Supporting Report 12.2.3

STP Process Calculation Sample
Flow < 10 MLD

*Note: All the STP calculations are compiled in the soft copy.

Kindly refer to the data file.

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

Design Condition

Item	7MLD STP-TSPS
(1) Design Flow for the year 2049	

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	11,000	458	0.127
Daily Maximum	11,000	458	0.127
Hourly Max. Peak factor 2.25	24,750	1031	0.286

Item	7MLD STP-TSPS
(1) Design Flow for the year 2034	

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	7,000	292	0.081
Daily Maximum	7,000	292	0.081
Hourly Max. Peak factor 2.25	15,750	656	0.182

1. Inlet Chamber

Item	7MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Hourly Maximum ＝ 24,750 m3/d
	＝ 0.286 m3/sec
(2) Inlet Pipe	
Pipe Diameter	・ ×
Gradient	‰
Roughness Coefficient	n= 0.013 （Manning Fornula）
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 ＝ 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.286 × 1
	＝ 11.01 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m
	× Depth 0.600 m

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A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

2. Coarse Screen Channel

Item	7MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.286 ／ 0.400 ／ 0.500 ／ 2
whe Design Flow for the year 2049	＝ 0.715 ＜ 1.000 m/sec OK
Velocity	0.182 ／ 0.400 ／ 0.500 ／ 1
whe Design Flow for the year 2034	＝ 0.910 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	0.800 m
Side Water Depth	0.600 m
Velocity	0.286 ／ 0.800 ／ 0.600 ／ 2
whe Design Flow for the year 2049	＝ 0.298 ≒ 0.450 m/sec OK
Velocity	0.182 ／ 0.800 ／ 0.600 ／ 1
whe Design Flow for the year 2034	＝ 0.379 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 0.8 m × Length 6.0 m
	× SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.4 m × Height 0.60 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.286 ／ 0.700 ／ 0.550 ／ 2
	× (20 + 9) / 20
	＝ 0.539 ＜ 0.800 m/sec OK
Velocity through screen	0.182 ／ 0.700 ／ 0.550 ／ 1
whe Design Flow for the year 2034	× (20 + 9) / 20
	＝ 0.685 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.6 m
Velocity through screen	0.286 ／ 0.800 ／ 0.600 ／ 2
whe Design Flow for the year 2049	× (50 + 9) / 50
	＝ 0.352 ＜ 0.800 m/sec OK
Velocity through screen	0.182 ／ 0.800 ／ 0.600 ／ 1
whe Design Flow for the year 2034	× (50 + 9) / 50
	＝ 0.447 ＜ 0.800 m/sec OK

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3. Raw Sewage Sump

Item	7MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	9.50 m
Pump Operating Depth	1.000 m
Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.286 ／60
whe Design Flow for the year 2049	＝ 4.13 ＞ 3.75 min (=minimum time of one pump cycle : OK
Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.182 ／60
whe Design Flow for the year 2034	＝ 6.49 ＞ 3.75 min (=minimum time of one pump cycle : OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	200 mm
Discharge Flow ： 40% Q* 2	0.182 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 262 ⇒ 270 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	150 mm
Discharge Flow ： 20% Q* 1	0.182 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 131 ⇒ 135 m3/Hr
Total Head	15.0 m

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

Item	***-STP 7MLD

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	7,000	291.67	0.081
Max Daily	7,000	291.67	0.081
Max Hourly Peak factor 2.25	15,750	656.25	0.182

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly ＝ 15,750 m3/day
＝ 0.182 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.500 m

(3) Width of Basin — 1.700 m

(4) Length of Basin — 2.000 m

(5) Volume required of Basin — 1.500 × 1.700 × 2.000 ＝ 1.3 m3

(6) Retention Time — 1.500 × 1.700 × 2.000 ／ 0.182 × 1
＝ 28.02 sec

(7) Basin Dimensions — Width 1.700 m × Length 2.000 m
× Depth 1.500 m

STP basic &Stilling Chamber4/21

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

3.	**Fine Screen Channel**	
〔1〕Design Condition		
(1)	Design Wastewater Flow	Max Hourly ＝ 15,750 m3/d
		＝ 0.182 m3/sec
[2]	Geometory	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Width	0.300 m
	Height	0.450 m
	Floor Level	+ 2.000 m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.300 m
	Velocity	0.182 ／ 0.300 ／ 0.300 ／ 2
		＝ 1.011 ≒ 1.000 m/sec
(2)	Screen Channel	
	Number	2 Main + 1 Bypass
	Width	0.600 m
	Side Water Depth	0.400 m
	Velocity	0.182 ／ 0.600 ／ 0.400 ／ 2
		＝ 0.379 ≒ 0.450 m/sec
(3)	Channel Dimensions	Width 0.6 m × Length 6.0 m
		× SWD 0.4 m
[3]	Equipment	
(1)	Inlet Gate	
	Number	2 W + 1 S
	Dimension	Width 0.3 m × Height 0.45 m
	Design Water Level	2.00 m
(2)	Fine Screens (Main Channel)	
	Number	2 W + 0 S
	Open Space	6 mm
	Bar Thickness	2 mm
	Channel Width	0.6 m
	Width of side plate	50 mm
	Side Water Depth	0.4 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.182 ／ 0.500 ／ 0.350 ／ 2
		× (6 + 2) / 6
		＝ 0.693 ＜ 0.800 m/sec
(3)	Fine Screens (Bypass Channel)	
	Number	0 W + 1 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	0.6 m
	Side Water Depth	0.4 m
	Velocity through screen	0.182 ／ 0.600 ／ 0.400 ／ 2
		× (20 + 9) / 20
		＝ 0.550 ＜ 0.800 m/sec

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A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Peak flow ＝ 15,750 m^3/day
	＝ 0.182 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec ＝ 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.182 ／ 0.0111 ＝ 16.40 m^2
(2) Number of Basins	1 S + 1 W
(3) Surface Area required/Basin	16.4 ／ 1 ＝ 16.40 m^2
(4) Length of Basin	16.40 ^0.5 ＝ 4.0 m → 4.5 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.182 × 60 sec ／1 ＝ 10.9 m^3
(7) Depth required	10.9 ／ 4.5 ／ 4.5 ＝ 0.539 m
(8) Basin Dimensions	Width 4.5 m × Length 4.5 m
	× Depth 0.5 m (Freeboard 0.3m)
(9) Retention Time	4.5 × 4.5 × 0.5 ／ 0.182 × 1
	＝ 60.00 sec
(10) Surface Overflow Rate at Peak Flow	15,750 ／ 4.5 ／ 4.5 ／ 1
	＝ 777.777778 ＜ 960 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 182.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
	Ha= 0.317 m
(4) Crest Level	+ m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 0.317 m
(6) Channel bottom level	+ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.173 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.600 m
(3) Stroke	0.450 m
(4) Overflow Height	0.400 m
(5) Overflow Height (actual)	(0.182 ／ 1.840 ／ 0.600 ／ 2) $^{2/3}$
	＝ 0.189 ＜ 0.400 m

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5. Reactor

〔1〕 Design Condition

(1)	Design Wastewater Flow	Q＝	7,000	m^3/day (summer)	
		Q'＝	7,000	m^3/day(Winter)	
(2)	Design Sewage Quality				
	Inlet BOD		350	mg/*l*	
	Outlet BOD		10.0	mg/*l*	
	Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
	Inlet COD		800	mg/*l*	
	Inlet bCOD :S_0		578	mg/*l*	
	Inlet nbCOD		223	mg/*l*	
	bCOD/BOD		1.65		
	Inlet S-COD :sCOD		271	mg/*l*	
	Inlet rbCOD		231	mg/*l*	bCOD*40%
	Inlet sbCOD		347	mg/*l*	bCOD*60%
	Outlet S-COD :nbsCODe		40	mg/*l*	
	Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
	Inlet SS		450	mg/*l*	
	Inlet VSS		383	mg/*l*	assumed as 85% of TSS
	:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
	:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
	:iTSS		67.50	gnbVSS/m3	=TSS-VSS
	Inlet T-N		70	mg/*l*	
	Inlet TKN		70	mg/*l*	
	Inlet NH_4-N		45.0	mg/*l*	
	Inlet T-P		7	mg/*l*	
	Inlet D-P		5	mg/*l*	
	Inlet Alkalinity as CaCO3		380	mg/*l*	
	Outlet Kjeldahl N		1.0	mg/*l*	
	Outlet NH4-N		1.0	mg/*l*	
	Outlet NO3-N		9.0	mg/*l*	
	Outlet T-P		2	mg/*l*	
	Outlet D-P		1	mg/*l*	
(3)	Water Temperature	T＝	20.0	℃	
(4)	Safety Factor for Nitrogen	SF=	1.5		
(5)	Return Sludge Concentration	*Rs* ＝	8,000	mg/*l*	
(6)	MLSS MLVSS	X_{TSS} ＝	3,000	mg/*l*	
(7)	DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2)	μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
	$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
	DO	DO=	2.0000	mg/*l*	
	$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB}\times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}=$	2188.927	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}=$	2884.700	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	$b_H=$	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	$Y_H=$	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}=$	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μmax at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}=$	1265.214	kg VSS/c	$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
					+QYn(Nox)/[2+bAOB(SRT)]
			1136.066		$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			102.246		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			26.903		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	4,808	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS}\cdot Va$	$X_{VSS}\cdot Va=$	10,945	kg VSS	$=Px,_{VSS}\cdot SRT$
	$X_{TSS}\cdot Va$	$X_{TSS}\cdot Va=$	14,423	kg TSS	$=Px,_{TSS}\cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}=$	$Y_{obs,TSS}=$	1.178	gTSS/gBOD	
	$Y_{obs,VSS}=$	$Y_{obs,VSS}=$	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	4,039	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	$b_{NOB}=$	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}=$	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μmax at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}=$	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		$S_0=$	2.000	mg/*l*	
		$K_{O2,NOB}=$	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	$b_{NOB}=$	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}=$	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μmax at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}=$	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		$S_0=$	2.000	mg/*l*	
		$K_{O2,NOB}=$	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = $Q \cdot (SRT)/V \cdot Y_H(S_0\text{-}S)/[1+b_H(SRT)]$
= 1,181.47 mg/*l*

(2) IR ratio
IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= $(IR+R) \cdot Q \cdot Ne$
= 268,174.27 kg/d

(4) The anoxic tank volume
Vnor= 481 m3 = Va× 10%
Vnor= 1,458 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb
SDNRb= 0.296 g/g・d $= b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.110 g/g・d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d $=SDNR_t - 0.029\ln(F/M_b)-0.012$ IR=3-4
$=SDNR_t - 0.0166\ln(F/M_b)-0.078$ IR=2

SDNRt= 0.296 g/g・d $=SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 364,695.16 kg/d $=N_{nox} \cdot SDNR \cdot X_b$
>Nox feed= 268,174 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 2188.927 kg /d
Rwmoval Phosphorus 21.88926619 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Alumnum Sulfate 300.84 kg/d
(6) Required Alumnum Sulfate solutic 10% 2.87 m3/d
119.38 L/H
(7) Additional sludge 121.96 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

$V_A = Q' * \theta a/24$

$= 5,250$ m^3

(2) Total volume of Anoxic Basins

$V_{DN} = Q' * \theta_{DN}/24$

$= 1,458$ m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	440	1.50	1.50	0.30
Anoxic	V_{DN}	1,458	5.00	5.00	1.00
Aerobic	V_A	5,250	18.00	18.00	3.60
Total	V	7,148	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

	Width	Length	Depth	Basins
	8.0	84.0	5.5	2
Cross Section	8.0*5.5	=	44.0 m^2/Basin	
Hantzsch Subtraction		=	1.0 m^2/Basin	
after Subtraction	44.0-1.0	=	43.0 m^2/Basin	
Total Volume	43.0*84.0	=	3,612 m^2/Basin	7,224 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**5.1**	**17.0**	**61.0**	**83.1**
Volume required per Basin	m^3	220	729	2,625	3,574
Total Volume required	m^3	440	1,458	5,250	7,148
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	6.0	17.0	61.0	84.0
Actual Volume per Basin	m^3	258	731	2,623	3,612
Actual Total Volume	m^3	516	1,462	5,246	7,224
Actual Ratio of Volume		0.35	1.00	3.59	
Actual Retention Time	hour	1.77	5.01	17.99	24.77

[7] Equipment

(1) Ras Pumps

Ras Ratio 60%

Required Capacity 7,000 m3/day× 60% ／24 ／ 2

= 88 m3/Hr ⇒ 90 m3/Hr

Number 2 Work

2 Stanby

(2) Circulation Pumps

Ras Ratio 366%

Required Capacity 7,000 m3/day× 366% ／24 ／ 4

= 267 m3/Hr ⇒ 270 m3/Hr

Number 4 Work

2 Stanby

(3) SAS Pumps

Excess Sludge 380 m3/day

Sludge withdraw 12 Times/day

Running Time 0.5 Hr/Time

Required Capacity 380 m3/day ／ 12 ／ 0.50 ／ 2

= 31.64 m3/Hr ⇒ 35 m3/Hr

Number 2 Work

2 Stanby

(4)	Alum Solution Tank												
	Number	2		W	+	0	S						
	Alum concentration as crystal	10	%										
	Gravity of dissolved dechlorine	1.05											
	Required solution volume	300.84	kg / d		×	100	/	10	/	1.05	/	1000	
		＝	2.87		m3/d								
	Volume of Tank		2.6		m3/tank								
	Total Volume of Tanks		5.2		m3	(Duration=		1.81	day)				
(5)	Mixer for Alum Solution Tank												
	Number	2		W	+	0	S						
(6)	Alum Dosing Pump												
	Number	2		W	+	1	S						
	Capacity	2.87	m3/d	/	24	×	1000	/	2	×	2		
		119.38	l/h/unit		⇒	120	l/h/unit						

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR	AOR = 3,029 kg/day
		= 126.2 kg/h
	Qin :Design Average Flow m^3/d	7,000
	Inlet bCOD :S_0	578 mg/*l*
	S=	S= 0.451 mg/*l*
	Nox=	Nox 47.400 mg/*l*
	$P_{X,bio}$=	$P_{X,b}$ 1,238.3 kg VSS/d does not include nitrifying bacteria
	R_0=	$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$
	R_0=	R_0= 3,029 kg O2/d
		k= 2.86
(2)	SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		$1+0.40D_j/Pa$	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R*T]$	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{32,858}{4.2591} = 7,714.69 \text{ kg/day}$$

(3)	No. of Basins	2 Basin
(4)	Standard O2 required at Field Conditions per Bas	= 3,857 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	15%
(9)	Air required at Field Conditions per Basins	= 56,731 m^3/day = 2,363.8 m^3/hr
[2]	Equipment	

Air Requirement at Average Flow12/21

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

(1) Air Blower						
Number	4	W	+	2	S	
Required Capacity	2363.8	m^3/Hr・Basin	／	2	unit/Basin	
	= 1181.9	m^3/h	⇒	1200	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	22.704	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	32.101	kW				
Rated Output of Motor	35.311	kW	⇒	37	kW	

Air Requirement at Average Flow13/21

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

7. Final Clarifire	
〔1〕 **Design Condition**	
(1) Design Wastewater Flow	Q＝ 7,000 m^3/day
(2) Water Temperature	T＝ 20.0 ℃
(3) MLSS	Xef＝ 3,000 mg/*l*
(4) SVI	SVI＝ 300
(5) Sedimentation Velocity	*v* ＝ 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)
	＝ 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770
	＝ 20.7 m/day
(6) Surface Overflow Rate required	*S*'＝ v/(1.5*1)＝ 20.7/(1.5*1.0) ＝ 13.8 m^3/m^2･day
	→ 12.0 m^3/m^2･day
[2] Geometory	
(1) Surface Area required	A＝ 7,000/12.0＝ ＝ 583 m^2
(2) Demensions	Diameter **19.5** Depth **3.5** Basin **2**
(3) Actual Surface Area	S＝ 19.5^2 * 3.14 /4 * 2.0 ＝ 597 m^2
(4) Surface Overflow Rate	S＝ 7,000/597 ＝ 11.7 m^3/m^2･day

Final Clarifire14/21

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow 7,000 m^3/day 291.67 m^3/h
		Peak Flow 15,750 m^3/day 656.25 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 70.0 kg/d
		＝ 2.92 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 145.8 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	2.00 m
(4)	Length of lane	13.00 m
(5)	Side Water Depth	2.00 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	6.80 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 291.67 ／ 3600 ／ 2.00 ／ 2.00
		＝ 0.020 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 2.0 m × 13.0 m × 2.0 m
		× 3 × 1
		＝ 156 m^3 > 145.8 m^3

[3] Equipment

(1)	Chlorine Dosing Condition		
	Operation Dosage Rate -1	DC1	10 mg/L
(2)	Chlorine Cylinder		
	Type	-	Cylindrical Convexsd Container
	Cylinder Capacity	Cc	928 kg/cylinder
	Average Dosage Rate -1	q1	Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^3 = 70 kg/day
	Maximum Dosage Rate -1	q3	Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^3 = 158 kg/day
	Storage day	T	More than 15 days
	Required Storage Capacity	EC1	D x T = 1,050 kg
	Unit Number	EN1	EC1 / Cc = 1.1 cylinders
	Maximum Operation Numbers		
	Cl_2-Gas Volatilize Rate	Vr1	#### @ 20^{O}C Standard temperature
	Maximum Dosing Rate	DC1	10 mg/L, $Q_{T\text{-}D}$ x q3 x 10^{-3} / 24 = 6.56 kg/h
	Operation Numbers	EN2	DC1 / Vr1 = 0.8sets
	Number		2 W + 2 S
(3)	Chlorinator		
	Type		Solution Feed Vacuum Type
	Number		1 W + 1 S
	Operation Dosage Rate -1	Dq1	Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^3 =
			157.5 kg/day
	Required Dosage Rate		Chlorine -1 : Dq1 / (EN1x 24) =
			Minimum 0.00 kg/hr; Maximum 6.6 kg/hr

Chlorination Tank (gas) 15/21

(4) Chlorine Booster Pump	
Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori
Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
Water Demand	(L/min) 15 20 25 30 35 40
Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
Water Demand	(L/min) 45 50 60 300 600 1,200
Water requiamet	-
For Chlorin	Qp1 Maximum dosage ra 6.6 kg/hr
	therefore 60 L/min
Booster Pump Type	Single suction volute pump
Number	1 W + 1 S
9. Dechlorination	
〔1〕 Design Condition	
(1) Design Flow Rate	Average Daily Flow 7,000 m^3/day
(2) Contact Time	10 min
(3) Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4) Free Residual Chlorine	1.0 mg/L assumed value
(5) Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
	× 1.5 (safety factor)
	＝ 18.4 kg/d
	＝ 0.77 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Flow Rate ／ 60 × Contact Time
	＝ 48.6 m^3
(2) Width of lane	6.80 m
(3) Length of lane	4.00 m
(4) Side Water Depth	2.00 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 6.8 m × 4.0 m × 2.0 m
	＝ 54 m^3 > 48.6 m^3
[3] Equipment	
(1) Dechlorine Solution Tank	
Number	1 W + 0 S
Dechlorine concentration	10 %
Gravity of dissolved dechlorine	1.10
Required solution volume	18.38 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.17 m3/d
Volume of Tank	0.200 m3/tank (= 0.5 mW× 0.5 mL× 0.8 mH)
Total Volume of Tanks	0.200 m3 (Duration= 1.20 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	0.38 m3/d / 24 × 1000 / 1
	15.66 l/h/unit ⇒ 16 l/h/unit

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge	
(2)	Generated Sludge	3,038 kg/day	
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte	5 kg/t-DS･day
(4)	Volume of Thickend Sludge	379.7 m^3/day	
(5)	Consistency of Dewatered Sludge	82 %	
(6)	Operation Time	12 hours/day	(6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{379.7}{12 \times 2} \times \frac{7}{6} = 18.5$$

$\rightarrow$ 19 m^3/hour

[3] Dewatered Solids

$$\text{Digested Sludge} \times (1 + \text{Injection Rate})$$

$$= 3{,}038 \times (1 + 0.0050)$$

$= 3{,}053$ kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 3.053 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

$= 19.79$ t/day

apparent specific gravity 1.00

19.79 ／ 1.0 ＝ 19.8 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte	5 kg/t-DS･day
(2)	Required Polyelectrolyte		15.19 kg/day
(3)	Dissolving concentration		0.20 %
(4)	Volume of Polyelectrolyte solution		7.59 m3/day

Centrifuge 17/21

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Supporting 12.2.3

[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	19 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	19 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	7.59 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	7.59 m3/da × 7 ／ 6 ／ 12 ／ 2
		＝ 0.37 m^3/Hr
	Specification Capacity	0.37 m^3/Hr × 1.5
		＝ 0.554 m^3/Hr ⇒ 0.60 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	15.19 kg/day × 7 ／ 6 ／ 12
		＝ 1.48 kg/hr
		＝ 4.43 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	9 kg/h
	Tanks Dimensions	Width 1.0 m × Length 1.5 m
		× Depth 1.5 m × 2
		＝ 4.5 m^3
	Retention Time of Tank	2.25 m^3 /tank ／ 0.37 m^3/Hr ／ 2
		＝ 3.047 Hr > 3 Hr
	Number	2 W + 0 S

Centrifuge 18/21

11.	**Centrifuge Feed Sump**	
[1]	**Design Condition**	
(1)	Generated Thickend Sludge	3,038 kg/day
(2)	Solids Consistency	0.80 %
(3)	Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
		$= 3{,}038 \times \frac{100}{0.80} \times 10^{-3}$
		= 380 m^3/day
		= 15.82 m^3/h
(4)	Sludge feed flow rate	19 m3/h × 2 = 38 m3/h
(5)	Centrifuge Operation Time	12 hours/day (6 days per week)
[2]	**Geometry**	
(1)	Basin Dimensions	Width 6.0 m × Length 6.0 m
		× Depth 3.5 m × 2
		= 252.0 m^3
[3]	**Equipment**	
(1)	Mixers for Centrifuge Feed Sumps	
	Required Volume	252.0 m^3
	Number	1 W + 1 S

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

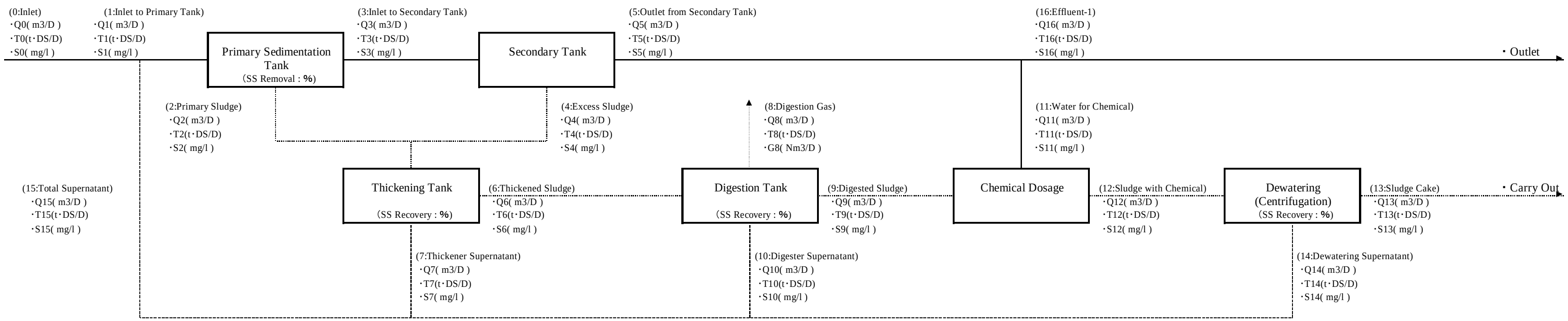
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	7,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)				16	17
Q(m^3/day)	7,000	7,371	0	7,371	380	6,991	380	0	0	380	0	8	387	16	371	371	371				6,991	0
T(t･DS/day)	3.150	3.303	0.000	3.303	3.038	0.070	3.038	0.000	0.000	3.038	0.000	0.015	3.053	2.900	0.153	0.153	0.153				0.070	0.195
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411					10	
X(Ti/T0*100)	100	104.9	0.0	104.9	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8					2.2	6.2

Figure -1 Material Balance Model

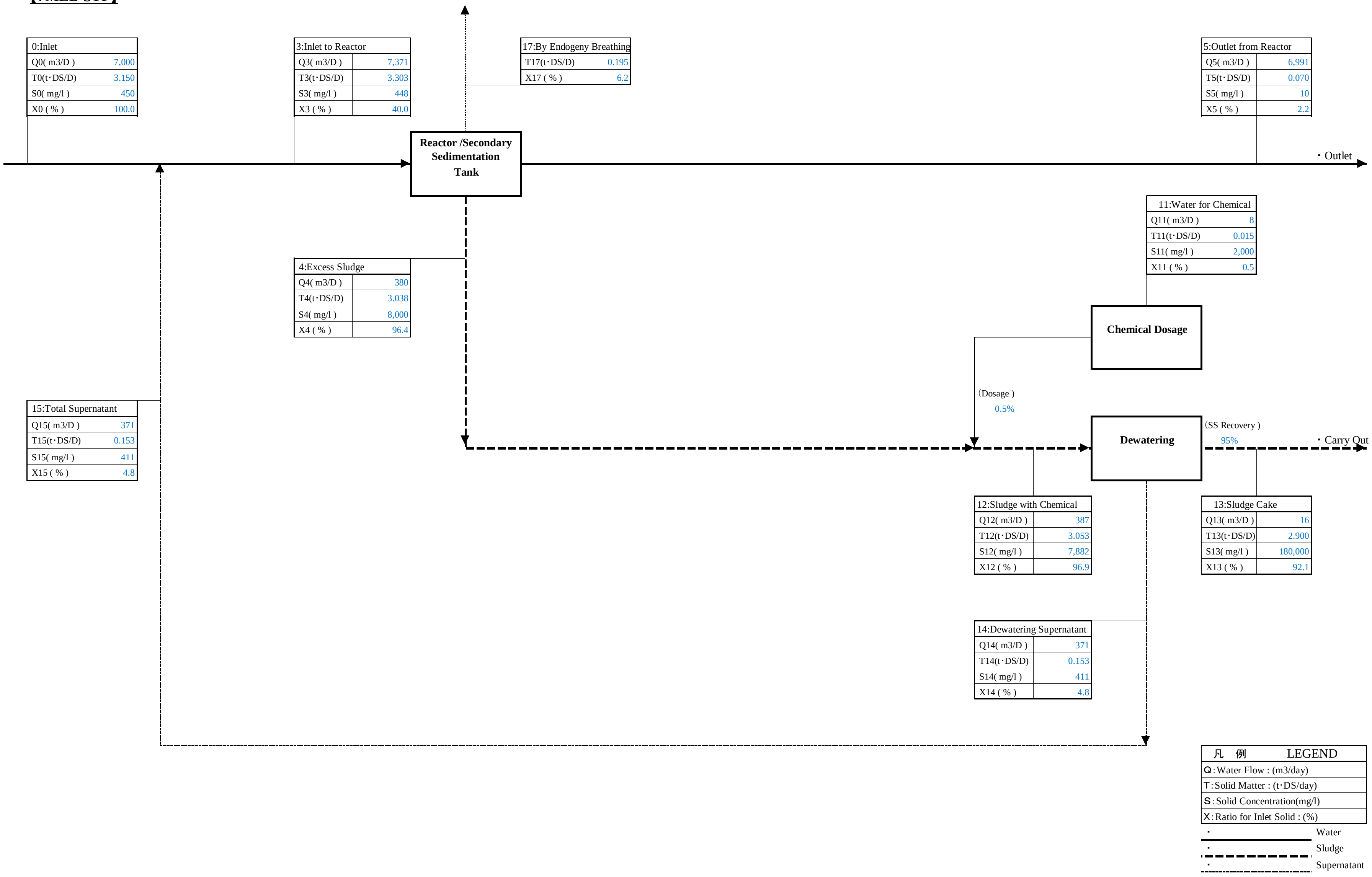


Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet

【7MLD STP】



Material Balance Sheet 21/21

Supporting Report 12.2.3

STP Process Calculation Sample

Flow $\geqq$ 10 MLD

＊Note: All the STP calculations are compiled in the soft copy.

Kindly refer to the data file.

