PART-D FORMULATION OF MASTER PLAN

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PART-D FORMULATION OF THE NEW MASTER PLAN

D1 General Considerations

D1.2 Improvement Targets

Table S/R-D1-1 Improvement Targets for Off-site and On-site Development Plan (for 5-year span)

Item		Units	2012	2014	2020	2025	2030	2035	2040	2045	2050
Population	Design Population	1,000person	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665
	Administrative Population	1,000person	10,035	10,361	11,284	11,994	12,665	12,665	12,665	12,665	12,665
	Day-time Population	1,000person	13,379	13,815	15,046	15,992	16,887	16,887	16,887	16,887	16,887
	Sewerage Population	1,000person	168	387	1,685	2,884	4,478	5,775	7,130	8,572	10,166
	Floating Population	1,000person	3,345	3,454	3,761	3,998	4,222	4,222	4,222	4,222	4,222
	On-site Served Population	1,000person	8,567	9,974	9,599	9,110	8,188	6,890	5,535	4,093	2,500
	*CST Served Population	1,000person	8,366	8,425	7,199	5,694	4,094	2,584	1,384	512	0
	* On-call population for CST	1,000person	8,366	8,024	4,799	3,321	2,047	969	346	64	0
	* Regular De-sludging Population for CST	1,000person	0	401	2,400	2,372	2,047	1,615	1,038	448	0
	*MST Served Population	1,000person	201	1,550	2,400	3,416	4,094	4,306	4,151	3,582	2,500
	*Regular De-sludging Population for MST	1,000person	0	1,550	2,400	3,416	4,094	4,306	4,151	3,582	2,500
	Open Defecation Population	1,000person	1,300	0	0	0	0	0	0	0	0
Off-Site	**Facility Coverage Ratio**	%	2	7	21	30	42	50	64	74	80
	Adopted as Target of Facility Coverage Ratio	%	2	7	20	30	40	50	65	75	80
	Facility Coverage Population	1,000person	168	747	2,334	3,631	5,327	6,286	8,049	9,322	10,166
	Facility Capacity (daily average wastewater flow)	1,000m^3/day	34	149	467	726	1,065	1,257	1,610	1,864	2,033
	Facility Capacity (daily maximum wastewater flow)	1,000m^3/day	45	199	622	968	1,420	1,647	2,117	2,456	2,681
	Service Coverage Ratio	%	2	4	15	24	35	46	56	68	80
	Adopted as Target of Service Coverage Ratio	%	2	4	15	25	35	45	55	70	80
	Served Population for Off-Site	1,000person	168	387	1,685	2,884	4,478	5,775	7,130	8,572	10,166
	Wastewater Flow should be treated (daily average)	1,000m^3/day	34	77	337	577	896	1,133	1,404	1,692	2,011
	Wastewater Flow should be treated (daily maximum)	1,000m^3/day	45	103	449	769	1,194	1,511	1,872	2,257	2,681
On-Site	**On-site system Coverage Ratio**	%	85	96	85	76	65	54	44	32	20
	Adopted as Target of On-site system Coverage Ratio	%	85	96	85	75	65	55	45	30	20
	CST user ratio	%	83	81	64	47	32	20	11	4	0
	MST user ratio	%	2	15	21	28	32	34	33	28	20
	Upgrading Ratio CST to MST	%	2	16	25	38	50	63	75	88	100
	On-site Served Population	1,000person	8,567	9,974	9,599	9,110	8,188	6,890	5,535	4,093	2,500
	CST Served Population	1,000person	8,366	8,425	7,199	5,694	4,094	2,584	1,384	512	0
	MST Served Population	1,000person	201	1,550	2,400	3,416	4,094	4,306	4,151	3,582	2,500
	Regular Desludging Ratio (CST & MST)	%	0	20	50	64	75	86	94	98	100
	Regular Desludging Ratio for CST	%	0	5	33	42	50	63	75	88	100
	Regular Desludging Ratio for MST	%	0	100	100	100	100	100	100	100	100
	Regular Desludging Population	1,000person	0	1,951	4,799	5,788	6,141	5,921	5,189	4,029	2,500
	Regular Desludging Population for CST	1,000person	0	401	2,400	2,372	2,047	1,615	1,038	448	0
	Regular Desludging Population for MST	1,000person	0	1,550	2,400	3,416	4,094	4,306	4,151	3,582	2,500
	Non-Desludging Population	1,000person	8,567	8,024	4,799	3,321	2,047	969	346	64	0
Slum	**Open Defecation Ratio**	%	13	0	0	0	0	0	0	0	0
	Open Defecation Population	1,000person	1,300	0	0	0	0	0	0	0	0
River Water	River Water Quality(BOD)	mg/L	61	54	33	29	24	21	17	14	10

Table S/R-D1-2 Improvement Targets for Off-site and On-site Development Plan (for 5-year span)

Items		Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Population	Design Population	1,000person	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665
	Administrative Population	1,000person	10,035	10,198	10,361	10,529	10,680	10,831	10,982	11,133	11,284	11,426	11,568	11,710	11,852	11,994	12,128	12,262	12,397	12,531	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665	12,665
	Day-time Population	1,000person	13,379	13,597	13,815	14,038	14,240	14,441	14,643	14,844	15,046	15,235	15,424	15,613	15,803	15,992	16,171	16,350	16,529	16,708	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887	16,887
	Sewerage Population	1,000person	168	171	387	603	820	1,036	1,252	1,469	1,685	1,902	2,118	2,438	2,612	2,884	3,156	3,429	3,778	4,128	4,478	4,860	5,132	5,420	5,609	5,775	6,025	6,345	6,579	6,814	7,130	7,447	7,685	8,028	8,300	8,572	8,844	9,145	9,445	9,745	10,166
	Floating Population	1,000person	3,345	3,399	3,454	3,510	3,560	3,610	3,661	3,711	3,761	3,809	3,856	3,903	3,951	3,998	4,043	4,087	4,132	4,177	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222
	On-site Served Population	1,000person	8,567	9,367	9,974	9,925	9,860	9,795	9,730	9,664	9,599	9,525	9,450	9,272	9,240	9,110	8,972	8,834	8,618	8,403	8,188	7,805	7,533	7,246	7,056	6,890	6,641	6,320	6,086	5,852	5,535	5,218	4,981	4,638	4,365	4,093	3,821	3,521	3,220	2,920	2,500
	*CST Served Population	1,000person	8,366	8,502	8,425	8,227	8,017	7,810	7,604	7,401	7,199	6,905	6,615	6,259	6,006	5,694	5,383	5,079	4,740	4,412	4,094	3,708	3,390	3,079	2,822	2,584	2,324	2,054	1,826	1,609	1,384	1,174	996	812	655	512	382	264	161	73	0
	* On-call population for CST	1,000person	8,366	8,502	8,024	7,443	6,872	6,322	5,794	5,286	4,799	4,488	4,190	3,860	3,604	3,321	3,050	2,794	2,528	2,279	2,047	1,761	1,525	1,309	1,129	969	813	668	548	443	346	264	199	142	98	64	38	20	8	2	0
	* Regular De-sludging Population for CST	1,000person	0	0	401	784	1,145	1,488	1,810	2,114	2,400	2,417	2,426	2,399	2,402	2,372	2,333	2,286	2,212	2,132	2,047	1,946	1,864	1,771	1,693	1,615	1,511	1,386	1,278	1,167	1,038	910	797	670	557	448	344	244	153	71	0
	*MST Served Population	1,000person	201	865	1,550	1,699	1,843	1,985	2,125	2,264	2,400	2,619	2,835	3,013	3,234	3,416	3,589	3,754	3,878	3,991	4,094	4,098	4,143	4,166	4,234	4,306	4,316	4,266	4,260	4,242	4,151	4,044	3,984	3,826	3,711	3,582	3,439	3,257	3,059	2,847	2,500
	*Regular De-sludging Population for MST	1,000person	0	0	1,550	1,699	1,843	1,985	2,125	2,264	2,400	2,619	2,835	3,013	3,234	3,416	3,589	3,754	3,878	3,991	4,094	4,098	4,143	4,166	4,234	4,306	4,316	4,266	4,260	4,242	4,151	4,044	3,984	3,826	3,711	3,582	3,439	3,257	3,059	2,847	2,500
	Open Defecation Population	1,000person	1,300	661	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Site	**Facility Coverage Ratio**	%	1.7	4.5	7.2	9.8	12	15	17	20	21	20	22	24	27	30	33	38	41	43	42	43	44	45	47	50	53	56	58	61	64	66	69	71	72	74	76	78	79	79	80
	Adopted as Target of Facility Coverage Ratio	%	**2**	4	**7**	10	12	14	17	19	**20**	22	24	26	28	**30**	32	34	36	38	**40**	42	44	46	48	**50**	53	56	59	62	**65**	67	69	71	73	**75**	76	77	78	79	**80**
	Facility Coverage Population	1,000person	168	459	747	1,035	1,323	1,611	1,899	2,188	2,334	2,334	2,489	2,772	3,202	3,631	4,061	4,607	5,025	5,327	5,327	5,437	5,581	5,724	6,007	6,286	6,689	7,092	7,356	7,765	8,049	8,334	8,760	9,041	9,181	9,322	9,610	9,898	10,046	10,046	10,166
	Facility Capacity (daily average wastewater flow)	1,000m^3/day	34	92	149	207	265	322	380	438	467	467	498	554	640	726	812	921	1,005	1,065	1,065	1,087	1,116	1,145	1,201	1,257	1,338	1,418	1,471	1,553	1,610	1,667	1,752	1,808	1,836	1,864	1,922	1,980	2,009	2,009	2,033
	Facility Capacity (daily maximum wastewater flow)	1,000m^3/day	45	122	199	276	353	430	507	583	622	622	664	739	854	968	1,083	1,228	1,340	1,420	1,420	1,420	1,459	1,497	1,572	1,647	1,754	1,862	1,932	2,041	2,117	2,193	2,307	2,381	2,419	2,456	2,533	2,610	2,649	2,649	2,681
	Service Coverage Ratio	%	1.7	1.7	3.7	5.7	8	10	11	13	15	17	18	21	22	24	26	28	30	33	35	38	41	43	44	46	48	50	52	54	56	59	61	63	66	68	70	72	75	77	80
	Adopted as Target of Service Coverage Ratio	%	**2**	2	**4**	6	8	10	11	13	**15**	17	19	21	23	**25**	27	29	31	33	**35**	37	39	41	43	**45**	47	49	51	53	**55**	58	61	64	67	**70**	72	74	76	78	**80**
	Served Population for Off-Site	1,000person	168	171	387	603	820	1,036	1,252	1,469	1,685	1,902	2,118	2,438	2,612	2,884	3,156	3,429	3,778	4,128	4,478	4,860	5,132	5,420	5,609	5,775	6,025	6,345	6,579	6,814	7,130	7,447	7,685	8,028	8,300	8,572	8,844	9,145	9,445	9,745	10,166
	Wastewater Flow should be treated(daily average)	1,000m^3/day	34	34	77	121	164	207	250	294	337	380	424	488	522	577	631	686	756	826	896	950	1,004	1,062	1,100	1,133	1,183	1,247	1,294	1,341	1,404	1,467	1,515	1,584	1,638	1,692	1,747	1,807	1,867	1,927	2,011
	Wastewater Flow should be treated (daily maximum)	1,000m^3/day	45	45	103	161	219	276	334	392	449	507	565	650	697	769	842	914	1,008	1,101	1,194	1,267	1,339	1,416	1,466	1,511	1,577	1,663	1,725	1,788	1,872	1,957	2,020	2,111	2,184	2,257	2,329	2,409	2,489	2,569	2,681
On-Site	**On-site system Coverage Ratio**	%	85	92	96	94	92	90	89	87	85	83	82	79	78	76	74	72	70	67	65	62	59	57	56	54	52	50	48	46	44	41	39	37	34	32	30	28	25	23	20
	Adopted as Target of On-site system Coverage Ratio	%	**85**	92	**96**	94	92	90	89	87	**85**	83	81	79	77	**75**	73	71	69	67	**65**	63	61	59	57	**55**	53	51	49	47	**45**	42	39	36	33	**30**	28	26	24	22	**20**
	CST user ratio	%	83	83	81	78	75	72	69	66	64	60	57	53	51	47	44	41	38	35	32	29	27	24	22	20	18	16	14	13	11	9	8	6	5	4	3	2	1	1	0
	MST user ratio	%	2	8	15	16	17	18	19	20	21	23	25	26	27	28	30	31	31	32	32	32	33	33	33	34	34	34	34	33	33	32	31	30	29	28	27	26	24	22	20
	Upgrading Ratio CST to MST	%	2	9	16	17	19	20	22	23	25	28	30	33	35	38	40	43	45	48	50	53	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90	93	95	98	100
	On-site Served Population	1,000person	8,567	9,367	9,974	9,925	9,860	9,795	9,730	9,664	9,599	9,525	9,450	9,272	9,240	9,110	8,972	8,834	8,618	8,403	8,188	7,805	7,533	7,246	7,056	6,890	6,641	6,320	6,086	5,852	5,535	5,218	4,981	4,638	4,365	4,093	3,821	3,521	3,220	2,920	2,500
	CST Served Population	1,000person	8,366	8,502	8,425	8,227	8,017	7,810	7,604	7,401	7,199	6,905	6,615	6,259	6,006	5,694	5,383	5,079	4,740	4,412	4,094	3,708	3,390	3,079	2,822	2,584	2,324	2,054	1,826	1,609	1,384	1,174	996	812	655	512	382	264	161	73	0
	MST Served Population	1,000person	201	865	1,550	1,699	1,843	1,985	2,125	2,264	2,400	2,619	2,835	3,013	3,234	3,416	3,589	3,754	3,878	3,991	4,094	4,098	4,143	4,166	4,234	4,306	4,316	4,266	4,260	4,242	4,151	4,044	3,984	3,826	3,711	3,582	3,439	3,257	3,059	2,847	2,500
	Regular Desludging Ratio (CST & MST)	%	0	0	20	25	30	35	40	45	50	53	56	58	61	64	66	68	71	73	75	77	80	82	84	86	88	89	91	92	94	95	96	97	98	98	99	99	100	100	100
	Regular Desludging Ratio for CST	%	0	0	5	10	14	19	24	29	33	35	37	38	40	42	43	45	47	48	50	53	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90	93	95	98	100
	Regular Desludging Ratio for MST	%	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	Regular Desludging Population	1,000person	0	0	1,951	2,482	2,988	3,473	3,936	4,378	4,799	5,036	5,261	5,413	5,636	5,788	5,921	6,040	6,090	6,124	6,141	6,044	6,008	5,937	5,927	5,921	5,827	5,653	5,538	5,409	5,189	4,954	4,781	4,496	4,267	4,029	3,783	3,501	3,212	2,918	2,500
	Regular Desludging Population for CST	1,000person	0	0	401	784	1,145	1,488	1,810	2,114	2,400	2,417	2,426	2,399	2,402	2,372	2,333	2,286	2,212	2,132	2,047	1,946	1,864	1,771	1,693	1,615	1,511	1,386	1,278	1,167	1,038	910	797	670	557	448	344	244	153	71	0
	Regular Desludging Population for MST	1,000person	0	0	1,550	1,699	1,843	1,985	2,125	2,264	2,400	2,619	2,835	3,013	3,234	3,416	3,589	3,754	3,878	3,991	4,094	4,098	4,143	4,166	4,234	4,306	4,316	4,266	4,260	4,242	4,151	4,044	3,984	3,826	3,711	3,582	3,439	3,257	3,059	2,847	2,500
	Non-Regular(On-call) Desludging Population	1,000person	8,567	9,367	8,024	7,443	6,872	6,322	5,794	5,286	4,799	4,488	4,190	3,860	3,604	3,321	3,050	2,794	2,528	2,279	2,047	1,761	1,525	1,309	1,129	969	813	668	548	443	346	264	199	142	98	64	38	20	8	2	0
ITP	Incremental Population(Day-time Pop.-Administrative Pop.)	1,000person	3,345	3,399	3,454	3,510	3,560	3,610	3,661	3,711	3,761	3,809	3,856	3,903	3,951	3,998	4,043	4,087	4,132	4,177	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222	4,222
	Converted Ratio from ITP into Sewerage	%	0	0	2	4	6	9	11	13	15	17	19	21	23	25	27	29	31	33	35	39	42	45	48	52	55	58	61	64	68	71	74	77	81	84	87	90	94	97	100
	Converted Population from ITP into Sewerage	1,000person	0	0	74	150	228	308	390	475	562	647	733	822	913	1,005	1,099	1,195	1,292	1,391	1,493	1,629	1,765	1,902	2,038	2,175	2,311	2,448	2,584	2,721	2,857	2,994	3,130	3,267	3,403	3,539	3,676	3,812	3,949	4,085	4,222
	Population of ITP user	1,000person	3,345	3,399	3,380	3,360	3,332	3,302	3,270	3,236	3,200	3,162	3,123	3,081	3,038	2,993	2,944	2,893	2,840	2,786	2,729	2,593	2,456	2,320	2,183	2,047	1,910	1,774	1,638	1,501	1,365	1,228	1,092	955	819	682	546	409	273	136	0
	Introduction Ratio of appropriate O&M for ITP	%	0	0	10	12	13	15	17	18	20	23	26	29	32	35	38	41	44	47	50	53	55	58	60	63	65	68	70	73	75	78	80	83	85	88	90	93	95	98	100
	Introduction Population of appropriate O&M for ITP	1,000person	0	0	338	392	444	495	545	593	640	727	812	894	972	1,047	1,119	1,186	1,250	1,309	1,365	1,361	1,351	1,334	1,310	1,279	1,242	1,197	1,146	1,088	1,023	952	873	788	696	597	491	379	259	133	0
De-sludging amount	**Total de-sludging amount**	m3/day	257	281	1,385	1,564	1,735	1,902	2,063	2,219	2,370	2,569	2,763	2,930	3,118	3,279	3,430	3,572	3,687	3,792	3,887	3,858	3,842	3,806	3,782	3,752	3,683	3,578	3,485	3,377	3,229	3,065	2,915	2,713	2,522	2,317	2,099	1,856	1,600	1,331	1,000
	* De-sludging amount from CST	m3/day	257	281	307	354	397	438	475	511	544	537	530	516	508	495	480	465	444	424	403	377	356	334	316	298	276	251	229	208	183	160	139	116	96	77	58	41	26	12	0
	* De-sludging amount from CST by **regular de-sludging**	m3/day	0	0	67	131	191	248	302	352	400	403	404	400	400	395	389	381	369	355	341	324	311	295	282	269	252	231	213	194	173	152	133	112	93	75	57	41	25	12	0
	* De-sludging amount from CST by **On-call de-sludging**	m3/day	257	281	241	223	206	190	174	159	144	135	126	116	108	100	91	84	76	68	61	53	46	39	34	29	24	20	16	13	10	8	6	4	3	2	1	1	0	0	0
	* De-sludging amount from MST by regular de-sludging	m3/day	0	0	620	679	737	794	850	905	960	1,048	1,134	1,205	1,294	1,366	1,435	1,502	1,551	1,597	1,638	1,639	1,657	1,666	1,693	1,723	1,727	1,706	1,704	1,697	1,660	1,618	1,594	1,530	1,484	1,433	1,376	1,303	1,224	1,139	1,000
	* De-sludging amount from ITP	m3/day	0	0	457	530	601	670	738	803	866	984	1,099	1,209	1,316	1,418	1,514	1,605	1,691	1,772	1,847	1,842	1,828	1,805	1,773	1,731	1,681	1,621	1,551	1,473	1,385	1,288	1,182	1,067	942	808	665	512	351	180	0
Slum	**Open Defecation Ratio**	%	13	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Open Defecation Population	1,000person	1,300	661	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Water	River Water Quality(BOD)	mg/L	61	58	54	51	47	44	40	37	33	33	32	31	30	29	28	27	26	25	24	24	23	22	21	21	20	19	19	18	17	16	16	15	14	14	13	12	11	11	10

