.3 - 32.6	15.0
Depth	m	3.5 - 4.5	3.0 - 4.0	3.7 -	4.0
2.5 Sand Filtration (future)					
Filtration rate	m/day	-	max. 300	176	200.0
2.6 Disinfection Tank					
Detention time	min	-	15.0	-	15.0
2.7 Sludge Thickening Tank					
Solid surface load	kg/m2/day	25 - 30	60 - 90	12.2 - 34.2	30.0
Depth	m	3.0	4.0	-	3.0
2.8 Sludge Digestion Tank					
Solids retention time	days	14.0	20.0	15.0 - 20.0	14.0
Operating temperature	℃	30.0	30.0	-	30.0
Digestion rate	%	-	35.0	-	35.0
Depth	m	6.0 - 12.0	> 4.0	> 7.5	6.0
2.9 Sludge Dewatering Equipment					
Operation time	hr/day	-	-	-	8.0

CPHEEO: Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, New Delhi,1993

3 CAPACITY CALCULATION

3-1 Wet Well with Pump Equipment

Item	Sign	Unit	Calculation	Result
3-1-1 Wet Well				
Design sewage flow	Q1	m^3/day	Peak Flow	7,500
	Q2	m^3/min	Peak Flow	5.21
Basin number	BN	basin		1
Retention time	RT	min		9.0
Required volume	RV	m^3	Q2×RT	46.9
Depth	H	m		2.5
Required area	RA	m^2	RV/RA	18.75
Width	W	m		4.0
Length	L1	m	RA/W	4.69
	L2	m	*Therefore*	4.7
Dimension (Width)	W	m		**4.0**
(Length)	L	m		**4.7**
(Depth)	H	m		**2.5**
(Basin)	N	basin		**1**
3-1-2 Pump Equipment				
Design sewage flow	Q1	m^3/day	Peak flow	7,500
	Q2	m^3/min	Peak flow	5.21
Pump unit number	UN	unit	including stand-by (=1unit)	4
Pump discharging flow	DF1	m^3/min/unit	Q2/4	1.30
	DF2	m^3/min/unit	Q2/2	2.60
Pump inflow velocity	PV	m/sec		1.5 - 3.0
Required pump diameter	D1-1	mm	$146\times(DF1/3.0)^{0.5}$	96
	D1-2	mm	$146\times(DF1/1.5)^{0.5}$	136
	D1	mm	*Therefore*	100
	D2-1	mm	$146\times(DF2/3.0)^{0.5}$	136
	D2-2	mm	$146\times(DF2/1.5)^{0.5}$	192
	D2	mm	*Therefore*	150
Pump total head	H	m	assumption	15.0
Pump efficiency	PE	-		0.60
Axis power	AP1	kw	0.163×DF1×H/PE	5.31
	AP2	kw	0.163×DF2×H/PE	10.61
Motor allowance	MA	-		0.15
Pump power	P1	kw	AP1×(1+MA)	6.10
		kw	*Therefore*	7.0
	P2	kw	AP2×(1+MA)	12.20
		kw	*Therefore*	13.0
Pump Specification	**100 mmdia × 1.30 m3/min × 15 m × 7.0 kW × 2 units** **150 mmdia × 2.60 m3/min × 15 m × 13.0 kW × 2(1) units**			

3-2 Screen and Grit Chamber

Item	Sign	Unit	Calculation	Result
3-2-1 Grit Chamber				
Type	-	-	Parallel flow type	
Design sewage flow	Q1	m^3/day	Peak flow	7,500
	Q2	m^3/sec	Peak flow	0.087
Water surface load	SL	m^3/m^2/day		2,160

Item	Sign	Unit	Calculation	Result
Required surface area	RA	m^2	Q1/SL	3.5
Basin number	BN	basin		2
Average velocity	V	m/sec		0.3
Water depth	H	m		0.3
Width	W1	m	Q2/(V×H×BN)	0.48
	W2	m	*Trerefore*	0.6
Length	L1	m	RA/(W2×BN)	2.89
	L2	m	*Therefore*	2.9
Dimension (Width)	W	m	W2	**0.6**
(Length)	L	m	L2	**2.9**
(Depth)	H	m	H	**0.3**
(Basin)	N	basin		**2**
3-2-2 Fine Screen				
Type	-	-	One rake type intermittent rake-up	
Set number	SSN	set	1 set = Manual screen	1
Screen opening	-	mm	10 to 20	20
Unit removed screenings	RS	$m^3/1{,}000m^3$		0.010
Design sewage flow	Q	m^3/day	Daily average	2,500
Volume of screenings	VS	m^3/day	Q×RS/1,000	0.025
				↓
				Carry out

3-3 Oxidation Ditch Reactor Tank

Item	Sign	Unit	Calculation	Result
Type			Endless ditch flow type	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/hr	Daily average	104.2
BOD-SS load	BS	kgBOD/kgSS·day		0.15
Inlet BOD	BD	mg/l		300
MLSS concentration	MLSS	mg/l		3,500
Required volume -1	RV1	m^3	BD×Q1/(MLSS×BS)	1,429
Hydraulic retention time	HT	hr		15.0
Required volume -2	RV2	m^3	Q2×HT	1,563
	RV	m^3	RV2 > RV1 *Therefore*	1,600
Basin number	BN	basin		2
Water depth	H	m		3.0
Width	W	m		4.0
Length	L1	m	RV/(H×W×BN)	66.7
	L2	m	*Therefore*	67.0
Dimension (width)	W	m		**4.0**
(Depth)	H	m		**3.0**
(Length)	L2	m		**67.0**
(Basin)	BN	basin		**2**

3-4 Final Sedimentation Tank

Item	Sign	Unit	Calculation	Result
Type			Radial Flow Circular Type	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/hr	Daily average	104.2

Item	Sign	Unit	Calculation	Result
Required surface area	RA	m^2	Q1/SL	3.5
Basin number	BN	basin		2
Average velocity	V	m/sec		0.3
Water depth	H	m		0.3
Width	W1	m	Q2/(V×H×BN)	0.48
	W2	m	*Trerefore*	0.6
Length	L1	m	RA/(W2×BN)	2.89
	L2	m	*Therefore*	2.9
Dimension (Width)	W	m	W2	**0.6**
(Length)	L	m	L2	**2.9**
(Depth)	H	m	H	**0.3**
(Basin)	N	basin		**2**
3-2-2 Fine Screen				
Type	-	-	One rake type intermittent rake-up	
Set number	SSN	set	1 set = Manual screen	1
Screen opening	-	mm	10 to 20	20
Unit removed screenings	RS	$m^3/1{,}000m^3$		0.010
Design sewage flow	Q	m^3/day	Daily average	2,500
Volume of screenings	VS	m^3/day	Q×RS/1,000	0.025
				↓
				Carry out

3-3 Oxidation Ditch Reactor Tank

Item	Sign	Unit	Calculation	Result
Type			Endless ditch flow type	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/hr	Daily average	104.2
BOD-SS load	BS	kgBOD/kgSS·day		0.15
Inlet BOD	BD	mg/l		300
MLSS concentration	MLSS	mg/l		3,500
Required volume -1	RV1	m^3	BD×Q1/(MLSS×BS)	1,429
Hydraulic retention time	HT	hr		15.0
Required volume -2	RV2	m^3	Q2×HT	1,563
	RV	m^3	RV2 > RV1 *Therefore*	1,600
Basin number	BN	basin		2
Water depth	H	m		3.0
Width	W	m		4.0
Length	L1	m	RV/(H×W×BN)	66.7
	L2	m	*Therefore*	67.0
Dimension (width)	W	m		**4.0**
(Depth)	H	m		**3.0**
(Length)	L2	m		**67.0**
(Basin)	BN	basin		**2**

3-4 Final Sedimentation Tank

Item	Sign	Unit	Calculation	Result
Type			Radial Flow Circular Type	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/hr	Daily average	104.2

Item	Sign	Unit	Calculation	Result
Overflow rate	OR	$m^3/m^2/day$		15.0
Required area	RA	m^2	Q1/OR	166.7
Basin number	BN	basin		2
Required tank diameter	D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	10.3
	D2	m	*Therefore*	10.5
Water depth	H	m		4.0
Dimension (Diameter)	W	m		**10.5**
(Depth)	H	m		**4.0**
(Basin)	BN	basin		**2**

3-5 Sand Filtration Tank (future)

Item	Sign	Unit	Calculation	Result
Type	-	-	Gravity Upflow Filter Type	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/sec	Daily average	0.029
Filtration rate	FR	m/day		200.0
Required surface area	RA	m^2	Q1/FR	12.5
Basin number	BN	basin		2
Width	W	m		3.0
Length	L1	m	RA/(W×BN)	2.08
	L2	m	*Therefore*	2.5
Dimension (Width)	W	m	W2	**3.0**
(Length)	L	m	L2	**2.5**
(Basin)	N	basin		**2**

3-6 Disinfection Tank

Item	Sign	Unit	Calculation	Result
Chemical type	-	-	Chlorination Type	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/min	Daily average	1.74
Retention time	RT	min		15.0
Required volume	RV	m^3	Q2×RT	26.0
Width	W	m		1.0
Water depth	H	m		1.0
Pass number	N	pass		6
Length	L1	m	RV/(W×H×N)	4.3
	L2	m	*Therefore*	4.5
Dimension (Width)	W	m		**1.0**
(Length)	L	m	L2	**4.5**
(Depth)	H	m		**1.0**
(Pass Number)	N	pass		**6**

3-7 Sludge Thickening Tank

Item	Sign	Unit	Calculation	Result
Type	-	-	Radial Flow Circular Type	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/hr	Daily average	104.2
Basin number	BN	basin		2
Influent SS quality	ISQ	mg/L		250

Item	Sign	Unit	Calculation	Result
Effluent SS quality	ESQ	mg/L		50
Generated sludge	GS	kg/day	$Q1\times(ISQ-ESQ)\times10^{-3}$	500
Sludge surface load	SL	$kg/m^2/day$		30.0
Required surface area	RA	m^2	GS/SL	16.7
Required tank diameter	D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	3.3
	D2	m	*Therefore*	3.5
Water depth	H	m		3.0
Dimension (Diameter)	D	m		**3.5**
(Depth)	H	m		**3.0**
(Basin)	BN	basin		**2**

3-8 Sludge Digestion Tank

Item	Sign	Unit	Calculation	Result
Type	-	-	Anaerobic Tank	
Design sewage flow	Q1	m^3/day	Daily average	2,500
	Q2	m^3/hr	Daily average	104.2
Generated sludge weight	GS1	kg/day	refer to 3-7	500
	GS2	ton/day	GS1/1000	0.50
Sludge moisture rate	MR	%	Thickened sludge	97.0
Sludge volume	SV	m^3/day	GS2×100/(100-MR)	16.7
Solid retention time	T	day		14.0
Basin number	BN	basin		1
Required tank volume	RV1	$m^3/basin$	SV×T/BN	233.3
Water depth	H	m		6.0
Required surface area	RA	$m^2/basin$	RV1/H	38.9
Required tank diameter	D1	m	$(RA\times4/3.14)^{0.5}$	7.0
	D2	m	*Therefore*	7.0
Dimension (Diameter)	D	m		**7.0**
(Depth)	H	m		**6.0**
(Basin)	BN	basin		**1**

3-9 Digestion Gas Tank

Item	Sign	Unit	Calculation	Result
Generated sludge weight	GS	kg/day	refer to 3-8	500
Organic matter ratio	OM	%		70
Generation ratio of gas	GR	%		35
Retention time	RT	day		0.5
Required tank volume	RV	m^3	$GS\times OM\times GR\times RT/10^4$	61
Depth of tank	H	m		3.0
Basin number	BN	basin		1
Required tank diameter	D1	m	$2\times(RV/(3.14\times H\times BN))^{0.5}$	5.1
	D2			5.5
Dimension (Diameter)	D	m	**New Facility**	**5.5**
(Depth)	H	m		**3.0**
(Number)	BN	basin		**1**

3-10 Sludge Dewatering Equipment

Item	Sign	Unit	Calculation	Result
Type	-	-	Centrifugal type	
Generated sludge weight	GSW	ton/day	refer to 3-8	0.50
Digestion rate	DR	%		35.0
Digested sludge weight	DSW	ton/day	GSW×(100-DR)/100	0.33
Sludge moisture rate	MR	%	digested sludge	97.0
Generated sludge volume	GSV	m^3/day	DSW×100/(100-MR)	10.8
Unit number	UN	unit	including stand-by (=1 unit)	2
Operation time	OT	hr/day		8.0
Required capacity	RC1	m^3/hr	GSV/((UN-1)×OT)	1.4
	RC2	m^3/hr		2.0
Specification	**2.0 m3/hr×2 (1) units**			
Digested sludge weight	DSW	ton/day		0.33
Sludeg moisture ratio	DM	%	dewatered sludge	80.0
Dewatered sludge volume	DV	m^3/day	DSW×100/(100-DM)	**1.6**
				↓
				Carry out

