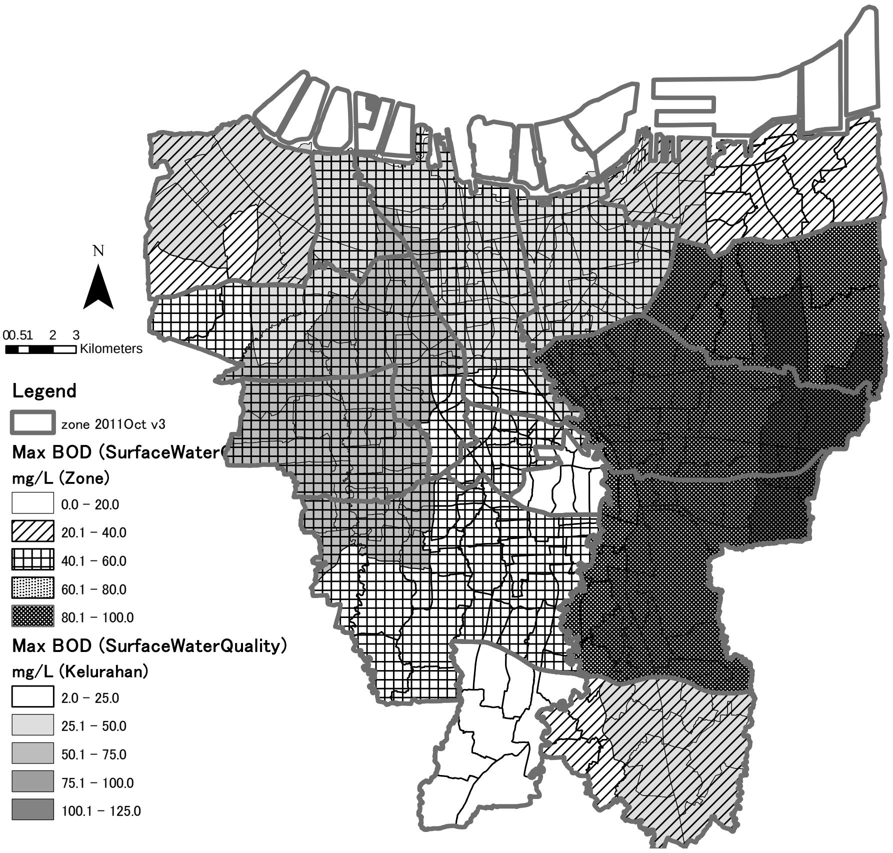
After the examination, the priority for Indicator No.7 is as shown in Figure D2-14.

Indicator No.7	River water quality is not good (BOD is high).



River Water Quality by BOD (2011)

[Priority for Indicator No.7]

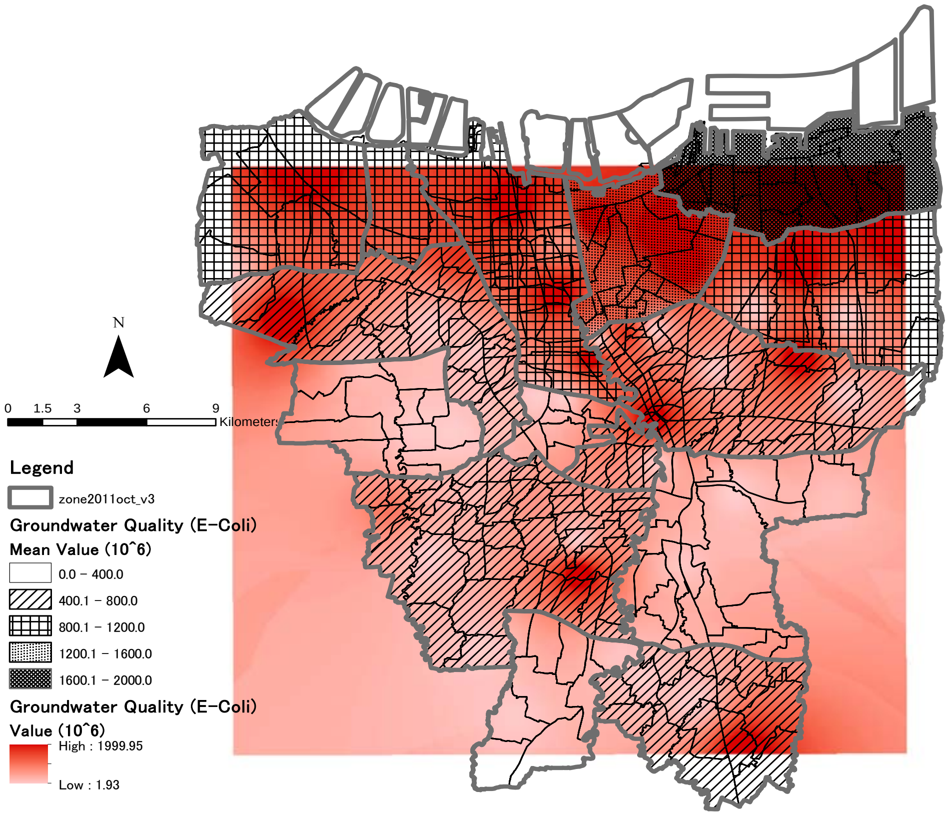
Zone No.	BOD (Maximum)	Rank
1	60	4
2	60	4
3	60	4
4	9	13
5	50	9
6	60	4
7	32	11
8	30	12
9	86	1
10	86	1
11	60	4
12	9	13
13	86	1
14	37	10
0	50	

Source: JICA Expert Team

Figure D2-14 Priority for Indicator No.7

After the examination, the priority for Indicator No.8 is as shown in Figure D2-15.

Indicator No.8	Groundwater quality is not good (E-coli is high).



Groundwater Quality by E-Coli (2011)

[Priority for Indicator No.8]

Zone No.	E-Coli (x10^6)	Rank
1	1164.3	5
2	1175.4	4
3	217.2	13
4	581.8	9
5	1433.0	2
6	642.0	8
7	1177.9	3
8	1670.4	1
9	1061.7	6
10	673.7	7
11	409.0	11
12	201.1	14
13	264.0	12
14	519.7	10
0	375.1	

Source: JICA Expert Team

Figure D2-15 Priority for Indicator No.8

D2.5.3 Priority of Sewerage Zones and Determination of Prioritized Project Areas

According to the evaluation for each indicator, priority for sewerage zones has been determined as shown in Table D2-7. The highest priority is put on No.1 and No. 6. Therefore, Zone No.1 and No.6 have been selected as the prioritized project areas.

Table D2-7 Evaluation Result for Prioritized Project Areas

Zone No.	Indicator Number								Total	Rank
	1	2	3	4	5	6	7	8		
1	**13**	**14**	**13**	**14**	**1**	**3**	**11**	**10**	**79**	**1**
2	2	3	13	1	1	1	11	11	43	14
3	8	14	13	4	1	2	11	2	55	11
4	14	14	14	11	1	4	2	6	66	6
5	10	14	13	13	1	5	6	13	75	4
6	**12**	**14**	**13**	**12**	**1**	**8**	**11**	**7**	**78**	**2**
7	4	14	13	12	1	12	4	12	62	8
8	9	14	13	5	1	9	3	14	68	5
9	1	14	13	3	1	11	14	9	66	6
10	11	14	13	8	1	7	14	8	76	3
11	7	3	13	10	1	13	11	4	62	8
12	6	14	13	6	1	10	2	1	53	13
13	5	3	13	9	1	6	14	3	54	12
14	3	14	13	7	1	14	5	5	62	8

Source: JICA Expert Team

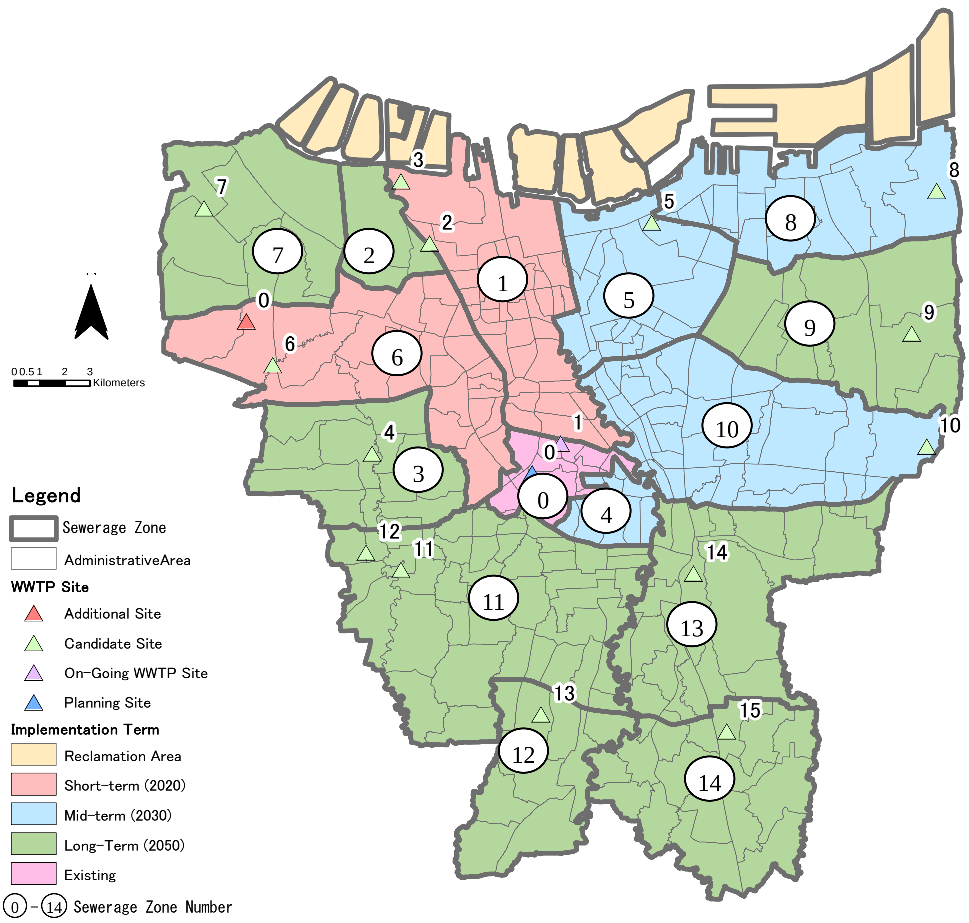
D2.5.4 Priority Rank for Sewerage Zones in Target Development Years

Based on the rank for priority, sewerage zones for each target development year has been determined as shown in Table D2-8 and Figure D2-16.

Table D2-8 Sewerage Zones for Each Target Development Year

Priority	Zone No.	Target Development Year
1	**1**	Short-Term Plan: Year 2012 to 2020
2	**6**	
3	**10**	Mid-Term Plan: Year 2021 to 2030
4	**5**	
5	**8**	
6	**4**	
7	**9**	Long-Term Plan: 2031 to 2050
8	**7**	
9	**11**	
10	**14**	
11	**3**	
12	**13**	
13	**12**	
14	**2**	

Source: JICA Expert Team



Source: JICA Expert Team

Figure D2-16 Sewerage Zones for Each Target Development Year

D3 Wastewater Quantities & Qualities and Pollution Loads

D3.1 Wastewater Generation

Unit wastewater volume is usually obtained in the following manners:

1. Daily maximum (or average) water supply is directory applied as the wastewater generation.
2. The volume after deducting water losses such as gardening, car washing, etc. from the water consumption is applied.

In the New M/P, since it is possible to overestimate wastewater volume in the method item-1, method item-2 above is applied. In the method item-2, it is necessary to deduct water losses from the water consumption to obtain the wastewater generation and after that add 10 to 20% of the wastewater generation as the infiltration of groundwater into sewer pipeline. Therefore, method item-2 is applied on condition that the water consumption shall be applied as it is as the wastewater generation.

Wastewater Generation ＝ Water Consumption

D3.2 Estimated Water Consumption Rates

Data for water consumption in year 2010 obtained from PAM JAYA (water supply system of PAM JAYA and existing wells) are as shown in Table D3-1.

Table D3-1 Water Consumption for PAM JAYA System and Existing Well (2010)

Item	Water Consumption by Household	Water Consumption by Non-Household (Commercial, Public and Industry)	Total
PAM JAYA	130	83	213
Existing Wells	179	12	191
Average	**154**	**45**	**199**

Source: PAM JAYA

On the other hand, the estimated water consumption in the future (year 2010 and further) made in the Old M/P 1991 is shown in Table D3-2.

Table D3-2 Estimated Unit Wastewater Volume in the Old M/P 1991 (from year 2010 downward)

City	Population	Unit Wastewater Volume (m^3/day)					
		① Household	Unit Wastewater for ① (LCD)	②Non-Household	③Industry	②＋③Unit Wastewater (LCD)	Unit Wastewater
South Jakarta	3,157,600	468,354	148	87,205	2,328	28	177
East Jakarta	3,292,400	495,461	150	93,891	79,194	53	203
Central Jakarta	1,730,600	253,756	147	121,227	3,906	72	219
West Jakarta	2,716,600	398,882	147	86,312	35,718	45	192
North Jakarta	1,902,800	266,233	140	60,298	135,485	103	243
Total	**12,800,000**	**1,882,686**	**147**	**448,933**	**256,631**	**55**	**202**

Source: Old M/P

Based on the data collected, in the New M/P, the values in Table D3-3 are applied as the unit wastewater at present and in the future.

Table D3-3 Water Consumption Applied in the New M/P

Item	Water Consumption for Household	Water Consumption for Non-Household (Commercial, Public and Industry)	Total Water Consumption (LCD)
Actual in 2010	154	47	201
Estimation in the Old M/P	147	55	202
Average	150.5	51.0	201.5
Applied in the New M/P	**150**	**50**	**200**

Source: JICA Expert Team

Therefore, unit wastewater generation in the New M/P is as shown in Table D3-4.

Table D3-4 Wastewater Generation for the New M/P

Item	Wastewater Generation for Household	Water Consumption by Non-Household (Commercial, Public and Industry)	Total of Wastewater Generation (LCD)
Unit Wastewater Generation in the New M/P	**150**	**50**	**200**

Source: JICA Expert Team

D3.3 Pollution Loads

Design wastewater volume in the New M/P for the target development years of 2020, 2030 and 2050 is calculated by multiplying the unit wastewater generation by the design population (administrative population x sewerage service ratio 80%). The calculation result is as shown in Table D3-5.

Design Wastewater Volume ＝ Design Population x Unit Wastewater Generation

Table D3-5 Design Wastewater Volume for Each Sewerage Zone in DKI Jakarta

Zone No.	Administ. Population (2030)	Sewerage Service Ratio (%)	Design Population (2030)	Unit Wastewater Generation (LCD)	Design Wastewater Volume
0	211,865	100.00	211,865	200	42,373
1	1,236,736	80.00	989,389	200	197,878
2	149,042	80.00	119,234	200	23,847
3	721,501	80.00	577,201	200	115,440
4	290,796	80.00	232,637	200	46,527
5	795,109	80.00	636,087	200	127,217
6	1,465,718	80.00	1,172,574	200	234,515
7	692,649	80.00	554,119	200	110,824
8	1,100,137	80.00	880,110	200	176,022
9	537,477	80.00	429,982	200	85,996
10	1,549,252	80.00	1,239,402	200	247,880
11	1,578,573	80.00	1,262,858	200	252,572
12	555,385	80.00	444,308	200	88,862
13	1,053,724	80.00	842,979	200	168,596
14	617,269	80.00	493,815	200	98,763
Total	12,445,184		9,976,510	200	1,995,302

Note: Excluding Seribu Islands and the reclamated area.
Source: JICA Expert Team

The existing Zone No.0 is for the existing sewerage service area and the sewerage service ration has been set as 100% since it has already been known that in comparison with other zones there is little slum area in the zone.

D4 Mass Balance of Wastewater

D4.1 Setting Basic Units

Table D4-1 shows per-capita basic unit amounts for generated BOD and SS in Indonesia, which were determined based on established values and other data of the Old M/P 1991 and Governor Decree, No.122-2005. The per capita amount of generated wastewater was set at 150 L/day, within which the amount of black water generated was set at 25 L/day. In addition, the per-day basic unit amount for generated BOD and SS was set at 30 g/person, within which that for black water was set at 12.5 g/person. Table D4-2 shows generated wastewater amounts and water quality for general wastewater, black water (BW), and gray water (GW).

Table D4-1 Design Set Up: Basic Unit of BOD and SS

Item		Wastewater (Gray & Black Water)		Black Water	
		(g/PE/d)	(mg/L)	(g/PE/d)	(mg/L)
Current Set Up Standard					
Quantity (L/PE/d)			**150**		**25**
Quality	BOD	**30.0**	**200**	**12.5**	**500**
	SS	**30.0**	**200**	**12.5**	**500**
Old M/P 1991 and Government Decree No.122-2005					
Quantity (L/PE/d)			120		23
Quality(BOD)		23.2	193	23.2	193
Recent Example in Japan					
Quantity (L/PE/d)			265		50
Quality	BOD	48	181	13	260
	SS	39	147	22	440
Wastewater Characteristic (Polprasert 1996)					
		Strong	Typical	Weak	
Quality (mg/L)	BOD	400	220	110	
	SS	350	220	100	

Reference: Function Diagnosis and Countermeasure of Johkasou
Upgrading Conventional Septic Tanks by Integrating In Tank Baffles
Source: JICA Expert Term

Table D4-2 Design Set Up : Basic Unit of Wastewater Amounts and Quality

Items		Wastewater (Total)		Black Water		Gray Water	
		(g/PE・d)	(mg/L)	(g/PE・d)	(mg/L)	(g/PE・d)	(mg/L)
Quantity	(g/PE・d)		150		25		125
Quality	BOD	30.0	200	12.5	500	17.5	140
	SS	30.0	200	12.5	500	17.5	140
	CODcr	60.0	400	25.0	1000	35.0	280
	N	5.25	35	4.5	180	0.75	6
	P	1.2	8	0.625	25	0.575	4.6

Source: JICA Expert Term

D4.2 Setting Design Conditions of Each Facility and Setting Current Conditions

D4.2.1 Septic Tanks

A septic tank is an energy-efficient wastewater treatment facility that simply stores wastewater. Commonly used in Southeast Asia, Europe, and the United States from old times, septic tanks work by using a primitive decay and anaerobic treatment process that does not use energy. The larger a septic tank is, the less it requires management such as desludging, and thus septic tanks can be used for years or even decades without maintenance. Stable and steady treatment takes place in regions with relatively high temperatures; however, because the basic process involves decay by methane fermentation, the treated water quality is significantly lower compared to aerobic treatment. Moreover, when tanks are not equipped to capture methane gas, the gas is released into the atmosphere, which presents a problem in terms of measures to control global warming.

(1) Design Model

Average design conditions for a septic tank without underground seepage are set as shown in Table D4-3**.** For BW only, the organic matter ratio for influent is set at 80%, with 40% established as decomposing. The sludge conversion rate for general anaerobic treatment is set at 5% of the rate for aerobic treatment, and it is assumed that the converted sludge is included in the effluent water (40%) and in the sediment (20%). Accordingly the removal rate for BOD and SS becomes 60%.

On the other hand, for general wastewater (BW + GW), the decomposition rate was set at 30% and the BOD and SS removal rate at 50% because HRT is shorter and the range of polluting matter (such as kitchen waste and oil) is much wider compared to excreta only. The numbers of desludging years calculated from this setting are shown in Table D4-4. The number was calculated as 3.7 years for BW only and 2.7 years for general wastewater (BW + GW).

Table D4-3 Standard Design of Septic Tank

Item	Black water			Black water + Gray water		
Design Basis						
Quantity	25L/PE・d			150L/PE・d		
Tank Volume	225L/PE			300L/PE		
Sedimentation Volume Rate	75%			50%		
HRT	9 days			2 days (48h)		
Sedimentation Rate	20%			20%		
Reduction Rate	40%			30%		
Sedimentation Concentration	2%			2%		
Frequency of Desludging	1time/3.7years			1time/2.7years		
Water Quality						
Items	Influent	Effluent	Removal Rate	Influent	Effluent	Removal Rate
BOD	500	200	60%	200	100	50%
SS	500	200	60%	200	100	50%
CODcr	1000	400	60%	400	200	50%
T-N	180	153	15%	35	30	15%
T-P	25	21	15%	8	7	15%

Source: JICA Expert Term

Table D4-4 Assumption and Calculation of Desludging of Septic Tank

Black water	Sedimentation Sludge Volume is assumed 75%(168.75L/PE)of CST Generated Sludge:500mg/L×0.2×25L/d=2.5g/PE・d Sedimentation Sludge Amount:225L/PE/d×0.75×0.02＝3.375kg/PE Available Period: 3.375kg/PE÷2.5g /PE・d＝1350d=3.7years
Black water +Gray water	Sedimentation Sludge Volume is assumed 50%(150L/PE)of CST Generated Sludge:200mg/L×0.2×150L/d=6.0g/PE・d Sedimentation Sludge Amount:300L/PE/d×0.5×0.02＝3.0kg/PE Available Period: 3.0kg/PE÷6.0g /PE・d＝500d=1.4years

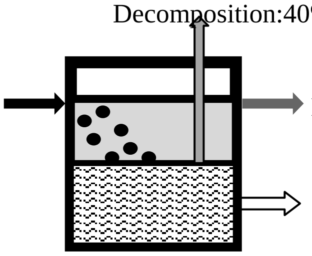
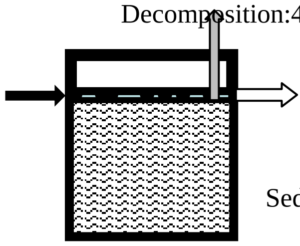
Source: JICA Expert Term

(2) Operation Model for Current Situation

Currently, in DKI Jakarta, desludging is limited to on-call operations that are provided only in emergencies. For ordinary households having BW septic tanks, this problem is limited to times when, for example, a toilet cannot be drained due to the accumulation of sediment or other matter in the septic tank. In several cases mentioned in hearings, it was discovered that ordinary households have almost no awareness of the impact that BW treatment in septic tanks has on their living environments. This was demonstrated by a household that responded that it had not experienced any problems despite not servicing its septic tank for 30 years, and another that said it had evacuated its tank when it rebuilt its house some 10 years ago, but had done nothing since. Thus, it is reasonable to conclude that the general sense is that desludging is something done just once or twice in a lifetime, somewhat akin to rebuilding one’s house. Accordingly, it is assumed that almost all septic tanks have lost their sedimentation function and that as a result sediment SS is flowing out together with treated water.

Table D4-5 shows the results when current-situation operating conditions are established for a BW septic tank based on the situation described above.

Table D4-5 Set-up of Current Situation of Septic Tank

Items		Design Standard			Current Situation		
Design Basis	Quantity	25L/PE・day			25L/PE・day		
	HRT	9days(Minimum 2.25day)			9days(Minimum 2.25day)		
M/B of BOD/SS	Total	100%			100%		
	Sedimentation Rate	20%			0%		
	Decomposition Rate	40%			40%		
	Effluent Rate	40%			60%		
Frequency of Desludging		1time/3.7years			Nothing (Carried over in Effluent)		
Quality	Items	Influent	Effluent	Removal Rate	Influent	Effluent	Removal Rate
	BOD	500	200	60%	500	300	40%
	SS	500	200	60%	500	300	40%
Image							

Source: JICA Expert Term

D4.2.2 Individual Treatment Plant (ITP)

(1) Design Model

For ITP of an establishment such as office buildings and commercial buildings, the extended aeration method was set as the standard ITP design because this method is the one typically used for such facilities. The design was set as shown in Table D4-6. The generated excess sludge volume was set at 75% of SS, and the removal rate for BOD and SS was set at 90%.

Table D4-6 Standard Design of ITP (Extended Aeration)

Design Basis			
Quantity	50L/PE・day		
Tank Volume	50L/PE		
HRT	24h		
Excess Sludge Rate	75%of Removed SS		
Sludge Concentration	2%		
Frequency	1time（4t:Honny Truck）/40days（300PE ITP） Generated Sludge：10g/PE・d×0.9×0.75=6.75g/PE・day Sludge Amount：6.75g/PE・d÷0.02＝0.34L /PE・day		
Water quality			
Items	Influent	Effluent	Removal Rate
BOD	200	20	90%
SS	200	20	90%
COD_{cr}	400	40	90%
T-N	35	25	30%
NH_4-N	25	8	70%
T-P	8	6	30%

Source: JICA Expert Term

(2) Operation Model for Current Situation

Current situation of operation could not be set up because almost no information was available concerning the operation conditions of reactors (MLSS, etc.). Treated water was set based on the results of the ITP survey mentioned in PART B.4.2. However, these results indicated that desludging took place about once a year, and the amount of excess sludge reported was extremely low. Consequently, actual treated water concentration was estimated to be even higher since most of sludge is considered to be carried over into treated water.

Table D4-7 Set-up of Current Situation of ITP

Items		Design Standard			Current Situation		
Design Basis	Quantity	50L/PE・day			Unknown		
	HRT	24h			Unknown		
	Excess Sludge Rate	75%of Removed SS			Unknown		
	Sludge Concentration	2%			Unknown		
	Desludging Frequency	1 time/40days（4t Honey Truck / 300PE ITP）			1 time/year		
Quality	Items	Influent	Effluent	Removal Rate	Influent	Effluent	Removal Rate
	BOD	200	20	90%	200	75	62.5%
	SS	200	20	90%	200	75	62.5%

Source: JICA Expert Term

D4.3 BOD and Solid Matter Volume Balance in DKI Jakarta

Table D4-8 and Table D4-9 show the results of calculation of BOD and SS mass balance for wastewater treatment in DKI Jakarta in the current situation (2012). This calculation was based on the design models set above as well as an actual operation-situation model. The mass balances for these tables are shown in Figure D4-1 and Figure D4-2.

Approximately 70% or more of the generated amount of BOD flows to public water bodies (including groundwater). It is clear that this situation is harming river environments in DKI Jakarta as well as worsening groundwater quality. Meanwhile, approximately 70% or more of the generated amount of SS is likewise flowing to public water bodies.

Table D4-8 BOD Mass Balance of Wastewater Treatment in DKI Jakarta (2012)

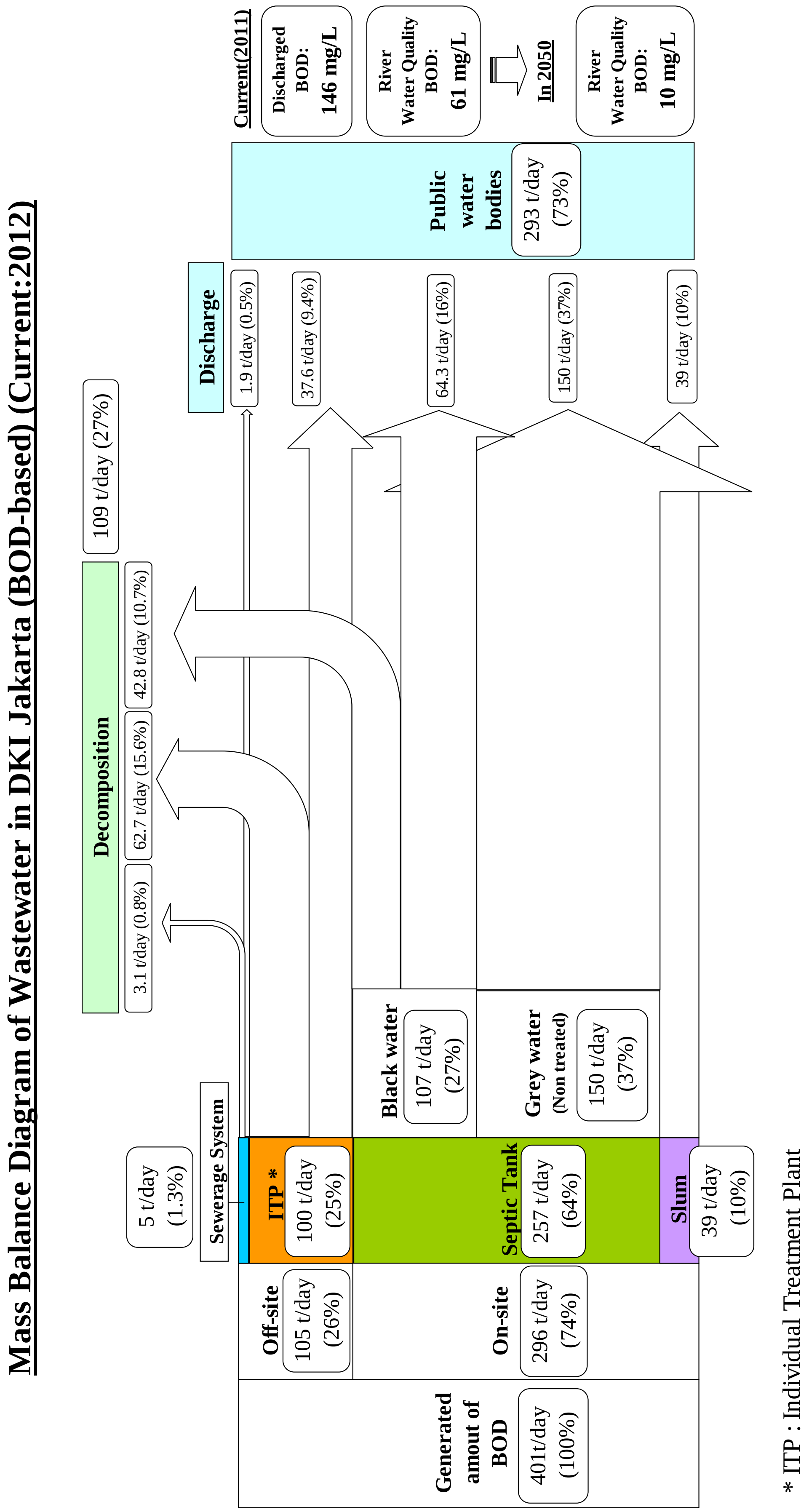
Classification	Category	Type of Wastewater	Population		BOD		
			Night-Time	Day-Time	Generated Amount	Removal Amount	Discharged Amount
			PE*10^3	PE*10^3	t/day	t/day	t/day
Off-site	Sewerage	B W& GW	168 (2%)	168 (1%)	5.0 (1.3%)	3.1 (0.8%)	1.9 (0.5%)
	ITP	BW & GW	-	3,345 (25%)	100.3 (25.0%)	62.7 (15.6%)	37.6 (9.4%)
On-site	Septic Tank	BW	8,567 (85%)	8,567 (64%)	107.1 (26.7%)	42.8 (10.7%)	64.3 (16.0%)
		GW			149.9 (37.4%)	0.0 (0.0%)	149.9 (37.3%)
	Slum	BW & GW	1,300 (13%)	1,300 (10%)	39.0 (9.7%)	0.0 (0.0%)	39.0 (9.7%)
Total			10,035 (100%)	13,379 (100%)	401.4 (100%)	108.7 (27%)	292.7 (73%)

Source: JICA Expert Term

Table D4-9 SS Mass Balance of Wastewater Treatment in DKI Jakarta (2012)

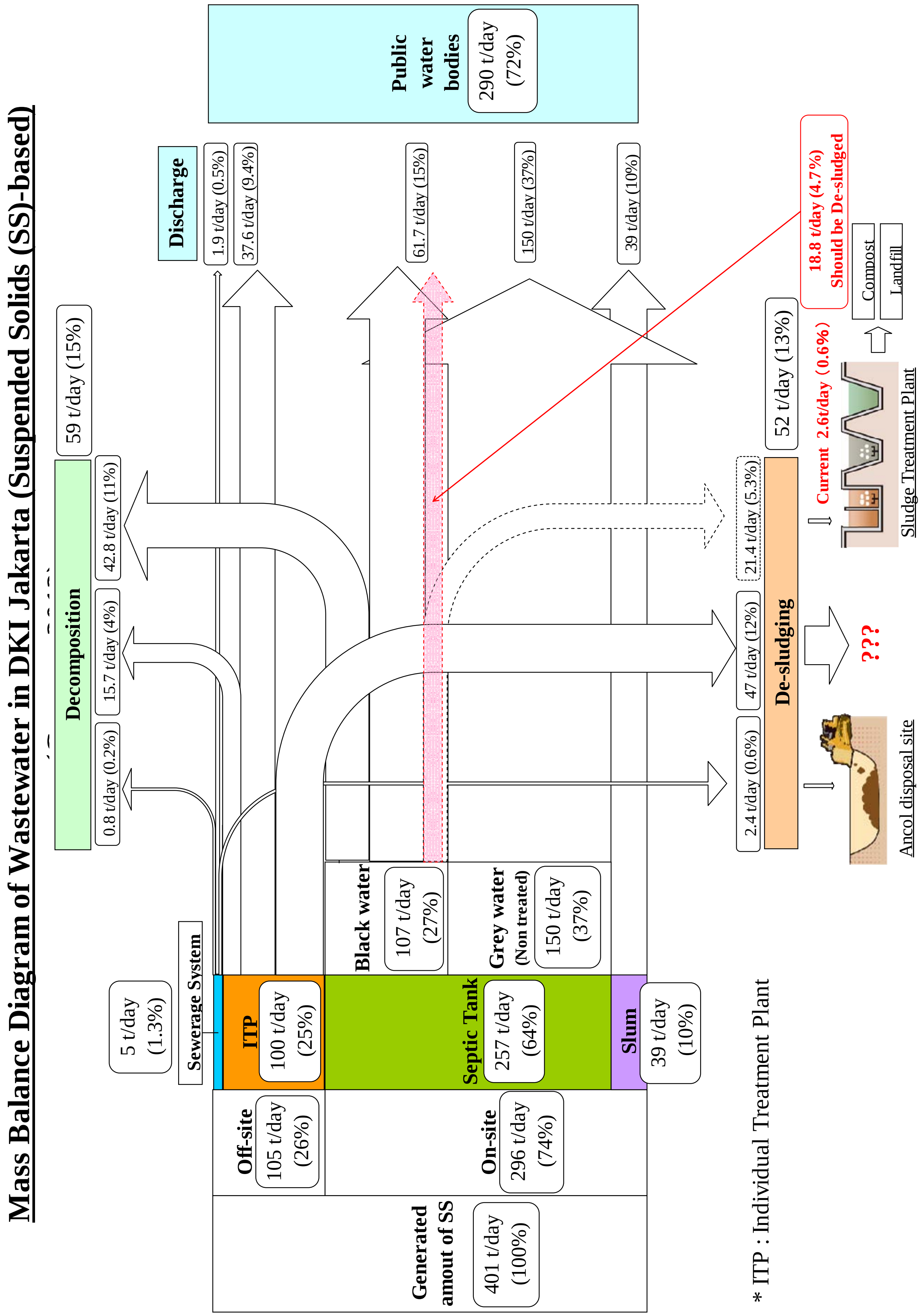
Classification	Category	Type of Wastewater	SS				
			Generated Amount	Removal Amount			Discharged Amount
					Decomposition Amount	Desludging Amount	
			t/day	t/day	t/day	t/day	t/day
Off-site	Sewerage	B W& GW	5.0 (1%)	3.1 (0.8%)	0.8 (0.2%)	2.4 (0.6%)	1.9 (0.5%)
	ITP	BW & GW	100.3 (25.0%)	62.7 (15.6%)	15.7 (3.9%)	47.0 (11.7%)	37.6 (9.4%)
On-site	Septic Tank	BW	107.1 (26.7%)	45.4 (11.3%)	42.8 (10.7%)	2.6 (0.6%)	61.7 (15.4%)
		GW	149.9 (37.4%)	0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	149.9 (37.4%)
	Slum	BW & GW	39.0 (9.7%)	0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	39.0 (9.7%)
Total			401.4 (100%)	111.3 (28%)	59.3 (59.3%)	52.0 (13%)	290.1 (72%)

Source: JICA Expert Term



Source: JICA Expert Term

Figure D4-1 BOD Mass Balance (M/B) of Wastewater Treatment in DKI Jakarta (2012)



Source: JICA Expert Term

Figure D4-2 SS Mass Balance (M/B) of Wastewater Treatment in DKI Jakarta (2012)

D4.4 Changes in BOD and SS (Solid Matter Volume) Resulting from Various Measures

D4.4.1 Measures

Table D4-10 shows four major issues concerning current wastewater treatment in DKI Jakarta. Issue No. 4 assumes the development of a sewerage system, while Nos. 1 to 3 concern measures to develop laws and ordinances, reinforce regulations, and improve administrative organizations as well as measures that can be applied based on the establishment of private-sector bodies. Table D4-11 and Table D4-12 shows the results of calculations on how BOD and SS balance in DKI Jakarta would change if appropriate operation were executed in line with general design values arising from the resolution of these issues.