Note ; The number of Facility Coverage Population and Served Population for Off-Site after 2031 are added up the population in the reclamation area as 110,049.

Table S/R-D1-3 Treatment Capacity Allocation for On-site Sludge Treatment between STPs and WWTPs

Items	Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
De-sludging amount of sludge (should be treated)	m^3/day	**257**	**281**	**1,385**	**1,564**	**1,735**	**1,902**	**2,063**	**2,219**	**2,370**	**2,569**	**2,763**	**2,930**	**3,118**	**3,279**	**3,430**	**3,572**	**3,687**	**3,792**	**3,887**	**3,858**	**3,842**	**3,806**	**3,782**	**3,752**	**3,683**	**3,578**	**3,485**	**3,377**	**3,229**	**3,065**	**2,915**	**2,713**	**2,522**	**2,317**	**2,099**	**1,856**	**1,600**	**1,331**	**1,000**
Treatment Capacity Allocation between STPs and WWTPs																																								
Sludge amount treated by New On-site Sludge Treatment Plant(STP)	**m^3/day**	**0**	**0**	**0**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**
New STP in South area	m^3/day				600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
STP's capacity = 600 m^3/day	STP		*	*																																				
	Acceptance of sludge				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	O&M																																							
Sludge amount treated by Off-site WWTPs integrated with the function of existing On-site STPs	**m^3/day**	**257**	**281**	**957**	**729**	**822**	**912**	**1,000**	**1,085**	**1,166**	**1,275**	**1,380**	**1,697**	**1,561**	**1,377**	**1,455**	**1,528**	**1,587**	**1,641**	**1,690**	**1,675**	**1,667**	**1,648**	**1,636**	**1,620**	**1,585**	**1,531**	**1,483**	**1,428**	**1,351**	**1,267**	**1,190**	**1,086**	**988**	**883**	**771**	**646**	**514**	**376**	**206**
Duri Kosambi WWTP integrated with existing On-site STP (WWTP site No. 6 / Zone 6)	m^3/day	128	140	507	279	372	462	550	635	716	825	930	752	692	611	645	677	704	728	749	743	739	731	725	718	703	679	658	633	599	562	528	482	438	391	342	286	228	167	91
WWTP wastewater flow(average)= 235,000 m3/day	WWTP		*	*	*	*																																		
STP's capacity = 930 m^3/day	Acceptance of sludge	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M																																							
Pulo Gebang WWTP expanded and integrated with existing On-site STP (WWTP site No. 10 / Zone 10)	m^3/day	128	140	450	450	450	450	450	450	450	450	450	944	869	767	810	850	883	913	940	932	928	917	911	902	882	852	825	795	752	705	662	605	550	491	429	360	286	209	114
WWTP wastewater flow(average)= 295,000 m3/day	STP(expanded)		*																																				
STP's capacity =(2014 - 2022) 450 m^3/day (2023 - 2050) 940 m^3/day	WWTP										*	*	*	*																										
	Acceptance of sludge	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M																																							
Sludge amount treated by Off-site WWTPs(The function of STPs has been integrated with WWTPs)	**m^3/day**	**0**	**0**	**427**	**235**	**313**	**390**	**463**	**535**	**604**	**695**	**783**	**634**	**957**	**1,302**	**1,375**	**1,444**	**1,500**	**1,551**	**1,597**	**1,583**	**1,575**	**1,558**	**1,546**	**1,532**	**1,498**	**1,447**	**1,402**	**1,350**	**1,277**	**1,198**	**1,125**	**1,027**	**934**	**834**	**728**	**611**	**486**	**355**	**194**
Pejagalan WWTP (site No. 2 / Zone 1)	m^3/day			427	235	313	390	463	535	604	695	783	634	583	514	543	571	593	613	631	626	623	616	611	605	592	572	554	533	505	473	444	406	369	330	288	241	192	140	77
WWTP wastewater flow(average)= 198,000 m3/day	WWTP		*	*	*																																			
STP's capacity = 790 m^3/day	Acceptance of sludge			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M																																							
Sunter Pond WWTP (site No. 5 / Zone 5)	m^3/day													374	330	349	366	380	393	405	401	399	395	392	388	380	367	355	342	324	304	285	260	237	212	185	155	123	90	49
WWTP wastewater flow(average)= 127,000 m3/day	WWTP											*	*																											
STP's capacity = 410 m^3/day	Acceptance of sludge													+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M																																							
Marunda WWTP (site No. 8 / Zone 8)	m^3/day														457	483	507	527	545	561	556	553	547	543	538	526	508	492	474	449	421	395	361	328	293	256	214	171	125	68
WWTP wastewater flow(average)= 176,000 m3/day	WWTP												*	*	*																									
STP's capacity = 570 m^3/day	Acceptance of sludge														+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M																																							
Total	m^3/day	**257**	**281**	**1,385**	**1,564**	**1,735**	**1,902**	**2,063**	**2,219**	**2,370**	**2,569**	**2,763**	**2,930**	**3,118**	**3,279**	**3,430**	**3,572**	**3,687**	**3,792**	**3,887**	**3,858**	**3,842**	**3,806**	**3,782**	**3,752**	**3,683**	**3,578**	**3,485**	**3,377**	**3,229**	**3,065**	**2,915**	**2,713**	**2,522**	**2,317**	**2,099**	**1,856**	**1,600**	**1,331**	**1,000**

Remarks : * ; Construction + ; Acceptance of sludge into WWTP or STP ▪▪▪▪▪ ; O&M of WWTP or STP

D4 Mass Balance of Wastewater

Table S/R-D4-1 Current Removal Rate for BOD and SS

Classification	Category	Type of wastewater	Day-time Population	BOD		SS			
				Removal Rate for BOD	Effluent Rate for BOD	Removal Rate for SS			Effluent Rate for SS
			person*10^3	(Decomposition Rate)			Decomposition Rate	Sedimentation Rate	
Off-site	Sewerage	B & G water	168	62.5%	37.5%	62.5%	15.6%	46.9%	37.5%
	ITP	B & G water	3,345	62.5%	37.5%	62.5%	15.6%	46.9%	37.5%
On-site	Septic Tank	Black water	8,567	40%	60%	42.4%	40.0%	2.4%	57.6%
		Grey water		0%	100%	0%	0%	0%	100%
	Slum	B & G water	1,300	0%	100%	0%	0%	0%	100%

Notes:

* Sedimentation rate for SS of Septic Tank is based on Actual transportation amount of current Sludge Treatment Plants.

Actual transportation amount(2010) : 93,769 m^3/year (liquid based) = 256 m^3/day (Liquid based) = 2.6 t/day (Dry based; sludge concentration=1%)
Sedimentation rare for SS of Septic Tank : 2.6 t/day / Generated amount of Septic Tank 104.1 t/day = 2.5 %

Table S/R-D4-2 Basic Unit for Calculation of Mass Balance

Setting the Basic Unit of generated pollution load

Items		Total		Black water		Grey water	
		g	mg/L	g	mg/L	g	mg/L
The amount of wastewater (per person per day)	(LCD)	150		25		125	
The amount of water quality (per person per day)	BOD	30	200	12.5	500	17.5	140
	SS	30	200	12.5	500	17.5	140
	N	5.25	35	4.5	180	0.75	6
	P	1.2	8	0.625	25	0.575	4.6

List of Basic Unit for Calculation of Mass Balance

Classification	Category	Case	Type of wastewater	BOD					SS								
				Rate		Load			Rate				Load				
				Removal Rate for BOD	Effluent Rate for BOD	Generated load	Removal load	Effluent load	Removal Rate for SS			Effluent Rate for SS	Generated load	Removal load			Effluent load
										Decomposition Rate	Sedimentation Rate				Decomposition	Sedimentation	
				%	%	g/day・per	g/day・per	g/day・per	%	%	%	%	g/day・per	g/day・per	g/day・per	g/day・per	g/day・per
Off-site	Sewerage	①Current	B & G water	62.5%	37.5%	30	18.8	11.3	62.5%	15.6%	46.9%	37.5%	30	18.8	4.7	14.1	11.3
		②After coutermeasures : Establish new WWTP	B & G water	90.0%	10.0%	30	27.0	3.0	90.0%	22.5%	67.5%	10.0%	30	27.0	6.8	20.3	3.0
	ITP	①Current	B & G water	62.5%	37.5%	30	18.8	11.3	62.5%	15.6%	46.9%	37.5%	30	18.8	4.7	14.1	11.3
		②After coutermeasures : Improvement of O & M	B & G water	90.0%	10.0%	30	27.0	3.0	90.0%	22.5%	67.5%	10.0%	30	27.0	6.8	20.3	3.0
On-site	Septic Tank	①Current	Black water	40%	60%	12.5	5.0	7.5	42%	40%	2.4%	58%	12.5	5.3	5.0	0.3	7.2
			Grey water	0%	100%	17.5	0.0	17.5	0%	0%	0%	100%	17.5	0.0	0.0	0.0	17.5
		②After coutermeasures : Introduction of Regular Desludging	Black water	60%	40%	12.5	7.5	5.0	60%	40%	20%	40%	12.5	7.5	5.0	2.5	5.0
			Grey water	0%	100%	17.5	0.0	17.5	0%	0%	0%	100%	17.5	0.0	0.0	0.0	17.5
		③After coutermeasures : Change CST to MST	Black water	50%	50%	12.5	6.3	6.3	50%	30%	20%	50%	12.5	6.3	3.8	2.5	6.3
			Grey water	50%	50%	17.5	8.8	8.8	50%	30%	20%	50%	17.5	8.8	5.3	3.5	8.8
	Slum	①Current	B & G water	0%	100%	30	0.0	30.0	0%	0%	0%	100%	30	0.0	0.0	0.0	30.0
		②Establish MST	B & G water	50%	50%	30	15.0	15.0	50%	30%	20%	30%	30	15.0	9.0	6.0	9.0