5 SUMMARY OF PROPOSED FACILITIES

5-1 Wet Well										
4.0	m(W)	×	4.7	m(L)	×	2.5	m(H)	×	1	basin
5-2 Pump Equipment										
100 mmdia × 1.30 m3/min × 15 m × 7.0 kW × 2 units										
150 mmdia × 2.60 m3/min × 15 m × 13.0 kW × 2(1) units										
5-3 Grit Chamber										
0.6	m(W)	×	2.9	m(L)	×	0.3	m(H)	×	2	basin
5-4 Oxidation Ditch Reactor Tank										
4.0	m(W)	×	67.0	m(L)	×	3.0	m(H)	×	2	basin
5-5 Final Sedimentation Tank										
10.5	m(dia)	×	4.0	m(H)	×	2	basin			
5-6 Sand Filtration Tank (Future Plan)										
3.0	m(W)	×	2.5	m(L)	×	2	basin			
5-7 Disinfection Tank										
1.0	m(W)	×	4.5	m(L)	×	1.0	m(H)	×	6	pass
5-8 Sludge Thickening Tank										
3.5	m(dia)	×	3.0	m(H)	×	2	basin			
5-9 Sludge Digestion Tank										
7.0	m(dia)	×	6.0	m(H)	×	1	basin			
5-10 Digestion Gas Tank										
5.5	m(dia)	×	3.0	m(H)	×	1	basin			
5-11 Sludge Dewatering Equipment										
2.0	m3/hr	×	2	units	(including 1 stand-by)					

(3) Porvorim

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **Porvorim Sewage Treatment Plant**

(2) Land Area : Approximately m^2

(3) Elevation : + m

(4) Inlet Pipe Level : - m

(5) Pipe Diameter : - mm

(6) Land Use :

(7) Collection System : Combined System ・ (Separate System)

(8) Treatment Method :

Sewage Treatment ; Pre-treatment + OD + Final Sedimentation + Sand Filtration (future) + Disinfection Tank

Sludge Treatment ; Sludge Thickening + Sludge Digestion + Dewatering

(9) Effluent Point :

(10) Effluent Point Water Level : + m

(11) Target Year : 2025 Year

1-2 Design Population and Area

Design Population : 47,800 Persons (Residents)

Design Area : 560 ha

1-3 Design Sewage Flow

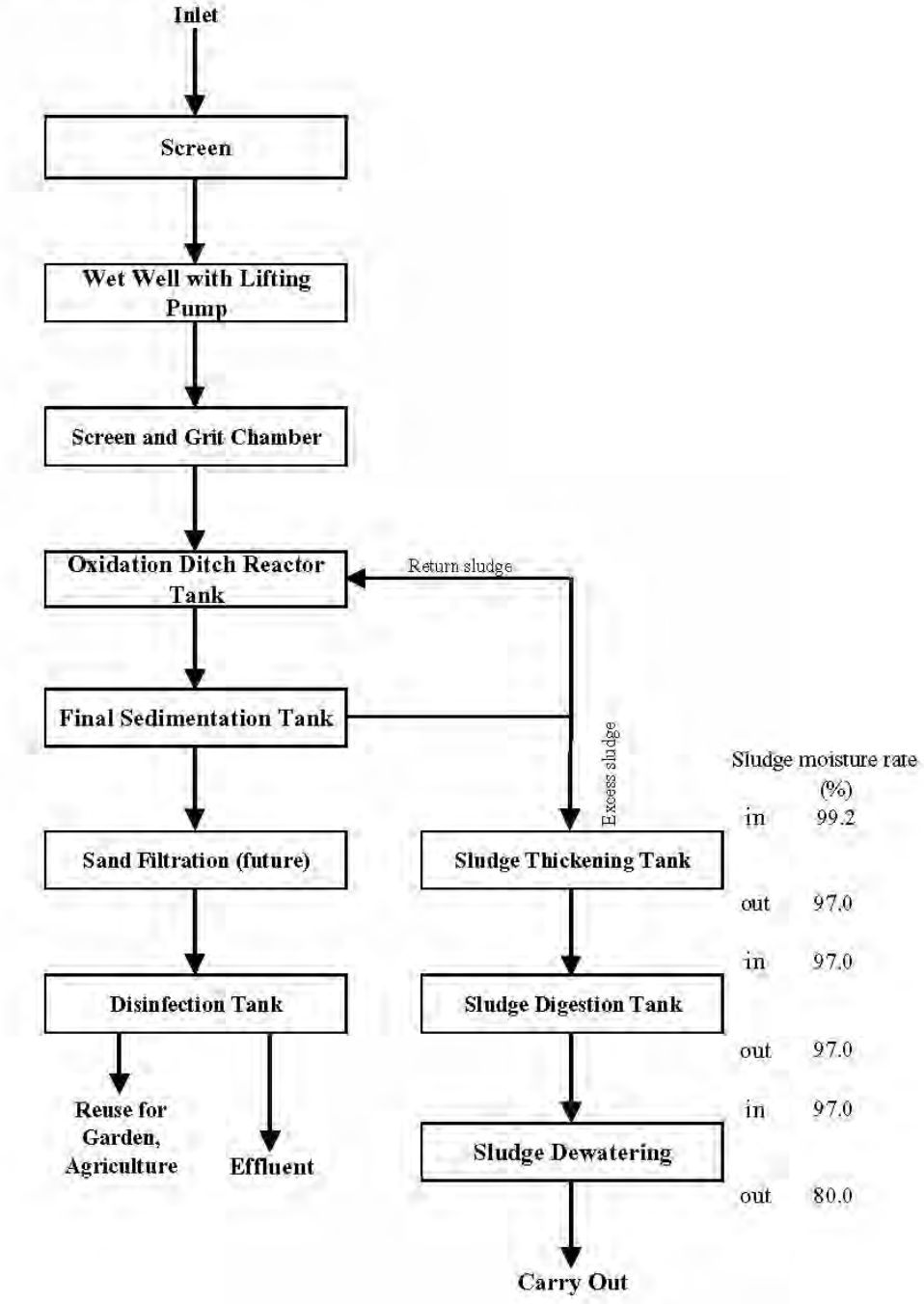
Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average	7,600	316.7	5.28	0.088	
Peak Flow	19,000	791.7	13.19	0.220	Peak factor = 2.50

1-4 Design Sewage Quality

Item	Influent (mg/L)	T.R.R (%)	Effluent (mg/L)	Remarks
BOD	300	90	30	Effluent Quality Regulation = 30 mg/l
SS	250	80	50	Effluent Quality Regulation = 100 mg/l

T.R.R. : Total Removal Ratio

2 **Flow Chart (OD Method)**



3 Design Criteria for STP

Items	Unit	CPHEEO	Japanese Standards	Metcalf&Eddy	**Adoption**
3.1 Screen and Grit Chamber					
(1) Screen					
Openings of screen bars	mm	Less than 20	-	15	20
(2) Grit Chamber					
Water surface loading	m3/m2/day	2,160	-	1,382 - 1,814	2,160
Horizontal velocity	m/sec	0.15 - 0.30	-	0.24 - 0.39	0.3
3.2 Pump Equipment					
Pump inflow velocity	m/sec	-	-	1.5 - 3.0	1.5 - 3.0
Retention time in wet well	min	> 5.0	-	-	9.0
3.3 Oxidation Ditch Reactor Tank					
Hydraulic retention time	hr	12 - 24	24 - 48	8.0 - 36.0	15.0
MLSS concentration	mg/l	3,000 - 5,000	3,000 - 4,000	3,000 - 6,000	3,500
BOD-SS load	kgBOD/kgSS/day	0.10 - 0.18	0.03 - 0.05	0.05 - 0.30	0.15
Depth	m	-	1.0 - 3.0	-	3.0
Width	m	-	2.0 - 6.0	-	4.0
3.4 Final Sedimentation Tank					
Overflow rate	m3/m2/day	8.0 - 15.0	8.0 - 12.0	16.3 - 32.6	15.0
Depth	m	3.5 - 4.5	3.0 - 4.0	3.7 -	4.0
3.5 Sand Filtration (future)					
Filtration rate	m/day	-	max. 300	176	200.0
3.6 Disinfection Tank					
Detention time	min	-	15.0	-	15.0
3.7 Sludge Thickening Tank					
Solid surface load	kg/m2/day	25 - 30	60 - 90	12.2 - 34.2	30.0
Depth	m	3.0	4.0	-	3.0
3.8 Sludge Digestion Tank					
Solids retention time	days	14.0	20.0	15.0 - 20.0	14.0
Digestion rate	%	-	35.0	-	35.0
Operating temperature	℃	30.0	30.0	-	30.0
Depth	m	6.0 - 12.0	> 4.0	> 7.5	8.0
3.9 Sludge Dewatering Equipment					
Operation time	hr/day	-	-	-	8.0

CPHEEO: Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, New Delhi,1993

4 CAPACITY CALCULATION

4-1 Wet Well with Pump Equipment

Item	Sign	Unit	Calculation	Result
4-1-1 Wet Well				
Design sewage flow	Q1	m^3/day	Peak Flow	10,500
	Q2	m^3/min	Peak Flow	7.29
Basin number	BN	basin		1
Retention time	RT	min		9.0
Required volume	RV	m^3	Q2×RT	65.6
Depth	H	m		2.5
Required area	RA	m^2	RV/RA	26.25
Width	W	m		4.5
Length	L1	m	RA/W	5.83
	L2	m	*Therefore*	6.0
Dimension (Width)	W	m		**4.5**
(Length)	L	m		**6.0**
(Depth)	H	m		**2.5**
(Basin)	N	basin		**1**
4-1-2 Pump Equipment				
Design sewage flow	Q1	m^3/day	Peak flow	10,500
	Q2	m^3/min	Peak flow	7.29
Pump unit number	UN	unit	including stand-by (=1unit)	4
Pump discharging flow	DF1	m^3/min/unit	Q2/4	1.82
	DF2	m^3/min/unit	Q2/2	3.65
Pump inflow velocity	PV	m/sec		1.5 - 3.0
Required pump diameter	D1-1	mm	$146\times(DF1/3.0)^{0.5}$	114
	D1-2	mm	$146\times(DF1/1.5)^{0.5}$	161
	D1	mm	*Therefore*	150
	D2-1	mm	$146\times(DF2/3.0)^{0.5}$	161
	D2-2	mm	$146\times(DF2/1.5)^{0.5}$	228
	D2	mm	*Therefore*	200
Pump total head	H	m	assumption	15.0
Pump efficiency	PE	-		0.60
Axis power	AP1	kw	0.163×DF1×H/PE	7.43
	AP2	kw	0.163×DF2×H/PE	14.86
Motor allowance	MA	-		0.15
Pump power	P1	kw	AP1×(1+MA)	8.54
		kw	*Therefore*	9.0
	P2	kw	AP2×(1+MA)	17.09
		kw	*Therefore*	18.0
Pump Specification	**150 mmdia × 1.82 m3/min × 15 m × 9.0 kW × 2 units** **200 mmdia × 3.65 m3/min × 15 m × 18.0 kW × 2(1) units**			

4-2 Screen and Grit Chamber

Item	Sign	Unit	Calculation	Result
4-2-1 Grit Chamber				
Type	-	-	Parallel flow type	
Design sewage flow	Q1	m^3/day	Peak flow	10,500
	Q2	m^3/sec	Peak flow	0.122
Water surface load	SL	m^3/m^2/day		2,160
Required surface area	RA	m^2	Q1/SL	4.9
Basin number	BN	basin		2

Item	Sign	Unit	Calculation	Result
4-2-1 Grit Chamber				
Type	-	-	Parallel flow type	
Design sewage flow	Q1	m^3/day	Peak flow	19,000
	Q2	m^3/sec	Peak flow	0.220
Water surface load	SL	m^3/m^2/day		2,160
Required surface area	RA	m^2	Q1/SL	8.8
Basin number	BN	basin		2
Average velocity	V	m/sec		0.3
Water depth	H	m		0.3
Width	W1	m	Q2/(V×H×BN)	1.22
	W2	m	*Therefore*	1.3
Length	L1	m	RA/(W2×BN)	3.38
	L2	m	*Therefore*	3.5
Dimension (Width)	W	m	W2	**1.3**
(Length)	L	m	L2	**3.5**
(Depth)	H	m	H	**0.3**
(Basin)	N	basin		**2**
4-2-2 Fine Screen				
Type	-	-	One rake type intermittent rake-up	
Set number	SSN	set	1 set = Manual screen	1
Screen opening	-	mm	10 to 20	20
Unit removed screenings	RS	m^3/1,000m^3		0.010
Design sewage flow	Q	m^3/day	Daily average	7,600
Volume of screenings	VS	m^3/day	Q×RS/1,000	0.076
				↓
				Carry out

4-3 Oxidation Ditch Reactor Tank

Item	Sign	Unit	Calculation	Result
Type			Endless ditch flow type	
Design sewage flow	Q1	m^3/day	Daily average	7,600
	Q2	m^3/hr	Daily average	316.7
BOD-SS load	BS	kgBOD/kgSS·day		0.15
Inlet BOD	BD	mg/l		300
MLSS concentration	MLSS	mg/l		3,500
Required volume -1	RV1	m^3	BD×Q1/(MLSS×BS)	4,343
Hydraulic retention time	HT	hr		15.0
Required volume -2	RV2	m^3	Q2×HT	4,750
	RV	m^3	RV2 > RV1 *Therefore*	4,750
Basin number	BN	basin		4
Water depth	H	m		3.0
Width	W	m		4.0
Length	L1	m	RV/(H×W×BN)	99.0
	L2	m	*Therefore*	100.0
Dimension (width)	W	m		**4.0**
(Depth)	H	m		**3.0**
(Length)	L2	m		**100.0**
(Basin)	BN	basin		**4**