Table D4-10 Major Issues and Measures

No.	Issue	Measure
1	Onsite desludging is implemented on an on-call basis only.	Implement periodic desludging
2	Septic tank-based treatment handles BW only	Replace with modified septic tanks that handle general wastewater treatment (BW and GW).
3	ITP are not appropriately operated and desludging is rare.	Operate ITP appropriately and perform desludging based on stronger ITP management.
4	Almost no sewerage facilities exist.	Develop sewerage facilities.

Source: JICA Expert Term

D4.4.2 Estimations of Changes in BOD and SS

Table D4-11 and Table D4-12 show the estimated changes in BOD and SS following the implementation of each measure.

According to Table D4-11, implementation of periodic desludging of septic tanks (Item 1), for example, can reduce BOD amount by 21 tons/day. This is equivalent to the amount achievable by the construction of a wastewater treatment plant serving approximately 980,000 people. Moreover, switching to improved septic tanks (Item 2) could achieve a reduction equivalent to a plant serving 3.9 million people, and stronger ITP management (Item 3) could achieve an amount equivalent to a plant for 1.3 million people. This means that, although building the sewerage system of Item 4 is the ultimate goal for the future, it will be important to promote a systematic wastewater treatment policy covering each phase by combining sewerage system development (which requires capital investment and many years to lay a vast pipeline network and build treatment facilities) with the measures to develop laws and ordinances, reinforce regulations, and improve administrative organizations presented in Items 1 to 3.

On the other hand, as is shown in Table D4-12, the implementation of BOD reduction measures means that the amount of SS that must be removed and disposed from each facility will increase dramatically. In other words, it shows that the management of wastewater requires measures that consider not only wastewater treatment but also treatment and disposal of increasing amounts of sludge.

Table D4-11 Changes in BOD Discharged into Rivers Following Implementation of Measures (Estimate 2012-based)

Countermeasure	BOD Amount			BOD (mg/L)	
	Legends; Measured subject of processing type / Others			Discharged	River water quality
1.Regular Desludging (100%)	Current	Septic Tank	293 t/d	146 mg/L	61 mg/L
			▼22 t/d	▼11	▼4
	Result	Septic Tank	271 t/d	135 mg/L	57 mg/L
2.Reform CST to Appropriate System(100%)	Current	Septic Tank			
		Septic Tank	▼86 t/d	▼43	▼18
	Result		207 t/d	103 mg/L	43 mg/L
3.Appropriate operation of ITP	Current	ITP			
			▼28 t/d	▼14	▼6
	Result		265 t/d	132 mg/L	55 mg/L
4.Sewerage (80% area)	Current	All of types			
			▼237 t/d	▼118	▼49
	Result		56 t/d	28 mg/L	12 mg/L

Source: JICA Expert Term

Table D4-12 Changes in Removed SS Following Implementation of Measures (Estimate 2012-based)

Countermeasure	SS Amount which should be desludged and transported			SS increment (t/d)	
	Legends; Measured subject of processing type / Others			Desludged SS (t/d)	Transported SS (m^3/d)
1.Regular Desludging (100%)	Current		52 t/d		
			▲19 t/d	19	950
	Result	Septic Tank	71 t/d		
2.Reform CST to Appropriate System(100%)	Current		52 t/d		
			▲49 t/d	49	2,450
	Result	Septic Tank	101 t/d		
3.Appropriate operation of ITP	Current	ITP	52 t/d		
			▲21 t/d	21	1,050
	Result	ITP	73 t/d		
4.Sewerage (80% area)	Current		52 t/d		
			▲200 t/d	(200)	-
	Result	All of types	252 t/d		

* Assumption; Concentration of transported SS is assumed 2%.
Source: JICA Expert Term

D4.5 Setting Short-term, Medium-term, and Long-term Targets and BOD/SS Mass Balance

D4.5.1 Current Situation of River BOD and Target Setting

The results of the above studies were used to establish short-term, medium-term, and long-term off-site and on-site measures as well as their targets.

The BOD of rivers within DKI Jakarta for 2012 was set at 61 mg/L based on the average of actual measured values in year 2011. The long-term target of the New M/P was set at lowering river BOD to around 10 mg/L, which would make it comparably easy to use rivers as a water source, by year 2050. The short- term and medium-term targets were set at 35 mg/L and 25 mg/L, respectively.

The source of BOD load in rivers is not only within DKI Jakarta but also includes BOD influent from neighboring cities located upstream from DKI Jakarta. Consequently, the self-purification effect of rivers (diluting effect) was set at 3.0 times based on the relationship between wastewater BOD currently discharged into rivers (146 mg/L) and river BOD (61 mg/L), with consideration given to the average of upstream river BOD near the administrative border of DKI Jakarta of 18 m/L (average of actual measured values in year 2011).

D4.5.2 Target Values Set for Each Measure

The following target values are set for achieving the river BOD levels described above.

(1) Sewerage development rate: The short-term, medium-term, and long-term targets are 10%, 30%, and 80%, respectively.
(2) Periodic desludging rate for septic tanks: The short-term, medium-term, and long-term targets are 50%, 75%, and 100%, respectively.
(3) Replacement rate of Conventional Septic Tank by Modified Septic Tank for general effluent treatment (BW + GW): The short-term, medium-term, and long-term targets are 25%, 50%, and 100%, respectively.
(4) Open defecation elimination rate in slums: The short-term target is 100% (This target reflects the fact that Indonesia has set a nationwide goal of eliminating open defecation by 2014. It should be noted, however, that measures to achieve this goal are outside the scope of the New M/P.)

D4.5.3 General Overview of the Target Years

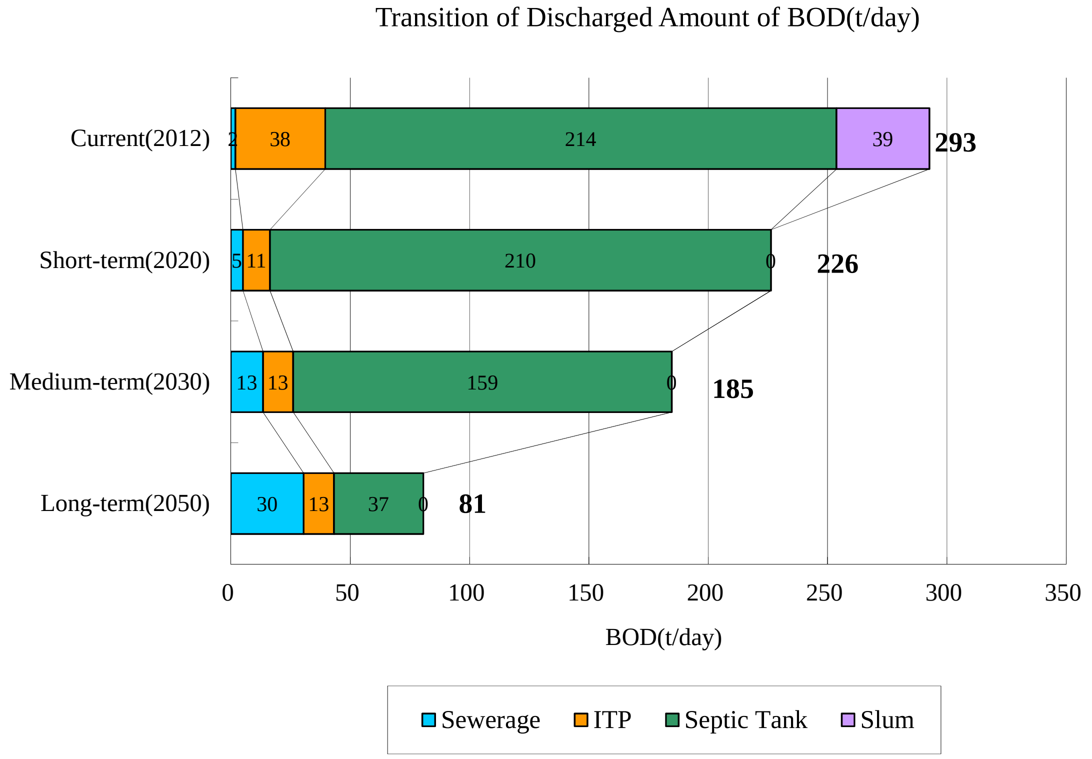
Table D4-13 provides a schedule for each target year. Figure D4-3 provides predictions of BOD discharged into rivers and removed SS. Action plans for each on-site and off-site measure will be formulated based on these schedules.

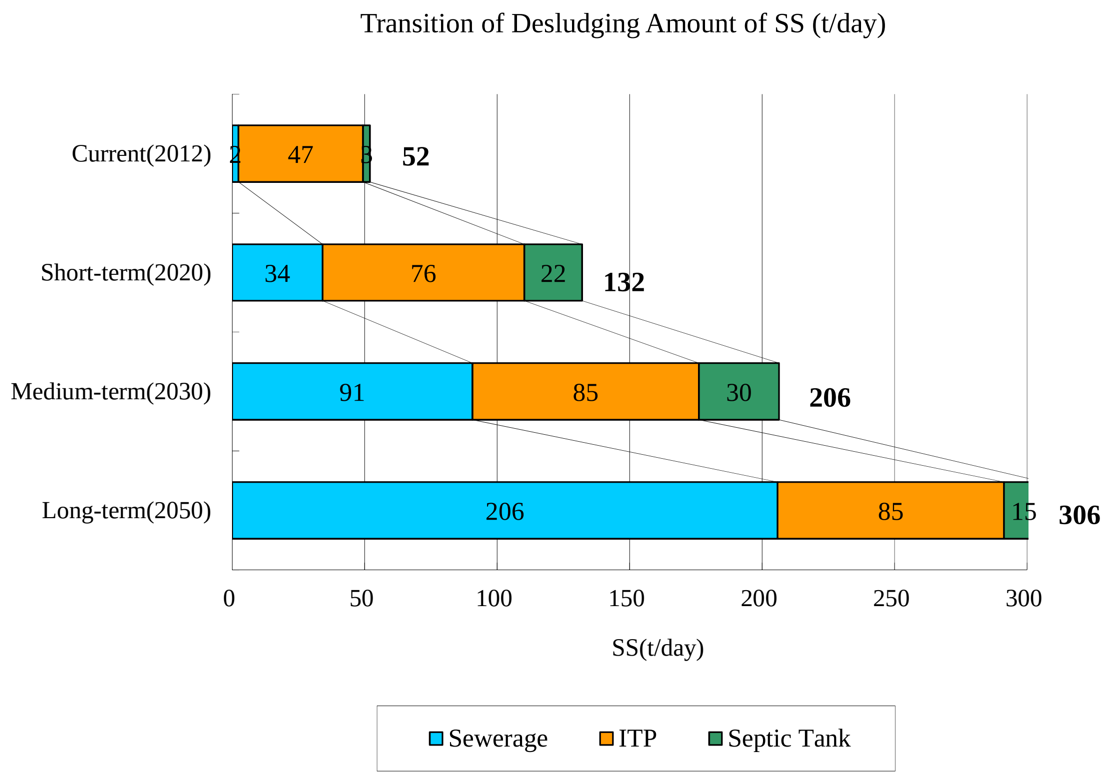
Table D4-13 Targets for Each Stage and Amount of BOD & SS

Items			Current			Short-term			Medium-term			Long-term		
Year			2012			2020			2030			2050		
Population (person*10^3)			10,035			11,284			12,665			12,665		
The unit amount of wastewater (L/day/per)			150			150			150			150		
Population for Wastewater Treatment (including floating population) (person*10^3)			(13,379)			(15,046)			(16,887)			(16,887)		
Break-down	Sewerage System		168			1,685			4,478			10,166		
	ITP for business		(3,345)			(3,761)			(4,222)			(4,222)		
	Septic Tank		8,567			9,599			8,288			2,500		
	Slum		1,300			0			0			0		
Amount of BOD or SS (t/day)			Generate BOD	Desludging SS	Effluent BOD	Generate BOD	Desludging SS	Effluent BOD	Generate BOD	Desludging SS	Effluent BOD	Generate BOD	Desludging SS	Effluent BOD
	Sewerage System		5	2	2	51	34	5	134	91	13	305	206	30
	ITP for business		100	47	38	113	76	11	127	85	13	127	85	13
	Septic Tank (Black water)		107	3	64	120	13	63	102	16	51	31	6	16
	Septic Tank (Gray water)		150	0	150	168	8	147	143	16	107	44	9	22
	Slum		39	0	39	0	0	0	0	0	0	0	0	0
	Total (t/day)		401	52	293	451	132	226	507	206	185	507	306	81
Load of BOD (g/per/day)			40.0	-	21.9	40.0	-	15.0	40.0	-	10.9	40.0	-	4.8
Concentration of BOD (mg/l)			267	-	146	267	-	100	267	-	73	267	-	32
Dilution rate			3.0			3.0			3.0			3.0		
River Water Quality (BOD)			61*			33			24			10		
Target	Target of River Water Quality (BOD)		-			45			30			10		
	Served Population for Off-Site		2%			15%			35%			80%		
	On-site	Regular Desludging	-			50%			75%			100%		
		Change CST to MST	-			25%			50%			100%		
	Slum	Open Defecation dissolution Ratio	-			100%			100%			100%		

* Average value of river water quality inside Jakarta measured in year 2011

Source: JICA Expert Term





Source: JICA Expert Term

Figure D4-3 Transition of the Amount of Discharged BOD and Desludging SS

D5 Introduction of Regular Desludging

D5.1 Basic Consideration on Domestic On-site Treatment System in DKI Jakarta

In a large city, septic tanks do not have sufficient performance to work as a domestic on-site treatment system. Accordingly, it is recommended to ban the tanks from being used or reduce their number by introducing connections with sewers or aerobic type individual wastewater treatment system (johkasou etc.), that works as a high-performance on-site treatment system. This master plan aims to address issues in the septic tank by connecting as many houses as possible to sewers all over Jakarta by 2050. It takes a long time to construct sewage works. Therefore, the on-site plan included in the master plan proposes the improvement of the structure and maintenance of septic tanks and, particularly, the introduction of regular desludging while focusing on the minimization of problems the tanks have until they are replaced with connections with the sewage system.

Aerobic type individual wastewater treatment system (johkasou etc.) is hardly installed in houses in Jakarta, but has already been used in many commercial facilities. If the system is maintained appropriately, they display good performance. Making aerobic type individual wastewater treatment system work well as a domestic wastewater treatment system requires increasing family's income levels, building up a maintenance system with specialized companies, and establishing a regular desludging system. However, Jakarta has a high population of poor people and has not yet established such systems, so it has no environment in which aerobic type individual wastewater treatment system is introduced to many houses. As a result, this master plan does not consider aerobic type individual wastewater treatment system a standard on-site treatment system for household use. This does not mean that Jakarta has no possibility of raising the living level of citizens and awareness of the environment, of improving the structure and maintenance of septic tanks to be described below, and of introducing and establishing a regular desludging system, which would provide a favorable environment for acceptance of aerobic type individual wastewater treatment system.

D5.2 Prior Examples of Regular Sludge Extraction Systems

Obligation to extract sludge regularly to effectively increase desludging rate requires introduction of various systems to control regulations and incentives skillfully. Prior examples may be helpful to work on concrete action plans. Japan and Malaysia have records of regular sludge collection, so it is recommended that these records be investigated to introduce a highly feasible and effective system. As shown in Table D5-1 and Table D5-2, both countries issue laws, regulations, mechanisms, and guidelines for regular sludge extraction.

Table D5-1 Japanese System for Extracting Sludge from Johkasou

Action	Law and regulation	Concrete rule and system	Guideline, instruction, and incentive
Installing johkasou	• Application and certification as per Johkasou Law • Confirmation as per Building Standard Law	• Grant-in-aids for change • Regulations for installing johkasou	• Concrete description of subsidies • Johkasou installation guidelines
Maintenance and inspection	• Johkasou Law obliges johkasou owners to let licensers perform maintenance and inspection.	• Requirements for obtaining license • Technical and maintenance standards	• Maintenance guidelines • Inspection guidelines
Desludging	• Johkasou Law obliges johkasou owners to let licensers desludge.	• Requirements for obtaining license • Technical and maintenance standard	• Sludge extraction guidelines
Training workers	• Johkasou Law obliges johkasou installers and inspectors to obtain licenses through testing and training. Designated Institute System defines testing and training organizations.	• Requirements for obtaining license • Vendor's responsibilities • Penalty rules	• Work procedures for operators • Good vendor award system • Training

Source: JICA Expert Term

Table D5-2 Malaysian System for Extracting Sludge from Septic Tanks

Action	Law and regulation	Concrete rule and system	Guideline, instruction, and incentive
Installing septic tank	• National policy shows gradual reduction in number of septic tanks.	• Fine of up to USD 140,000 or imprisonment of up to 5 years is given if septic tank is modified or disconnected without SPAN's approval.	• Guidelines for septic tank developers specify that (1) A septic tank shall not be developed as a sewerage system for not less than 30 houses or 150 users, (2) Talk with IWK is necessary if there is a future plan for connecting with a sewer within 30 meters, and (3) An on-site treatment facility shall be added to a septic tank that discharges treated water into an important water area.
Maintenance and inspection	• Wastewater Service Law obliges septic tank owners to perform correct maintenance.	• Wastewater Service Law obliges septic tank owners to make tank accessible for maintenance and desludging.	
Desludging	• National policy shows obligation to extract sludge regularly. • Responsibility-taking system is clearly defined to promote regular sludge extraction. • Wastewater Service Law requires sludge extraction once every 3 years as per national act.	• Fine of up to USD 14,000 is given for violation of maintenance or desludging. • Sludge extraction charge given to members is lower than that given to nonmembers.	• Guidelines for septic tank developers require septic tanks to be designed and arranged in consideration of regular sludge extraction.
Training workers	• Obligation to train workers • Wastewater Service Law requires authorized vendors to clean septic tanks.		

Source: JICA Expert Term

As shown above, the Japanese Johkasou Law specifies sludge extraction systems and guidelines. The law applies to johkasou and the system is divided into subsystems. Malaysia is similar to Indonesia in terms of religion and culture, so the table above shows requirements that DKI Jakarta should initially work on when introducing a regular sludge extraction system. The following describes regular sludge extraction in Malaysia as an example.

D5.2.1 History of Regular Sludge Extraction in Malaysia

Among developing countries, Malaysia shows an example of regularly extracting sludge from septic tanks. In 2005, the Malaysia sewerage connection was 73 percent; the remaining 27% were connected with septic tanks, and sludge was regularly extracted from 50 percent of them. This was attained through a series of legal modifications and an action model. The following describes the history of the regular sludge extraction in detail. First, to offer sewerage services more complicated than drinking water services, the former was centralized and all sewerage facilities were transferred to the national government in 1993. After that, the government promoted privatization and commissioned Indah Water Konsortium (IWK) to offer sewerage services. However, the government acquired IWK in 2000, and the latter, as a government-managed corporation, has constructed sewerage systems, extracted sludge, and built sludge treatment facilities. The following shows the history of sludge management in Malaysia.

1) Before independence, the local governments were responsible for sewage control.

2) After independence, wastewater was controlled differently between urban and rural areas. The city government and the Ministry of Health were in charge of the former and latter, respectively.
3) In 1993, the Sewage Service Act (SSA) was enforced and Sewage Service Department (SSD) was organized as a control agency.
4) Until 1994, 144 local governments had offered and controlled sewerage services.
5) After April 1994, IWK controlled wastewater in most of the states in the Malay Peninsula.
6) In June 2000, the Ministry of Finance determined that the government took over IWK's right of control.
7) In January 2008, the National Water Services Commission (Suruhanjaya Perkhidmatan Air Negara: SPAN) was established and the implementation of the Water Service Industry Act (WSIA) enacted in 2006, was reinforced.
8) Currently, IWK controls wastewater in 88 of 144 municipalities in Malaysia.

D5.2.2 Laws and Systems for Regular Sludge Extraction

The Sewage Service Act (SSA), enforced in 1993, defines core policies of Malaysian wastewater management and requires septic tank owners to perform proper maintenance. To put it more concretely, the act obliges owners to keep their septic tanks in good conditions by maintaining all the components, by extracting sludge once every two years, and by making a request to authorized service companies for cleaning the tanks. It also requires access to the tanks to make these activities possible.

Moreover, the Water Service Industry Act (WSIA) was enforced on January 1, 2008 to take the place of the SSA. Sludge management guidelines were developed and announced in accordance with the WSIA. They changed the desludging frequency from once every two years to once ever three years, because IWK showed that the function of the tank did not vary even when the frequency exceeded two years.

D5.2.3 Charges and Fines

Households that join the regular sludge extraction program shall pay USD1.7 as a wastewater charge. This is lower than a sewage charge of USD2.2. Households other than the participants shall pay money every time sludge is extracted. The charge is USD106 per time on the condition that the maximum tank size is 2 m^3.

The Water Service Industry Act (WSIA) defines a fine to prevent owners from committing any violation. If found in violation of maintenance or sludge extraction requirements, a septic tank owner shall pay a fine of less than USD14,000. This is because the WSIA has changed the person responsible for regular sludge extraction from the service provider (IWK) to the owner.

This year marks the third year since the desludging frequency was changed to three years in 2008, so it is said that the desludging ratio will increase.

D5.2.4 IWK's Regular Sludge Extraction

(1) IWK's Action System and Records of Accomplishment

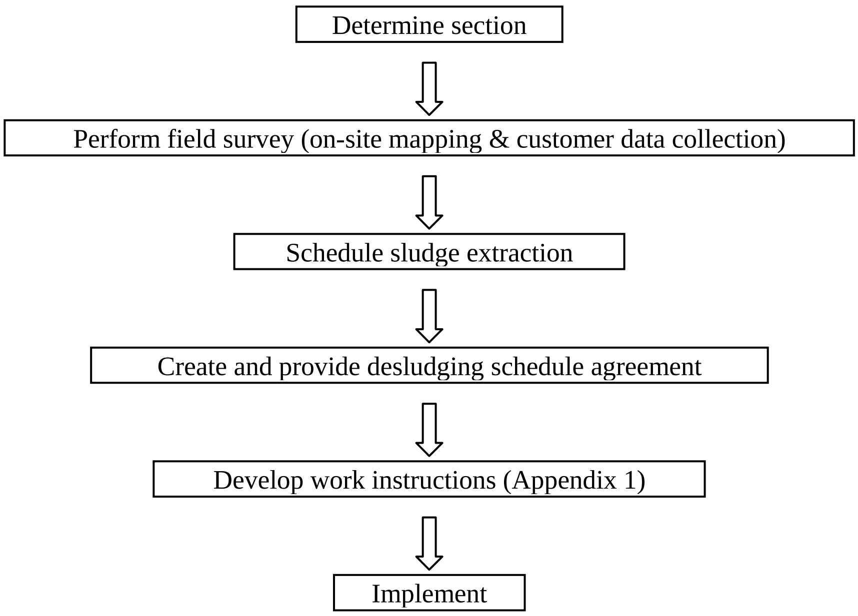
IWK has 18 unit offices, 48 reporting centers, 3 assay laboratories, 11 certification offices, and 4 local planning offices throughout the country. It also has 2,800 employees. The organizations maintain part of all the sewage treatment facilities in Malaysia the number is about 5,800.

Concerning septic tanks, the 18 unit offices use a customized system to receive and control inquiries, requests, and complaints from customers and to offer a regular sludge extraction service. Malaysia has one million septic tanks and sludge is extracted from 400,000 houses 40 percent of them. IWK has 220 tank trucks, each having a capacity of 2.5 m^3, 4.5 m^3, or 11 m^3. It is obliged to extract sludge but has no responsibility for maintenance and water quality. Concerning the remaining septic tanks (600,000 houses holding a 60% share) that are not under IWK control, private companies issued licenses from

SPAN extract sludge.

(2) Action Procedures

Sludge is extracted from seven septic tanks per day on average, but the number varies depending on road and traffic conditions, and distance. After a septic tank is installed in a new house, IWK conducts a completion inspection, issues a "Certificate of Fitness," and collects information about the tank. Figure D5-1 shows procedures for extracting sludge.



Source: JICA Expert Term

Figure D5-1 IWK's Procedures for Regular Sludge Extraction

(3) Monitoring and Evaluation (COEDS System)

After sludge extraction, IWK issues to the customer a desludging certificate (S/R PART-D : D5) that shows a record of the extraction. The data is recorded in the COEDS system for computer control. As a result, the system accumulates customer data. COEDS is an abbreviation for Customer Operational Enquiry and Desludging, and the system controls data on septic tanks from which sludge is extracted, information necessary for work, and complaints and service-related requests received from customers.

In addition, to improve desludging quality, IWK conducts a survey of customer's satisfaction (S/R PART-D : D5), prepares a sheet for evaluating desludging supervisors (S/R PART-D : D5), and runs training programs for workers (S/R PART-D : D5). If finding any problem after work, IWK sends a letter to that effect to the customer (S/R PART-D : D5). These documents make it possible to monitor and evaluate the sludge extraction service.

(4) Enlightening Activities

To promote regular sludge extraction, IWK conducts enlightening activities through governmental liaisons, advertisement in mass media including newspapers, exhibitions, local activities, interaction with residents, and school programs. The purpose is to let the users understand the importance of regular sludge extraction and the payment of charges.

D5.3 Measures for Introducing a Desludging System in DKI Jakarta

D5.3.1 Development of Laws, Regulations, Guidelines, etc.

The following explains the laws, regulations, guidelines, etc. expected to be required in order for DKI Jakarta to introduce a regular desludging system.

(1) The Structures of Septic Tanks and their Installation

In Japan, the Johkasou Law stipulates the certification of each type of johkasou (septic tank). Every type of septic tank must be certified before it is put on the market. In Indonesia, many improved-type septic tanks are being manufactured and this trend is expected to continue. A septic tank certification system (a similar system to the Japanese system) should be stipulated in the DKI Jakarta sludge control regulations for commercial products in order to guarantee their quality.

Indonesia has a system to check if housing plans meet building standards. The building supervision agency (DB2B) is responsible for checking building plans. The buildings are also inspected by the agency after completion of the construction, but the procedures do not include the inspection of septic tanks. Although the governor's ordinance No. 122 in 2005 stipulates the replacement of traditional septic tanks with improved septic tanks, there is no procedure for a third party to check implementation on-site. If it is difficult for the agency to check or inspect septic tanks during the building check or the completion inspection, the DKI Jakarta sludge control regulations should include a provision that such checking shall be conducted by the department responsible for sludge treatment.

Many septic tanks are currently installed in places which are difficult to access for maintenance. Therefore, installation locations should be stipulated in guidelines, etc.

(2) Cleaning

The DK Jakarta I sludge control regulations should stipulate that owners of septic tanks are responsible for cleansing the septic tanks.

(3) Desludging

The DKI Jakarta sludge control regulations should require regular desludging and clarify who is responsible for sludge extraction. The septic tank structure guidelines should ensure that the structures are designed to allow smooth sludge extraction from the septic tanks.

(4) Training for Implementing Workers

In order for septic tanks to function properly to the rated level and not cause groundwater contamination, those who conduct desludging operations need to have a specific level of skills. Those who engage in the regular collection and transportation of sludge need to have expertise because their work affects hygiene and health. In addition, in order to protect those workers, the DKI Jakarta sludge control regulations should include provisions which prevent excessive competition by introducing a licensing system and restricting the participation of newcomers.

The following table summarizes the above-mentioned proposals for provisions which need to be stipulated in the sludge control regulations and guidelines in order to launch a regular desludging system.

Table D5-3 Regular Desludge Proposals

Proposal	Description of the proposal	Regulations and guidelines
Structures of septic tanks and their installation	A septic tank certification system should be stipulated.	DKI Jakarta sludge control regulations
	Checking septic tanks should be stipulated as part of the building check or completion inspection.	DKI Jakarta sludge control regulations
	Septic tanks should be installed in places which are easily accessible for maintenance.	Guidelines
Cleaning	It should be stipulated that owners of septic tanks are responsible for cleaning the septic tanks.	DKI Jakarta sludge control regulations
Desludging	Regular sludge extraction should be made compulsory and it should be made clear who is responsible for the sludge extraction.	DKI Jakarta sludge control regulations
	The structures of septic tanks should be designed to allow smooth sludge extraction.	Guidelines

Table D5-3 Regular Desludge Proposals

Proposal	Description of the proposal	Regulations and guidelines
Training workers	Training and licensing system for the desludging operators and the maintenance vendors for ITP should be established. Training institution should be established.	Guidelines
Other desirable measures	• Commendation system for workers with good practices • Penal provisions	Guidelines

Source: JICA Expert Term

D5.3.2 Human Resource Development

DKI Jakarta does not have a department specialized in household effluent treatment. It does not have enough staff with the knowledge and experience in household effluent treatment. Therefore, even if laws, regulations and guidelines are developed for implementing regular desludging, only a few staff members have the abilities needed to utilize the regulations and guidelines. When the regular desludging system starts, many private businesses will participate in the desludging project. This will require officials who will control and supervise the operations of these businesses. Therefore, in parallel to the introduction of the regular desludging system, it is an urgent task to conduct human resource development.

D5.3.3 Regular Desludging Introduction Plan

The introduction of the full scale regular desludging system will start in 2014. A trial introduction will be conducted and a set of DKI Jakarta sludge control regulations will be established by 2014. The experiences and knowledge obtained through the trial introduction will be utilized when developing the regulations. A septic tank certification system will be established before the full-scale introduction of the regular desludging system, in order to ensure the quality of the septic tanks on the market. Once the full-scale system is launched, it will be essential for many private businesses to participate in the operations. Therefore, registration and training systems for the operators will start and training will be conducted as the introduction of the regular desludging system progresses. Table D5-4 shows the implementation schedule for the full-scale regular desludging.

Table D5-4 Planned Schedule for the Full-scale Introduction of Regular Desludging

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Trial introduction of regular desludging	↔	↔							
Development of draft DKI Jakarta sludge control regulations	↔	↔							
Establishment of DKI Jakarta sludge control regulations			↔						
Full-scale implementation of regular desludging			↔	↔	↔	↔	↔	↔	↔
Implementation of the septic tank (ST) certification system	↔	↔							
Registration of ST cleaners (including training and exams)		↔	↔	↔	↔	↔			
Registration of ST desludging workers (including training and exams)		↔	↔	↔	↔	↔			
Development of a regular ST desludging plan		↔							

Source: JICA Expert Term

D6 Design Criteria

D6.1 Off-Site System

D6.1.1 Hydraulic Conditions

The design criteria are not inclusive of all criteria that will be required for final design and construction. The design criteria for hydraulic, sewers & manholes and pumping station are limited to those criteria required for planning purposes only. More extensive criteria should be identified during F/S of the Project. Similarly, multiple pipe and manhole construction materials are listed as potentially allowable; however, final selection of appropriate materials will be dependent on further detailed analysis and evaluation of alternative materials.

Recommended hydraulic considerations are listed in the following table.

Table D6-1 Recommended Hydraulic Considerations

Type of Pipe	Item	Condition
Gravity pipes	Manning's formula	$V = 1/n\ R^{2/3}S^{1/2}$
	Roughness factor	RCC n = 0.013 new pipe PVC n = 0.010 new pipe
	Minimum velocity	0.60 m/s average flow 0.80 m/s ultimate flow
	Maximum velocity	3.00 m/s
	Maximum depth	d/D = 0.8 at ultimate peak flow
Pressure pipes	Hazen William's formula	$V = 0.85\ CR^{0.63}\ S^{0.54}$
	Roughness factor	C = 100 for cast iron pipe C = 110 for PVC pipe
	Minimum velocity	0.8 m/s
	Maximum velocity	3.0 m/s

Source: JICA expert team

D6.1.2 Sewers and Manholes

Recommended design criteria for sewers and manholes are listed in the following table.

Table D6-2 Recommended Design Criteria for Sewers and Manholes

No	Item	Design Criteria
1	Peaking factor (PF) (Typical Factors)	$PF = 4.02*(0.0864*Q)^{-0.154}$
2	Minimum Pipe Diameter	200 mm
3	Minimum Cover Over Top of Pipe	1.0 m
4	Potential Gravity Flow Pipe Materials Diameter < 350 mm Diameter > 350 mm	 RCC, PVC, HDPE, FRP/GRP RCC, PVC, HDPE, Brick, FRP/GRP
5	Manhole Size Pipe Diameter < 450 mm Pipe Diameter > 450 mm Pipe Diameter > 900 mm to = 1350 mm Pipe Diameter > 1350 mm	 Manhole Diameter = 1.22 m Manhole Diameter = 1.52 m Manhole Diameter = 1.83 m Special Design
6	Maximum Manhole Spacing Pipe Diameter < 200 mm Pipe Diameter = 200 mm to < 500 mm Pipe Diameter = 500 mm to < 1,000 mm Pipe Diameter > 1,000 mm	 50 m to 100 m 100 m to 125 m 125 m to 150 m 150 m to 200 m
7	Potential Manhole Materials 0 to 4 m Deep > 4 m Deep	 Brick, RCC, HDPE RCC, HDPE

Source: JICA expert team

D6.1.3 Load Factors for WWTPs

Treatment capacity of WWTPs is determined by the daily maximum wastewater volume. The daily maximum wastewater volume is calculated as dividing the daily average wastewater volume by the load factor. Load factor is the ratio of the daily average wastewater volume to the daily maximum wastewater volume, and generally is 0.7 to 0.8.

In the Spatial Plan 2030, the daily variation coefficient for water supply is set as 1.2, however, its calculation basis is unknown. Considering the lifestyle in Indonesia, the seasonal change is small, but the volume of water use would be largely change through a year because there are many various religious events (especially the period of Ramadan). Therefore, load factor is determined as 0.75 which is the reciprocal of the daily variation coefficient with margin of safety ratio 10%.

However, in the F/S stage, daily variation coefficient should be examined in detail using the latest data and information and the most practicable load factor suitable for DKI Jakarta shall be adopted.

Load factor = Daily average wastewater volume / Daily maximum wastewater volume = 0.7 to 0.8 Daily maximum wastewater volume = Daily average wastewater volume / Load factor (= 0.75)

D6.1.4 Pumping Facilities

Recommended design criteria for pumping facilities are listed in the following table.

Table D6-3 Recommended Design Criteria for Pumping Facilities

No	Item	Design Criteria
1	Peak Factor	2.0 for large stations
2	Maximum Wet Well Detention Time	30 minutes at Average Flow
3	Minimum Detention Time	5 minutes at Peak Flow
4	Pumps	All pumps of the same capacity at peak flow. Standby capacity at least 50% of duty capacity
5	Screening	Screening Chamber Required
6	Pumping Station Piping	Ductile Iron (DI) or Cast Iron (CI)
7	Rising Mains Alternative Materials	DI, PVC, HDPE, CI
8	Rising Main Flow Velocities	Minimum Velocity = 0.6 mps Maximum Velocity = 2.4 mps

Source: JICA expert team

D6.1.5 WWTPs

(1) Design Influent Quality

The actual past field data on domestic wastewater quality in DKI Jakarta is almost non-existent. In the old M/P, the wastewater quality of a mixture of toilet wastewater and gray water was estimated to be 224 mg/L as BOD and the design influent/wastewater quality was adopted as 200 mg/L as BOD considering the dilution effect of ground water infiltration (about 10% of the wastewater) in the sewer network. In JWDP 2001, the design influent and effluent quality was 210 mg/L as BOD and 30 mg/L as BOD, respectively.