Table S/R-D4-3 Calculation of Mass Balance for Wastewater (1/2)

∗ **①Current(2012)**

Classification	Category	Type of wastewater	Population		BOD			SS				
			Actual	Virtual	Generated amount	Removal amount	Discharged amount	Generated amount	Removal amount			Discharged amount
										Decomposition amount	Desludging amount	
			person*10^3	person*10^3	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/day
Off-site	Sewerage	B & G water	168	168	5.0	3.1	1.9	5.0	3.1	0.8	2.4	1.9
			(1%)	(1%)	(1.1%)	(0.7%)	(0.4%)	(1%)	(0.7%)	(0.2%)	(0.5%)	(0.4%)
	ITP	B & G water	-	3,345	100.3	62.7	37.6	100.3	62.7	15.7	47.0	37.6
				(22%)	(22.2%)	(13.9%)	(8.3%)	(22.2%)	(13.9%)	(3.5%)	(10.4%)	(8.3%)
On-site	Septic Tank	Black water			107.1	42.8	64.3	107.1	45.4	42.8	2.6	61.7
			8,567	8,567	(23.7%)	(9.5%)	(14.2%)	(23.7%)	(10.1%)	(9.5%)	(0.6%)	(13.7%)
		Grey water			149.9	0.0	149.9	149.9	0.0	0.0	0.0	149.9
			(76%)	(57%)	(33.2%)	(0.0%)	(33.2%)	(33.2%)	(0.0%)	(0.0%)	(0.0%)	(33.2%)
	Slum	B & G water	1,300	1,300	39.0	0.0	39.0	39.0	0.0	0.0	0.0	39.0
			(12%)	(9%)	(8.6%)	(0.0%)	(8.6%)	(8.6%)	(0.0%)	(0.0%)	(0.0%)	(8.6%)
		total	10,035	13,379	401.4	108.7	**292.7**	401.4	111.3	59.3	**52.0**	**290.1**
			(100.%)	(100.%)	(100%)	(27%)	(73%)	(100%)	(28%)	(15%)	(13%)	(72%)

∗ **②Short-term（2020）**

Classification	Category	Type of wastewater	Population		BOD			SS				
			Actual	Virtual	Generated amount	Removal amount	Discharged amount	Generated amount	Removal amount			Discharged amount
										Decomposition amount	Desludging amount	
			person*10^3	person*10^3	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/day
Off-site	Sewerage	B & G water	1,685	1,685	50.6	45.5	5.1	50.6	45.5	11.4	34.1	5.1
			(15%)	(11%)	(11.2%)	(10.1%)	(1.1%)	(11%)	(10.1%)	(2.5%)	(7.6%)	(1.1%)
	ITP	B & G water	-	3,761	112.8	101.6	11.3	112.8	101.6	25.4	76.2	11.3
				(25%)	(25.0%)	(22.5%)	(2.5%)	(25.0%)	(22.5%)	(5.6%)	(16.9%)	(2.5%)
On-site	Septic Tank	Black water			60.0	24.0	36.0	60.0	25.4	24.0	1.4	34.6
	①still CST		4,799	4,799	(13.3%)	(5.3%)	(8.0%)	(13.3%)	(5.6%)	(5.3%)	(0.3%)	(7.7%)
	ratio=50%	Grey water			84.0	0.0	84.0	84.0	0	0.0	0.0	84.0
			(43%)	(32%)	(18.6%)	(0.0%)	(18.6%)	(18.6%)	(0.0%)	(0.0%)	(0.0%)	(18.6%)
	②Regular Desl	Black water			30.0	18.0	12.0	30.0	18.0	12.0	6.0	12.0
			2,400	2,400	(6.6%)	(4.0%)	(2.7%)	(6.6%)	(4.0%)	(2.7%)	(1.3%)	(2.7%)
	ratio=25%	Grey water			42.0	0.0	42.0	42.0	0	0.0	0.0	42.0
			(21%)	(16%)	(9.3%)	(0.0%)	(9.3%)	(9.3%)	(0.0%)	(0.0%)	(0.0%)	(9.3%)
	③CST→MST	Black water			30.0	15.0	15.0	30.0	15.0	9.0	6.0	15.0
			2,400	2,400	(6.6%)	(3.3%)	(3.3%)	(6.6%)	(3.3%)	(2.0%)	(1.3%)	(3.3%)
	ratio=25%	Grey water			42.0	21.0	21.0	42.0	21.0	12.6	8.4	21.0
			(21%)	(16%)	(9.3%)	(4.7%)	(4.7%)	(9.3%)	(4.7%)	(2.8%)	(1.9%)	(4.7%)
	Slum	B & G water	0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
			(%)	(%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)
		total	11,284	15,046	451.4	225.0	**226.3**	451.4	226.5	94.4	**132.1**	**224.9**
			(100.%)	(100.%)	(100%)	(50%)	(50%)	(100%)	(50%)	(21%)	(29%)	(50%)

Table S/R-D4-3 Calculation of Mass Balance for Wastewater (2/2)

∗ **③Medium-term(2030)**

Classification	Category	Type of wastewater	Population		BOD			SS				
			Actual	Virtual	Generated amount	Removal amount	Discharged amount	Generated amount	Removal amount			Discharged amount
										Decomposition amount	Desludging amount	
			person*10^3	person*10^3	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/day
Off-site	Sewerage	B & G water	4,478	4,478	134.3	120.9	13.4	134.3	120.9	30.2	90.7	13.4
			(35%)	(27%)	(27%)	(24%)	(3%)	(27%)	(24%)	(6%)	(18%)	(3%)
	ITP	B & G water	-	4,222	126.7	114.0	12.7	126.7	114.0	28.5	85.5	12.7
				(25%)	(25%)	(23%)	(3%)	(25%)	(23%)	(6%)	(17%)	(3%)
On-site	Septic Tank	Black water			25.6	10.2	15.4	25.6	10.8	10.2	0.6	14.7
	①still CST		2,047	2,047	(5%)	(2%)	(3%)	(5%)	(2%)	(2%)	(0%)	(3%)
	ratio=25%	Grey water			35.8	0.0	35.8	35.8	0	0.0	0.0	35.8
			(16%)	(12%)	(7%)	(0%)	(7%)	(7%)	(0%)	(0%)	(0%)	(7%)
	②Regular Desl	Black water			25.6	15.4	10.2	25.6	15.4	10.2	5.1	10.2
			2,047	2,047	(5%)	(3%)	(2%)	(5%)	(3%)	(2%)	(1%)	(2%)
	ratio=25%	Grey water			35.8	0.0	35.8	35.8	0	0.0	0.0	35.8
			(16%)	(12%)	(7%)	(0%)	(7%)	(7%)	(0%)	(0%)	(0%)	(7%)
	③CST→MST	Black water			51.2	25.6	25.6	51.2	25.6	15.4	10.2	25.6
			4,094	4,094	(10%)	(5%)	(5%)	(10%)	(5%)	(3%)	(2%)	(5%)
	ratio=50%	Grey water			71.6	35.8	35.8	71.6	35.8	21.5	14.3	35.8
			(32%)	(24%)	(14%)	(7%)	(7%)	(14%)	(7%)	(4%)	(3%)	(7%)
	Slum	B & G water	0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
			(%)	(%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
		total	12,665	16,887	506.6	321.9	**184.7**	506.6	322.5	116.0	**206.5**	**184.1**
			(100.%)	(100.%)	(100%)	(64%)	(36%)	(100%)	(64%)	(23%)	(41%)	(36%)

∗ **④Long-term(2050)**

Classification	Category	Type of wastewater	Population		BOD			SS				
			Actual	Virtual	Generated amount	Removal amount	Discharged amount	Generated amount	Removal amount			Discharged amount
										Decomposition amount	Desludging amount	
			person*10^3	person*10^3	t/day	t/day	t/day	t/day	t/day	t/day	t/day	t/day
Off-site	Sewerage	B & G water	10,166	10,166	305.0	274.5	30.5	305.0	274.5	68.6	205.9	30.5
			(80%)	(60%)	(60%)	(54%)	(6%)	(60%)	(54%)	(14%)	(41%)	(6%)
	ITP	B & G water	-	4,222	126.7	114.0	12.7	126.7	114.0	28.5	85.5	12.7
				(25.%)	(25%)	(23%)	(3%)	(25%)	(23%)	(6%)	(17%)	(3%)
On-site	Septic Tank	Black water			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	①still CST		0	0	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
	ratio=0%	Grey water			0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
			(.%)	(.%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
	②Regular Desl	Black water			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0	0	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
	ratio=0%	Grey water			0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	(Already change MST)		(.%)	(.%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
	③CST→MST	Black water			31.2	15.6	15.6	31.2	15.6	9.4	6.2	15.6
			2,500	2,500	(6%)	(3%)	(3%)	(6%)	(3%)	(2%)	(1%)	(3%)
	ratio=100%	Grey water			43.7	21.9	21.9	43.7	21.9	13.1	8.7	21.9
			(19.7%)	(14.8%)	(9%)	(4%)	(4%)	(9%)	(4%)	(3%)	(2%)	(4%)
	Slum	B & G water	0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
			(.%)	(.%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
		total	12,665	16,887	506.6	426.0	**80.7**	506.6	426.0	119.6	**306.3**	**80.7**
			(100.%)	(100.%)	(100%)	(84%)	(16%)	(100%)	(84%)	(24%)	(60%)	(16%)

Table S/R-D4-4 Unit Amount of Desludging Sludge

Category		Type of wastewater	Generated sludge(Influent)		De-sludging sludge				
			Wastewater quality	Generated load	Sedimentation Rate for SS	De-sludging sludge load	Sludge consetration ratio	Unit amount of de-sludging sludge	
			(mg/L)	(g/day・per)	(%)	(g/day・per)	(%)	(g/day・per)	(m3/day・per)
Septic Tank	CST	Black water	500	12.5	20%	2.5	1.5	167	**0.000167**
	MST	B & G water	200	30.0	20%	6.0	1.5	400	**0.000400**
ITP		B & G water	200	30.0	67.5%	20.3	1.5	1,353	**0.001353**

D5 Introduction of Regular Desludging

D5.2 Prior Examples of Regular Desludging Systems

D5.2.4 IWK's Regular Desludging

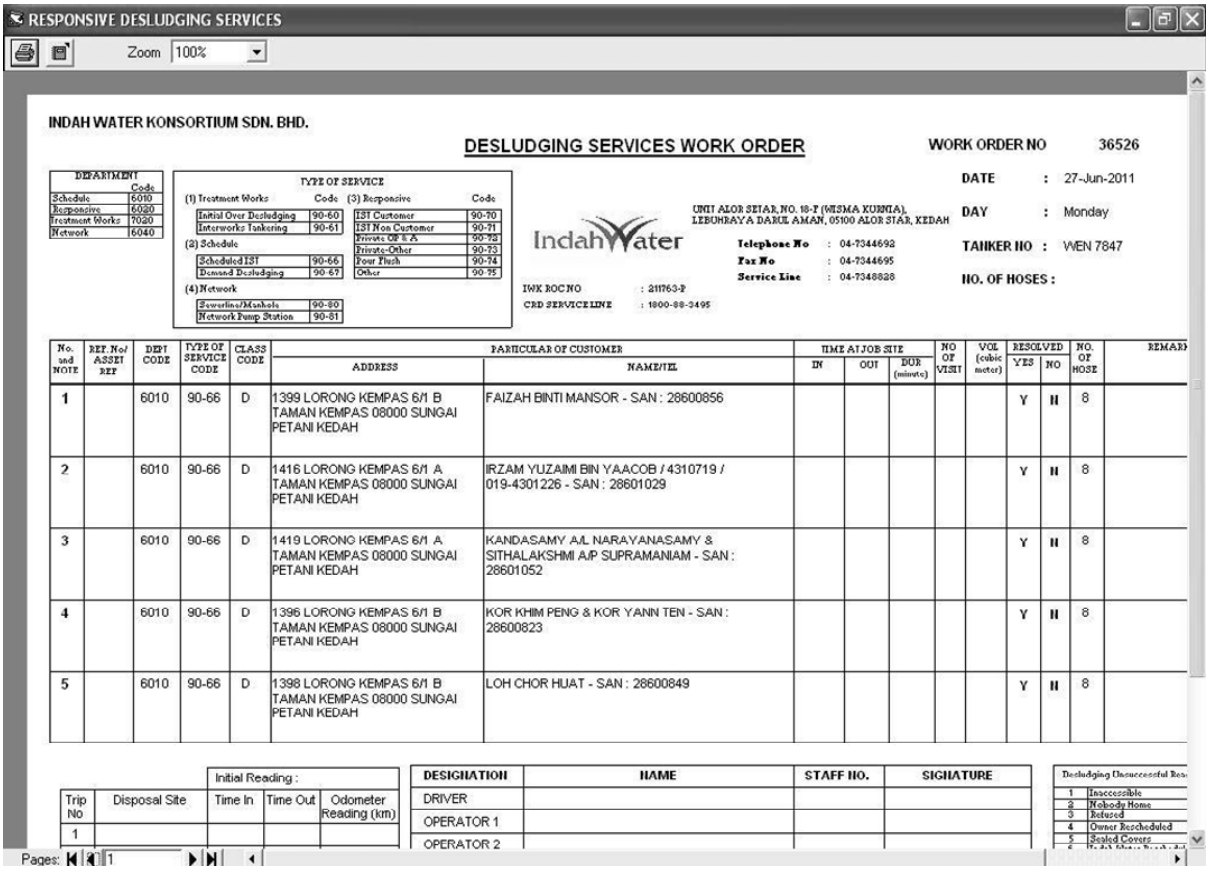
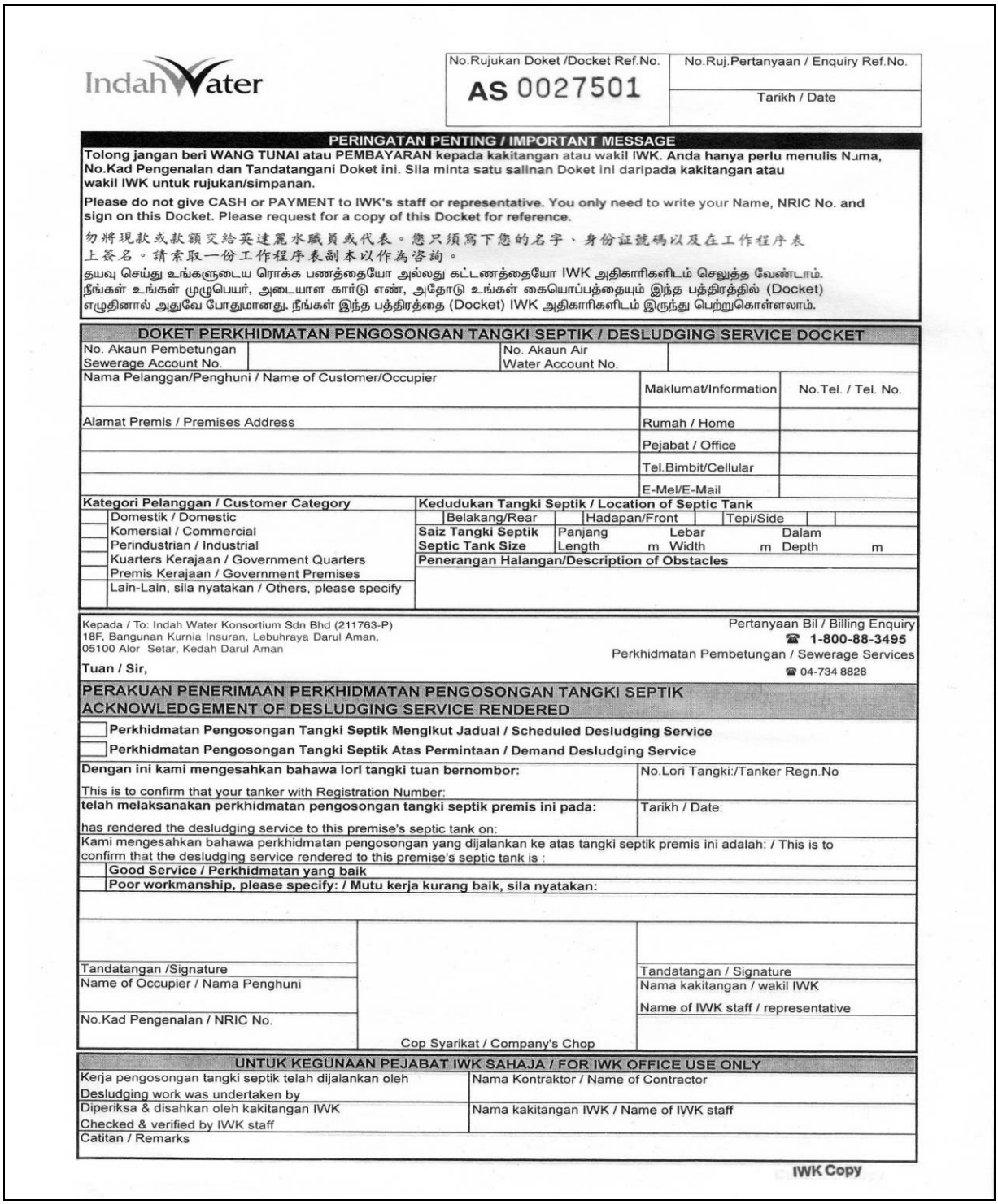