Dimension	**(Diameter)**	W	m		**12.5**
	(Depth)	H	m		**4.0**
	(Basin)	BN	basin		**2**

4-5 Sand Filtration Tank (future)

Item		Sign	Unit	Calculation	Result
Type		-	-	Gravity Upflow Filter Type	
Design sewage flow		Q1	m^3/day	Daily average	3,500
		Q2	m^3/sec	Daily average	0.041
Filtration rate		FR	m/day		200.0
Required surface area		RA	m^2	Q1/FR	17.5
Basin number		BN	basin		2
Width		W	m		3.0
Length		L1	m	RA/(W×BN)	2.92
		L2	m	*Therefore*	3.0
Dimension	**(Width)**	W	m	W2	**3.0**
	(Length)	L	m	L2	**3.0**
	(Basin)	N	basin		**2**

4-6 Disinfection Tank

Item		Sign	Unit	Calculation	Result
Chemical type		-	-	Chlorination Type	
Design sewage flow		Q1	m^3/day	Daily average	3,500
		Q2	m^3/min	Daily average	2.43
Retention time		RT	min		15.0
Required volume		RV	m^3	Q2×RT	36.5
Width		W	m		1.0
Water depth		H	m		1.0
Pass number		N	pass		8
Length		L1	m	RV/(W×H×N)	4.6
		L2	m	*Therefore*	5.0
Dimension	**(Width)**	W	m		**1.0**
	(Length)	L	m	L2	**5.0**
	(Depth)	H	m		**1.0**
	(Pass Number)	N	pass		**8**

4-7 Sludge Thickening Tank

Item		Sign	Unit	Calculation	Result
Type		-	-	Radial Flow Circular Type	
Design sewage flow		Q1	m^3/day	Daily average	3,500
		Q2	m^3/hr	Daily average	145.8
Basin number		BN	basin		2
Influent SS quality		ISQ	mg/L		240
Effluent SS quality		ESQ	mg/L		50
Generated sludge		GS	kg/day	$Q1\times(ISQ-ESQ)\times10^{-3}$	665
Sludge surface load		SL	kg/m^2/day		30.0
Required surface area		RA	m^2	GS/SL	22.2
Required tank diameter		D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	3.8
		D2	m	*Therefore*	4.0
Water depth		H	m		3.0
Dimension	**(Diameter)**	D	m		**4.0**
	(Depth)	H	m		**3.0**
	(Basin)	BN	basin		**2**

Item	Sign	Unit	Calculation	Result
Basin number	BN	basin		2
Influent SS quality	ISQ	mg/L		250
Effluent SS quality	ESQ	mg/L		50
Generated sludge	GS	kg/day	$Q1\times(ISQ-ESQ)\times10^{-3}$	1,520
Sludge surface load	SL	$kg/m^2/day$		30.0
Required surface area	RA	m^2	GS/SL	50.7
Required tank diameter	D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	5.7
	D2	m	*Therefore*	6.0
Water depth	H	m		3.0
Dimension (Diameter)	D	m		**6.0**
(Depth)	H	m		**3.0**
(Basin)	BN	basin		**2**

4-8 Sludge Digestion Tank

Item	Sign	Unit	Calculation	Result
Type	-	-	Anaerobic Tank	
Design sewage flow	Q1	m^3/day	Daily average	7,600
	Q2	m^3/hr	Daily average	316.7
Generated sludge weight	GS1	kg/day	refer to 4-7	1,520
	GS2	ton/day	GS1/1000	1.52
Sludge moisture rate	MR	%	Thickened sludge	97.0
Sludge volume	SV	m^3/day	GS2×100/(100-MR)	50.7
Solid retention time	T	day		14.0
Basin number	BN	basin		1
Required tank volume	RV1	$m^3/basin$	SV×T/BN	709.3
Water depth	H	m		8.0
Required surface area	RA	$m^2/basin$	RV1/H	88.7
Required tank diameter	D1	m	$(RA\times4/3.14)^{0.5}$	10.6
	D2	m	*Therefore*	11.0
Dimension (Diameter)	D	m		**11.0**
(Depth)	H	m		**8.0**
(Basin)	BN	basin		**1**

4-9 Digestion Gas Tank

Item	Sign	Unit	Calculation	Result
Generated sludge weight	GS	kg/day	refer to 4-8	1,520
Organic matter ratio	OM	%		70
Generation ratio of gas	GR	%		35
Retention time	RT	day		0.5
Required tank volume	RV	m^3	$GS\times OM\times GR\times RT/10^4$	186
Depth of tank	H	m		4.0
Basin number	BN	basin		1
Required tank diameter	D1	m	$2\times(RV/(3.14\times H\times BN))^{0.5}$	7.7
	D2			8.0
Dimension (Diameter)	D	m	**New Facility**	**8.0**
(Depth)	H	m		**4.0**
(Number)	BN	basin		**1**

4-10 Sludge Dewatering Equipment

Item	Sign	Unit	Calculation	Result
Type	-	-	Centrifugal type	
Digestion rate	DR	%		35.0
Generated sludge weight	GSW	ton/day	refer to 4-8	1.52
Digested sludge weight	DSW	ton/day	GSW×(100-DR)/100	0.99
Sludge moisture rate	MR	%	digested sludge	97.0
Generated sludge volume	GSV	m^3/day	DSW×100/(100-MR)	32.9
Unit number	UN	unit	including stand-by (=1 unit)	2
Operation time	OT	hr/day		8.0
Required capacity	RC1	m^3/hr	GSV/((UN-1)×OT)	4.1
	RC2	m^3/hr		4.5
Specification	**4.5 m3/hr×2 (1) units**			
Digested sludge weight	DSW	ton/day		0.99
Sludeg moisture ratio	DM	%	dewatered sludge	80.0
Dewatered sludge volume	DV	m^3/day	DSW×100/(100-DM)	**4.9**
				↓
				Carry out

5 SUMMARY OF PROPOSED FACILITIES

5-1 Wet Well										
4.5	m(W)	×	5.5	m(L)	×	2.5	m(H)	×	2	basin
5-2 Pump Equipment										
125 mmdia × 1.65 m3/min × 15 m × 8.0 kW × 2 units										
200 mmdia × 3.30 m3/min × 15 m × 16.0 kW × 1 unit										
250 mmdia × 6.60 m3/min × 15 m × 31.0 kW × 2(1) units										
5-3 Grit Chamber										
1.3	m(W)	×	3.5	m(L)	×	0.3	m(H)	×	2	basin
5-4 Oxidation Ditch Reactor Tank										
4.0	m(W)	×	100.0	m(L)	×	3.0	m(H)	×	4	basin
5-5 Final Sedimentation Tank										
13.0	m(dia)	×	4.0	m(H)	×	4	basin			
5-6 Sand Filtration Tank (Future Plan)										
2.5	m(W)	×	4.0	m(L)	×	4	basin			
5-7 Disinfection Tank										
1.5	m(W)	×	7.0	m(L)	×	1.0	m(H)	×	8	pass
5-8 Sludge Thickening Tank										
6.0	m(dia)	×	3.0	m(H)	×	2	basin			
5-9 Sludge Digestion Tank										
11.0	m(dia)	×	8.0	m(H)	×	1	basin			
5-10 Digestion Gas Tank										
8.0	m(dia)	×	4.0	m(H)	×	1	basin			
5-11 Sludge Dewatering Equipment										
4.5	m3/hr	×	2	units	(including 1 stand-by)					

(4) Ponda

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **Ponda Sewage Treatment Plant**

(2) Land Area : Approximately m^2

(3) Elevation : + m

(4) Inlet Pipe Level : - m

(5) Pipe Diameter : - mm

(6) Land Use :

(7) Collection System : Combined System · (Separate System)

(8) Treatment Method :

Sewage Treatment ; Pre-treatment + OD + Final Sedimentation + Sand Filtration (future) + Disinfecti

Sludge Treatment ; Sludge Thickening + Sludge Digestion + Dewatering

(9) Effluent Point :

(10) Effluent Point Water Level : + m

(11) Target Year : 2025 Year

1-2 Design Population and Area

Design Population : 19,400 Persons (Residents)

Design Area : 201 ha

1-3 Design Sewage Flow

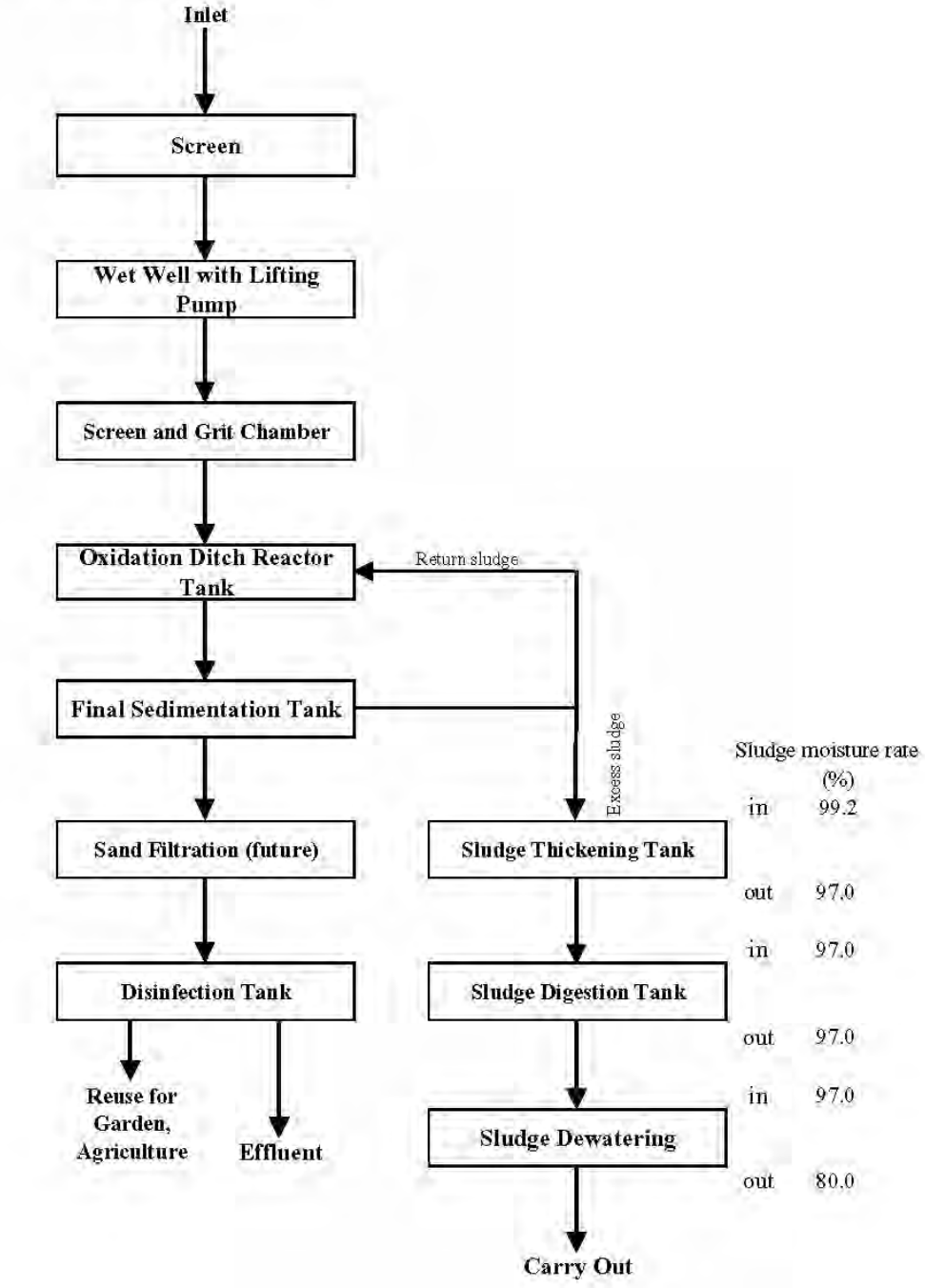
Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average	3,500	145.8	2.43	0.041	
Peak Flow	10,500	437.5	7.29	0.122	Peak factor = 3.00

1-4 Design Sewage Quality

Item	Influent (mg/L)	T.R.R (%)	Effluent (mg/L)	Remarks
BOD	280	89	30	Effluent Quality Regulation = 30 mg/l
SS	240	79	50	Effluent Quality Regulation = 100 mg/l