In Review Master Plan 2009, the design influent and effluent quality was 213.31 mg/L as BOD, 124.52 mg/L as SS and 20 mg/L as BOD, respectively. The design quality for the proposed WWTP of capacity 21,600 m^3/day (or 250 L/second) at the East Setiabudi pond site is 250 mg/L as BOD for influent and less than 25 mg/L as BOD and less than 50 mg/L as TSS for effluent.

A survey for wastewater (influent) quality was conducted in a small scale WWTP in Malakasari by the JICA long term expert. The survey result showed that the influent BOD was around 154 mg/L using the composite sampling method. The residents of Malakasari which are serviced by the small scale WWTP are mostly medium income households. For the variation in the influent quality as seen above, it should be noted that the influent quality depends on the characteristic of each sewerage zone, for example the type and ratio of residential, commercial, institutional and industrial area in each sewerage zone.

Based on above data & consideration, a representative value of 200 mg/L as BOD and 200 mg/L as SS has been proposed in this new MP as the design influent/wastewater quality. For the actual wastewater/influent quality, survey should be conducted during the F/S, implementation/design stage.

Design influent quality: BOD 200 mg/L SS 200 mg/L

(2) Design Effluent Quality

The quality standards for liquid waste for the communal wastewater treatment in DKI Jakarta (Governor's Decree No. 122 in 2005) is 50 mg/L as BOD, 10 mg/L as ammonia and 50 mg/L as TSS. However, there are no quality standards as yet in DKI Jakarta for off-site sewage treatment plants.

Internationally, criteria and standards for "secondary treatment" range from 20 to 30 mg/L for BOD and from 20 to 30 mg/L for TSS. And most of the technologies meet these criteria and standards for secondary treatment. The JICA Project Team would adopt effluent discharge standards for BOD and TSS initially at 20 mg/L (daily average).

Design effluent quality:	BOD 20 mg/L
	TSS 20 mg/L

Regarding bacteria discharge standards, the JICA Project Team has adopted Group B (drinking water source) standard (Governor's Decree No 582 in year 1995) for BOD (10 mg/L) as the Target river water quality for year 2050. Under Group B, Fecal Coliform standard is 2,000 MPN/100 mL for Fecal Coliform and 10,000 MPN/100 mL for Total Coliform. The effluent discharge standard should be set higher than the river water quality standard due to dilution of the effluent in the river water. The JICA Project Team would adopt the Design effluent discharge standard for WWTP for Fecal Coliform initially at 10,000 MPN/100 mL (maximum). This will require that all WWTPs have some form of disinfection process or tertiary treatment process for reducing the fecal Coliform counts.

Therefore, technology selected shall meet the design effluent discharge standards, which are 20 mg/L as BOD (daily average) and 20 mg/L as TSS (daily average) and 10,000 MPN/100 mL (maximum) as Fecal Coliform. To justify more stringent standard at this time, there are insufficient information. There would be provision of renovation & flexibility in technology for upgradation in the future such as in case of stringent water quality criteria and necessarily to produce industrial grade/non-potable/potable water for recycling wastewater.

1) Technologies for Tertiary Treatment Plants

- Have proven treatment technology
- Are easy to operate
- Have consistent performance
- Have scope of modular expansion
- Have small foot print

2) Necessity for Water Recycle and Meaning of "Zero Discharge" for DKI Jakarta

Necessity for Water Recycle

The entire drainage network in DKI Jakarta, including both rivers and manmade drains, is essentially a combined sewer system, as black and gray water runoff are directly discharged to small or large drains alike. There is virtually no surface body of water in the city which is safe for recreational use or even casual contact. The groundwater too is heavily polluted. The cost of production of drinking water from such heavy polluted water would be significantly high. As a result, there are no significant investments since last 20 years to expand the piped water supply system in DKI Jakarta. Therefore, the piped water supply in DKI Jakarta is still limited to only 50% of the city population in DKI Jakarta. On the other hand, land subsidence in DKI Jakarta is very high. The impact of ground water exploitation is considered to be one of the main reasons of incidents of frequent ground subsidence in DKI Jakarta. Under such serious condition of pollution of water sources and excessive groundwater extraction, water reuse and recycle could be an economic and sustainable solution, which DKI Jakarta should looked into in the future.

Meaning of "Zero Discharge" for DKI Jakarta

"Zero Discharge" in the rivers means all the treated wastewater should be re-used. As stated above, the piped water supply in DKI Jakarta is limited to only 50% of population. As a result there is practice of uncontrolled huge extraction of ground water for all purposes (domestic, institutional, commercial and industrial) in DKI Jakarta, which amount could be two times of the existing piped water supply (based on unconfirmed information). Therefore, if all the treated wastewater is re-used, ground water extraction will also reduce. With the use of all the treated wastewater, river will be cleaner than receiving the treated wastewater of secondary effluent standards.

- Wastewater Recycling for non potable use have several advantages:
  a) Save raw water for potable use
  b) Reduce depleting Ground Water table
  c) Reduce river water contamination
  d) Save bulk water transportation & distribution cost

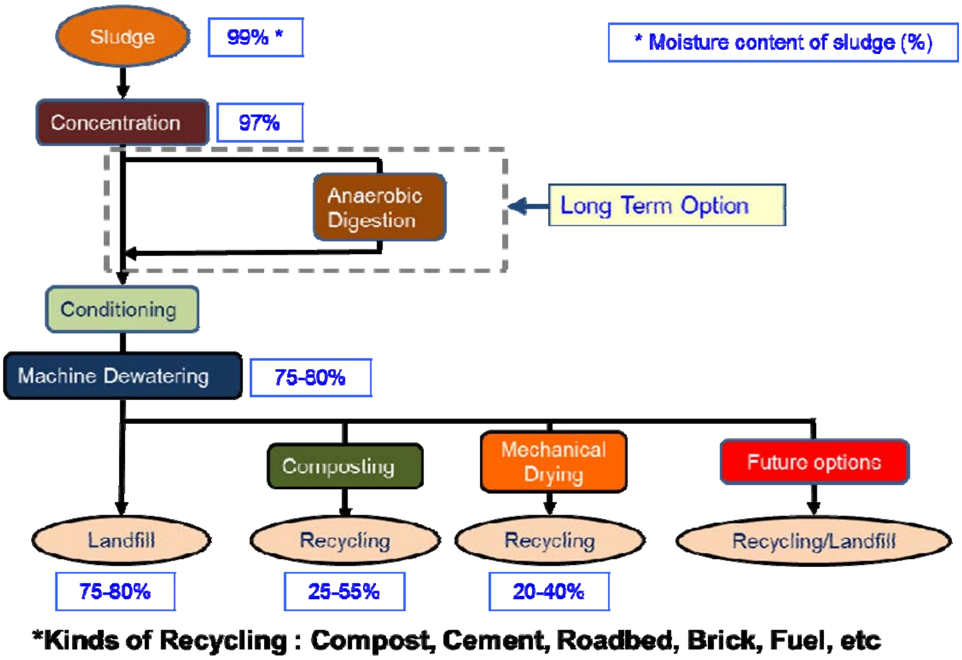
- Recycled wastewater among others can be used for several purposes:
  a) Agricultural irrigation: production agriculture, commercial seedling
  b) Urban Reuse: landscaping/irrigation, parks, schoolyards, offices, golf courses, roads, green areas
  c) For industry: process water, cooling water, boiler feed water and construction work
  d) Automobile workshops
  e) Residential Reuse: toilet, laundry
  f) Groundwater recharge: groundwater recharge, sea water intrusion control.
  g) Recreation and environment function: lakes/pond recharge, fishery
  h) Public facilities: fire extinguisher, toilet water

3) Case Study

In Singapore, three wastewater recycling plants recycle close to 90,000 m^3 per day (about 6.5% of water demand of Singapore). The (local and/or central) government in Singapore tried to promote the recycled sewage water called “NEWater”, through the TV commercial in which the Prime Minister of Singapore drinks “NEWater” to assure the consumers of safety and taste. However, it met with strong opposition from the population. Therefore, above treated water is first returned to the fresh water reservoir, and then treatment of this water from this reservoir is done again for tap water. The bottled “NEWater” is sold at very cheap price compared to the other bottled water.

(3) Sludge Treatment and Disposal Criteria

All sewage treatment facilities produce sludge that must be disposed of in a manner that protects the public health and provides benefit to the local economy or people. The sludge can generate power through biogas production and residual sludge can be composted for using as Organic Fertilizer for Urban/Agricultural Use. The objective of sludge treatment is two-fold. First, the volume and mass of sludge to be disposed will be reduced. And, second, the volatile nature of the sludge will be reduced so that it may be handled without issues of odor and public health. Depending on a number of factors, sludge treatment could range from thickening, anaerobic (or aerobic) digestion, followed by mechanical dewatering; to disposal in facultative lagoons that are intermittently cleaned out; or disposal to sludge drying beds. In case of DKI Jakarta, there is no land for facultative lagoons and sludge drying beds. The sludge produced in WWTP would be thickened, followed by dewatering and disposal in landfill and/or recycle. There are several kinds of recycling such as composting, cement, roadbed, brick, fuel, etc. The sludge digestion facility has not been considered in the New M/P. In the long term when there is sufficient capability build up of PD PAL JAYA to operate and maintain the proposed sewerage system, sludge digestion may be studied at the same WWTP if land is still available or elsewhere. The following figure shows flow diagram of sludge treatment and disposal.



Source: JICA expert team

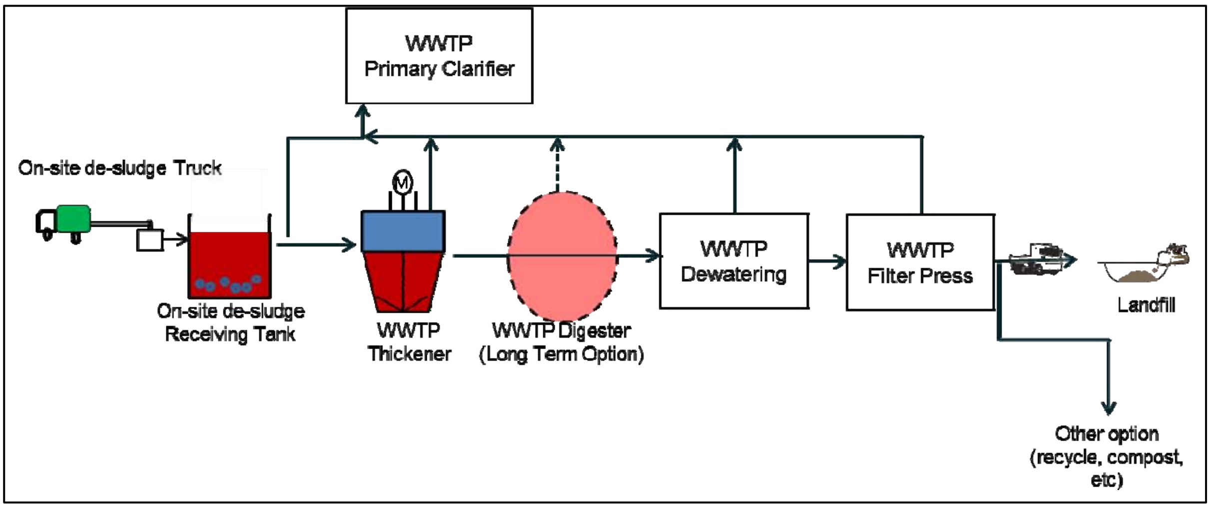
Figure D6-1 Flow Diagram of Sludge Treatment and Disposal

(4) Treatment of On-Site De-sludge

According to the New M/P 80% of design population would be covered by sewerage system and 20% population by 2050 still will be using on-site system. On the other hand, on-site system is scattered all across the DKI Jakarta.

According to the new M/P, after introduction of regular desludging, the amount of de-sludge including ITP de-sludge would increase to 2,370 m^3/day in year 2020, at its peak in year 2030 at 3,887 m^3/day and 1,000 m^3/day in year 2050.

Therefore, all WWTPs facility would be designed to receive the on-site de-sludge over the capacity of separate sludge treatment plants (described elsewhere in this report). The on-site de-sludge truck would be emptied in the storage/receiving tank from where it will be pumped into WWTP thickener followed by dewatering and so on. The following figure shows the flow diagram for treatment of on-site de-sludge.



Source: JICA expert team

Figure D6-2 Flow Diagram for Treatment of On-Site De-sludge

(5) Selection of Treatment Technology

1) Technology Selection Criteria

One of the most challenging aspects of a WWTP design is the analysis and selection of technology capable of meeting the project requirements. The technology will be selected based on compliance with applicable standards. While numerical evaluation is important, other factors are also given due consideration. For instance, effluent quality, process complexity, process reliability, environmental issues and land requirements are evaluated and weighted against cost considerations. The following table shows the considerations for the selection of technology for WWTP.

Table D6-4 Technology Selection Consideration

No.	Considerations	Goal
1.	Treated wastewater quality	The technology must consistently meet the standards as required.
2.	Power requirement	The process choice should consider minimizing power requirements
3.	Land required	Minimize land requirement
4.	Capital cost of plant	Process should allow optimum utilization of capital
5.	Operation & Maintenance costs	Process design should be conducive to attaining lower running cost
6.	Maintenance requirement	Simplicity and reliability
7.	Operator attention	Easy to understand procedures
8.	Load Fluctuations	Plant is able to withstand organic and hydraulic load fluctuations
9.	Reliability	Deliver the desired quality on a consistent basis
10.	Resource Recovery	Ability to minimize operational costs.
11.	Sustainability	Process should be ultimately sustainable

Source: JICA expert team

2) Design Matrix for Selection of Technology

In order to select the treatment technology, the key parameters are evaluated as the following table. The matrix attributes are ranked as "Very Good", "Good", "Average", or "Poor" recognizing that differences between technologies are relative, and often, the result of commonly accepted observations.

Activated sludge treatment facility is mainly categorized as the facility focus type and the O&M focus type. The facility focus type of WWTP is a small scale, or for low population density areas, small service population, and has enough volume of reactor tanks. It does not need a high technology for O&M, so the necessary cost is relatively small. For example, anaerobic-aerobic lagoon process, which is one of the traditional system, and extended aeration process and oxidation ditch process are categorized in this type. On the other hand, in high population density areas, the site is usually limited. However, it is easy to find management engineers. Therefore, the O&M focus type is applied for such areas because the function is optimized and the size of WWTP is relatively small. This type utilizes fully the variation of activated sludge function, such as step-feed biological nitrogen removal process, anaerobic-anoxic-oxic process. Also this type include membrane bio reactor process, which separates activated sludge and treatment water directly by the separation membrane, contrary to the conventional activated sludge process which needs a sedimentation pond for separation.

Table D6-5 Matrix for Selection of Wastewater Treatment Technology

Process	Effluent Quality	Coli forms removal	Nitrification-Denitrification	Phosphorous removal	Process Reliability	Land Use	Ease of Operation	Ease of Maintenance	Electrical Demand	Capital Cost	Track Record
Conventional Activated Sludge Process (ASP)	G	G	P	P	VG	G	VG	VG	AV	G	VG
Anaerobic Anoxic Oxic Process (A_2O)	VG	G	VG	VG	VG	G	G	G	AV	G	VG
Step-feed biological nitrogen removal process	VG	G	VG	VG	VG	G	G	G	AV	G	VG
Sequencing Batch Reactor (SBR)	VG	G	VG	VG	G	G	G	G	AV	G	G
Moving-Bed Biofilm Reactor	G	G	P	P	G	G	G	G	AV	G	G
Membrane Biological Nitrogen Removal Reactor (MBR)	VG	VG	VG	P	VG	VG	P	P	P	AV	AV
UASB + ASP	G	G	P	P	AV	AV	AV	VG	VG	VG	G
Extended Aeration	G	G	P	P	G	P	G	VG	P	VG	G
Aerated Lagoon	G	G	P	P	AV	P	AV	AV	P	VG	G
Stabilization Pond	AV	P	P	P	P	P	G	VG	VG	VG	AV

Note: VG: Very Good, G: Good, AV: Average, P: Poor
Source: JICA Expert Team

Based on the above examination, the following six technologies have been screened for large flow WWTP to select the most appropriate technology under this new M/P;

1) Conventional Activated Sludge Process: ASP

2) Anaerobic Anoxic Oxic Process: A2O

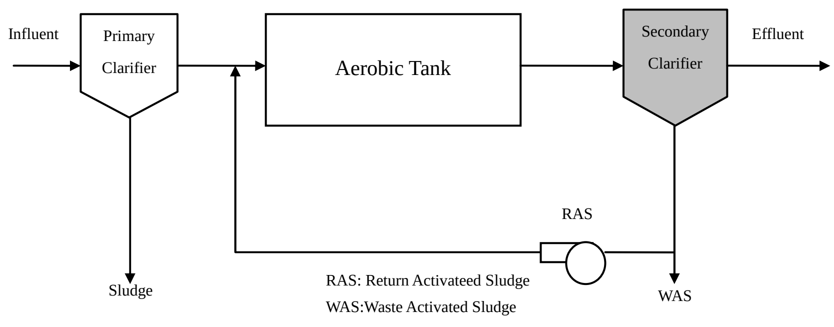
3) Step-feed Biological Nitrogen Removal Process

4) Membrane Biological Nitrogen Removal Reactor: MBR

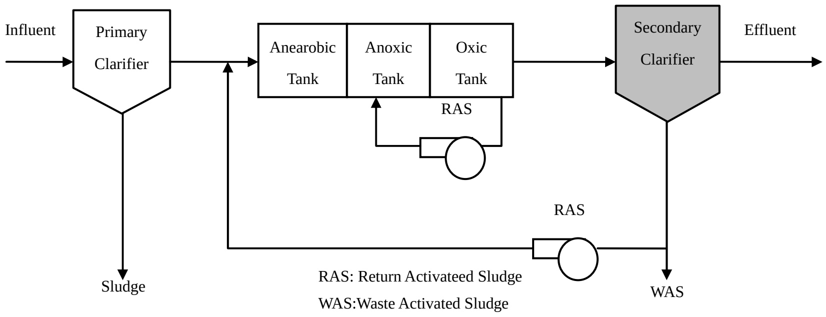
5) Sequencing Batch Reactor: SBR

6) Upflow Anaerobic Sludge Blanket + Activated Sludge Process: UASB + ASP

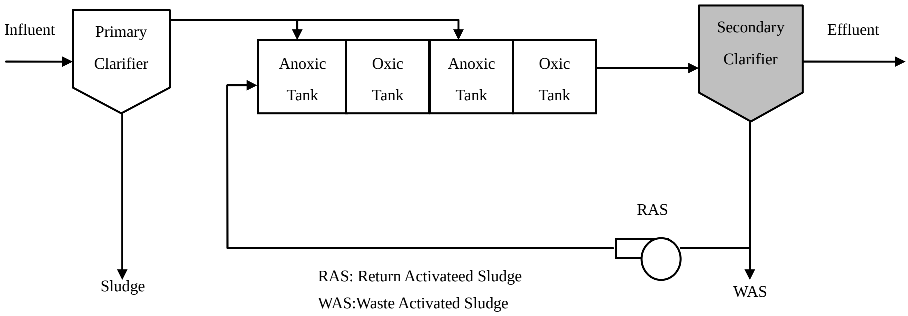
The following figure shows the illustrations of above selected technologies for further examination.



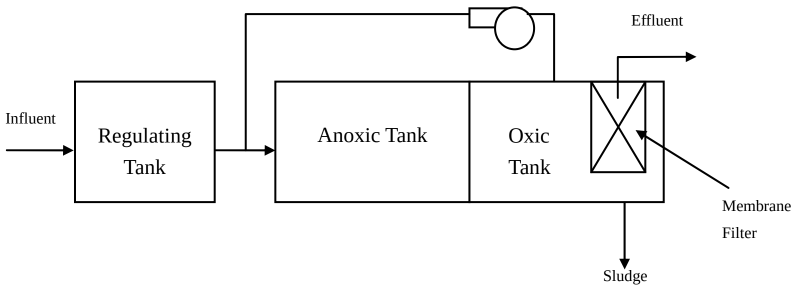
1) Conventional Activated Sludge Process



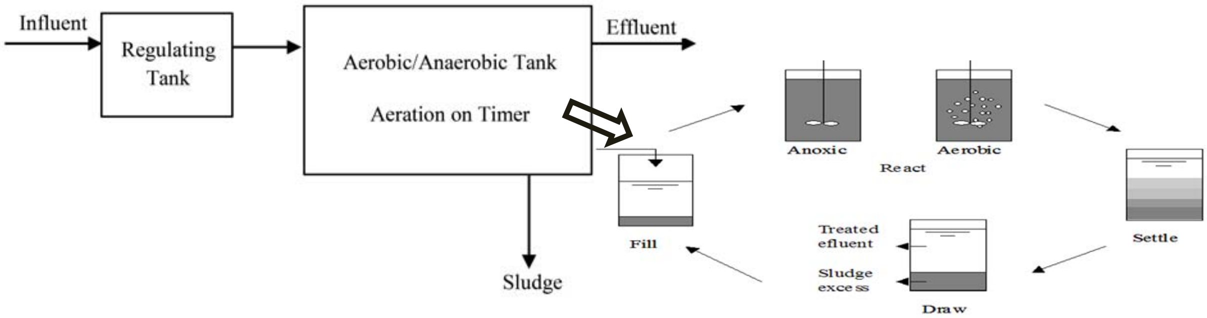
2) Anearobic Anoxic Oxic Process (A2O)



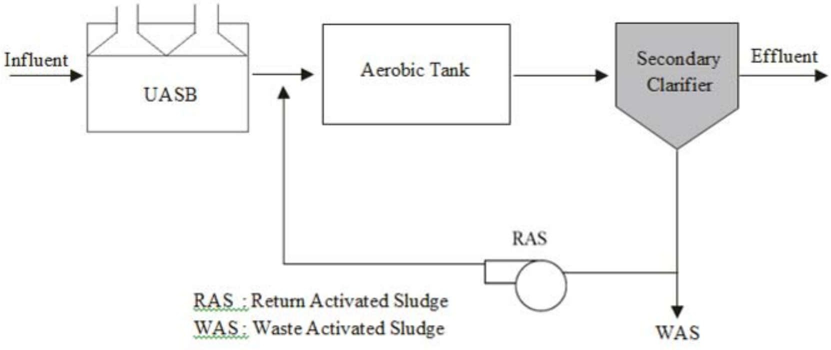
3) Step Feed Biological Nitrogen Removal Process



4) Membrane Biological Reactor (MBR)



5) Sequencing Batch Reactor (SBR)



6) UASB + ASP

Source: JICA expert team

Figure D6-3 Outline Treatment Flow of Selected Technologies

3) Comparison Examination of Selected Treatment Technology

Table D6-6 shows the comparison of above selected technologies for WWTP with a capacity around 200,000 m^3/day based on basic design conditions. For construction of WWTPs, it is the most important that DKI Jakarta should secure the necessary land. Consequently, WWTPs should be O&M focus type. For appropriate operation of activated sludge treatment process, the comprehensive knowledge and experiences on the biological treatment are required. However, DKI Jakarta has very little potential for such knowledge and experiences.

Therefore, in Table D6-6 conditions for facility focus type treatment process are indicated as much as possible. As a biological reactor, the processes and hydraulic retention time to which flexible measures can be taken for O&M for the time being and more severe regulations for water quality in the future are set up.

Table D6-6 Comparison of Selected Technologies

Items		Case-1	Case-2	Case-3	Case-4	Case-5	Case-6
Process		Activated Sludge Process (ASP)	Anaerobic Anoxic Oxic Process (A2O)	Step Feed Biological Nitrogen Removal Process	Membrane Biological Nitrogen Removal Reactor (MBR)	SBR	UASB ＋ASP
Water Quality	BOD	○	○	○	◎	○	○
	SS	○	○	○	◎	○	○
	Nitrogen	×	○	○	○	○	×
Hydroulic Retention Time (h)	Regulating Tank	0.0	0.0	0.0	4.0	4.0	0.0
	Primary Settling Tank	1.5	1.5	1.5	0.0	0.0	0.0
	Bio-Reactor	6.0	10.0	9.0	6.0	24.0	8.0＋4.0
	Final Settling Tank	5.0	5.0	5.0	0.0	0.0	5.0
	Total	12.5	16.5	15.5	10.0	28.0	17.0
Air volume	Oxygen Ratio (%)	100	170	170	224	211	55
Sludge	Yield Ratio (%)	100	91	91	98	76	72
Required Land Area	Area Ratio (%)	100	132	124	80	224	134

Note: All the figures in this table are subject to change in the further F/S
Source: JICA expert team

For the selection of treatment process, it is recommendable that flexible treatment process should be selected taking into account more severe regulations of water quality in the future and demand for recycled water.

Moreover, for DKI Jakarta where it is very difficult to secure WWTP lands, MBR will be one of options as space-saving process. Stable operation of MBR will require O&M technology based on the experiences for proper flow control, flushing technology for protecting clogging of membrane, etc. Therefore, when it is introduced in DKI Jakarta without the experience of MBR operation, it is more desirable to conduct O&M under the contract with private company of such experiences.

Based on the above, at the further stage of F/S to be conducted in each sewerage zone, it is proposed that treatment process and its design conditions should be examined in detail and determined, bearing in mind of advanced treatment process such as Case-2, Case-3 and Case-4.

4) Pilot Project for the Future Treatment Process

(a) Position of Proposed Pilot Project in the New M/P

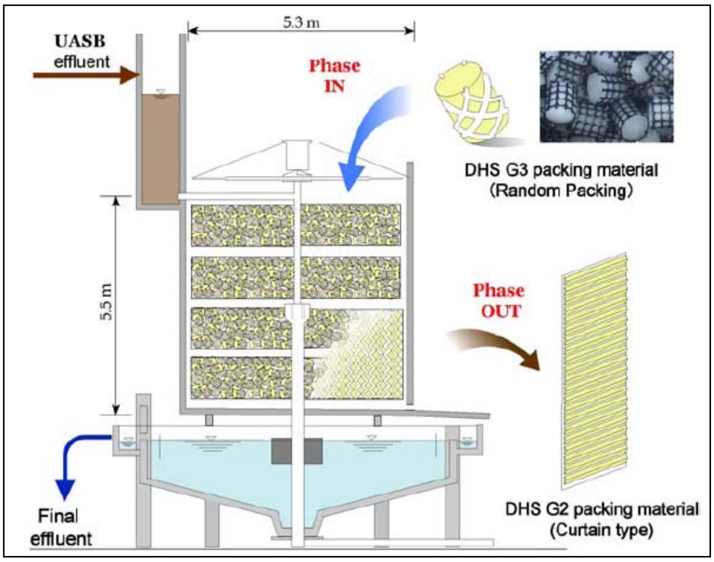
For the medium and long term, it would be valuable for DKI Jakarta to have experience their own to adopt an appropriate treatment process which meets their requirement. The DKI Jakarta should collect necessary data and experience on various parameters related to process performance and O&M using the pilot project for replicating its results in real scale application in the medium and long term. Aerobic sewage treatment technologies are energy intensive and comparatively complicated in O&M but they consistently meet the effluent standards. Therefore, the candidate for pilot project for future technology was judged from the following points of view: effectiveness of land use, energy efficient, ease of O&M, standard effluent quality, reduced overall construction cost, and reduced overall O&M cost. JICA Project Team has proposed under the pilot project to demonstrate the Primary Settling Tank (PST) followed by DHS. The PST followed DHS is a simpler version of wastewater treatment technology which has potential as the candidate for pilot project for future technology for medium and long term. The Pilot project can be implemented by DKI Jakarta government in the future from their own fund in collaboration with research institute/university. .

(b) Research and Development

Over more than a decade, Down-flow Hanging Sponge (DHS) of 1st to 6th Generation was used as a post treatment unit for UASB. First, 2nd Generation DHS of capacity 1,000 m^3/day was constructed in a sewage treatment center at Karnal city in year 2002. This project was carried out by the National River Conservation Directorate under the Ministry of Environment & Forests, National River of the Government of India. Later, the 2nd Generation type DHS was replaced with the 3rd Generation type DHS which has an advantage of easy construction of DHS. In year 2010 under "JICA Data Collection Survey on Water Environment Improvement through Low-Cost Wastewater Treatment System in Jakarta", bench scale UASB-DHS of capacity 3.39 L/day and DHS only of capacity 0.48 L/day was tested for the sewage treatment in collaboration with PD PAL JAYA. The results of both the experiments encouraged PD PAL JAYA to engage in pilot project on DHS in the future.

(c) Basic Concept of DHS

The basic concept of DHS is somewhat similar to that of trickling filter (Figure D6-4), except that the packing material is sponge, which has a void space of more than 90%, resulting in a significant increase in entrapped biomass and thus longer solid retention time (SRT). This provides longer SRT for the degradation of sludge in the system itself, largely reducing the production of excess sludge. As the sponge in a DHS is not submerged and freely hung/placed in the air, oxygen is dissolved into the wastewater when it flows down the reactor and therefore there is no need of external aeration or any other energy inputs.



Note: Tohoku University, Kisarazu National College of Technology and Nagaoka University of Technology (2007)
Source: JICA expert team

Figure D6-4 Treatment Scheme of DHS

(d) Proposal for Pilot Project for Future Technology

Existing JSSP Pilot Project

The Malakasari WWTP and sewer system were built by JSSP as a pilot project to demonstrate a self contained system in a middle-low income residential area. The sewerage system was completed in the year 2001, serves an area of 474 houses of which 463 are connected. The anaerobic-aerobic based treatment plant has a capacity of 400m^3/day and occupies an area of 1,131.45 m^2. The sewer line is 2,744 m in length and has 46 manholes and 500 inspection chambers. Pipe sizes are 300 mm, 200 mm and 150 mm. At present, JSSP anaerobic-aerobic based treatment plant is only partially functioning with the broken equipments.

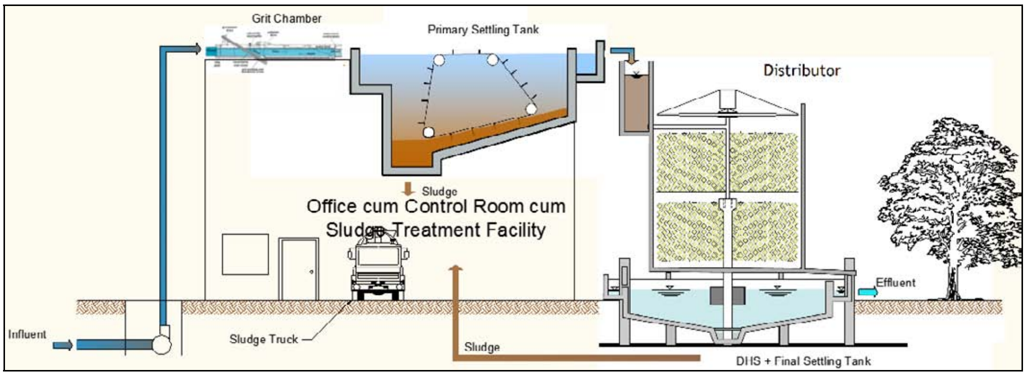
Proposed Pilot Project for Future Technology

Malakasari is one of the 7 Kelurahan in Kecamatan Duren Sawit of the East Jakarta municipality. Kelurahan Malakasari lies at 06^{o}13’293’’ South latitude and 106^{o}55’748’’ East longitude. In the target year 2030, it will have estimated population of approximately 37,489 people and population density of 270 cap/ha. We have proposed the Pilot Project of capacity 500 m^3/day to the serve approximate population of 2,500. Figure D6-5 shows the Sewerage Service Area and the layout of WWTP for Pilot Plant.

Source: JICA expert team

Figure D6-5 Sewerage Service Area and Layout of Malakasari Pilot Plant

The following figure shows the illustration of PST (Primary Settling Tank) followed by DHS Pilot plant. The sewage would be pumped to the inlet of the grit removal chamber from where sewage will flow under gravity to PST and then to DHS. The sludge treatment facility would be in the building which will support PST structure.



Source: JICA expert team

Figure D6-6 Illustration of Proposed PST-DHS Plant

(6) Required Land for WWTP

JICA Project Team underwent several times negotiation with DKI Jakarta for the required land for WWTPs. After having several discussions with DKI Jakarta we proposed the required land based on value of 0.5 m^2 per m^3/d of an average wastewater flow. That too was not acceptable to DKI Jakarta and required us to further reduce the land requirement for WWTPs. This is a fact that there is serious constraint of available land in DKI Jakarta and old M/P did not proceed as planned because of land matter only. To avoid similar situation to occur again with the New M/P, we studied several variants of ASP and space saving innovations. Then we proposed the required land based on value of 0.35 m^2 per m^3/d of an average wastewater flow. We reduced the required land to about 30%, and BAPPEDA accepted the required land area and sites for WWTPs (refer to MM of 21st October 2011). The following table shows required land area for WWTPs. There are 15 WWTP sites. The required land area ranges from 8.7 hectares for zone 10 WWTP (Pulo Gebang) to 0.8 hectare for zone 2 WWTP

(Muara Angke). The total land required for WWTPs for the short (15.1 hectares), medium (18.8 hectares) and long term (35.0 hectares) is 68.9 hectares.

Table D6-7 Required Land for WWTPs

Site No.	Candidate Land	Location	Zone Coverag	Zone Area (Ha)	Location Municipality	Population (People)	Coverage Population (80% People	Percentage	Flow Rate (m3/d)	Land Required
2	Pejagalan (Taman Kota Penjaringan)	Pejagalan	1	4,901	Central Jakarta	1,236,736	989,389	7.81%	197,878	6.9
3	Muara Angke	Muara Angke	2	1,376	North Jakarta	149,042	119,234	0.94%	23,847	0.8
4	Srengseng City Forest Park	Srengseng	3	3,563	West Jakarta	721,501	577,201	4.56%	115,440	4
	To Be Transferred to Pulo Gebang		4	935	South Jakarta	290,796	232,637	1.84%	46,527	1.6
5	City Forest North Sunter Pond	Sunter	5	3,375	North Jakarta	795,109	636,087	5.02%	127,217	4.6
6	WWTP Duri Kosambi	Duri Kosambi	6	5,874	West Jakarta	1,465,718	1,172,574	9.26%	234,515	8.2
7	Kamal - Pegadungan	Kamal, Pegadungan	7	4,544	West Jakarta	692,649	554,119	4.38%	110,824	3.9
8	Marunda	Marunda	8	4,702	North Jakarta	1,100,137	880,110	6.95%	176,022	6
9	Rorotan	Rorotan	9	5,389	East Jakarta	537,477	429,982	3.39%	85,996	2.9
10	WWTP Pulo Gebang	Pulo Gebang	10	6,289	East Jakarta	1,549,252	1,239,402	9.79%	247,880	8.7
11	Bendi Park	Taman Bendi	11	8,246	South Jakarta	1,578,573	1,262,858	9.97%	252,572	3
12	Ulujami Pond (Pond Planning)	Pesanggrahan			South Jakarta					5.9
13	Ragunan Land	Ragunan	12	3,172	South Jakarta	555,385	444,308	3.51%	88,862	3.1
14	Waduk Kp. Dukuh (Pond Planning)	Halim Perdana Kusuma/Kramat Jati	13	6,433	East Jakarta	1,053,724	842,979	6.66%	168,596	5.7
15	Waduk Ceger RW 05 (Pond Planning)	Cipayung	14	4,605	East Jakarta	617,269	493,815	3.90%	98,763	3.6
Reclamation Area			WWTP to be prepared by the Developers			110,049	110,049	0.86%	-	Planning
1	Existing System and On-going project (Casablanca Sewerage System)	Setiabudi Pond	0	1,220	South Jakarta	211,865	211,865	1.67%	-	On-Going
0		Krukut PS							-	Planning
Grand Total						12,665,282	10,196,608	80.50%	1974939*	

Note: This table excludes the existing sewerage service area and the future reclamation areas. And the percentage of population shows the ratio of the target population to the total population in DKI Jakarta. In total, around 80% of total population is the target population finally.