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

Design Condition

Item	17MLD STP-TSPS
(1) Design Flow for the year 2049	

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	27,000	1125	0.313
Max Dayly	27,000	1125	0.313
Max Hourly Peak factor 2.25	60,750	2531	0.703

Item	17MLD STP-TSPS
(1) Design Flow for the year 2034	

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	17,000	708	0.197
Max Dayly	17,000	708	0.197
Max Hourly Peak factor 2.25	38,250	1594	0.443

1. Inlet Chamber

Item	17MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly ＝ 60,750 m3/d
	＝ 0.703 m3/sec
(2) Inlet Pipe	
Pipe Diameter	・ ×
Gradient	‰
Roughness Coefficient	n= 0.013 （Manning Fornula）
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.900 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.900 × 2.500 ＝ 0.7 m3
(6) Retention Time	0.600 × 2.900 × 2.500 ／ 0.703 × 1
	＝ 6.19 sec
(7) Basin Demensions	Width 2.900 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

2. Coarse Screen Channel

Item	17MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.600 m
Velocity	0.703 ／ 0.600 ／ 0.600 ／ 2
whe Design Flow for the year 2049	＝ 0.976 ＜ 1.000 m/sec OK
Velocity	0.443 ／ 0.600 ／ 0.600 ／ 2
whe Design Flow for the year 2034	＝ 0.615 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	1.200 m
Side Water Depth	0.700 m
Velocity	0.703 ／ 1.200 ／ 0.700 ／ 2
whe Design Flow for the year 2049	＝ 0.418 ≒ 0.450 m/sec OK
Velocity	0.443 ／ 1.200 ／ 0.700 ／ 2
whe Design Flow for the year 2034	＝ 0.264 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 1.2 m × Length 6.0 m
	× SWD 0.7 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	8.0 m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Width of side plate	50 mm
Side Water Depth	0.7 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.703 ／ 1.100 ／ 0.650 ／ 2
	× (20 + 9) / 20
	＝ 0.713 ＜ 0.800 m/sec OK
Velocity through screen	0.443 ／ 1.100 ／ 0.650 ／ 2
whe Design Flow for the year 2034	× (20 + 9) / 20
	＝ 0.449 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Side Water Depth	0.7 m
Velocity through screen	0.703 ／ 1.200 ／ 0.700 ／ 2
whe Design Flow for the year 2049	× (50 + 9) / 50
	＝ 0.494 ＜ 0.800 m/sec OK
Velocity through screen	0.443 ／ 1.200 ／ 0.700 ／ 2
whe Design Flow for the year 2034	× (50 + 9) / 50
	＝ 0.311 ＜ 0.800 m/sec OK

Coarse Screen 2/23

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3. Raw Sewage Sump

Item	17MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	12.00 m
Pump Operating Depth	1.500 m
Retention Time whe Design Flow for the year 2049	(12.00 ^{2}× π／4 × 1.500)／ 0.703 ／60 ＝ 4.02 ＞ 3.75 min (=minimum time of one pump cycle OK
Retention Time whe Design Flow for the year 2034	(12.00 ^{2}× π／4 × 1.500)／ 0.443 ／60 ＝ 6.38 ＞ 3.75 min (=minimum time of one pump cycle OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.500 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	300 mm
Discharge Flow ： 40% Q* 2 whe Design Flow for the year 2034	0.443 × 3600 × 40.0% Q ＝ 638 ⇒ 640 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	200 mm
Discharge Flow ： 20% Q* 1 whe Design Flow for the year 2034	0.443 × 3600 × 20.0% Q ＝ 319 ⇒ 320 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/23

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Item	17MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	17,000	708.33	0.197
Max Daily	17,000	708.33	0.197
Max Hourly Peak factor 2.25	38,250	1593.75	0.443

(2) Design Water Quality

Unit : mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45	25	0	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly ＝ 38,250 m3/day

＝ 0.443 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 2.000 m

(3) Width of Basin — 2.900 m

(4) Length of Basin — 2.500 m

(5) Volume required of Basin — 2.000 × 2.900 × 2.500 ＝ 2.3 m3

(6) Retention Time — 2.000 × 2.900 × 2.500 ／ 0.443 × 1

＝ 32.73 sec

(7) Basin Dimensions — Width 2.900 m × Length 2.500 m

× Depth 2.000 m

STP basic &Stilling Chamber4/23

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3.	**Fine Screen Channel**	
〔1〕	Design Condition	
(1)	Design Wastewater Flow	Max Hourly ＝ 38,250 m3/d
		＝ 0.443 m3/sec
[2]	Geometory	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Width	0.500 m
	Height	0.750 m
	Floor Level	+ 2.000 m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.443 ／ 0.500 ／ 0.500 ／ 2
		＝ 0.886 ≒ 1.000 m/sec
(2)	Screen Channel	
	Number	2 Main + 1 Bypass
	Width	1.000 m
	Side Water Depth	0.500 m
	Velocity	0.443 ／ 1.000 ／ 0.500 ／ 2
		＝ 0.443 ≒ 0.450 m/sec
(3)	Channel Dimensions	Width 1.0 m × Length 6.0 m
		× SWD 0.5 m
[3]	Equipment	
(1)	Inlet Gate	
	Number	2 W + 1 S
	Dimension	Width 0.5 m × Height 0.75 m
	Design Water Level	2.00 m
(2)	Fine Screens (Main Channel)	
	Number	2 W + 0 S
	Open Space	6 mm
	Bar Thickness	2 mm
	Channel Width	1.0 m
	Width of side plate	50 mm
	Side Water Depth	0.5 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.443 ／ 0.900 ／ 0.450 ／ 2
		× (6 + 2) / 6
		＝ 0.729 ＜ 0.800 m/sec
(3)	Fine Screens (Bypass Channel)	
	Number	0 W + 1 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	1.0 m
	Side Water Depth	0.5 m
	Velocity through screen	0.443 ／ 1.000 ／ 0.500 ／ 2
		× (20 + 9) / 20
		＝ 0.642 ＜ 0.800 m/sec

Fine Screen5/23

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Peak flow ＝ 38,250 m^3/day
	＝ 0.443 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec ＝ 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.443 ／ 0.0111 ＝ 39.91 m^2
(2) Number of Basins	1 S + 1 W
(3) Surface Area required/Basin	39.9 ／ 1 ＝ 39.91 m^2
(4) Length of Basin	39.91 ^0.5 ＝ 6.317 m → 6.5 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.443 × 60 sec ／ 1 ＝ 26.6 m^3
(7) Depth required	26.6 ／ 6.5 ／ 6.5 ＝ 0.629 m
(8) Basin Dimensions	Width 6.5 m × Length 6.5 m
	× Depth 0.6 m (Freeboard 0.3m)
(9) Retention Time	6.5 × 6.5 × 0.6 ／ 0.443 × 1
	＝ 60.00 sec
(10) Surface Overflow Rate at Peak Flow	38,250 ／ 6.5 ／ 6.5 ／ 1
	＝ 905.325444 ＜ 960 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 443.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= $(Q ／ 2264 ／ W)^{2/3}$
	Ha= 0.574 m
(4) Crest Level	+ m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 0.574 m
(6) Channel bottom level	+ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.422 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.800 m
(3) Stroke	0.550 m
(4) Overflow Height	0.500 m
(5) Overflow Height (actual)	$(0.443 ／ 1.840 ／ 0.800 ／ 2)^{2/3}$
	＝ 0.283 ＜ 0.500 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	17,000	m^3/day (summer)	
	Q'=	17,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	assumed as 33% of BOD
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=(TCOD-sCOD)/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45.0	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* =	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g･d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g･d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	=1/ μ_{AOB} × SF
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	5315.965	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	7301.896	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al
	S	S=	0.4507	mg/*l*	=Ks[1+b_H(SRT)]/[SRT(μ_m-b_H)-1]
	b_H	b_H=	0.1200		=b*$1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	=μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	3072.664	kg VSS/c	=Q・Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)] +QYn(Nox)/[2+bAOB(SRT)]
			2759.017		=Q・Y_H(S_0-S)/[1+b_H(SRT)]
			248.312		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]
			65.335		=QYn(Nox)/[1+b_{AOB}(SRT)]
	NOx	NOx=	47.311	mg/*l*	=TKN-Ne-0.12$P_{X,bio}$/Q
(4)	Required Aeration Tank Volume				
	Va=	Va=	12,170	m3	
	τ =	τ =	17.18	hr	=Va/Q×24
		⇒	18.00	hr	
	X_{VSS}・Va	X_{VSS}・Va=	26,580	kg VSS	=$Px,_{VSS}$・SRT
	X_{TSS}・Va	X_{TSS}・Va=	36,509	kg TSS	=$Px,_{TSS}$・SRT
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.728		
	MLVSS=	MLVSS=	2184	mg/L	
(5)	BODloading	BODloading	0.489	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.228	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	9,810	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	=μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	=μ_{max}*$1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = Q・(SRT)/V・$Y_H(S_0\text{-}S)/[1+b_H(SRT)]$
= 1,133.55 mg/*l*

(2) IR ratio
IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= (IR+R)・Q・Ne
= 651,280.37 kg/d

(4) The anoxic tank volume
Vnor= 1,217 m3 = Va× 10%
Vnor= 3,542 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.48 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients	
	b0	b1
10	0.186	0.078
20	0.213	0.118
30	0.235	0.141
40	0.242	0.152
50	0.270	0.162

(8) SDNRb
SDNRb= 0.302 g/g・d $= b_0+b_1[\ln(F/M_b)]$

$b_{0=}$ 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.113 g/g・d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.217 g/g・d $=SDNR_t - 0.029\ln(F/M_b)-0.012$ IR=3-4
$=SDNR_t - 0.0166\ln(F/M_b)-0.078$ IR=2

SDNRt= 0.302 g/g・d $=SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 872,270.70 kg/d $=N_{nox} \cdot SDNR \cdot X_b$
>Nox feed= 651,280 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 5315.965 kg /d
Rwmoval Phosphorus 53.15964645 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Alumnum Sulfate 730.62 kg/d
(6) Required Alumnum Sulfate solutic 10% 6.96 m3/d
289.93 L/H
(7) Additional sludge 296.20 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins $V_A = Q'*\theta a/24$

$= 12,750\ m^3$

(2) Total volume of Anoxic Basins $V_{DN} = Q'*\theta_{DN}/24$

$= 3,542$ m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	1,060	1.50	1.50	0.30
Anoxic	V_{DN}	3,542	5.00	5.00	1.00
Aerobic	V_A	12,750	18.00	18.00	3.60
Total	V	17,352	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	204.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin

Hantzsch Subtraction: = 1.0 m^2/Basin

after Subtraction: 44.0-1.0 = 43.0 m^2/Basin

Total Volume: 43.0*204.0 = 8,772 m^2/Basin 17,544 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**12.3**	**41.2**	**148.3**	**201.8**
Volume required per Basin	m^3	530	1,771	6,375	8,676
Total Volume required	m^3	1,060	3,542	12,750	17,352
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	13.0	42.0	149.0	204.0
Actual Volume per Basin	m^3	559	1,806	6,407	8,772
Actual Total Volume	m^3	1,118	3,612	12,814	17,544
Actual Ratio of Volume		0.31	1.00	3.55	
Actual Retention Time	hour	1.58	5.10	18.09	24.77

[7] Equipment

(1) Ras Pumps

Ras Ratio: 60%

Required Capacity: 17,000 m3/day× 60% ／24 ／ 2

= 213 m3/Hr ⇒ 220 m3/Hr

Number: 2 Work

2 Stanby

(2) Circulation Pumps

Ras Ratio: 366%

Required Capacity: 17,000 m3/day× 366% ／24 ／ 4

= 648 m3/Hr ⇒ 650 m3/Hr

Number: 4 Work

2 Stanby

(3) SAS Pumps

Excess Sludge: 1,068 m3/day

Sludge withdraw: 12 Times/day

Running Time: 0.5 Hr/Time

Required Capacity: 1,068 m3/day／ 12 ／ 0.50 ／ 2

= 88.98 m3/Hr ⇒ 90 m3/Hr

Number: 2 Work

2 Stanby

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(4)	Alum Solution Tank	
	Number	2 W + 0 S
	Alum concentration as crystal	10 %
	Gravity of dissolved dechlorine	1.05
	Required solution volume	730.62 kg / d × 100 / 10 / 1.05 / 1000
		＝ 6.96 m3/d
	Volume of Tank	4.1 m3/tank (= 1.5 mW× 1.5 mL× 1.8 mH)
	Total Volume of Tanks	8.1 m3 (Duration= 1.16 day)
(5)	Mixer for Alum Solution Tank	
	Number	2 W + 0 S
(6)	Alum Dosing Pump	
	Number	2 W + 1 S
	Capacity	6.96 m3/d / 24 × 1000 / 2 × 2
		289.93 l/h/unit ⇒ 290 l/h/unit

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6.	**Air Requirement at Average Flow**	
〔1〕Design Condition		
(1)	AOR	AOR ＝ 7,355 kg/day
		＝ 306.5 kg/h
	Qin :Design Average Flow m^3/d	17,000
	Inlet bCOD :S_0	578 mg/*l*
	S=	S= 0.451 mg/*l*
	Nox=	Nox 47.400 mg/*l*
	$P_{X,bio}$=	$P_{X,b}$ 3,007.3 kg VSS/d does not include nitrifying bacteria
	R_0=	$R_0 = Q(S_0-S-k(Nox-NOxe)-1.42P_{X,bio}+4.57Q\cdot NOx$
	R_0=	R_0= 7,355 kg O2/d
		k= 2.86
(2)	SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S\cdot a \times 1.024^{20-T}}{\alpha \times F\ (\beta\cdot C_{SW}/C_S\cdot(Pb/Pa)a - C_A)}$
		C_S : Saturated DO at sea level and 20 ℃ 9.09 mg/L
		C_{SW} : Saturated DO at sea level and operating Temperature 9.09 mg/L at 20 ℃
		20-T : 0.0 1.024^{20-T} : 1.0000
		C_A : operating DO in Basin 2.0 mg/L
		a : Correction Factor by the Water Depth $1+0.40D_j/Pa$ 1.19357
		D_j : Tank Liquid Depth 5.00 m
		P_a : Standard absolute pressure at s 10.332 m
		P_b : Absolute pressure at Plant Site Elevation m
		P_b/P_a : $\exp[-gM(z_b-z_a)/R*T]$ 0.900
		g : Acceleration due to Gravity 9.80665 m/s^2
		M : Mole of Air 28.97 kg/kg-mole
		z_b : Plant Site Elevation 900 m
		z_a : Sea Elevation 0 m
		R : Universal Gas Constant 8314 Nm/kg-mole.K
		T : Temperature 273.15+t ＝ 293.15 Kelvin
		α : relative Transfer Rate to clean Wa 0.65
		β : relative DO Saturation to clean Wa 0.95
		F : Diffuser Fouling Factor 0.90
		$= \dfrac{79,798}{4.2591} =$ 18,735.68 kg/day
(3)	No. of Basins	2 Basin
(4)	Standard O2 required at Field Conditions per Bas	＝ 9,368 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	15%
(9)	Air required at Field Conditions per Basins	＝ 137,776 m^3/day ＝ 5,740.6 m^3/hr
[2]	Equipment	

Air Requirement at Average Flow12/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

(1)	Air Blower						
	Number	4	W	+	2	S	
	Required Capacity	5740.6	m^3/Hr・Basin	／	2	unit/Basin	
		＝ 2870.3	m^3/h	⇒	2900	m^3/h /Unit	
	Pressure	65	kPa				
	Safty Factor	10	%				
	Heat capacity ratio	1.4					
	Atmospheric pressuer at site elevation	91.234	kPa				
	Total inlet pressure	89.234	kPa				
	Volume rate of flow at inlet point	54.869	m3/min				
	Total discharge pressure	156.234	kPa				
	Overall adiabatic effeciency	0.65					
	Inlet air temperature (min.)	15	℃				
	Shaft power	77.578	kW				
	Rated Output of Motor	85.335	kW	⇒	90	kW	

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

7.	**Final Clarifire**		
〔1〕	**Design Condition**		
(1)	Design Wastewater Flow	Q＝ 17,000 m^3/day	
(2)	Water Temperature	T＝ 20.0 ℃	
(3)	MLSS	Xef＝ 3,000 mg/*l*	
(4)	SVI	SVI＝ 300	
(5)	Sedimentation Velocity	*v* ＝ 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77) ＝ 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770 ＝ 20.7 m/day	
(6)	Surface Overflow Rate required	*S*'＝ v/(1.5*1)＝ 20.7/(1.5*1.0) ＝ →	13.8 m^3/m^2·day 12.0 m^3/m^2·day
[2]	**Geometory**		
(1)	Surface Area required	A＝ 17,000/12.0＝ ＝	1,417 m^2
(2)	Demensions	Diameter Depth Basin **30.0** **3.5** **2**	
(3)	Actual Surface Area	S＝ 30.0^2 * 3.14 /4 * 2.0 ＝	1,414 m^2
(4)	Surface Overflow Rate	S＝ 17,000/1,414 ＝	12.0 m^3/m^2·day

Final Clarifire14/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

8. Chlorination

[1] Design Condition

(1) Design Flow Rate
Average Daily Flow 17,000 m^3/day 708.33 m^3/h
Peak Flow 38,250 m^3/day 1593.75 m^3/h

(2) Contact Time
30 min

(3) Type of Chlorine
Cl_2-GAS

(4) Design Chlorine Dosage Rate
10 mg/L

(5) Required Chlorine per day
Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
＝ 170.0 kg/d
＝ 7.08 kg/h

[2] Chlorination Contact Tank

(1) Volume required
Average Daily Flow ／ 1440 × Contact Time
＝ 354.2 m^3

(2) Nos. of lanes
3 lanes

(3) Width of lane
2.00 m

(4) Length of lane
30.00 m

(5) Side Water Depth
2.00 m

(6) Nos. of Tanks
1 tank

(7) Total Width of Tank
6.80 m Approx..

(8) Average Velocity
Decant Flow ／ 3600 ／ Width ／ Depth
＝ 708.33 ／ 3600 ／ 2.00 ／ 2.00
＝ 0.049 m/sec

(9) Total Volume
Width × Length × Depth × Nos. of lanes × Nos. of Tanks
＝ 2.0 m × 30.0 m × 2.0 m
× 3 × 1
＝ 360 m^3 ＞ 354.2 m^3

[3] Equipment

(1) Chlorine Dosing Condition

Operation Dosage Rate -1 DC1 10 mg/L

(2) Chlorine Cylinder

Type	-	Cylindrical Convexsd Container
Cylinder Capacity	Cc	928 kg/cylinder
Average Dosage Rate -1	q1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^{3} = 170 kg/day
Maximum Dosage Rate -1	q3	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^{3} = 383 kg/day
Storage day	T	More than 15 days
Required Storage Capacity	EC1	D x T = 2,550 kg
Unit Number	EN1	EC1 / Cc = 2.7 cylinders
Maximum Operation Numbers		
Cl_2-Gas Volatilize Rate	Vr1	#### @ 20^{O}C Standard temperature
Maximum Dosing Rate	DC1	10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = 15.94 kg/h
Operation Numbers	EN2	DC1 / Vr1 = 2.0sets
Number		2 W + 2 S

(3) Chlorinator

Type		Solution Feed Vacuum Type
Number		1 W + 1 S
Operation Dosage Rate -1	Dq1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^{3} = 382.5 kg/day
Required Dosage Rate		Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum 0.00 kg/hr; Maximum 16.0 kg/hr

(4) Chlorine Booster Pump

Chlorination Tank (gas)15/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori
Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
Water Demand	(L/min) 15 20 25 30 35 40
Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
Water Demand	(L/min) 45 50 60 300 600 1,200
Water requiamet	-
For Chlorin	Qp1 Maximum dosage ra 16.0 kg/hr
	therefore 100 L/min
Booster Pump Type	Single suction volute pump
Number	1 W + 1 S
9. Dechlorination	
〔1〕 Design Condition	
(1) Design Flow Rate	Average Daily Flow 17,000 m^3/day
(2) Contact Time	10 min
(3) Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4) Free Residual Chlorine	1.0 mg/L assumed value
(5) Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
	× 1.5 (safety factor)
	＝ 44.6 kg/d
	＝ 1.86 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Flow Rate ／ 60 × Contact Time
	＝ 118.1 m^3
(2) Width of lane	6.80 m
(3) Length of lane	9.00 m
(4) Side Water Depth	2.00 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 6.8 m × 9.0 m × 2.0 m
	＝ 122 m^3 > 118.1 m^3
[3] Equipment	
(1) Dechlorine Solution Tank	
Number	2 W + 0 S
Dechlorine concentration	10 %
Gravity of dissolved dechlorine	1.10
Required solution volume	44.63 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.41 m3/d
Volume of Tank	0.288 m3/tank (= 0.6 mW× 0.6 mL× 0.8 mH)
Total Volume of Tanks	0.576 m3 (Duration= 1.42 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	2 W + 1 S
Capacity	0.91 m3/d / 24 × 1000 / 2
	19.02 l/h/unit ⇒ 20 l/h/unit

Chlorination Tank (gas)16/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

10.	**Sludge Thikener**	
[1]	**Design Condition**	
(1)	Primary Sludge	0 kg/day — 0 m3/day
(2)	Secondary Sludge	8,542 kg/day — 1,068 m3/day
(3)	Total Solids	8,542 kg/day — 1,068 m3/day
(4)	Operation Time	24 hours/day
(5)	Thikened Sludge Moisture Content	97.5 %
[2]	**Geometory**	
(1)	Type	
(2)	Number	2 W + 0 S
(3)	Design Solid Loadong	40 kg / m2/d
(4)	Required Surface Area	$8542 \times \frac{1}{40} = 213.50$ m2
(5)	Required diameter	$\left(\frac{4}{\pi} \times 213.50 \times \frac{1}{2} \right)^{1/2} = 11.66$ m → 12.00 m
(6)	Side Water Depth	4 m
(7)	Actual Volume of Tank	$\frac{\pi}{4} \times 12.00^{2} = 113.10$ m3
(8)	Retention Time	$\frac{113.10}{1068} \times 4 \times 2 \times 24 = 20.34$ Hr
[3]	**Volume of Thikened Sludge**	= 308 m^3/d
[4]	**Quantity of Separation Liquid**	Inlet Sludge Volume − Thikened Sludge Volume = 1067.7 − 307.5 = 760.2 m^3/day

Gravity Sludge Thikener17/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

11.	**Thickened Sludge Sump**								
[1]	**Design Condition**								
(1)	Inlet Solids	8,542	kg/day						
(2)	Inlet Sludge Volume	1,068	m^3/d						
[2]	**Geometory**								
(1)	Sludge withdrawl	12	Times/day						
(2)	Required Sump Volume	89	m^3/d						
(3)	Number	2	Basins						
(4)	Width	3.5	m						
(5)	Length	4.0	m						
(6)	Side Water Depth	3.0	m						
(7)	Actual Sump Volume	3.5	×	4.0	×	3.0	×	2	
		＝	84.0	m^3					
[3]	**Equipment**								
(1)	Thickened Sludge Transfer Pumps								
	Transfer Time	6.00	Hr						
	Number	2	W	+	2	S			
	Required Capacity	1068	m^3	／	6.0	／	2		
		＝	89.0	m^3/Hr	⇒	90	m^3/Hr /Unit		

Thickened Sludge Sump18/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

12. Centrifuge

[1] Design Condition

(1) Type of Dewatering	Centrifuge			
(2) Generated Sludge	7,688	kg/day		
(3) Design Polyelectrolyte Dosage	Polyelectrolyte		5	kg/t-DS･day
(4) Volume of Thickend Sludge	307.5	m^3/day		
(5) Consistency of Dewatered Sludge	82	%		
(6) Operation Time	12	hours/day	(6 days per week)	

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{307.5}{12 \times 2} \times \frac{7}{6} = 14.9$$

$$\rightarrow 15 \ m^3/\text{hour}$$

[3] Dewatered Solids

$$\text{Digested Sludge} \times (1 + \text{Injection Rate})$$

$$= 7{,}688 \times (1 + 0.0050)$$

$$= 7{,}726 \ \text{kg/day}$$

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 7.726 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

$$= 50.08 \ \text{t/day}$$

apparent specific gravity 1.00

$$50.08 \,/\, 1.0 = 50.1 \ m^3/\text{day}$$

[5] Polyelectrolyte

(1) Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS･day
(2) Required Polyelectrolyte		38.44	kg/day
(3) Dissolving concentration		0.20	%
(4) Volume of Polyelectrolyte solution		19.22	m3/day

Centrifuge 19/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	15 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	15 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	19.22 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	19.22 m3/da × 7 ／ 6 ／ 12 ／ 2
		＝ 0.93 m^3/Hr
	Specification Capacity	0.93 m^3/Hr × 1.5
		＝ 1.401 m^3/Hr ⇒ 1.40 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	38.44 kg/day × 7 ／ 6 ／ 12
		＝ 3.74 kg/hr
		＝ 11.21 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	22 kg/h
	Tanks Dimensions	Width 1.5 m × Length 2.0 m
		× Depth 2.0 m × 2
		＝ 12 m^3
	Retention Time of Tank	6.00 m^3 /tank ／ 0.93 m^3/Hr ／ 2
		＝ 3.211 Hr > 3 Hr
	Number	2 W + 0 S

Centrifuge 20/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Supporting 12.2.3

11.	**Centrifuge Feed Sump**	
[1]	**Design Condition**	
(1)	Generated Thickend Sludge	7,688 kg/day
(2)	Solids Consistency	2.50 %
(3)	Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
		$= 7{,}688 \times \frac{100}{2.50} \times 10^{-3}$
		= 308 m^3/day
		= 12.81 m^3/h
(4)	Sludge feed flow rate	15 m3/h × 2 = 30 m3/h
(5)	Centrifuge Operation Time	12 hours/day (6 days per week)
[2]	**Geometry**	
(1)	Basin Dimensions	Width 6.0 m × Length 6.5 m
		× Depth 4.0 m × 2
		= 312.0 m^3
[3]	**Equipment**	
(1)	Mixers for Centrifuge Feed Sumps	
	Required Volume	312.0 m^3
	Number	1 W + 1 S

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernatants are same level removed with inlet sewage 2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

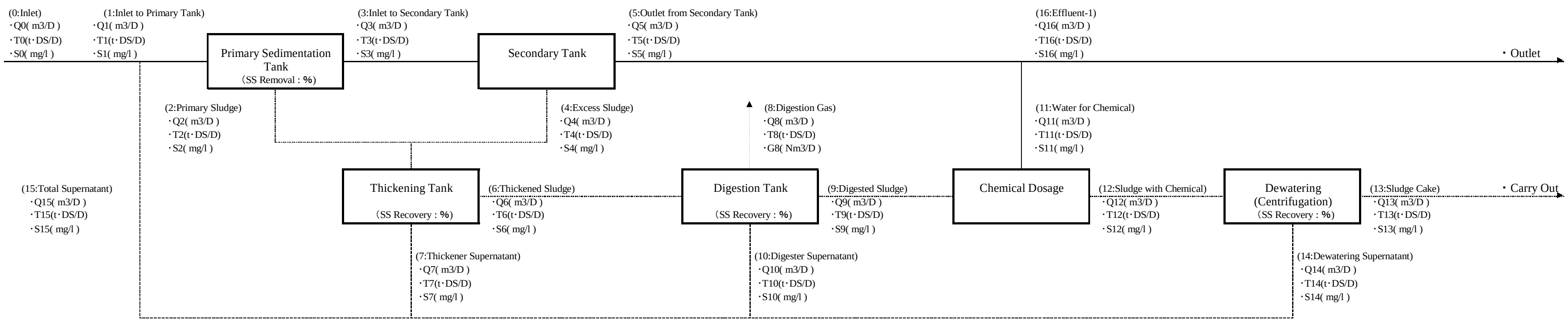
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	17,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	90.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	97.5	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	97.5	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)				16	17
Q(m^3/day)	17,000	18,046	0	18,046	1,068	16,978	308	760	0	308	0	19	327	41	286	1,046	1,046				16,978	0
T(t･DS/day)	7.650	8.890	0.000	8.890	8.542	0.170	7.688	0.854	0.000	7.688	0.000	0.038	7.726	7.340	0.386	1.240	1.240				0.170	0.178
S(mg/l)	450	493	0	493	8,000	10	25,000	1,124	0	25,000	0	2,000	23,647	180,000	1,351	1,186					10	
X(Ti/T0*100)	100	116.2	0.0	116.2	111.7	2.2	100.5	11.2	0.0	100.5	0.0	0.5	101.0	95.9	5.0	16.2					2.2	2.3

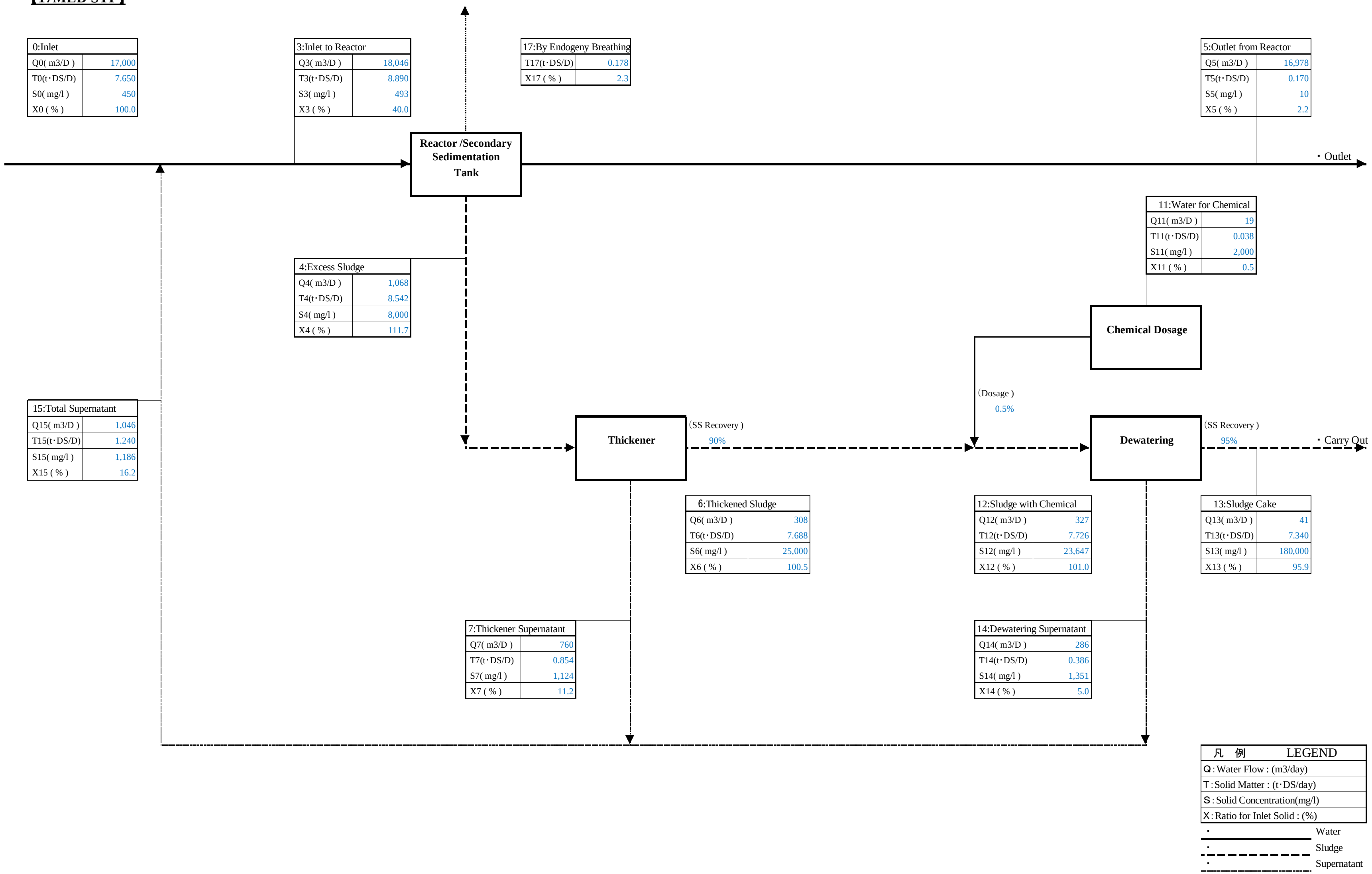
Figure -1 Material Balance Model



Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet
【17MLD STP】



A-1 Process Cal_ EA&al 7MLD Jakkur STP_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	7MLD STP-TSPS
(1) Design Flow for the year 2049	