T.R.R. : Total Removal Ratio

2 Flow Chart (OD Method)



3 Design Criteria for STP

Items	Unit	CPHEEO	Japanese Standards	Metcalf&Eddy	**Adoption**
3.1 Screen and Grit Chamber					
(1) Screen					
Openings of screen bars	mm	Less than 20	-	15	20
(2) Grit Chamber					
Water surface loading	m3/m2/day	2,160	-	1,382 - 1,814	2,160
Horizontal velocity	m/sec	0.15 - 0.30	-	0.24 - 0.39	0.3
3.2 Pump Equipment					
Pump inflow velocity	m/sec	-	-	1.5 - 3.0	1.5 - 3.0
Retention time in wet well	min	> 5.0	-	-	9.0
3.3 Oxidation Ditch Reactor Tank					
Hydraulic retention time	hr	12 - 24	24 - 48	8.0 - 36.0	15.0
MLSS concentration	mg/l	3,000 - 5,000	3,000 - 4,000	3,000 - 6,000	3,500
BOD-SS load	kgBOD/kgSS/day	0.10 - 0.18	0.03 - 0.05	0.05 - 0.30	0.15
Depth	m	-	1.0 - 3.0	-	3.0
Width	m	-	2.0 - 6.0	-	4.0
3.4 Final Sedimentation Tank					
Overflow rate	m3/m2/day	8.0 - 15.0	8.0 - 12.0	16.3 - 32.6	15.0
Depth	m	3.5 - 4.5	3.0 - 4.0	3.7 -	4.0
3.5 Sand Filtration (future)					
Filtration rate	m/day	-	max. 300	176	200.0
3.6 Disinfection Tank					
Detention time	min	-	15.0	-	15.0
3.7 Sludge Thickening Tank					
Solid surface load	kg/m2/day	25 - 30	60 - 90	12.2 - 34.2	30.0
Depth	m	3.0	4.0	-	3.0
3.8 Sludge Digestion Tank					
Solids retention time	days	14.0	20.0	15.0 - 20.0	14.0
Operating temperature	℃	30.0	30.0	-	30.0
Digestion rate	%	-	35.0	-	35.0
Depth	m	6.0 - 12.0	> 4.0	> 7.5	8.0
3.9 Sludge Dewatering Equipment					
Operation time	hr/day	-	-	-	8.0

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4 CAPACITY CALCULATION

4-1 Wet Well with Pump Equipment

Item	Sign	Unit	Calculation	Result
4-1-1 Wet Well				
Design sewage flow	Q1	m^3/day	Peak Flow	10,500
	Q2	m^3/min	Peak Flow	7.29
Basin number	BN	basin		1
Retention time	RT	min		9.0
Required volume	RV	m^3	Q2×RT	65.6
Depth	H	m		2.5
Required area	RA	m^2	RV/RA	26.25
Width	W	m		4.5
Length	L1	m	RA/W	5.83
	L2	m	*Therefore*	6.0
Dimension (Width)	W	m		**4.5**
(Length)	L	m		**6.0**
(Depth)	H	m		**2.5**
(Basin)	N	basin		**1**
4-1-2 Pump Equipment				
Design sewage flow	Q1	m^3/day	Peak flow	10,500
	Q2	m^3/min	Peak flow	7.29
Pump unit number	UN	unit	including stand-by (=1unit)	4
Pump discharging flow	DF1	m^3/min/unit	Q2/4	1.82
	DF2	m^3/min/unit	Q2/2	3.65
Pump inflow velocity	PV	m/sec		1.5 - 3.0
Required pump diameter	D1-1	mm	$146\times(DF1/3.0)^{0.5}$	114
	D1-2	mm	$146\times(DF1/1.5)^{0.5}$	161
	D1	mm	*Therefore*	150
	D2-1	mm	$146\times(DF2/3.0)^{0.5}$	161
	D2-2	mm	$146\times(DF2/1.5)^{0.5}$	228
	D2	mm	*Therefore*	200
Pump total head	H	m	assumption	15.0
Pump efficiency	PE	-		0.60
Axis power	AP1	kw	0.163×DF1×H/PE	7.43
	AP2	kw	0.163×DF2×H/PE	14.86
Motor allowance	MA	-		0.15
Pump power	P1	kw	AP1×(1+MA)	8.54
		kw	*Therefore*	9.0
	P2	kw	AP2×(1+MA)	17.09
		kw	*Therefore*	18.0
Pump Specification	**150 mmdia × 1.82 m3/min × 15 m × 9.0 kW × 2 units** **200 mmdia × 3.65 m3/min × 15 m × 18.0 kW × 2(1) units**			

4-2 Screen and Grit Chamber

Item	Sign	Unit	Calculation	Result
4-2-1 Grit Chamber				
Type	-	-	Parallel flow type	
Design sewage flow	Q1	m^3/day	Peak flow	10,500
	Q2	m^3/sec	Peak flow	0.122
Water surface load	SL	m^3/m^2/day		2,160
Required surface area	RA	m^2	Q1/SL	4.9
Basin number	BN	basin		2

Average velocity	V	m/sec		0.3
Water depth	H	m		0.3
Width	W1	m	Q2/(V×H×BN)	0.68
	W2	m	*Therefore*	0.7
Length	L1	m	RA/(W2×BN)	3.47
	L2	m	*Therefore*	3.5
Dimension (Width)	W	m	W2	**0.7**
(Length)	L	m	L2	**3.5**
(Depth)	H	m	H	**0.3**
(Basin)	N	basin		**2**
4-2-2 Fine Screen				
Type	-	-	One rake type intermittent rake-up	
Set number	SSN	set	1 set = Manual screen	1
Screen opening	-	mm	10 to 20	20
Unit removed screenings	RS	$m^3/1{,}000m^3$		0.010
Design sewage flow	Q	m^3/day	Daily average	3,500
Volume of screenings	VS	m^3/day	Q×RS/1,000	0.035
				▼
				Carry out

4-3 Oxidation Ditch Reactor Tank

Item	Sign	Unit	Calculation	Result
Type			Endless ditch flow type	
Design sewage flow	Q1	m^3/day	Daily average	3,500
	Q2	m^3/hr	Daily average	145.8
BOD-SS load	BS	kgBOD/kgSS·day		0.15
Inlet BOD	BD	mg/l		280
MLSS concentration	MLSS	mg/l		3,500
Required volume -1	RV1	m^3	BD×Q1/(MLSS×BS)	1,867
Hydraulic retention time	HT	hr		15.0
Required volume -2	RV2	m^3	Q2×HT	2,188
	RV	m^3	RV2 > RV1 *Therefore*	2,200
Basin number	BN	basin		2
Water depth	H	m		3.0
Width	W	m		4.0
Length	L1	m	RV/(H×W×BN)	91.7
	L2	m	*Therefore*	92.0
Dimension (width)	W	m		**4.0**
(Depth)	H	m		**3.0**
(Length)	L2	m		**92.0**
(Basin)	BN	basin		**2**

4-4 Final Sedimentation Tank

Item	Sign	Unit	Calculation	Result
Type			Radial Flow Circular Type	
Design sewage flow	Q1	m^3/day	Daily average	3,500
	Q2	m^3/hr	Daily average	145.8
Overflow rate	OR	m^3/m^2/day		15.0
Required area	RA	m^2	Q1/OR	233.3
Basin number	BN	basin		2
Required tank diameter	D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	12.2
	D2	m	*Therefore*	12.5
Water depth	H	m		4.0

Dimension	**(Diameter)**	W	m		**12.5**
	(Depth)	H	m		**4.0**
	(Basin)	BN	basin		**2**

4-5 Sand Filtration Tank (future)

Item		Sign	Unit	Calculation	Result
Type		-	-	Gravity Upflow Filter Type	
Design sewage flow		Q1	m^3/day	Daily average	3,500
		Q2	m^3/sec	Daily average	0.041
Filtration rate		FR	m/day		200.0
Required surface area		RA	m^2	Q1/FR	17.5
Basin number		BN	basin		2
Width		W	m		3.0
Length		L1	m	RA/(W×BN)	2.92
		L2	m	*Therefore*	3.0
Dimension	**(Width)**	W	m	W2	**3.0**
	(Length)	L	m	L2	**3.0**
	(Basin)	N	basin		**2**

4-6 Disinfection Tank

Item		Sign	Unit	Calculation	Result
Chemical type		-	-	Chlorination Type	
Design sewage flow		Q1	m^3/day	Daily average	3,500
		Q2	m^3/min	Daily average	2.43
Retention time		RT	min		15.0
Required volume		RV	m^3	Q2×RT	36.5
Width		W	m		1.0
Water depth		H	m		1.0
Pass number		N	pass		8
Length		L1	m	RV/(W×H×N)	4.6
		L2	m	*Therefore*	5.0
Dimension	**(Width)**	W	m		**1.0**
	(Length)	L	m	L2	**5.0**
	(Depth)	H	m		**1.0**
	(Pass Number)	N	pass		**8**

4-7 Sludge Thickening Tank

Item		Sign	Unit	Calculation	Result
Type		-	-	Radial Flow Circular Type	
Design sewage flow		Q1	m^3/day	Daily average	3,500
		Q2	m^3/hr	Daily average	145.8
Basin number		BN	basin		2
Influent SS quality		ISQ	mg/L		240
Effluent SS quality		ESQ	mg/L		50
Generated sludge		GS	kg/day	$Q1\times(ISQ-ESQ)\times10^{-3}$	665
Sludge surface load		SL	kg/m^2/day		30.0
Required surface area		RA	m^2	GS/SL	22.2
Required tank diameter		D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	3.8
		D2	m	*Therefore*	4.0
Water depth		H	m		3.0
Dimension	**(Diameter)**	D	m		**4.0**
	(Depth)	H	m		**3.0**
	(Basin)	BN	basin		**2**

4-8 Sludge Digestion Tank

Item	Sign	Unit	Calculation	Result
Type	-	-	Anaerobic Tank	
Design sewage flow	Q1	m^3/day	Daily average	3,500
	Q2	m^3/hr	Daily average	145.8
Generated sludge weight	GS1	kg/day	refer to 4-7	665
	GS2	ton/day	GS1/1000	0.67
Sludge moisture rate	MR	%	Thickened sludge	97.0
Sludge volume	SV	m^3/day	GS2×100/(100-MR)	22.2
Solid retention time	T	day		14.0
Basin number	BN	basin		1
Required tank volume	RV1	m^3/basin	SV×T/BN	310.3
Water depth	H	m		8.0
Required surface area	RA	m^2/basin	RV1/H	38.8
Required tank diameter	D1	m	$(RA\times4/3.14)^{0.5}$	7.0
	D2	m	*Therefore*	7.0
Dimension (Diameter)	D	m		**7.0**
(Depth)	H	m		**8.0**
(Basin)	BN	basin		**1**

4-9 Digestion Gas Tank

Item	Sign	Unit	Calculation	Result
Generated sludge weight	GS	kg/day	refer to 4-8	665
Organic matter ratio	OM	%		70
Generation ratio of gas	GR	%		35
Retention time	RT	day		0.5
Required tank volume	RV	m^3	$GS\times OM\times GR\times RT/10^4$	81
Depth of tank	H	m		3.0
Basin number	BN	basin		1
Required tank diameter	D1	m	$2\times(RV/(3.14\times H\times BN))^{0.5}$	5.9
	D2			6.0
Dimension (Diameter)	D	m	**New Facility**	**6.0**
(Depth)	H	m		**3.0**
(Number)	BN	basin		**1**

4-10 Sludge Dewatering Equipment

Item	Sign	Unit	Calculation	Result
Type	-	-	Centrifugal type	
Digestion rate	DR	%		35.0
Generated sludge weight	GSW	ton/day	refer to 4-8	0.67
Digested sludge weight	DSW	ton/day	GSW×(100-DR)/100	0.43
Sludge moisture rate	MR	%	digested sludge	97.0
Generated sludge volume	GSV	m^3/day	DSW×100/(100-MR)	14.4
Unit number	UN	unit	including stand-by (=1 unit)	2
Operation time	OT	hr/day		8.0
Required capacity	RC1	m^3/hr	GSV/((UN-1)×OT)	1.8
	RC2	m^3/hr		2.0
Specification	**2.0 m3/hr×2 (1) units**			
Digested sludge weight	DSW	ton/day		0.43
Sludeg moisture ratio	DM	%	dewatered sludge	80.0
Dewatered sludge volume	DV	m^3/day	DSW×100/(100-DM)	**2.2**
				↓
				Carry out

5 SUMMARY OF PROPOSED FACILITIES

5-1 Wet Well										
	4.5	m(W)	×	6.0	m(L)	×	2.5	m(H)	×	1 basin
5-2 Pump Equipment										
	150 mmdia × 1.82 m3/min × 15 m × 9.0 kW × 2 units									
	200 mmdia × 3.65 m3/min × 15 m × 18.0 kW × 2(1) units									
5-3 Grit Chamber										
	0.7	m(W)	×	3.5	m(L)	×	0.3	m(H)	×	2 basin
5-4 Oxidation Ditch Reactor Tank										
	4.0	m(W)	×	92.0	m(L)	×	3.0	m(H)	×	2 basin
5-5 Final Sedimentation Tank										
	12.5	m(dia)	×	4.0	m(H)	×	2 basin			
5-6 Sand Filtration Tank (Future Plan)										
	3.0	m(W)	×	3.0	m(L)	×	2 basin			
5-7 Disinfection Tank										
	1.0	m(W)	×	5.0	m(L)	×	1.0	m(H)	×	8 pass
5-8 Sludge Thickening Tank										
	4.0	m(dia)	×	3.0	m(H)	×	2 basin			
5-9 Sludge Digestion Tank										
	7.0	m(dia)	×	8.0	m(H)	×	1 basin			
5-10 Digestion Gas Tank										
	6.0	m(dia)	×	3.0	m(H)	×	1 basin			
5-11 Sludge Dewatering Equipment										
	2.0	m3/hr	×	2	units (including 1 stand-by)					

(5) Colva (South Coastal Belt)

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **Colva Sewage Treatment Plant**

(2) Land Area : Approximately m^2

(3) Elevation : + m

(4) Inlet Pipe Level : - m

(5) Pipe Diameter : - mm

(6) Land Use :

(7) Collection System : Combined System · (Separate System)

(8) Treatment Method :

Sewage Treatment ; Pre-treatment + OD + Final Sedimentation + Sand Filtration + Disinfection Tank