Source: JICA expert team

D6.2 On-Site Treatment System

(1) Common Toilets

In DKI Jakarta, 1,263 common toilets are installed for residents who have no bathrooms in their houses. Some of these toilets have problems, such as discontinuance due to insufficient maintenance and discharging wastewater without treatment into public water areas, including rivers. However, it is necessary to continuously and appropriately deploy common toilets as the first step of sanitation improvement and as a means of eliminating outdoor excretion. Moreover, the city government in charge of management shall conduct a regular survey of the toilets to improve and maintain them properly.

The second step is to correctly treat wastewater from the toilets in order to preserve the water environment. SANIMAS is a proven method as one of several on-site technologies that have been developed and put to practical use. Therefore, it is recommended to take advantage of this technology.

(2) Septic Tanks

Conventional septic tanks, the most popular units for treating excrement and wastewater from houses, are classified into two types: one has a soak pit downstream of the tank to make treated water penetrate the ground, and the other discharges the supernatant water in the tank directly into side drains. Both have an anaerobic tank whose BOD removal ratio is 50-60 percent (BOD of treated water is about 200 mg/L), which is an imperfect wastewater treatment unit. Basically, the septic tank relies on the purification function of soil, so it is applied to local and rural areas where there is no risk of groundwater contamination and the site is sufficiently wide. On the other hand, urban areas have a high water pollution risk, so restraints shall be put on the application of septic tanks. Expected policies for using septic tanks include (1) The underground penetration type shall be used in limited areas, (2) Wastewater treated by a septic tank shall be treated by a secondary means before discharge, and (3) Conventional septic tanks shall be switched to the modified type having stable performance. Of these, Policy (3) is effective in environmental preservation, because it can improve the treatment function and enables switching to combined treatment. Note that the city government is required to give financial aid to cover costs for the switchover.

Conventional septic tanks once had cast-in-place concrete structure, but in recent years, they have been constructed by piling up precast concrete rings or installed as a plastic product. The present structural standards (guidelines) specify no such structure, so they shall be reviewed. In some septic tanks, the tank position cannot be identified because the slab is underground or no cleaning port is arranged. Therefore, the structure shall be reviewed.

Modified septic tanks have problems in quality control; for example, there is no performance evaluation system and different manufacturers specify different tank capacities. Accordingly, the structure standards shall be reviewed as soon as possible to define a minimum tank capacity. The modified type must make the retention time longer in order to mitigate hourly changes in the flow rate of domestic wastewater. Accordingly, tank capacity is a very important design factor.

As mentioned above, there are problems in the systems for checking septic tanks for structure and size before installation and for maintaining them after installation, so the city government shall reinforce its role and organizations as well as improve the maintenance system.

(3) Sludge Treatment Plant

Promoting the management of sludge generated from on-site facilities, such as septic tanks and wastewater treatment plants for business, requires the construction of facilities that treat the collected sludge together. Currently, DKI Jakarta has two sludge treatment plants (whose total throughput is 600 m^3/day): one runs in the eastern part and the other operates in the western part. However, the amount of sludge delivered to both facilities is small, because most generated sludge may be treated or disposed of illegally. One of the causes is the low efficiency, because the number of sludge treatment plants is insufficient and the transportation distance is long. Currently, the delivery efficiency of sludge collected in the southern part is low, so it is effective to construct a new sludge treatment plant in the region. Figure C2-3 shows the concept of a treatment system for extracted sludge.

D6.3 Individual Treatment Plant (ITP)

D6.3.1 Summary of Current State and Issues

Regulations established in 2005 require establishments such as office buildings and commercial buildings to install wastewater treatment plants. The following is a summary of the current state of and issues concerning ITP that were identified from the onsite survey of establishments described in PART B4.2.

(1) Scale and System of ITP

Of the ITP that were surveyed, the oldest were built in the 1960s. Their average daily treated wastewater flows ranged from several m^3/day to as much as 800 m^3/day, and their maximum daily wastewater flows ranged from between 1.5 and around 2 times their average daily wastewater flows. In general, for ITP having an average daily treated flow of 20 m^3/day or more, the nominal treatment process noted is the extended aeration process.

In medium-sized and large establishments, wastewater treatment facilities are often incorporated as constructions in a building’s basement, a parking lot, or building periphery. However, in the case of recently constructed small and medium-sized establishments, there are instances where portable devices are installed on the ground’s surface or in the ground. In those establishments that have large-scale constructions, the extended aeration process (nominal) is used. In other cases, various processes are used depending on the plant manufacturer’s design.

It is necessary to present size-specific guidelines for selection of processes that suitably match the ITP, to formulate appropriate design criteria, and then conduct maintenance that are based on the particular characteristics of the selected process.

(2) Design Criteria

Because there are no specific legal stipulations regarding design criteria, design is conducted independently by plant manufacturers.

For certain types of industrial effluent from establishments, it is necessary to study wastewater treatment facilities that are appropriate for each pollutant that is discharged. At the same time, it is important to set forth basic design criteria for sewage and organic effluent that can be treated biologically.

(3) Water Quality and Treatment Performance

Looking at the results of water quality tests conducted by BPLHD, there are few cases that exceed current regulatory values for water quality. However, BPLHD conducts tests once every six months, and it uses a system in which the establishment who owns ITP conducts sampling by itself. Thus, based on observations of ITP operating conditions in the onsite survey, it is concluded that the reliability of these tests is low. At the same time, the establishment who owns and conducts sampling has poor understanding of the significance of each water quality item that is established in water quality criteria and of why the items are regulated.

Moreover, although it is commonly understood that, if the extended aeration process is applied and properly executed in domestic wastewater treatment, the BOD concentration of treated water will fall below 20 mg/L. Thus, the current regulatory value (BOD 50 mg/L) is too lenient. Furthermore, because almost no measurements are made of wastewater flow, no thought is given to overall control of pollution load.

(4) Operation & Maintenance

Roughly 60% of the facilities surveyed are not operating properly. Reasons include inadequate management of activated sludge and poor maintenance of blowers and other important equipment. Almost no facilities routinely obtain quantitative operation/management information by, for example, conducting simple water quality tests (for example, of transparency) or tests of sludge properties (such as MLSS concentration and SV30). Furthermore, although there were some operation managers and operators who have extremely strong knowledge of water management, the majority lack even basic knowledge. Operation indicators are poorly understood quantitatively, and this interferes with efforts to feed back indicator results on operation. Moreover, there is almost no measurement of wastewater flow and return sludge volume, which are basic to facility operation.

(5) Sludge Treatment and Disposal

The reported desludging frequency and extracted sludge volume are extremely low compared to the anticipated frequency and amount of sludge generation. Moreover, the balances of generated sludge volume and extracted sludge volume are not accurately understood, as, due to the lack of a system of manifests, etc., there are almost no records that verify where sludge is transported to and disposed of. In fact, respondents at several hearings clearly stated that extracted sludge is washed away in rivers or in rainwater drainage pipes.

(6) Pollution Load and its Understanding

Although wastewater flow that is necessary in ITP design should be set in establishments' initial plans, in almost all cases, facilities do not have means of measuring wastewater flow. Moreover, analysis of BOD, etc., must rely only on sampling data provided by the sampling business for BPLHD tests once every six months. Accordingly, neither BLPHD nor the private business properly grasps pollution load, discharged pollution load, and excess sludge volume.

Consequently, there is no one who can determine whether the cause of faulty wastewater treatment is due to changes in wastewater flow or pollution load, defective design or facilities, or inadequate management. This situation obscures contract conditions and the scope of responsibility among the establishment who owns ITPs, the manufacturer that designed and manufactured the ITP, and the maintenance company. It simultaneously prevents the government from providing appropriate guidance.

D6.3.2 Issues and Countermeasures

The following is a list of issues and countermeasures that were drawn from the aforementioned conditions.

(1) Basic Concept of ITP Design Standard

The wastewater treatment facilities can be classified into two camps a facility-oriented approach that fully maintains reactor capacity, and a comparatively compact maintenance-oriented approach that seeks to achieve greater functional efficiency.

In the case of ITP, if stable maintenance of treated water quality with the fewest maintenance problems (e.g., those concerning response to variations in inflowing wastewater load, activated sludge management, equipment malfunctions, etc.) as well as ease of sludge management are considered, then treatment facilities that are based on the facility-oriented approach are both desirable and economical. Because anticipated facility size can range from the ordinary household level to up to 1,000 m^3/day, it is important to study size specific design criteria that extend from the portable treatment devices that have recently appeared to facilities having constructed tanks.

In classifying scale of wastewater treatment, it can be concluded that a system of three classifications namely, the scale of a single-person operated establishment that is slightly larger than an ordinary household (small), a scale that can be handled with one or several portable wastewater treatment devices (middle), and anything larger (large) is appropriate.

As for treatment process, the primary approach will be to use a process that involves installing an anaerobic tank that functions as a putrefactive tank in the first phase, and an oxic tank that combines a comparatively long retention time with aerobic digestion in the latter stage. This is to minimize aeration power as well as machinery and equipment to reduce sludge volume. Biological treatment shall be based on a process that uses suspension or a filter bed filled with filter material.

And for treated water quality, based on consideration of the standard performance of the extended aeration process, it is generally thought that standards of BOD 20 mg/L, SS20 mg/L, and ammonia nitrogen 5 mg or less are sufficient.

Table D6-8 presents examples of ITP water treatment scale classifications and expected main treatment processes and set water quality values based on organization of the basic thinking discussed above.

Table D6-8 Case of Classified Scale and Expected Process

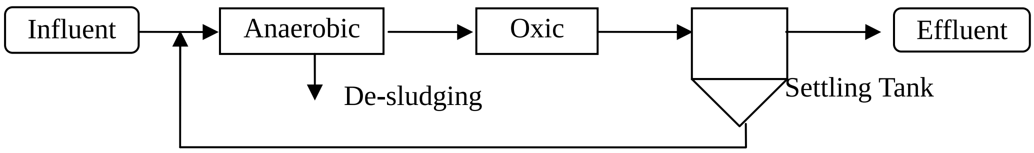
Scale	Maximum Daily Flow	Population	Typical Treatment Process	Water quality of Effluent		
				BOD	SS	NH_4-N
Small ITP	Less than 3m^3/d	Less than 60 PE	Anaerobic/Oxic（Activated Sludge type /Media Type）	20 (50)	20 (50)	5 (10)
Middle ITP	3 m^3/d - 30 m^3/d	60 PE to 600 PE	Anaerobic/Aerobic（Activated Sludge type /Media Type） Anaerobic/Anoxic/Oxic（Activated Sludge type /Media Type）	20	20	5
Large ITP	More than 30 m^3/d	More than 601 PE	Anaerobic /Aerobic（Activated Sludge type /Media Type） Anaerobic/Anoxic/Oxic（Activated Sludge type /Media Type）	20	20	5

*Treated water quality is presented as set value. Figures in parentheses indicate the current regulatory value.
Source: JICA Expert Term

The following presents a discussion of basic design policy for processes at each scale.

1) Small-scale ITP (Anaerobic/Oxic)

For a small-scale ITP, the fundamental approach is a system in which an oxic tank and settling tank are installed for latter stage finishing treatment of the septic tank. Accordingly, the anaerobic tank in a small ITP shall maintain the same retention time and have the same function as a conventional household septic tank. This will make it possible to minimize the aeration power needed for aerobic treatment. The oxic tank retention time is set at 24 hours or more with a view to reducing sludge volume through aerobic digestion. A portion of return sludge is regularly returned to the anaerobic tank to undergo sludge volume reduction. Either the suspended sludge process or use of a filter bed for contact aeration, etc., is possible; however, even with the filter bed method, it is important to install a final settling tank, maintain the tank's capacity, and control SS effluent.



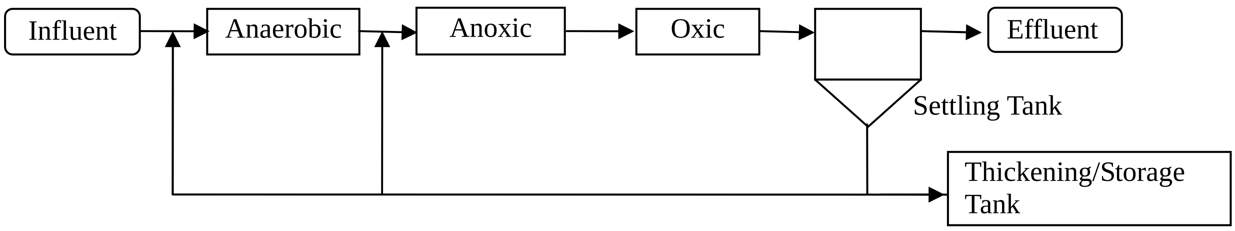
Source: JICA Expert Term

Figure D6-7 Basic Process (Small -scale ITP)

2) Middle-scale ITP (Anaerobic/Anoxic/Oxic)

Even in the case of a middle scale ITP, the basic concept is the same as a small ITP.

The general process used for a middle-scale ITP involves setting the combined retention time in the anaerobic tank and anoxic tank at eight hours, and setting the retention time in the oxic tank at 16 hours or more with a view to reducing sludge volume through aerobic digestion. Because the retention time in the oxic tank is comparatively long, there is a possibility that pH will fall due to progressing nitrification. Thus, the alkali level is recovered and nitrogen removal function maintained by returning sludge to the anaerobic or anoxic reactor.

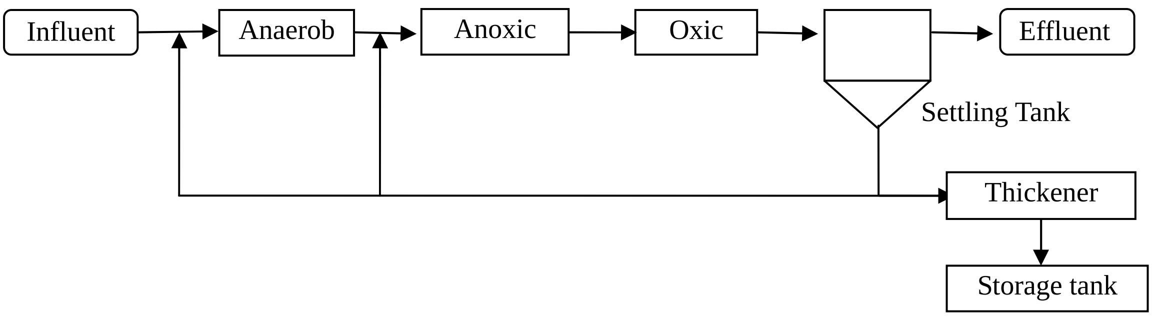


Source: JICA Expert Term

Figure D6-8 Basic Process (Middle-scale ITP)

3) Large-scale ITP (Anaerobic/Anoxic/Oxic)

The general process for a large-scale ITP involves setting the combined retention time in the anaerobic tank and anoxic tank at eight hours, and setting the retention time in the oxic tank at 16 hours or more with a view to reducing sludge volume through aerobic digestion. Because the retention time in the oxic tank is long, there is the possibility that pH will fall due to loss of ammonia nitrogen (nitrification) and progressing nitrification. Thus, the alkali level is recovered and nitrogen removal function maintained by returning sludge to the anaerobic or anoxic reactor. For sludge, install a thickener tank for excess sludge and a storage tank for thickened sludge.



Source: JICA Expert Term

Figure D6-9 Basic Process (Large-scale ITP)

(2) Standards of Other Processes

For some establishments, it becomes necessary to introduce maintenance-oriented facilities to increase the efficiency of plans and functions designed by the manufacturer. This can because of difficulty securing land for ITP due to conditions of the establishment's location or in order to reuse treated water, etc. Thus, it is necessary to establish the minimum standards so that stable operation of these facilities will be maintained.

There are already instances in which plant manufacturers' unique design methods are employed and installed, and therefore there are many cases where judging whether or not design conditions are appropriate is problematic. Accordingly, it is necessary to establish basic design criteria based on the aforementioned general criteria for methods employed by plant manufacturers as well.

In addition, when new methods are to be employed, it will be necessary for the government to inspect design criteria prior to their employment. It will similarly be necessary to create laws requiring the gathering of confirmation data during the first one year of operation following trial operation, and to establish systems for guarantees, correction citations, and punishments when criteria are not observed.

(3) Main Points of Preparation on Design Standard

The following points require consideration when formulating ITP standards

1) As a rule, utilize facilities with a facilities-oriented approach that has capacity margin.
2) Be certain to install means for measuring wastewater flow (to be mentioned later).
3) Install dust-collecting equipment to thoroughly remove inflowing screen residues (for protection of latter stage equipment and facilities).
4) If polluting load that is above the standard quality of wastewater influent (such as oil from dining halls, etc.) flows in, install first-stage treatment facilities, such as an oil separation tank, etc., at the first stage.
5) Install a regulating tank that can absorb load and flow fluctuations of wastewater influent and supply wastewater to reactors evenly.
6) Even when using the filter bed method for the contact aeration process, etc., be sure to install a settling tank and make every effort to minimize surface loading in the settling tank.
7) Install treatment tanks that can confirm treatment water properties and permit water sampling.
8) For the thickener tank in middle-scale ITP and storage tank in large-scale ITP, make the capacity at least twice as large as the sludge extraction flow that is set with extraction frequency.
9) Use a structure that facilitates facility maintenance and repair. For example, secure sufficient space for routine inspections and work, as well as sufficient opening space for replacing aeration pipes and plumbing, cleaning filter material blockages, etc.

(4) Understanding of Pollution Loading

1) Measurement of Wastewater Quantity

For middle-scale and large-scale ITP, installing electromagnetic flow meters or other such devices for measuring wastewater quantity is desired. However, because such devices are expensive, be sure to install simple measuring devices as substitutes. Particularly for wastewater from establishments, it is important to grasp temporal fluctuations in wastewater quantity. However, constantly and continuously measuring such quantity by human means is difficult. This makes it necessary to ascertain temporal fluctuations in wastewater quantity and cumulative quantity by using the methods shown in Table D6-9.

Table D6-9 Measurement of Wastewater Quantity

	Item	Contents
1	Measurement with weir	Install a triangular notch weir where wastewater intake, and calculate flow by continuously measuring the water level at the weir's top.
2	Measurement by pump operation time	During trial operation, measure valve opening degree and pump discharge volume, and prepare a correlation chart. Calculate flow by continuously measuring pump operation time.
3	Measurement by siphon tank	Install a siphon tank and continuously measure the tank's water level. Calculate flow from the number of times the siphon operates.

Source: JICA Expert Term

2) Measurement of Pollution Loading and Confirmation of Water Quality

The composite sampling forms the basis of Influent sampling. It is possible to get a more accurate picture of sludge volume by conducting analyses with high frequency. However, due to the troublesome nature of sampling and the high cost of analysis, conduct sampling of major items about once a month.

Conduct simple onsite measures to determine whether pollution loading is roughly the same each day or shows abnormal variations. Also, make arrangements that allow routine monitoring of pollution loading by ascertaining the correlation between simple measurement items and analysis items (for example, BOD, etc.).

Observing degree of transparency is the simplest form of onsite measurement. However, consider simple onsite methods for measuring pollution loading by looking at the characteristics of the individual establishment. The following presents examples of methods that can be used to ascertain abnormal fluctuations in daily pollution loading.

1) Simple measurement of SS amount: Let one liter of wastewater stand still for 30 minutes in a 1-liter measuring cylinder and let the contents settle. Measure the amount of settling solids.
2) Simple measurement of SS amount: Let one liter of wastewater stand still for 30 minutes in a 1-liter measuring cylinder and let the contents settle. Then measure the difference in the degree of transparency of the supernatant water in the cylinder and the degree of transparency observed immediately after taking the wastewater sample.
3) Ascertaining oil mixture: Place one liter of wastewater in a 1-liter beaker. Shine light on the upper surface of the water and check if there is oil in the wastewater.
4) Simple color measurement: Place one liter of wastewater in a 1-liter measuring cylinder. Place a piece of white paper behind the cylinder and observe the wastewater's color immediately after taking the sample and again after allowing the water to stand still for 30 minutes so that its contents settle.
5) Recording changes with photography: Abnormal changes in wastewater can be ascertained by taking digital photographs of samples at a set time and place and under the same conditions, and then continuously observing and comparing the photographs together with the results of the above-mentioned simple measurements on a computer.
   In addition, work to raise the accuracy of estimates of wastewater pollution levels by correlating main analysis items and simple analysis items. For example, over a long period of time, prepare a correlation chart for monthly BOD measured values and measured values for degree of transparency or SS, and then routinely make assumptions about the BOD value based on the degree of transparency value.

Table D6-10 Analysis Items and its Frequency (Influent/Effluent)

No.	Item	Method	Frequency
1	pH	Site: Litmus Paper	1 time/day
		Analysis	1 time/month
2	Water Temperature	Site: Temperature	1 time/day
3	Transparency	Site: Transparency Equipment	1 time/day
4	SS	Site: Measuring of settling amount	1 time/day
		Analysis	1 time/month
5	COD	Analysis	1 time/month
6	BOD	Analysis	1 time/month
7	NH_4-N	Analysis	1 time/month
8	Others	Site, Analysis	Suitability

Source: JICA Expert Term

(5) Operation and Maintenance

The following are main points to remember in ITP operation and maintenance.

1) In order to ensure that treated water quality meets ordinary target values, set the substitute indicators having a correlation to BOD, etc., that were discussed in D6.3.2.4 and then implement necessary measures in response to the indicators.
2) Clarify the mass balances of wastewater influent, pollution load, and generated sludge volume, and ascertain operation conditions by constantly comparing them to project design values.
3) Confirm activated sludge and treated water properties on a daily basis, and if there is any deviance from the appropriate range, identify the cause of deviation and make appropriate changes to operating conditions.

The following are required to execute the above-mentioned actions and respond to routine events and sudden accidents:

1) Management of design drawings, capacity calculation sheets, and operation manuals
2) Updating of operation and management manuals
3) Daily inspections based on operation manuals and recording and analysis of results
4) Adjustment of treatment equipment based on operation manuals
5) Compilation of treatment conditions, expenses, generated sludge volume, etc., in monthly inspection reports and annual reports
6) Records storage (daily reports should be kept for one year; monthly and annual reports should be kept for three years)

Items necessary for operation and management are presented in Table D6-11. Prepare a daily operation journal for each ITP by noting these measurable or calculable measurement items. For middle-scale and large-scale ITP, storing these journals for one year and then submitting them as records compiled every six months can raise the establishment’s capabilities in water treatment management.

Table D6-11 Required Items for Operation & Maintenance

Category	No.	Items	Contents and Notes
General	1	Record date and time	Enable data analysis in chronological order.
	2	Name of recorder	Clarify person in charge.
	3	Weather and temperature	Grasp infiltration of rainfall in rainy weather.
	4	House keeping	Environmental measure such as odor control, noise control, etc. Total facilities management.
Wastewater	1	Flow rate	Average daily flow, maximum daily flow, maximum hourly flow, fluctuation pattern
	2	Grit volume	Investigating the cause of the infiltration. Taking measures against the infiltration.
	3	Water quality (daily onsite analysis)	Water temperature, pH, transparency, SS amount, color, etc.
	4	Water quality (sample analysis)	BOD, SS, COD, etc.
	5	Oil and fat	Investigating the cause of the infiltration. Taking measures against the infiltration.
Operation and maintenance	1	SV30 of each reactor	Understanding of sludge volume on a daily basis. Confirmation of sludge properties.
	2	SV30 of oxic tank	Daily confirmation of sludge settleability in oxic tanks.
	3	MLSS	Taking sample basically in an aerobic / oxic tank
	4	Return sludge volume	Return sludge ratio
	5	Return sludge concentration	MLSS control
	6	Aeration rate	Confirmation of aerobic condition in aerobic / oxic tanks.
	7	Level of sludge-liquid interface in settling tank	Control extracted volume of excess sludge.
	8	Extracted sludge volume	Control MLSS concentrations.
	9	Comparison with design value	HRT, SRT, BOD-SS loading, SS balance, etc.
Treated water	1	Transparency	Monitor transparency on a daily basis, and grasp correlation with other water quality items.
	2	Water quality(Daily site)	pH, SS amount, color, etc.
	3	Water quality(Sample analysis)	BOD, SS, COD, etc.
Sludge disposal	1	Sludge storage volume	Grasp sludge generation volume.
	2	Sludge transported volume	Concentration and volume.
Facilities management	1	Operational state of equipment	Clarify operational states such as suspension, breakdown, etc.
	2	Operating condition of equipment	Temperature, and existence of noise, vibration, slack of belts, etc.
	3	Mechanical maintenance	Change of oil and grease, replace of belts, etc.
	4	Electrical management	Accumulative electric energy, electrical current, insulation resistance, etc.
	5	Inventory management (Chemicals and consumable goods)	Disinfectant etc.
	6	Repair	Repainting, repair of equipment, etc.

Source: JICA Expert Term

(6) Treatment and Disposal of Excess Sludge

At the present time, few existing ITP are disposing of sludge appropriately. Water treatment is the act of separating pollutants from water. When improving the quality of treated water, the amount of separated pollutants in other words, sludge generated increases. Consequently, appropriately disposing of sludge in accordance with the amount generated is linked to appropriate water treatment.

In order to appropriately dispose of sludge at establishments that treat wastewater (which is a topic that has traditionally received little consideration), it is important to correctly ascertain wastewater flow and its pollution load and predict the amount of sludge to be generated from it.

At the same time, it will be necessary to introduce a manifest system to guarantee that extraction, transport, and treatment and disposal of excess sludge are conducted properly. It will also be necessary to levy strict punishments on illegal activities, such as dumping of sludge in rivers.

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

D7.1 Proposed Plans

D7.1.1 Proposed Plans for Sewer Network

(1) Materials

One of the materials for sewer pipes is hard vinyl chloride. Roughness coefficient of the inside of the hard vinyl chloride pipe (n = 0.010) is smaller than that of reinforced concrete pipe (n = 0.13). It means the water flow is more smooth in hard vinyl chloride pipe. Therefore, hard vinyl chloride pipe has an economical advantage because its gradient can be gentler than that of reinforced concrete pipe, and the excavation depth will be shallow.

And the workability of the hard vinyl chloride pipe is high because its weight is small. The available length per one pipe is long (4,000m). Most of foundation of the pipe would be sand and it can shorten the construction period because the hard vinyl chloride pipe is flexible.

However, the material cost would be much increased if the diameter is more than 450mm. For utilization, economical analysis is important.

Therefore, the hard vinyl chloride pipe will be proposed for sewer network, which diameter is less than 450mm, by open cut method.

Regarding to the manholes, precast manholes will be proposed. Although it has an economical disadvantage with comparison of cast-in-place manholes, it can hold reliable quality, shorten the construction period, and ease the traffic jam.

(2) Construction Method

1) Open Cut

Regarding to the soil and groundwater conditions in DKI Jakarta, the groundwater level is high, and the soil around ground level (GL) -10m is clay where N-value is less than 10. If the excavation depth is more than 1.5m, earth retaining construction will be required because there is a possibility of landslide. If the excavation depth is more than 4m, steel sheet pile method will be required.

For the branch of sewer network, the excavation depth is generally less than 4m and the scale of earth retaining construction is small. The light-weight steel sheet pile method (easy sheathing work) is usually applied because of its workability and economical advantages.

Based on the workability, safe construction, impact by the excavation, and other factors, the conditions of open cut method are as follows;

- Excavation depth = or < 4m: light-weight steel sheet pile method (easy sheathing work)
- Excavation depth > 4m: steel sheet pile method

If the excavation depth is more than 4m, the impact by the construction of steel sheet pile will be wide and long, and drawing out the piles will cause the uneven land subsidence and other impacts on the surroundings. If the piles are left as the countermeasures for such impact, the construction will be costly.

In case of the excavation depth is more than 4m, the sufficient examination is necessary beforehand. If it is impossible to reduce impact by the construction of steel sheet pile, it is suggested to apply the pipe jacking method. At present, it is possible to construct the pipes with the diameter 150mm by the pipe jacking method, and it is the main methodology in Japan.

2) Pipe Jacking Method

Conditions to apply the pipe jacking method are as follows;

- Open cut is difficult because traffic is heavy, and underground facility is concentrated.
- Open cut is difficult because the sewer network cross the rivers and/or railways.
- Open cut is costly because the excavation depth is very deep.

It is better to avoid the open cut method at the heavy traffic roads as much as possible because the chronic traffic jam is one of the serious problems in DKI Jakarta. It is highly possible that the road is closed temporary especially in case of the construction at the road crossing points. Also there are many large rivers and canals in DKI Jakarta, therefore, the pipe jacking method is necessary. As mentioned above, construction of steel sheet piles will lead some impacts on the surrounding environment if open cut method with the more than 4m excavation depth is applied in DKI Jakarta. Therefore, the pipe jacking method is highly recommended.

At present, it is possible to construct the pipes with diameter 150mm to 3,000mm by the pipe jacking method. Although the span of jacking length depends on the pipe diameter and soil condition, one span of jacking length for the pipes with diameter 800mm is more than 300m. Even more than 700m span is possible in case of the specific method. And the development of the small diameter pipe jacking method is remarkable recently. Hard vinyl chloride pipes can be used for the pipe jacking method.

In DSDP Project in Bali, the construction by the pipe jacking method was implemented for the pipe diameter 800mm from 2010 and 2011, and the total length of construction is about 5km. However, the achievement of this work is not so much in Indonesia. Although it will be costly to import the machines, to train workers, and so on at present, the pipe jacking method will be clearly indispensable for the sewer network construction in Indonesia from now on.

3) Shield Tunneling Method

The shield tunneling method has an advantage to construct sewer pipes for a long distance. So it would be relatively costly where the size of the pipe is easily changed. The final lining work is generally included, so the construction period is relatively long. And the specific equipment is necessary because the construction work is implemented for more than 1km and it takes relatively long period of time. And the construction cost by the shield tunneling method is higher than that by the pipe jacking method because the materials of lining are not produced in Indonesia, and they will be imported from other countries. However, there is a possibility that the construction cost by the shield tunneling method is lower than that by the pipe jacking method in case that the construction point of the pipe (dimension is more than 1,350mm) is deep (more than 15m). The reasons are as follows;

- If the large scale of earth retaining construction is necessary, and the construction cost of vertical shaft is relatively high, the shield tunneling method has an advantage because one span of the construction length is long.
- If the construction point of the pipe is deep, the strength of the reinforced concrete pipe for the pipe jacking method is not enough, and the special pipes should be utilized. However, the procurement of them is difficult in Indonesia.

Therefore, in order to apply the shield tunneling method, technical and economical comparison to the pipe jacking method is necessary including the material procurement.

D7.1.2 Proposed Plans 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.

(1) Wastewater Treatment Process

As mentioned above, more detail analysis on available technology alternatives for wastewater treatment should be done at the F/S stage when additional information would be obtained. For the New M/P, an advance treatment process is proposed and as an example, step-feed biological nitrogen removal process is presented.

(2) Recommendations for Screening

The flowing table shows advantages and disadvantages for screening recommendations.

Table D7-1 Screening Types with Advantages and Disadvantages

Screen Type	Advantages	Disadvantage
Mechanically Raked Bar Screen	• Drive mechanism is above the liquid level • Non-lubricated pin rack and cog wheel system – less maintenance than submerged chain and sprockets drive • Flexible to meet various water depth and channel width configuration	• More expensive than back-racked screens • Inclined screen position requires more floor space than the back-racked screen • Rake arm only penetrates approximately 25 mm between the bars so screen not completely cleaned • Front raked design can push screenings through the bars • Only able to reduce screen openings to 8 mm • Prone to stalling due to larger debris
Segmented Chain Screens	• Will remove more debris from influent because of 6 mm openings –better protection for downstream equipment • Lower headspace requirements • Comparable capital cost to climber screens	• Wetted parts require much more maintenance • Screenings tend to stick to tongs of screen and wash off as the screens re-enters the wastewater flow • Tongs tend to break or bend • Higher head loss than bar screens • May require trash rack for screen protection
Step Screens	• 3 mm to 6 mm or smaller openings • Lower headspace requirement • Simple mechanism with no drive parts below water level • Relatively simple to enclose	• Higher head loss than bar screens • Wear of thin members for some units • Some restriction on screen size and channel depth
Escalator Screens	• 3 mm to 6 mm or smaller openings • Lower headspace requirement • Simple mechanism with no drive parts below water level • Relatively simple to enclose	• Higher head loss than bar screens • High maintenance requirements dues to 2 drive mechanisms • May need upstream medium screen to protect • Some restriction on screen size and channel depth • Can be damaged by large, heavy debris
Basket Screens	• 3 mm to 6 mm openings	• High capital cost • Often need upstream medium screenings to protect • Tends to plug due to scum • Poor screenings transport during high debris and scum loads • Can be damaged by heavy debris

Source: JICA expert team

It is recommended that screens with openings of 6 mm or less be used at the WWTP to minimize blockages and maintenance requirements in the downstream unit processes. The size opening precludes the use of mechanically raked bar screens. Segmented chain screens are available with 6 mm openings, but allow some screenings to be washed from the back of the screen and re-enter the flow in its return path. In addition, when links break, they are difficult to replace. For these reasons, this type of screen is not recommended.

Step screens and escalator screens are available with a 3 to 6 mm opening size and do not allow the captured screens to escape to the downstream channel. Further, step screens do not appear to require a first stage medium or coarse screen. For this reason, it is recommended that either step screens or escalator be incorporated into the WWTP. In addition to these screens, a screw compactor with the ability to wash the screenings prior to disposal in a bin for shipment to landfill should be incorporated into the design.

(3) Recommendations for Grit Removal

The following table shows the summary of the grit removal options with their associated advantages and disadvantages. Key factors in selecting grit removal equipment include operating cost and head loss requirements.

Table D7-2 Grit Removal Types with Advantages and Disadvantages

Process Type	Advantages	Disadvantages
Constant Velocity Grit Channels	• Simple design with limited moving parts • Simple to operate	• Large footprint • High head loss • Multiple units required, so flow splitting can be a problem • Prone to plugging, although this might be alleviated by finer influent screens
Aerated Grit Chambers	• Obtain excellent grit removal • Aeration can improve downstream primary treatment • Removes some of the influent sulfides • Can incorporate scum removal • Low head loss	• Expensive in comparison to mechanically induced vortex grit removal • Involves mechanical equipment that has to operate in a very aggressive environment • Aeration strips sulphides from solution and can cause high odors • Difficult to cover • Significant amount of water removed with grit • Removal systems extract a lot of water • Conveyor maintenance requires in tank work
Mechanically Induced Vortex Grit Removal	• Simple and small device • Less costly than aerated grit chambers and velocity controlled grit removal channels • System can be covered to minimize odor emissions • Low head loss • Less turbulence than aerated systems; so fewer emissions	• Not as efficient as aerated grit chambers • Concrete work is more complex • Removal system extract a lot of water • Gear drives require maintenance

Source: JICA expert team

Constant velocity grit channels incur more head loss and are more prone to plugging than the other two options. For these reasons, this option is not considered or incorporation into the WWTP. Although they are not as efficient at grit removal, mechanically induced vortex grit removal systems are less expensive and involve less mechanical equipment than aerated grit chambers. In addition, emissions are significantly reduces from these systems and they are simple to cover. The loss in grit removal efficiency can be tolerated without having a significant impact downstream. The primary reason is their better efficiency in removal of fine silts, due to induce gravity from the vortex grit removal systems at WWTP. Grit should be classified and dewatered using a conventional system.

(4) Recommendations for Disinfection

The following table shows the capital cost and annual operating maintenance (O&M) cost associated with the four disinfection types

Table D7-3 Capital and Annual O&M Costs Comparison of Disinfection Types

Item	Chlorination with Gas	Chlorination with NaOCl	UV radiation Low Constant Dose	UV radiation Hi Power Pulsated	Polishing Ponds
Initial Capital Cost (%)	100	87	356	409	1212
Annual O&M Cost (%)	100	209	268	223	14

Source: JICA expert team

As can be seen, polishing pond has lowest O&M cost. However, it is only cost effective when there is existing pond nearby WWTP. The polishing ponds have significantly lower reliability than the other three disinfection processes. The cost associated with chlorination using chlorine gas is less than cost of UV radiation

D7.2 Facility Plan of Main facility of WWTP in Priority Project Areas

D7.2.1 Outline of Priority Project Areas

Among 14 zones, Zone No. 1 and Zone No. 6 are selected as the priority project areas. The outline of these areas is shown in Table D7-4.