Figure S/R-D5-1 Desludging Services Work Order



IndahWater

No.Rujukan Doket /Docket Ref.No.	No.Ruj.Pertanyaan / Enquiry Ref.No.
AS 0027501	Tarikh / Date

PERINGATAN PENTING / IMPORTANT MESSAGE

Tolong jangan beri WANG TUNAI atau PEMBAYARAN kepada kakitangan atau wakil IWK. Anda hanya perlu menulis Nama, No.Kad Pengenalan dan Tandatangani Doket ini. Sila minta satu salinan Doket ini daripada kakitangan atau wakil IWK untuk rujukan/simpanan.

Please do not give CASH or PAYMENT to IWK's staff or representative. You only need to write your Name, NRIC No. and sign on this Docket. Please request for a copy of this Docket for reference.

勿將現款或款額交給英達麗水職員或代表。您只須寫下您的名字、身份証號碼以及在工作程序表上簽名。請索取一份工作程序表副本以作為咨詢。

தயவு செய்து உங்களுடைய ரொக்க பணத்தையோ அல்லது கட்டணத்தையோ IWK அதிகாரிகளிடம் செலுத்த வேண்டாம். நீங்கள் உங்கள் முழுபெயர், அடையாள கார்டு எண், அதோடு உங்கள் கையொப்பத்தையும் இந்த பத்திரத்தில் (Docket) எழுதினால் அதுவே போதுமானது. நீங்கள் இந்த பத்திரத்தை (Docket) IWK அதிகாரிகளிடம் இருந்து பெற்றுகொள்ளலாம்.

DOKET PERKHIDMATAN PENGOSONGAN TANGKI SEPTIK / DESLUDGING SERVICE DOCKET

No. Akaun Pembetungan Sewerage Account No.		No. Akaun Air Water Account No.	

Nama Pelanggan/Penghuni / Name of Customer/Occupier	Maklumat/Information	No.Tel. / Tel. No.
Alamat Premis / Premises Address	Rumah / Home	
	Pejabat / Office	
	Tel.Bimbit/Cellular	
	E-Mel/E-Mail	

Kategori Pelanggan / Customer Category	Kedudukan Tangki Septik / Location of Septic Tank
☐ Domestik / Domestic	☐ Belakang/Rear ☐ Hadapan/Front ☐ Tepi/Side ☐
☐ Komersial / Commercial	**Saiz Tangki Septik / Septic Tank Size** Panjang / Length m Lebar / Width m Dalam / Depth m
☐ Perindustrian / Industrial	
☐ Kuarters Kerajaan / Government Quarters	**Penerangan Halangan/Description of Obstacles**
☐ Premis Kerajaan / Government Premises	
☐ Lain-Lain, sila nyatakan / Others, please specify	

Kepada / To: Indah Water Konsortium Sdn Bhd (211763-P)
18F, Bangunan Kurnia Insuran, Lebuhraya Darul Aman,
05100 Alor Setar, Kedah Darul Aman

Pertanyaan Bil / Billing Enquiry
☎ 1-800-88-3495
Perkhidmatan Pembetungan / Sewerage Services
☎ 04-734 8828

Tuan / Sir,

PERAKUAN PENERIMAAN PERKHIDMATAN PENGOSONGAN TANGKI SEPTIK
ACKNOWLEDGEMENT OF DESLUDGING SERVICE RENDERED

☐ **Perkhidmatan Pengosongan Tangki Septik Mengikut Jadual / Scheduled Desludging Service**

☐ **Perkhidmatan Pengosongan Tangki Septik Atas Permintaan / Demand Desludging Service**

Dengan ini kami mengesahkan bahawa lori tangki tuan bernombor: This is to confirm that your tanker with Registration Number:	No.Lori Tangki:/Tanker Regn.No
telah melaksanakan perkhidmatan pengosongan tangki septik premis ini pada: has rendered the desludging service to this premise's septic tank on:	Tarikh / Date:

Kami mengesahkan bahawa perkhidmatan pengosongan yang dijalankan ke atas tangki septik premis ini adalah: / This is to confirm that the desludging service rendered to this premise's septic tank is :

☐ **Good Service / Perkhidmatan yang baik**

☐ **Poor workmanship, please specify: / Mutu kerja kurang baik, sila nyatakan:**

Tandatangan /Signature		Tandatangan / Signature
Name of Occupier / Nama Penghuni		Nama kakitangan / wakil IWK Name of IWK staff / representative
No.Kad Pengenalan / NRIC No.	Cop Syarikat / Company's Chop	

UNTUK KEGUNAAN PEJABAT IWK SAHAJA / FOR IWK OFFICE USE ONLY

Kerja pengosongan tangki septik telah dijalankan oleh Desludging work was undertaken by	Nama Kontraktor / Name of Contractor
Diperiksa & disahkan oleh kakitangan IWK Checked & verified by IWK staff	Nama kakitangan IWK / Name of IWK staff
Catitan / Remarks	

IWK Copy

Figure S/R-D5-2 Customer Desludging Certificate

IndahWater
Syarikat Pembetungan Nasional Anda
Your National Sewerage Company

FORM A – Customer Evaluation of Desludging Services Provided

Customer Particulars : Name (optional) : ……...

Premises address : ……....

……

Contact No : …….

Date of Deslusging Provided : ……..

Desludging Done by : ☐ IWK staffs
☐ IWK appointed contractor

Dear Sir / Madam,

We have recently provided septic tank desludging services to your premises and as part of our attempt to further improve IWK services to its customers, we would like to know your opinion of the desludging services provided to you. We would also be pleased to have your comments on improvements to desludging services that you would like to see.

We would appreciate it very much if you could spare a few minutes of your valuable time in filling up this evaluation form and returning it to IWK staff or return it to us at a later date. Any comments you give will be treated in the strictest confidential.

We thank you for your cooperation.

Please response to the following questionnaires by tick one of the box for each subject

	Questionnaires	Yes	Satisfactory	No
1	Were you satisfied that your septic tank was desludged properly ?			
2	Were the operators on time as promised or scheduled ?			
3	Was the work place left clean after the desludging work completed ?			
4	Were the operators polite and courteous ?			
5	Were the operators dressed properly ?			
6	Did the operators appear neatly dressed and clean ?			
7	Do you have any other suggestions or comments to further improve IWK desludging services :			

Figure S/R-D5-3 Customer Evaluation of Desludging Services Provided

FORM B – Supervisor's Evaluation of Desludging Services Provided

Customer Particulars : Name (optional) : ……

Premises address : …….

……

Contact No : …….

Date of Deslusging Provided : ……..

Desludging Done by : ☐ IWK team, Driver : …….

☐ IWK appointed contractor, Name : …….

Please complete the following checklist by tick one of the box for each subject

	Checklist	Yes	Satisfactory	No
1	Was the septic tank desludged properly / empty completely ?			
2	Was the desludging services done on the scheduled / appointment date and time ?			
3	Was the work place left clean after the desludging work completed ?			
4	Were the operators polite and courteous to the customer ?			
5	Were there any suggestions or comments from the customer to improve IWK desludging services :			
7	General comments :			

Signature of Supervisor : ……

Name of Supervisor : ……..

Date of inspection : …….

Figure S/R-D5-4 Supervisor's Evaluation of Desludging Services Provided

Training Program For Desludging Services Personnel

Training program and refresher courses should be provided to all the desludging services personnel in all aspects of the customer–IWK interface, as part of the efforts to :

- Improve communication techniques, courtesy and etiquette when approaching and talking to customers;
- Enhance the image of IWK that is projected by the desludging crew at customer's premises;
- Brief on follow up action that would be taken to assess level of customer satisfaction;
- Provide a feedback on customer perception and expectation of quality desludging services provided by IWK.

The following desludging services personnel shall undergo the training :

- Head of Section
- Supervisor of both IWK staff and the appointed desludging contractor
- Field Surveyor
- Desludging crew comprising the Tanker Driver and Operator of both IWK staff and the appointed desludging contractor

The Unit Manager and Head of Section should ensure that all desludging services personnel from both IWK staff and also from appointed desludging contractors are given sufficient training and coaching in order for them to carry out the desludging services efficiently and safely whilst potraying a good image of IWK at all times. The training program shall be carried out before the personnel are assigned to carry out the desludging services. The follow up refresher training courses also to be organised as part of improvement program.

The training program should include but not limited to the following topics :

(a) How to greet the customer and communicate with them, tone and voice level etc.;

(b) Personal appearance and grooming, use of proper dressing and name tag;

(c) Behaviour at work site;

(d) The concept of operator is the representative of IWK to serve the customer;

(e) The concept of "customer is always right" and what to do under any possible situation at site;

(f) Honesty at work and giving the customer the best service possible;

(g) Assessing customer satisfaction level through surveys and general feedback;

(h) The extent of IWK obligations to carry out desludging services to septic tanks;

(i) Operation of desludging tanker and equipment on board the vehicle;

(j) Maintenance of desludging tanker, equipment and vehicle;

(k) Cleanliness of vehicle, tools and equipment and image of IWK;

(l) Safety at work site, confined space entry, personal hygiene and cleanliness;

(m) Responsibility to have the covers open, clearing of blockage at private sewer lines, inspection chambers, damage to cover, septic tank etc.

(n) How to entertain customers request on additional services which are not part of IWK desludging services;

(o) Consequences of neglect of duty, willfully wrong reporting, soliciting or receiving money for service provided, bringing disrepute to the good name of IWK, improper disposal of tankered sludge to unauthorised site etc;

(p) What to do when access denied, nobody at home etc.

(q) Confirmation, verification and acknowledge by the customer upon desludging services being provided.

(r) Responsive desludging services and charging tariff/rates and payment mechanism.

Figure S/R-D5-5 Training Program For Desludging Services Personnel

Our Reference :

Date :

WITHOUT THE SUPPOSITION

Owner / Resident,

Sir,

Per : Problem / Damage to septic tanks on the premises
No.

Refer to a matter that mentioned above, would like to inform that according to our records, the de-sludging services on the premises has been done in …… ago.

For your information, we will only provide de-sludging services once every two years. Therefore, it is advised to ensure the tank can operate well and perfect with the following provisions :

a. Septic tank have an appropriate size and capacity
b. Hane an effluent pipe that not blocked (good condition)
c. Have an appropriate effluent pipe
d. Have a filter layer (filter media) that is not blocked
e. Ensure that the drain water does not enter back into septictank
f. Have a effluent pump that can work and appropriate
g. Fat and oil are not routed into the septic tank

Regarding to a matter that mentioned above, you are requested to take the steps as above to ensure that septic tank can be functional and can be used with care.

Thank you.

The signature,

Unit Manager,

Indah Water Konsortium Sdn. Bhd.

s.k Regional Director,

National Water Service Commision,

Figure S/R-D5-6 Problem of Damage to Septic Tanks on the Premises

D7 Layout Plan and Facility Plan for Off-Site System (Sewerage)

D7.1 Proposed Plans

D7.1.1 Proposed Plans for Sewer Network

(1) Outline of Sewer Network

14 candidate sites for WWTP to be secured were selected as mentioned in "D2 Proposed Sewerage Zones". To verify its feasibility, 4 cases were examined and compared with other 3 alternatives.

- Case-1: Proposed 2 large-scale sewerage zones
- Case-2: Proposed 3 large-scale sewerage zones
- Case-3: Proposed 6 medum-scale sewerage zones
- Case-4: Proposed 14 small-scale sewerage zones determined based on the location of WWTP sites (proposed in the New M/P)

Since land acquisition of WWTP sites has become one of the major problems in DKI, alternative proposals have been prepared focusing on the lands among the 14 sites where relatively big areas can be secured with a reference of current land use plan and future land use plan.