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	11,000	458	0.127
Daily Maximum	11,000	458	0.127
Hourly Max. Peak factor 2.25	24,750	1031	0.286

Item	7MLD STP-TSPS
(1) Design Flow for the year 2034	

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	7,000	292	0.081
Daily Maximum	7,000	292	0.081
Hourly Max. Peak factor 2.25	15,750	656	0.182

1. Inlet Chamber

Item	7MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Hourly Maximum ＝ 24,750 m3/d
	＝ 0.286 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 （Manning Fornula）
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 ＝ 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.286 × 1
	＝ 11.01 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/1

A-1 Process Cal_ EA&al 7MLD Jakkur STP_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	7MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity whe Design Flow for the year 2049	0.286 ／ 0.400 ／ 0.500 ／ 2 ＝ 0.715 ＜ 1.000 m/sec OK
Velocity whe Design Flow for the year 2034	0.182 ／ 0.400 ／ 0.500 ／ 1 ＝ 0.910 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	0.800 m
Side Water Depth	0.600 m
Velocity whe Design Flow for the year 2049	0.286 ／ 0.800 ／ 0.600 ／ 2 ＝ 0.298 ≒ 0.450 m/sec OK
Velocity whe Design Flow for the year 2034	0.182 ／ 0.800 ／ 0.600 ／ 1 ＝ 0.379 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 0.8 m × Length 6.0 m × SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.4 m × Height 0.60 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.286 ／ 0.700 ／ 0.550 ／ 2 ×(20 + 9)/ 20 ＝ 0.539 ＜ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.182 ／ 0.700 ／ 0.550 ／ 1 ×(20 + 9)/ 20 ＝ 0.685 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.6 m
Velocity through screen whe Design Flow for the year 2049	0.286 ／ 0.800 ／ 0.600 ／ 2 ×(50 + 9)/ 50 ＝ 0.352 ＜ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.182 ／ 0.800 ／ 0.600 ／ 1 ×(50 + 9)/ 50 ＝ 0.447 ＜ 0.800 m/sec OK

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STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item		7MLD STP-TSPS
[2]	Geometory	
(1)	Raw Sewage Sump	
	Number	1 Basin
	Dia	9.50 m
	Pump Operating Depth	1.000 m
	Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.286 ／60
	whe Design Flow for the year 2049	＝ 4.13 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
	Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.182 ／60
	whe Design Flow for the year 2034	＝ 6.49 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
	High Water Level	+ 0.000 m
	Pump Off Level	+ -1.000 m
[3]	Equipment	
(1)	Sewage Pumps 1	
	Number	2 W + 1 S
	Bore Diameter	200 mm
	Discharge Flow : 40% Q* 2	0.182 × 3600 × 40.0% Q
	whe Design Flow for the year 2034	＝ 262 ⇒ 270 m3/Hr
	Total Head	15.0 m
(2)	Sewage Pumps 2	
	Number	1 W + 1 S
	Bore Diameter	150 mm
	Discharge Flow : 20% Q* 1	0.182 × 3600 × 20.0% Q
	whe Design Flow for the year 2034	＝ 131 ⇒ 135 m3/Hr
	Total Head	15.0 m

Raw Sewage Sump 3/21

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STP Process Calculation_Supporting Report 12.2.3

Item	***-STP 7MLD
1. STP Design Condition	
(1) Design Flow Rate	

	m3/d	m3/h	m3/s
Average Daily	7,000	291.67	0.081
Max Daily	7,000	291.67	0.081
Max Hourly Peak factor 2.25	15,750	656.25	0.182

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 15,750 m3/day

= 0.182 m3/sec

[2] Geometry

(1) Number of Basins: 1 Basin

(2) Depth of Basin: 1.500 m

(3) Width of Basin: 1.700 m

(4) Length of Basin: 2.000 m

(5) Volume required of Basin: 1.500 × 1.700 × 2.000 = 1.3 m3

(6) Retention Time: 1.500 × 1.700 × 2.000 ／ 0.182 × 1

= 28.02 sec

(7) Basin Dimensions: Width 1.700 m × Length 2.000 m × Depth 1.500 m

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A-1 Process Cal_ EA&al 7MLD Jakkur STP_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

3.	**Fine Screen Channel**								
〔1〕Design Condition									
(1)	Design Wastewater Flow	Max Hourly			＝	15,750	m3/d		
					＝	0.182	m3/sec		
[2]	Geometory								
(1)	Inlet Gate								
	Number	2	Main	+	1	Bypass			
	Width	0.300	m						
	Height	0.450	m						
	Floor Level	+	2.000	m					
	Bottom	+	0.000	m					
	Influent Water Level	+	0.300	m					
	Velocity	0.182	／	0.300	／	0.300	／	2	
		＝	1.011	≒	1.000	m/sec			
(2)	Screen Channel								
	Number	2	Main	+	1	Bypass			
	Width	0.600	m						
	Side Water Depth	0.400	m						
	Velocity	0.182	／	0.600	／	0.400	／	2	
		＝	0.379	≒	0.450	m/sec			
(3)	Channel Dimensions	Width	0.6	m	×	Length	6.0	m	
			×	SWD	0.4	m			
[3]	Equipment								
(1)	Inlet Gate								
	Number	2	W	+	1	S			
	Dimension	Width	0.3	m	×	Height	0.45	m	
	Design Water Level	2.00	m						
(2)	Fine Screens (Main Channel)								
	Number	2	W	+	0	S			
	Open Space	6	mm						
	Bar Thickness	2	mm						
	Channel Width	0.6	m						
	Width of side plate	50	mm						
	Side Water Depth	0.4	m						
	Height of Blind Plate at the bottom	50	mm						
	Velocity through screen	0.182	／	0.500	／	0.350	／	2	
		×(	6	+	2	)/	6		
		＝	0.693	＜	0.800	m/sec			
(3)	Fine Screens (Bypass Channel)								
	Number	0	W	+	1	S			
	Open Space	20	mm						
	Bar Thickness	9	mm						
	Channel Width	0.6	m						
	Side Water Depth	0.4	m						
	Velocity through screen	0.182	／	0.600	／	0.400	／	2	
		×(	20	+	9	)/	20		
		＝	0.550	＜	0.800	m/sec			

STP Process Calculation_Supporting Report 12.2.3

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Peak flow = 15,750 m^3/day
	= 0.182 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.182 ／ 0.0111 = 16.40 m^2
(2) Number of Basins	1 S + 1 W
(3) Surface Area required/Basin	16.4 ／ 1 = 16.40 m^2
(4) Length of Basin	16.40 ^0.5 = 4.0 m → 4.5 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.182 × 60 sec ／ 1 = 10.9 m^3
(7) Depth required	10.9 ／ 4.5 ／ 4.5 = 0.539 m
(8) Basin Dimensions	Width 4.5 m × Length 4.5 m
	× Depth 0.5 m (Freeboard 0.3m)
(9) Retention Time	4.5 × 4.5 × 0.5 ／ 0.182 × 1
	= 60.00 sec
(10) Surface Overflow Rate at Peak Flow	15,750 ／ 4.5 ／ 4.5 ／ 1
	= 777.777778 ＜ 960 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 182.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
	Ha= 0.317 m
(4) Crest Level	+ m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 0.317 m
(6) Channel bottom level	+ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.173 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.600 m
(3) Stroke	0.450 m
(4) Overflow Height	0.400 m
(5) Overflow Height (actual)	(0.182 ／ 1.840 ／ 0.600 ／ 2) $^{2/3}$
	= 0.189 ＜ 0.400 m

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STP Process Calculation_Supporting Report 12.2.3

5. Reactor

〔1〕 Design Condition

(1)	Design Wastewater Flow	Q＝	7,000	m^3/day (summer)	
		Q'＝	7,000	m^3/day(Winter)	
(2)	Design Sewage Quality				
	Inlet BOD		350	mg/*l*	
	Outlet BOD		10.0	mg/*l*	
	Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
	Inlet COD		800	mg/*l*	
	Inlet bCOD :S_0		578	mg/*l*	
	Inlet nbCOD		223	mg/*l*	
	bCOD/BOD		1.65		
	Inlet S-COD :sCOD		271	mg/*l*	
	Inlet rbCOD		231	mg/*l*	bCOD*40%
	Inlet sbCOD		347	mg/*l*	bCOD*60%
	Outlet S-COD :nbsCODe		40	mg/*l*	
	Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
	Inlet SS		450	mg/*l*	
	Inlet VSS		383	mg/*l*	assumed as 85% of TSS
	:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
	:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
	:iTSS		67.50	gnbVSS/m3	=TSS-VSS
	Inlet T-N		70	mg/*l*	
	Inlet TKN		70	mg/*l*	
	Inlet NH_4-N		45.0	mg/*l*	
	Inlet T-P		7	mg/*l*	
	Inlet D-P		5	mg/*l*	
	Inlet Alkalinity as CaCO3		380	mg/*l*	
	Outlet Kjeldahl N		1.0	mg/*l*	
	Outlet NH4-N		1.0	mg/*l*	
	Outlet NO3-N		9.0	mg/*l*	
	Outlet T-P		2	mg/*l*	
	Outlet D-P		1	mg/*l*	
(3)	Water Temperature	T＝	20.0	℃	
(4)	Safety Factor for Nitrogen	SF=	1.5		
(5)	Return Sludge Concentration	*Rs* ＝	8,000	mg/*l*	
(6)	MLSS MLVSS	X_{TSS} ＝	3,000	mg/*l*	
(7)	DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2)	μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
	$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
	DO	DO=	2.0000	mg/*l*	
	$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	=1/ μ_{AOB} × SF
		⇒	5.0000	day	
(3)	Biomass production				
	$Px_{,VSS}$	$Px_{,VSS}$=	2188.927	kg /d	=Px,bio+Q(nbVSS)
	$Px_{,TSS}$	$Px_{,TSS}$=	2884.700	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al
	S	S=	0.4507	mg/*l*	=Ks[1+b_H(SRT)]/[SRT(μ_m-b_H)-1]
	b_H	b_H=	0.1200		=b*$1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g･d	=μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1265.214	kg VSS/d	=Q･Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)] +QYn(Nox)/[2+bAOB(SRT)]
			1136.066		=Q･Y_H(S_0-S)/[1+b_H(SRT)]
			102.246		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]
			26.903		=QYn(Nox)/[1+b_{AOB}(SRT)]
	NOx	NOx=	47.311	mg/*l*	=TKN-Ne-0.12$P_{X,bio}$/Q
(4)	Required Aeration Tank Volume				
	Va=	Va=	4,808	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	X_{VSS}･Va	X_{VSS}･Va=	10,945	kg VSS	=$Px_{,VSS}$･SRT
	X_{TSS}･Va	X_{TSS}･Va=	14,423	kg TSS	=$Px_{,TSS}$･SRT
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3･d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	4,039	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g･d	=μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g･d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g･d	=μ_{max}*$1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g･d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = Q・(SRT)/V・$Y_H(S_0$-S)/[1+b_H(SRT)]
= 1,181.47 mg/*l*

(2) IR ratio
IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= (IR+R)・Q・Ne
= 268,174.27 kg/d

(4) The anoxic tank volume
Vnor= 481 m3 = Va× 10%
Vnor= 1,458 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb
SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.110 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 364,695.16 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 268,174 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to maint: 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 2188.927 kg /d
Rwmoval Phosphorus 21.88926619 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, $Al_2(SO_4)_3 \cdot 18H_2O$
(5) Required Alumnum Sulfate 300.84 kg/d
(6) Required Alumnum Sulfate solutic 10% 2.87 m3/d
119.38 L/H
(7) Additional sludge 121.96 kg/d

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A-1 Process Cal_EA&al 7MLD Jakkur STP_Appendix 12.2.3
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[5] Reactor

(1) Total volume of Aeration Basins
V_A = Q'*θa/24
= 5,250 m^3

(2) Total volume of Anoxic Basins
V_{DN} = Q'*$θ_{DN}$/24
= 1,458 m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	440	1.50	1.50	0.30
Anoxic	V_{DN}	1,458	5.00	5.00	1.00
Aerobic	V_A	5,250	18.00	18.00	3.60
Total	V	7,148	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	84.0	5.5	2

Cross Section 8.0*5.5 = 44.0 m^2/Basin
Hantzsch Subtraction = 1.0 m^2/Basin
after Subtraction 44.0-1.0 = 43.0 m^2/Basin
Total Volume 43.0*84.0 = 3,612 m^2/Basin 7,224 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**5.1**	**17.0**	**61.0**	**83.1**
Volume required per Basin	m^3	220	729	2,625	3,574
Total Volume required	m^3	440	1,458	5,250	7,148
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	6.0	17.0	61.0	84.0
Actual Volume per Basin	m^3	258	731	2,623	3,612
Actual Total Volume	m^3	516	1,462	5,246	7,224
Actual Ratio of Volume		0.35	1.00	3.59	
Actual Retention Time	hour	1.77	5.01	17.99	24.77

[7] Equipment

(1) Ras Pumps
Ras Ratio 60%
Required Capacity 7,000 m3/day× 60% ／24 ／ 2
= 88 m3/Hr ⇒ 90 m3/Hr
Number 2 Work
2 Stanby

(2) Circulation Pumps
Ras Ratio 366%
Required Capacity 7,000 m3/day× 366% ／24 ／ 4
= 267 m3/Hr ⇒ 270 m3/Hr
Number 4 Work
2 Stanby

(3) SAS Pumps
Excess Sludge 380 m3/day
Sludge withdraw 12 Times/day
Running Time 0.5 Hr/Time
Required Capacity 380 m3/day ／ 12 ／ 0.50 ／ 2
= 31.64 m3/Hr ⇒ 35 m3/Hr
Number 2 Work
2 Stanby

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A-1 Process Cal_ EA&al 7MLD Jakkur STP_Appendix 12.2.3

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(4)	Alum Solution Tank												
	Number	2	W	+		0	S						
	Alum concentration as crystal	10	%										
	Gravity of dissolved dechlorine	1.05											
	Required solution volume	300.84	kg / d	×	100	/	10	/	1.05	/	1000		
		＝	2.87	m3/d									
	Volume of Tank	2.6		m3/tank									
	Total Volume of Tanks	5.2		m3		(Duration=		1.81		day)			
(5)	Mixer for Alum Solution Tank												
	Number	2	W	+	0		S						
(6)	Alum Dosing Pump												
	Number	2	W	+	1		S						
	Capacity	2.87	m3/d	/	24	×	1000	/	2	×	2		
		119.38	l/h/unit	⇒	120	l/h/unit							

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A-1 Process Cal_ EA&al 7MLD Jakkur STP_Appendix 12.2.3
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6. Air Requirement at Average Flow	
〔1〕Design Condition	
(1) AOR	AOR = 3,029 kg/day
	= 126.2 kg/h
Qin :Design Average Flow m^3/d	7,000
Inlet bCOD : S_0	578 mg/*l*
S=	S= 0.451 mg/*l*
Nox=	Nox 47.400 mg/*l*
$P_{X,bio}$=	$P_{X,b}$ 1,238.3 kg VSS/d does not include nitrifying bacteria
R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx
R_0=	R_0= 3,029 kg O2/d
	k= 2.86
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃ 9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature 9.09 mg/L at 20 ℃
	20-T : 0.0 1.024^{20-T} : 1.0000
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth 1+0.40D_j/Pa 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at s 10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : exp[-gM(z_b-z_a)/R*T] 0.900
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t = 293.15 Kelvin
	α : relative Transfer Rate to clean Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \dfrac{32,858}{4.2591} =$ 7,714.69 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas	= 3,857 kg/day
(5) SOTE for the above Effective Aeration Depth	28.0 %
(6) Fraction of O2 in Air	23.18 %
(7) Specific Gravity of Air at Standard Condition	1.293
(8) Safety Factor	15%
(9) Air required at Field Conditions per Basins	= 56,731 m^3/day = 2,363.8 m^3/hr
[2] Equipment	

Air Requirement at Average Flow12/21

(1) Air Blower						
Number	4	W	+	2	S	
Required Capacity	2363.8	m^3/Hr・Basin	／	2	unit/Basin	
	＝ 1181.9	m^3/h	⇒	1200	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	22.704	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	32.101	kW				
Rated Output of Motor	35.311	kW	⇒	37	kW	

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7. Final Clarifire	
〔1〕 Design Condition	
(1) Design Wastewater Flow	Q= 7,000 m^3/day
(2) Water Temperature	T= 20.0 ℃
(3) MLSS	Xef= 3,000 mg/*l*
(4) SVI	SVI= 300
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77) = 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770 = 20.7 m/day
(6) Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0) = 13.8 m^3/m^2·day → 12.0 m^3/m^2·day
[2] Geometory	
(1) Surface Area required	A= 7,000/12.0= = 583 m^2
(2) Demensions	Diameter **19.5** Depth **3.5** Basin **2**
(3) Actual Surface Area	S= 19.5^2 * 3.14 /4 * 2.0 = 597 m^2
(4) Surface Overflow Rate	S= 7,000/597 = 11.7 m^3/m^2·day

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow	7,000	m^3/day	291.67	m^3/h		
		Peak Flow	15,750	m^3/day	656.25	m^3/h		
(2)	Contact Time	30	min					
(3)	Type of Chlorine	Cl_2-GAS						
(4)	Design Chlorine Dosage Rate	10	mg/L					
(5)	Required Chlorine per day	Average Daily Flow	／	1000	×	Design Chlorine Dosage Rate		
		=	70.0	kg/d				
		=	2.92	kg/h				

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow	／	1440	×	Contact Time				
		=	145.8	m^3						
(2)	Nos. of lanes	3	lanes							
(3)	Width of lane	2.00	m							
(4)	Length of lane	13.00	m							
(5)	Side Water Depth	2.00	m							
(6)	Nos. of Tanks	1	tank							
(7)	Total Width of Tank	6.80	m Approx..							
(8)	Average Velocity	Decant Flow	／	3600	／	Width	／	Depth		
		=	291.67	／	3600	／	2.00	／	2.00	
		=	0.020	m/sec						
(9)	Total Volume	Width	×	Length	×	Depth	×	Nos. of lanes	×	Nos. of Tanks
		=	2.0	m	×	13.0	m	×	2.0	m
			×	3	×	1				
		=	156	m^3	>	145.8	m^3			

[3] Equipment

(1) Chlorine Dosing Condition

Operation Dosage Rate -1	DC1	10 mg/L	

(2) Chlorine Cylinder

Type	-	Cylindrical Convexsd Container		
Cylinder Capacity	Cc	928 kg/cylinder		
Average Dosage Rate -1	q1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =	70	kg/day
Maximum Dosage Rate -1	q3	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =	158	kg/day
Storage day	T	More than 15 days		
Required Storage Capacity	EC1	D x T = 1,050 kg		
Unit Number	EN1	EC1 / Cc = 1.1 cylinders		
Maximum Operation Numbers				
Cl_2-Gas Volatilize Rate	Vr1	#### @ 20°C Standard temperature		
Maximum Dosing Rate	DC1	10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 =	6.56	kg/h
Operation Numbers	EN2	DC1 / Vr1 = 0.8sets		
Number	2	W + 2 S		

(3) Chlorinator

Type	Solution Feed Vacuum Type	
Number	1	W + 1 S
Operation Dosage Rate -1	Dq1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 157.5 kg/day
Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =	
	Minimum 0.00 kg/hr	Maximum 6.6 kg/hr

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(4)	Chlorine Booster Pump	
	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 6.6 kg/hr
		therefore 60 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 7,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 18.4 kg/d
		＝ 0.77 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 48.6 m^3
(2)	Width of lane	6.80 m
(3)	Length of lane	4.00 m
(4)	Side Water Depth	2.00 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 6.8 m × 4.0 m × 2.0 m
		＝ 54 m^3 > 48.6 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	1 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	18.38 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.17 m3/d
	Volume of Tank	0.200 m3/tank (= 0.5 mW× 0.5 mL× 0.8 mH)
	Total Volume of Tanks	0.200 m3 (Duration= 1.20 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	2 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	1 W + 1 S
	Capacity	0.38 m3/d / 24 × 1000 / 1
		15.66 l/h/unit ⇒ 16 l/h/unit

Chlorination Tank (gas) 16/21

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10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge			
(2)	Generated Sludge	3,038	kg/day		
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte		5	kg/t-DS・day
(4)	Volume of Thickend Sludge	379.7	m^3/day		
(5)	Consistency of Dewatered Sludge	82	%		
(6)	Operation Time	12	hours/day	(6 days per week)	

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{379.7}{12 \times 2} \times \frac{7}{6} = 18.5$$

$\rightarrow$ 19 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 3,038 × (1 + 0.0050)

= 3,053 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 3.053 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 19.79 t/day

apparent specific gravity 1.00

19.79 ／ 1.0 = 19.8 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS・day
(2)	Required Polyelectrolyte		15.19	kg/day
(3)	Dissolving concentration		0.20	%
(4)	Volume of Polyelectrolyte solution		7.59	m3/day

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[6]	**Equipment**											
(1)	Centrifuge											
	Capacity	19	m^3/hr									
	Number	2	W		+		1	S				
(2)	Centrifuge Feed Pumps											
	Capacity	19	m^3/hr									
	Number	2	W		+		1	S				
(3)	Polyelectrolyte Dosing Pumps											
	Volume of Polyelectrolyte solution	7.59	m3/day									
	Operation Time	12	hours/day		(6 days per week)							
	Safety Factor	1.5										
	Number	2	W		+		1	S				
	Required Capacity	7.59	m3/day ×		7	／	6	／	12	／	2	
		=	0.37	m^3/Hr								
	Specification Capacity	0.37	m^3/Hr		×		1.5					
		=	0.554	m^3/Hr	⇒			0.60	m^3/Hr /Unit			
(4)	Polyelectrolyte dosing System											
	Preparation time for solution	3	hr									
	Required dry polymer	15.19	kg/day ×		7	／	6	／	12			
		=	1.48	kg/hr								
		=	4.43	kg per one batch								
	Feedong time per one batch	30	min									
	Capacity of Dry polymer Feeder	9	kg/h									
	Tanks Dimensions	Width	1.0	m	×	Length		1.5	m			
		×	Depth	1.5	m	×	2					
		=	4.5	m^3								
	Retention Time of Tank	2.25	m^3 /tank		／		0.37	m^3/Hr		／	2	
		=	3.047	Hr	>		3	Hr				
	Number	2	W		+		0	S				

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11.	**Centrifuge Feed Sump**		
[1]	**Design Condition**		
(1)	Generated Thickend Sludge	3,038 kg/day	
(2)	Solids Consistency	0.80 %	
(3)	Volume of Thickened Sludge	Total Solids × $\frac{100}{\text{Solids Consistency}}$ × 10^{-3}	
		= 3,038 × $\frac{100}{0.80}$ × 10^{-3}	
		= 380 m^3/day	
		= 15.82 m^3/h	
(4)	Sludge feed flow rate	19 m3/h × 2 = 38 m3/h	
(5)	Centrifuge Operation Time	12 hours/day (6 days per week)	
[2]	**Geometry**		
(1)	Basin Dimensions	Width 6.0 m × Length 6.0 m	
		× Depth 3.5 m × 2	
		= 252.0 m^3	
[3]	**Equipment**		
(1)	Mixers for Centrifuge Feed Sumps		
	Required Volume	252.0 m^3	
	Number	1 W + 1 S	

Centrifuge Feed Sump 19/21

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Material Balance Calculation （Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4·S4=(a·S_{BOD}+b·S1-c·θ·XA)·Q3/10^6··(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

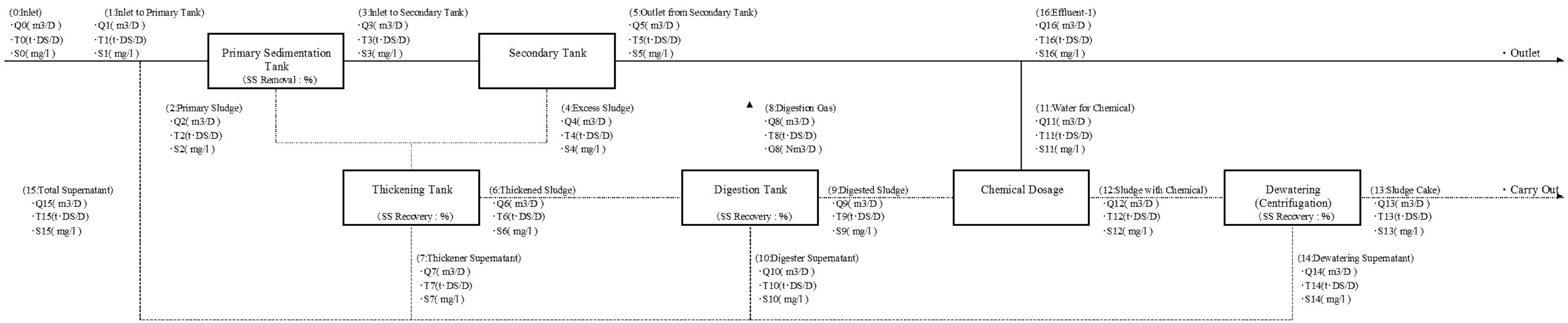
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
·Inlet flow : Q_0(m3/D)	7,000	·Primary sludge moisture ratio : W1(%)	0.0	·Removal ratio in primary tank : A2(%)	0.0	·Content of organics in thickened sludge : A6(%)	75.0	·Chemical dosage : A9(%)	0.5	
·Inlet quality : S_0(mg/l)	450	·Excess sludge moisture ratio : W2(%)	99.2	·Recovery ratio in sludge thickener : A3(%)	100.0	·Digestion ratio : A7(%)	#REF!	·Chemical dissolve concentration : A10(%)	0.2	
·Total removal ratio : A1(%)	-	·Thickened sludge moisture ratio : W3(%)	99.2	·Recovery ratio in sludge digester : A4(%)	100.0	·Digestion gas generation : A8(Nm3/kgVS)				
·Effluent quality : St(mg/l)	10.0	·Digested sludge moisture ratio : W4(%)	99.2	·Recovery ratio in dewatering : A5(%)	95.0					
·Sludge generation ratio per removal SS : Si(%)	-	·Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要仮定)				16	17
Q(m^3/day)	7,000	7,371	0	7,371	380	6,991	380	0	0	380	0	8	387	16	371	371	371				6,991	0
T(t·DS/day)	3.150	3.303	0.000	3.303	3.038	0.070	3.038	0.000	0.000	3.038	0.000	0.015	3.053	2.900	0.153	0.153	0.153				0.070	0.195
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411					10	
X(Ti/T0*100)	100	104.9	0.0	104.9	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8					2.2	6.2

Figure -1 Material Balance Model



Calculation Formula						
·Q0=Input Data ·T0=Q0*S0*10^(-6) ·S0=Input Data	·Q3=Q1-Q2 ·T3=T0*(100-A2)/100 ·S3=T3*10^6/Q3	·Q6=T6*100/(100-W3) ·T6=(T2+T4)*A3/100 ·S6=10^6*(100-W3)/100	·Q9=Q6 ·T9=(T6-T8)*A4/100 ·S9=T9*10^6/Q9	·Q12=Q9+Q11 ·T12=T9+T11 ·S12=T12*10^6/Q12	·Q15=Q7+Q10+Q14 ·T15=T7+T10+T14 ·S15=T15*10^6/Q15	·Q5-1=Q5-Q11 ·T5-1=T5-T11 ·S5-1=S5
·Q1=Q0+Q15 ·T1=T0+T15 ·S1=T1*10^6/Q1	·Q4=T4*100/(100-W2) ·T4=余剰汚泥発生式による ·S4=10^6*(100-W2)/100	·Q7=(Q2+Q4)-Q6 ·T7=(T2+T4)-T6 ·S7=T7*10^6/Q7	·Q10=Q6-Q8-Q9 ·T10=T6-T8-T9 ·S10=T10*10^6/Q10	·Q13=T13*100/(100-W5) ·T13=T12*A5/100 ·S13=10^6*(100-W5)/100		
·Q2=T2*100/(100-W1) ·T2=T1-T3 ·S2=10^6*(100-W1)/100	·Q5=Q3-Q4*(T3-T5)/T4 ·T5=Q5*ST/10^6 ·S5=St	·Q8=0 ·T8=T6*A6*A7/10^4 #REF!	·Q11=T10*A9/A10 ·T11=Q11*S11/10^6 ·S11=10^4*A10	·Q14=Q12-Q13 ·T14=T12-T13 ·S14=T14*10^6/Q14		