Sludge Treatment ; Sludge Thickening + Sludge Digestion + Dewatering

(9) Effluent Point :

(10) Effluent Point Water Level : + m

(11) Target Year : 2025 Year

1-2 Design Population and Area

Design Population : 5,300 Persons (Residents)

Design Area : 110 ha

1-3 Design Sewage Flow

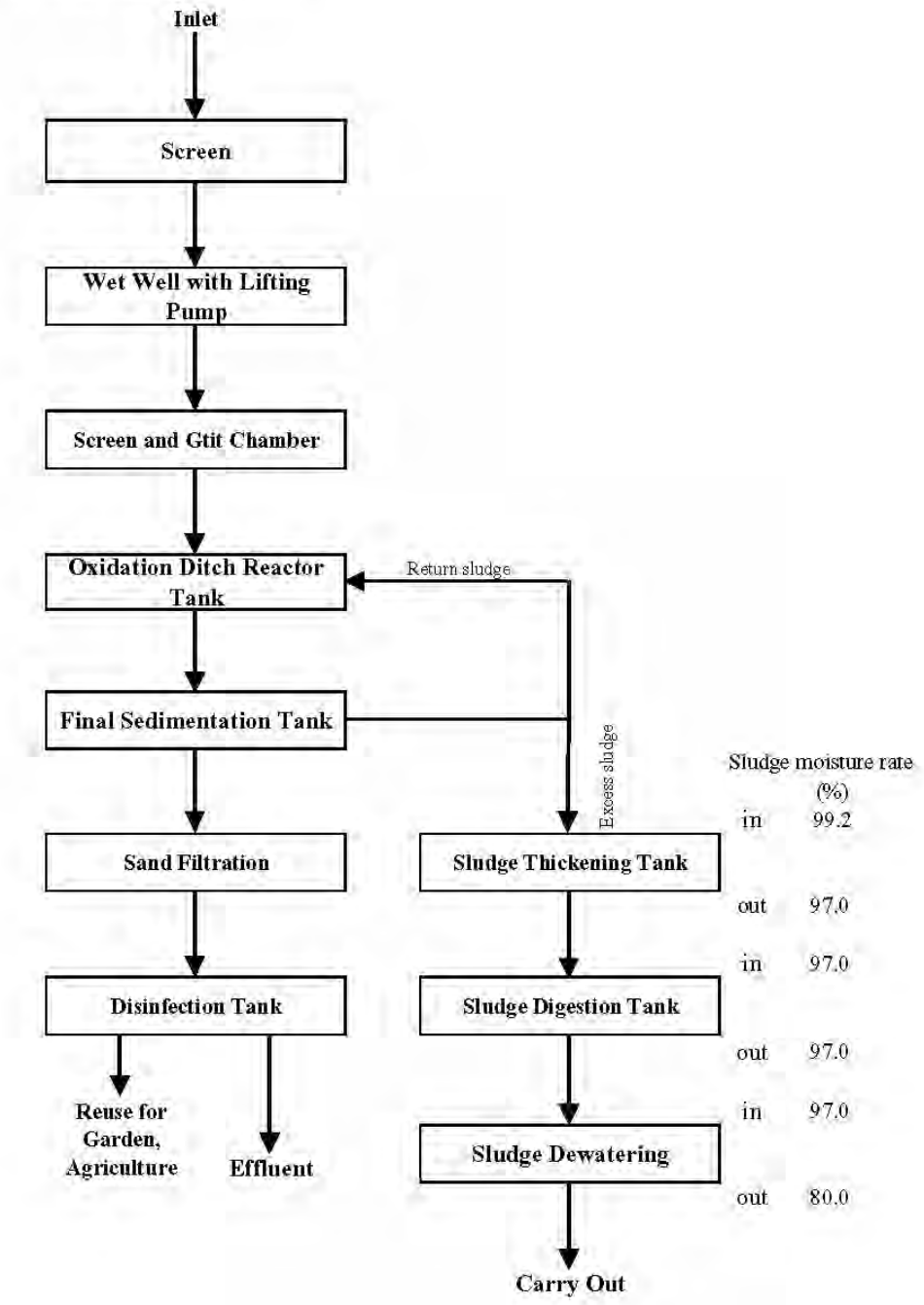
Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average	2,200	91.7	1.53	0.025	
Peak Flow	6,600	275.0	4.58	0.076	Peak factor = 3.00

1-4 Design Sewage Quality

Item	Influent (mg/L)	T.R.R (%)	Effluent (mg/L)	Remarks
BOD	220	86	30	Effluent Quality Regulation = 30 mg/l
SS	190	74	50	Effluent Quality Regulation = 100 mg/l

T.R.R. : Total Removal Ratio

2 **Flow Chart (OD Method)**



3 Design Criteria for STP

Items	Unit	CPHEEO	Japanese Standards	Metcalf&Eddy	**Adoption**
3.1 Screen and Grit Chamber					
(1) Screen					
Openings of screen bars	mm	Less than 20	-	15	20
(2) Grit Chamber					
Water surface loading	m3/m2/day	2,160	-	1,382 - 1,814	2,160
Horizintal velocity	m/sec	0.15 - 0.30	-	0.24 - 0.39	0.3
3.2 Pump Equipment					
Pump inflow velocity	m/sec	-	-	1.5 - 3.0	1.5 - 3.0
Retention time in wet well	min	> 5.0	-	-	9.0
3.3 Oxidation Ditch Reactor Tank					
Hydraulic retention time	hr	12 - 24	24 - 48	8.0 - 36.0	15.0
MLSS concentration	mg/l	3,000 - 5,000	3,000 - 4,000	3,000 - 6,000	3,500
BOD-SS load	kgBOD/kgSS/day	0.10 - 0.18	0.03 - 0.05	0.05 - 0.30	0.15
Depth	m	-	1.0 - 3.0	-	3.0
Width	m	-	2.0 - 6.0	-	4.0
3.4 Final Sedimentation Tank					
Overflow rate	m3/m2/day	8.0 - 15.0	8.0 - 12.0	16.3 - 32.6	15.0
Depth	m	3.5 - 4.5	3.0 - 4.0	3.7 -	4.0
3.5 Sand Filtration					
Filtration rate	m/day	-	max. 300	176	200.0
3.6 Disinfection Tank					
Detention time	min	-	15.0	-	15.0
3.7 Sludge Thickening Tank					
Solid surface load	kg/m2/day	25 - 30	60 - 90	12.2 - 34.2	30.0
Depth	m	3.0	4.0	-	3.0
3.8 Sludge Digestion Tank					
Solids retention time	days	14.0	20.0	15.0 - 20.0	14.0
Operating temperature	℃	30.0	30.0	-	30.0
Digestion rate	%	-	35.0	-	35.0
Depth	m	6.0 - 12.0	> 4.0	> 7.5	6.0
3.9 Sludge Dewatering Equipment					
Operation time	hr/day	-	-	-	8.0

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4 CAPACITY CALCULATION

4-1 Wet Well with Pump Equipment

Item	Sign	Unit	Calculation	Result
4-1-1 Wet Well				
Design sewage flow	Q1	m^3/day	Peak Flow	6,600
	Q2	m^3/min	Peak Flow	4.58
Basin number	BN	basin		1
Retention time	RT	min		9.0
Required volume	RV	m^3	Q2×RT	41.3
Depth	H	m		2.5
Required area	RA	m^2	RV/RA	16.50
Width	W	m		4.0
Length	L1	m	RA/W	4.13
	L2	m	*Therefore*	4.5
Dimension (Width)	W	m		**4.0**
(Length)	L	m		**4.5**
(Depth)	H	m		**2.5**
(Basin)	N	basin		**1**
4-1-2 Pump Equipment				
Design sewage flow	Q1	m^3/day	Peak flow	6,600
	Q2	m^3/min	Peak flow	4.58
Pump unit number	UN	unit	including stand-by (=1unit)	4
Pump discharging flow	DF1	m^3/min/unit	Q2/4	1.15
	DF2	m^3/min/unit	Q2/2	2.29
Pump inflow velocity	PV	m/sec		1.5 - 3.0
Required pump diameter	D1-1	mm	$146\times(DF1/3.0)^{0.5}$	90
	D1-2	mm	$146\times(DF1/1.5)^{0.5}$	128
	D1	mm	*Therefore*	100
	D2-1	mm	$146\times(DF2/3.0)^{0.5}$	128
	D2-2	mm	$146\times(DF2/1.5)^{0.5}$	180
	D2	mm	*Therefore*	150
Pump total head	H	m	assumption	15.0
Pump efficiency	PE	-		0.60
Axis power	AP1	kw	0.163×DF1×H/PE	4.67
	AP2	kw	0.163×DF2×H/PE	9.34
Motor allowance	MA	-		0.15
Pump power	P1	kw	AP1×(1+MA)	5.37
		kw	*Therefore*	6.0
	P2	kw	AP2×(1+MA)	10.74
		kw	*Therefore*	11.0
Pump Specification	**100 mmdia × 1.15 m3/min × 15 m × 6.0 kW × 2 units** **150 mmdia × 2.29 m3/min × 15 m × 11.0 kW × 2(1) units**			

4-2 Screen and Grit Chamber

Item	Sign	Unit	Calculation	Result
4-2-1 Grit Chamber				
Type	-	-	Parallel flow type	
Design sewage flow	Q1	m^3/day	Peak flow	6,600
	Q2	m^3/sec	Peak flow	0.076
Water surface load	SL	m^3/m^2/day		2,160
Required surface area	RA	m^2	Q1/SL	3.1
Basin number	BN	basin		2

Average velocity	V	m/sec		0.3
Water depth	H	m		0.3
Width	W1	m	Q2/(V×H×BN)	0.42
	W2	m	*Trerefore*	0.6
Length	L1	m	RA/(W2×BN)	2.55
	L2	m	*Therefore*	2.6
Dimension (Width)	W	m	W2	**0.6**
(Length)	L	m	L2	**2.6**
(Depth)	H	m	H	**0.3**
(Basin)	N	basin		**2**
4-2-2 Fine Screen				
Type	-	-	One rake type intermittent rake-up	
Set number	SSN	set	1 set = Manual screen	1
Screen opening	-	mm	10 to 20	20
Unit removed screenings	RS	$m^3/1{,}000m^3$		0.010
Design sewage flow	Q	m^3/day	Daily average	2,200
Volume of screenings	VS	m^3/day	Q×RS/1,000	0.022
				↓
				Carry out

4-3 Oxidation Ditch Reactor Tank

Item	Sign	Unit	Calculation	Result
Type			Endless ditch flow type	
Design sewage flow	Q1	m^3/day	Daily average	2,200
	Q2	m^3/hr	Daily average	91.7
BOD-SS load	BS	kgBOD/kgSS·day		0.15
Inlet BOD	BD	mg/l		220
MLSS concentration	MLSS	mg/l		3,500
Required volume -1	RV1	m^3	BD×Q1/(MLSS×BS)	922
Hydraulic retention time	HT	hr		15.0
Required volume -2	RV2	m^3	Q2×HT	1,375
	RV	m^3	RV2 > RV1 *Therefore*	1,400
Basin number	BN	basin		2
Water depth	H	m		3.0
Width	W	m		4.0
Length	L1	m	RV/(H×W×BN)	58.3
	L2	m	*Therefore*	59.0
Dimension (width)	W	m		**4.0**
(Depth)	H	m		**3.0**
(Length)	L2	m		**59.0**
(Basin)	BN	basin		**2**

4-4 Final Sedimentation Tank

Item	Sign	Unit	Calculation	Result
Type			Radial Flow Circular Type	
Design sewage flow	Q1	m^3/day	Daily average	2,200
	Q2	m^3/hr	Daily average	91.7
Overflow rate	OR	m^3/m^2/day		15.0
Required area	RA	m^2	Q1/OR	146.7
Basin number	BN	basin		2
Required tank diameter	D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	9.7
	D2	m	*Therefore*	10.0
Water depth	H	m		4.0

Dimension	**(Diameter)**	W	m		**10.0**
	(Depth)	H	m		**4.0**
	(Basin)	BN	basin		**2**

4-5 Sand Filtration Tank

Item		Sign	Unit	Calculation	Result
Type		-	-	Gravity Upflow Filter Type	
Design sewage flow		Q1	m^3/day	Daily average	2,200
		Q2	m^3/sec	Daily average	0.025
Filtration rate		FR	m/day		200.0
Required surface area		RA	m^2	Q1/FR	11.0
Basin number		BN	basin		2
Width		W	m		3.0
Length		L1	m	RA/(W×BN)	1.83
		L2	m	*Therefore*	2.0
Dimension	**(Width)**	W	m	W2	**3.0**
	(Length)	L	m	L2	**2.0**
	(Basin)	N	basin		**2**

4-6 Disinfection Tank

Item		Sign	Unit	Calculation	Result
Chemical type		-	-	Chlorination Type	
Design sewage flow		Q1	m^3/day	Daily average	2,200
		Q2	m^3/min	Daily average	1.53
Retention time		RT	min		15.0
Required volume		RV	m^3	Q2×RT	22.9
Width		W	m		1.0
Water depth		H	m		1.0
Pass number		N	pass		4
Length		L1	m	RV/(W×H×N)	5.7
		L2	m	*Therefore*	6.0
Dimension	**(Width)**	W	m		**1.0**
	(Length)	L	m	L2	**6.0**
	(Depth)	H	m		**1.0**
	(Pass Number)	N	pass		**4**