Table S/R-D7-1 Required Land Area for WWTP Sites in Each Case

Sewerage Plant Site		Minimum Required Area (ha)				Space for Expansion	Current Conditions	
		Case-1	Case-2	Case-3	Case-4		2011	2030
1	Setiabudi Pond	(Sewerage expansion project is on-going)				—	—	—
2	Pejagalan	—	—	—	6.9	×	Park	Park
3	Muara Angke	—	—	—	0.8	×	Open space	Open space
4	Srengseng City Forest Park	—	—	—	4.0	△	Park	Park
5	Sunter Pond	—	—	15.0	4.6	△	Open space	Green area
6	STP Duri Kosambi	—	—	12.2	8.2	△	Green area	Green area
7	Kamal - Pegadungan	35.8	23.8	11.6	3.9	◎	Green area	Green area
8	Marunda	33.3	24.0	9.0	6.0	◎	Pond	Green area
9	Rorotan	—	—	—	2.9	○	Green area	Pond
10	STP Pulo Gebang	—	—	—	10.3	×	Green area	Green area
11	Bendi Park	—	—	—	3.0	×	Park	Park
12	Waduk Ulujami	—	—	12.0	5.9	△	Pond	Pond
13	Ragunan Land	—	—	—	3.1	×	Park	Park
14	Waduk Kp. Dukuh	—	21.4	9.4	5.7	○	Pond	Pond
15	Waduk Ceger RW 05	—	—	—	3.6	△	Pond	Pond
Total		69.1	69.2	69.2	68.9			

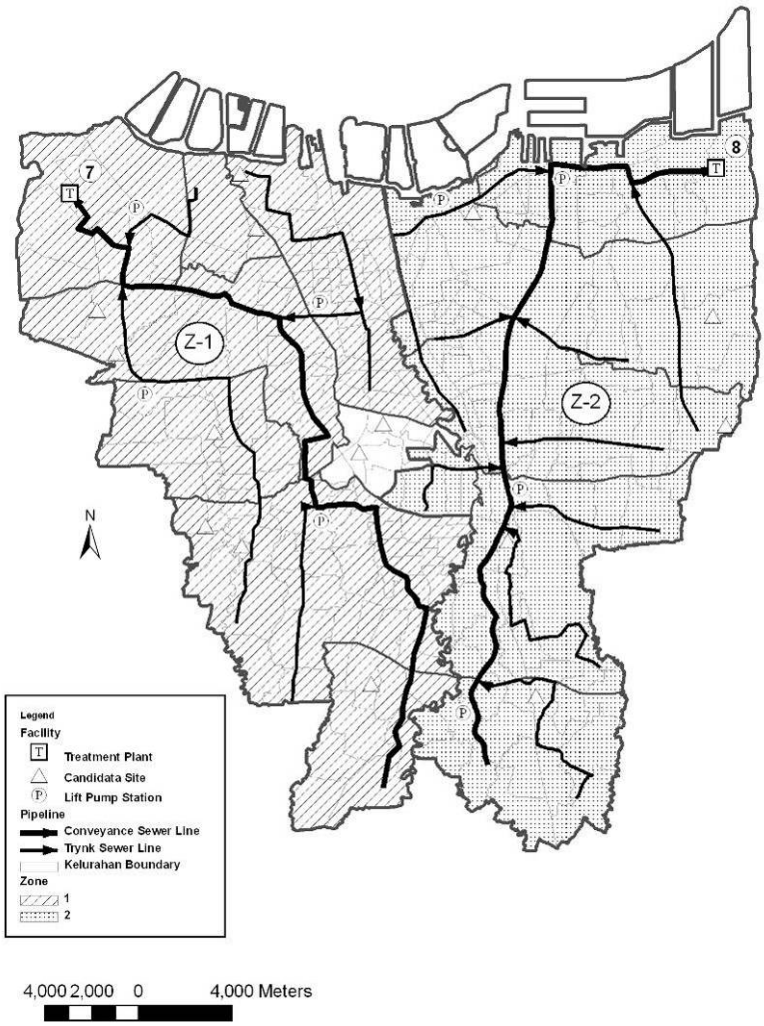
Note : Space for expansion at the proposed site : ◎Enough、○Moderate、△Few、×No space
Source: JICA Expert Team

(2) Proposed 2 Large-Scale Sewerage Zones (Case-1)

This is a proposal to divide into 2 large-sale sewerage zones from east to west of DKI Jakarta and WWTPs are planned at Kamal-Pegadungan in the north-west and Marunda in the north-west. Facility plan and main sewer facilities are shown in Figure S/R-D7-1.

This plan will cost much because maximum diameter of trunk sewer becomes 3,800mm, pipe jacking will not be applied (usually up 3,000mm) and relay pumping station are needed.

Also, since the high prioritized areas become far from WWTP, it will take much time to construct the pipe installation work and accordingly the initial investment becomes high. Moreover, it is needed to secure a large land as one WWTP site and it is expected to be more difficult for land acquisition.



Item	Sewerage Zone No.1	Sewerage Zone No.2
Population	6,399,604 PE	5,943,764 PE
Area	31,598 ha	31,590 ha
Candidate Sites	Kamal - Pegadungan	Marunda
Minimum Area	35.8 ha	33.3 ha
Land Acquisition	Green area, open space exists neaby	Green area, open space
Extension of Trunk Sewer	95 km	84 km
Maximum Pipe Diameter	ϕ 3,800 mm	ϕ 3,800 mm
Relay Pumping Station	300m^3/min : 2point	300m^3/min : 2point

Figure S/R-D7-1 Proposed 2 Large-Scale Sewerage Zones (Case-1) - Schematic Diagram and Main Sewerage Facilities

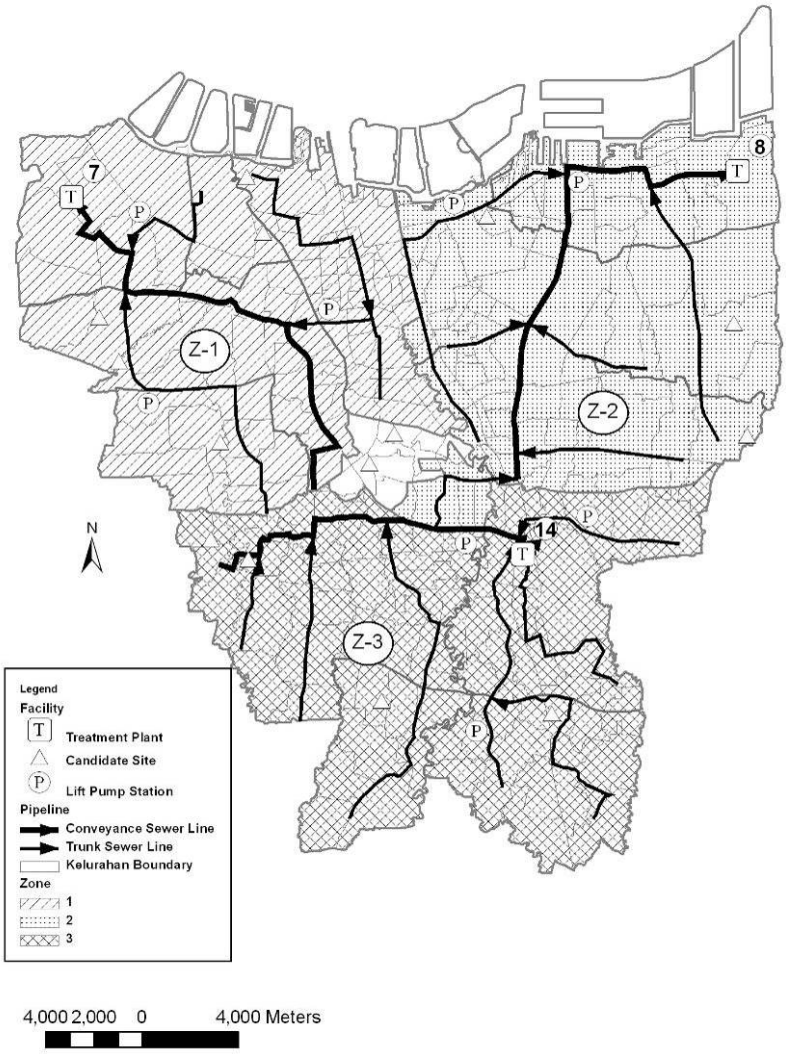
(3) Proposed 3 Sewerage Zones (Case-2)

This is a proposal to divide into 3 large-scale sewerage zones among east, west and south of DKI Jakarta and WWTPs are planned at Kamal-Pegadungan in the north-west, Marunda in the north-west, and Waduk Kp. Dukuh (Pond Planning). Facility plan and main sewer facilities are shown in Figure S/R-D7-2.

This plan, as in the case of 2 large-scale sewerage zones, will cost much because maximum diameter of trunk sewer becomes 3,200mm, pipe jacking will not be applied and relay pumping station are needed.

Also, since the high prioritized areas become far from WWTP, it will take much time to construct the

pipe installation work and accordingly the initial investment becomes high. Moreover, it is needed to secure a large land as one WWTP site and it is expected to be more difficult for land acquisition.



Item	Sewerage Zone No.1	Sewerage Zone No.2	Sewerage Zone No.3
Population	4,265,646 Persons	4,272,771 Persons	3,804,951 Persons
Area	20,180 ha	20,552 ha	22,456 ha
Candidate Sites	Kamal - Pegadungan	Marunda	Waduk Kp. Dukuh
Minimum Area	23.9 ha	23.9 ha	21.3 ha
Land aquisition	Green area, open space exists nearby	Green area, open space exists nearby	Green area, open space exists nearby
Extension of Main Trunk	53 km	50 km	71 km
Maximum Pipe Diameter	ϕ 3,200 mm	ϕ 3,200 mm	ϕ 3,200 mm
Relay Pumping Station	300m^3/min : 1point	300m^3/min : 1point	200m^3/min : 2point

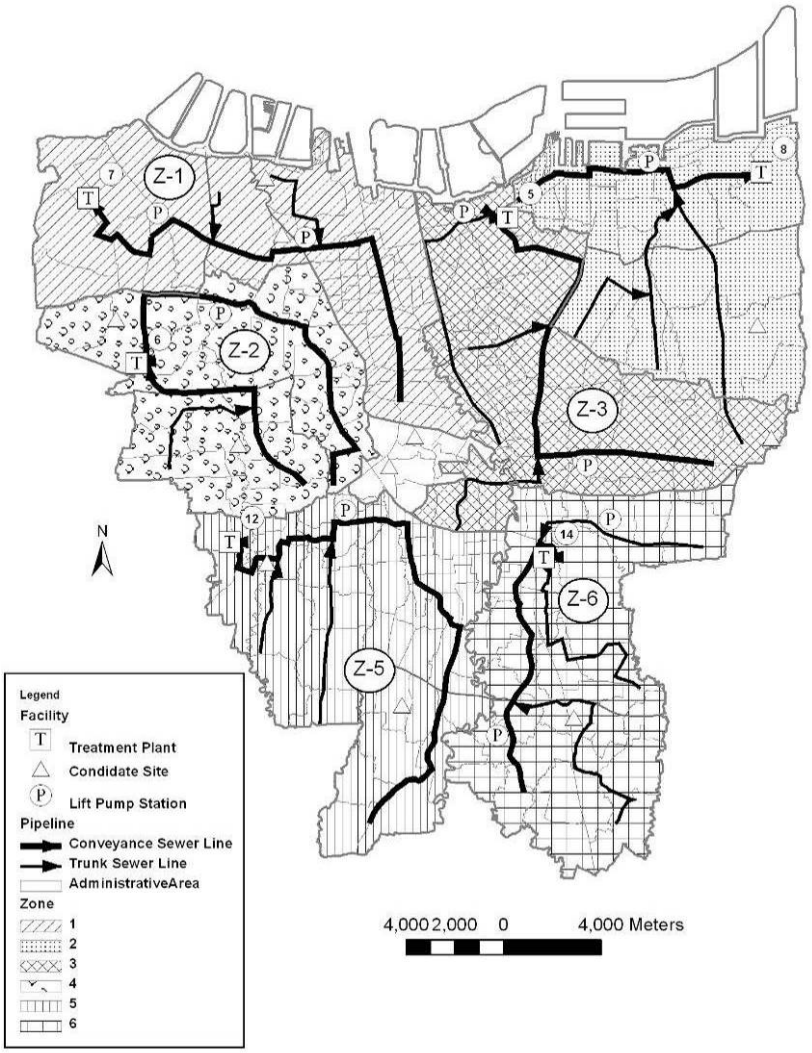
Figure S/R-D7-2 Proposed 3 Large-Scale Sewerage Zones (Case-2) - Schematic Diagram and Main Sewerage Facilities

(4) Proposed 6 Medium-Scale Sewerage Zones (Case-3)

This is a proposal to divide into 6 medium-scale sewerage zones which contains the candidate sites for WWTP with relatively large scale area to be secured.

Since the maximum diameter of trunk sewer is 2,600mm, pipe jakcking can be adoptd and the construction cost will be less than that in Case-1 and Case-2. However, investment cost will become high because the sewerage zone is relativey large and it will take a long time for pipe installation. Moreover, a part of

WWTP site belongs to the private land and it will lead to difficulty of land acquisition.Therefore, it will be faced with several problems in the realization.



Item	Sewerage Zone No.1	Sewerage Zone No.2	Sewerage Zone No.3	Sewerage Zone No.4	Sewerage Zone No.5	Sewerage Zone No.6
Population	2,078,472 persons	2,187,219 persons	2,635,157 persons	1,637,614 persons	2,133,958 persons	1,670,993 persons
Area	10,743 ha	9,437 ha	10,577 ha	9,975 ha	11,418 ha	11,038 ha
Candidate Sites	Kamal - Pegadungan	STP Duri Kosambi	Sunter Pond	Marunda	Waduk Ulujami	Waduk Kp. Dukuh
Minimum Area	11.6 ha	12.3 ha	14.8 ha	9.2 ha	12.0 ha	9.4 ha
Procuring Site	Green area, open space near organic	Private land is near	Green space, open space near organic	Green space, open space near organic	Private land is near	Green space, open space near organic
Extension of Main Trunk	25 km	25 km	35 km	25 km	42 km	21 km
Maximum Pipe Diameter	φ2,600 mm	φ2,600 mm	φ2,800 mm	φ2,400 mm	φ2,600 mm	φ2,400 mm
Relay Pumping Station	300m^3/min : 1point	–	200m^3/min : 1point	150m^3/min : 1point	200m^3/min : 1point	–

Figure S/R-D7-3 Proposed 6 Medium-Scale Sewerage Zones (Case-3) - Schematic Diagram and Main Sewerage Facilities

(5) Summary of Case Study

The case study shown above is summarized in Table S/R-D7-4. As seen in the table, it is found that Case-4 is considered as the most appropriate sewerage zones.