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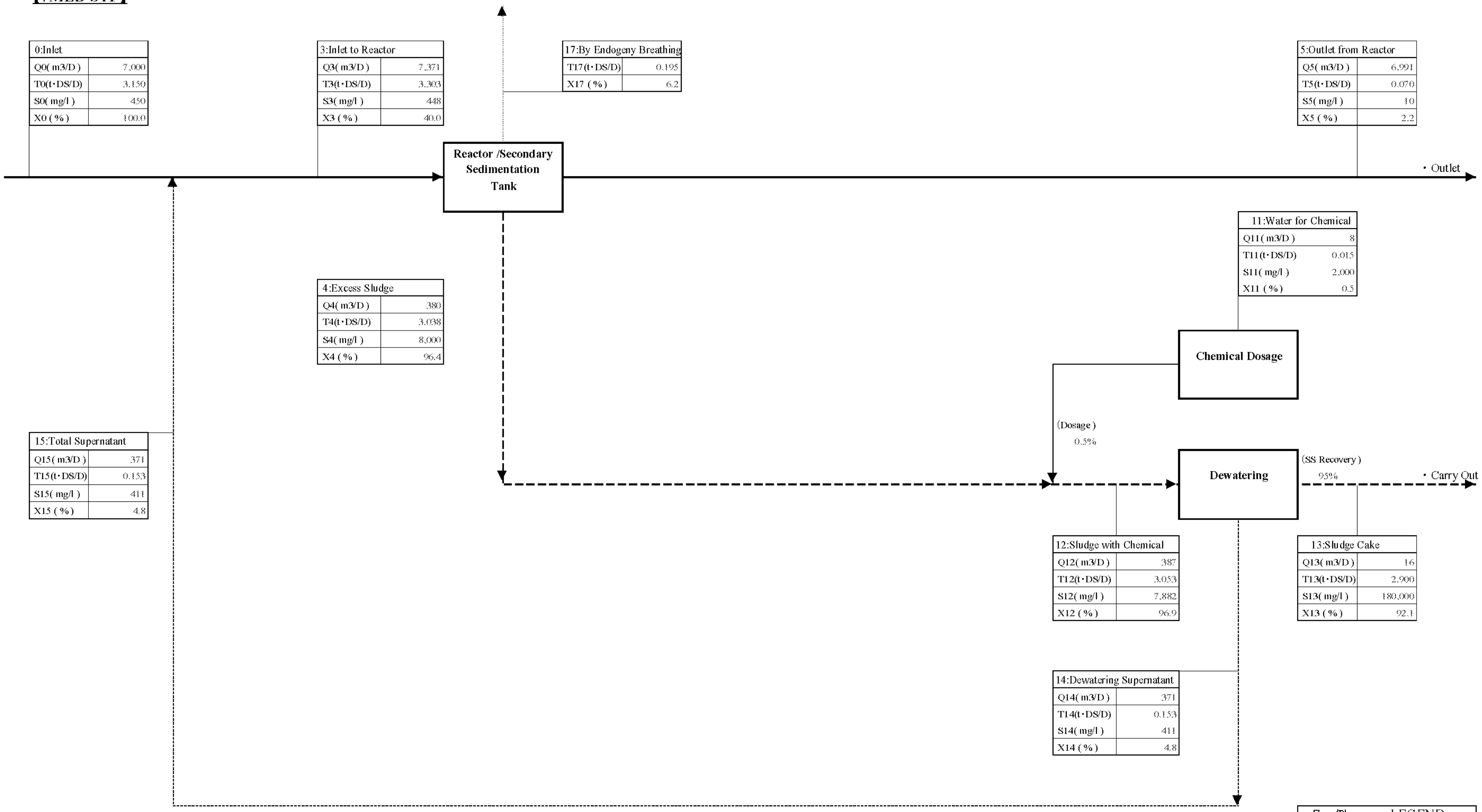
Material Balance Sheet
【7MLD STP】



0:Inlet	
Q0(m3/D)	7,000
T0(t・DS/D)	3.150
S0(mg/l)	450
X0 (%)	100.0

3:Inlet to Reactor	
Q3(m3/D)	7,371
T3(t・DS/D)	3.303
S3(mg/l)	448
X3 (%)	40.0

17:By Endogeny Breathing	
T17(t・DS/D)	0.195
X17 (%)	6.2

5:Outlet from Reactor	
Q5(m3/D)	6,991
T5(t・DS/D)	0.070
S5(mg/l)	10
X5 (%)	2.2

11:Water for Chemical	
Q11(m3/D)	8
T11(t・DS/D)	0.015
S11(mg/l)	2,000
X11 (%)	0.5

4:Excess Sludge	
Q4(m3/D)	380
T4(t・DS/D)	3.038
S4(mg/l)	8,000
X4 (%)	96.4

15:Total Supernatant	
Q15(m3/D)	371
T15(t・DS/D)	0.153
S15(mg/l)	411
X15 (%)	4.8

12:Sludge with Chemical	
Q12(m3/D)	387
T12(t・DS/D)	3.053
S12(mg/l)	7,882
X12 (%)	96.9

13:Sludge Cake	
Q13(m3/D)	16
T13(t・DS/D)	2.900
S13(mg/l)	180,000
X13 (%)	92.1

14:Dewatering Supernatant	
Q14(m3/D)	371
T14(t・DS/D)	0.153
S14(mg/l)	411
X14 (%)	4.8

凡　例　　LEGEND
Q: Water Flow : (m3/day)
T: Solid Matter : (t・DS/day)
S: Solid Concentration(mg/l)
X: Ratio for Inlet Solid : (%)

・Water
・Sludge
・Supernatant

Material Balance Sheet 21/21

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STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	6MLD STP-TSPS			
(1) Design Flow for the year 2049		Flow Rate		
		m3/d	m3/h	m3/s
	Average Daily	15,000	625	0.174
	Max Dayly	15,000	625	0.174
	Max Hourly Peak factor 2.25	33,750	1406	0.391
(1) Design Flow for the year 2034		Flow Rate		
		m3/d	m3/h	m3/s
	Average Daily	6,000	250	0.069
	Max Dayly	6,000	250	0.069
	Max Hourly Peak factor 2.5	15,000	625	0.174

1. Inlet Chamber

Item	6MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly = 33,750 m3/d
	= 0.391 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Formula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometry	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.500 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.500 × 2.500 = 0.6 m3
(6) Retention Time	0.600 × 2.500 × 2.500 ⁄ 0.391 × 1
	= 9.59 sec
(7) Basin Demensions	Width 2.500 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

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2. Coarse Screen Channel

Item	6MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.500 m
Height	0.750 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.391 ／ 0.500 ／ 0.500 ／ 2
whe Design Flow for the year 2049	＝ 0.782 ＜ 1.000 m/sec OK
Velocity	0.174 ／ 0.500 ／ 0.500 ／ 1
whe Design Flow for the year 2034	＝ 0.696 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	1.000 m
Side Water Depth	0.500 m
Velocity	0.391 ／ 1.000 ／ 0.500 ／ 2
whe Design Flow for the year 2049	＝ 0.391 ≒ 0.450 m/sec OK
Velocity	0.174 ／ 1.000 ／ 0.500 ／ 1
whe Design Flow for the year 2034	＝ 0.348 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 1.0 m × Length 8.5 m
	× SWD 0.5 m
[3] Equipment	
(1) Inlet Gate	
Number	3 Units
Dimension	Width 0.5 m × Height 0.8 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.391 ／ 0.900 ／ 0.450 ／ 2
	×(20 + 9)/ 20
	＝ 0.700 ≒ 0.800 m/sec OK
Velocity through screen	0.174 ／ 0.900 ／ 0.450 ／ 1
whe Design Flow for the year 2034	×(20 + 9)/ 20
	＝ 0.623 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Side Water Depth	0.5 m
Velocity through screen	0.391 ／ 1.000 ／ 0.500 ／ 2
whe Design Flow for the year 2049	×(20 + 9)/ 20
	＝ 0.567 ＜ 0.800 m/sec OK
Velocity through screen	0.174 ／ 1.000 ／ 0.500 ／ 1
whe Design Flow for the year 2034	×(20 + 9)/ 20
	＝ 0.505 ＜ 0.800 m/sec OK

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3. Raw Sewage Sump

Item		6MLD STP-TSPS									
[2]	Geometory										
(1)	Raw Sewage Sump										
	Number	1	Basin								
	Dia	11.00	m								
	Pump Operating Depth	1.000	m								
	Retention Time	(	11.00	^{2}×	π／4	×	1.000	)／	0.391	／60	
	whe Design Flow for the year 2049	＝	4.05	＞	3.75		min (=minimum time of one pump cycle				OK
	Retention Time	(	11.00	^{2}×	π／4	×	1.000	)／	0.174	／60	
	whe Design Flow for the year 2034	＝	9.10	＞	3.75		min (=minimum time of one pump cycle				OK
	High Water Level	+	0.000	m							
	Pump Off Level	+	-1.000	m							
[3]	Equipment										
(1)	Sewage Pumps 1										
	Number	2	W	+	1	S					
	Bore Diameter	250	mm								
	Discharge Flow : Q	0.174	×	3600	／	2.0					
	whe Design Flow for the year 2034	＝	313	⇒	315	m3/Hr					
	Total Head	15.0	m								
(2)	Sewage Pumps 2										
	Number		W	+		S					
	Bore Diameter		mm								
	Discharge Flow : 0.5			／							
	whe Design Flow for the year 2034	＝		⇒		m3/Hr					
	Total Head		m								

Raw Sewage Sump 3/21

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STP Process Calculation_Supporting Report 12.2.3

Item	6MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	6,000	250.00	0.069
Max Daily	6,000	250.00	0.069
Max Hourly Peak factor 2.5	15,000	625.00	0.174

(2) Design Water Quality

Unit:mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 15,000 m3/day
= 0.174 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.000 m

(3) Width of Basin — 2.100 m

(4) Length of Basin — 1.500 m

(5) Volume required of Basin — 1.000 × 2.100 × 1.500 = 1.4 m3

(6) Retention Time — 1.000 × 2.100 × 1.500 ⁄ 0.174 × 1
= 18.10 sec

(7) Basin Dimensions — Width 2.100 m × Length 1.500 m
× Depth 1.000 m

STP basic &Stilling Chamber4/21

3. Fine Screen Channel

〔1〕Design Condition

(1) Design Wastewater Flow — Max Hourly = 15,000 m3/d
= 0.174 m3/sec

[2] Geometory

(1) Inlet Gate

Number	1	Main	+	1	Bypass			
Width	0.400	m						
Height	0.600	m						
Floor Level	+	2.000	m					
Bottom	+	0.000	m					
Influent Water Level	+	0.500	m					
Velocity	0.174	／	0.400	／	0.500	／	1	
	=	0.870	≒	1.000	m/sec			

(2) Screen Channel

Number	1	Main	+	1	Bypass			
Width	0.800	m						
Side Water Depth	0.500	m						
Velocity	0.174	／	0.800	／	0.500	／	1	
	=	0.435	≒	0.450	m/sec			

(3) Channel Dimensions — Width 0.8 m × Length 6.0 m
× SWD 0.5 m (Freeboard 0.3m)

[3] Equipment

(1) Inlet Gate

Number	1	W	+	1	S			
Dimension	Width	0.4	m	×	Height	0.60	m	
Design Water Level	2.00	m						

(2) Fine Screens (Main Channel)

Number	1	W	+	0	S			
Open Space	6	mm						
Bar Thickness	2	mm						
Channel Width	0.8	m						
Width of side plate	50	mm						
Side Water Depth	0.5	m						
Height of Blind Plate at the bottom	50	mm						
Velocity through screen	0.174	／	0.700	／	0.450	／	1	
	×(	6	+	2	)/	6		
	=	0.737	<	0.800	m/sec			

(3) Fine Screens (Bypass Channel)

Number	0	W	+	1	S			
Open Space	20	mm						
Bar Thickness	9	mm						
Channel Width	0.8	m						
Side Water Depth	0.5	m						
Velocity through screen	0.174	／	0.800	／	0.500	／	1	
	×(	20	+	9	)/	20		
	=	0.631	<	0.800	m/sec			

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4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Max Hourly = 15,000 m^3/day
	= 0.174 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.174 ／ 0.0111 = 15.68 m^2
(2) Number of Basins	1 S + 1 W
(3) Surface Area required/Basin	15.7 ／ 1 = 15.68 m^2
(4) Length of Basin	15.68 ^0.5 = 4.0 m → 4.0 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.174 × 60 sec ／ 1 = 10.4 m^3
(7) Depth required	10.4 ／ 4.0 ／ 4.0 = 0.653 m
(8) Basin Dimensions	Width 4.0 m × Length 4.0 m
	× Depth 0.7 m (Freeboard 0.3m)
(9) Retention Time	4 × 4.0 × 0.7 ／ 0.174 × 1
	= 60.00 sec
(10) Surface Overflow Rate at Peak Flow	15,000 ／ 4.0 ／ 4.0 ／ 1
	= 937.5 ＜ 960 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 174.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
	Ha= 0.308 m
(4) Crest Level	+ 75.400 m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 75.708 m
(6) Channel bottom level	+ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.166 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.400 m
(3) Stroke	0.450 m
(4) Overflow Height	0.400 m
(5) Overflow Height (actual)	(0.174 ／ 1.840 ／ 0.400 ／ 2) $^{2/3}$
	= 0.241 ＜ 0.400 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	6,000	m^3/day (summer)	
	Q'=	6,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/l	
Outlet BOD		10.0	mg/l	
Inlet S-BOD		235	mg/l	assumed as 67% of BOD
Inlet COD		800	mg/l	
Inlet bCOD :S_0		578	mg/l	
Inlet nbCOD		223	mg/l	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/l	
Inlet rbCOD		231	mg/l	bCOD*40%
Inlet sbCOD		347	mg/l	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/l	
Inlet nbpCOD :nbpCOD		183	mg/l	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/l	
Inlet VSS		383	mg/l	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/l	
Inlet TKN		70	mg/l	
Inlet NH_4-N		45	mg/l	
Inlet T-P		7	mg/l	
Inlet D-P		5	mg/l	
Inlet Alkalinity as CaCO3		380	mg/l	
Outlet Kjeldahl N		1.0	mg/l	
Outlet NH4-N		1.0	mg/l	
Outlet NO3-N		9.0	mg/l	
Outlet T-P		2	mg/l	
Outlet D-P		1	mg/l	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	Rs =	8,000	mg/l	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/l	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃= 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃= 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/l	
DO	DO=	2.0000	mg/l	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/l	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	1876.223	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	2472.600	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/l	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/l	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1084.470	kg VSS/d	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
			973.771		$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			87.639		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			23.059		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/l	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	4,121	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS} \cdot Va$	$X_{VSS} \cdot Va$=	9,381	kg VSS	$=Px,_{VSS} \cdot SRT$
	$X_{TSS} \cdot Va$	$X_{TSS} \cdot Va$=	12,363	kg TSS	$=Px,_{TSS} \cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	3,462	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.900	mg/l	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.500	mg/l	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration

X_b = $Q \cdot (SRT)/V \cdot Y_H(S_0\text{-}S)/[1+b_H(SRT)]$

= 1,181.47 mg/*l*

(2) IR ratio

IR = NOx/Ne-1.0-R

= 3.66

(3) The amount of NO3-N fed to the anoxic tank

Nox feed= (IR+R)・Q・Ne

= 229,863.66 kg/d

(4) The anoxic tank volume

Vnor= 412 m3 = Va × 10%

Vnor= 1,250 m3 τ_{DN}= 5.000 h

(5) F/M_b

F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD

40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb

SDNRb= 0.296 g/g・d $= b_0+b_1[\ln(F/M_b)]$

b_0= 0.242

b_1= 0.152

(8) SDNR

SDNR= 0.110 g/g・d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d $=SDNR_t - 0.029\ln(F/M_b)-0.012$ IR=3-4

$=SDNR_t - 0.0166\ln(F/M_b)-0.078$ IR=2

SDNRt= 0.296 g/g・d $=SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr

NOr= 312,595.85 kg/d $=N_{nox} \cdot SDNR \cdot X_b$

>Nox feed= 229,864 kg/d

(10) Alkalinity to be added to maintain pH7

-108.33 mg/*l*

Influent Alk 380.00 mg/*l*

Alk used 338.44 mg/*l* =7.14×Nox

Alk produce(136.77 mg/*l* =3.57×(NOx-NOxe)

Alk to maint: 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l

P in waste sludge px= 1.00%

Generated waste sludge $Px_{,VSS}$= 1876.223 kg /d

Rwmoval Phosphorus 18.76222816 kg /d

(2) Effluent T-P without Al 3.87 mg/l

(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol

(4) Required Al dosing rate 3.48 mg/l as Al

42.98 mg/l as crystal, Al2(SO4)3・18H2O

(5) Required Aluminium Sulphate 257.87 kg/d

(6) Required Aluminium Sulphate solı 10% 2.46 m3/d

102.33 L/H

(7) Additional sludge 104.54 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins
V_A = Q'*θa/24
= 4,500 m^3

(2) Total volume of Anoxic Basins
V_{DN} = Q'*$θ_{DN}$/24
= 1,250 m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	380	1.50	1.50	0.30
Anoxic	V_{DN}	1,250	5.00	5.00	1.00
Aerobic	V_A	4,500	18.00	18.00	3.60
Total	V	6,130	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	75.0	5.5	2

Cross Section 8.0*5.5 = 44.0 m^2/Basin
Hantzsch Subtraction = 1.0 m^2/Basin
after Subtraction 44.0-1.0 = 43.0 m^2/Basin
Total Volume 43.0*75.0 = 3,225 m^2/Basin 6,450 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**4.4**	**14.5**	**52.3**	**71.3**
Volume required per Basin	m^3	190	625	2,250	3,065
Total Volume required	m^3	380	1,250	4,500	6,130
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	6.0	15.0	54.0	75.0
Actual Volume per Basin	m^3	258	645	2,322	3,225
Actual Total Volume	m^3	516	1,290	4,644	6,450
Actual Ratio of Volume		0.40	1.00	3.60	
Actual Retention Time	hour	2.06	5.16	18.58	25.80

[7] Equipment

(1) Ras Pumps
Ras Ratio 60%
Required Capacity 6,000 m3/day× 60% ／24 ／ 2
= 75 m3/Hr ⇒ 75 m3/Hr
Number 2 Work
2 Standby

(2) Circulation Pumps
Ras Ratio 366%
Required Capacity 6,000 m3/day× 366% ／24 ／ 4
= 229 m3/Hr ⇒ 230 m3/Hr
Number 4 Work
2 Standby

(3) SAS Pumps
Excess Sludge 325 m3/day
Sludge withdraw 12 Times/day
Running Time 0.5 Hr/Time
Required Capacity 325 m3/day ／ 12 ／ 0.50 ／ 2
= 27.12 m3/Hr ⇒ 28 m3/Hr
Number 2 Work
2 Standby

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(4) Alum Solution Tank											
Number	2	W	+	0	S						
Alum concentration as crystal	10	%									
Gravity of dissolved dechlorine	1.05										
Required solution volume	257.87	kg / d	×	100	/	10	/	1.05	/	1000	
	=	2.46	m3/d								
Volume of Tank	1.5		m3/tank								
Total Volume of Tanks	3.0		m3	(Duration=	1.22	day)					
(5) Mixer for Alum Solution Tank											
Number	2	W	+	0	S						
(6) Alum Dosing Pump											
Number	2	W	+	1	S						
Capacity	2.46	m3/d	/	24	×	1000	/	2	×	2	
	102.33	l/h/unit	⇒	110	l/h/unit						

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6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR		AOR	= 2,596 kg/day
				= 108.2 kg/h
	Qin :Design Average Flow	m^3/d	6,000	
	Inlet bCOD :S_0		578 mg/l	
	S=		S= 0.451 mg/l	
	Nox=		Nox 47.400 mg/l	
	$P_{X,bio}$=		$P_{X,b}$ 1,061.4 kg VSS/d	does not include nitrifying bacteria
	R_0=		$R_0=Q(S_0\text{-}S\text{-}k(Nox\text{-}NOxe)\text{-}1.42P_{X,bio}+4.57Q\cdot NOx$	
	R_0=		R_0= 2,596 kg O2/d	
			k= 2.86	

(2) SOR(Standard Oxygen Transfer Rate at site)

$$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		$1+0.40D_j/Pa$	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R^*T]$	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{28,164}{4.2591} = 6,612.59 \text{ kg/day}$$

(3)	No. of Basins	2 Basin
(4)	Standard O2 required at Field Conditions per Bas	= 3,306 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	15%
(9)	Air required at Field Conditions per Basins	= 48,627 m^3/day = 2,026.1 m^3/hr
[2]	Equipment	

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(1) Air Blower						
Number	2	W	+	1	S	
Required Capacity	2026.1	m^3/Hr・Basin	／	1	unit/Basin	
	＝ 2026.1	m^3/h	⇒	2100	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	39.733	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	56.177	kW				
Rated Output of Motor	61.795	kW	⇒	75	kW	

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7.	**Final Clarifire**				
〔1〕	**Design Condition**				
(1)	Design Wastewater Flow	Q= 6,000 m^3/day			
(2)	Water Temperature	T= 20.0 ℃			
(3)	MLSS	Xef= 3,000 mg/*l*			
(4)	SVI	SVI= 300			
(5)	Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)			
		= 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770			
		= 20.7 m/day			
(6)	Surface Overflow Rate required	*S'*= v/(1.5*1)=	20.7/(1.5*1.0)	=	13.8 $m^3/m^2 \cdot day$
				→	12.0 $m^3/m^2 \cdot day$
[2]	**Geometory**				
(1)	Surface Area required	A= 6,000/12.0=		=	500 m^2
(2)	Demensions	Diameter	Depth Basin		
		18.0	**3.5** **2**		
(3)	Actual Surface Area	S= 18.0^2 * 3.14 /4 * 2.0		=	509 m^2
(4)	Surface Overflow Rate	S= 6,000/509		=	11.8 $m^3/m^2 \cdot day$

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Flow 6,000 m^3/day 250.00 m^3/h
		Peak Flow 15,000 m^3/day 625.00 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 60.0 kg/d
		＝ 2.50 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 125.0 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	1.50 m
(4)	Length of lane	19.00 m
(5)	Side Water Depth	1.50 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	5.30 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 250.00 ／ 3600 ／ 1.50 ／ 1.50
		＝ 0.031 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 1.5 m × 19.0 m × 1.5 m
		× 3 × 1
		＝ 128 m^3 > 125.0 m^3

[3] Equipment

(1)	Chlorine Dosing Condition		
	Operation Dosage Rate -1	DC1	1 mg/L 10 mg/L
	Average Dosage Rate -1	DC2	10 mg/L
(2)	Chlorine Cylinder		
	Type	-	Cylindrical Convexsd Container
	Cylinder Capacity	Cc	928 kg/cylinder
	Average Dosage Rate -1	q1	Chlorine -1 : Q_{T-D} x DC2 x 10^{-6} x 10^3 = 60 kg/day
	Storage day	T	More than 15 days
	Required Storage Capacity	EC1	D x T = 900 kg
	Unit Number	EN1	EC1 / Cc = 1.0 cylinders
	Maximum Operation Numbers		
	Cl_2-Gas Volatilize Rate	Vr1	#### @ 20^{O}C Standard temperature
	Maximum Dosing Rate	DC1	10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = ####
	Operation Numbers	EN2	DC1 / Vr1 = 0.8sets
(3)	Chlorinator		
	Type		Solution Feed Vacuum Type
	Number		1 W + 1 S
	Operation Dosage Rate -1	Dq1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
			6 kg/day to 150 kg/day
	Required Dosage Rate		Chlorine -1 : Dq1 / (EN1x 24) =
			Minimum Maximum
			0.25 kg/hr 6.3 kg/hr

Chlorination Tank (gas)15/21

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(4)	Chlorine Booster Pump	
	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 6.3 kg/hr
		therefore 50 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 6,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 15.75 kg/d
		＝ 0.656 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 41.7 m^3
(2)	Width of lane	5.30 m
(3)	Length of lane	6.00 m
(4)	Side Water Depth	1.50 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 5.3 m × 6.0 m × 1.5 m
		＝ 48 m^3 > 41.7 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	1 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	15.75 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.14 m3/d
	Volume of Tank	0.2 m3/tank
	Total Volume of Tanks	0.2 m3 (Duration= 1.40 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	1 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	1 W + 1 S
	Capacity	0.36 m3/d / 24 × 1000 / 1
		14.91 l/h/unit ⇒ 15.0 l/h/unit

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10. Centrifuge

[1] Design Condition

(1) Type of Dewatering	Centrifuge			
(2) Generated Sludge	2,604	kg/day		
(3) Design Polyelectrolyte Dosage	Polyelectrolyte		5	kg/t-DS･day
(4) Volume of Thickend Sludge	325.4	m^3/day		
(5) Consistency of Dewatered Sludge	82	%		
(6) Operation Time	12	hours/day	(6 days per week)	

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{325.4}{12 \times 1} \times \frac{7}{6} = 31.6$$

$\rightarrow$ 32 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 ＋ Injection Rate)

＝ 2,604 × (1 ＋ 0.0050)

＝ 2,617 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 2.617 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

＝ 16.96 t/day

apparent specific gravity 1.00

16.96 ／ 1.0 ＝ 17.0 m^3/day

[5] Polyelectrolyte

(1) Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS･day
(2) Required Polyelectrolyte		13.02	kg/day
(3) Dissolving concentration		0.20	%
(4) Volume of Polyelectrolyte solution		6.51	m3/day

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[6]	**Equipment**											
(1)	Centrifuge											
	Capacity		32	m^3/hr								
	Number		1	W		+		1	S			
(2)	Centrifuge Feed Pumps											
	Capacity		32	m^3/hr								
	Number		1	W		+		1	S			
(3)	Polyelectrolyte Dosing Pumps											
	Volume of Polyelectrolyte solution		6.51	m3/day								
	Operation Time		12	hours/day		(6 days per week)						
	Safety Factor		1.5									
	Number		1	W		+		1	S			
	Required Capacity		6.51	m3/day ×		7	／	6	／	12	／	1
			＝	0.63	m^3/Hr							
	Specification Capacity		0.63	m^3/Hr		×		1.5				
			＝	0.949	m^3/Hr	⇒		1.00	m^3/Hr /Unit			
(4)	Polyelectrolyte dosing System											
	Tanks Dimensions	Width	1.5	m	×	Length		1.5	m			
		×	Depth		1.8	m	×	2				
			＝	8.1	m^3							
	Retention Time of Tanks		8.10	m^3	／		0.63	m^3/Hr		／		1
			＝	12.800	Hr							
	Number		2	W		+		0	S			

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11.	**Centrifuge Feed Sump**	
[1]	**Design Condition**	
(1)	Generated Thickend Sludge	2,604 kg/day
(2)	Solids Consistency	0.80 %
(3)	Volume of Excess Sludge	$\text{Total Solids} \times \dfrac{100}{\text{Solids Consistency}} \times 10^{-3}$
		$= 2{,}604 \times \dfrac{100}{0.80} \times 10^{-3}$
		= 325 m^3/day
		= 13.56 m^3/h
(4)	Sludge feed flow rate	32 m3/h × 1 = 32 m3/h
(5)	Centrifuge Operation Time	12 hours/day (6 days per week)
[2]	**Geometry**	
(1)	Basin Dimensions	Width 5.0 m × Length 5.0 m
		× Depth 4.0 m × 2
		= 200.0 m^3
[3]	**Equipment**	
(1)	Mixers for Centrifuge Feed Sumps	
	Required Volume	200.0 m^3
	Number	1 W + 1 S

Centrifuge Feed Sump 19/21

Material Balance SD4

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Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

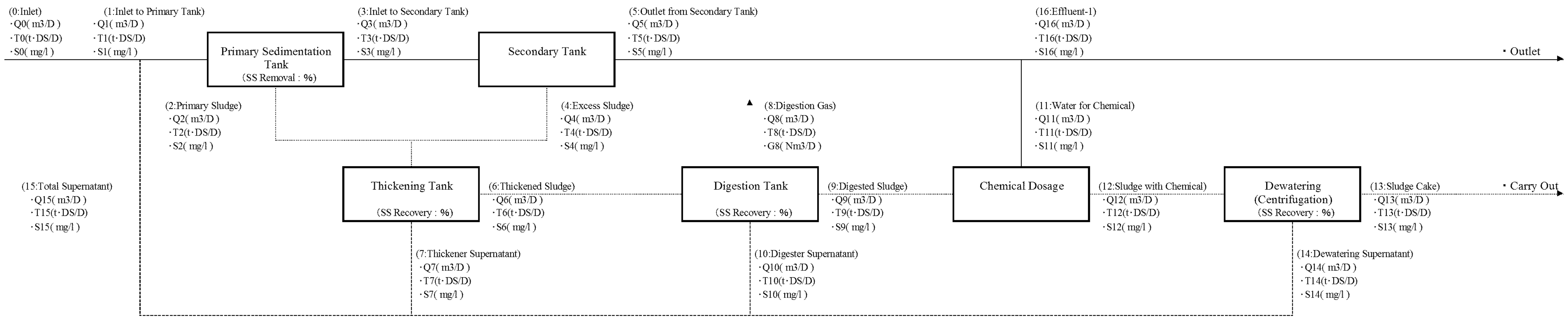
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	6,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	6,000	6,318	0	6,318	325	5,993	325	0	0	325	0	7	332	14	318	318	318			5,993	0
T(t･DS/day)	2.700	2.831	0.000	2.831	2.604	0.060	2.604	0.000	0.000	2.604	0.000	0.013	2.617	2.486	0.131	0.131	0.131			0.060	0.167
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.9	0.0	104.9	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