4-7 Sludge Thickening Tank

Item		Sign	Unit	Calculation	Result
Type		-	-	Radial Flow Circular Type	
Design sewage flow		Q1	m^3/day	Daily average	2,200
		Q2	m^3/hr	Daily average	91.7
Basin number		BN	basin		1
Influent SS quality		ISQ	mg/L		190
Effluent SS quality		ESQ	mg/L		50
Generated sludge		GS	kg/day	$Q1\times(ISQ-ESQ)\times10^{-3}$	308
Sludge surface load		SL	kg/m^2/day		30.0
Required surface area		RA	m^2	GS/SL	10.3
Required tank diameter		D1	m	$(RA\times4/(3.14\times BN))^{0.5}$	3.6
		D2	m	*Therefore*	4.0
Water depth		H	m		3.0
Dimension	**(Diameter)**	D	m		**4.0**
	(Depth)	H	m		**3.0**
	(Basin)	BN	basin		**1**

4-8 Sludge Digestion Tank

Item	Sign	Unit	Calculation	Result
Type	-	-	Anaerobic Tank	
Design sewage flow	Q1	m^3/day	Daily average	2,200
	Q2	m^3/hr	Daily average	91.7
Generated sludge weight	GS1	kg/day	refer to 4-7	308
	GS2	ton/day	GS1/1000	0.31
Sludge moisture rate	MR	%	Thickened sludge	97.0
Sludge volume	SV	m^3/day	GS2×100/(100-MR)	10.3
Solid retention time	T	day		14.0
Basin number	BN	basin		1
Required tank volume	RV1	m^3/basin	SV×T/BN	143.7
Water depth	H	m		6.0
Required surface area	RA	m^2/basin	RV1/H	24.0
Required tank diameter	D1	m	$(RA\times4/3.14)^{0.5}$	5.5
	D2	m	*Therefore*	6.0
Dimension (Diameter)	D	m		**6.0**
(Depth)	H	m		**6.0**
(Basin)	BN	basin		**1**

4-9 Digestion Gas Tank

Item	Sign	Unit	Calculation	Result
Generated sludge weight	GS	kg/day	refer to 4-8	308
Organic matter ratio	OM	%		70
Generation ratio of gas	GR	%		35
Retention time	RT	day		0.5
Required tank volume	RV	m^3	$GS\times OM\times GR\times RT/10^4$	38
Depth of tank	H	m		3.0
Basin number	BN	basin		1
Required tank diameter	D1	m	$2\times(RV/(3.14\times H\times BN))^{0.5}$	4.0
	D2			4.0
Dimension (Diameter)	D	m	**New Facility**	**4.0**
(Depth)	H	m		**3.0**
(Number)	BN	basin		**1**

4-10 Sludge Dewatering Equipment

Item	Sign	Unit	Calculation	Result
Type	-	-	Centrifugal type	
Digestion rate	DR	%		35.0
Generated sludge weight	GSW	ton/day	refer to 4-8	0.31
Digested sludge weight	DSW	ton/day	GSW×(100-DR)/100	0.20
Sludge moisture rate	MR	%	digested sludge	97.0
Generated sludge volume	GSV	m^3/day	DSW×100/(100-MR)	6.7
Unit number	UN	unit	including stand-by (=1 unit)	2
Operation time	OT	hr/day		8.0
Required capacity	RC1	m^3/hr	GSV/((UN-1)×OT)	0.8
	RC2	m^3/hr		1.0
Specification	**1.0 m3/hr×2 (1) units**			
Digested sludge weight	DSW	ton/day		0.20
Sludeg moisture ratio	DM	%	dewatered sludge	80.0
Dewatered sludge volume	DV	m^3/day	DSW×100/(100-DM)	**1.00**
				↓
				Carry out

5 SUMMARY OF PROPOSED FACILITIES

5-1 Wet Well										
	4.0	m(W)	×	4.5	m(L)	×	2.5	m(H)	×	1 basin
5-2 Pump Equipment										
	100 mmdia × 1.15 m3/min × 15 m × 6.0 kW × 2 units									
	150 mmdia × 2.29 m3/min × 15 m × 11.0 kW × 2(1) units									
5-3 Grit Chamber										
	0.6	m(W)	×	2.6	m(L)	×	0.3	m(H)	×	2 basin
5-4 Oxidation Ditch Reactor Tank										
	4.0	m(W)	×	59.0	m(L)	×	3.0	m(H)	×	2 basin
5-5 Final Sedimentation Tank										
	10.0	m(dia)	×	4.0	m(H)	×	2 basin			
5-6 Sand Filtration Tank										
	3.0	m(W)	×	2.0	m(L)	×	2 basin			
5-7 Disinfection Tank										
	1.0	m(W)	×	6.0	m(L)	×	1.0	m(H)	×	4 pass
5-8 Sludge Thickening Tank										
	4.0	m(dia)	×	3.0	m(H)	×	1 basin			
5-9 Sludge Digestion Tank										
	6.0	m(dia)	×	6.0	m(H)	×	1 basin			
5-10 Digestion Gas Tank										
	4.0	m(dia)	×	3.0	m(H)	×	1 basin			
5-11 Sludge Dewatering Equipment										
	1.0	m3/hr	×	2	units	(including 1 stand-by)				

Appendix M63.4 Comparison Study for Allocation of Sewerage Facilities

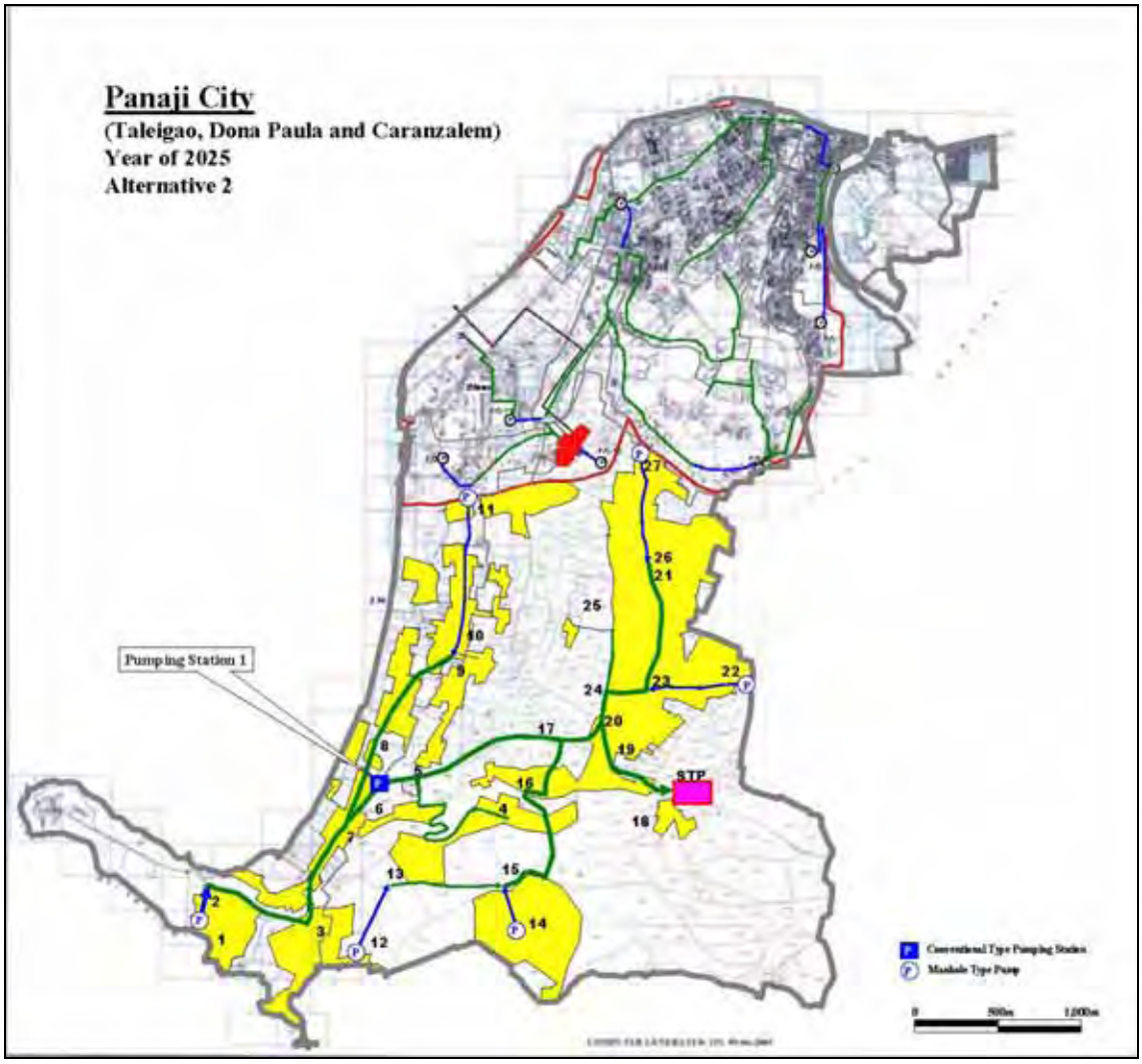
(1) Taleigao, Dona Paula and Caranzalem Area, Panaji

Alternative 1: Wastewater will be treated at existing Tonca STP with augmentation

Alternative 2: Wastewater will be treated at new STP in lowland in Taleigao

Comparison Sheet of Alternative

	Alternative 1	**Alternative 2**
Sewage Treatment Plant	Existing Tonca STP Augmentation required (6.2 MLD) Existing site area is sufficient for Additional facilities	New STP (6.2 MLD) Land acquisition required
Sewer and Pressure Main	14.7 km	14.4 km
Pumping Station	Conventional type PS: 2	Conventional type PS: 1
Advantage / Disadvantage	Advantage: - Land acquisition is not required - High treatment reliability of STP by less manpower due to centralization of STP operation	
Conclusion	**Alternative 1** should be adopted, because - Existing SBR type Tonca STP has been working well, and better O&M performance is expected in future also - Area of the existing STP site is sufficient for augmentation of treatment capacity - Length of sewer is almost same	



(2) St. Crus

No alternative study is required for this scheme.

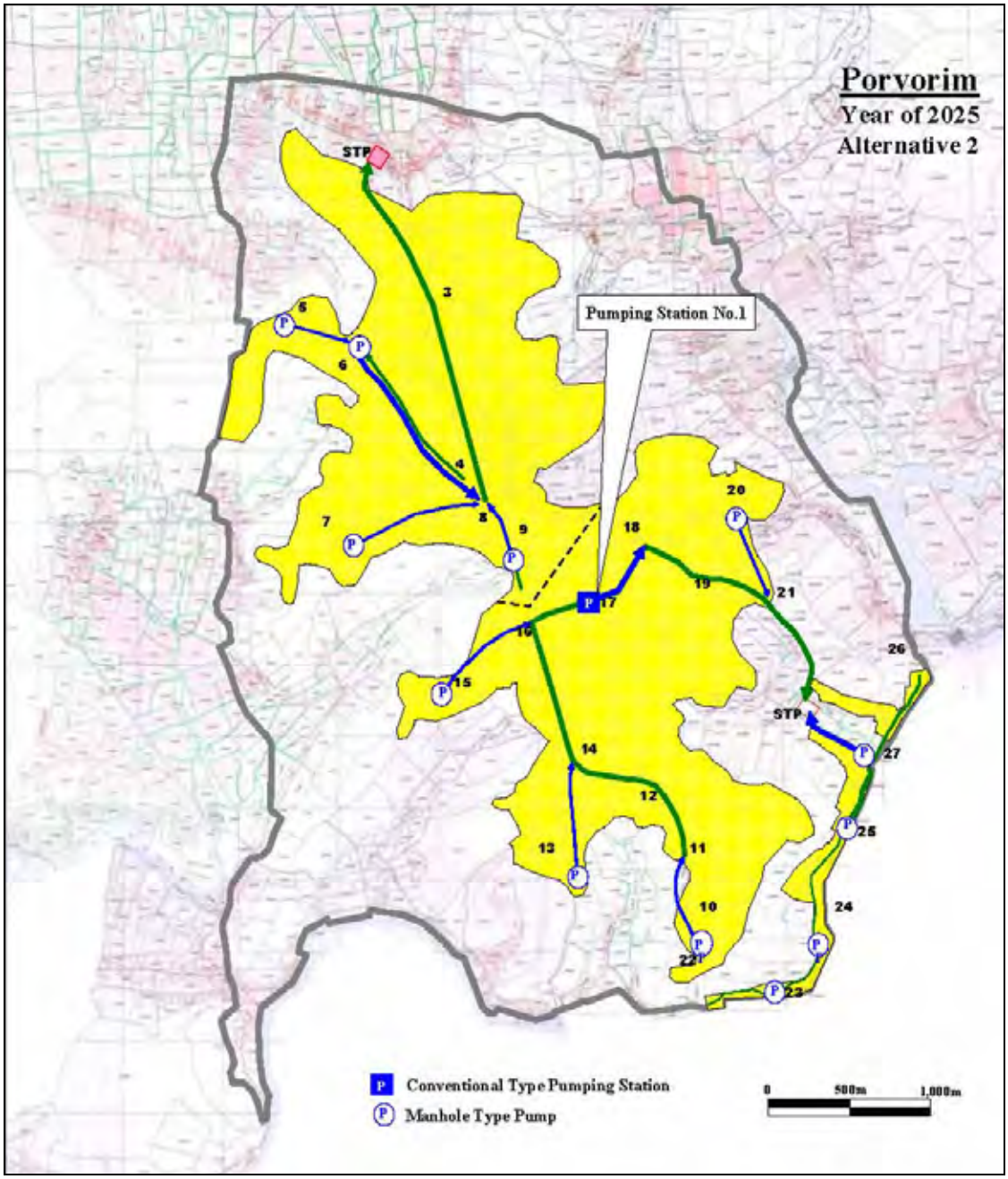
(3) Porvorim

Alternative 1: Wastewater will be treated at one new STP near Mondovi River

Alternative 2: Wastewater will be treated at two new STP, one is same as Alternative 1, and other is located in the northern part of service area