Table S/R-D7-4 Summary of Case Study

Case	Difficulty in Securing WWTP Site	Rank	Length of Trunk Sewer (Difficulty in Works)	Rank	Max. Pipe Diameter (Difficulty in Works)	Rank	Initial Construction Cost	Rank	Evalu-ation
1	Large	1	Large	1	Large	1	Large	1	4
2	Large	1	Large	1	Large	1	Large	1	4
3	Large	1	Medium	2	Medium	2	Medium	2	7
4	Small	3	Small	3	Small	3	Small	3	12

Source : JICA expert team

D7.1.2 Proposed Plans for WWTP

(1) Technology for WWTP

The proposed plans for WWTP at the Mater Plan level are prepared here. At the F/S stage, detail analysis with additional information shall be carried out.

(2) Screening

1) Introduction

Preliminary treatment typically consists of screening and grit removal. Screening removes large material such as rags, wood and plastics objects. If not removed, this material causes operating and maintenance problems such as plugging and damage to downstream pipe work and mechanical equipment.

2) Proposal Screening

Screen openings have historically been decreasing in size. In the 1970s, 19 to 25 mm screen openings were common. Through the 1980s and 1990s, screen openings generally decreased. Today, screens are generally equipped with openings that are 3 to 10 mm. smaller openings remove much of the material that can cause scum blanket accumulations in digesters and can plug sludge pumps. The move to screens with smaller opening is also driven in part by the need to remove identifiable objects from the sludge so that aesthetic issues do not arise during land application or other beneficial re-use.

In larger plants, mechanical cleaning is generally done on a timed basis or when head loss across the screen exceeds a preset maximum. Very little operator attention should be required during normal plant operations. Screens have to be lubricated and which have minimal moving parts below the water line are generally favored to minimize the exposure of maintenance personnel to raw sewage. Screens have few hazards. Protective enclosures are generally provided around the channel opening in which they are placed to eliminate fall hazards and exposure to moving parts. The environment around the influent screens generally contains odors and sometimes dangerous gases. Ventilation and corrosion in the screening area are major concerns, and odors from the area must be managed properly. The head works structure of a plant often can be visible due to the height of a screen structure.

Generally an inlet screen with 6 mm openings is used for WWTP. This size is becoming more common in North America. However, it does place limitations on equipment selection because some of the more common types of screens have larger openings.

The use of finer screens mandates the washing and compaction of removed solids. This additional process returns fecal material to the liquid stream for treatment in downstream processes, reduces screenings volumes substantially, and lowers the odor potential of the screenings. Compacted material also is much less objectionable and as a result is more readily accepted at a landfill.

Normally average quantity of screenings is approximately 0.175 m^3 per 1,000 m^3/day of wastewater treated. After washing and compaction, the daily volume will be half that amount, approximately 0.09 m^3 per 1,000 m^3/day wastewater treated. Peak screenings volumes are about 10 times that amount.

Table S/R-D7-5 Proposed Screening

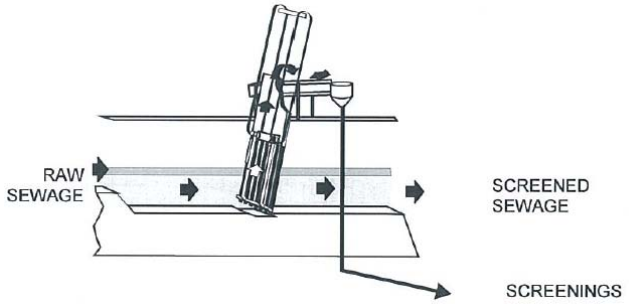
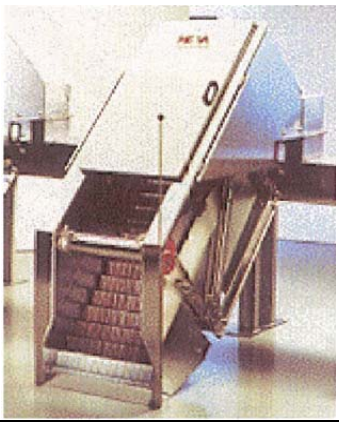
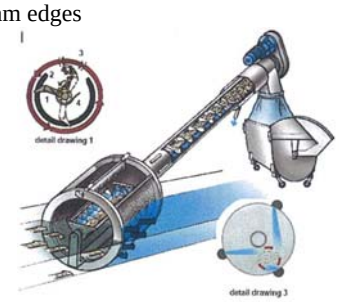
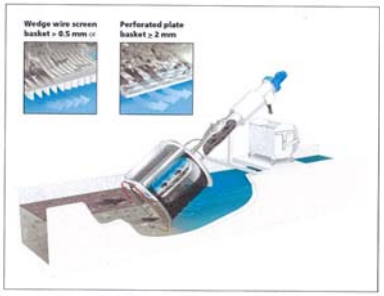
Item	Proposal
Mechanically Raked Bar Screens	Mechanically raked bar screens are commonly used in WWTP to remove debris from the incoming wastewater, protecting downstream processes from plugging and debris accumulation. The screen is comprised of parallel bars, typically 8 to 8 mm to 25 mm. it is not possible to reduce opening width to less than 8 mm. these screens employ dual chain and sprocket mechanisms to drive the rake that cleans the bar screen. Multiple rakes are attached to the chain and remove the screenings by conveying them upward across a dead plate. At an elevated location, the screenings are wiped from the rakes and discharge to a conveyor. The rakes then return to the bottom of the screen through the flow upstream of the screen. The rake types do not completely penetrate the bar screen due to structural cross members that support the bars. Therefore, the screen is not completely cleaned. The rake arm can actually push screenings through the bars. Mechanically raked bar screens can be designed to fit almost any application, as there is a wide range of units available to fit various combinations of channel depth and width. The screens require significant headspace - more than that required for other screening options. These screens are generally durable. 
Segmented Chain Fine Screens	This screen is comprised of a series of links that are held together by rods. The links are plastic or stainless steel and each has a tooth that 'grabs' screenings for transport to the top and back of the screen for discharge. Each link is approximately 75 mm long and 6 mm wide. When placed alternately, the openings between the links provide the screen opening. Segmented chain screens were some of the first fine screens on the market and have been used in numerous plants where 6 mm openings were required. However, they have been prone to problems; the teeth have not released the solids when they pass through the spray bar or rotating brush that is intended to remove them. As a result, some screenings are washed from the back of the screen in its return path and re-enter the flow. In addition, when links break, they are difficult to replace.
Step Screens	Step screens use rows of self-cleaning plates that are cut in a staircase configuration. Every other plate is fixed and the alternating plates are connected to a rotating frame that revolves in a circular motion. Through its revolutions, the rotating plate steps pick up debris that has been deposited on the screen and lift it to the succeeding "step", lifting the material step-by-step to discharge at the top. Step screens have a low profile and can be fully enclosed. Enclosing the screens, as shown in the picture of the units, allows foul air to be contained and directed to an odor control system. None of the drive mechanism located below water level. 
Escalator Screens	The escalator fine screen has perforated panels that are built in "steps" to provide increased screening surface area and the ability to remove larger screenings. The screen rotates in a clockwise direction, carrying heavier solids on the "step" to the screenings discharge. A rotating brush (as opposed to the typical rake wiper) is used to brush the screenings maintenance on escalator screens is generally higher

Table S/R-D7-5 Proposed Screening

Item	Proposal
	than mechanically raked bar screens because two drives are associated with this screen (one for the screen and one for the brush), wetted moving parts, and because of the finer degree of screening. These screens have a relatively low profile and can be readily contained for odor control. However, they have moving drive components below the water level that will require maintenance. 
Drum - Basket Screens	Drum basket screens have a series of concentric circular screen bars that form an enclosed basket that is immersed in the incoming raw wastewater stream. The screen bars capture the debris by forming a mat on the upstream edges   A series of tynes that extend through the screen bars is attached to a central shaft. As the shaft rotates, the tynes remove the screenings and raising them to a vertical position, from where they drop into a centrally positioned through that is equipped with a screw conveyor. The rotating movement of the screw conveyor transports the screenings out of the channel, and into a container located at floor level. During transport , the screenings are compacted, washed and dewatered to a solids content as high as 40 percent (as dry solids). The drum-basket screens have a low profile and can be either installed in a separate chamber or directly in the inlet channel. Excessive quantities of plastic and debris can interfere with the screening and screenings transport mechanisms.

3) Grit Removal

(a) Introduction

Grit removal takes out heavy inorganic and some organic particulates. Grit removal systems are generally sized to extract all inert material over 200 microns with a specific gravity over 2.5. There are options available that purport to remove smaller inert material. However, these process alternatives are not generally suited to large wastewater treatment plants. Grit is abrasive and causes substantial wear on downstream rotating equipment. This heavy, non-biodegradable material also accumulates in process tanks where the mixing intensity is not very high, e.g. aeration tanks and digesters.

Grit is classified and dewatered to reduce organics content and increase solids content. The goal of this process is to increase the solids content to above 80 percent while reducing the volatile solids content to less than 15 percent of the total. Material in this state is relatively innocuous and does not create serious odors.

The expected average dewatered grit quantities are 0.013 to 0.015 m^3 per 1,000 m^3/day of wastewater treated. Peak grit quantities will be almost 20 time this amount.

Table S/R-D7-6 Proposed Grit Removal

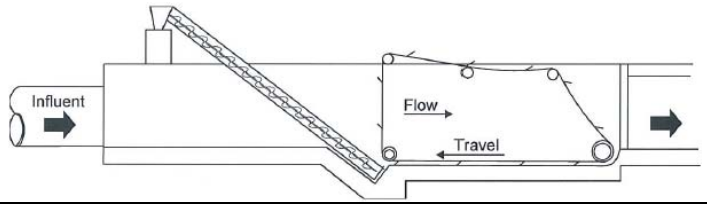
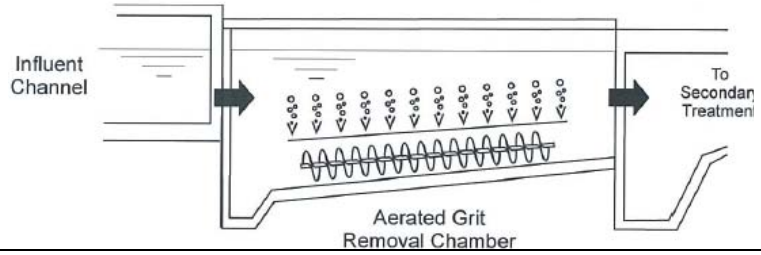
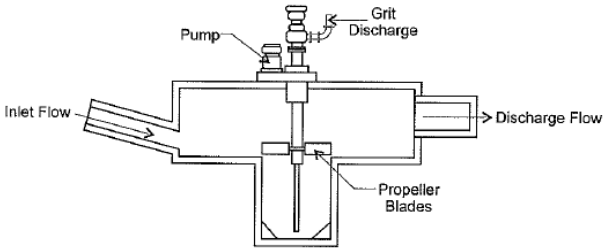
Item	Proposal
Constant Velocity Grit Channels	Constant velocity grit removal channels remove send, silt, and gravel from the influent wastewater to reduce abrasive wear on downstream rotating equipment and to minimize solids deposition in downstream unit processes. Grit is removed in a channel in which the level is controlled to ensure that the horizontal velocity is maintained at a relatively constant rate. Depending on size, grit can be removed by hand, by gravity or mechanically. When removed mechanically, the grit is generally classified to separate large organic particles for return to the treatment stream, and dewatered. Constant velocity grit removal channel are generally only used in smaller facilities. For larger flows, the structural requirements become substantial and other grit removal processes with smaller footprints are generally used. Constant velocity grit removal channels and the associated equipment are subjected to considerable abrasive wear. Even equipment designed for this duty requires frequent maintenance to keep it in service. There is minimal flexibility available with this process unless multiple units are provided that can be brought on line as the flows increase. They generally operate all of the time. Well classified and dewatered grit can be disposed as solid waste with minimal difficulties. Constant velocity grit removal channels are easily operated. Relatively little operator attention is required for mechanically cleaned channels, but manually cleaned channels are labor intensive. The grit removal equipment has to be lubricated and repaired. Its operating environment is generally offensive. For this work to be done, the equipment must be extracted from the wastewater and cleaned. Constant velocity grit removal channels offer little hazard to the operating staff. However, the environment around the channel generally contains odors and sometimes dangerous gases. As a result, ventilation of the area is a major concern. 
Aerated Grit Removal Chambers	Aerated grit removal chambers are designed to remove sand, silt, and gravel from the influent wastewater to reduce abrasive wear on downstream rotating equipment and to minimize solids deposition in downstream unit process. Grit is removed in a chamber where air is introduced along one wall, inducing a spiral flow pattern. The bottom velocities are maintained at relatively constant rate by this action, allowing the grit to settle while the organics are maintained in suspension. Grit is removed mechanically using cantilever pumps or screw conveyors. The removed grit is generally classified to separate large organic particles for return to the treatment stream, and dewatered. This process requires less space than constant velocity grit removal channels, but more space than vortex grit removal chambers. Aerated grit channels are the most common means of grit removal in large WWTP. Equipment located within the chambers is subjected to considerable abrasive wear. Even equipment designed for this duty requires frequent maintenance to keep it in service. The aeration rate can be manipulated to achieve lesser or greater rates of solids removal. The chambers generally operate all of the time. Well classified and dewatered grit can be disposed as solid waste with minimal difficulties. Due to the classifying nature of this process, the grit removed from aerated grit removal chambers generally has a lower organic content than that from other processes. Aerated grit chambers are easily operated. The aeration rates should occasionally be checked to ensure that the system is optimized. The grit removal equipment has to be lubricated and repaired. The operating environment is generally offensive. For this work to be done the operator must enter the tank or the equipment must be extracted from the wastewater and cleaned. Grit removal chambers offer little hazard to the operating staff, but the environment around the channel generally contains odors and sometimes dangerous gases. Ventilation of the area is a major concern. A primary concern about the choice of aerated grit removal systems is their ability to remove fine sands and silts. Normally, these system work well where sand and silts densities are above 1.65, but where densities are less than 1.65, they can pass large quantities to the downstream process. As a result, downstream unit processes become clog with silt and operation and maintenance issues are increasing at the facilities.