Calculation Formula

･Q0=Input Data	･Q3=Q1-Q2	･Q6=T6*100/(100-W3)	･Q9=Q6	･Q12=Q9+Q11	･Q15=Q7+Q10+Q14	･Q5-1=Q5-Q11
･T0=Q0*S0*10^(-6)	･T3=T0*(100-A2)/100	･T6=(T2+T4)*A3/100	･T9=(T6-T8)*A4/100	･T12=T9+T11	･T15=T7+T10+T14	･T5-1=T5-T11
･S0=Input Data	･S3=T3*10^6/Q3	･S6=10^6*(100-W3)/100	･S9=T9*10^6/Q9	･S12=T12*10^6/Q12	･S15=T15*10^6/Q15	･S5-1=S5
･Q1=Q0+Q15	･Q4=T4*100/(100-W2)	･Q7=(Q2+Q4)-Q6	･Q10=Q6-Q8-Q9	･Q13=T13*100/(100-W5)		
･T1=T0+T15	･T4=余剰汚泥発生式による	･T7=(T2+T4)-T6	･T10=T6-T8-T9	･T13=T12*A5/100		
･S1=T1*10^6/Q1	･S4=10^6*(100-W2)/100	･S7=T7*10^6/Q7	･S10=T10*10^6/Q10	･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1)	･Q5=Q3-Q4*(T3-T5)/T4	･Q8=0	･Q11=T10*A9/A10	･Q14=Q12-Q13		
･T2=T1-T3	･T5=Q5*ST/10^6	･T8=T6*A6*A7/10^4	･T11=Q11*S11/10^6	･T14=T12-T13		
･S2=10^6*(100-W1)/100	･S5=St	#REF!	･S11=10^4*A10	･S14=T14*10^6/Q14		

Material Balance Sheet SD4

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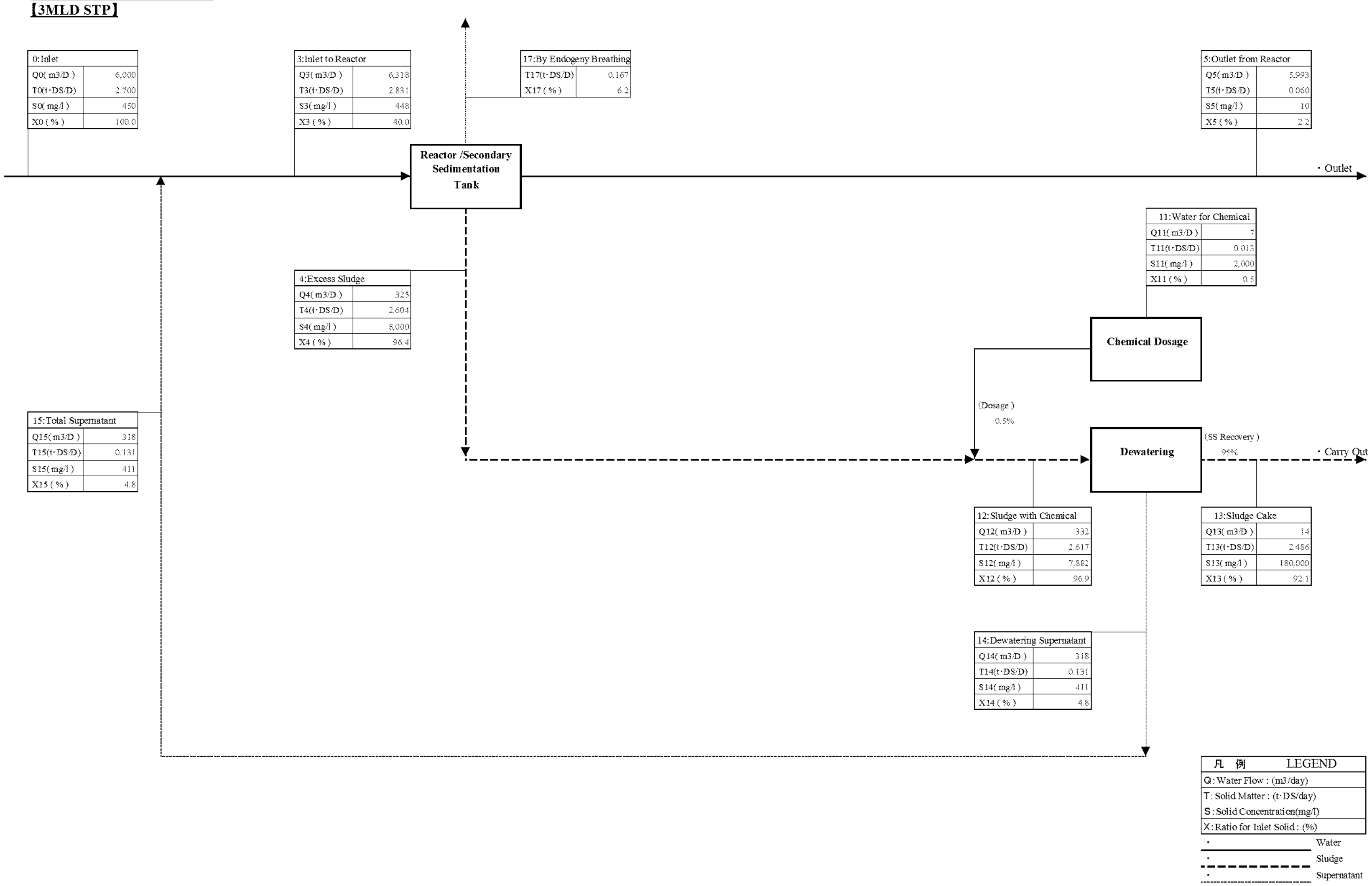
Material Balance Sheet
【3MLD STP】



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Design Condition

Item	7MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	11,000	458	0.127
Max Dayly	11,000	458	0.127
Max Hourly Peak factor 2.25	24,750	1031	0.286

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	7,000	292	0.081
Max Dayly	7,000	292	0.081
Max Hourly Peak factor 2.25	15,750	656	0.182

1. Inlet Chamber

Item	7MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly = 24,750 m3/d
	= 0.286 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 = 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.286 × 1
	= 11.01 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/23

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2. Coarse Screen Channel

	Item	7MLD STP-TSPS
[1]	Geometry	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Width	0.400 m
	Height	0.600 m
	Floor Level	+ 5.000 m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.286 ／ 0.400 ／ 0.500 ／ 2
	whe Design Flow for the year 2049	= 0.715 < 1.000 m/sec OK
	Velocity	0.182 ／ 0.400 ／ 0.500 ／ 1
	whe Design Flow for the year 2034	= 0.910 < 1.000 m/sec OK
(2)	Screen Channel	
	Number	2.0 Main + 1.0 Bypass
	Width	0.800 m
	Side Water Depth	0.600 m
	Velocity	0.286 ／ 0.800 ／ 0.600 ／ 2
	whe Design Flow for the year 2049	= 0.298 ≒ 0.450 m/sec OK
	Velocity	0.182 ／ 0.800 ／ 0.600 ／ 1
	whe Design Flow for the year 2034	= 0.379 < 0.450 m/sec OK
(3)	Channel Dimensions	Width 0.8 m × Length 6.0 m × SWD 0.6 m
[3]	Equipment	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Dimension	Width 0.4 m × Height 0.60 m
	Design Water Level	m
(2)	Coarse Screens (Main Channel)	
	Number	2 W + 0 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	0.8 m
	Width of side plate	50 mm
	Side Water Depth	0.6 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.286 ／ 0.700 ／ 0.550 ／ 2 × (20 + 9) / 20
		= 0.539 < 0.800 m/sec OK
	Velocity through screen	0.182 ／ 0.700 ／ 0.550 ／ 1
	whe Design Flow for the year 2034	× (20 + 9) / 20
		= 0.685 < 0.800 m/sec OK
(3)	Coarse Screens (Bypass Channel)	
	Number	0 W + 1 S
	Open Space	50 mm
	Bar Thickness	9 mm
	Channel Width	0.8 m
	Side Water Depth	0.6 m
	Velocity through screen	0.286 ／ 0.800 ／ 0.600 ／ 2
	whe Design Flow for the year 2049	× (50 + 9) / 50
		= 0.352 < 0.800 m/sec OK
	Velocity through screen	0.182 ／ 0.800 ／ 0.600 ／ 1
	whe Design Flow for the year 2034	× (50 + 9) / 50
		= 0.447 < 0.800 m/sec OK

Coarse Screen 2/23

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3. Raw Sewage Sump

Item	7MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	9.50 m
Pump Operating Depth	1.000 m
Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.286 ／60
whe Design Flow for the year 2049	＝ 4.13 ＞ 3.75 min (=minimum time of one pump cycle ˙ OK
Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.182 ／60
whe Design Flow for the year 2034	＝ 6.49 ＞ 3.75 min (=minimum time of one pump cycle ˙ OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	200 mm
Discharge Flow : 40% Q* 2	0.182 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 262 ⇒ 270 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	150 mm
Discharge Flow : 20% Q* 1	0.182 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 131 ⇒ 135 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/23

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Item	7MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	7,000	291.67	0.081
Max Daily	7,000	291.67	0.081
Max Hourly Peak factor 2.25	15,750	656.25	0.182

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 15,750 m3/day
= 0.182 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.500 m

(3) Width of Basin — 1.700 m

(4) Length of Basin — 2.000 m

(5) Volume required of Basin — 1.500 × 1.700 × 2.000 = 1.3 m3

(6) Retention Time — 1.500 × 1.700 × 2.000 ／ 0.182 × 1
= 28.02 sec

(7) Basin Dimensions — Width 1.700 m × Length 2.000 m
× Depth 1.500 m

STP basic &Stilling Chamber4/23

3. Fine Screen Channel	
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 15,750 m3/d
	= 0.182 m3/sec
[2] Geometory	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.300 m
Height	0.450 m
Floor Level	+ 2.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.300 m
Velocity	0.182 ／ 0.300 ／ 0.300 ／ 2
	= 1.011 ≒ 1.000 m/sec
(2) Screen Channel	
Number	2 Main + 1 Bypass
Width	0.600 m
Side Water Depth	0.400 m
Velocity	0.182 ／ 0.600 ／ 0.400 ／ 2
	= 0.379 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 0.6 m × Length 6.0 m
	× SWD 0.4 m
[3] Equipment	
(1) Inlet Gate	
Number	2 W + 1 S
Dimension	Width 0.3 m × Height 0.45 m
Design Water Level	2.00 m
(2) Fine Screens (Main Channel)	
Number	2 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	0.6 m
Width of side plate	50 mm
Side Water Depth	0.4 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.182 ／ 0.500 ／ 0.350 ／ 2
	×(6 + 2)/ 6
	= 0.693 ＜ 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.6 m
Side Water Depth	0.4 m
Velocity through screen	0.182 ／ 0.600 ／ 0.400 ／ 2
	×(20 + 9)/ 20
	= 0.550 ＜ 0.800 m/sec

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4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Peak flow = 15,750 m^3/day
	= 0.182 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.182 ／ 0.0111 = 16.40 m^2
(2) Number of Basins	1 S + 1 W
(3) Surface Area required/Basin	16.4 ／ 1 = 16.40 m^2
(4) Length of Basin	16.40 ^0.5 = 4.0 m → 4.5 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.182 × 60 sec ／ 1 = 10.9 m^3
(7) Depth required	10.9 ／ 4.5 ／ 4.5 = 0.539 m
(8) Basin Dimensions	Width 4.5 m × Length 4.5 m
	× Depth 0.5 m (Freeboard 0.3m)
(9) Retention Time	4.5 × 4.5 × 0.5 ／ 0.182 × 1
	= 60.00 sec
(10) Surface Overflow Rate at Peak Flow	15,750 ／ 4.5 ／ 4.5 ／ 1
	= 777.777778 ＜ 960 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 182.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
	Ha= 0.317 m
(4) Crest Level	+ m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 0.317 m
(6) Channel bottom level	+ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.173 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.600 m
(3) Stroke	0.450 m
(4) Overflow Height	0.400 m
(5) Overflow Height (actual)	(0.182 ／ 1.840 ／ 0.600 ／ 2) $^{2/3}$
	= 0.189 ＜ 0.400 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	7,000	m^3/day (summer)	
	Q'=	7,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45.0	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* =	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃= 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃= 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	2188.927	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	2884.700	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g･d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1265.214	kg VSS/d	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ +QYn(Nox)/[2+bAOB(SRT)]
			1136.066		$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			102.246		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			26.903		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	4,808	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS} \cdot Va$	$X_{VSS} \cdot Va$=	10,945	kg VSS	$=Px,_{VSS} \cdot SRT$
	$X_{TSS} \cdot Va$	$X_{TSS} \cdot Va$=	14,423	kg TSS	$=Px,_{TSS} \cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3･d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	4,039	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g･d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g･d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g･d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g･d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = Q・(SRT)/V・$Y_H(S_0$-S)/[1+b_H(SRT)]
= 1,181.47 mg/l

(2) IR ratio
IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= (IR+R)・Q・Ne
= 268,174.27 kg/d

(4) The anoxic tank volume
Vnor= 481 m3 = Va× 10%
Vnor= 1,458 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb
SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.110 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 364,695.16 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 268,174 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/l

Influent Alk 380.00 mg/l
Alk used 338.44 mg/l =7.14×Nox
Alk producec 136.77 mg/l =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/l

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 2188.927 kg /d
Rwmoval Phosphorus 21.88926619 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Alumnum Sulfate 300.84 kg/d
(6) Required Alumnum Sulfate solutic 10% 2.87 m3/d
119.38 L/H
(7) Additional sludge 121.96 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins $V_A = Q'*\theta a/24$

$= 5{,}250$ m^3

(2) Total volume of Anoxic Basins $V_{DN} = Q'*\theta_{DN}/24$

$= 1{,}458$ m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	440	1.50	1.50	0.30
Anoxic	V_{DN}	1,458	5.00	5.00	1.00
Aerobic	V_A	5,250	18.00	18.00	3.60
Total	V	7,148	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	84.0	5.5	2

Cross Section 8.0*5.5 = 44.0 m^2/Basin

Hantzsch Subtraction = 1.0 m^2/Basin

after Subtraction 44.0-1.0 = 43.0 m^2/Basin

Total Volume 43.0*84.0 = 3,612 m^2/Basin 7,224 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**5.1**	**17.0**	**61.0**	**83.1**
Volume required per Basin	m^3	220	729	2,625	3,574
Total Volume required	m^3	440	1,458	5,250	7,148
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	6.0	17.0	61.0	84.0
Actual Volume per Basin	m^3	258	731	2,623	3,612
Actual Total Volume	m^3	516	1,462	5,246	7,224
Actual Ratio of Volume		0.35	1.00	3.59	
Actual Retention Time	hour	1.77	5.01	17.99	24.77

[7] Equipment

(1) Ras Pumps

Ras Ratio 60%

Required Capacity 7,000 m3/day× 60% ／24 ／ 2

= 88 m3/Hr ⇒ 90 m3/Hr

Number 2 Work

2 Stanby

(2) Circulation Pumps

Ras Ratio 366%

Required Capacity 7,000 m3/day× 366% ／24 ／ 4

= 267 m3/Hr ⇒ 270 m3/Hr

Number 4 Work

2 Stanby

(3) SAS Pumps

Excess Sludge 380 m3/day

Sludge withdraw 12 Times/day

Running Time 0.5 Hr/Time

Required Capacity 380 m3/day ／ 12 ／ 0.50 ／ 2

= 31.64 m3/Hr ⇒ 35 m3/Hr

Number 2 Work

2 Stanby

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(4)	Alum Solution Tank											
	Number	2	W	+	0	S						
	Alum concentration as crystal	10	%									
	Gravity of dissolved dechlorine	1.05										
	Required solution volume	300.84	kg / d	×	100	/	10	/	1.05	/	1000	
		＝	2.87	m3/d								
	Volume of Tank	2.6		m3/tank								
	Total Volume of Tanks	5.2		m3	(Duration=	1.81	day)					
(5)	Mixer for Alum Solution Tank											
	Number	2	W	+	0	S						
(6)	Alum Dosing Pump											
	Number	2	W	+	1	S						
	Capacity	2.87	m3/d	/	24	×	1000	/	2	×	2	
		119.38	l/h/unit	⇒	120	l/h/unit						

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6. Air Requirement at Average Flow	
〔1〕Design Condition	
(1) AOR	AOR = 3,029 kg/day
	= 126.2 kg/h
Qin :Design Average Flow m^3/d	7,000
Inlet bCOD :S_0	578 mg/l
S=	S= 0.451 mg/l
Nox=	Nox 47.400 mg/l
$P_{X,bio}$=	$P_{X,b}$ 1,238.3 kg VSS/d does not include nitrifying bacteria
R_0=	$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$
R_0=	R_0= 3,029 kg O2/d
	k= 2.86
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃ 9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature 9.09 mg/L at 20 ℃
	20-T : 0.0 1.024^{20-T} : 1.0000
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth $1+0.40D_j/Pa$ 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at s 10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : $\exp[-gM(z_b-z_a)/R^*T]$ 0.900
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t = 293.15 Kelvin
	α : relative Transfer Rate to clean Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \frac{32,858}{4.2591} =$ 7,714.69 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas	= 3,857 kg/day
(5) SOTE for the above Effective Aeration Depth	28.0 %
(6) Fraction of O2 in Air	23.18 %
(7) Specific Gravity of Air at Standard Condition	1.293
(8) Safety Factor	15%
(9) Air required at Field Conditions per Basins	= 56,731 m^3/day = 2,363.8 m^3/hr
[2] Equipment	

Air Requirement at Average Flow12/23

(1) Air Blower						
Number	4	W	+	2	S	
Required Capacity	2363.8	m^3/Hr・Basin	／	2	unit/Basin	
	＝ 1181.9	m^3/h	⇒	1200	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	22.704	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	32.101	kW				
Rated Output of Motor	35.311	kW	⇒	37	kW	

7. Final Clarifire	
〔1〕 Design Condition	
(1) Design Wastewater Flow	Q= 7,000 m^3/day
(2) Water Temperature	T= 20.0 ℃
(3) MLSS	Xef= 3,000 mg/*l*
(4) SVI	SVI= 300
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77) = 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770 = 20.7 m/day
(6) Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0) = 13.8 $m^3/m^2 \cdot day$ → 12.0 $m^3/m^2 \cdot day$
[2] Geometory	
(1) Surface Area required	A= 7,000/12.0= = 583 m^2
(2) Demensions	Diameter **19.5** Depth **3.5** Basin **2**
(3) Actual Surface Area	S= 19.5^2 * 3.14 /4 * 2.0 = 597 m^2
(4) Surface Overflow Rate	S= 7,000/597 = 11.7 $m^3/m^2 \cdot day$

A-3 Process Cal_ EA&al 7MLD Doddabettahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

8.	**Chlorination**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 7,000 m^3/day 291.67 m^3/h
		Peak Flow 15,750 m^3/day 656.25 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 70.0 kg/d
		＝ 2.92 kg/h
[2]	**Chlorination Contact Tank**	
(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 145.8 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	2.00 m
(4)	Length of lane	13.00 m
(5)	Side Water Depth	2.00 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	6.80 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 291.67 ／ 3600 ／ 2.00 ／ 2.00
		＝ 0.020 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 2.0 m × 13.0 m × 2.0 m
		× 3 × 1
		＝ 156 m^3 > 145.8 m^3
[3]	**Equipment**	
(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 70 kg/day
	Maximum Dosage Rate -1	q3 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 158 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 1,050 kg
	Unit Number	EN1 EC1 / Cc = 1.1 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vr1 #### @ 20^{O}C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = 6.56 kg/h
	Operation Numbers	EN2 DC1 / Vr1 = 0.8sets
	Number	2 W + 2 S
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
		157.5 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.00 kg/hr 6.6 kg/hr

Chlorination Tank (gas) 15/23

A-3 Process Cal_ EA&al 7MLD Doddabettahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

(4)	Chlorine Booster Pump	
	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 6.6 kg/hr
		therefore 60 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 7,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 18.4 kg/d
		＝ 0.77 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 48.6 m^3
(2)	Width of lane	6.80 m
(3)	Length of lane	4.00 m
(4)	Side Water Depth	2.00 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 6.8 m × 4.0 m × 2.0 m
		＝ 54 m^3 > 48.6 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	1 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	18.38 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.17 m3/d
	Volume of Tank	0.200 m3/tank (= 0.5 mW× 0.5 mL× 0.8 mH)
	Total Volume of Tanks	0.200 m3 (Duration= 1.20 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	2 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	1 W + 1 S
	Capacity	0.38 m3/d / 24 × 1000 / 1
		15.66 l/h/unit ⇒ 16 l/h/unit

Chlorination Tank (gas) 16/23

A-3 Process Cal_ EA&al 7MLD Doddabettahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Generated Sludge	3,038 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(4)	Volume of Thickend Sludge	379.7 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	12 hours/day (6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{379.7}{12 \times 2} \times \frac{7}{6} = 18.5$$

$\rightarrow$ 19 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 ＋ Injection Rate)

＝ 3,038 × (1 ＋ 0.0050)

＝ 3,053 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 3.053 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

＝ 19.79 t/day

apparent specific gravity 1.00

19.79 ／ 1.0 ＝ 19.8 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(2)	Required Polyelectrolyte	15.19 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	7.59 m3/day

Centrifuge 19/23

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STP Process Calculation_Supporting Report 12.2.3

11.	**Centrifuge Feed Sump**	
[1]	**Design Condition**	
(1)	Generated Thickend Sludge	3,038 kg/day
(2)	Solids Consistency	0.80 %
(3)	Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
		$= 3{,}038 \times \frac{100}{0.80} \times 10^{-3}$
		$= 380\ m^3/day$
		$= 15.82\ m^3/h$
(4)	Sludge feed flow rate	19 m3/h × 2 = 38 m3/h
(5)	Centrifuge Operation Time	12 hours/day (6 days per week)
[2]	**Geometry**	
(1)	Basin Dimensions	Width 6.0 m × Length 6.0 m
		× Depth 3.5 m × 2
		$= 252.0\ m^3$
[3]	**Equipment**	
(1)	Mixers for Centrifuge Feed Sumps	
	Required Volume	$252.0\ m^3$
	Number	1 W + 1 S

Centrifuge Feed Sump 21/23

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[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	19 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	19 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	7.59 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	7.59 m3/day × 7 ／ 6 ／ 12 ／ 2
		＝ 0.37 m^3/Hr
	Specification Capacity	0.37 m^3/Hr × 1.5
		＝ 0.554 m^3/Hr ⇒ 0.60 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	15.19 kg/day × 7 ／ 6 ／ 12
		＝ 1.48 kg/hr
		＝ 4.43 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	9 kg/h
	Tanks Dimensions	Width 1.0 m × Length 1.5 m × Depth 1.5 m × 2
		＝ 4.5 m^3
	Retention Time of Tank	2.25 m^3 /tank ／ 0.37 m^3/Hr ／ 2
		＝ 3.047 Hr > 3 Hr
	Number	2 W + 0 S

Centrifuge 20/23

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

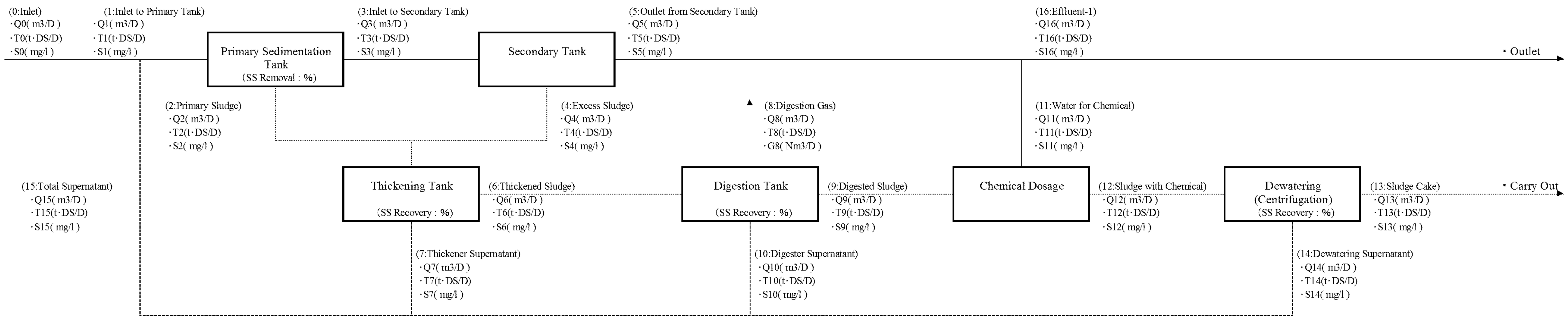
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	7,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	7,000	7,371	0	7,371	380	6,991	380	0	0	380	0	8	387	16	371	371	371			6,991	0
T(t･DS/day)	3.150	3.303	0.000	3.303	3.038	0.070	3.038	0.000	0.000	3.038	0.000	0.015	3.053	2.900	0.153	0.153	0.153			0.070	0.195
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.9	0.0	104.9	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



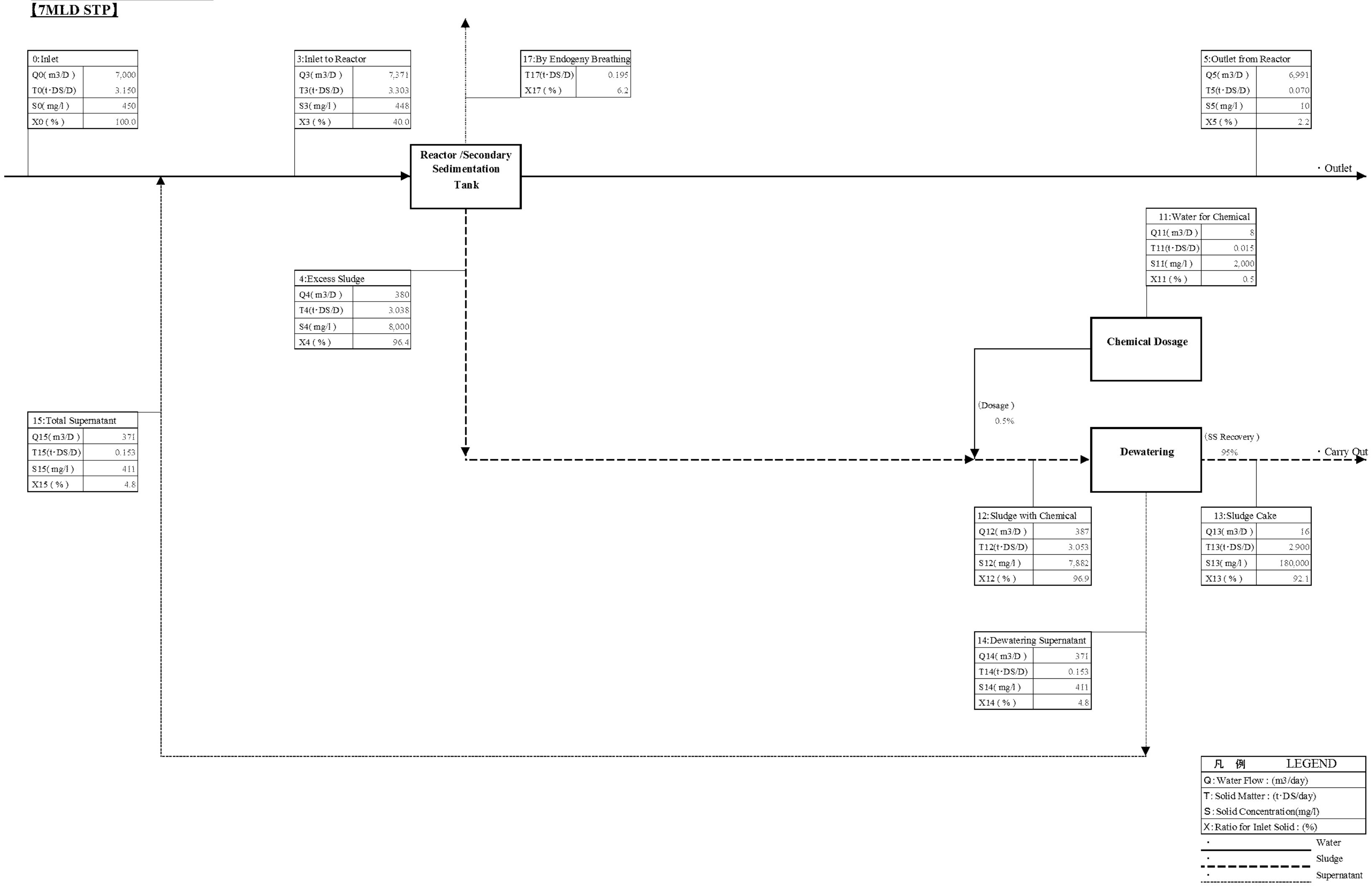
Calculation Formula

･Q0=Input Data	･Q3=Q1-Q2	･Q6=T6*100/(100-W3)	･Q9=Q6	･Q12=Q9+Q11	･Q15=Q7+Q10+Q14	･Q5-1=Q5-Q11
･T0=Q0*S0*10^(-6)	･T3=T0*(100-A2)/100	･T6=(T2+T4)*A3/100	･T9=(T6-T8)*A4/100	･T12=T9+T11	･T15=T7+T10+T14	･T5-1=T5-T11
･S0=Input Data	･S3=T3*10^6/Q3	･S6=10^6*(100-W3)/100	･S9=T9*10^6/Q9	･S12=T12*10^6/Q12	･S15=T15*10^6/Q15	･S5-1=S5
･Q1=Q0+Q15	･Q4=T4*100/(100-W2)	･Q7=(Q2+Q4)-Q6	･Q10=Q6-Q8-Q9	･Q13=T13*100/(100-W5)		
･T1=T0+T15	･T4=余剰汚泥発生式による	･T7=(T2+T4)-T6	･T10=T6-T8-T9	･T13=T12*A5/100		
･S1=T1*10^6/Q1	･S4=10^6*(100-W2)/100	･S7=T7*10^6/Q7	･S10=T10*10^6/Q10	･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1)	･Q5=Q3-Q4*(T3-T5)/T4	･Q8=0	･Q11=T10*A9/A10	･Q14=Q12-Q13		
･T2=T1-T3	･T5=Q5*ST/10^6	･T8=T6*A6*A7/10^4	･T11=Q11*S11/10^6	･T14=T12-T13		
･S2=10^6*(100-W1)/100	･S5=St	#REF!	･S11=10^4*A10	･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【7MLD STP】