Comparison Sheet of Alternative

	Alternative 1	**Alternative 2**
Sewage Treatment Plant	New STP near Mondovi River (7.6 MLD) - Land acquisition required	New STP near Mondovi River (4.6 MLD) New STP for northern area (3.0 MLD) - Land acquisition required (both site)
Sewer and Pressure Main	17.9 km	16.9 km
Pumping Station	Conventional type PS: 3	Conventional type PS: 1
Advantage / Disadvantage	Advantage: - High treatment reliability of STP by less manpower due to centralization of STP operation	Advantage: - Less number of pumping stations - Shorter sewer Disadvantage: - Receiving water body is far from site of STP at northern area, therefore long pressure main and pumping facility for effluent is necessary
Conclusion	**Alternative 1** should be adopted, because - High treatment reliability of STP by less manpower due to centralization of STP Operation - STP site is close to receiving water body	


Porvorim
Year of 2025
Alternative 2
STP
Pumping Station No.1
3
5
6
4
7
8
9
18
20
19
21
17
16
15
26
STP
27
14
12
25
13
11
10
24
22
23
Conventional Type Pumping Station
Manhole Type Pump
0
500m
1,000m

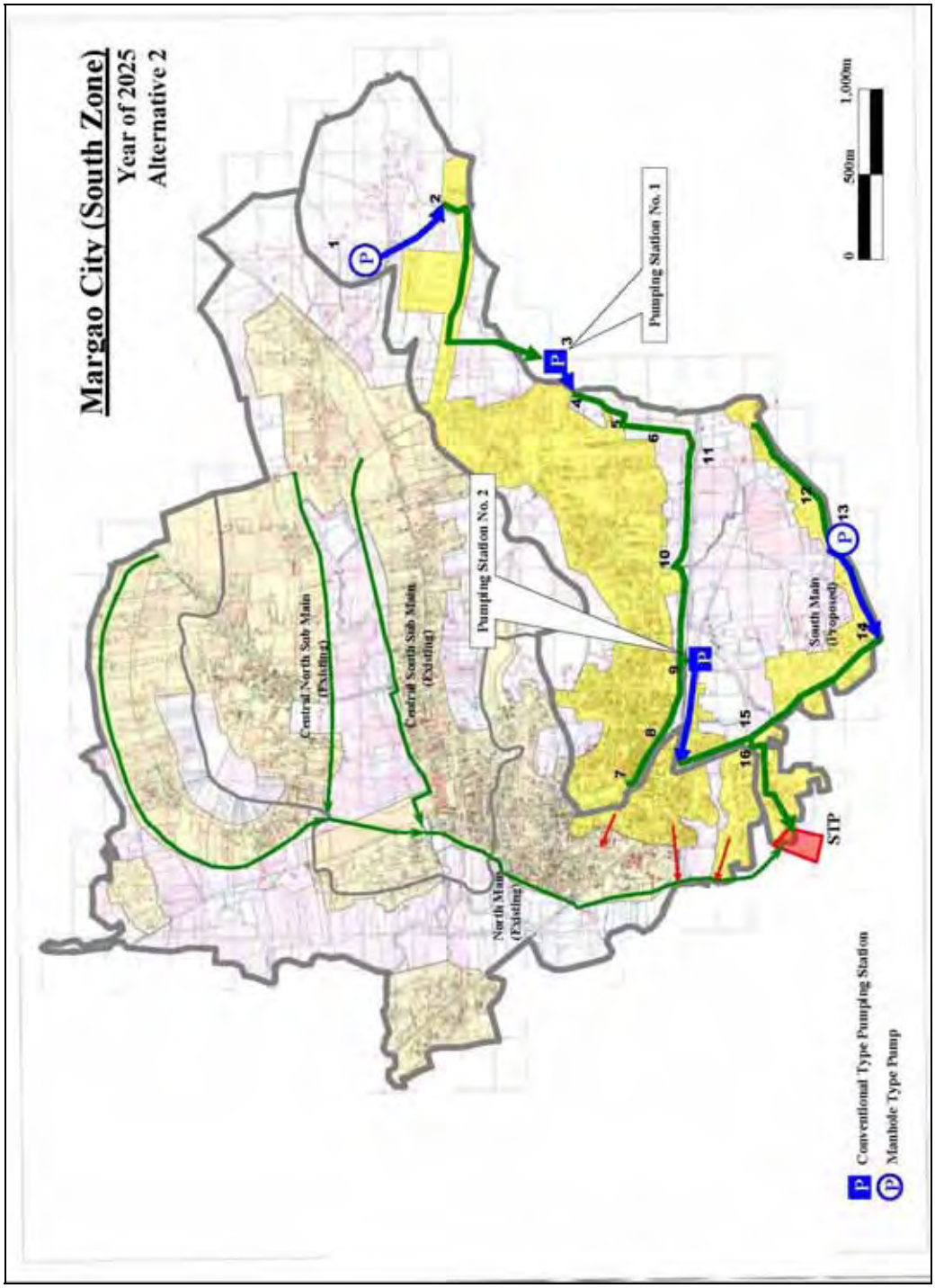
(4) Margao

Alternative 1: Wastewater will be treated at existing Margao STP
Railway crossing site is at west edge of municipality, in rural area

Alternative 2: Wastewater will be treated at existing Margao STP (same as Alternative 1)
Railway crossing site is near "Old Station" in congested area

Comparison Sheet of Alternative

	Alternative 1	**Alternative 2**
Sewage Treatment Plant	Existing Margao STP Augmentation required (10 MLD) Existing site area is sufficient for additional facilities	Same as Alternative 1
Sewer and Pressure Main	9.0 km	9.8 km
Railway crossing site	- Rural area - Space for shaft for jacking is available - No residential receiving adverse affect From laying sewer	- Congested area - Congested are, difficult to lay sewer crossing under railway track by jacking method
Pumping Station	Conventional type PS: 2	Conventional type PS: 2
Evaluation	Advantage: - Shorter trunk sewer	Disadvantage: - Difficult to lay sewer crossing under railway track by jacking method
Adoption	**Alternative 1** should be adopted, because - Shorter trunk sewer - Construction of sewer crossing under railway track is possible	


Margao City (South Zone)
Year of 2025
Alternative 2
Pumping Station No. 1
Pumping Station No. 2
Central North Sub Main (Existing)
Central South Sub Main (Existing)
North Main (Existing)
South Main (Proposed)
STP
0
500m
1,000m
Conventional Type Pumping Station
Manhole Type Pump

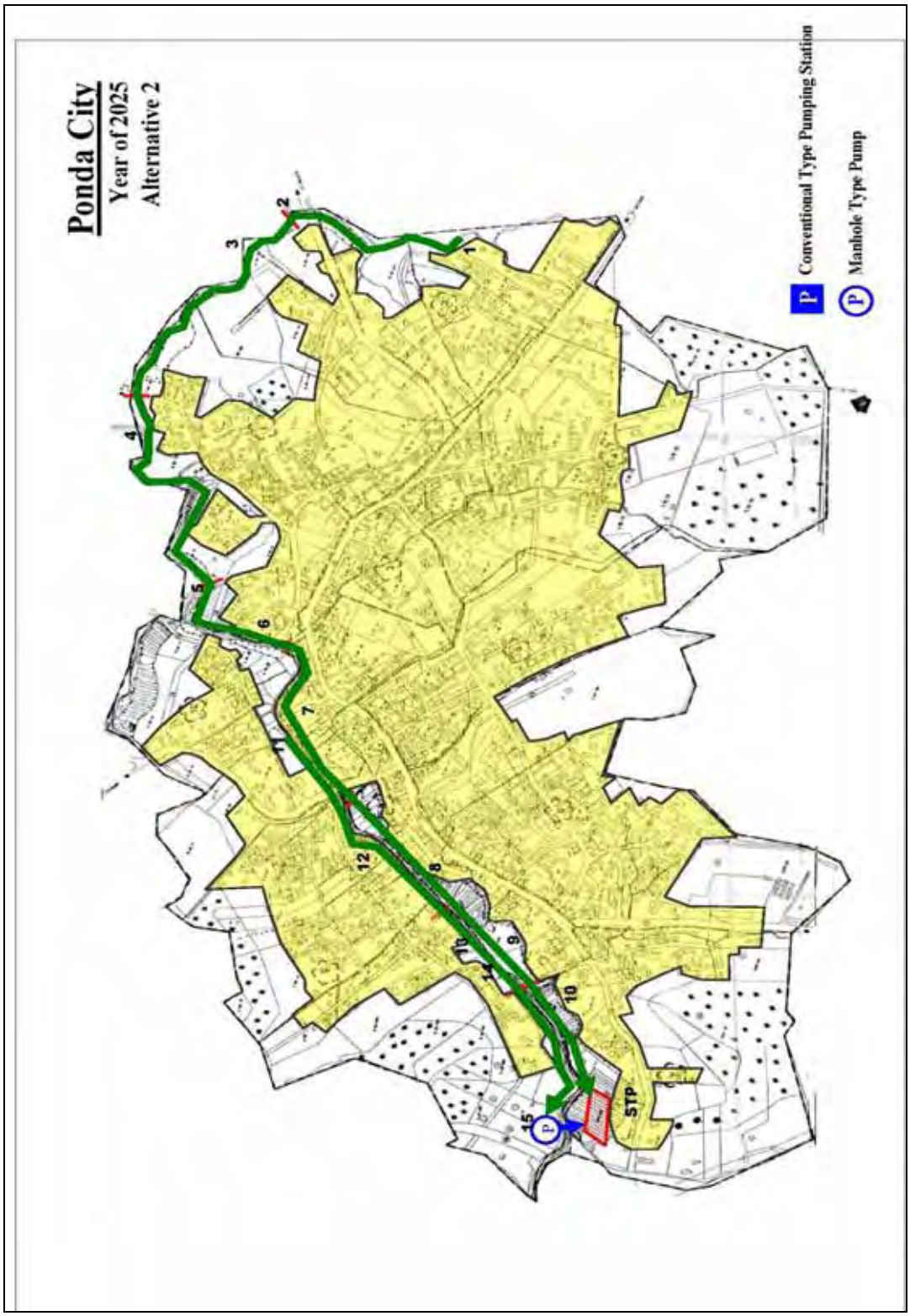
(5) Ponda

Alternative 1: Wastewater will be treated at new STP at just down stream of service area
Trunk sewers will be laid under main roads running parallel to the main drainage

Alternative 2: Wastewater will be treated at same new STP as Alternative 1
Trunk sewers will be laid in drainage area or very close to the drainage

Comparison Sheet of Alternative

	Alternative 1	**Alternative 2**
Sewage Treatment Plant	New STP at riverside area (3.5 MLD) Land acquisition required	Same as Alternative 1
Sewer and Pressure Main	3.3 km	4.0 km
Pumping Station	Conventional type PS: 1	Conventional type PS: 1
Evaluation	Advantage: - Shorter trunk sewer Disadvantage: - Many small manhole type pumps for lowland area is necessary	Disadvantage: -Difficult to lay trunk sewers along the drainage
Adoption	**Alternative 1** should be adopted, because - In practice, it is impossible to lay trunk sewers in drainage area or close to the Drainage due to many residential facing or close to the drainage - Shorter trunk sewer	


Ponda City
Year of 2025
Alternative 2
Conventional Type Pumping Station
Manhole Type Pump
STP