Table D7-4 Outline of Priority Project Areas

Priority Project Area	Wilayah	Kecamatan	Kelurahan
ZoneNo.1 [Target Population] 989,389 [Target Average Wastewater Volume] 198,000m^3/day	Central Jakarta	Gambir, Sawah Besar, Senen, Menteng, Tanah Abang	Cideng, Petojo Utara, Kebon Kelapa, Gambir, Petojo Selatan, Duri Pulo, Mangga Dua Selatan, Karang Anyar, Kartini, Senen, Kenari, Kebon Sirih, Gondangdia, Cikini, Menteng, Pegangsaan, Kampung Bali, Kebon Kacang, Kebon Melati, Petamburan, Bendungan Hilir
	East Jakarta	Matraman	Kebon Manggis
	West Jakarta	Grogol Petamburan, Taman Sari, Tambora	Grobol, Tomang, Jelambar Baru, Pinangsia, Glodok, Mangga Besar, Tangki, Keagungan, Krukut, Taman Sari, Maphar, Pekojan, Roa Malaka, Krendang, Tambora, Jembatan Lima, Duri Utara, Tanah Sereal, Angke, Jembatan Besi, Kali Anyar, Duri Selatan
	South Jakarta	Setia Budi	Pasar Manggis
	North Jakarta	Penjaringan	Penjaringan, Pejagalan, Kapuk Muara, Pluit
ZoneNo.6 [Target Population] 1,172,574 [Target Average Wastewater Volume] 235,000m^3/day	Central Jakarta	Gambir, Tanah Abang	Cideng, Kampung Bali, Kebon Kacang, Kebon Melati, Petamburan, Karet Tengsin, Bendungan Hilir, Gelora
	West Jakarta	Cengkareng, Grogol Petamburan, Kebon Jeruk, Kalideres, Palmerah, Kembangan, Tambora	Kapuk, Kedaung Kali Angke, Duri Kosambi, Rawa Buaya, Grogol, Jelambar, Tanjung Duren Utara, Tomang, Jelambar Baru, Wijaya Kusuma, Tanjung Duren Selatan, Kedoya Utara, Duri Kepa, Kedoya Selatan, Semanan, Jatipulo, Kota Bambu Utara, Slipi, Palmerah, Kemanggisan, Kota Bambu Selatan, Kembangan Selatan, Kembangan Utara, Angke
	South Jakarta	Kebayoran Lama	Grogol Utara
	North Jakarta	Penjaringan	Pejagalan

Source: JICA expert team

D7.2.2 Facility Plan for Sewer Facilities

(1) Overview of Facility Plan for Sewer Facility

This section examines the most rational and efficient pipeline route plan for sewers for the 14 sewerage zones which are defined in the previous Section D2 Selection of Sewerage Zone.

The followings are the principals to examine the pipeline route plan of sewers.

1) Adopting gravity flow in principal

2) Minimizing the number of pump station as much as possible

3) Employing culvert structure

4) Minimizing the length of the pipeline as much as possible

5) Minimizing the earth covering area as much as possible

6) Avoiding expensive and special technology such as shield method as much as possible

7) Adjusting and harmonizing with other project plans such as road planning

8) Taking into account MRT project under implementation, underground utilities, etc. for determining the route plan.

(2) Topographic, Geological and Groundwater Conditions

The previous section B3 Environmental Condition discussed the topographic, geological and groundwater condition in DKI Jakarta. DKI Jakarta generally extends in low land with an alluvial fan in the southern area and the mean ground level is approximately 7m. Pleistocene sediment covers up to approximately 50m below the ground level. Turfs with an N value of more than 50 occasionally scatters in the depth between 10 and 20m. It is estimated that the groundwater table is considerably high as approximately within the depth of 5m below the ground level. There are 19 rivers and canals for other projects such as water resources and fishery ports and 8 drainage channels. Such water course may become obstacle against the sewer line planning.

Although there are some mining infrastructure such as water supply pipelines, electricity cables and telephone lines, it is expected there are no such mining infrastructure below the depth of 10 m or deeper below the ground level. However, there is a MRT plan between Lebak, which is in the south west area of Jakarta, and Kota, which is in the north area, via Jl. Sudirman and Jl. Gajamada. The design depth of the MRT is approximately 10 to 20m below the ground level. Therefore, the sewer main layout shall take such MRT plan in consideration.

(3) Pipeline Route Plan for Sewers in Each Sewerage Zone

Overview of the main sewer facilities at each sewerage zone per construction year is shown in Table D7-5. Overview of the each sewerage zone and main sewer facility layout plan is shown in Figure D7-1.

Pipeline route plan for sewers concerning to the priority projects (short term development plan) is shown in Figure D7-2 and Figure D7-3. A facility plan was prepared for the sewerage zone of No.1 and No.6 as per detailed division of the sewage discharging areas.

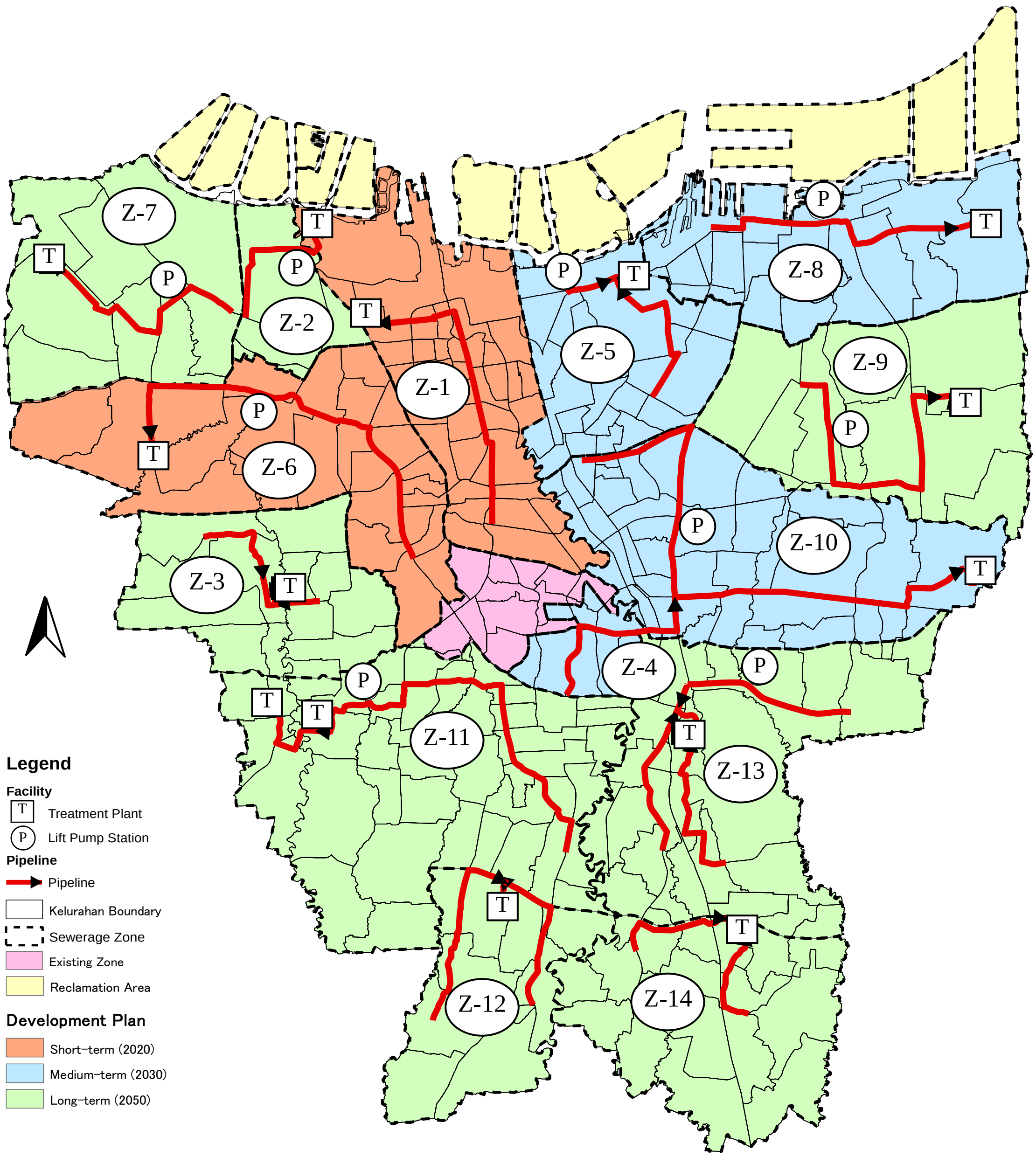
S/R Part D: D7 shows the plans for such as route plans for sewers in Mid-term and Long-term development plan.

For the pipeline route plan for sewers in the New M/P, it is subject to change according to the detailed survey for the route plan in terms of execution work for pipe installation.

Table D7-5 Overview of the Main Sewer Line Facility at Each Sewerage Zone per Construction Year

Treatment Area	Area (ha)	Joint Pipe (Nos)	Sewer Pipeline (m)					No. Relay Pump Station
			Secondary/ Tertiary Sewer	Sewer Main	Sewer Trunk	Sewer Line	Total	
[Short Term Development plan:2012～2020]								
1	4,901	101,952	656,638	86,069	5,263	10,269	758,238	-
6	5,874	130,956	829,313	154,809	11,532	12,426	1,008,080	1
Sub-total	10,775	232,908	1,485,951	240,878	16,795	22,694	1,766,318	1
[Mid Term Development plan:2021～2030]								
4	935	21,398	133,518	28,375	2,313	304	164,510	-
5	3,375	71,253	445,534	102,462	6,369	3,079	557,445	1
8	4,702	93,841	587,691	147,192	5,400	3,333	743,616	1
10	6,289	140,385	876,530	192,932	6,860	8,726	1,085,049	1
Sub-total	15,301	326,877	2,043,273	470,962	20,942	15,442	2,550.619	3
[Long Term Development plan:2031～2050]								
2	1,376	2,089	181,881	42,041	3,580	0	227,501	1
3	3,563	86,455	538,705	109,736	5,277	3,125	656,843	2
7	4,544	85,444	536,031	139,243	11,037	402	686,714	1
9	5,389	114,682	511,296	170,647	5,026	2,998	689,968	1
11	8,246	194,515	1,212,849	251,348	15,789	6,285	1,486,271	1
12	3,172	59,913	536,245	144,176	7,844	660	688,925	-
13	6,433	113,902	715,891	199.969	9,659	3,676	929,195	1
14	4,605	80,887	508,518	146,045	5,703	932	661,198	2
Sub-total	37,328	1,324,671	4,741,416	1,203,205	63,917	18,078	6,026,616	9
Grand	63,404	1,324,671	8,270,641	1,915,044	101,654	56,214	10,343,553	13

Source: JICA Expert Team



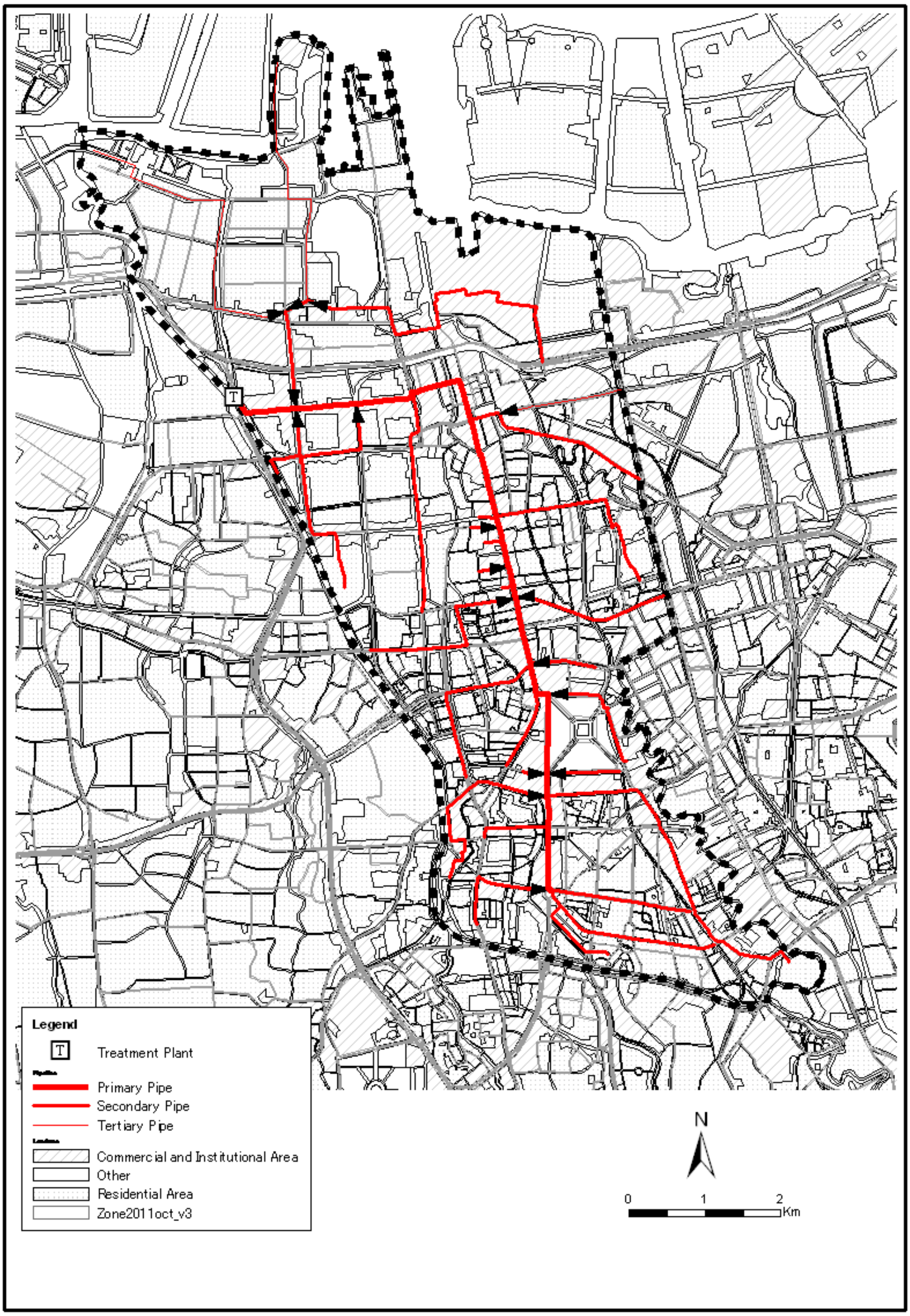
Source: JICA Expert Team

Figure D7-1 Overview of the Each Sewerage Zone and Main Sewer Facility Layout Plan

(4) Facility Plan of Sewer Pipeline Facility under Priority Projects (Short Term Development plan)

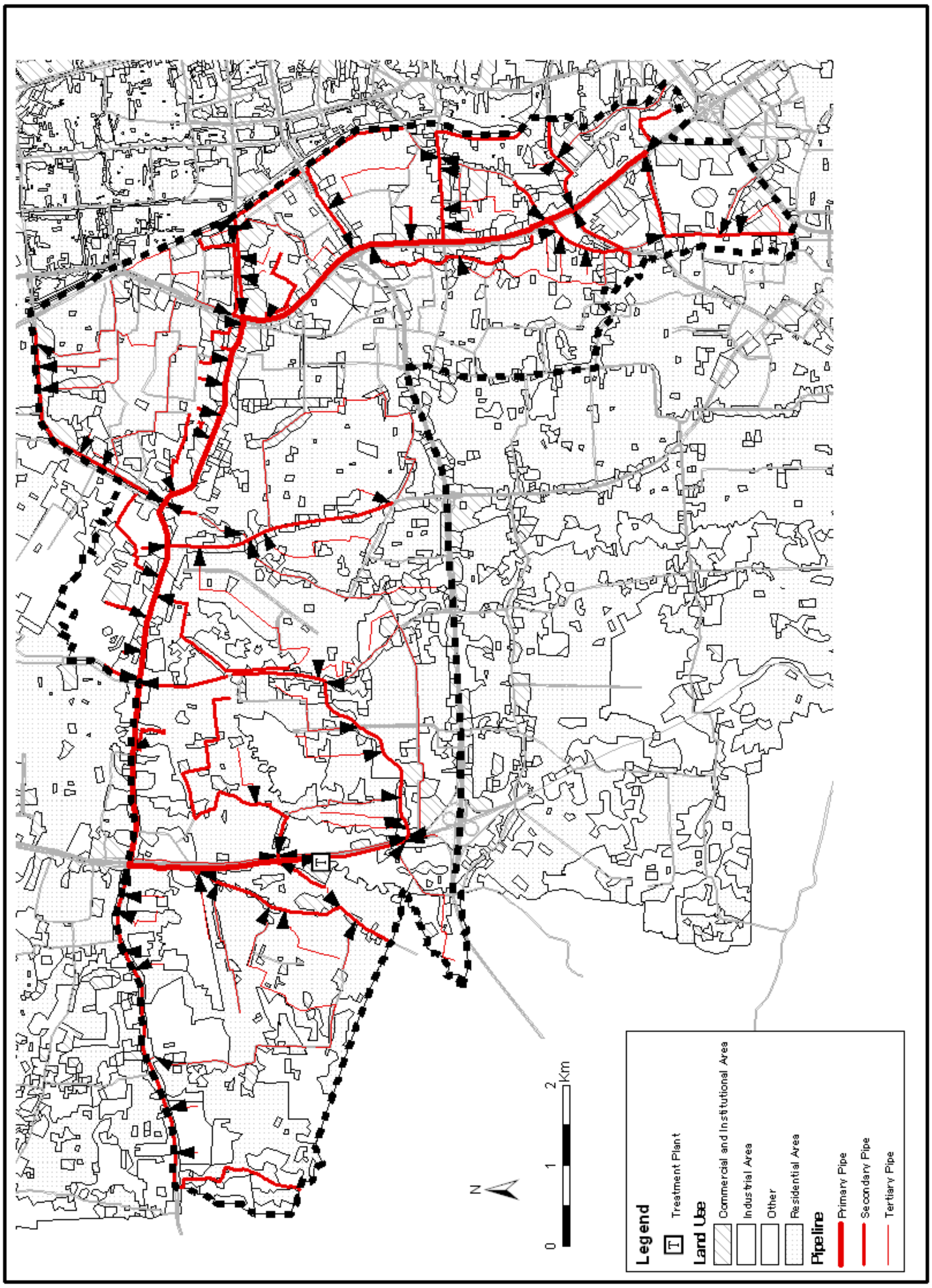
1) Pipeline Route Map in Sewerage Zone No. 1

Short Term Development plan: 2012 – 2020 Sewerage Zone No. 1 and No. 6



Source: JICA expert team

Figure D7-2 Facility Plan of Sewerage Zone No. 1



Source: JICA expert team

Figure D7-3 Facility Plan of Sewerage Zone No. 6

D7.2.3 Facility Plan for WWTP

(1) Wastewater Treatment Capacity in Priority Project Areas

Wastewater treatment capacity is set based on the daily maximum wastewater volume as mentioned in D6.1.3. The daily maximum wastewater volume is calculated from the daily average wastewater volume devided by the load factor. The following table shows the calculation results of wastewater treatment capacity in the priority project areas.

However, as explained in the previous section (D-53, D6.1.3), the load factor shall be reviewed at F/S stage. Therefore, the daily maximum volumes shown in the table are subject to change in F/S.

Table D7-6 Wastewater Treatment Capacity in Priority Project Areas

Zone No.	WWTP No.	Site	Site Area (ha)	Wastewater Inflow Volume (daily average volume) (m^3/day)	Treatment Capacity (daily maximum volume) (m^3/day)
1	2	Pejagalan	6.9	198,000	264,000
6	6	Duri Kosambi	8.2	235,000	313,000

Source: JICA expert team

(2) Facility Plan for WWTP (as One Example for Advanced Treatment Process)

1) Process

For the advanced treatment processes shown in Table D6-6, as an example, facility plan for step-feed biological nitrogen removal process is presented.

2) Facility Structure

The following table shows principles of facility structure for facility plan of WWTPs.

Table D7-7 Principles for Facility Plan of WWTPs.

Item		Principle
Structure of facilities		• The depth of bio-rector tank is usually 5 to 6m because of considering economic efficiency of civil engineering and electric efficiency of blower. However, in the area of metropolis with high population density, deep bio-rector with depth of 10 m and two-storied primary and final settling tanks can be installed simultaneously. • As acquiring land area is the most important and prioritized issue and has many limitations in DKI Jakarta, the deep bio-reactor should be examined.
Wastewater Treatment Facility	Grit chamber	• The dumped screenings like plastic bag can be seen at everywhere of drainage in DKI Jakarta and causes so many accidents of screenings collector in each pump station for rain drainage. In the separated sewerage system, it is expected that the amount of floating screenings become smaller, but sufficient capacity and function of the facility is required to enable easier O&M of the facilities afterwards.
	Primary settling tank	• Two-storied type is examined because of land area limitation. If there is room, conventional type is better because of easy maintenance of screenings and scum production.
	Bio-reactor	• It can be examimend that depth of Bio-reactor is set up as 10 m. In the case that in future membrane filtration is set up and operated as MBR for waste water re-use, it is possible to consider that bio-reactor can be divided into two stories, lower tank for anoxic tank and upper tank for oxic tank.
	Final settling tank	• Final settling tank should be working well as not only in routine operation but also in the worst case of no operation of activated sludge as a primary treatment. So, the surface loading should be less than $25m^3/m^2/d$ and in case of no limitation of land area, $15m^3/m^2/d$.
	Rapid filtration	• It can be examined that treated water by rapid filtration is reused for cleansing of dewatering facilities and other equipment in WWTP.
Sludge Treatment Facility	Sludge thickener	• Sludge thickener facility should be used not only for thickening and storing excess sludge but also for receiving on-site desludging sludge. • In Zone No. 6, it is necessary to integrate with the existing sludge treatment function. It is required to keep the function of sludge receiving, thickness and storage during the construction.

Table D7-7 Principles for Facility Plan of WWTPs.

Item		Principle
	Sludge digester	• In the case that land area is not limited, Sludge digester should be installed in the future not only for decreasing excess sludge but also for storage of sludge in emergency and treatment of on-site desludging sludge. Moreover, the sludge can generate power through biogas production which will help in reducing in global warming. The sludge digestion facility has not been considered in the New M/P. In the long term when there is sufficient capability build up of PD PAL JAYA to operate and maintain the proposed sewerage system, sludge digestion facility may be installed at the same WWTP if land is still available or elsewhere.
	Dewatering facility	• The capacity of dewatering machine is designed based on digested sludge volume generated from daytime operation. • In case that no digester is equipped or on-site desludging sludge is received, one measure should be taken such as capacity of the facility is increased or operation time a day is extended. • In Zone No. 6, it is necessary to integrate with the existing sludge treatment function.
Sludge Disposal		Dewatered sludge is transferred to the final disposal site for landfill, etc.

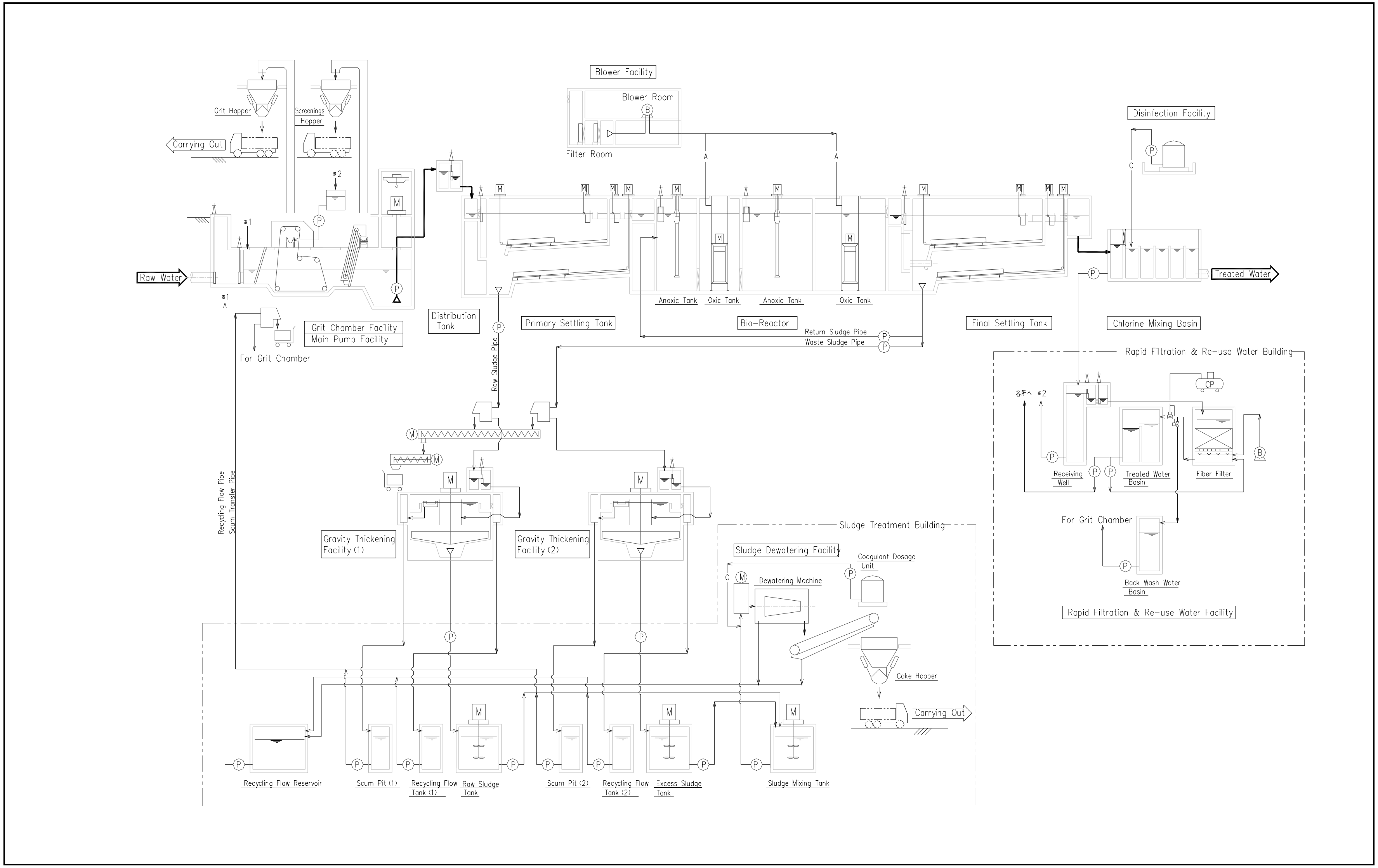
Source: JICA expert team

Based on the above principles, the outline design for Zone No.1 and No.6 was prepared. Main design parameters are shown in Table 7-8. Treatment flow and layout of each zone are shown from Figure D7.4 to Figure 7-10 respectively. As a result, it has been found that, as presented by one example, an advanced treatment process can be designed within the boundary of the secured land area for the priority projects in Zone No.1 and No.6.

Table D7-8 Main Design Parameters for WWTPs in Zone No.1 and No.6 (Example)

Item		Parameter
Process		• Wastewater treatment: Step influent multistage denitrification- nitrification process (excluding returning water load) • Sludge Treatment: gravity thickening + dewatering (excluding the treatment of sludge from on-site system)
Wastewater Treatment Facility	Grit chamber	• Surface loading: 1,800m^3/m^2/day
	Primary settling tank	• 2 channels / 1 train x 10 trains (2 layers) • Surface loading: 65m^3/m^2/day • Retention time: 1.5h
	Bio-reactor	• Step influent multistage denitrification- nitrification process (deep tank) • Step-feed ratio: 0.5 : 0.5 with 2 stages • Water temperature: 20˚C(or more depending on actual data) • HRT: 8.52h
	Final settling tank	• 2 channels / 1 train x 10 trains (2 layers) • Surface loading: 25m^3/m^2/day (15 to 25 m^3/m^2/day) • Retention time: 3.5h (3 to 4h)
	Rapid filtration	• High-speed fiber filter • Filtration speed: 1000m/day
	Chlorine sterilization pond	• HRT: 15 min
Sludge Treatment Facility	Sludge thickener	• Gravity thickening tank • Primary settling sludge thickening tank: 2 tanks, Excess sludge thickening tank: 3 tanks
	Sludge digester	• None (future option)
	Dewatering facility	• Pressure screw press • Operation time: 9hours x 7 days/week

Note: Values in ( ) shows the design guideline values.
Source: JICA expert team



Source: JICA expert team

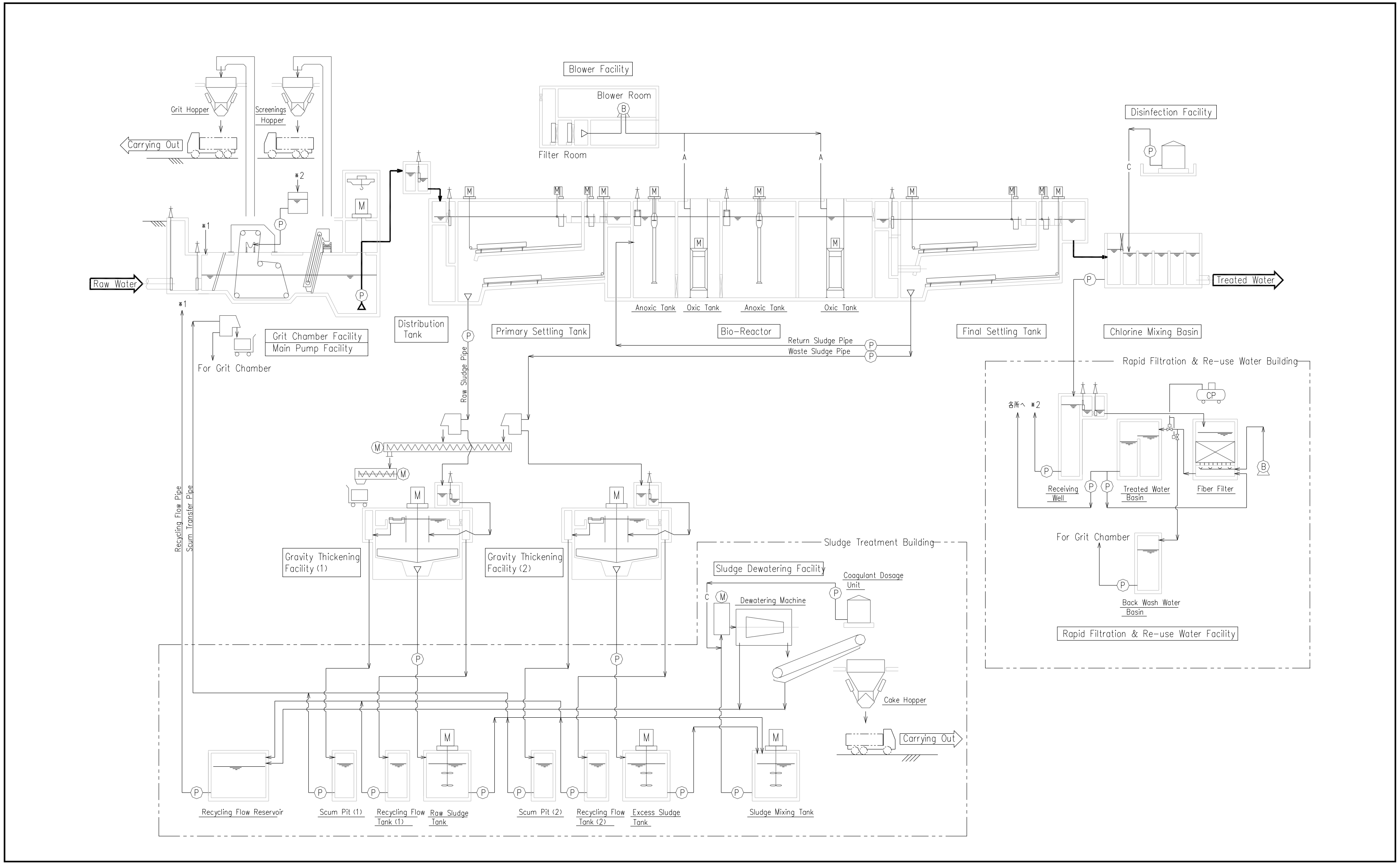
Figure D7-4 Treatment Flow of WWTP in Zone No. 1 (Pejagalan) (Example)

Notes:

1. The land area required for Zone 1 WWTP is 6.9 Ha
2. New M/P proposed policy to integrate the WWTP facility area with non-facility area (called as green area)

Source: JICA expert team

Figure D7-5 Layout of WWTP Land in Zone 1 (Pejagalan)



Source: JICA expert team

Figure D7-6 Treatment Flow of WWTP in Zone No. 6 (Duri Kosambi) (Example)

Notes:

1. The land area required for Zone 6 WWTP is 8.2 Ha
2. Layout of the Existing STP is covered in 4 -5 Ha land area
3. New M/P combined the function of the Existing STP with WWTP

Source: JICA expert team

Figure D7-7 Layout of WWTP Land in Zone No. 6 (Duri Kosambi)

Zone 1 WWTP has also provision of Technology Park for the purpose of education and awareness of general public, decision makers, Engineers and Technocrats, stakeholders, school children, college students, etc. thus to accelerate the implementation of the New M/P. The Public Outreach activities will help not only to promote the public awareness on necessity of the Project, maximize the Project benefits and enhance the sustainability of the Project, but also to promote public understanding on necessity of revision of tariff structures as well as reuse of treated wastewater.

Features of the Technology Park can include but not limited to:

- Multi media center
- Public awareness and educational work
- Educational films
- Photo Gallery
- Virtual tour of the treatment plant
- Interactive web
- Puzzles, quiz for school children using Animation
- Research & development
- Water quality testing kit for school children
- Training and Conference Room
- WWTP tour for the visitors
- Gardens (traditional garden)
- Plantation
- Landscaping

D7.2.4 Construction Cost and O&M Cost of Off-site Development Plan.

The construction cost and O&M cost related to Off-site development plan, which the summary is mentioned.

Table D7-9 Construction Cost and O&M Cost related to On-site Development Plan

Unit: Million IDR

development contents			Construction cost: Initial construction cost	Construction cost: Facilities replacement cost (2013-2050)	Construction cost: Total	Annual O&M cost (Maximum)	Remarks
A. Short-term development plan							
(1)	Zone No.1	Development of sewerage system	5,192,315	1,079,250	6,271,565	124,945	Replacement period; after 2025
(2)	Zone No.6	Development of sewerage system	7,110,408	1,357,898	8,468,307	153,535	Replacement period; after 2026
Total of Short-term plan			12,302,723	2,437,148	14,739,871	278,480	
B. Medium-term development plan							
(1)	Zone No.4	Development of sewerage network	636,325	0	636,325	29,148	
(2)	Zone No.5	Development of sewerage system	3,586,678	570,552	4,157,230	81,514	Replacement period; after 2033
(3)	Zone No.8	Development of sewerage system	4,856,836	794,711	5,651,547	112,733	Replacement period; after 2035
(4)	Zone No.10	Development of sewerage system	7,639,771	1,322,893	8,962,664	159,289	Replacement period; after 2034
Total of Medium-term plan			16,719,610	2,688,156	19,407,766	382,684	
C. long-term development plan							
(1)	Zone No.2	Development of sewerage system	1,158,206	0	1,158,206	17,082	Replacement period; after 2051
(2)	Zone No.3	Development of sewerage system	3,701,406	24,508	3,725,914	74,939	Replacement period; after 2049
(3)	Zone No.7	Development of sewerage system	3,967,381	23,963	3,991,345	73,248	Replacement period; after 2044
(4)	Zone No.9	Development of sewerage system	4,333,679	18,550	4,352,229	59,821	Replacement period; after 2042
(5)	Zone No.11	Development of sewerage system	8,643,992	56,387	8,700,380	167,885	Replacement period; after 2047
(6)	Zone No.12	Development of sewerage system	3,253,732	0	3,253,732	58,309	Replacement period; after 2051
(7)	Zone No.13	Development of sewerage system	5,624,321	0	5,624,321	110,360	Replacement period; after 2051
(8)	Zone No.14	Development of sewerage system	3,674,569	21,449	3,696,018	65,689	Replacement period; after 2046
Total of Long-term plan			34,357,286	144,858	34,502,144	627,332	
Grand total			63,379,619	5,270,162	68,649,781	1,288,496	

Source: JICA expert team

D8 On-site Sanitation System Planning, Design and O&M

D8.1 Basic Policies for the Plan for Improving On-site Treatment Systems

In DKI Jakarta, 90% of the domestic wastewater relies on on-site treatment, mainly septic tanks. They are used widely but have issues to be addressed; for example, most of them are of a soil penetration type that causes environmental pollution. A typical environmental pollution problem caused by the septic tank is groundwater contamination, which results in well and tap water pollution. This problem is expected to cause damage to health, such as water-derived infectious diseases.