A-4 Process Cal_ EA&al 17MLD Bilishivalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	17MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate m3/d	Flow Rate m3/h	Flow Rate m3/s
Average Daily	27,000	1125	0.313
Max Dayly	27,000	1125	0.313
Max Hourly Peak factor 2.25	60,750	2531	0.703

Design Flow for the year 2034:

	Flow Rate m3/d	Flow Rate m3/h	Flow Rate m3/s
Average Daily	17,000	708	0.197
Max Dayly	17,000	708	0.197
Max Hourly Peak factor 2.25	38,250	1594	0.443

1. Inlet Chamber

Item	17MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly ＝ 60,750 m3/d
	＝ 0.703 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.900 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.900 × 2.500 ＝ 0.7 m3
(6) Retention Time	0.600 × 2.900 × 2.500 ／ 0.703 × 1
	＝ 6.19 sec
(7) Basin Demensions	Width 2.900 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	17MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.600 m
Velocity whe Design Flow for the year 2049	0.703 / 0.600 / 0.600 / 2 = 0.976 < 1.000 m/sec OK
Velocity whe Design Flow for the year 2034	0.443 / 0.600 / 0.600 / 2 = 0.615 < 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	1.200 m
Side Water Depth	0.700 m
Velocity whe Design Flow for the year 2049	0.703 / 1.200 / 0.700 / 2 = 0.418 ≒ 0.450 m/sec OK
Velocity whe Design Flow for the year 2034	0.443 / 1.200 / 0.700 / 2 = 0.264 < 0.450 m/sec OK
(3) Channel Dimensions	Width 1.2 m × Length 6.0 m × SWD 0.7 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	8.0 m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Width of side plate	50 mm
Side Water Depth	0.7 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.703 / 1.100 / 0.650 / 2 × (20 + 9) / 20 = 0.713 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.443 / 1.100 / 0.650 / 2 × (20 + 9) / 20 = 0.449 < 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Side Water Depth	0.7 m
Velocity through screen whe Design Flow for the year 2049	0.703 / 1.200 / 0.700 / 2 × (50 + 9) / 50 = 0.494 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.443 / 1.200 / 0.700 / 2 × (50 + 9) / 50 = 0.311 < 0.800 m/sec OK

Coarse Screen 2/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item	17MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	12.00 m
Pump Operating Depth	1.500 m
Retention Time whe Design Flow for the year 2049	(12.00 ^{2}× π／4 × 1.500)／ 0.703 ／60 ＝ 4.02 ＞ 3.75 min (=minimum time of one pump cycle OK
Retention Time whe Design Flow for the year 2034	(12.00 ^{2}× π／4 × 1.500)／ 0.443 ／60 ＝ 6.38 ＞ 3.75 min (=minimum time of one pump cycle OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.500 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	300 mm
Discharge Flow : 40% Q* 2 whe Design Flow for the year 2034	0.443 × 3600 × 40.0% Q ＝ 638 ⇒ 640 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	200 mm
Discharge Flow : 20% Q* 1 whe Design Flow for the year 2034	0.443 × 3600 × 20.0% Q ＝ 319 ⇒ 320 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	17MLD STP
1. STP Design Condition	
(1) Design Flow Rate	

	m3/d	m3/h	m3/s
Average Daily	17,000	708.33	0.197
Max Daily	17,000	708.33	0.197
Max Hourly Peak factor 2.25	38,250	1593.75	0.443

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45	25	0	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 38,250 m3/day
= 0.443 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 2.000 m

(3) Width of Basin — 2.900 m

(4) Length of Basin — 2.500 m

(5) Volume required of Basin — 2.000 × 2.900 × 2.500 = 2.3 m3

(6) Retention Time — 2.000 × 2.900 × 2.500 ∕ 0.443 × 1
= 32.73 sec

(7) Basin Dimensions — Width 2.900 m × Length 2.500 m
× Depth 2.000 m

STP basic &Stilling Chamber4/23

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3. Fine Screen Channel	
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 38,250 m3/d
	= 0.443 m3/sec
[2] Geometory	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.500 m
Height	0.750 m
Floor Level	+ 2.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.443 ／ 0.500 ／ 0.500 ／ 2
	= 0.886 ≒ 1.000 m/sec
(2) Screen Channel	
Number	2 Main + 1 Bypass
Width	1.000 m
Side Water Depth	0.500 m
Velocity	0.443 ／ 1.000 ／ 0.500 ／ 2
	= 0.443 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 1.0 m × Length 6.0 m
	× SWD 0.5 m
[3] Equipment	
(1) Inlet Gate	
Number	2 W + 1 S
Dimension	Width 0.5 m × Height 0.75 m
Design Water Level	2.00 m
(2) Fine Screens (Main Channel)	
Number	2 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	1.0 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.443 ／ 0.900 ／ 0.450 ／ 2
	× (6 + 2) / 6
	= 0.729 ＜ 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Side Water Depth	0.5 m
Velocity through screen	0.443 ／ 1.000 ／ 0.500 ／ 2
	× (20 + 9) / 20
	= 0.642 ＜ 0.800 m/sec

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4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Peak flow = 38,250 m^3/day
		= 0.443 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec
[2]	**Grit Chamber**	**Square Grit Chamber**
(1)	Surface Area required	0.443 ／ 0.0111 = 39.91 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	39.9 ／ 1 = 39.91 m^2
(4)	Length of Basin	39.91 ^0.5 = 6.317 m → 6.5 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.443 × 60 sec ／ 1 = 26.6 m^3
(7)	Depth required	26.6 ／ 6.5 ／ 6.5 = 0.629 m
(8)	Basin Dimensions	Width 6.5 m × Length 6.5 m
		× Depth 0.6 m (Freeboard 0.3m)
(9)	Retention Time	6.5 × 6.5 × 0.6 ／ 0.443 × 1
		= 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	38,250 ／ 6.5 ／ 6.5 ／ 1
		= 905.325444 ＜ 960 m^3/m^2/day
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 443.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
		Ha= 0.574 m
(4)	Crest Level	+ m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 0.574 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.422 m/sec
(10)	Total Length of channel	10.000 m
[4]	**Inlet Weir Gate**	
(1)	Number	2 Units
(2)	Weir Width	0.800 m
(3)	Stroke	0.550 m
(4)	Overflow Height	0.500 m
(5)	Overflow Height (actual)	(0.443 ／ 1.840 ／ 0.800 ／ 2) $^{2/3}$
		= 0.283 ＜ 0.500 m

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5. Reactor

〔1〕 **Design Condition**

(1) Design Wastewater Flow		Q=	17,000	m^3/day (summer)	
		Q'=	17,000	m^3/day(Winter)	
(2) Design Sewage Quality					
Inlet BOD			350	mg/*l*	
Outlet BOD			10.0	mg/*l*	
Inlet S-BOD			235	mg/*l*	assumed as 67% of BOD
Inlet COD			800	mg/*l*	
Inlet bCOD	:S_0		578	mg/*l*	
Inlet nbCOD			223	mg/*l*	
bCOD/BOD			1.65		
Inlet S-COD	:sCOD		271	mg/*l*	assumed as 33% of BOD
Inlet rbCOD			231	mg/*l*	bCOD*40%
Inlet sbCOD			347	mg/*l*	bCOD*60%
Outlet S-COD	:nbsCODe		40	mg/*l*	
Inlet nbpCOD	:nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS			450	mg/*l*	
Inlet VSS			383	mg/*l*	assumed as 85% of TSS
	:VSS_{COD}		1.38	gCOD/gVSS	=(TCOD-sCOD)/VSS
	:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
	:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N			70	mg/*l*	
Inlet TKN			70	mg/*l*	
Inlet NH_4-N			45.0	mg/*l*	
Inlet T-P			7	mg/*l*	
Inlet D-P			5	mg/*l*	
Inlet Alkalinity as CaCO3			380	mg/*l*	
Outlet Kjeldahl N			1.0	mg/*l*	
Outlet NH4-N			1.0	mg/*l*	
Outlet NO3-N			9.0	mg/*l*	
Outlet T-P			2	mg/*l*	
Outlet D-P			1	mg/*l*	
(3) Water Temperature		T=	20.0	℃	
(4) Safety Factor for Nitrogen		SF=	1.5		
(5) Return Sludge Concentration		*Rs* =	8,000	mg/*l*	
(6) MLSS MLVSS		X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor			2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃ = 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃ = 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2) Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$	
	⇒	5.0000	day		
(3) Biomass production					
$Px,_{VSS}$	$Px,_{VSS}$=	5315.965	kg /d	=Px,bio+Q(nbVSS)	
$Px,_{TSS}$	$Px,_{TSS}$=	7301.896	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al	
S	S=	0.4507	mg/l	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$	
b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$	b at20℃＝ 0.120
Y_H	Y_H=	0.4500	gVSS/g bCOD		
$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$	μ max at20℃＝ 6.000
Yn	Yn=	0.150	gVSS/g Nox		
NOx	NOx=	47.400	mg/l		
$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	3072.664	kg VSS/d	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ +QYn(Nox)/[2+bAOB(SRT)]	
		2759.017		$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$	
		248.312		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$	
		65.335		$=QYn(Nox)/[1+b_{AOB}(SRT)]$	
NOx	NOx=	47.311	mg/l	$=TKN-Ne-0.12P_{X,bio}/Q$	
(4) Required Aeration Tank Volume					
Va=	Va=	12,170	m3		
τ =	τ =	17.18	hr	=Va/Q×24	
	⇒	18.00	hr		
$X_{VSS} \cdot Va$	$X_{VSS} \cdot Va$=	26,580	kg VSS	$=Px,_{VSS} \cdot SRT$	
$X_{TSS} \cdot Va$	$X_{TSS} \cdot Va$=	36,509	kg TSS	$=Px,_{TSS} \cdot SRT$	
F/M	F/M=	0.224	kgBOD/kgMLVSS		
FractionVSS=	FractionVSS	0.728			
MLVSS=	MLVSS=	2184	mg/L		
(5) BODloading	BODloading	0.489	kg/m3・d		
(6) Observed Yield					
$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.228	gTSS/gBOD		
$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD		
bCODremoved=	bCODremov	9,810	kg/d		
(7) effluent NO_2-N	NO_2-N=	0.2315	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$	
b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$	b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$	μ max at20℃＝ 1.000
μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$	
	S_0=	2.000	mg/l		
	$K_{O2,NOB}$=	0.900	mg/l		
(8) effluent NH_4-N	NH_4-N=	0.5286	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$	
b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$	b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$	μ max at20℃＝ 0.900
μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$	
	S_0=	2.000	mg/l		
	$K_{O2,NOB}$=	0.500	mg/l		
(9) Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L		
	3,000/(8,000-3,000)＝	0.60			
	Rr ＝	0.60			

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — X_b = Q・(SRT)/V・Y_H(S_0-S)/[1+b_H(SRT)]
= 1,133.55 mg/*l*

(2) IR ratio — IR = NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 651,280.37 kg/d

(4) The anoxic tank volume — Vnor= 1,217 m3 = Va× 10%
Vnor= 3,542 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.48 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients	
	b0	b1
10	0.186	0.078
20	0.213	0.118
30	0.235	0.141
40	0.242	0.152
50	0.270	0.162

(8) SDNRb — SDNRb= 0.302 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.113 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.217 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.302 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 872,270.70 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 651,280 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/*l*

Influent Alk	380.00	mg/*l*	
Alk used	338.44	mg/*l*	=7.14×Nox
Alk produce(	136.77	mg/*l*	=3.57×(NOx-NOxe)
Alk to maint:	70.00	mg/*l*	

[4] Design of Phosphourus Removal Process

(1)	Removal T-P		3.13	mg/l	
	P in waste sludge	px=	1.00%		
	Generated waste sludge	$Px_{,VSS}$=	5315.965	kg /d	
	Rwmoval Phosphorus		53.15964645	kg /d	
(2)	Effluent T-P without Al		3.87	mg/l	
(3)	Required Al toinitial soluble phosphourus ratio		1.00	mol/mol	
(4)	Required Al dosing rate		3.48	mg/l	as Al
			42.98	mg/l	as crystal, Al2(SO4)3・18H2O
(5)	Required Alumnum Sulfate		730.62	kg/d	
(6)	Required Alumnum Sulfate solutic 10%		6.96	m3/d	
			289.93	L/H	
(7)	Additional sludge		296.20	kg/d	

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[5] Reactor

(1) Total volume of Aeration Basins

V_A = Q'*θa/24
= 12,750 m^3

(2) Total volume of Anoxic Basins

V_{DN} = Q'*$θ_{DN}$/24
= 3,542 m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	1,060	1.50	1.50	0.30
Anoxic	V_{DN}	3,542	5.00	5.00	1.00
Aerobic	V_A	12,750	18.00	18.00	3.60
Total	V	17,352	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	204.0	5.5	2

Cross Section	8.0*5.5	=	44.0 m^2/Basin
Hantzsch Subtraction		=	1.0 m^2/Basin
after Subtraction	44.0-1.0	=	43.0 m^2/Basin
Total Volume	43.0*204.0	=	8,772 m^2/Basin 17,544 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**12.3**	**41.2**	**148.3**	**201.8**
Volume required per Basin	m^3	530	1,771	6,375	8,676
Total Volume required	m^3	1,060	3,542	12,750	17,352
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	13.0	42.0	149.0	204.0
Actual Volume per Basin	m^3	559	1,806	6,407	8,772
Actual Total Volume	m^3	1,118	3,612	12,814	17,544
Actual Ratio of Volume		0.31	1.00	3.55	
Actual Retention Time	hour	1.58	5.10	18.09	24.77

[7] Equipment

(1) Ras Pumps

Ras Ratio 60%

Required Capacity 17,000 m3/day× 60% ／24 ／ 2
= 213 m3/Hr ⇒ 220 m3/Hr

Number 2 Work
2 Stanby

(2) Circulation Pumps

Ras Ratio 366%

Required Capacity 17,000 m3/day× 366% ／24 ／ 4
= 648 m3/Hr ⇒ 650 m3/Hr

Number 4 Work
2 Stanby

(3) SAS Pumps

Excess Sludge 1,068 m3/day

Sludge withdraw 12 Times/day

Running Time 0.5 Hr/Time

Required Capacity 1,068 m3/day ／ 12 ／ 0.50 ／ 2
= 88.98 m3/Hr ⇒ 90 m3/Hr

Number 2 Work
2 Stanby

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(4)	Alum Solution Tank												
	Number	2	W	+	0	S							
	Alum concentration as crystal	10	%										
	Gravity of dissolved dechlorine	1.05											
	Required solution volume	730.62	kg / d	×	100	/	10	/	1.05	/	1000		
		＝	6.96	m3/d									
	Volume of Tank	4.1	m3/tank	(=	1.5	mW×	1.5	mL×	1.8	mH)			
	Total Volume of Tanks	8.1	m3	(Duration=	1.16	day)							
(5)	Mixer for Alum Solution Tank												
	Number	2	W	+	0	S							
(6)	Alum Dosing Pump												
	Number	2	W	+	1	S							
	Capacity	6.96	m3/d	/	24	×	1000	/	2	×	2		
		289.93	l/h/unit	⇒	290	l/h/unit							

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6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR		AOR = 7,355 kg/day
			= 306.5 kg/h
	Qin :Design Average Flow	m^3/d	17,000
	Inlet bCOD : S_0		578 mg/l
	S=		S= 0.451 mg/l
	Nox=		Nox 47.400 mg/l
	$P_{X,bio}$=		$P_{X,b}$ 3,007.3 kg VSS/d does not include nitrifying bacteria
	R_0=		$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$
	R_0=		R_0= 7,355 kg O2/d
			k= 2.86
(2)	SOR(Standard Oxygen Transfer Rate at site)		$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F\ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$

C_S	:	Saturated DO at sea level and 20 ℃	
		9.09 mg/L	
C_{SW}	:	Saturated DO at sea level and operating Temperature	
		9.09 mg/L at 20 ℃	
20-T	:	0.0 1.024^{20-T} : 1.0000	
C_A	:	operating DO in Basin	2.0 mg/L
a	:	Correction Factor by the Water Depth	
		$1+0.40D_j/Pa$	1.19357
D_j	:	Tank Liquid Depth 5.00 m	
P_a	:	Standard absolute pressure at s	
			10.332 m
P_b	:	Absolute pressure at Plant Site Elevation	m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R^*T]$	0.900
g	:	Acceleration due to Gravity	9.80665 m/s^2
M	:	Mole of Air	28.97 kg/kg-mole
z_b	:	Plant Site Elevation	900 m
z_a	:	Sea Elevation	0 m
R	:	Universal Gas Constant	8314 Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15 Kelvin
α	:	relative Transfer Rate to clean Wa	0.65
β	:	relative DO Saturation to clean Wa	0.95
F	:	Diffuser Fouling Factor	0.90

$$= \frac{79,798}{4.2591} = 18,735.68 \text{ kg/day}$$

(3)	No. of Basins	2 Basin
(4)	Standard O2 required at Field Conditions per Bas	= 9,368 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	15%
(9)	Air required at Field Conditions per Basins	= 137,776 m^3/day = 5,740.6 m^3/hr

[2] Equipment

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(1)	Air Blower							
	Number		4	W	+	2	S	
	Required Capacity		5740.6	m^3/Hr・Basin	／	2	unit/Basin	
		＝	2870.3	m^3/h	⇒	2900	m^3/h /Unit	
	Pressure		65	kPa				
	Safty Factor		10	%				
	Heat capacity ratio		1.4					
	Atmospheric pressuer at site elevation		91.234	kPa				
	Total inlet pressure		89.234	kPa				
	Volume rate of flow at inlet point		54.869	m3/min				
	Total discharge pressure		156.234	kPa				
	Overall adiabatic effeciency		0.65					
	Inlet air temperature (min.)		15	℃				
	Shaft power		77.578	kW				
	Rated Output of Motor		85.335	kW	⇒	90	kW	

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STP Process Calculation_Supporting Report 12.2.3

7.	**Final Clarifire**			
〔1〕	**Design Condition**			
(1)	Design Wastewater Flow	Q= 17,000 m^3/day		
(2)	Water Temperature	T= 20.0 ℃		
(3)	MLSS	Xef= 3,000 mg/*l*		
(4)	SVI	SVI= 300		
(5)	Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)		
		= 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770		
		= 20.7 m/day		
(6)	Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0)	=	13.8 m^3/m^2·day
			→	12.0 m^3/m^2·day
[2]	**Geometory**			
(1)	Surface Area required	A= 17,000/12.0=	=	1,417 m^2
(2)	Demensions	Diameter / Depth / Basin		
		30.0 / **3.5** / **2**		
(3)	Actual Surface Area	S= 30.0^2 * 3.14 /4 * 2.0	=	1,414 m^2
(4)	Surface Overflow Rate	S= 17,000/1,414	=	12.0 m^3/m^2·day

Final Clarifire14/23

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8. Chlorination

[1] Design Condition

(1) Design Flow Rate	Average Daily Flow	17,000	m^3/day	708.33	m^3/h			
	Peak Flow	38,250	m^3/day	1593.75	m^3/h			
(2) Contact Time	30	min						
(3) Type of Chlorine	Cl_2-GAS							
(4) Design Chlorine Dosage Rate	10	mg/L						
(5) Required Chlorine per day	Average Daily Flow	／	1000	×	Design Chlorine Dosage Rate			
	＝	170.0	kg/d					
	＝	7.08	kg/h					

[2] Chlorination Contact Tank

(1) Volume required	Average Daily Flow	／	1440	×	Contact Time					
	＝	354.2	m^3							
(2) Nos. of lanes	3	lanes								
(3) Width of lane	2.00	m								
(4) Length of lane	30.00	m								
(5) Side Water Depth	2.00	m								
(6) Nos. of Tanks	1	tank								
(7) Total Width of Tank	6.80	m Approx..								
(8) Average Velocity	Decant Flow	／	3600	／	Width	／	Depth			
	＝	708.33	／	3600	／	2.00	／	2.00		
	＝	0.049	m/sec							
(9) Total Volume	Width	×	Length	×	Depth	×	Nos. of lanes	×	Nos. of Tanks	
	＝	2.0	m	×	30.0	m	×	2.0	m	
		×	3	×	1					
	＝	360	m^3	>	354.2	m^3				

[3] Equipment

(1) Chlorine Dosing Condition

Operation Dosage Rate -1	DC1	10 mg/L				

(2) Chlorine Cylinder

Type	-	Cylindrical Convexsd Container			
Cylinder Capacity	Cc	928 kg/cylinder			
Average Dosage Rate -1	q1	Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^{3} =	170	kg/day	
Maximum Dosage Rate -1	q3	Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^{3} =	383	kg/day	
Storage day	T	More than 15 days			
Required Storage Capacity	EC1	D x T = 2,550 kg			
Unit Number	EN1	EC1 / Cc = 2.7 cylinders			
Maximum Operation Numbers					
Cl_2-Gas Volatilize Rate	Vr1	#### @ 20^{O}C Standard temperature			
Maximum Dosing Rate	DC1	10 mg/L, $Q_{T\text{-}D}$ x q3 x 10^{-3} / 24 =	15.94	kg/h	
Operation Numbers	EN2	DC1 / Vr1 = 2.0sets			
Number	2	W	+	2	S

(3) Chlorinator

Type	Solution Feed Vacuum Type				
Number	1	W	+	1	S
Operation Dosage Rate -1	Dq1	Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^{3} =			
		382.5 kg/day			
Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =				
	Minimum		Maximum		
	0.00	kg/hr	16.0	kg/hr	

(4) Chlorine Booster Pump

Chlorination Tank (gas)15/23

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	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 16.0 kg/hr
		therefore 100 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 17,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3\ 5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 44.6 kg/d
		＝ 1.86 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 118.1 m^3
(2)	Width of lane	6.80 m
(3)	Length of lane	9.00 m
(4)	Side Water Depth	2.00 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 6.8 m × 9.0 m × 2.0 m
		＝ 122 m^3 > 118.1 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	2 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	44.63 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.41 m3/d
	Volume of Tank	0.288 m3/tank (= 0.6 mW× 0.6 mL× 0.8 mH)
	Total Volume of Tanks	0.576 m3 (Duration= 1.42 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	2 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	2 W + 1 S
	Capacity	0.91 m3/d / 24 × 1000 / 2
		19.02 l/h/unit ⇒ 20 l/h/unit

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10. Sludge Thikener

[1] Design Condition

(1)	Primary Sludge	0	kg/day	0	m3/day
(2)	Secondary Sludge	8,542	kg/day	1,068	m3/day
(3)	Total Solids	8,542	kg/day	1,068	m3/day
(4)	Operation Time	24	hours/day		
(5)	Thikened Sludge Moisture Content	97.5	%		

[2] Geometory

(1) Type

(2) Number: 2 W + 0 S

(3) Design Solid Loadong: 40 kg / m2/d

(4) Required Surface Area

$$8542 \times \frac{1}{40} = 213.50 \text{ m2}$$

(5) Required diameter

$$\left(\frac{4}{\pi} \times 213.50 \times \frac{1}{2} \right)^{1/2} = 11.66 \text{ m}$$

$$\rightarrow 12.00 \text{ m}$$

(6) Side Water Depth: 4 m

(7) Actual Volume of Tank

$$\frac{\pi}{4} \times 12.00^{2} = 113.10 \text{ m3}$$

(8) Retention Time

$$\frac{113.10}{1068} \times 4 \times 2 \times 24 = 20.34 \text{ Hr}$$

[3] Volume of Thikened Sludge

$$= 308 \text{ m}^3\text{/d}$$

[4] **Quantity of Separation Liquid**

Inlet Sludge Volume − Thikened Sludge Volume

$$= 1067.7 - 307.5 = 760.2 \text{ m}^3\text{/day}$$

Gravity Sludge Thikener17/23

STP Process Calculation_Supporting Report 12.2.3

11.	**Thickened Sludge Sump**								
[1]	**Design Condition**								
(1)	Inlet Solids	8,542	kg/day						
(2)	Inlet Sludge Volume	1,068	m^3/d						
[2]	**Geometory**								
(1)	Sludge withdrawl	12	Times/day						
(2)	Required Sump Volume	89	m^3/d						
(3)	Number	2	Basins						
(4)	Width	3.5	m						
(5)	Length	4.0	m						
(6)	Side Water Depth	3.0	m						
(7)	Actual Sump Volume	3.5	×	4.0	×	3.0	×	2	
		=	84.0	m^3					
[3]	**Equipment**								
(1)	Thickened Sludge Transfer Pumps								
	Transfer Time	6.00	Hr						
	Number	2	W	+	2	S			
	Required Capacity	1068	m^3	／	6.0	／	2		
		＝	89.0	m^3/Hr	⇒	90	m^3/Hr /Unit		

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12. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Generated Sludge	7,688 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(4)	Volume of Thickend Sludge	307.5 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	12 hours/day (6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{307.5}{12 \times 2} \times \frac{7}{6} = 14.9$$

→ 15 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)
= 7,688 × (1 + 0.0050)
= 7,726 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 7.726 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 50.08 t/day

apparent specific gravity 1.00

50.08 ／ 1.0 = 50.1 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(2)	Required Polyelectrolyte	38.44 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	19.22 m3/day

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[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	15 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	15 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	19.22 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	19.22 m3/da; × 7 ／ 6 ／ 12 ／ 2
		＝ 0.93 m^3/Hr
	Specification Capacity	0.93 m^3/Hr × 1.5
		＝ 1.401 m^3/Hr ⇒ 1.40 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	38.44 kg/day × 7 ／ 6 ／ 12
		＝ 3.74 kg/hr
		＝ 11.21 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	22 kg/h
	Tanks Dimensions	Width 1.5 m × Length 2.0 m
		× Depth 2.0 m × 2
		＝ 12 m^3
	Retention Time of Tank	6.00 m^3 /tank ／ 0.93 m^3/Hr ／ 2
		＝ 3.211 Hr > 3 Hr
	Number	2 W + 0 S

Centrifuge 20/23

A-4 Process Cal_ EA&al 17MLD Bilishivalli_Appendix 12.2.3
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11. Centrifuge Feed Sump

[1] Design Condition

(1) Generated Thickend Sludge: 7,688 kg/day

(2) Solids Consistency: 2.50 %

(3) Volume of Thickened Sludge

$$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$$

$$= 7,688 \times \frac{100}{2.50} \times 10^{-3}$$

= 308 m^3/day

= 12.81 m^3/h

(4) Sludge feed flow rate: 15 m3/h × 2 = 30 m3/h

(5) Centrifuge Operation Time: 12 hours/day (6 days per week)