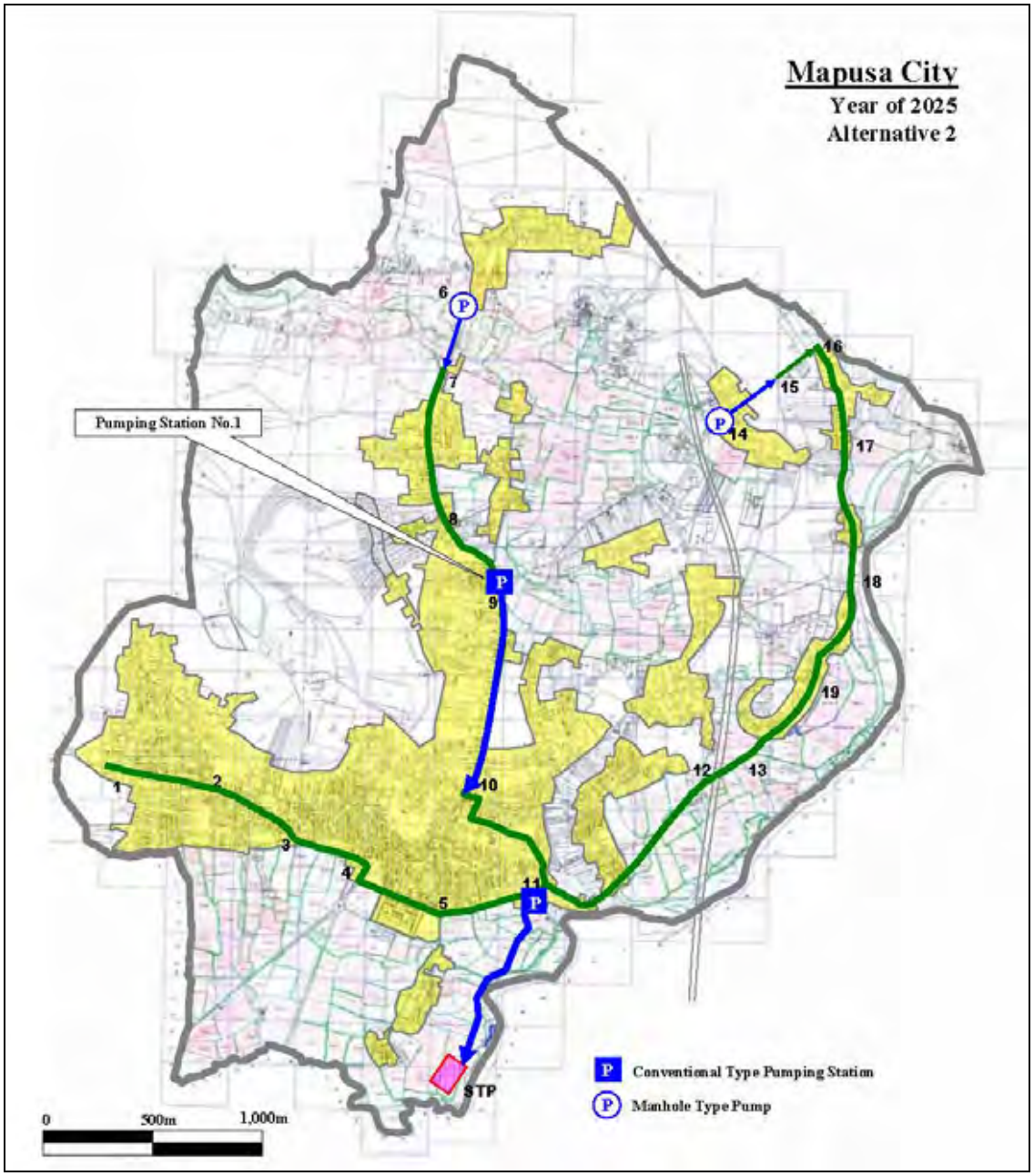
(6) Mapusa

Alternative 1: Wastewater will be treated at new STP at east edge of sewerage service area

Alternative 2: Wastewater will be treated at new STP at 1.2 km south of Municipal Market

Comparison Sheet of Alternative

	Alternative 1	**Alternative 2**
Sewage Treatment Plant	New STP at riverside area (11 MLD) Land acquisition required Land is used for semi public purpose	New STP at riverside area (11 MLD) Land acquisition required
Sewer and Pressure Main	10.3 km	11.1 km
Pumping Station	Conventional type PS: 1	Conventional type PS: 2
Evaluation	Advantage: - Shorter trunk sewer - Less number of pumping stations	
Adoption	**Alternative 1** should be adopted, because - Shorter trunk sewer - Less number of pumping stations	


Mapusa City
Year of 2025
Alternative 2
Pumping Station No.1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
STP
0
500m
1,000m
Conventional Type Pumping Station
Manhole Type Pump

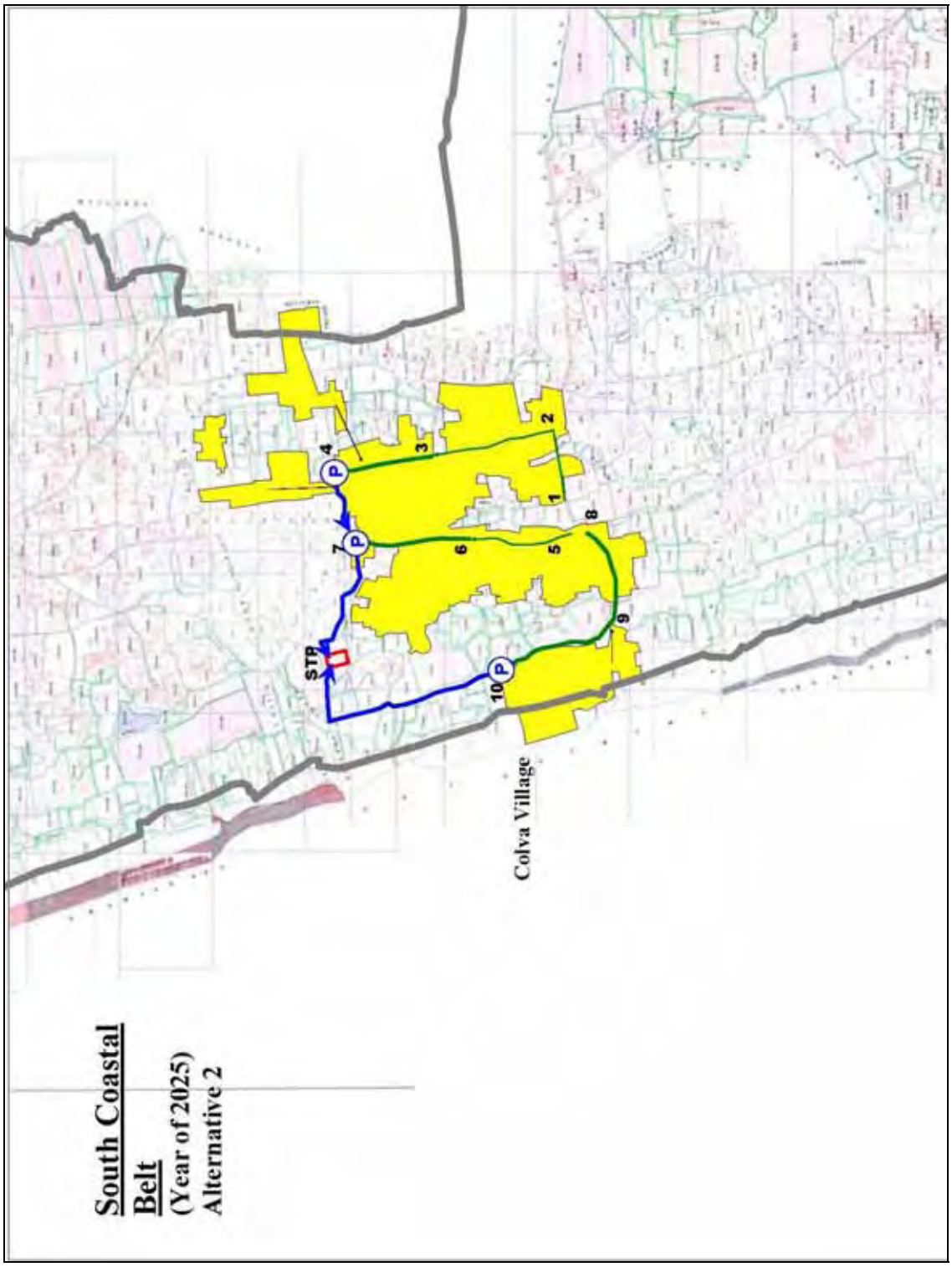
(7) South Coastal Belt

Alternative 1: Wastewater will be treated at new STP at south edge of sewerage service area

Alternative 2: Wastewater will be treated at new STP north edge of sewerage service area

Comparison Sheet of Alternative

	Alternative 1	**Alternative 2**
Sewage Treatment Plant	New STP at south edge (2.2 MLD) Land acquisition required	New STP at north edge (2.2 MLD) Land acquisition required
Effluent pipe	About 3 km to receiving water body (Sal River)	About 4 km to receiving water body (Sal River)
Sewer and Pressure Main	3.9 km	5.1 km
Pumping Station	Conventional type PS: 1	Conventional type PS: 0
Evaluation	Advantage: - Shorter trunk sewer / effluent pipe Disadvantage: - One conventional type pumping station is necessary, but it worked as main pump of STP, therefore it is not disadvantage in practice	
Adoption	**Alternative 1** should be adopted, because - Shorter trunk sewer / effluent pipe	


South Coastal
Belt
(Year of 2025)
Alternative 2
Colva Village
STP
P
1
2
3
4
5
6
7
8
9
10

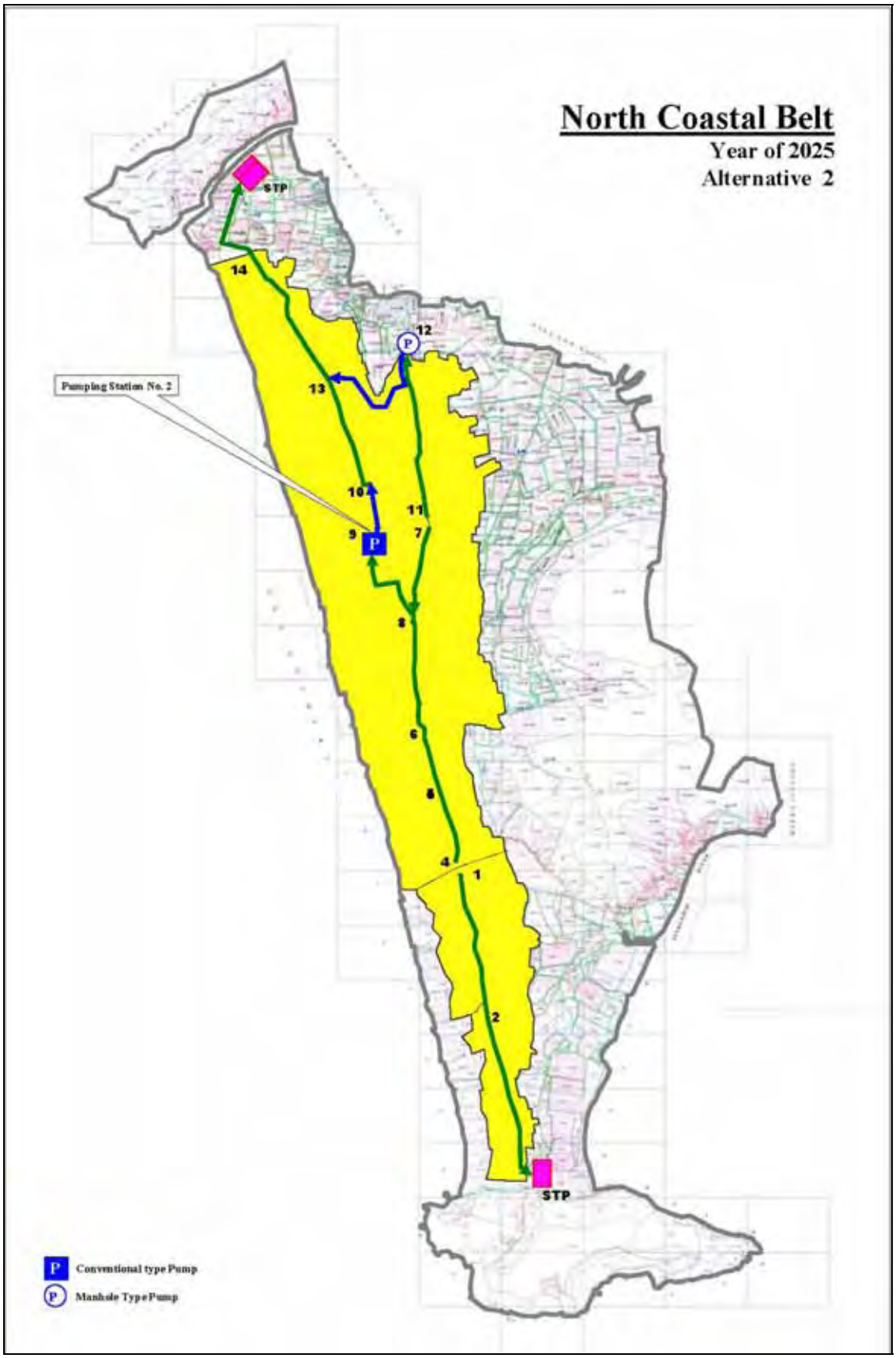
(8) North Coastal Belt

Alternative 1: Wastewater will be treated at one new STP at north edge of Calangute Village

Alternative 2: Wastewater will be treated at two new STP, one is same as Alternative 1, and other is located at south end of Candolim Village

Comparison Sheet of Alternative

	Alternative 1	**Alternative 2**
Sewage Treatment Plant	New STP at Calangute (11.2 MLD) Land acquisition required	New STP at Candolim (2.5 MLD) New STP at Calangute (8.7 MLD) Land acquisition required (both)
Sewer and Pressure Main	14.1 km	11.6 km
Pumping Station	Conventional type PS: 2	Conventional type PS: 1
Evaluation	Advantage: - High treatment reliability of STP by less manpower due to centralization of STP operation	Advantage: - Less number of pumping station and shorter pressure main
Adoption	**Alternative 1** should be adopted, because - High treatment reliability of STP by less manpower due to centralization of STP Operation	


North Coastal Belt
Year of 2025
Alternative 2
STP
14
12
Pumping Station No. 2
13
10
11
9
7
8
6
5
4
1
2
STP
Conventional type Pump
Manhole Type Pump