Basic policies for improving the on-site treatment system include switching to sewage works (discontinuance of septic tanks) and changing the conventional septic tank to the modified one to improve its functions.

D8.2 Plan for Improvement of Septic Tanks

D8.2.1 Structure of Septic Tanks

The structures of single (conventional type) and combined (new type) septic tanks were standardized in 2002 and 2005, respectively. However, both standards are just guidelines and do not define tank capacity. As a result, it is said that many tanks installed actually may not work well because of insufficient capacity. If a modified septic tank does not have sufficient capacity, the treatment function degrades considerably. Therefore, it is necessary to review the structural standards and to introduce a performance evaluation system.

Obligation to install modified septic tanks in a newly developed area is the most effective way to switch from the conventional type to the modified type, but many developers install the former in each house at their own discretion. The introduction of a distributed wastewater treatment system (as opposed to house-by-house treatment) that collects and treats wastewater from multiple houses in each block is advantageous from a cost point of view, but it is hardly employed. As one measure in a newly developed area, the government shall strengthen its administrative functions and oblige the developers to install modified septic tanks or to select collective treatment.

The following shows the design and structure of an on-site treatment facility, as well as issues in maintenance and measures against them.

(1) Setting the Flow Rate of Wastewater

In the combined treatment type, the flow rate of wastewater shall be set in consideration of a rise in and hourly changes in water volume, because domestic water from kitchens and baths are added to the wastewater. Taking the safety of the equipment into consideration suggests that the tank capacity shall be designed at a wastewater flow rate of 200 L/person/day, which requires changes in structural standards.

(2) Quality Criteria for Treated Water

The quality criteria for treated water specify that combined treatment units shall reduce ammonia content to not more than 10 mg/L after treating wastewater whose BOD is 50-75 mg/L. The structural standards do not define how to remove nitrogen, so they shall be reviewed.

(3) Estimating the Scale of a Septic Tank

The new structural standards (guidelines) show how to estimate the flow rate of wastewater on a building application basis. It is necessary to develop a system for checking whether septic tanks are actually designed to an appropriate scale when an application for installation is submitted.

(4) Regulating the Flow Rate

Combined treatment units other than the small type require the installation of a flow equalization tank that reduces changes in the wastewater inflow rate, which shall be clearly defined in the structural standards.

(5) Introducing a Certification System

Most modified septic tanks are manufactured in factories, so it is necessary to strengthen quality control. The introduction of a certification system for performance and structure is an effective measure against quality issues.

D8.3 Sludge Treatment Plant

D8.3.1 Sludge Treatment Methods

(1) Forecasting the (Throughput) Generation of Sludge

Table D8-1 and Figure D8-1 show the estimated sludge generation rates of conventional septic tanks (CST), modified septic tanks (MST), and individual wastewater treatment plants (ITP) for commercial buildings.

The rate will continue to increase from 2014, when a regular sludge extraction system will start, and reach a peak of 3,887 m^3/day in 2030. After that, it will reduce continuously thanks to the progress of change to sewerage systems, decreasing to 1,000 m^3/day in 2050. Meanwhile, the sludge receiving capacity of sludge treatment facilities will be 600 m^3/day in 2012, decrease to 450 m^3/day in 2014 because the existing plant (Pulo Gebang) in the eastern part will be modified and expanded, and increase to 1,050 m^3/day in 2015 because a new plant will be constructed. The total capacity of dedicated sludge treatment facilities will reduce to 600 m^3/day after 2023 because the Pulo Gebang facility in the eastern part will be integrated in a sewage treatment plant (No. 10 treatment block) and only the facilities in the southern part will remain dedicated ones.

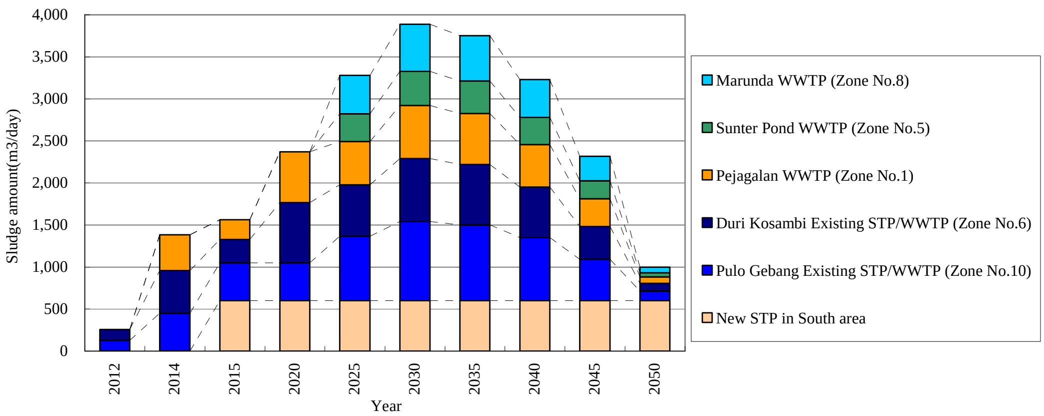
Accordingly, the New M/P includes a short-term plan (from 2012 to 2020) for expanding and modifying existing sludge treatment facilities and constructing new ones.

The plan also includes joint treatment by adding the sludge treatment function to sewage treatment plants to be constructed to compensate for the lack of capacity of dedicated sludge treatment facilities after 2014.

Table D8-1 Estimated Sludge Generation Rate (m^3/day)

Year	2012	2014	2015	2020	2025	2030	2035	2040	2045	2050
CST	257	307	354	544	495	403	298	183	77	0
MST	0	620	679	960	1,366	1,638	1,723	1,660	1,433	1,000
ITP	0	457	530	866	1,418	1,847	1,731	1,385	808	0
Sludge(total)	257	1,385	1,564	2,370	3,279	3,887	3,752	3,229	2,317	1,000
Capacity	600	450	1,050	1,050	600	600	600	600	600	600
Co-treatment	0	934	514	1,320	2,679	3,287	3,152	2,329	1,717	400

Note: Capacity represents the throughput of dedicated sludge treatment facilities.
Co-treatment means joint treatment with sewage treatment plants.
Source: JICA Expert Term



Source: JICA Expert Term

Figure D8-1 Estimated Sludge Generation Rate

(2) Characteristics of Sludge

Table D8-2 shows the SS concentration of sludge generated in CST, MST, and ITP.

Table D8-2 SS Concentration of Sludge

Type	SS (%)
CST	1.5
MST	1.5
ITP	1.5

Source: JICA expert team

Note that the sludge treatment facility applies to sludge generated in CST and MST from the viewpoints of the collection method and characteristics of the sludge. Because excess sludge in ITP is expected to have characteristics similar to that after wastewater treatment, it should ideally be delivered to sewage treatment plants.

(3) Sludge Treatment System

This system consists of three elements: collection and transportation, treatment, and disposal. The following describes these elements from a technical point of view. Note that the DKI Jakarta Cleansing Department is responsible for the collection and treatment of sludge from the existing septic tanks.

1) Collection and Transportation

Currently, respective city governments and private companies collect sludge by tank truck. Running the regular sludge extraction system requires reviewing the introduction of a facility database, the manner of issuing licenses to companies, and a system for authorizing sanitation workers.

Four-ton trucks are used to collect sludge from houses, but the regular sludge extraction system requires a combination of relay stations and 10-ton trucks to increase efficiency. Therefore, the current collection system shall be reviewed. In addition, the introduction of a manifest system is effective as a measure for preventing illegal disposal.

In densely populated areas having bad roads, an extension hose (about 50 meters long) is used to extract sludge, but it is necessary to develop more effective collection technologies, such as combination with an engine pump.

2) Treatment

Sludge treatment systems are classified into two kinds: one is a dedicated treatment facility (an existing one) and the other is delivery to sewage treatment plants. The following shows points for working on each system.

a) Dedicated Treatment Facility

This facility receives sludge generated in conventional and modified septic tanks, as well as excess sludge in individual wastewater treatment plants. The sludge has common characteristics: liquefied and dense organic waste, high corrosiveness, and offensive odor, so sanitary treatment is necessary. Figure D8-2 shows the basic sludge treatment, which includes solid-liquid separation in the first stage and the biological treatment of the resultant wastewater. In the existing sludge treatment facility, the solid-liquid separation process requires manpower, but it should be changed to a mechanical system, from the viewpoints of sanitation and efficiency. In addition, an activated sludge method should be used in the biological treatment process in order to increase efficiency.

Pre-treatment→Storage, aeration, & stirring→Thickening→Mechanical separation→
Activated sludge treatment→Disinfection→Discharge ↓
Dry sludge→Spread over farmland

Source: JICA expert team

Figure D8-2 Flowchart of Basic Sludge Treatment

b) Delivery to Sewage Treatment Plants

This plant is equipped with a unit for treating sludge generated in the wastewater treatment process. Sludge generated will be first condensed and then treated with the sludge dehydrator. Figure D8-3 shows the flowchart.

Dedicated stirring and storage → Sewage sludge thickening

Source: JICA expert team

Figure D8-3 Flowchart of the Delivery of Sludge to a Sewage Treatment Plant

c) Facility Plan

The following shows a plan (draft) for modifying or constructing sludge treatment facilities.

Existing facilities: Will start at a throughput of 450 m^3/day in 2014 (modification in 2013).
New facilities: Will start at a throughput of 600 m^3/day in 2015 (construction from 2013 to 2014).

D8.3.2 Facility Plan of Sludge Treatment Plant (STP)

(1) Basic Plan for Sludge Treatment Plant

a) In principle, the sludge generated from the on-site system, in conjunction with the sludge generated from the processing off-site system and process mixture of sludge and sewage sludge in the sludge treatment facilities of sewage treatment facilities.

b) Two existing sludge treatment facilities will be integrated into the sludge treatment facilities The sewage treatment facilities are developed into new

c) Sludge treatment facilities to new development in the district of South Jakarta is the development of sewage treatment facility is not expected during the short and medium-term plan, to facilitate introduction of periodic sludge withdrawal the same district.

(2) Development Plan Sludge Treatment Facilities

Development plan sludge treatment facilities are the following.

Table D8-3 Outline of Short-term Plan for STPs

Facility name and place	Outline of the plan
A. Improving existing sludge treatment facilities Pulo Gebang Sludge Treatment Plant (East Jakarta) Duri Kosambi Sludge Treatment Plant (West Jakarta)	[Short-term plan] <Duri Kosambi Sluge Treatment Facility> • The existing facility is discontinued after commissioning of new sewage treatment plant and the septic sludge treatment function is integrated into a new sewage treatment plant to be constructed at the same site. • Throughput: Up to 930 m^3/day • Period: 2013 (1 year) <Pulo Gebang Sluge Treatment Facility> • Mechanization: Reduces unsanitary working conditions and

Table D8-3 Outline of Short-term Plan for STPs

Facility name and place	Outline of the plan
	overwork by using machines for taking out grit and extracting sludge. • Increased throughput by mechanization: 300 m^3/day → 450 m^3/day • Necessary area for addition: 500 m^2 • Period: 2013 (1 year) [Medium-term plan] • The sludge treatment function is integrated into a new sewage treatment plant to be constructed at the same site. • Throughput: Up to 940 m^3/day • Period: 2021 to 2022 (2 years)
B. Constructing a new facility This facility will be constructed in the southern part. (It will be integrated into a new sewage treatment plant to be constructed in the southern part of Jakarta during the long-term plan when the latter will be completed.)	[Short-term plan] • Throughput: 600 m^3/day • Treatment system: Solid-liquid separation and activated sludge treatment • Necessary site area: 1.5 ha • Period: 2013 to 2014 (2 years)
C. Delivering on-site sludge to sewage treatment plants	• Off-site sewage treatment plants to be constructed according to the short- and medium-term plans receive and treat sludge from on-site facilities. [Receiving plant] • Pejagalan WWTP (Zone No. 1): Up to 790 m^3/day • Sunter Pond WWTP (Zone No. 5): Up to 410 m^3/day • Marunda WWTP (Zone No. 8): Up to 570 m^3/day

Note) The requirements new sludge treatment facility

(1) Land area required

1.5ha (For facility : 0.4ha, For parking and green area: 1.1ha)

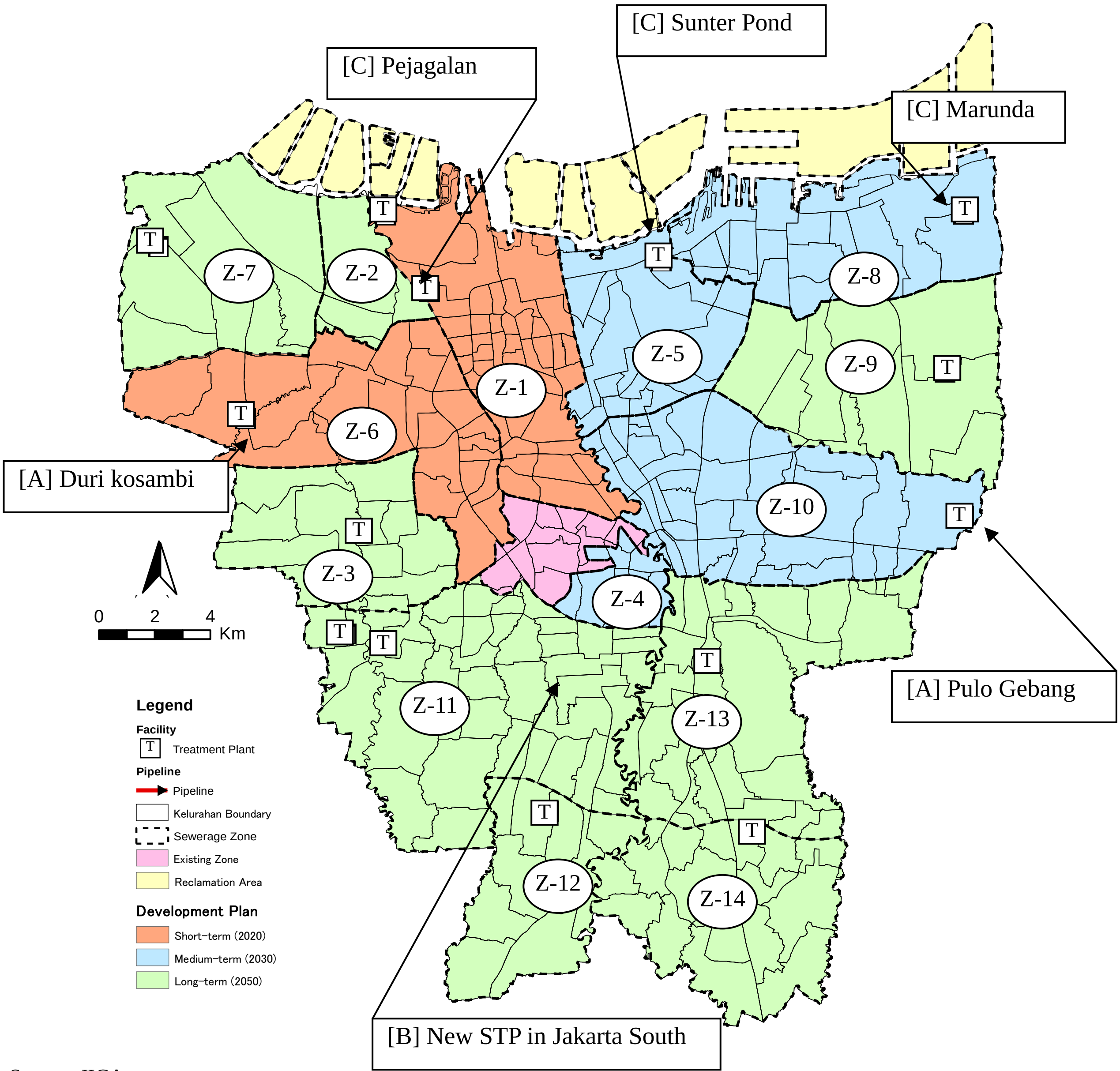
(2) The requirements land selection

1) To support efficient periodic sludge withdrawal, STP will be located in a new convenient location in the transport of sludge was collected from each district the South Jakarta area. Sludge that has been collected from center and north and west and east Jakarta to be processed in a sewage

2) That there are no effects of floods, landslides does not occur, in the sunny land, good topography, good geological conditions

3) Land acquisition is easy that no environmental. (Aesthetic standpoint, Stink side)

Source: JICA expert team



Source: JICA expert team

Figure D8-4 Existing Sludge Treatment Plants and Planned Construction Sites of New Sewage Treatment Plants

(3) Candidate Construction Sites of New Sludge Treatment Plants

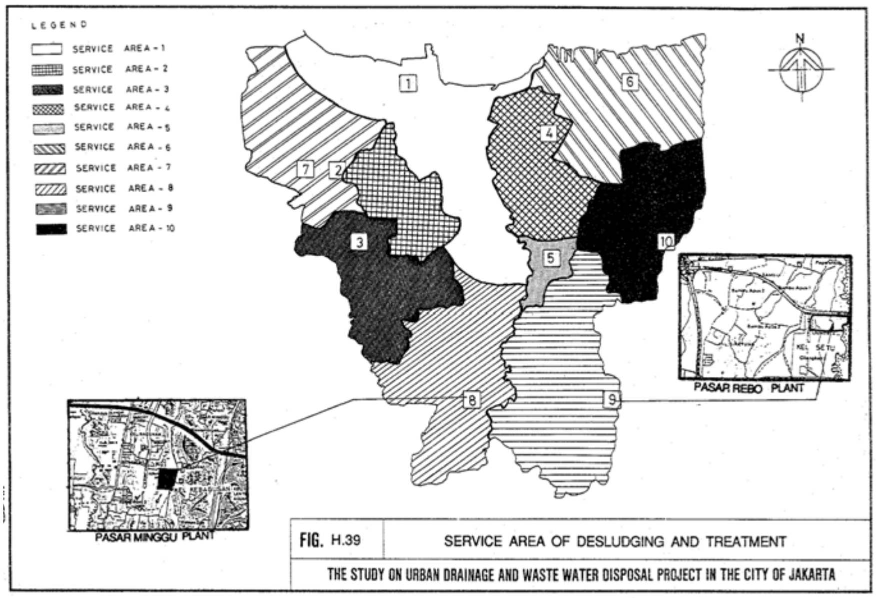
1) Sludge Treatment Improvement Project in the Old M/P (1991)

In the Old M/P (1991), communities are classified into A, B, or C according to population density. The total population of communities classified into A and B, communities with low population densities, is regarded as on-site population, and the total population of communities classified into C, communities with high population density, is regarded as off-site population. The quantity of desludging (quantity of generated sludge) from on-site treatment equipment, such as septic tanks, was calculated by multiplying the unit quantity of sludge generation by this on-site population (1998). Based on the calculation, the quantity of treated sludge was set at 1,315 m^3/day. The total treatment capacity of existing on-site treatment plants, Pulo Gebang plant and Duri Kosambi plant, was 600 m^3/day. Accordingly, the capacity of new sludge treatment plants was set at 600 m^3/day, and a site in Kecamatan Pasar Minggu, South Jakarta City and a site in Kecamatan Pasar Rebo, East Jakarta City were proposed as candidate construction sites for sludge treatment. These two sites used to be green parks, but at present, they are used as residential land.

Table D8-4 Estimated On-site Population and Quantity of Generated Sludge in the Old M/P

Area	Estimated Served Population with the On-Site System		Estimated Population Density (person/ha)	Desludging Quantity (m^3/day)	
	Year 1988	Year 2010	Year 2010	Year 1988	Year 2010
A	726,400	1,482,000	70	89	253
B	2,890,300	4,967,000	181	441	1,790
C	5,169,300	3,772,000[1]	381	785	797
Total	8,786,000	10,221,000		1,315	2,840

[1]Out of this population of area C, 684,300 people is served with the public toilets and remaining population (3,087,700 people) of area C, where gray water was proposed to be treated through the interceptor system, black water was proposed to be served with the on-site system.
Source: Old M/P 1991



Source: Old M/P 1991

Figure D8-5 Candidate Construction Sites for Sludge Treatment Plants in the Old M/P 1991

2) Need for Constructing a New Sludge Treatment Plant in the Southern Jakarta Area

As for the sewerage system, the whole of DKI Jakarta was divided into 15 zones from Zone 0 to Zone 14. According to the priority, it was planned that laying out of the system would be completed in a short term in Zone 1 and Zone 6, in a medium term in Zone 4, Zone 5, Zone 8, and Zone 10, and in a long term in Zone 2, Zone 3, Zone 7, Zone 9, Zone 11, Zone 12, Zone 13, and Zone 14. The zones where the sewerage system would be laid out in a medium term extended to the northeastern Jakarta area, the central Jakarta area, and a part of the southern Jakarta area. It was planned that sludge in these areas would be treated by the existing Pulo Gebang sludge treatment plant; Dri Kosambi sewage treatment plant (Zone 6), which has the integrated sludge treatment function; and Pejagalan sewage treatment plant (Zone 1). However, the following issues remain to be solved as to sludge treatment in the southern Jakarta area, which was assigned a low priority concerning the laying out of a sewerage system.

- Regular desludging is needed in the southern Jakarta area, which includes many residential areas.
- The existing sludge treatment plants and the sewage treatment plant with the integrated sludge treatment function are located far from the southern Jakarta area, and therefore it is necessary to improve the situation in the southern Jakarta area.
- It is necessary to prevent sludge collectors from dumping sludge illegally, which may result from the long sludge transportation distance from the southern Jakarta area.
- It is necessary to prevent traffic congestion caused by the long-distance transportation of tank trucks.

To solve the above issues, the revised M/P proposes the construction of a new sludge treatment plant in the southern Jakarta area, taking into consideration cost reduction for the sludge collectors and efficiency in transportation. The details of a plan for the new sludge treatment plant are indicated in Table D8-5.

Table D8-5 Details of a Plan for Constructing the New Sludge Treatment Plant

Service Area	Southern Jakarta area
Capacity of STP	600 m^3/day
Required Area	The required land area for STP is 1.5 hectare in which only 4,000-5,000 m^2 would be used for the facilities construction and remaining surrounding-area of the facilities will be developed for the plantation & greenery. Development of green belt will minimize the noise levels to the outside of the plant boundary and filter the odor levels to a considerable extent. Greenbelt will also give an aesthetic cover to the green area and the activities going on within the plant will not pose any disturbance to the local people outside.
Number of expected trips of trucks for desludging at the New STP	About 150 trips per day (based on honey truck capacity of 4 m^3) would be made at this plant.
Location	STP site is not far from any location in the Southern Jakarta area.
Treated Effluent	The treated effluent can be recycled for various uses (Please ref. Section D6.1.5(2)2) for different uses.)
Treated Sludge	The treated sludge can be recycled for various uses (Please ref. Section D6.1.5(3) for different uses.)

3) Requirements for the Construction Site

In selecting the site for constructing the sludge treatment plant, it is necessary to select the optimum site after comprehensively studying environmental conditions, land use, financial conditions, technological conditions, and other conditions. Matters to consider in selecting the site are as follows:

a) To be located within the collection area and near the trunk road, and the access road has adequate width
b) To secure the path of flow of collection vehicles so that the collection vehicles need not wait on the public road during the peak hours of carrying in
c) The land receives plenty of sun and is flat.
d) The land has adequate bearing capacity of soil against the building load so that the buildings can bear earthquakes, floods, and other risks. There is no risk of soil pollution.
e) There are no obstacles to land purchase and development.
f) Water and power supply can be secured, and the river into which treated water is discharged has ample water.
g) The construction of the treatment plant does not impair the sanitary environment of the surrounding area. In particular, the construction site has adequate land area to avoid emitting offensive odor to the surrounding area.

4) Results of Researching Candidate Construction Sites

Research was conducted at four sites in the southern Jakarta area as candidate construction sites for the sludge treatment plant. (Figure D8-6, Table D8-6) Based on the results of the research, the appropriateness of each candidate site was studied. The results are shown in Table 8.1-8 according to the evaluation items. Matters requiring special attention are written as notes outside the table. The details of these matters need confirmation.

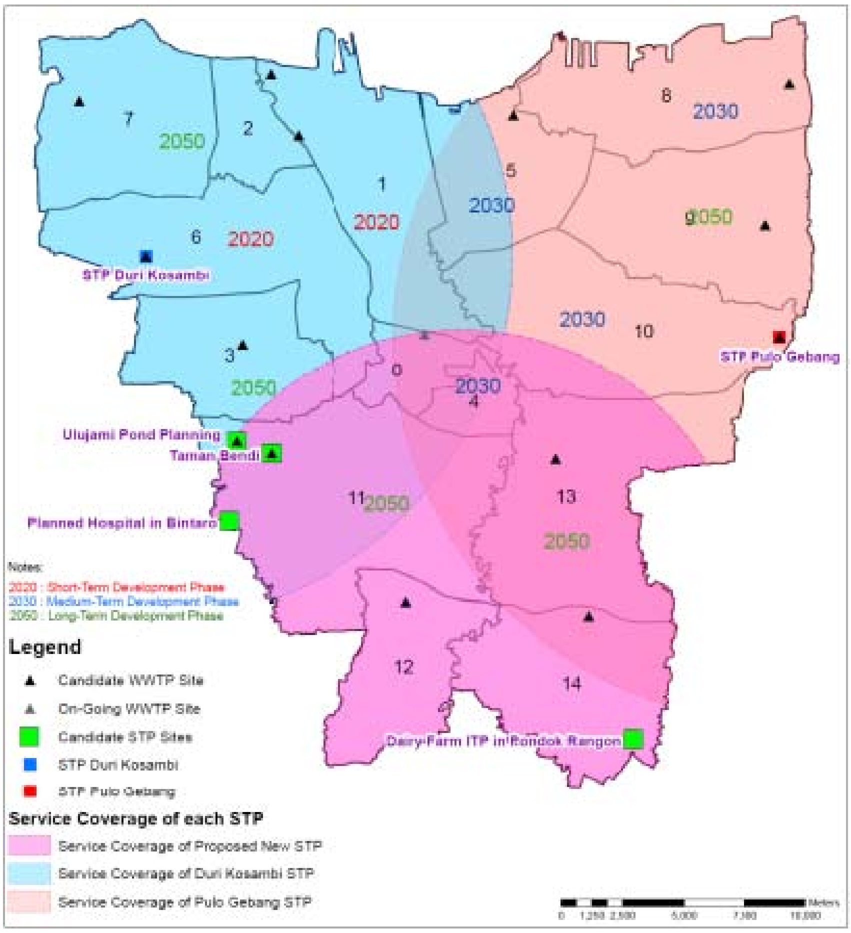


Figure D8-6 Locations of Candidate Plant Construction Sites

Table D8-6 Outline of Candidate Plant Construction Sites

No.	Sites	Location (GPS point)	Land Ownership	Land Available	Land Required	Remarks
1.	Bendi Park	S 06° 014.942' E 106° 46.440'	Government land	~3 Ha	1.5 Ha	Proposed WWTP site No. 11
2.	Ulujami Pond Planning	S 06° 014.718' E 106° 45.632'	Land with the pond planning development project of DKI Jakarta, needs to check the status	Large track of land	1.5 Ha	Proposed WWTP site No. 12
3.	Pondok Rangon	S 06° 021.402' E 106° 54.382'	Government land, private land required to construct the approach road	2 – 3 Ha (including government and private land)	1.5 Ha	Government land (existing Dairy Farm ITP), private land required to construct the approach road for which land acquisition is necessary
4.	Bintaro (planned hospital site)	S 06° 016.484' E 106° 45.453'	Government land	3 – 4 Ha	1.5 Ha	It is planned hospital site. However, the plan was abandon by the South Jakarta Municipality due to far-off location and low laying land.

Bendi Park

Ulujami Pond Planning

Pondok Ranggon

Bintaro (planned hospital site)

Figure D8-7 Proposal of Candidate Plant Construction Sites

Table D8-7 Comparison of Candidate Plant Construction Sites (by item)

No.	Technical and Non-Technical Aspects		Bendi Park	Ulujami Pond Planning	Pondok Rangon	Bintaro (planned hospital site)
a.	Land availability and technical aspects	Area should not be far from any location in Southern Jakarta area	△	△	△	△
		Area should be such located that it has maximum efficiency of service coverage	△	○	△	△
		Area should avoid flooding and land slide	○	○	○	△[1]
		Areas that have facilities of connecting road	△	○	△	△
		Area that is located on the smooth transportation routes (to avoid a traffic congestion), site located near toll road is preferable	△	○	△	△
		Area that is located relatively close to the receiving water body	△	○	○	○
		Area that is located on open land with good sunshine	○	○	○	○
b.	Land characteristics	Areas that have good geological structure/ground strength with capacity to bear the load of construction of STP	○	○	○	○
		Soil characteristics of the area that is relatively safe against the risk of contamination.	○	○	○	○
c.	Investment and O & M cost	Land status	○	△[2]	△[3]	△[4]
		Land development	○	○	△	△
		The availability of water and electricity supply	○	○	○	○
d.	Environment	Aesthetic factors with the existence of STP facilities to the surrounding environment, especially related with the beauty and odor aspects that may come from STP.	×	○	○	△
		Quantity and Quality of River Water where treated effluent would be	△	△	△	△

No.	Technical and Non-Technical Aspects		Bendi Park	Ulujami Pond Planning	Pondok Rangon	Bintaro (planned hospital site)
		discharged.				
		Sanitation and environmental health factor for the people who live and/or have activity in the vicinity of the location of STP, which can be caused by the existence of STP	×	○	△	△
		External risk factors due to environmental conditions, such as landslides, earthquakes, and floods that can threat the existence of STP	○	○	○	△

Note: "○", "△" and "×" marks mean "Appropriate", " less appropriate or Appropriate with Recommendations" and "Inappropriate" respectively.

1. This area has low topography make it prone to flooding. Land for STP needs to be elevated and ponds for flood mitigation needs to be constructed to protect neighboring residents, which may contribute to gain their support for STP. Discussion with residents may be required.
2. This is proposed WWTP land with the pond planning development project of DKI Jakarta. A part of the land is occupied by the low income people who claim the land ownership. Needs to be checked whether enough land can be obtained for STP without causing the dispute with the people.
3. Unused private land needs to be acquired to construct the approach road. Needs to be checked whether land acquisition is easy or not
4. Is there dispute on land with Tangerang?

Source: JICA Expert Team

(4) Construction Cost and O&M Cost of On-site STPs Development Plan.

The construction cost and annual O&M cost related to On-site STPs development plan, which the summary is mentioned Table D8-3, are as given in Table D8-8.

Table D8-8 Construction Cost and annual O&M Cost related to On-site STPs Development Plan

Unit: Million IDR

development contents	Term	Construction cost			Annual O&M cost (maximum)
		Initial construction cost	Facilities replacement cost (2013-2050)	Total	
A. Improvement of existing STPs					
Pulo Gebang STP					
Rehabilitation and expansion of Pulo Gebang STP	Short-term	24,390	0	247,257	3,298
Integration Pulo Gebang STP with newly constructed WWTP	Medium-term	156,949	65,919		6,889
Duri Kosambi STP					
Integration Duri Kosambi STP with newly constructed WWTP	Short-term	155,279	80,745	236,025	6,816
	Sub-total	336,618	146,664	483,282	17,004
B. Construction of a new STP in south area					
Construction of a new STP in south area	Short-term	42,100	20,275	62,375	12,934
	Sub-total	42,100	20,275	62,375	12,934
C. Co-treatment of On-site sludge at WWTPs					
Pejagalan WWTP（Zone No.1）	Short-term	131,904	68,590	200,494	5,790
Sumtar Pond WWTP（Zone No.5）	Medium-term	68,457	28,752	97,208	3,005
Marunda WWTP（Zone No.8）	Medium-term	95,171	39,972	135,143	4,178
	Sub-total	295,532	137,314	432,846	12,973
	Total	674,250	304,252	978,503	42,910

Pulo Gebang / Waduk Ulujami / Sunter Pond
Source: JICA expert team

(5) Plan for Modifying Existing sludge Treatment Facilities

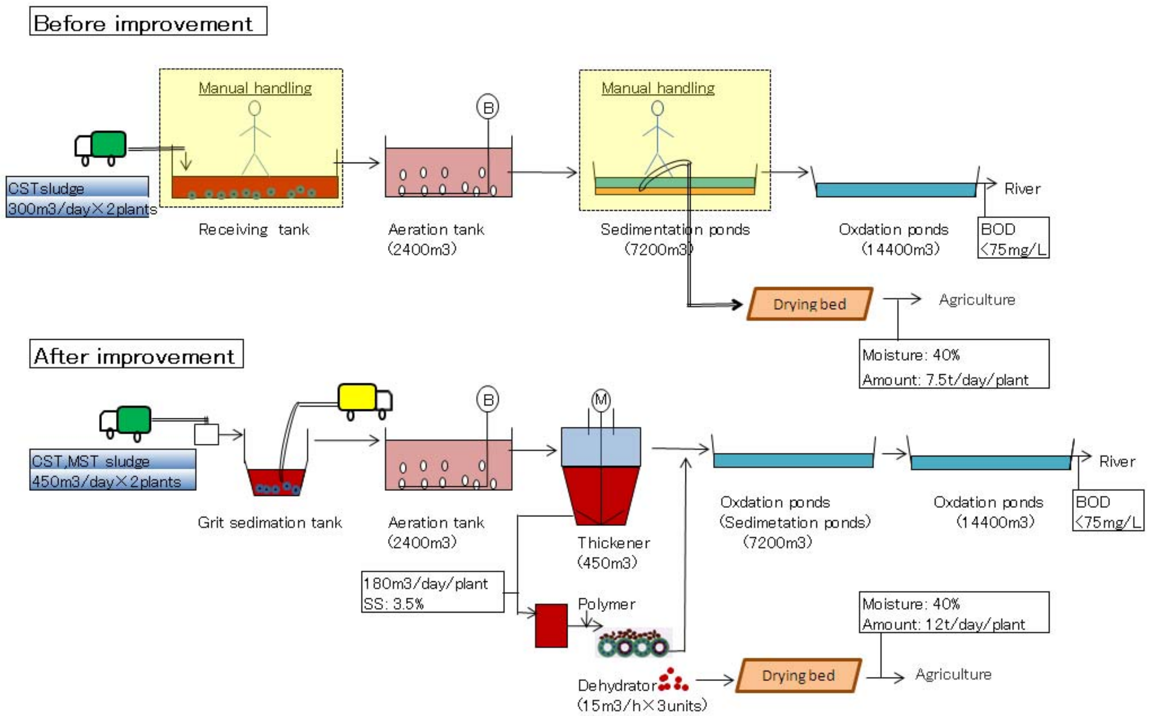
1) Features

An existing sludge treatment facility is a system in which sludge becoming inorganic is aerated and stirred in consideration of the properties, then settled by gravity, and finally, the supernatant water is treated in an oxidation pond. It features a mixture whose SV value is about 40 percent after the aerating and stirring process, as well as easy-to-settle sludge, unlike excess sludge remaining after the activated sludge treatment process. The planned aerating and stirring time is 8 days, and the design retention times of the sedimentation and oxidation (including maturation) ponds are 12 and 48 days, respectively. BOD area load on the oxidation pond is 0.014 kg/m^2/day (which is the same as the BOD volume load of 0.014 kg/m^3/day when the water depth is 1 meter). The lagoon process has advantages, such as low energy cost, easy operation, and stable performance, but has a disadvantage of requiring vast land, because the BOD load per unit area is small. The growth of algae supplies oxygen into the water, but the lagoon process requires an area nearly 86 times that required by the activated sludge method. Therefore, it is not suitable for urban areas.