[2] Geometry

(1) Basin Dimensions: Width 6.0 m × Length 6.5 m × Depth 4.0 m × 2

= 312.0 m^3

[3] Equipment

(1) Mixers for Centrifuge Feed Sumps

Required Volume: 312.0 m^3

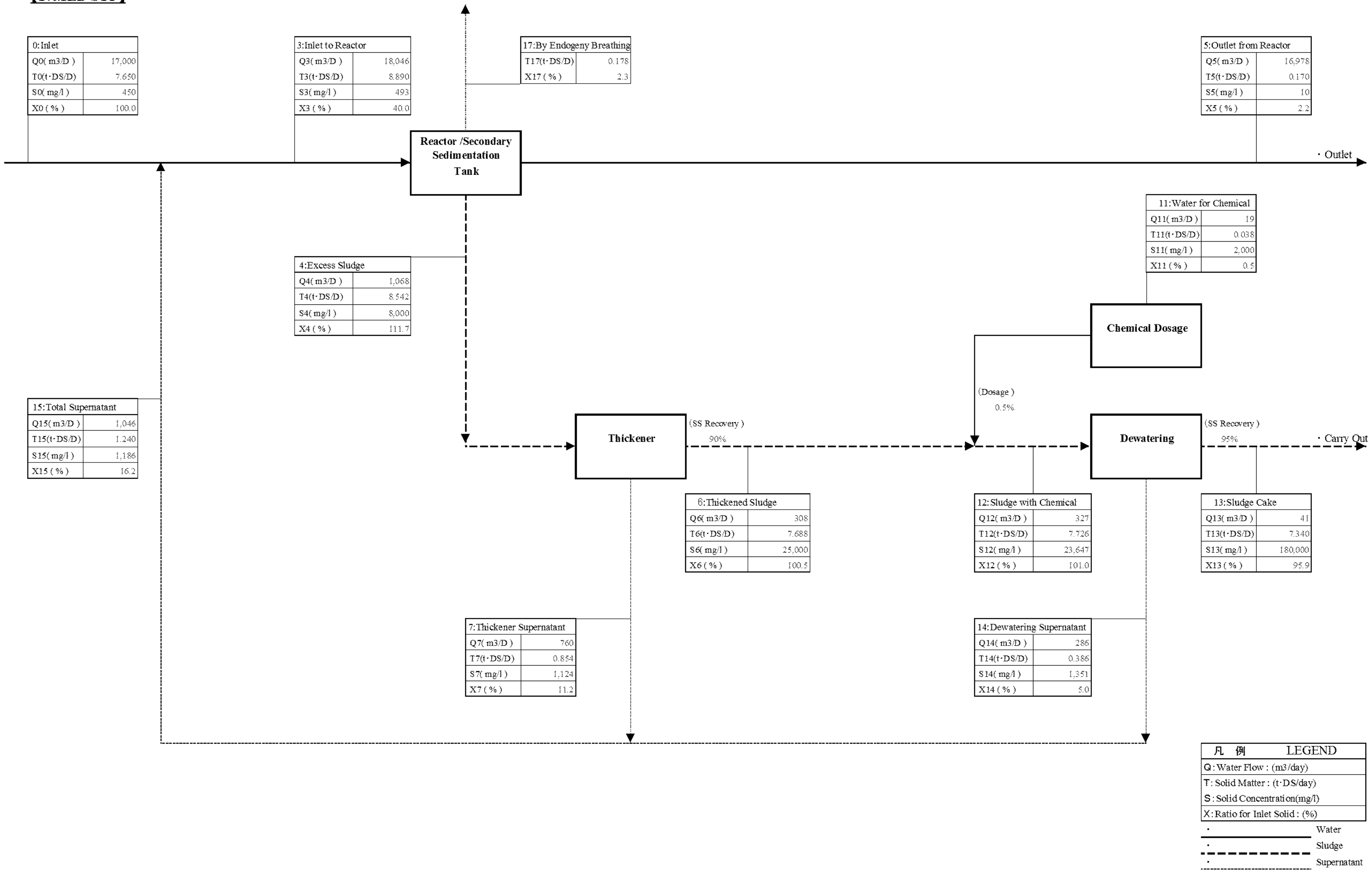
Number: 1 W + 1 S

Centrifuge Feed Sump 21/23

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【17MLD STP】



Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

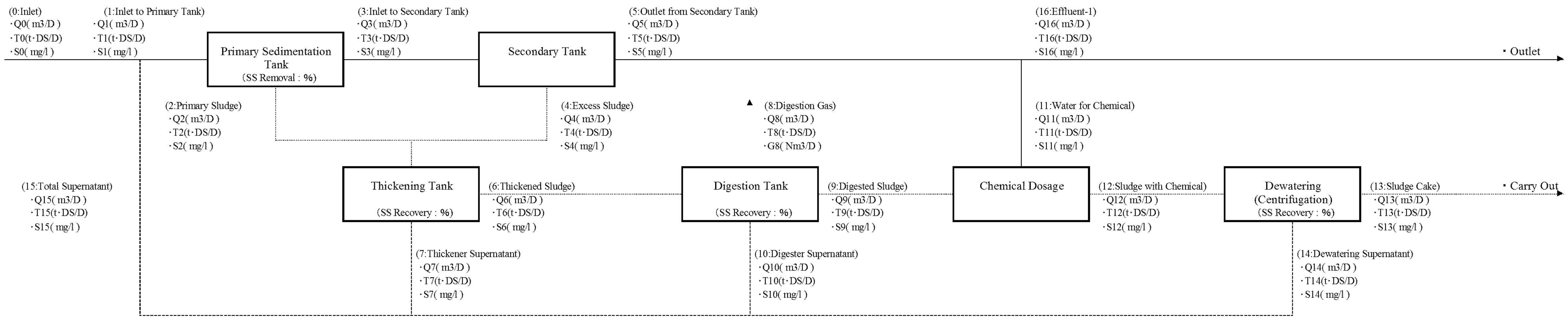
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	17,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	90.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	97.5	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	97.5	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	17,000	18,046	0	18,046	1,068	16,978	308	760	0	308	0	19	327	41	286	1,046	1,046			16,978	0
T(t･DS/day)	7.650	8.890	0.000	8.890	8.542	0.170	7.688	0.854	0.000	7.688	0.000	0.038	7.726	7.340	0.386	1.240	1.240			0.170	0.178
S(mg/l)	450	493	0	493	8,000	10	25,000	1,124	0	25,000	0	2,000	23,647	180,000	1,351	1,186				10	
X(Ti/T0*100)	100	116.2	0.0	116.2	111.7	2.2	100.5	11.2	0.0	100.5	0.0	0.5	101.0	95.9	5.0	16.2				2.2	2.3

Figure -1 Material Balance Model



Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	15MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	24,000	1000	0.278
Max Dayly	24,000	1000	0.278
Max Hourly Peak factor 2.25	54,000	2250	0.625

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	15,000	625	0.174
Max Dayly	15,000	625	0.174
Max Hourly Peak factor 2.25	33,750	1406	0.391

1. Inlet Chamber

Item	15MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly = 54,000 m3/d
	= 0.625 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.900 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.900 × 2.500 = 0.7 m3
(6) Retention Time	0.600 × 2.900 × 2.500 ／ 0.625 × 1
	= 6.96 sec
(7) Basin Demensions	Width 2.900 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	15MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.600 m
Velocity whe Design Flow for the year 2049	0.625 ／ 0.600 ／ 0.600 ／ 2 = 0.868 < 1.000 m/sec OK
Velocity whe Design Flow for the year 2034	0.391 ／ 0.600 ／ 0.600 ／ 2 = 0.543 < 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	1.200 m
Side Water Depth	0.600 m
Velocity whe Design Flow for the year 2049	0.625 ／ 1.200 ／ 0.600 ／ 2 = 0.434 ≒ 0.450 m/sec OK
Velocity whe Design Flow for the year 2034	0.391 ／ 1.200 ／ 0.600 ／ 2 = 0.272 < 0.450 m/sec OK
(3) Channel Dimensions	Width 1.2 m × Length 6.0 m × SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	8.0 m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.625 ／ 1.100 ／ 0.550 ／ 2 ×(20 + 9)/ 20 = 0.749 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.391 ／ 1.100 ／ 0.550 ／ 2 ×(20 + 9)/ 20 = 0.469 < 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Side Water Depth	0.6 m
Velocity through screen whe Design Flow for the year 2049	0.625 ／ 1.200 ／ 0.600 ／ 2 ×(50 + 9)/ 50 = 0.512 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.391 ／ 1.200 ／ 0.600 ／ 2 ×(50 + 9)/ 50 = 0.320 < 0.800 m/sec OK

Coarse Screen 2/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item	15MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	11.00 m
Pump Operating Depth	1.500 m
Retention Time	(11.00 ^{2}× π／4 × 1.500)／ 0.625 ／60
whe Design Flow for the year 2049	＝ 3.80 ＞ 3.75 min (=minimum time of one pump cycle OK
Retention Time	(11.00 ^{2}× π／4 × 1.500)／ 0.391 ／60
whe Design Flow for the year 2034	＝ 6.08 ＞ 3.75 min (=minimum time of one pump cycle OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.500 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	300 mm
Discharge Flow : 40% Q* 2	0.391 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 563 ⇒ 570 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	200 mm
Discharge Flow : 20% Q* 1	0.391 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 282 ⇒ 285 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	15MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	15,000	625.00	0.174
Max Daily	15,000	625.00	0.174
Max Hourly Peak factor 2.25	33,750	1406.25	0.391

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45	25	0	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 33,750 m3/day
= 0.391 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 2.000 m

(3) Width of Basin — 2.900 m

(4) Length of Basin — 2.500 m

(5) Volume required of Basin — 2.000 × 2.900 × 2.500 = 2.3 m3

(6) Retention Time — 2.000 × 2.900 × 2.500 ／ 0.391 × 1
= 37.08 sec

(7) Basin Dimensions — Width 2.900 m × Length 2.500 m
× Depth 2.000 m

STP basic &Stilling Chamber4/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

3. Fine Screen Channel	
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 33,750 m3/d
	= 0.391 m3/sec
[2] Geometory	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.500 m
Height	0.750 m
Floor Level	+ 2.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.391 ／ 0.500 ／ 0.500 ／ 2
	＝ 0.782 ≒ 1.000 m/sec
(2) Screen Channel	
Number	2 Main + 1 Bypass
Width	1.000 m
Side Water Depth	0.500 m
Velocity	0.391 ／ 1.000 ／ 0.500 ／ 2
	＝ 0.391 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 1.0 m × Length 6.0 m
	× SWD 0.5 m
[3] Equipment	
(1) Inlet Gate	
Number	2 W + 1 S
Dimension	Width 0.5 m × Height 0.75 m
Design Water Level	2.00 m
(2) Fine Screens (Main Channel)	
Number	2 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	1.0 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.391 ／ 0.900 ／ 0.450 ／ 2
	×(6 + 2)/ 6
	＝ 0.644 ＜ 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Side Water Depth	0.5 m
Velocity through screen	0.391 ／ 1.000 ／ 0.500 ／ 2
	×(20 + 9)/ 20
	＝ 0.567 ＜ 0.800 m/sec

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Peak flow = 33,750 m^3/day
	= 0.391 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.391 ／ 0.0111 = 35.23 m^2
(2) Number of Basins	1 S + 1 W
(3) Surface Area required/Basin	35.2 ／ 1 = 35.23 m^2
(4) Length of Basin	35.23 ^0.5 = 5.935 m → 6.0 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.391 × 60 sec ／ 1 = 23.5 m^3
(7) Depth required	23.5 ／ 6.0 ／ 6.0 = 0.652 m
(8) Basin Dimensions	Width 6.0 m × Length 6.0 m
	× Depth 0.7 m (Freeboard 0.3m)
(9) Retention Time	6 × 6.0 × 0.7 ／ 0.391 × 1
	= 60.00 sec
(10) Surface Overflow Rate at Peak Flow	33,750 ／ 6.0 ／ 6.0 ／ 1
	= 937.5 ＜ 960 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 391.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
	Ha= 0.528 m
(4) Crest Level	+ m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 0.528 m
(6) Channel bottom level	+ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.372 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.800 m
(3) Stroke	0.550 m
(4) Overflow Height	0.500 m
(5) Overflow Height (actual)	(0.391 ／ 1.840 ／ 0.800 ／ 2) $^{2/3}$
	= 0.260 ＜ 0.500 m

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B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

5. Reactor

〔1〕 Design Condition

(1)	Design Wastewater Flow	Q=	15,000	m^3/day (summer)	
		Q'=	15,000	m^3/day(Winter)	
(2)	Design Sewage Quality				
	Inlet BOD		350	mg/*l*	
	Outlet BOD		10.0	mg/*l*	
	Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
	Inlet COD		800	mg/*l*	
	Inlet bCOD :S_0		578	mg/*l*	
	Inlet nbCOD		223	mg/*l*	
	bCOD/BOD		1.65		
	Inlet S-COD :sCOD		271	mg/*l*	assumed as 33% of BOD
	Inlet rbCOD		231	mg/*l*	bCOD*40%
	Inlet sbCOD		347	mg/*l*	bCOD*60%
	Outlet S-COD :nbsCODe		40	mg/*l*	
	Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
	Inlet SS		450	mg/*l*	
	Inlet VSS		383	mg/*l*	assumed as 85% of TSS
	:VSS_{COD}		1.38	gCOD/gVSS	=(TCOD-sCOD)/VSS
	:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
	:iTSS		67.50	gnbVSS/m3	=TSS-VSS
	Inlet T-N		70	mg/*l*	
	Inlet TKN		70	mg/*l*	
	Inlet NH_4-N		45.0	mg/*l*	
	Inlet T-P		7	mg/*l*	
	Inlet D-P		5	mg/*l*	
	Inlet Alkalinity as CaCO3		380	mg/*l*	
	Outlet Kjeldahl N		1.0	mg/*l*	
	Outlet NH4-N		1.0	mg/*l*	
	Outlet NO3-N		9.0	mg/*l*	
	Outlet T-P		2	mg/*l*	
	Outlet D-P		1	mg/*l*	
(3)	Water Temperature	T=	20.0	℃	
(4)	Safety Factor for Nitrogen	SF=	1.5		
(5)	Return Sludge Concentration	Rs =	8,000	mg/*l*	
(6)	MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7)	DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2)	μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
	$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
	DO	DO=	2.0000	mg/*l*	
	$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2) Design SRT	SRT=	4.8387	day	=1/μ_{AOB}×SF
	⇒	5.0000	day	
(3) Biomass production				
$Px,_{VSS}$	$Px,_{VSS}$=	4690.557	kg /d	=Px,bio+Q(nbVSS)
$Px,_{TSS}$	$Px,_{TSS}$=	6442.849	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al
S	S=	0.4507	mg/*l*	=Ks[1+b_H(SRT)]/[SRT(μ_m-b_H)-1]
b_H	b_H=	0.1200		=b*$1.04^{(T-20)}$ b at20℃＝ 0.120
Y_H	Y_H=	0.4500	gVSS/g bCOD	
$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g･d	=μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 6.000
Yn	Yn=	0.150	gVSS/g Nox	
NOx	NOx=	47.400	mg/*l*	
$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	2711.174	kg VSS/d	=Q･Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)] +QYn(Nox)/[2+bAOB(SRT)]
		2434.427		=Q･Y_H(S_0-S)/[1+b_H(SRT)]
		219.098		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]
		57.649		=QYn(Nox)/[1+b_{AOB}(SRT)]
NOx	NOx=	47.311	mg/*l*	=TKN-Ne-0.12$P_{X,bio}$/Q
(4) Required Aeration Tank Volume				
Va=	Va=	10,738	m3	
τ =	τ =	17.18	hr	=Va/Q×24
	⇒	18.00	hr	
X_{VSS}･Va	X_{VSS}･Va=	23,453	kg VSS	=$Px,_{VSS}$･SRT
X_{TSS}･Va	X_{TSS}･Va=	32,214	kg TSS	=$Px,_{TSS}$･SRT
F/M	F/M=	0.224	kgBOD/kgMLVSS	
FractionVSS=	FractionVSS	0.728		
MLVSS=	MLVSS=	2184	mg/L	
(5) BODloading	BODloading	0.489	kg/m3･d	
(6) Observed Yield				
$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.228	gTSS/gBOD	
$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
bCODremoved=	bCODremov	8,656	kg/d	
(7) effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g･d	=μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 1.000
μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g･d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
	S_0=	2.000	mg/*l*	
	$K_{O2,NOB}$=	0.900	mg/*l*	
(8) effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g･d	=μ_{max}*$1.072^{(T-20)}$ μ max at20℃＝ 0.900
μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g･d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
	S_0=	2.000	mg/*l*	
	$K_{O2,NOB}$=	0.500	mg/*l*	
(9) Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
	3,000/(8,000-3,000)＝	0.60		
	Rr ＝	0.60		

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = $Q \cdot (SRT)/V \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
= 1,133.55 mg/l

(2) IR ratio
IR = NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= $(IR+R) \cdot Q \cdot Ne$
= 574,659.15 kg/d

(4) The anoxic tank volume
Vnor= 1,074 m3 = Va× 10%
Vnor= 3,125 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.48 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients	
	b0	b1
10	0.186	0.078
20	0.213	0.118
30	0.235	0.141
40	0.242	0.152
50	0.270	0.162

(8) SDNRb
SDNRb= 0.302 g/g・d $= b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.113 g/g・d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.217 g/g・d $=SDNR_t - 0.029\ln(F/M_b)-0.012$ IR=3-4
$=SDNR_t - 0.0166\ln(F/M_b)-0.078$ IR=2

SDNRt= 0.302 g/g・d $=SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 769,650.62 kg/d $=N_{nox} \cdot SDNR \cdot X_b$
>Nox feed= 574,659 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/l

Influent Alk 380.00 mg/l
Alk used 338.44 mg/l =7.14×Nox
Alk producec 136.77 mg/l =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/l

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 4690.557 kg /d
Rwmoval Phosphorus 46.9055704 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, $Al_2(SO_4)_3 \cdot 18H_2O$
(5) Required Alumnum Sulfate 644.66 kg/d
(6) Required Alumnum Sulfate solutic 10% 6.14 m3/d
255.82 L/H
(7) Additional sludge 261.35 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

$V_A = Q'*\theta a/24$
$= 11,250$ m^3

(2) Total volume of Anoxic Basins

$V_{DN} = Q'*\theta_{DN}/24$
$= 3,125$ m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	940	1.50	1.50	0.30
Anoxic	V_{DN}	3,125	5.00	5.00	1.00
Aerobic	V_A	11,250	18.00	18.00	3.60
Total	V	15,315	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	180.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin
Hantzsch Subtraction: = 1.0 m^2/Basin
after Subtraction: 44.0-1.0 = 43.0 m^2/Basin
Total Volume: 43.0*180.0 = 7,740 m^2/Basin 15,480 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**10.9**	**36.3**	**130.8**	**178.1**
Volume required per Basin	m^3	470	1,563	5,625	7,658
Total Volume required	m^3	940	3,125	11,250	15,315
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	12.0	37.0	131.0	180.0
Actual Volume per Basin	m^3	516	1,591	5,633	7,740
Actual Total Volume	m^3	1,032	3,182	11,266	15,480
Actual Ratio of Volume		0.32	1.00	3.54	
Actual Retention Time	hour	1.65	5.09	18.03	24.77

[7] Equipment

(1) Ras Pumps
Ras Ratio: 60%
Required Capacity: 15,000 m3/day× 60% ／24 ／ 2
= 188 m3/Hr ⇒ 190 m3/Hr
Number: 2 Work
2 Stanby

(2) Circulation Pumps
Ras Ratio: 366%
Required Capacity: 15,000 m3/day× 366% ／24 ／ 4
= 571 m3/Hr ⇒ 580 m3/Hr
Number: 4 Work
2 Stanby

(3) SAS Pumps
Excess Sludge: 942 m3/day
Sludge withdraw: 12 Times/day
Running Time: 0.5 Hr/Time
Required Capacity: 942 m3/day ／ 12 ／ 0.50 ／ 2
= 78.52 m3/Hr ⇒ 80 m3/Hr
Number: 2 Work
2 Stanby

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B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

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(4)	Alum Solution Tank													
	Number	2	W	+		0	S							
	Alum concentration as crystal	10	%											
	Gravity of dissolved dechlorine	1.05												
	Required solution volume	644.66	kg / d	×	100	/	10	/	1.05	/	1000			
		＝	6.14	m3/d										
	Volume of Tank	3.5	m3/tank	(=	1.4	mW×	1.4	mL×	1.8	mH)				
	Total Volume of Tanks	7.1		m3		(Duration=		1.15		day)				
(5)	Mixer for Alum Solution Tank													
	Number	2	W	+	0		S							
(6)	Alum Dosing Pump													
	Number	2	W	+	1		S							
	Capacity	6.14	m3/d	/	24	×	1000	/	2	×	2			
		255.82	l/h/unit	⇒	260	l/h/unit								

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B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3
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6. Air Requirement at Average Flow	
〔1〕Design Condition	
(1) AOR	AOR = 6,490 kg/day
	= 270.4 kg/h
Qin :Design Average Flow m^3/d	15,000
Inlet bCOD :S_0	578 mg/l
S=	S= 0.451 mg/l
Nox=	Nox 47.400 mg/l
$P_{X,bio}$=	$P_{X,b}$ 2,653.5 kg VSS/d does not include nitrifying bacteria
R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx
R_0=	R_0= 6,490 kg O2/d
	k= 2.86
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃
	9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature
	9.09 mg/L at 20 ℃
	20-T : 0.0 1.024^{20-T} : 1.0000
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth
	1+0.40D_j/Pa 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at s
	10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : exp[-gM(z_b-z_a)/R*T] 0.900
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t = 293.15 Kelvin
	α : relative Transfer Rate to clean Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \frac{70,410}{4.2591} =$ 16,531.48 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas	= 8,266 kg/day
(5) SOTE for the above Effective Aeration Depth	28.0 %
(6) Fraction of O2 in Air	23.18 %
(7) Specific Gravity of Air at Standard Condition	1.293
(8) Safety Factor	15%
(9) Air required at Field Conditions per Basins	= 121,567 m^3/day = 5,065.3 m^3/hr
[2] Equipment	

Air Requirement at Average Flow12/23

(1)	Air Blower		
	Number	4 W + 2 S	
	Required Capacity	5065.3 m^3/Hr・Basin ／ 2 unit/Basin	
		＝ 2532.6 m^3/h ⇒ 2600 m^3/h /Unit	
	Pressure	65	kPa
	Safty Factor	10	%
	Heat capacity ratio	1.4	
	Atmospheric pressuer at site elevation	91.234	kPa
	Total inlet pressure	89.234	kPa
	Volume rate of flow at inlet point	49.193	m3/min
	Total discharge pressure	156.234	kPa
	Overall adiabatic effeciency	0.65	
	Inlet air temperature (min.)	15	℃
	Shaft power	69.552	kW
	Rated Output of Motor	76.508	kW ⇒ 90 kW

7.	**Final Clarifire**					
〔1〕	**Design Condition**					
(1)	Design Wastewater Flow	Q=	15,000 m^3/day			
(2)	Water Temperature	T=	20.0 ℃			
(3)	MLSS	Xef=	3,000 mg/*l*			
(4)	SVI	SVI=	300			
(5)	Sedimentation Velocity	*v* =	4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)			
		=	4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770			
		=	20.7 m/day			
(6)	Surface Overflow Rate required	*S*'=	v/(1.5*1)=	20.7/(1.5*1.0)	=	13.8 m^3/m^2·day
					→	12.0 m^3/m^2·day
[2]	**Geometory**					
(1)	Surface Area required	A=	15,000/12.0=		=	1,250 m^2
(2)	Demensions		Diameter	Depth	Basin	
			28.5	**3.5**	**2**	
(3)	Actual Surface Area	S=	28.5^2 * 3.14 /4 * 2.0		=	1,276 m^2
(4)	Surface Overflow Rate	S=	15,000/1,276		=	11.8 m^3/m^2·day

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow 15,000 m^3/day 625.00 m^3/h
		Peak Flow 33,750 m^3/day 1406.25 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 150.0 kg/d
		＝ 6.25 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 312.5 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	2.00 m
(4)	Length of lane	27.00 m
(5)	Side Water Depth	2.00 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	6.80 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 625.00 ／ 3600 ／ 2.00 ／ 2.00
		＝ 0.043 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 2.0 m × 27.0 m × 2.0 m
		× 3 × 1
		＝ 324 m^3 > 312.5 m^3

[3] Equipment

(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 150 kg/day
	Maximum Dosage Rate -1	q3 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 338 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 2,250 kg
	Unit Number	EN1 EC1 / Cc = 2.4 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vr1 #### @ 20^{O}C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = 14.06 kg/h
	Operation Numbers	EN2 DC1 / Vr1 = 1.8sets
	Number	2 W + 2 S
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
		337.5 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.00 kg/hr 14.1 kg/hr
(4)	Chlorine Booster Pump	

Chlorination Tank (gas)15/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori

Chlorinator Discharge	(kg/hr)	1.0	1.5	2.0	2.5	3.0	4.0
Water Demand	(L/min)	15	20	25	30	35	40
Chlorinator Discharge	(kg/hr)	5.0	6.0	10.0	50.0	100.0	200.0
Water Demand	(L/min)	45	50	60	300	600	1,200

Water requiamet -

For Chlorin Qp1 Maximum dosage ra 14.1 kg/hr

therefore 90 L/min

Booster Pump Type: Single suction volute pump

Number: 1 W + 1 S

9. Dechlorination

〔1〕 Design Condition

(1) Design Flow Rate: Average Daily Flow 15,000 m^3/day

(2) Contact Time: 10 min

(3) Type of Dechlorine: Sodium Thiosulfate ($Na_2S_2O_3\ 5H_2O$)

(4) Free Residual Chlorine: 1.0 mg/L assumed value

(5) Consumption per day: Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75

× 1.5 (safety factor)

＝ 39.4 kg/d

＝ 1.64 kg/h

[2] Dechlorination Contact Tank

(1) Volume required: Average Flow Rate ／ 60 × Contact Time

＝ 104.2 m^3

(2) Width of lane: 6.80 m

(3) Length of lane: 8.00 m

(4) Side Water Depth: 2.00 m

(5) Nos. of Tanks: 1 tank

(6) Total Volume: Width × Length × Depth

＝ 6.8 m × 8.0 m × 2.0 m

＝ 109 m^3 > 104.2 m^3

[3] Equipment

(1) Dechlorine Solution Tank

Number: 2 W + 0 S

Dechlorine concentration: 10 %

Gravity of dissolved dechlorine: 1.10

Required solution volume: 39.38 kg / d × 100 / 10 / 1.10 / 1000

＝ 0.36 m3/d

Volume of Tank: 0.200 m3/tank (= 0.5 mW× 0.5 mL× 0.8 mH)

Total Volume of Tanks: 0.400 m3 (Duration= 1.12 day)

(2) Mixer for Dechlorine Solution Tank

Number: 2 W + 0 S

(3) Dechlorine Dosing Pump

Number: 2 W + 1 S

Capacity: 0.81 m3/d / 24 × 1000 / 2

16.78 l/h/unit ⇒ 17 l/h/unit

Chlorination Tank (gas)16/23

STP Process Calculation_Supporting Report 12.2.3

10. Sludge Thikener

[1] Design Condition

(1)	Primary Sludge	0	kg/day	0	m3/day
(2)	Secondary Sludge	7,538	kg/day	942	m3/day
(3)	Total Solids	7,538	kg/day	942	m3/day
(4)	Operation Time	24	hours/day		
(5)	Thikened Sludge Moisture Content	97.5	%		

[2] Geometory

(1) Type

(2) Number: 2 W + 0 S

(3) Design Solid Loadong: 40 kg / m2/d

(4) Required Surface Area

$$7538 \times \frac{1}{40} = 188.40 \text{ m2}$$

(5) Required diameter

$$\left(\frac{4}{\pi} \times 188.40 \times \frac{1}{2} \right)^{1/2} = 10.95 \text{ m}$$

$$\rightarrow 11.00 \text{ m}$$

(6) Side Water Depth: 4 m

(7) Actual Volume of Tank

$$\frac{\pi}{4} \times 11.00^{2} = 95.03 \text{ m3}$$

(8) Retention Time

$$\frac{95.03}{942} \times 4 \times 2 \times 24 = 19.37 \text{ Hr}$$

[3] Volume of Thikened Sludge

$$= 271 \text{ m}^3/\text{d}$$

[4] **Quantity of Separation Liquid**

Inlet Sludge Volume − Thikened Sludge Volume

$$= 942.2 - 271.4 = 670.9 \text{ m}^3/\text{day}$$

Gravity Sludge Thikener17/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

11.	**Thickened Sludge Sump**								
[1]	**Design Condition**								
(1)	Inlet Solids	7,538	kg/day						
(2)	Inlet Sludge Volume	942	m^3/d						
[2]	**Geometory**								
(1)	Sludge withdrawl	12	Times/day						
(2)	Required Sump Volume	79	m^3/d						
(3)	Number	2	Basins						
(4)	Width	3.5	m						
(5)	Length	4.0	m						
(6)	Side Water Depth	3.0	m						
(7)	Actual Sump Volume	3.5	×	4.0	×	3.0	×	2	
		＝	84.0	m^3					
[3]	**Equipment**								
(1)	Thickened Sludge Transfer Pumps								
	Transfer Time	6.00	Hr						
	Number	2	W	+	2	S			
	Required Capacity	942	m^3	／	6.0	／	2		
		＝	78.5	m^3/Hr	⇒	80	m^3/Hr /Unit		

Thickened Sludge Sump18/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

12. Centrifuge

[1] Design Condition

(1) Type of Dewatering	Centrifuge			
(2) Generated Sludge	6,784	kg/day		
(3) Design Polyelectrolyte Dosage	Polyelectrolyte		5	kg/t-DS･day
(4) Volume of Thickend Sludge	271.4	m^3/day		
(5) Consistency of Dewatered Sludge	82	%		
(6) Operation Time	12	hours/day	(6 days per week)	

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{271.4}{12 \times 2} \times \frac{7}{6} = 13.2$$

$\rightarrow$ 14 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 6,784 × (1 + 0.0050)

= 6,818 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 6.818 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 44.19 t/day

apparent specific gravity 1.00

44.19 ／ 1.0 = 44.2 m^3/day

[5] Polyelectrolyte

(1) Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS･day
(2) Required Polyelectrolyte		33.92	kg/day
(3) Dissolving concentration		0.20	%
(4) Volume of Polyelectrolyte solution		16.96	m3/day

Centrifuge 19/23

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

[6] Equipment	
(1) Centrifuge	
Capacity	14 m^3/hr
Number	2 W + 1 S
(2) Centrifuge Feed Pumps	
Capacity	14 m^3/hr
Number	2 W + 1 S
(3) Polyelectrolyte Dosing Pumps	
Volume of Polyelectrolyte solution	16.96 m3/day
Operation Time	12 hours/day (6 days per week)
Safety Factor	1.5
Number	2 W + 1 S
Required Capacity	16.96 m3/da; × 7 ／ 6 ／ 12 ／ 2
	＝ 0.82 m^3/Hr
Specification Capacity	0.82 m^3/Hr × 1.5
	＝ 1.237 m^3/Hr ⇒ 1.30 m^3/Hr /Unit
(4) Polyelectrolyte dosing System	
Preparation time for solution	3 hr
Required dry polymer	33.92 kg/day × 7 ／ 6 ／ 12
	＝ 3.30 kg/hr
	＝ 9.89 kg per one batch
Feedong time per one batch	30 min
Capacity of Dry polymer Feeder	20 kg/h
Tanks Dimensions	Width 1.5 m × Length 2.0 m
	× Depth 2.0 m × 2
	＝ 12 m^3
Retention Time of Tank	6.00 m^3 /tank ／ 0.82 m^3/Hr ／ 2
	＝ 3.639 Hr > 3 Hr
Number	2 W + 0 S

B-1 Process Cal_ EA&al 15MLD Varthur_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

11. Centrifuge Feed Sump

[1] Design Condition

(1) Generated Thickend Sludge: 6,784 kg/day

(2) Solids Consistency: 2.50 %

(3) Volume of Thickened Sludge

$$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$$

$$= 6,784 \times \frac{100}{2.50} \times 10^{-3}$$

= 271 m^3/day

= 11.31 m^3/h

(4) Sludge feed flow rate: 14 m3/h × 2 = 28 m3/h

(5) Centrifuge Operation Time: 12 hours/day (6 days per week)