Table S/R-D7-6 Proposed Grit Removal

Item	Proposal
	
Vortex Grit Removal Chambers	Vortex grit removal chambers are not as susceptible to passing low density sands and silts as other grit removal systems, due to the induce gravity from the vortex action of the chamber. This makes vortex grit removal systems a better choice for WWTP, where soil conditions contain a very fine silt/sand mixer.  Vortex grit removal chamber are designed to remove sand, silt, and gravel from the influent wastewater to reduce abrasive wear on downstream rotating equipment and to minimize solids deposition in the downstream unit processes. The flow into the channel is introduced tangentially and a vortex is a established by the velocity of the wastewater. The vortex is normally maintained by a mechanical mixer. Centrifugal forces convey the grit to the tank perimeter where it settles along the wall while organics are maintained in suspension. Grit is then pumped from the center of the bottom of central sump. Airlift pumps can also be used to remove the grit. However, these are ineffective and are not recommended. Flushing water or air is used to fluidize the settled grit prior to pumping to ease its removal. The removed grit is generally classified to separate large organic particles for return to the treatment stream, and dewatered. Vortex grit chambers are becoming more common for grit removal in small to large facilities all over the world. While not as effective at grit removal as aerated grit chambers, vortex chambers are less costly and have a smaller foot print than both constant velocity channels and aerated grit chambers, and have been used at increasing frequency in larger plants. Little mechanical equipment is subjected to aggressive wear in this process and when designed properly, it is not subject to grit accumulations that have been known to plug vortex grit removal chambers when the plant experiences high loads. However, there is little flexibility available with this process and the chambers generally operate all of the time. Well classified and dewatered grit can be disposed as solid waste with minimal difficulties. Vortex grit chambers are easily operated, but the grit removal equipment has to be lubricated and repaired. The general area is offensive. Grit removal chambers offer little hazards to the operating staff, but the environment around the chambers generally contains odors and sometimes dangerous gases. Ventilation of the area is a major concern, and odors from the area must be managed properly. Visible obtrusiveness is generally limited due to the small area occupied by the process.

4) Effluent Disinfection

Table S/R-D7-7 Proposed Effluent Disinfection

Item	Proposal
Polishing Ponds	Polishing ponds can be used to achieve effluent disinfection. Natural predation and UV light inactivate potential pathogenic organisms. Polishing ponds will reliably reduce pathogenic microorganism densities where the effluent is clear and sufficient sunlight occurs. Generally, a hydraulic retention time of 5 or 6 days is required. Due to the relatively large buffer afforded by storage in the ponds, this process is not adversely affected by flow variations. Polishing ponds are applicable where semi-arid conditions predominate and where land is readily available. However, they are not use for many large plants in urban areas due to the large areas required. The effectiveness of polishing ponds is somewhat dependent upon climatic conditions and the effluent quality.

Table S/R-D7-7 Proposed Effluent Disinfection

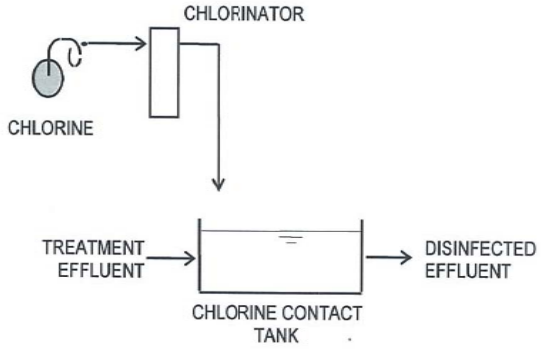
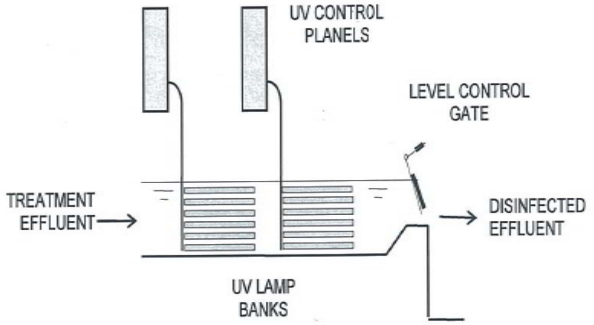
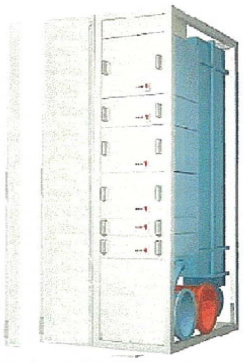
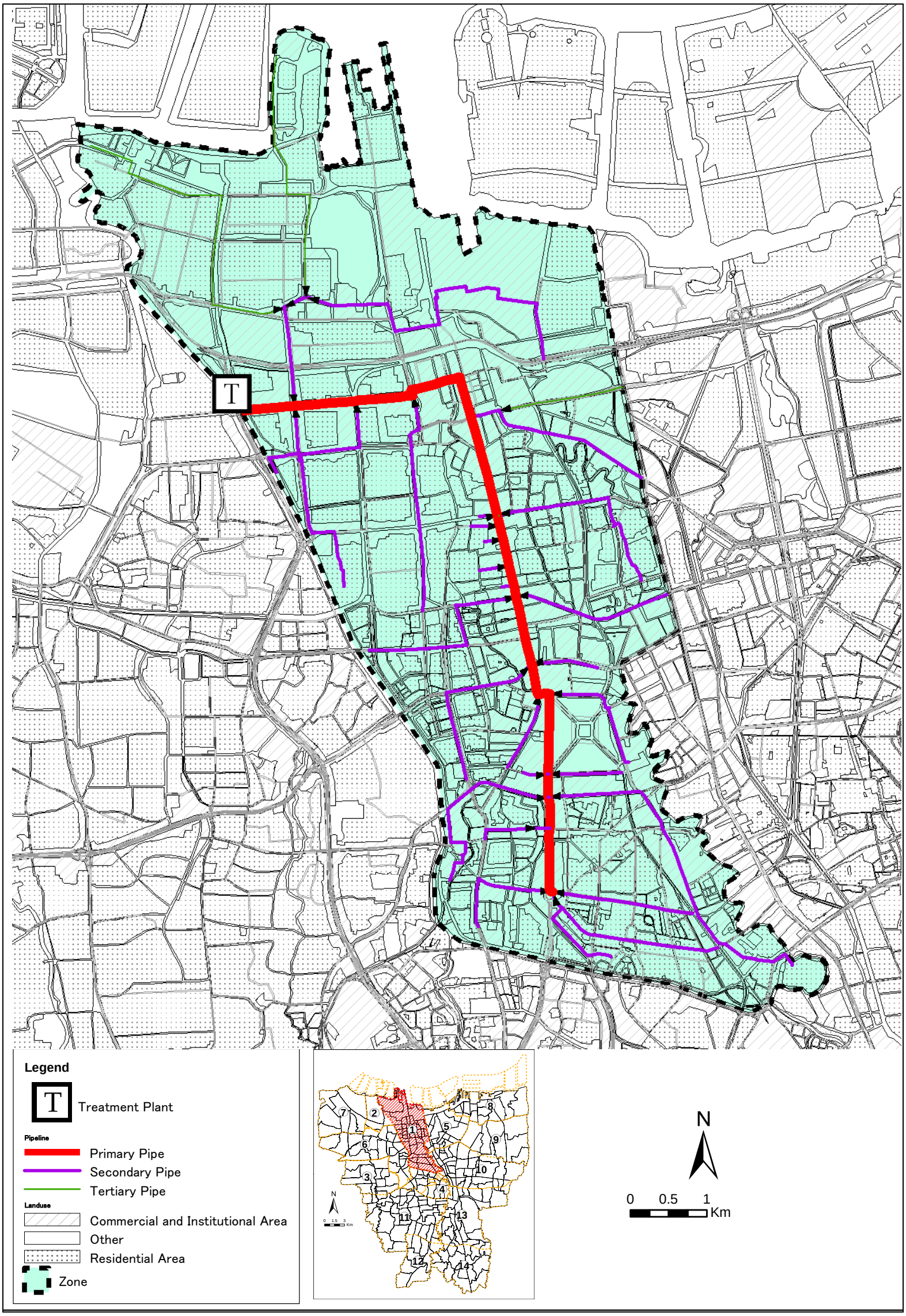
Item	Proposal
	Polishing ponds require minimal operator attention. However, settled solids have to be removed from the ponds on a regular basis. The berms and side slopes also require on-going maintenance. Ponds are often seeded with water hyacinth or other aquatic plants to inhibit algal growth which increases the effluent TSS and can affect the penetration of sunlight. Ponds can also serve as breeding grounds for mosquitoes.
Chlorination Using Chlorine Gas	Chlorine gas is added to the treated effluent to inactive potentially pathogenic bacteria, viruses, and protozoa. Chlorine is transported to the facility in compressed gas cylinders, or generated on site electrolytically. Gaseous chlorine is metered into a solution line that is fed to treated effluent. The wastewater passes through a chlorine contact tank with a minimum retention period of 15 or 30 minutes prior to discharge. At the end of the contact tank, the residual chlorine concentration is typically between 0.5 and 2.0 mg/L. lower costs and proven effectiveness have made chlorination the chemical disinfectant of choice at most WWTPs worldwide. Chlorination is a robust process provided that the effluent residual is monitored to ensure that sufficient chlorine is added upstream of the chlorine contact chamber. The effluent residual concentration has to be monitored continually. Chlorine feed rates are normally varied as necessary to disinfect varying flows. Adjustments of chlorine feed rate are generally automated in larger wastewater treatment plants. Chlorine containers have to be re-filled or replaced as the supply is exhausted. Various monitoring devices require frequent attention and safety appurtenances have to be maintained. Chlorine gas is extremely hazardous and has to be handled with caution. Chlorine release into the working environment presents a hazard to plant workers. In the event of an incident, staff must work in the area with the appropriate safety clothing and breathing apparatus. Chlorine is also toxic in the receiving environment. Accidental releases to the atmosphere can threaten the safety of the surrounding areas. Chlorine is toxic in the aquatic environment in relatively small concentrations. For this reason, a reducing agent is often added towards the end of the chlorine contact tank to react with the chlorine thereby removing the residual prior to discharge. Sulphur dioxide gas (S02) or liquid bi-sulphite are generally used for this purpose. The reaction is very quick and requires minimum retention time. However, like chlorine, sulphur dioxide is a toxic gas and caution has to be exercised in its use. 
Chlorination Using Sodium Hypochlorite	A sodium hypochlorite solutions or bleach powder can be used as an alternative to gaseous chlorine. This significantly reduces the safety issues related to the transport, storage and feeding of chlorine gas on the wastewater treatment plant site. Sodium hypochlorite is only available as a liquid and is usually purchased in bulk with between 12 and 15 percents available chlorine. The solution decomposes more readily at high concentrations, and affected bt exposure to sunlight and heat. For example, a 16.7 percent solution stored 26.7 oC will lose 10 percent of its strength in 10 days, 20 percent in 25 days, and 30 percent in 43 days. It must therefore be stored in a cool location. The handing and storage of sodium hypochlorite requires special design considerations because of its corrosiveness and the presence of chlorine fumes.
UV Disinfections Low Wattage Constant Dose	UV light with a wavelength between 250nm and 260nm will damage cellular DNA. This phenomenon is used to inactive wastewater bacteria by exposing effluent to light with these characteristics. Cell with damaged DNA are unable to replicate, and eventually die. UV light is emitted from low or medium pressure mercury vapor lamps. UV systems are available in various configurations. The most common for secondary or tertiary effluent consists of horizontal low or medium pressure UV lamps submerged in quartz tubes, mounted parallel to the flow in a relatively shallow channel. An alternative places vertical lamps perpendicular to the flow. Medium pressure or high pressure lamps may be more applicable to the disinfection of poor quality effluents. These lamps emit higher intensity light, but are not as energy

Table S/R-D7-7 Proposed Effluent Disinfection

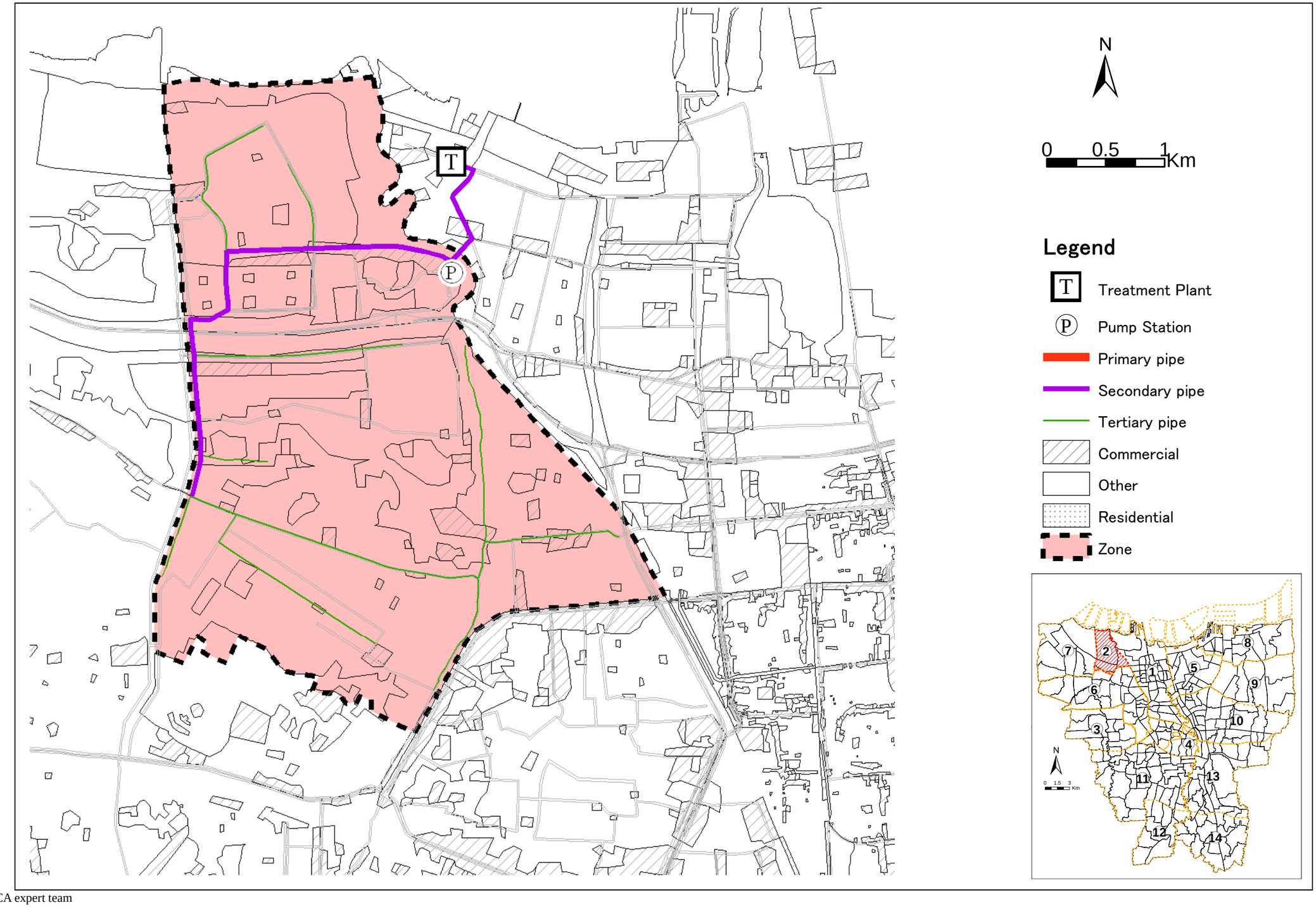
Item	Proposal
	efficient. The high ongoing cost of electrical power is a major disadvantage of UV disinfection. UV disinfections have been gaining rapidly in acceptance. UV disinfection systems require minimal space as the hydraulic retention time required is less than one minute. UV disinfection is hydraulically limited, so is robust as long as sufficient units are available to handle the flow. It works well where used for effluents which are relatively clear. Pilot testing is suggested prior to use for any large facility as deterioration of feed quality can reduce effectiveness significantly. Large systems are flexible as additional channels can be brought on line as required to treat increased flows. UV disinfection systems are relatively easy to operate and maintain. Effluent quality is monitored by measuring the residual coliform densities. The UV lamps tend to foul and eventually will burn out. Lamps need to be cleaned at frequent intervals and replaced every one to two years. Debris can cause plugging problems. The environment surrounding a UV disinfection system is relatively innocuous, and no toxic byproducts are released into the receiving environment. 
UV Disinfection High Wattage Pulsated Dose	Recent advances in UV technology have lead to the development of pulsed UV-based disinfection system that destroys microorganism and causes photo dissociation of organic contaminants in water and wastewater. The system generates UV light using pulses at very high voltages (10 to 45Kv) through a plasma lamp, which generates variable-pulsed UV light of intensity of up to 6 million watts. The system operates in a real-time mode adjusting the dose to both fluid flow and UV power (average and peak intensity) to accommodate a wide range of varying influent conditions, thereby producing the quality of fluid discharge desired by the operator. The system using Pulsed UV light technology with a peak power pulse of up to 6mm watts/pulse and with 1 to 30 pulses per second is able to achieve a 6 log, coliforms (~100%) destruction. This would permit the use of this technology on primary clarified wastewater for using then for agriculture. A typical such a UV module and lamp is depicted below:  Typical complete UV System  Typical Pulsated UV Plasma Lamp