2) Proposal for Modifying the Existing Sludge Treatment Facility

As mentioned above, the existing facility features the use of large space, resulting in a reduction in running cost. The following shows a proposal for modifying the existing sludge treatment facility for effective use. Note that the target quality of collected sludge and treated water is set as follows:

Collected sludge:	1,000-2,000 mg/L (BOD) and 15,000 mg/L (SS)
Treated water:	30 mg/L (BOD) and 30 mg/L (SS)



Source: JICA expert team

Figure D8-8 Flowchart of Modifying an Existing Sludge Treatment Facility

(a) Modifying the Receiving Tank

The existing receiving tank is changed to a grit sedimentation tank to remove sand mechanically. A tank truck extracts sludge accumulated on the bottom of the tank once every two days.

(b) Installing a Thickener and Dehydrator

A thickener and dehydrator are installed downstream of the aeration tank to change sludge extraction work in the existing sedimentation pond to a mechanical type. Separated fluid is fed to the sedimentation pond, and dehydrated sludge is dried on the existing sun-drying bed. The modified system is expected to increase throughput by 50 percent; that is, from 300 m^3/day to 450 m^3/day.

Pre-treatment→Storage & aeration→Thickening→Mechanical separation→Sedimentation→
Oxidation & maturation→Discharge
↓ (from Mechanical separation)
Sludge dehydration→Sun-drying

Source: JICA expert team

Figure D8-9 Flowchart of Modified Sludge Treatment

3) Design Summary

a. Throughput: 450 m^3/day (rise of 150 m^3/day).
b. Received sludge nature: SS content of 1.5%.
c. Aeration tank: The existing one is used.
d. Thickener: Newly installed (retention time: 24 hours).
e. Dense sludge: SS content of 3 to 4% (if 3%, 225 m^3/day).
f. Dehydrator: Newly installed (running time: 6 hours).
g. Dehydrated sludge: 33 t/day and water content of 80%.
h. Separated fluid: 450 m^3/day and BOD of 100-200 mg/L.
i. Sedimentation pond: The existing one is used (8 days).

4) Main Equipment Specifications

a. Grit sedimentation tank: The existing one is used.
b. Aeration tank: The existing one is used (capacity: 2,400 m^3; retention time: 5.3 days).
c. Thickener: Newly installed.
Daily capacity: 450 m^3 = 12 m in diameter × 4 m high.
d. Dense sludge storage tank: Newly installed (300 m^3 = 8 m long × 8 m wide × 5 m high).
e. Dehydrator: Newly installed.
6-hour run: 20 m^3/hour × 2 units.

Necessary area for extension: 500 m^2

(6) Plan for Constructing a New Sludge Treatment Facility

1) Facility Scale

The throughput of the new sludge treatment facility shall be defined appropriately in consideration of the enhancement of the existing facility and the amount of sludge to be delivered to the wastewater treatment plant. It should be 600 m^3/day, so that the total throughput including that of the existing facility after modification (450 m^3/day) becomes 1,050 m^3/day.

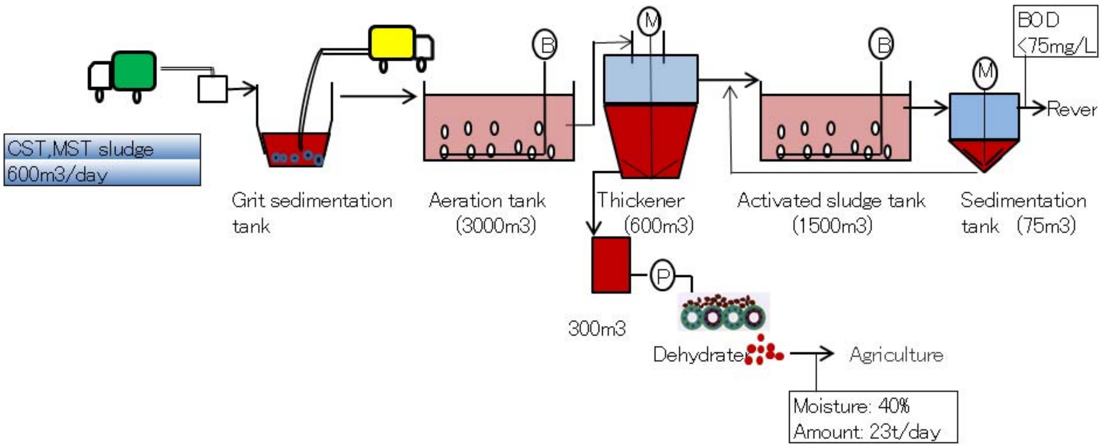
2) Treatment Method

Pre-treatment: Grit sedimentation, screening, aeration, and thickening.

Solid-liquid separation: Mechanical type (e.g. multi-disk or belt-press dehydrator).

Separated fluid treatment: Standard activated sludge method.

Figure D8-10 shows the flowchart of this facility.



Source: JICA expert team

Figure D8-10 Flowchart of the New Sludge Treatment Facility

3) Design Summary

a) Main Parameters (Estimated)

a. Throughput: 600 m^3/day.
b. Received sludge nature: SS content of 1.5%.
c. Aeration tank's retention time: 5 days.
d. Thickener's retention time: 24 hours.
e. Dense sludge: SS content of 3 to 4% (if 3%, 300 m^3/day).
f. Dehydrator: Running time of 6 hours and throughput of 20 m^3/hour × 6 units.
g. Dehydrated sludge: 45 t/day and water content of 80%.
h. Separated fluid: 300 m^3/day and BOD of 100-200 mg/L.
i. Separate fluid storage tank: Stores fluid for a day.
j. Activated sludge tank: BOD load of 0.2 kg/m^3/day and treated water BOD of 200 mg/L.
k. Sedimentation tank: Stores fluid for 3 hours.
l. Composting yard: Apparent specific gravity of 0.5, accumulation height of 1 m, and 30days.

b) Main Equipment Specifications

a. Truck receiving room
If four 4-ton trucks are to park in two lanes, the area must be 12 m wide and 20 m long.
b. Aeration tank
If it is to store sludge for 5 days, the capacity must be 3,000 m^3
(20 m wide, 30 m long, and 5 m high).
c. Thickener
If it is to store sludge for 1 day, the capacity must be 600 m^3
(7 m in diameter and 4 m high).
d. Dehydrator
If it is to run for 6 hours, 6 units (20 m^3/hour) are necessary.
e. Sludge storage tank
If it is to store sludge for 1 day, the capacity must be 300 m^3
(5 m in diameter and 4 m high).
f. Activated sludge tank
If BOD is 200 mg/L and BOD load is 0.2 kg/m^3/day, the capacity must be 600 m^3
(15 m wide, 20 m long, and 5 m high)
g. Sedimentation tank
If it is to store fluid for 3 hours, the capacity must be 75 m^3
(6 m in diameter and 2.5 m high).

h. Composting yard
If it is to store sludge for 30 days, the area must be 810 m^2 = 540 m^2 × 1.5 (20 m wide and 40 m long).

Necessary building area: About 5,000 m^2	Necessary site area: About 1.5 ha

(7) Outline of the Facilities

1) Receiving Facilities

The truck receiving room shall have a space where two 4-ton trucks can park in parallel, and four inlets to which hoses can be connected.

Collected sludge includes foreign matter and sand, which shall be removed in advance, because pipes, valves, and pumps have a failure risk due to clogging. This work should be a mechanical type, because the sludge is unsanitary. Accordingly, an automatic raking method applies to the screen, and a tank truck vacuums and removes sand from the grit sedimentation tank.

The nature of collected sludge varies, so the aeration tank is installed to make it uniform. The tank capacity shall meet a planned daily throughput × 5 days. The tank shall employ a combination of aeration and stirring with a blower, and the aeration strength shall be 2 m^3/m^3H. It shall have a structure sealed by a lid and the function of catching and eliminating offensive odor (deodorization). A combination of a pump and weighing tank feeds the sludge from the aeration tank to the thickener at a constant flow rate.

2) Solid-liquid Separation Facilities

A combination of gravitational and mechanical separation is used to separate sludge into solid and liquid components, so the thickener and centrifuge are installed. The former shall be equipped with a raker and shall have a structure of extracting dense sludge from the bottom with a pump. The capacity is equal to the planned daily throughput. The sludge storage tank shall have a capacity corresponding to the planned amount of dense sludge per day. The dense sludge is mixed with a coagulant (inorganic or high-polymer type) for aggregation, and then put into the dehydrator.

The dry sludge is loaded into a truck via a conveyor and delivered to the sun-drying yard. After the water content is reduced to about 50 percent, the sludge is carried out of the plant. The separated fluid is kept in the separated fluid tank, and then fed to the activated sludge tank via the weighing tank at a constant flow rate.

3) Wastewater Treatment Facilities

An activated sludge treatment process is applied to wastewater (supernatant water in the thickener and fluid separated by the dehydrator) generated in the treatment process. This process consists of an activated sludge tank, sedimentation tank, air supplier, and sludge returning unit. The treated water in the sedimentation tank needs to be discharged after it is mixed with sodium hypochlorite in the disinfection tank.

4) Common Facilities

i) Civil engineering and building units
ii) Electrical instruments
iii) Water quality analyzers

D8.3.3 Plan for Using Sludge

Effective use of dry sludge generated in its treatment process includes agricultural use as a fertilizer and application as a composting material. Both require regular analysis of heavy metal content to ensure safety. If the sludge is difficult to use, it is necessary to consider the possibility of landfill.

D9 Implementation Programme

D9.1 Construction and Running Costs

D9.1.1 Off-site (Sewerage System)

(1) Construction Cost

The approximate cost of developing the sewerage system has been calculated in the following expense items.

Unit prices applied in the construction cost estimation for sewerage system development are as shown in S/R PART-D: D9. For the applied unit prices, those for WWTP were referred to the prices applied in Japanese loan projects in Malaysia and Viet Nam, and those for sewers were referred to the prices applied in Denpasar Sewerage Development Project. However, these unit prices shall be reviewed using the latest data and information.

For the process of WWTP, the cost estimate is based on the assumption that modified activated sludge process with advanced treatment functions is applied. In case the applied process is changed in the F/S stage, the cost will also be changed.

1) Construction Cost

(a) Direct Construction Cost

The direct construction cost of sewerage connection pipe, sewerage pipeline, pumping station construction, wastewater treatment facilities construction and their replacement cost (up to 2050) has been calculated as initial phase cost.

The approximate replacement cost of machinery and electrical equipment that will be approaching service life by 2050, which is the long-term target year, is as given in the following table.

Table D9-1 Concept of Sewerage Facilities Replacement Cost

Item	10 years after construction	20 years after	30 years after
Machinery replacement cost	—	80% of relevant direct construction cost	20% of relevant direct construction cost
Electrical equipment replacement cost	20% of relevant direct construction cost	80% of relevant direct construction cost	20% of relevant direct construction cost

Source: JICA expert team

(b) Indirect Construction Cost

Posted as 13% of direct construction cost. “Indirect construction cost” includes expenses for common temporary works, expense for site management and other general items in the construction contracts other than the direct construction cost.

2) Engineering Cost

Posted as 7% of direct construction cost. “Engineering cost” includes consultation cost related to the projects and cost related to some activities such as environmental education and awareness programs, and action plans for human resources development.

3) Physical Contingency

In addition to the above cost, which are construction cost and engineering cost, physical contingency to cover uncertainties that can not be expected at the time of the survey, is assumed to be 5% of the construction cost.

4) Land Use Cost

Assuming the sites of wastewater treatment plants and pumping stations are owned by public, the land use cost does not occur. In case that the sites are private land, the cost of land acquisition needs to be incorporated separately.

5) Value Added Tax

Value added tax of 10% is added to total construction cost.

Construction cost for each zone is as given in Table D9-2. Details are provided in S/R Part-D:D9.

Table D9-2 Sewerage System Development Cost for Each Sewerage Zone

Unit : Million IDR

Items	Cost	Zone No.						
	Total	1	2	3	4	5	6	7
A. Construction Cost	56,125,784	5,127,423	946,911	3,046,184	520,238	3,398,813	6,923,407	3,263,191
a. Direct Construction Cost	49,668,836	4,537,543	837,974	2,695,738	460,388	3,007,799	6,126,909	2,887,780
(1) House Connection Cost	4,694,090	361,275	103,078	306,360	75,824	252,490	464,054	302,778
(2) Collection Sewer Line	25,700,306	1,893,787	527,414	1,485,046	384,564	1,359,651	2,791,067	1,700,773
(3) Lift Pump Station	467,854	0	25,466	14,440	0	19,690	107,094	25,067
(4) Wastewater Treatment Plant	14,993,568	1,501,632	182,016	872,160	0	963,168	1,782,240	841,824
(5) Facilities Replacement (from 2014 to 2050)	3,813,018	780,849	0	17,732	0	412,800	982,454	17,338
b. Indirect Construction Cost	6,456,949	589,881	108,937	350,446	59,850	391,014	796,498	375,411
B. Engineering Cost	3,476,818	317,628	58,658	188,702	32,227	210,546	428,884	202,145
C. Physical Contingency	2,806,289	256,371	47,346	152,309	26,012	169,941	346,170	163,160
D. Land Use Cost	0	0	0	0	0	0	0	0
Total	**62,408,892**	**5,701,422**	**1,052,914**	**3,387,195**	**578,478**	**3,779,300**	**7,698,461**	**3,628,495**
E. Value Added Tax	6,240,889	570,142	105,291	338,719	57,848	377,930	769,846	362,850
Grand Total	**68,649,781**	**6,271,565**	**1,158,206**	**3,725,914**	**636,325**	**4,157,230**	**8,468,307**	**3,991,345**

Unit : Million IDR

Items	Zone No.						
	8	9	10	11	12	13	14
A. Construction Cost	4,620,518	3,558,238	7,327,577	7,113,142	2,660,143	4,598,258	3,021,741
a. Direct Construction Cost	4,088,954	3,148,883	6,484,581	6,294,816	2,354,109	4,069,255	2,674,108
(1) House Connection Cost	332,536	406,387	497,467	689,282	212,307	403,621	286,631
(2) Collection Sewer Line	1,812,432	2,058,008	2,751,112	3,524,888	1,466,826	2,348,713	1,596,025
(3) Lift Pump Station	34,220	18,843	41,595	121,097	0	35,225	25,117
(4) Wastewater Treatment Plant	1,334,784	652,224	2,237,280	1,918,752	674,976	1,281,696	750,816
(5) Facilities Replacement (from 2014 to 2050)	574,982	13,421	957,127	40,797	0	0	15,519
b. Indirect Construction Cost	531,564	409,355	842,996	818,326	306,034	529,003	347,634
B. Engineering Cost	286,227	220,422	453,921	440,637	164,788	284,848	187,188
C. Physical Contingency	231,026	177,912	366,379	355,657	133,007	229,913	151,087
D. Land Use Cost	0	0	0	0	0	0	0
Total	**5,137,770**	**3,956,572**	**8,147,876**	**7,909,436**	**2,957,938**	**5,113,019**	**3,360,016**
E. Value Added Tax	513,777	395,657	814,788	790,944	295,794	511,302	336,002
Grand Total	**5,651,547**	**4,352,229**	**8,962,664**	**8,700,380**	**3,253,732**	**5,624,321**	**3,696,018**

Source: JICA expert team

(2) Operation & Maintenance Cost

The approximate O&M cost of sewerage facilities is as follows:

1) Wastewater Treatment Plant O&M Cost

Approximate cost of labor, utilities such as electric power and chemicals, repair, sludge disposal, water quality analysis, etc., cleaning and yard maintenance and direct expenses, and physical contingency (excluding price escalation) cost and overhead cost are calculated. When conducting approximate calculation of each of these items, a unit value is set for the amount of wastewater given in the following table, and total unit value of each item is approximated as 1,479 IDR/m^3.

Table D9-3 O&M Cost Unit Value per Wastewater Volume

No.	Items	Unit Cost (IDR/m^3)	Rate (%)
1	Labor cost	66	4.5%
2	Electricity consumption cost	384	26.0%
3	Chemicals cost and other utilities costs	257	17.4%
4	Facilities repair cost	191	12.9%
5	Sludge disposal cost	262	17.7%
6	Water quality Analysis cost and other inspection costs	3	0.2%
7	Cleaning and yard maintenance	2	0.2%
8	Direct expenses	68	4.6%
9	Physical Contingency cost and Overhead cost	246	16.6%
Total		**1,479**	**100.0%**

Source: JICA expert team

2) Sewerage System Pipeline Maintenance Cost

0.3% of sewerage pipeline direct construction cost is posted as sewerage system pipeline maintenance cost.

3) Pumping Station O&M Cost

3% of pumping station direct construction cost is posted as pump station O&M cost.

4) Value Added Tax

10% value added tax is added to total O&M cost.
Per year O&M cost for each zone is as given in Table D9-4. Details are provided in S/R Part-D:D9.

Table D9-4 Sewerage Facilities per Year O&M Cost for Each Zone

Unit : Million IDR/year

Items	Total	Zone No.						
		1	2	3	4	5	6	7
A. Collection Sewer Line	91,183	6,765	1,891	5,374	1,381	4,836	9,765	6,011
B. Lift Pump Station	14,036	0	764	433	0	591	3,213	752
C. Wastewater Treatment Plant	1,066,141	106,821	12,873	62,319	25,117	68,676	126,599	59,827
Total	**1,171,360**	**113,587**	**15,529**	**68,126**	**26,498**	**74,104**	**139,578**	**66,589**
D. Value Added Tax	117,136	11,359	1,553	6,813	2,650	7,410	13,958	6,659
Grand Total	**1,288,496**	**124,945**	**17,082**	**74,939**	**29,148**	**81,514**	**153,535**	**73,248**

Unit : Million IDR/year

Items	Zone No.						
	8	9	10	11	12	13	14
A. Collection Sewer Line	6,435	7,393	9,746	12,643	5,037	8,257	5,648
B. Lift Pump Station	1,027	565	1,248	3,633	0	1,057	754
C. Wastewater Treatment Plant	95,023	46,424	133,814	136,347	47,971	91,014	53,316
Total	**102,484**	**54,382**	**144,808**	**152,622**	**53,008**	**100,328**	**59,717**
D. Value Added Tax	10,248	5,438	14,481	15,262	5,301	10,033	5,972
Grand Total	**112,733**	**59,821**	**159,289**	**167,885**	**58,309**	**110,360**	**65,689**

Source: JICA expert team

D9.1.2 On-site

(1) Construction Cost

The approximate cost for developing the on-site STP (sludge treatment plant) has been calculated in the following expense items.

1) Construction Cost

(a) Direct Construction Cost

On-site STP development plans are categorized into 3 projects: (1) Development of new on-site STP in South area, (2) Rehabilitation and expansion of existing STP, and integration with newly constructed WWTPs, and (3) Development of On-site sludge treatment facilities added to newly constructed WWTPs.

The approximate cost of construction and replacement (up to 2050) of the above mentioned facilities has been calculated.

The direct construction cost of STP facilities replacement in terms of machinery and electrical equipment that will be approaching service life by 2050, which is the long-term target year, is as given in the following table.

Table D9-5 Concept of STP Facilities Replacement

Item	10 years after construction	20 years after	30 years after
Machinery replacement cost	—	80% of relevant direct construction cost	20% of relevant direct construction cost
Electrical equipment replacement cost	20% of relevant direct construction cost	80% of relevant direct construction cost	20% of relevant direct construction cost

Source: JICA expert team

(b) Indirect Construction Cost

Posted as 13% of direct construction cost. "Indirect construction cost" includes expenses for common temporary works, expense for site management and other general items in the construction contracts other than the direct construction cost.

2) Engineering Cost

Posted as 7% of direct construction cost. "Engineering cost" includes consultation cost related to the projects and cost related to some activities such as environmental education and awareness programs, and action plans for human resources development.

3) Physical Contingency

In addition to the above cost, which are construction cost and engineering cost, physical contingency to cover uncertainties that can not be expected at the time of the survey, is assumed to be 5% of the construction cost.

4) Land Use Cost

With assuming the sites of newly constructed STP is owned by public, the land use cost does not occur. In case that the site is private land, the cost of land acquisition needs to be incorporated separately

5) Value Added Tax

Value added tax of 10% is added to total construction cost.

Construction cost for developing the on-site STP is as given in Table D9-6. Details are provided in S/R Part-D:D9.

Table D9-6 Construction Cost of On-site STP

Unit : Million IDR

Items	Total	1. On-site STP Development Plan	2. Integration Plan for Off-site WWTP and On-site STP		
		Construction of a new STP in South area	(1) Duri Kosambi WWTP integrated with existing On-site STP	(2) Pulo Gebang WWTP expanded and integrated with existing On-site STP	
				Rehabilitation and Extension of Pulo Gebang STP	Pulo Gebang WWTP integrated with existing On-site STP
A. Construction Cost	799,991	50,996	192,966	19,940	182,209
a. Direct Construction Cost	707,957	45,129	170,766	17,646	161,247
(1) Civil and Building works	242,393	15,851	56,173	6,682	56,777
(2) Mechanical facilities	200,948	14,309	44,939	10,750	45,422
(3) Electrical facilities	44,486	300	11,235	214	11,355
(4)Facilities Replacement (from 2013 to 2050)	220,130	14,669	58,420	0	47,693
b. Indirect Construction Cost	92,034	5,867	22,200	2,294	20,962
B. Engineering Cost	49,557	3,159	11,954	1,235	11,287
C. Physical Contingency	40,000	2,550	9,648	997	9,110
D. Land Use Cost	0	0	0	0	0
Total	**889,548**	**56,705**	**214,568**	**22,172**	**202,607**
E. Value Added Tax	88,955	5,670	21,457	2,217	20,261
Grand Total	**978,503**	**62,375**	**236,025**	**24,390**	**222,868**

Unit : Million IDR

Items	3. Co-treatment Plan of On-site sludge at Off-site WWTPs		
	(1) Pejagalan WWTP (site No.2 / Zone No.1)	(2) Sunter Pond WWTP (site No.5 / Zone No. 5)	(3) Marunda WWTP (site No.8 / Zone No.8)
A. Construction Cost	163,917	79,474	110,489
a. Direct Construction Cost	145,060	70,331	97,778
(1) Civil and Building works	47,717	24,765	34,429
(2) Mechanical facilities	38,174	19,812	27,543
(3) Electrical facilities	9,543	4,953	6,886
(4)Facilities Replacement (from 2013 to 2050)	49,626	20,802	28,920
b. Indirect Construction Cost	18,858	9,143	12,711
B. Engineering Cost	10,154	4,923	6,844
C. Physical Contingency	8,196	3,974	5,524
D. Land Use Cost	0	0	0
Total	**182,267**	**88,371**	**122,857**
E. Value Added Tax	18,227	8,837	12,286
Grand Total	**200,494**	**97,208**	**135,143**

Source: JICA expert team

(2) Operation & Maintenance Cost

The approximate O&M cost of on-site STP is as follows:

1) O&M Cost

When conducting approximate calculation of O&M cost of on-site STP, a unit value is set at 170 JPY/m^3 (18,255 IDR/m^3) for existing STPs after rehabilitation, expansion and co-treatment with WWTP, and set at 500 JPY/m^3 (53,690 IDR/m^3) for a new STP.

2) Value Added Tax

10% value added tax is added to total O&M cost.

Per year O&M cost for on-site STP is as given in Table D9-7. Details are provided in S/R Part-D:D9.

Table D9-7 Per Year O&M Cost for On-site STP

Unit : Million IDR/year

Items	Total	1. On-site STP Development Plan	2. Integration Plan for Off-site WWTP and On-site STP		
		Construction of a new STP in South area	(1) Duri Kosambi WWTP integrated with existing On-site STP	(2) Pulo Gebang WWTP expanded and integrated with existing On-site STP	
				Rehabilitation and Extension of Pulo Gebang STP	Pulo Gebang WWTP integrated with existing On-site STP
A. O&M cost	39,009	11,758	6,197	2,998	6,263
Total	**39,009**	**11,758**	**6,197**	**2,998**	**6,263**
B. Value Added Tax	3,901	1,176	620	300	626
Grand Total	**42,910**	**12,934**	**6,816**	**3,298**	**6,889**

Items		3. Co-treatment Plan of On-site sludge at Off-site WWTPs		
		(1) Pejagalan WWTP (site No.2 / Zone No.1)	(2) Sunter Pond WWTP (site No.5 / Zone No. 5)	(3) Marunda WWTP (site No.8 / Zone No.8)
A. O&M cost		5,264	2,732	3,798
Total		**5,264**	**2,732**	**3,798**
B. Value Added Tax		526	273	380
Grand Total		**5,790**	**3,005**	**4,178**

Source: JICA expert team

D9.1.3 Total Cost of Construction and O&M of Off-site and On-site

Total cost of construction and annual O&M of off-site and on-site is as given in Table D9-8.

Regarding the construction cost of WWTP in Zone No.1, at the F/S stage, it is expected that the unit construction cost will be increased taking into account the severe constraint for the land area of Pejagalan site where at least 50% of the area shall be kept as a green area.

Table D9-8 Total of Construction and O&M Costs for Off-site and On-site Systems

Unit: Million IDR

development contents			Construction cost			Annual O&M cost (Maximum)	Remarks
			Initial construction cost	Facilities replacement cost (2013-2050)	Total		
A. Short-term plan							
(1)	Zone No.1	Development of sewerage system	5,192,315	1,079,250	6,271,565	124,945	Replacement period; after 2025
		On-site sludge treatment facilities	131,904	68,590	200,494	5,790	Co-treatment of On-site sludge
		Sub-total	5,324,219	1,147,840	6,472,059	130,735	
(2)	Zone No.6	Development of sewerage system	7,110,408	1,357,898	8,468,307	153,535	Replacement period; after 2026
		Integration Duri Kosambi STP with newly constructed WWTP	155,279	80,745	236,025	6,816	Co-treatment of On-site sludge
		Sub-total	7,265,688	1,438,644	8,704,331	160,351	
(3)	Rehabilitation and expansion of Pulo Gebang STP		24,390	0	24,390	3,298	
(4)	Construction of a new STP in south area		42,100	20,275	62,375	12,934	
		Total of Short-term plan	12,656,397	2,606,758	15,263,155	307,319	
B. Medium-term plan							
(1)	Zone No.4	Development of sewerage network	636,325	0	636,325	29,148	
(2)	Zone No.5	Development of sewerage system	3,586,678	570,552	4,157,230	81,514	Replacement period; after 2033
		On-site sludge treatment facilities	68,457	28,752	97,208	3,005	Co-treatment of On-site sludge
		Sub-total	3,655,134	599,304	4,254,438	84,519	
(3)	Zone No.8	Development of sewerage system	4,856,836	794,711	5,651,547	112,733	Replacement period; after 2035
		On-site sludge treatment facilities	95,171	39,972	135,143	4,178	Co-treatment of On-site sludge
		Sub-total	4,952,008	834,683	5,786,691	116,910	
(4)	Zone No.10	Development of sewerage system	7,639,771	1,322,893	8,962,664	159,289	Replacement period; after 2034
		Integration Pulo Gebang STP with newly constructed WWTP	156,949	65,919	222,868	6,889	
		Sub-total	7,796,720	1,388,812	9,185,531	166,178	
		Total of Medium-term plan	17,040,187	2,822,798	19,862,985	396,756	
C. long-term plan							
(1)	Zone No.2	Development of sewerage system	1,158,206	0	1,158,206	17,082	Replacement period; after 2051
(2)	Zone No.3	Development of sewerage system	3,701,406	24,508	3,725,914	74,939	Replacement period; after 2049
(3)	Zone No.7	Development of sewerage system	3,967,381	23,963	3,991,345	73,248	Replacement period; after 2044
(4)	Zone No.9	Development of sewerage system	4,333,679	18,550	4,352,229	59,821	Replacement period; after 2042
(5)	Zone No.11	Development of sewerage system	8,643,992	56,387	8,700,380	167,885	Replacement period; after 2047
(6)	Zone No.12	Development of sewerage system	3,253,732	0	3,253,732	58,309	Replacement period; after 2051
(7)	Zone No.13	Development of sewerage system	5,624,321	0	5,624,321	110,360	Replacement period; after 2051
(8)	Zone No.14	Development of sewerage system	3,674,569	21,449	3,696,018	65,689	Replacement period; after 2046
		Total of Long-term plan	34,357,286	144,858	34,502,144	627,332	
		Grand total	64,053,869	5,574,415	69,628,284	1,331,406	

Source: JICA expert team

D9.2 Priority Consideration

D9.2.1 Off-Site System

There are 14 sewerage zones (zone 1 to 14) and there is an existing zone named “Zone 0” where there is existing, on-going and planned sewerage works, operated and maintained by PD PAL JAYA. Priority sequences for implementation from zone 1 to zone 14 are determined in previous chapter. The highest priority is given to Zone No.1 and No. 6 (short-term) followed by Zone No. 5, No.10, No.4 and No. 8 (medium-term) and Zone No.2, No.3, No.9, No. 10, No.11, No.12, No.13 and No.14, (long-term) All the proposed sewerage development projects will be completed by 2050. The implementation programme is proposed based on this project priority sequences as shown in D9.4.1.

D9.2.2 On-Site System

The priority works for on-site system are structure improvement of the conventional septic tanks, introduction of regular desludging system, and development of sludge treatment capacity. These works should be included in the short-term plan. Regarding to the improvement and newly construction of the sludge treatment facility, it should be prioritized that sludge from the areas, where the sewerage system will be developed after 20 years (Zone No.2, No.3, No.9, No. 10, No.11, No.12, No.13 and No.14), should be collected and treated effectively.

D9.3 Capital Investment Considerations

D9.3.1 Potential Source of Funds

(1) Off-Site

Capital that must be provided for a sewerage project is roughly divided into construction capital and O&M cost.

1) Construction Capital

Construction capital is usually procured from budget of central government, budget of local government itself or financing from overseas financial institution. The foreign currency portion of construction capital is procured by financing from overseas financial institutions; the domestic currency portion is procured from grants or loans from the central government, the budget of the local government or from private sector financial institutions.

Sewerage projects are projects for the purpose of enhancing public benefit in the form of improving public sanitation and the environment that require financial assistance from the central government because they naturally tend to have low income in the form of sewerage tariff whereas upkeep requires an enormous investment. Construction funds, in particular, are required at the stage where the projects have little or no income. Those involved in sewerage projects, therefore, must procure construction funds, financial assistance from the central government or funding from financial institutions including international financial institutions in advance.

The following items are possible sources for procurement of construction funding:

*Central government budget (APBN)

*Local government budget (APBD)

*Local government loan (Municipality Bond)

*International financial institution

*Private financial institution

2) O&M Cost

O&M cost of sewerage projects must be financed by sewerage tariff by beneficiary-pay principle. The current sewerage system project operating authority is PD PAL JAYA. PD PAL JAYA pays the O&M cost of sewerage works using revenue from sewerage tariff and other revenues..

(2) On-Site

On-site wastewater treatment must be conducted by the private sector (residents or private entities); the public sector is in a position to regulate it. Funding for wastewater treatment therefore does not have to be provided by the public sector.

It is however the role of the public sector to accept, treat and dispose of sludge produced from on-site wastewater treatment. Funding is consequently required for developing and operating the sludge treatment facilities.

1) Construction Capital

The public sector should bear all the construction cost of on-site sludge treatment plants because it is responsible for sludge treatment and disposal.

Potential sources of construction capital are, as the same for off-site facilities, budget of central government, budget of local government or financing from overseas financial institution.

2) O&M Cost

It is not desirable to charge O&M cost of on-site sludge treatment plants on private desludging companies which bring sludge in the plants because that would be reverse-incentive for them to dispose the sludge into rivers. Furthermore, to ensure fairness with sewerage system users, it is not appropriate to burden on-site facilities users (households and business entities), who are not allowed to access to sewerage systems yet, with cost of sludge treatment in addition to repair and O&M cost of their septic tanks or ITPs.

Therefore, O&M cost of on-site sludge treatment plant needs to be borne by the public sector (DKI Jakarta). As a measure of securing the financial source, it is recommendable for DKI Jakarta to introduce environmental tax, etc.

It is furthermore effective for sludge treatment facilities for on-site sludge treatment to be set up in off-site wastewater treatment plants (WWTP), adding the capability of on-site sludge treatment to sludge treatment facilities of WWTPs so they can treat on-site sludge at WWTPs. The account of the O&M cost of on-site sludge treatment facilities must be separated from the account of the off-site sewerage treatment facilities, and must be compensated by the general account of the public sector backed by the environmental tax and so on.

The following projects are conceivable as a form of indirect support of on-site wastewater treatment from the public sector. The funding for operating these projects must come from financial assistance of the central government or be contributed by local government.

On-site projects requiring indirect support of the public sector

*Project for regular desludging from septic tanks

*Project for replacing Conventional Septic Tank (CST) by Modified Septic Tank (MST)

It is especially difficult for private citizens to bear the cost of replacing CST by MST, so it is necessary to provide them with an incentive to replace. It is therefore probably necessary to establish a system to provide financial assistance for replacing to MST. Local governments must consider providing financial assistance for replacing to MST as the cost of the replacement promotion project.

As the project for regular desludging from septic tanks should be basically carried out by strengthen regulation, the financial assistance by public sectors such as DKI Jakarta or central government is limited to construction costs and O&M costs of sludge treatment plants. When public sectors assist private citizens to replace CST by MST, the amount of funding should be estimated depending on the number of MST being subsided, the construction cost of MST per unit, and the subsidy rate.

Assuming public sectors give subsidy of 40% (the same rate for Joukasou in Japan) of the construction cost of MST, which is 4,000,000 IDR per unit, 583,619 million IDR (about 55 billion JPY) as the total amount is needed during the period from 2012 to 2020 as a budgetary measure, which is 72,952 million IDR (about 700 million JPY) per year. The calculation is made as follows;

* 9,599 thousand peoples (on-site population in 2020) / 5 peoples per household × 19% (replacing rate from 2012 to 2020) × 4,000,000 IDR/unit of MST × 40% = 583,619 million IDR

D9.3.2 Proposed Magnitude of Capital Investment

From 2013 when construction is expected to start for short, medium and long-term sewerage development projects and on-site sludge treatment plants development projects, the approximate total construction cost that must be capital-invested and financed by 2050, which is the long-term target year, is as given in Table D9-9 and Table D9-10. Detailed construction cost for each zone is as given in S/R Part-D:D9.

Table D9-9 Total Capital Investment Cost Required for Short, Medium and Long-term Sewerage Development Projects

<Initial Construction Cost>

Unit : Million IDR

Items			Cost		
			Local currency	Foreign currency	Total
A. Construction Cost			41,185,186	10,631,889	51,817,074
	a. Direct Construction Cost		36,447,067	9,408,751	45,855,818
	(1)House Connection Cost		4,694,090	0	4,694,090
	(2)Collection Sewer Line	Tertiary and Secondary	10,144,598	0	10,144,598
		Main	9,990,725	0	9,990,725
		Trunk	1,273,268	1,273,268	2,546,535
		Conveyance	603,690	2,414,758	3,018,448
		Sub-total	22,012,280	3,688,026	25,700,306
	(3)Lift Pump Station	Civil/Architect Works	233,930	0	233,930
		Mecanical Facility	37,429	149,714	187,143
		Electrical Facility	23,391	23,391	46,781
		Sub-total	294,749	173,105	467,854
	(4)Wastewater Treatmment Plant	Civil/Architect Works	7,496,784	0	7,496,784
		Mecanical Facility	1,199,485	4,797,942	5,997,427
		Electrical Facility	749,678	749,678	1,499,357
		Sub-total	9,445,948	5,547,620	14,993,568
	b. Indirect Construction Cost	13% of Direct Construction Cost	4,738,119	1,223,138	5,961,256
B. Engineering Cost		7% of Direct Construction Cost	2,551,295	658,613	3,209,907
C. Physical Contingency		5% of the sum of Direct Construction Cost and Indirect Construction Cost	2,059,259	531,594	2,590,854
D. Land Use Cost			0	0	0
Total			**45,795,740**	**11,822,096**	**57,617,835**
E. Value Added Tax		10%	4,579,574	1,182,210	5,761,784
Grand Total			**50,375,314**	**13,004,305**	**63,379,619**

<Facility Re placement (2013-2050)>

Unit : Million IDR

Items			Cost		
			Local currency	Foreign currency	Total
A. Construction Cost			1,192,197	3,116,512	4,308,710
	a. Facilities Replacement Cost (Direct Construction Cost) (from 2013 to 2050)	Mecanical Facility	567,645	2,270,578	2,838,223
		Electrical Facility	487,397	487,397	974,795
		Sub-total	1,055,042	2,757,976	3,813,018
	b. Indirect Construction Cost	13% of Direct Construction Cost	137,155	358,537	495,692
B. Engineering Cost		7% of Direct Construction Cost	73,853	193,058	266,911
C. Physical Contingency		5% of the sum of Direct Construction Cost and Indirect Construction Cost	59,610	155,826	215,435
Total			**1,325,660**	**3,465,396**	**4,791,057**
D. Value Added Tax		10%	132,566	346,540	479,106
Grand Total			**1,458,226**	**3,811,936**	**5,270,162**

Source: JICA expert team

Table D9-10 Total Capital Investment Cost Required for Short, Medium and Long-term On-site Sludge Treatment Plants Development Projects

<Initial Construction Cost>

Unit : Million IDR

Items		Cost		
		Local currency	Foreign currency	Total
A. Construction Cost		343,172	208,073	551,245
a. Direct Construction Cost		303,692	184,135	487,827
(1) Civil and Building works		242,393	0	242,393
(2) Mechanical facilities		16,812	184,135	200,948
(3) Electrical facilities		44,486	0	44,486
b. Indirect Construction Cost	13% of Direct Construction Cost	39,480	23,938	63,418
B. Engineering Cost	7% of Direct Construction Cost	21,258	12,889	34,148
C. Physical Contingency	5% of the sum of Direct Construction Cost and Indirect Construction Cost	17,159	10,404	27,562
D. Land Use Cost		0	0	0
Total		**381,589**	**231,366**	**612,955**
F. Value Added Tax	10%	38,159	23,137	61,295
Grand Total		**419,748**	**254,503**	**674,250**

<Facility Re placement (2013-2050)>

Unit : Million IDR

Items			Cost		
			Local currency	Foreign currency	Total
A. Construction Cost			71,018	177,728	248,747
	a. Facilities Replacement Cost (from 2013 to 2050)	Mecanical Facility	14,360	157,282	171,642
		Electrical Facility	48,488	0	48,488
		Sub-total	62,848	157,282	220,130
	b. Indirect Construction Cost	13% of Direct Construction Cost	8,170	20,447	28,617
B. Engineering Cost		7% of Direct Construction Cost	4,399	11,010	15,409
C. Physical Contingency		5% of the sum of Direct Construction Cost and Indirect Construction Cost	3,551	8,886	12,437
Total			**78,969**	**197,624**	**276,593**
D. Value Added Tax		10%	7,897	19,762	27,659
Grand Total			**86,865**	**217,387**	**304,252**

Source: JICA expert team

D9.4 Implementation Schedule

D9.4.1 Sewerage Development Project (Off-site)

(1) Implementation Schedule for Sewerage Development Project

Sewerage system development is divided into short-term projects to be implemented between 2013 and 2020, medium-term projects to be implemented between 2021 and 2030, and long-term projects to be implemented between 2031 and 2050; work is to be carried out by the zone according to the priority ranking of the various zones.

Basically, the wastewater treatment plant is to be built first, and the wastewater treatment plant and sewage pipeline are to be opened when the construction is complete or 1 to 2 years after the star of construction. Replacement of machinery and electrical equipment thought to have reached the service life is scheduled to be completed by 2050; some electrical equipment (especially equipment equipped with measuring instruments) is scheduled to be replaced 10 years after construction, and some machinery and electrical equipment is scheduled to be replaced 20 and 30 years after construction.

Construction for short-term projects is scheduled to begin in 2013, with feasibility studies (F/S) and design conducted in 2012.

In order to achieve "15% sewerage service coverage ratio by 2020," which is the goal of the short-term project, the system will be developed in zones No.1 and No.6 simultaneously from 2013 to 2020. It is necessary to perform the work in a concentrated and swift manner.

In addition, in the actual planning of particular investment in the particular zone like F/S, considering the policy priority, budget allocation, implementation capacity, etc., such adjustment of the size of investment would be made as the phased implementation of the investment, so that the size of investment would be realistic from the view point of the availability of DKI Jakarta's local budget in particular.

The sewerage development project schedule is given in Table D9-11.

(2) Construction Costs by Stage

Construction cost for each year and development plan is given in Table D9-12. Detailed construction cost for each zone is as given in S/R Part-D:D9.

The estimated construction costs required for short, medium and long-term plans are approximately 12.0 trillion IDR (111.8 billion JPY), 16.7 trillion IDR (155.5 billion JPY) and 40.0 trillion IDR (372.5 billion JPY) respectively. The total is 68.6 trillion IDR (638.8 billion JPY).

(3) O&M Costs by Stage

O&M cost for each year and term is given in

Table D9-13. Detailed O&M cost for each zone is as given in S/R Part-D:D9.

The annual O&M costs are estimated to be the maximum of 195 billion IDR/year (1.8 billion JPY/year) in the short-term development plan(by 2020), to be the maximum of 536 billion IDR/year (5.0 billion JPY/year) in the medium-term development plan(by 2030) and to be the maximum of 1.3 trillion IDR/year (11.8 billion JPY/year) in the long-term development plan(by 2050). Unlike construction cost, which is a temporary cost, O&M cost is and increases year by year as sewerage system development progresses.

Table D9-11 Sewerage Development Project Schedule (1/2)

Term	Zone	Population in 2030 Persons	Wastewater Flow m^3/day	WWTP Capacity m^3/day	Development Priority	Items	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Short-term (2012-2020)	Zone 1	989,389	198,000	264,000	1	WWTP		*		*		*								▽					
						Sewer		*	*	*	*	*	*	*											
						H/C			*	*	*	*	*	*	*	*	*	*							
						O&M			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 6	1,172,574	235,000	313,000	2	WWTP		*		*		*		*							▽				
						Sewer		*	*	*	*	*	*	*	*										
						H/C			*	*	*	*	*	*	*	*	*	*							
						O&M			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Medium-term (2021-2030)	Zone 4	232,637	(47,000)*	(62,000)*	6	WWTP																			
			* Wastewater in Zone 4 is treated at WWTP of Zone 10. Therefore there is no WWTP for Zone 4.			Sewer																*	*		
						H/C																	*	*	*
						O&M																	■	■	■
	Zone 5	636,087	127,000	170,000	4	WWTP											*			*					
						Sewer												*	*	*	*	*			
						H/C													*	*	*	*	*	*	*
						O&M													■	■	■	■	■	■	■
	Zone 8	880,110	176,000	235,000	5	WWTP												*			*		*		
						Sewer													*	*	*	*	*	*	
						H/C														*	*	*	*	*	*
						O&M														■	■	■	■	■	■
	Zone 10	1,239,402	295,000	393,000	3	WWTP										*			*		*		*		
			* WWTP of Zone 10 handles wastewater including Zone 4.			Sewer											*	*	*	*	*	*	*	*	
						H/C												*	*	*	*	*	*	*	*
						O&M												■	■	■	■	■	■	■	■
Long-term (2031-2050)	Zone 2	119,234	24,000	32,000	14	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Zone 3	577,201	115,000	154,000	11	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Zone 7	554,119	111,000	148,000	8	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Zone 9	429,982	86,000	115,000	6	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Zone 11	1,262,858	253,000	337,000	8	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Zone 12	444,308	89,000	118,000	13	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Zone 13	842,979	169,000	225,000	12	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Zone 14	493,815	99,000	132,000	8	WWTP																			
						Sewer																			
						H/C																			
						O&M																			
	Total	9,874,694	1,977,000	2,636,000																					

Remarks : * ; Construction ■■■■■ ; O & M ▼ ; Mecanical Facility replacement ▽ ; Electrical Facility replacement

Source: JICA expert team

Table D9-11 Sewerage Development Project Schedule (2/2)

Term	Zone	Population in 2030 Persons	Wastewater Flow m^3/day	WWTP Capacity m^3/day	Development Priority	Items	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Short-term (2012-2020)	Zone 1	989,389	198,000	264,000	1	WWTP					▼▽										▼▽					
						Sewer																				
						H/C																				
						O&M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 6	1,172,574	235,000	313,000	2	WWTP						▼▽										▼▽				
						Sewer																				
						H/C																				
						O&M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Medium-term (2021-2030)	Zone 4	232,637	(47,000)*	(62,000)*	6	WWTP							▽										▼▽			
			* Wastewater in Zone 4 is treated at WWTP of Zone 10. Therefore there is no WWTP for Zone 4.			Sewer																				
						H/C																				
						O&M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 5	636,087	127,000	170,000	4	WWTP			▽										▼▽							
						Sewer																				
						H/C	*	*																		
						O&M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 8	880,110	176,000	235,000	5	WWTP					▽										▼▽					
						Sewer																				
						H/C	*	*	*																	
						O&M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 10	1,239,402	295,000	393,000	3	WWTP				▽										▼▽						
			* WWTP of Zone 10 handles wastewater including Zone 4.			Sewer																				
						H/C	*	*	*	*																
						O&M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Long-term (2031-2050)	Zone 2	119,234	24,000	32,000	14	WWTP																			*	
						Sewer																				*
						H/C																				*
						O&M																				■
	Zone 3	577,201	115,000	154,000	11	WWTP								*			*								▽	
						Sewer									*	*	*	*								
						H/C										*	*	*	*	*	*	*				
						O&M										■	■	■	■	■	■	■	■	■	■	■
	Zone 7	554,119	111,000	148,000	8	WWTP			*			*								▽						
						Sewer				*	*	*	*													
						H/C					*	*	*	*	*	*	*									
						O&M					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 9	429,982	86,000	115,000	6	WWTP	*		*									▽								
						Sewer		*	*	*																
						H/C			*	*	*	*	*													
						O&M			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 11	1,262,858	253,000	337,000	8	WWTP				*			*		*		*						▽			
						Sewer					*	*	*	*	*	*	*	*	*							
						H/C						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
						O&M						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Zone 12	444,308	89,000	118,000	13	WWTP															*		*			
						Sewer																*	*	*		
						H/C																	*	*	*	*
						O&M																	■	■	■	■
	Zone 13	842,979	169,000	225,000	12	WWTP											*			*						
						Sewer												*	*	*	*	*	*			
						H/C													*	*	*	*	*	*	*	*
						O&M													■	■	■	■	■	■	■	■
	Zone 14	493,815	99,000	132,000	8	WWTP					*			*								▽				
						Sewer						*	*	*	*											
						H/C							*	*	*	*	*	*	*							
						O&M							■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Total	9,874,694	1,977,000	2,636,000	Remarks :	* ; Construction	■■■■■ ; O & M	▼ ; Mecanical Facility replacement	▽ ; Electrical Facility replacement																	

Source: JICA expert team

Table D9-12 Construction Cost by Stage

Unit: Million IDR

Items	Term	Short-term									Medium-term									
	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
A. Construction Cost	56,125,784	0	1,769,047	793,212	1,862,309	914,228	1,862,309	793,212	1,296,695	487,500	725,294	1,026,047	1,385,754	1,770,045	1,774,311	2,335,014	1,374,794	2,230,873	878,794	148,858
a. Direct Construction Cost	49,668,836	0	1,565,528	701,957	1,648,061	809,051	1,648,061	701,957	1,147,517	431,416	641,853	908,006	1,226,331	1,566,411	1,570,186	2,066,384	1,216,632	1,974,224	777,694	131,733
Short-term	10,664,451	0	1,565,528	701,957	1,648,061	809,051	1,648,061	701,957	1,147,517	431,416	82,533	82,533	82,533	0	30,033	37,787	0	0	0	0
Medium-term	14,041,722	0	0	0	0	0	0	0	0	0	559,320	825,473	1,143,798	1,566,411	1,540,154	2,028,598	1,216,632	1,974,224	777,694	131,733
Long-term	24,962,662	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b. Indirect Construction Cost	6,456,949	0	203,519	91,254	214,248	105,177	214,248	91,254	149,177	56,084	83,441	118,041	159,423	203,633	204,124	268,630	158,162	256,649	101,100	17,125
B. Engineering Cost	3,476,818	0	109,587	49,137	115,364	56,634	115,364	49,137	80,326	30,199	44,930	63,560	85,843	109,649	109,913	144,647	85,164	138,196	54,439	9,221
C. Physical Contingency	2,806,289	0	88,452	39,661	93,115	45,711	93,115	39,661	64,835	24,375	36,265	51,302	69,288	88,502	88,716	116,751	68,740	111,544	43,940	7,443
D. Land Use Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (excluding Value Added Tax	62,408,892	**0**	**1,967,086**	**882,009**	**2,070,789**	**1,016,573**	**2,070,789**	**882,009**	**1,441,855**	**542,075**	**806,488**	**1,140,909**	**1,540,885**	**1,968,196**	**1,972,939**	**2,596,412**	**1,528,698**	**2,480,613**	**977,173**	**165,523**
E. Value Added Tax	6,240,889	0	196,709	88,201	207,079	101,657	207,079	88,201	144,186	54,207	80,649	114,091	154,088	196,820	197,294	259,641	152,870	248,061	97,717	16,552
Grand Total	**68,649,781**	**0**	**2,163,795**	**970,210**	**2,277,868**	**1,118,230**	**2,277,868**	**970,210**	**1,586,041**	**596,282**	**887,137**	**1,255,000**	**1,694,973**	**2,165,015**	**2,170,233**	**2,856,053**	**1,681,567**	**2,728,674**	**1,074,890**	**182,075**
		11,960,505									**16,695,618**									

Items	Long-term																			
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
A. Construction Cost	488,805	916,774	1,821,973	2,016,215	2,197,646	2,924,553	2,291,719	1,957,501	2,018,410	1,058,623	2,576,213	1,467,253	1,573,629	2,133,148	1,770,569	1,867,041	1,591,221	721,419	423,406	881,370
a. Direct Construction Cost	432,570	811,304	1,612,365	1,784,261	1,944,820	2,588,100	2,028,070	1,732,302	1,786,203	936,835	2,279,835	1,298,454	1,392,592	1,887,742	1,566,875	1,652,249	1,408,161	638,424	374,696	779,974
Short-term	0	0	0	0	600,653	755,734	0	0	0	0	0	0	0	0	150,163	188,933	0	0	0	0
Medium-term	106,458	106,458	98,061	87,033	27,380	0	0	0	0	0	0	0	393,143	911,550	547,602	0	0	0	0	0
Long-term	326,112	704,846	1,514,304	1,697,228	1,316,787	1,832,366	2,028,070	1,732,302	1,786,203	936,835	2,279,835	1,298,454	999,449	976,192	869,111	1,463,315	1,408,161	638,424	374,696	779,974
b. Indirect Construction Cost	56,234	105,470	209,607	231,954	252,827	336,453	263,649	225,199	232,206	121,789	296,379	168,799	181,037	245,406	203,694	214,792	183,061	82,995	48,710	101,397
B. Engineering Cost	30,280	56,791	112,866	124,898	136,137	181,167	141,965	121,261	125,034	65,578	159,588	90,892	97,481	132,142	109,681	115,657	98,571	44,690	26,229	54,598
C. Physical Contingency	24,440	45,839	91,099	100,811	109,882	146,228	114,586	97,875	100,920	52,931	128,811	73,363	78,681	106,657	88,528	93,352	79,561	36,071	21,170	44,069
D. Land Use Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (excluding Value Added Tax	**543,525**	**1,019,404**	**2,025,937**	**2,241,924**	**2,443,666**	**3,251,947**	**2,548,269**	**2,176,637**	**2,244,365**	**1,177,133**	**2,864,612**	**1,631,508**	**1,749,792**	**2,371,948**	**1,968,779**	**2,076,050**	**1,769,354**	**802,179**	**470,805**	**980,037**
E. Value Added Tax	54,352	101,940	202,594	224,192	244,367	325,195	254,827	217,664	224,436	117,713	286,461	163,151	174,979	237,195	196,878	207,605	176,935	80,218	47,080	98,004
Grand Total	**597,877**	**1,121,344**	**2,228,531**	**2,466,117**	**2,688,033**	**3,577,142**	**2,803,096**	**2,394,301**	**2,468,801**	**1,294,846**	**3,151,074**	**1,794,659**	**1,924,772**	**2,609,142**	**2,165,657**	**2,283,655**	**1,946,289**	**882,397**	**517,885**	**1,078,040**
	39,993,659																			

Source: JICA expert team

Table D9-13 O&M Cost by Stage

Unit: Million IDR

Items	Term	Short-term									Medium-term									
	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
A. O&M Cost	20,272,175	0	0	25,316	50,633	75,949	101,266	126,582	151,898	177,215	202,531	227,848	263,328	281,725	311,509	341,294	371,078	409,696	448,313	486,930
Short-term	8,227,832	0	0	25,316	50,633	75,949	101,266	126,582	151,898	177,215	202,531	227,848	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164
Medium-term	7,286,166	0	0	0	0	0	0	0	0	0	0	0	10,164	28,561	58,345	88,130	117,914	156,531	195,149	233,766
Long-term	4,758,178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (excluding Value Added Tax)	**20,272,175**	**0**	**0**	**25,316**	**50,633**	**75,949**	**101,266**	**126,582**	**151,898**	**177,215**	**202,531**	**227,848**	**263,328**	**281,725**	**311,509**	**341,294**	**371,078**	**409,696**	**448,313**	**486,930**
B. Value Added Tax	2,027,218	0	0	2,532	5,063	7,595	10,127	12,658	15,190	17,721	20,253	22,785	26,333	28,172	31,151	34,129	37,108	40,970	44,831	48,693
Total	**22,299,393**	**0**	**0**	**27,848**	**55,696**	**83,544**	**111,392**	**139,240**	**167,088**	**194,936**	**222,784**	**250,632**	**289,660**	**309,897**	**342,660**	**375,423**	**408,186**	**450,665**	**493,144**	**535,623**
		779,745									**3,678,676**									

Items	Long-term																			
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
A. O&M Cost	516,714	546,499	578,926	599,966	620,355	650,919	690,014	718,233	746,452	784,403	822,353	850,792	891,771	924,219	956,667	989,115	1,025,083	1,061,051	1,097,018	1,148,515
Short-term	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164	253,164
Medium-term	263,550	293,335	314,886	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049	325,049
Long-term	0	0	10,876	21,753	42,142	72,706	111,801	140,020	168,238	206,189	244,140	272,578	313,558	346,006	378,454	410,902	446,870	482,837	518,805	570,302
Total (excluding Value Added Tax)	**516,714**	**546,499**	**578,926**	**599,966**	**620,355**	**650,919**	**690,014**	**718,233**	**746,452**	**784,403**	**822,353**	**850,792**	**891,771**	**924,219**	**956,667**	**989,115**	**1,025,083**	**1,061,051**	**1,097,018**	**1,148,515**
B. Value Added Tax	51,671	54,650	57,893	59,997	62,036	65,092	69,001	71,823	74,645	78,440	82,235	85,079	89,177	92,422	95,667	98,911	102,508	106,105	109,702	114,851
Total	**568,386**	**601,149**	**636,819**	**659,963**	**682,391**	**716,011**	**759,016**	**790,056**	**821,097**	**862,843**	**904,589**	**935,871**	**980,948**	**1,016,641**	**1,052,334**	**1,088,026**	**1,127,591**	**1,167,156**	**1,206,720**	**1,263,366**
	17,840,971																			

Source: JICA expert team

D9.4.2 On-site STP Development Plan

(1) Implementation Schedule for On-site STP Development Plan

On-site STP development plans are categorized into 3 projects: (1) Development of new on-site STP in South area, (2) Rehabilitation and expansion of existing STP, and integration with newly constructed WWTPs, and (3) Development of On-site sludge treatment facilities added to newly constructed WWTPs.

During the short-term plan, development of new STPs will be mainly invested. Additional investment will be made in on-site sludge treatment facilities added to WWTPs during the medium-term plan, and investment in replacement of these facilities will be required during the long-term plan.

Schedule of on-site STP development plan is given in Table D9-14.

(2) Construction Cost by Stage

Construction cost for each year and plan is given in Table D9-15. Detailed construction cost is as given in S/R Part-D:D9.

The estimated construction costs required for short, medium and long-term plans are approximately 354 billion IDR (3.3 billion JPY), 326 billion IDR (3.0 billion JPY) and 298 billion IDR (2.8 billion JPY) respectively. The total is 979 billion IDR (9.1 billion JPY).

(3) O&M Cost by Stage

O&M cost for each year and term is given in Table D9-16. Detailed O&M cost is as given in S/R Part-D:D9.

The annual O&M costs are estimated to be the maximum of 37 billion IDR/year (340 million JPY/year) at 2030 of the time when a regular sludge extraction systems will be promoted, and reach a peak of the sludge amount should be treated in on-site STPs, thereafter, are decreased to 16 billion IDR/year (150 million JPY/year) at 2050, owing to advance a switching to sewerage.

Table D9-14 Schedule of On-site STP Developing Plan (1/2)

Items		Unit	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. On-site Sludge Treatment Plant Development Plan																					
Construction of a new STP in South area	Sludge amount	m^3/day	0	0	0	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	-				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2. Integration Plan for Off-site WWTP and On-site STP																					
(1) Duri Kosambi WWTP integrated with existing On-site STP (WWTP site No. 6 / Zone No.6)	Sludge amount	m^3/day	128	140	507	279	372	462	550	635	716	825	930	752	692	611	645	677	704	728	749
	WWTP with STP	-		*		*		*		*				▽							
STP's capacity = 930 m^3/day	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M	-			■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■
(2) Pulo Gebang WWTP expanded and integrated with existing On-site STP (WWTP site No. 10 / Zone No.10)	Sludge amount	m^3/day	128	140	450	450	450	450	450	450	450	450	450	944	869	767	810	850	883	913	940
	WWTP with STP	-		* Expanded								*			*		*		*		
STP's capacity =(2014 - 2022) 450 m^3/day	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
(2023 - 2050) 940 m^3/day	WWTP O&M	-												■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■
3. Co-treatment Plan of On-site sludgeat Off-site WWTPs																					
(1) Pejagalan WWTP (site No. 2 / Zone No.1)	Sludge amount	m^3/day	0	0	427	235	313	390	463	535	604	695	783	634	583	514	543	571	593	613	631
STP's capacity = 790 m^3/day	WWTP with STP	-		*	*	*										▽					
	Acceptance of sludge	-			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M	-			■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■
(2) Sunter Pond WWTP (site No. 5 / Zone No.5)	Sludge amount	m^3/day	0	0	0	0	0	0	0	0	0	0	0	0	374	330	349	366	380	393	405
STP's capacity = 410 m^3/day	WWTP with STP	-											*			*					
	Acceptance of sludge	-													+	+	+	+	+	+	+
	WWTP O&M	-													■■■	■■■	■■■	■■■	■■■	■■■	■■■
(3) Marunda WWTP (site No. 8 / Zone No.8)	Sludge amount	m^3/day	0	0	0	0	0	0	0	0	0	0	0	0	0	457	483	507	527	545	561
STP's capacity = 570 m^3/day	WWTP with STP	-												*			*		*		
	Acceptance of sludge	-														+	+	+	+	+	+
	WWTP O&M	-														■■■	■■■	■■■	■■■	■■■	■■■
Total de-sludging amount(sludge concentration=1.5%)		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

Remarks : * ; Construction + ; Acceptance of sludge into WWTP or STP ■■■■■ ; O&M of WWTP or STP ▼ ; Mecanical Facility replacemen ▽ ; Electrical Facility replacement

Source: JICA expert team

Table D9-14 Schedule of On-site STP Developing Plan (2/2)

Items		Unit	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
1. On-site Sludge Treatment Plant Development Plan																						
Construction of a new STP in South area	Sludge amount	m³/day	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
STP's capacity = 600 m3/day	STP	-				▼▽										▼▽						
	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2. Integration Plan for Off-site WWTP and On-site STP																						
(1) Duri Kosambi WWTP integrated with existing On-site STP (WWTP site No. 6 / Zone No.6)	Sludge amount	m³/day	743	739	731	725	718	703	679	658	633	599	562	528	482	438	391	342	286	228	167	91
	WWTP with STP	-			▼▽										▼▽							
STP's capacity = 930 m3/day	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	O&M	-	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
(2) Pulo Gebang WWTP expanded and integrated with existing On-site STP (WWTP site No. 10 / Zone No.10)	Sludge amount	m³/day	932	928	917	911	902	882	852	825	795	752	705	662	605	550	491	429	360	286	209	114
	WWTP with STP	-		▽										▼▽								
STP's capacity =(2014 - 2022) 450 m3/day (2023 - 2050) 940 m3/day	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M	-	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3. Co-treatment Plan of On-site sludgeat Off-site WWTPs																						
(1) Pejagalan WWTP (site No. 2 / Zone No.1)	Sludge amount	m³/day	626	623	616	611	605	592	572	554	533	505	473	444	406	369	330	288	241	192	140	77
STP's capacity = 790 m3/day	WWTP with STP	-					▼▽										▼▽					
	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M	-	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
(2) Sunter Pond WWTP (site No. 5 / Zone No.5)	Sludge amount	m³/day	401	399	395	392	388	380	367	355	342	324	304	285	260	237	212	185	155	123	90	49
	WWTP with STP	-			▽										▼▽							
STP's capacity = 410 m3/day	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M	-	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
(3) Marunda WWTP (site No. 8 / Zone No.8)	Sludge amount	m³/day	556	553	547	543	538	526	508	492	474	449	421	395	361	328	293	256	214	171	125	68
	WWTP with STP	-					▽										▼▽					
STP's capacity = 570 m3/day	Acceptance of sludge	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	WWTP O&M	-	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Total de-sludging amount(sludge concentration=1.5%)		m³/day	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 ▼ ; Mecanical Facility replacemen ▽ ; Electrical Facility replacement

Source: JICA expert team

Table D9-15 Construction Cost of On-site STP by Stage

Unit: Million IDR

Items	Term	Short-term									Medium-term									
	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
A. Construction Cost	799,991	0	271,942	17,210	0	0	0	0	0	0	64,158	64,158	58,507	77,877	2,157	0	0	0	0	0
a. Direct Construction Cost	707,957	0	240,656	15,230	0	0	0	0	0	0	56,777	56,777	51,776	68,917	1,909	0	0	0	0	0
1. On-site STP Development Plan	45,129	0	15,230	15,230	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0
2. Integration Plan for Off-site WWTP and On-site STP	349,660	0	129,992	0	0	0	0	0	0	0	56,777	56,777	2,247	0	0	0	0	0	0	0
3. Co-treatment Plan of On-site sludge at Off-site WWTPs	313,168	0	95,434	0	0	0	0	0	0	0	0	0	49,529	68,857	1,909	0	0	0	0	0
b. Indirect Construction Cost	92,034	0	31,285	1,980	0	0	0	0	0	0	7,381	7,381	6,731	8,959	248	0	0	0	0	0
B. Engineering Cost	49,557	0	16,846	1,066	0	0	0	0	0	0	3,974	3,974	3,624	4,824	134	0	0	0	0	0
C. Physical Contingency	40,000	0	13,597	860	0	0	0	0	0	0	3,208	3,208	2,925	3,894	108	0	0	0	0	0
D. Land Use Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (excluding Value Added Tax)	889,548	**0**	**302,385**	**19,137**	**0**	**0**	**0**	**0**	**0**	**0**	**71,341**	**71,341**	**65,056**	**86,595**	**2,398**	**0**	**0**	**0**	**0**	**0**
E. Value Added Tax	88,955	0	30,238	1,914	0	0	0	0	0	0	7,134	7,134	6,506	8,659	240	0	0	0	0	0
Grand Total	**978,503**	**0**	**332,623**	**21,050**	**0**	**0**	**0**	**0**	**0**	**0**	**78,475**	**78,475**	**71,562**	**95,254**	**2,638**	**0**	**0**	**0**	**0**	**0**
		353,673									**326,403**									

Items	Long-term																			
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
A. Construction Cost	0	2,566	51,900	13,206	44,692	0	0	0	0	0	0	51,327	35,082	3,302	41,908	0	0	0	0	0
a. Direct Construction Cost	0	2,271	45,929	11,687	39,551	0	0	0	0	0	0	45,422	31,046	2,922	37,086	0	0	0	0	0
1. On-site STP Development Plan	0	0	0	11,687	0	0	0	0	0	0	0	0	0	2,922	0	0	0	0	0	0
2. Integration Plan for Off-site WWTP and On-site STP	0	2,271	44,939	0	0	0	0	0	0	0	0	45,422	11,235	0	0	0	0	0	0	0
3. Co-treatment Plan of On-site sludge at Off-site WWTPs	0	0	991	0	39,551	0	0	0	0	0	0	0	19,812	0	37,086	0	0	0	0	0
b. Indirect Construction Cost	0	295	5,971	1,519	5,142	0	0	0	0	0	0	5,905	4,036	380	4,821	0	0	0	0	0
B. Engineering Cost	0	159	3,215	818	2,769	0	0	0	0	0	0	3,180	2,173	205	2,596	0	0	0	0	0
C. Physical Contingency	0	128	2,595	660	2,235	0	0	0	0	0	0	2,566	1,754	165	2,095	0	0	0	0	0
D. Land Use Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (excluding Value Added Tax	**0**	**2,854**	**57,710**	**14,685**	**49,695**	**0**	**0**	**0**	**0**	**0**	**0**	**57,072**	**39,010**	**3,671**	**46,599**	**0**	**0**	**0**	**0**	**0**
E. Value Added Tax	0	285	5,771	1,468	4,970	0	0	0	0	0	0	5,707	3,901	367	4,660	0	0	0	0	0
Grand Total	**0**	**3,139**	**63,481**	**16,153**	**54,665**	**0**	**0**	**0**	**0**	**0**	**0**	**62,780**	**42,911**	**4,038**	**51,259**	**0**	**0**	**0**	**0**	**0**
	298,426																			

Source: JICA expert team

Table D9-16 O&M Cost of On-site STP by Stage

Unit: Million IDR

Items	Term	Short-term									Medium-term									
	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
A. O&M Cost	976,404	1,712	1,872	9,226	18,179	19,323	20,433	21,508	22,547	23,550	24,880	26,168	27,285	28,533	29,608	30,611	31,558	32,327	33,027	33,658
New STP in South area	423,292	0	0	0	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758
Duri Kosambi WWTP	143,544	856	936	3,380	1,858	2,478	3,081	3,664	4,228	4,773	5,494	6,193	5,012	4,611	4,069	4,297	4,513	4,688	4,848	4,992
Pulo Gebang WWTP	162,598	856	936	2,998	2,998	2,998	2,998	2,998	2,998	2,998	2,998	2,998	6,292	5,788	5,107	5,394	5,665	5,885	6,086	6,266
Sludge treatment by Off-site WWTPs	246,969	0	0	2,848	1,565	2,088	2,596	3,087	3,562	4,021	4,629	5,218	4,223	6,377	8,674	9,161	9,621	9,995	10,335	10,642
Total (excluding Value Added Tax)	**976,404**	**1,712**	**1,872**	**9,226**	**18,179**	**19,323**	**20,433**	**21,508**	**22,547**	**23,550**	**24,880**	**26,168**	**27,285**	**28,533**	**29,608**	**30,611**	**31,558**	**32,327**	**33,027**	**33,658**
B. Value Added Tax	97,640	171	187	923	1,818	1,932	2,043	2,151	2,255	2,355	2,488	2,617	2,728	2,853	2,961	3,061	3,156	3,233	3,303	3,366
Total	**1,074,044**	**1,883**	**2,059**	**10,149**	**19,997**	**21,255**	**22,476**	**23,658**	**24,802**	**25,905**	**27,368**	**28,785**	**30,013**	**31,387**	**32,569**	**33,673**	**34,714**	**35,559**	**36,330**	**37,024**
		152,184									**327,420**									

Items	Long-term																			
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
A. O&M Cost	33,469	33,360	33,120	32,962	32,761	32,302	31,601	30,979	30,264	29,274	28,184	27,180	25,835	24,563	23,199	21,745	20,130	18,423	16,627	14,422
New STP in South area	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758	11,758
Duri Kosambi WWTP	4,949	4,924	4,869	4,833	4,787	4,683	4,523	4,381	4,218	3,992	3,744	3,515	3,209	2,919	2,608	2,276	1,908	1,519	1,110	607
Pulo Gebang WWTP	6,212	6,181	6,112	6,067	6,009	5,878	5,678	5,500	5,295	5,012	4,700	4,413	4,028	3,664	3,274	2,858	2,395	1,907	1,393	762
Sludge treatment by Off-site WWTPs	10,550	10,497	10,380	10,304	10,206	9,983	9,642	9,340	8,993	8,512	7,982	7,494	6,841	6,222	5,560	4,853	4,068	3,239	2,366	1,295
Total (excluding Value Added Tax)	**33,469**	**33,360**	**33,120**	**32,962**	**32,761**	**32,302**	**31,601**	**30,979**	**30,264**	**29,274**	**28,184**	**27,180**	**25,835**	**24,563**	**23,199**	**21,745**	**20,130**	**18,423**	**16,627**	**14,422**
B. Value Added Tax	3,347	3,336	3,312	3,296	3,276	3,230	3,160	3,098	3,026	2,927	2,818	2,718	2,584	2,456	2,320	2,174	2,013	1,842	1,663	1,442
Total	**36,816**	**36,696**	**36,432**	**36,258**	**36,037**	**35,532**	**34,761**	**34,077**	**33,291**	**32,201**	**31,003**	**29,897**	**28,419**	**27,019**	**25,519**	**23,919**	**22,143**	**20,266**	**18,290**	**15,865**
	594,440																			

Source: JICA expert team

(4) Subsidy to the On-site Projects for which Indirect Support from the Public Sector is Required

As for the on-site projects for which indirect support from the public sector is required, it is conceivable that there are the project for regular desludging from septic tanks and the project for replacing Conventional Septic Tank (CST) by Modified Septic Tank (MST).

It is especially difficult for private citizens to bear the cost of replacing CST by MST, so it is necessary to provide them with an incentive to replace. It is therefore probably necessary to establish a system to provide financial assistance for replacing to MST. Local governments must consider providing financial assistance for replacing to MST as the cost of the replacement promotion project.

As the project for regular desludging from septic tanks should be basically carried out by strengthen regulation, the financial assistance by public sectors such as DKI or central government is limited to construction costs and O&M costs of sludge treatment plants.

When public sectors assist private citizens to replace CST by MST, the amount of funding should be estimated depending on the number of MST being subsided, the construction cost of MST per unit, and the subsidy rate.

Assuming public sectors give subsidy of 40% (the same rate for Joukasou in Japan) of the construction cost of MST, the required amount of funding can be estimated as following table;

Table D9-17 Required Amount of Funding for Promoting the Replacement CST by MST

Name of subsidy project	Subsidy for the promotion of replacing CST by MST
Subsidy rate	40 % of the construction cost of MST, which is 4,000,000 IDR per unit
Required amount of funding(estimated) during the period from 2013 to 2020	583,619 million IDR (about 55 billion JPY) as the total amount is needed during the period from 2013 to 2020 as a budgetary measure, which is 72,952 million IDR (about 700 million JPY) per year. The calculation is made as follows; * 9,599 thousand peoples (on-site population in 2020) / 5 peoples per household × 19% (replacing rate from 2012 to 2020) × 4,000,000 IDR/unit of MST × 40% = 583,619 million IDR * 583,619 million IDR / 8 years (2013-2020) = 72,952 million IDR (700 million JPY) per year