D7.2.2 Plan for Main Sewerage Facilities



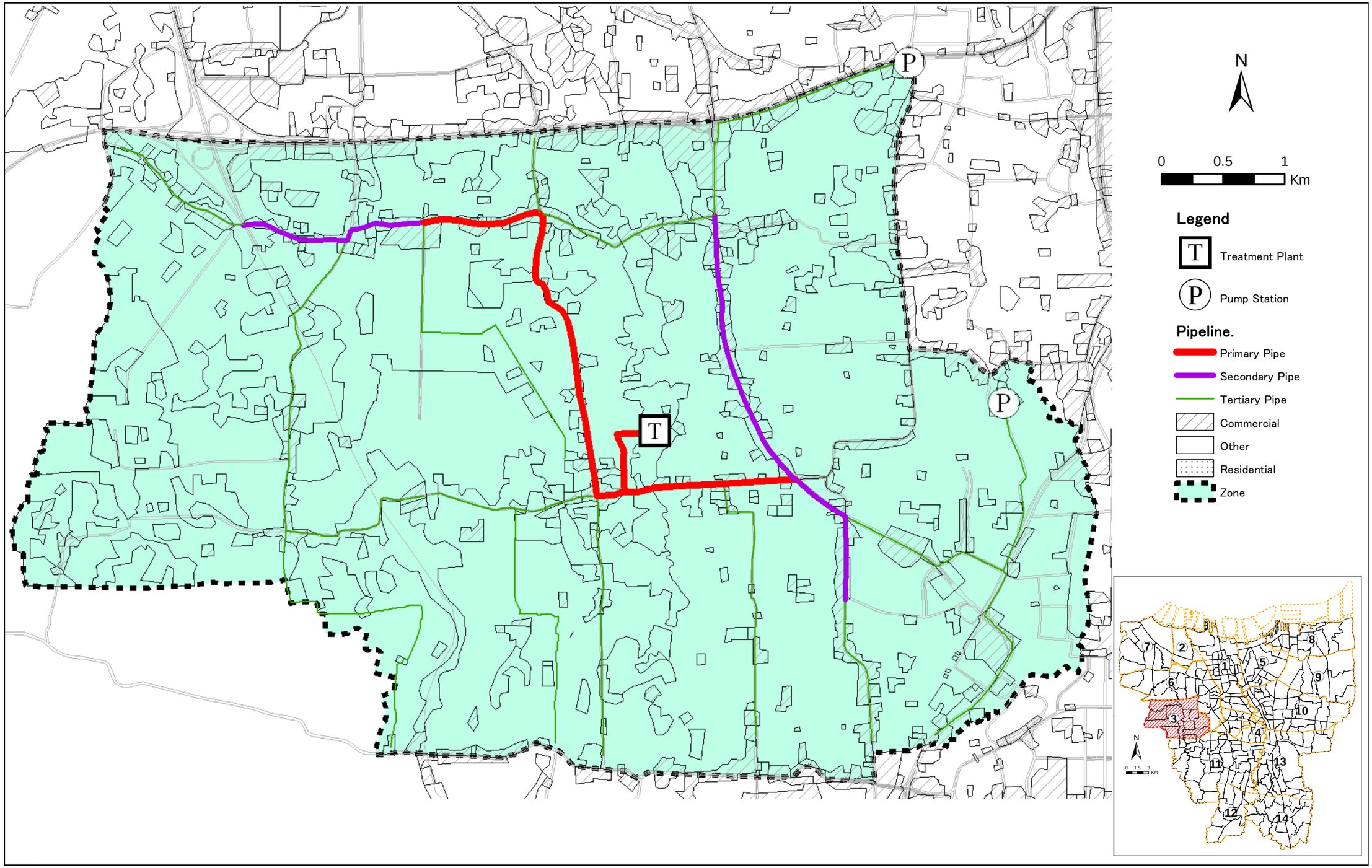
Source: JICA expert team

Figure S/R-D7-4 Main Sewerage Facility Plan in Sewerage Zone No.1



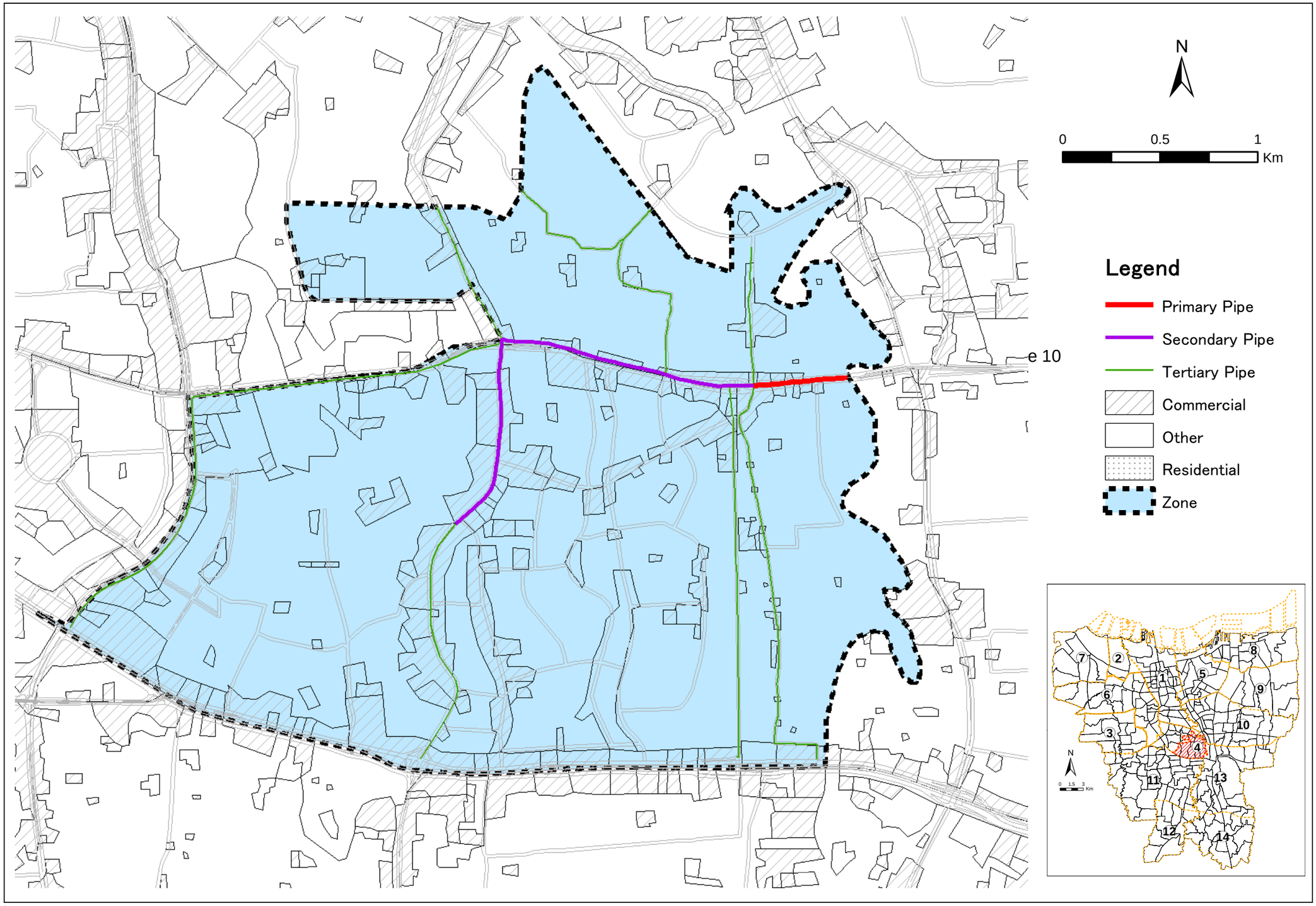
Source: JICA expert team

Figure S/R-D7-5 Main Sewerage Facility Plan in Sewerage Zone No. 2



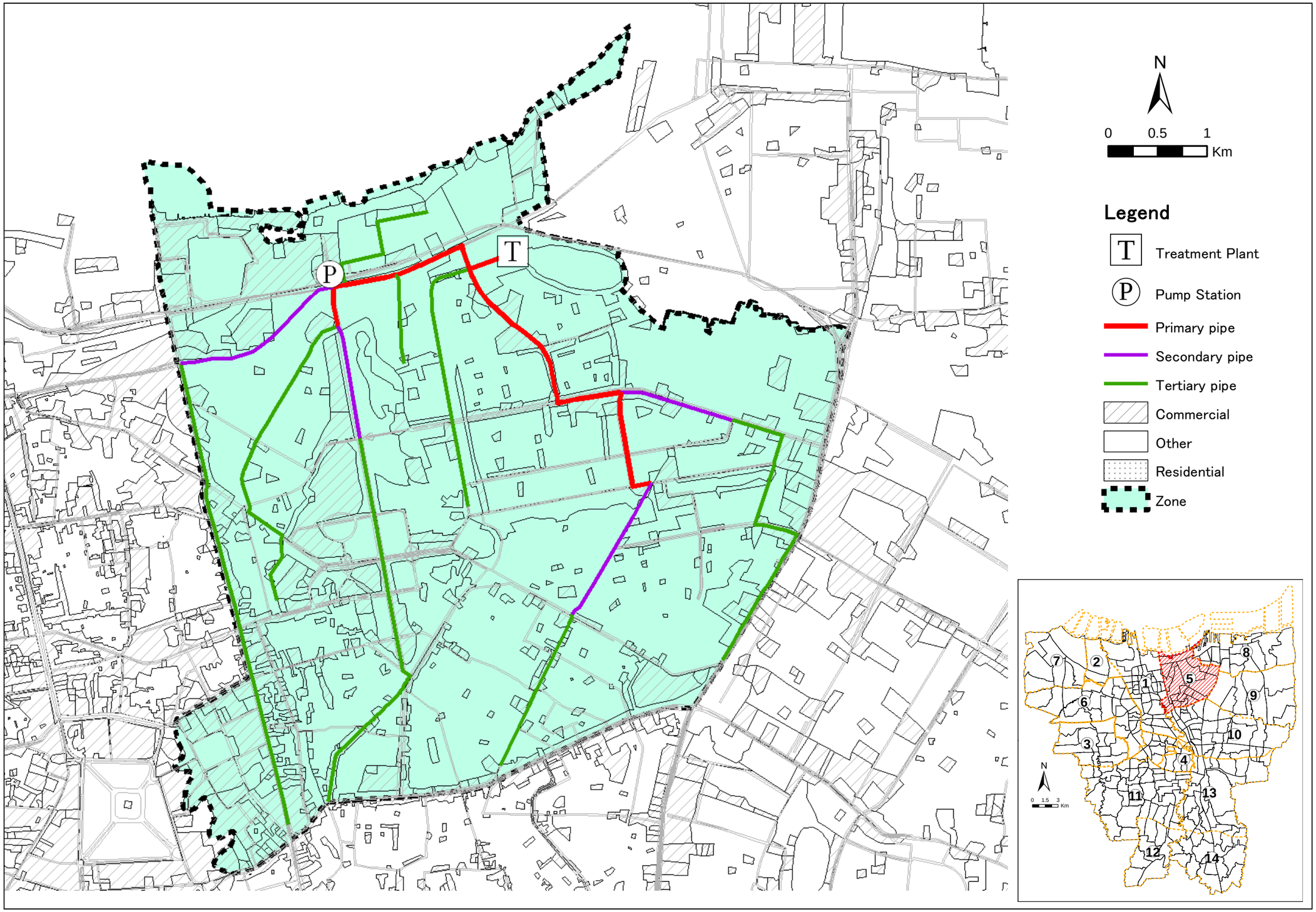
Source: JICA expert team

Figure S/R-D7-6 Main Sewerage Facility Plan in Sewerage Zone No. 3



Source: JICA expert team

Figure S/R-D7-7 Main Sewerage Facility Plan in Sewerage Zone No. 4



Source: JICA expert team

Figure S/R-D7-8 Main Sewerage Facility Plan in Sewerage Zone No. 5