[2] Geometry

(1) Basin Dimensions: Width 6.0 m × Length 6.0 m × Depth 4.0 m × 2

= 288.0 m^3

[3] Equipment

(1) Mixers for Centrifuge Feed Sumps

Required Volume: 288.0 m^3

Number: 1 W + 1 S

Centrifuge Feed Sump 21/23

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

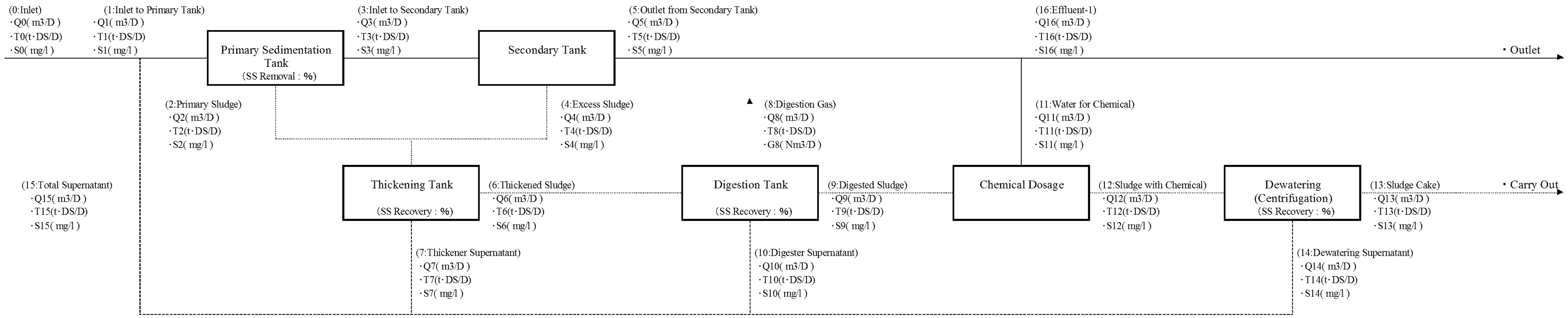
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	15,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	90.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	97.5	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	97.5	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	15,000	15,923	0	15,923	942	14,981	271	671	0	271	0	17	288	36	252	923	923			14,981	0
T(t･DS/day)	6.750	7.845	0.000	7.845	7.538	0.150	6.784	0.754	0.000	6.784	0.000	0.034	6.818	6.477	0.341	1.095	1.095			0.150	0.157
S(mg/l)	450	493	0	493	8,000	10	25,000	1,124	0	25,000	0	2,000	23,647	180,000	1,351	1,186				10	
X(Ti/T0*100)	100	116.2	0.0	116.2	111.7	2.2	100.5	11.2	0.0	100.5	0.0	0.5	101.0	96.0	5.1	16.2				2.2	2.3

Figure -1 Material Balance Model



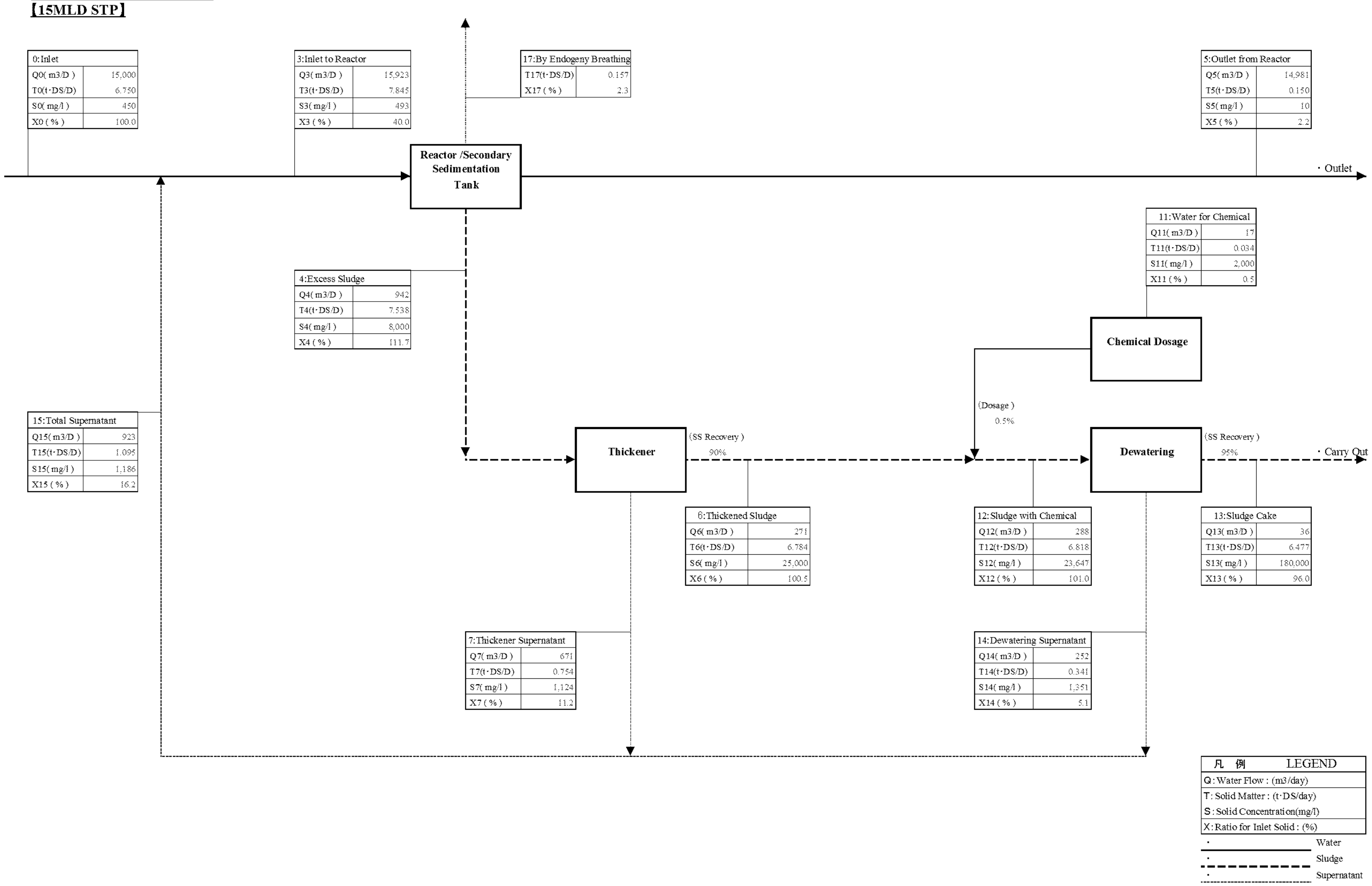
Calculation Formula

･Q0=Input Data	･Q3=Q1-Q2	･Q6=T6*100/(100-W3)	･Q9=Q6	･Q12=Q9+Q11	･Q15=Q7+Q10+Q14	･Q5-1=Q5-Q11
･T0=Q0*S0*10^(-6)	･T3=T0*(100-A2)/100	･T6=(T2+T4)*A3/100	･T9=(T6-T8)*A4/100	･T12=T9+T11	･T15=T7+T10+T14	･T5-1=T5-T11
･S0=Input Data	･S3=T3*10^6/Q3	･S6=10^6*(100-W3)/100	･S9=T9*10^6/Q9	･S12=T12*10^6/Q12	･S15=T15*10^6/Q15	･S5-1=S5
･Q1=Q0+Q15	･Q4=T4*100/(100-W2)	･Q7=(Q2+Q4)-Q6	･Q10=Q6-Q8-Q9	･Q13=T13*100/(100-W5)		
･T1=T0+T15	･T4=余剰汚泥発生式による	･T7=(T2+T4)-T6	･T10=T6-T8-T9	･T13=T12*A5/100		
･S1=T1*10^6/Q1	･S4=10^6*(100-W2)/100	･S7=T7*10^6/Q7	･S10=T10*10^6/Q10	･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1)	･Q5=Q3-Q4*(T3-T5)/T4	･Q8=0	･Q11=T10*A9/A10	･Q14=Q12-Q13		
･T2=T1-T3	･T5=Q5*ST/10^6	･T8=T6*A6*A7/10^4	･T11=Q11*S11/10^6	･T14=T12-T13		
･S2=10^6*(100-W1)/100	･S5=St	#REF!	･S11=10^4*A10	･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【15MLD STP】



C-1 Process Cal_ EA&al 4MLD Pillaganahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	4MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	6,000	250	0.069
Max Dayly	6,000	250	0.069
Max Hourly Peak factor 2.5	15,000	625	0.174

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	4,000	167	0.046
Max Dayly	4,000	167	0.046
Max Hourly Peak factor 2.5	10,000	417	0.116

1. Inlet Chamber

Item	4MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly ＝ 15,000 m3/d
	＝ 0.174 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 （Manning Fornula）
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 ＝ 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.174 × 1
	＝ 18.10 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

C-1 Process Cal_ EA&al 4MLD Pillaganahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	4MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	1 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.174 ／ 0.400 ／ 0.500 ／ 1
whe Design Flow for the year 2049	= 0.870 < 1.000 m/sec OK
Velocity	0.116 ／ 0.400 ／ 0.500 ／ 1
whe Design Flow for the year 2034	= 0.580 < 1.000 m/sec OK
(2) Screen Channel	
Number	1.0 Main + 1.0 Bypass
Width	0.800 m
Side Water Depth	0.500 m
Velocity	0.174 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2049	= 0.435 ≒ 0.450 m/sec OK
Velocity	0.116 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2034	= 0.290 < 0.450 m/sec OK
(3) Channel Dimensions	Width 0.8 m × Length 8.5 m × SWD 0.5 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Units
Dimension	Width 0.4 m × Height 0.6 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	1 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.174 ／ 0.700 ／ 0.450 ／ 1 × (20 + 9) / 20
	= 0.801 ≒ 0.800 m/sec OK
Velocity through screen	0.116 ／ 0.700 ／ 0.450 ／ 1
whe Design Flow for the year 2034	× (20 + 9) / 20
	= 0.534 < 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.5 m
Velocity through screen	0.174 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2049	× (50 + 9) / 50
	= 0.513 < 0.800 m/sec OK
Velocity through screen	0.116 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2034	× (50 + 9) / 50
	= 0.342 < 0.800 m/sec OK

Coarse Screen 2/21

C-1 Process Cal_ EA&al 4MLD Pillaganahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item	4MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	7.50 m
Pump Operating Depth	1.000 m
Retention Time	(7.50 ²× π／4 × 1.000)／ 0.174 ／60
whe Design Flow for the year 2049	＝ 4.23 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
Retention Time	(7.50 ²× π／4 × 1.000)／ 0.116 ／60
whe Design Flow for the year 2034	＝ 6.35 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	1 W + 1 S
Bore Diameter	250 mm
Discharge Flow : Q	0.116 × 3600 ／ 1.0
whe Design Flow for the year 2034	＝ 418 ⇒ 418 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	W + S
Bore Diameter	mm
Discharge Flow : 0.5	／
whe Design Flow for the year 2034	＝ ⇒ m3/Hr
Total Head	m

Raw Sewage Sump 3/21

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Item	4MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	4,000	166.67	0.046
Max Daily	4,000	166.67	0.046
Max Hourly Peak factor 2.5	10,000	416.67	0.116

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 10,000 m3/day
= 0.116 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin
(2) Depth of Basin — 1.000 m
(3) Width of Basin — 1.800 m
(4) Length of Basin — 1.500 m
(5) Volume required of Basin — 1.000 × 1.800 × 1.500 = 1.2 m3
(6) Retention Time — 1.000 × 1.800 × 1.500 ／ 0.116 × 1
= 23.28 sec
(7) Basin Dimensions — Width 1.800 m × Length 1.500 m
× Depth 1.000 m

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3.	**Fine Screen Channel**	
〔1〕Design Condition		
(1)	Design Wastewater Flow	Max Hourly ＝ 10,000 m3/d
		＝ 0.116 m3/sec
[2]	Geometory	
(1)	Inlet Gate	
	Number	1 Main ＋ 1 Bypass
	Width	0.400 m
	Height	0.600 m
	Floor Level	＋ 2.000 m
	Bottom	＋ 0.000 m
	Influent Water Level	＋ 0.500 m
	Velocity	0.116 ／ 0.400 ／ 0.500 ／ 1
		＝ 0.580 ≒ 1.000 m/sec
(2)	Screen Channel	
	Number	1 Main ＋ 1 Bypass
	Width	0.800 m
	Side Water Depth	0.400 m
	Velocity	0.116 ／ 0.800 ／ 0.400 ／ 1
		＝ 0.363 ≒ 0.450 m/sec
(3)	Channel Dimensions	Width 0.8 m × Length 6.0 m
		× SWD 0.4 m (Freeboard 0.3m)
[3]	Equipment	
(1)	Inlet Gate	
	Number	1 W ＋ 1 S
	Dimension	Width 0.4 m × Height 0.60 m
	Design Water Level	2.00 m
(2)	Fine Screens (Main Channel)	
	Number	1 W ＋ 0 S
	Open Space	6 mm
	Bar Thickness	2 mm
	Channel Width	0.8 m
	Width of side plate	50 mm
	Side Water Depth	0.4 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.116 ／ 0.700 ／ 0.350 ／ 1
		×(6 ＋ 2)/ 6
		＝ 0.631 ＜ 0.800 m/sec
(3)	Fine Screens (Bypass Channel)	
	Number	0 W ＋ 1 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	0.8 m
	Side Water Depth	0.4 m
	Velocity through screen	0.116 ／ 0.800 ／ 0.400 ／ 1
		×(20 ＋ 9)/ 20
		＝ 0.526 ＜ 0.800 m/sec

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4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Max Hourly = 10,000 m^3/day = 0.116 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec
[2]	**Grit Chamber**	**Square Grit Chamber**
(1)	Surface Area required	0.116 ／ 0.0111 = 10.45 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	10.5 ／ 1 = 10.45 m^2
(4)	Length of Basin	10.45 ^0.5 = 3.2 m → 3.5 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.116 × 60 sec ／ 1 = 7.0 m^3
(7)	Depth required	7.0 ／ 3.5 ／ 3.5 = 0.568 m
(8)	Basin Dimensions	Width 3.5 m × Length 3.5 m × Depth 0.6 m (Freeboard 0.3m)
(9)	Retention Time	3.5 × 3.5 × 0.6 ／ 0.116 × 1 = 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	10,000 ／ 3.5 ／ 3.5 ／ 1 = 816.326531 < 960 m^3/m^2/day
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 116.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$ Ha= 0.235 m
(4)	Crest Level	+ 75.400 m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 75.635 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.110 m/sec
(10)	Total Length of channel	10.000 m
[4]	**Inlet Weir Gate**	
(1)	Number	2 Units
(2)	Weir Width	0.400 m
(3)	Stroke	0.450 m
(4)	Overflow Height	0.400 m
(5)	Overflow Height (actual)	(0.116 ／ 1.840 ／ 0.400 ／ 2) $^{2/3}$ = 0.184 < 0.400 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q＝	4,000	m^3/day (summer)	
	Q'＝	4,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T＝	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* ＝	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} ＝	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	1250.815	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	1648.400	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μmax at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	722.980	kg VSS/d	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
			649.180		$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			58.426		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			15.373		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	2,747	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS} \cdot Va$	$X_{VSS} \cdot Va$=	6,254	kg VSS	$=Px,_{VSS} \cdot SRT$
	$X_{TSS} \cdot Va$	$X_{TSS} \cdot Va$=	8,242	kg TSS	$=Px,_{TSS} \cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	2,308	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μmax at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μmax at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = Q・(SRT)/V・Y_H(S_0-S)/[1+b_H(SRT)]
= 1,181.47 mg/*l*

(2) IR ratio
IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= (IR+R)・Q・Ne
= 153,242.44 kg/d

(4) The anoxic tank volume
Vnor= 275 m3 = Va× 10%
Vnor= 833 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb
SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

$b_{0=}$ 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.110 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 208,397.23 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 153,242 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 1250.815 kg /d
Rwmoval Phosphorus 12.50815211 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Aluminium Sulphate 171.91 kg/d
(6) Required Aluminium Sulphate solı 10% 1.64 m3/d
68.22 L/H
(7) Additional sludge 69.69 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

V_A = Q'*θa/24
= 3,000 m^3

(2) Total volume of Anoxic Basins

V_{DN} = Q'*$θ_{DN}$/24
= 833 m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	250	1.50	1.50	0.30
Anoxic	V_{DN}	833	5.00	5.00	1.00
Aerobic	V_A	3,000	18.00	18.00	3.60
Total	V	4,083	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	51.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin
Hantzsch Subtraction = 1.0 m^2/Basin
after Subtraction: 44.0-1.0 = 43.0 m^2/Basin
Total Volume: 43.0*51.0 = 2,193 m^2/Basin 4,386 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**2.9**	**9.7**	**34.9**	**47.5**
Volume required per Basin	m^3	125	417	1,500	2,042
Total Volume required	m^3	250	833	3,000	4,083
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	4.0	10.0	37.0	51.0
Actual Volume per Basin	m^3	172	430	1,591	2,193
Actual Total Volume	m^3	344	860	3,182	4,386
Actual Ratio of Volume		0.40	1.00	3.70	
Actual Retention Time	hour	2.06	5.16	19.09	26.31

[7] Equipment

(1) Ras Pumps

Ras Ratio: 60%
Required Capacity: 4,000 m3/day× 60% ／24 ／ 2
= 50 m3/Hr ⇒ 50 m3/Hr
Number: 2 Work
2 Standby

(2) Circulation Pumps

Ras Ratio: 366%
Required Capacity: 4,000 m3/day× 366% ／24 ／ 4
= 152 m3/Hr ⇒ 155 m3/Hr
Number: 4 Work
2 Standby

(3) SAS Pumps

Excess Sludge: 217 m3/day
Sludge withdraw: 12 Times/day
Running Time: 0.5 Hr/Time
Required Capacity: 217 m3/day ／ 12 ／ 0.50 ／ 2
= 18.08 m3/Hr ⇒ 18 m3/Hr
Number: 2 Work
2 Standby

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(4)	Alum Solution Tank													
	Number	2		W	+		0	S						
	Alum concentration as crystal	10	%											
	Gravity of dissolved dechlorine	1.05												
	Required solution volume	171.91	kg / d		×	100	/	10	/		1.05	/	1000	
		＝		1.64	m3/d									
	Volume of Tank		1.0		m3/tank									
	Total Volume of Tanks		2.0		m3		(Duration=			1.22		day)		
(5)	Mixer for Alum Solution Tank													
	Number	2		W	+	0		S						
(6)	Alum Dosing Pump													
	Number	2		W	+	1		S						
	Capacity	1.64	m3/d	/	24	×	1000	/	2	×	2			
		68.22	l/h/unit		⇒	70	l/h/unit							

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6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR	AOR	=	1,731	kg/day
			=	72.1	kg/h
	Qin :Design Average Flow m^3/d	4,000			
	Inlet bCOD :S_0	578 mg/*l*			
	S=	S= 0.451 mg/*l*			
	Nox=	Nox 47.400 mg/*l*			
	$P_{X,bio}$=	$P_{X,b}$ 707.6 kg VSS/d does not include nitrifying bacteria			
	R_0=	$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$			
	R_0=	R_0= 1,731 kg O2/d			
		k= 2.86			

(2) SOR(Standard Oxygen Transfer Rate at site)

$$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \; (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		$1+0.40D_j/Pa$	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R^*T]$	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{18,776}{4.2591} = 4,408.40 \text{ kg/day}$$

(3)	No. of Basins	2	Basin
(4)	Standard O2 required at Field Conditions per Bas =	2,204	kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0	%
(6)	Fraction of O2 in Air	23.18	%
(7)	Specific Gravity of Air at Standard Condition	1.293	
(8)	Safety Factor	15%	
(9)	Air required at Field Conditions per Basins	= 32,418 m^3/day =	1,350.7 m^3/hr
[2]	Equipment		

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(1) Air Blower						
Number	2	W	+	1	S	
Required Capacity	1350.7	m^3/Hr・Basin	／	1	unit/Basin	
	＝ 1350.7	m^3/h	⇒	1400	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	26.488	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	37.451	kW				
Rated Output of Motor	41.196	kW	⇒	45	kW	

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STP Process Calculation_Supporting Report 12.2.3

7. Final Clarifire	
〔1〕 Design Condition	
(1) Design Wastewater Flow	Q= 4,000 m^3/day
(2) Water Temperature	T= 20.0 ℃
(3) MLSS	Xef= 3,000 mg/*l*
(4) SVI	SVI= 300
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77) = 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770 = 20.7 m/day
(6) Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0) = 13.8 m^3/m^2·day → 12.0 m^3/m^2·day
[2] Geometory	
(1) Surface Area required	A= 4,000/12.0= = 333 m^2
(2) Demensions	Diameter **15.0** Depth **3.5** Basin **2**
(3) Actual Surface Area	S= 15.0^2 * 3.14 /4 * 2.0 = 353 m^2
(4) Surface Overflow Rate	S= 4,000/353 = 11.3 m^3/m^2·day

Final Clarifire14/21

C-1 Process Cal_ EA&al 4MLD Pillaganahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Flow	4,000	m^3/day	166.67	m^3/h			
		Peak Flow	10,000	m^3/day	416.67	m^3/h			
(2)	Contact Time	30	min						
(3)	Type of Chlorine	Cl_2-GAS							
(4)	Design Chlorine Dosage Rate	10	mg/L						
(5)	Required Chlorine per day	Average Daily Flow	／	1000	×	Design Chlorine Dosage Rate			
		＝	40.0	kg/d					
		＝	1.67	kg/h					

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow	／	1440	×	Contact Time				
		＝	83.3	m^3						
(2)	Nos. of lanes	3	lanes							
(3)	Width of lane	1.50	m							
(4)	Length of lane	14.00	m							
(5)	Side Water Depth	1.50	m							
(6)	Nos. of Tanks	1	tank							
(7)	Total Width of Tank	5.30	m Approx..							
(8)	Average Velocity	Decant Flow	／	3600	／	Width	／	Depth		
		＝	166.67	／	3600	／	1.50	／	1.50	
		＝	0.021	m/sec						
(9)	Total Volume	Width	×	Length	×	Depth	×	Nos. of lanes	×	Nos. of Tanks
		＝	1.5	m	×	14.0	m	×	1.5	m
			×	3	×	1				
		＝	95	m^3	>	83.3	m^3			

[3] Equipment

(1) Chlorine Dosing Condition

Operation Dosage Rate -1	DC1	1 mg/L	10 mg/L	
Average Dosage Rate -1	DC2	10 mg/L		

(2) Chlorine Cylinder

Type	-	Cylindrical Convexsd Container		
Cylinder Capacity	Cc	928 kg/cylinder		
Average Dosage Rate -1	q1	Chlorine -1 : $Q_{T\text{-}D}$ x DC2 x 10^{-6} x 10^3 =	40 kg/day	
Storage day	T	More than	15 days	
Required Storage Capacity	EC1	D x T =	600 kg	
Unit Number	EN1	EC1 / Cc =	0.6 cylinders	
Maximum Operation Numbers				
Cl_2-Gas Volatilize Rate	Vr1	####	@ 20^{O}C Standard temperature	
Maximum Dosing Rate	DC1	10 mg/L,	$Q_{T\text{-}D}$ x q3 x 10^{-3} / 24 =	####
Operation Numbers	EN2	DC1 / Vr1 =	0.5sets	

(3) Chlorinator

Type	Solution Feed Vacuum Type				
Number	1	W	+	1	S
Operation Dosage Rate -1	Dq1	Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^3 =			
	4	kg/day to	100	kg/day	
Required Dosage Rate	Chlorine -1 :	Dq1 / (EN1x 24) =			
	Minimum		Maximum		
	0.17	kg/hr	4.2	kg/hr	

Chlorination Tank (gas)15/21

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STP Process Calculation_Supporting Report 12.2.3

(4) Chlorine Booster Pump	
Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori
Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
Water Demand	(L/min) 15 20 25 30 35 40
Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
Water Demand	(L/min) 45 50 60 300 600 1,200
Water requiamet	-
For Chlorin	Qp1 Maximum dosage ra 4.2 kg/hr
	therefore 40 L/min
Booster Pump Type	Single suction volute pump
Number	1 W + 1 S
9. Dechlorination	
〔1〕 Design Condition	
(1) Design Flow Rate	Average Daily Flow 4,000 m^3/day
(2) Contact Time	10 min
(3) Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4) Free Residual Chlorine	1.0 mg/L assumed value
(5) Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
	× 1.5 (safety factor)
	＝ 10.50 kg/d
	＝ 0.438 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Flow Rate ／ 60 × Contact Time
	＝ 27.8 m^3
(2) Width of lane	5.30 m
(3) Length of lane	4.00 m
(4) Side Water Depth	1.50 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 5.3 m × 4.0 m × 1.5 m
	＝ 32 m^3 > 27.8 m^3
[3] Equipment	
(1) Dechlorine Solution Tank	
Number	1 W + 0 S
Dechlorine concentration	10 %
Gravity of dissolved dechlorine	1.10
Required solution volume	10.50 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.10 m3/d
Volume of Tank	0.2 m3/tank
Total Volume of Tanks	0.2 m3 (Duration= 2.10 day)
(2) Mixer for Dechlorine Solution Tank	
Number	1 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	0.24 m3/d / 24 × 1000 / 1
	9.94 l/h/unit ⇒ 10.0 l/h/unit

Chlorination Tank (gas)16/21

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STP Process Calculation_Supporting Report 12.2.3

10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge		
(2)	Generated Sludge	1,735	kg/day	
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS･day
(4)	Volume of Thickend Sludge	216.9	m^3/day	
(5)	Consistency of Dewatered Sludge	82	%	
(6)	Operation Time	12	hours/day	(6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{216.9}{12 \times 1} \times \frac{7}{6} = 21.1$$

→ 22 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 1,735 × (1 + 0.0050)

= 1,744 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 1.744 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 11.30 t/day

apparent specific gravity 1.00

11.30 ／ 1.0 = 11.3 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS･day
(2)	Required Polyelectrolyte		8.68	kg/day
(3)	Dissolving concentration		0.20	%
(4)	Volume of Polyelectrolyte solution		4.34	m3/day

Centrifuge 17/21

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STP Process Calculation_Supporting Report 12.2.3

[6]	**Equipment**									
(1)	Centrifuge									
	Capacity	22	m^3/hr							
	Number	1	W	+	1	S				
(2)	Centrifuge Feed Pumps									
	Capacity	22	m^3/hr							
	Number	1	W	+	1	S				
(3)	Polyelectrolyte Dosing Pumps									
	Volume of Polyelectrolyte solution	4.34	m3/day							
	Operation Time	12	hours/day	(6 days per week)						
	Safety Factor	1.5								
	Number	1	W	+	1	S				
	Required Capacity	4.34	m3/day ×	7	／	6	／	12	／	1
		＝	0.42	m^3/Hr						
	Specification Capacity	0.42	m^3/Hr	×	1.5					
		＝	0.633	m^3/Hr	⇒	0.65	m^3/Hr /Unit			
(4)	Polyelectrolyte dosing System									
	Tanks Dimensions	Width	1.5	m	×	Length	1.0	m		
		×	Depth	1.8	m	×	2			
		＝	5.4	m^3						
	Retention Time of Tanks	5.40	m^3	／	0.42	m^3/Hr	／	1		
		＝	12.802	Hr						
	Number	2	W	+	0	S				

Centrifuge 18/21

STP Process Calculation_Supporting Report 12.2.3

11. Centrifuge Feed Sump

[1] Design Condition

(1) Generated Thickend Sludge — 1,735 kg/day

(2) Solids Consistency — 0.80 %

(3) Volume of Excess Sludge

$$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$$

$$= 1{,}735 \times \frac{100}{0.80} \times 10^{-3}$$

$= 217$ m^3/day

$= 9.04$ m^3/h

(4) Sludge feed flow rate — 22 m3/h × 1 = 22 m3/h

(5) Centrifuge Operation Time — 12 hours/day (6 days per week)

[2] Geometry

(1) Basin Dimensions — Width 4.5 m × Length 4.5 m × Depth 3.0 m × 2

$= 121.5$ m^3

[3] Equipment

(1) Mixers for Centrifuge Feed Sumps

Required Volume — 121.5 m^3

Number — 1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage 2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

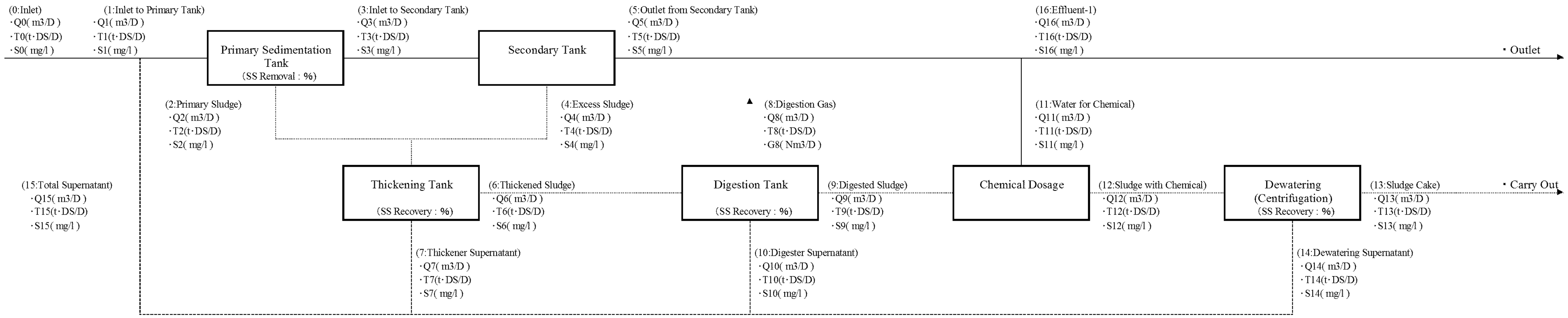
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	4,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	4,000	4,212	0	4,212	217	3,995	217	0	0	217	0	4	221	9	212	212	212			3,995	0
T(t･DS/day)	1.800	1.887	0.000	1.887	1.735	0.040	1.735	0.000	0.000	1.735	0.000	0.009	1.744	1.657	0.087	0.087	0.087			0.040	0.112
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.0	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



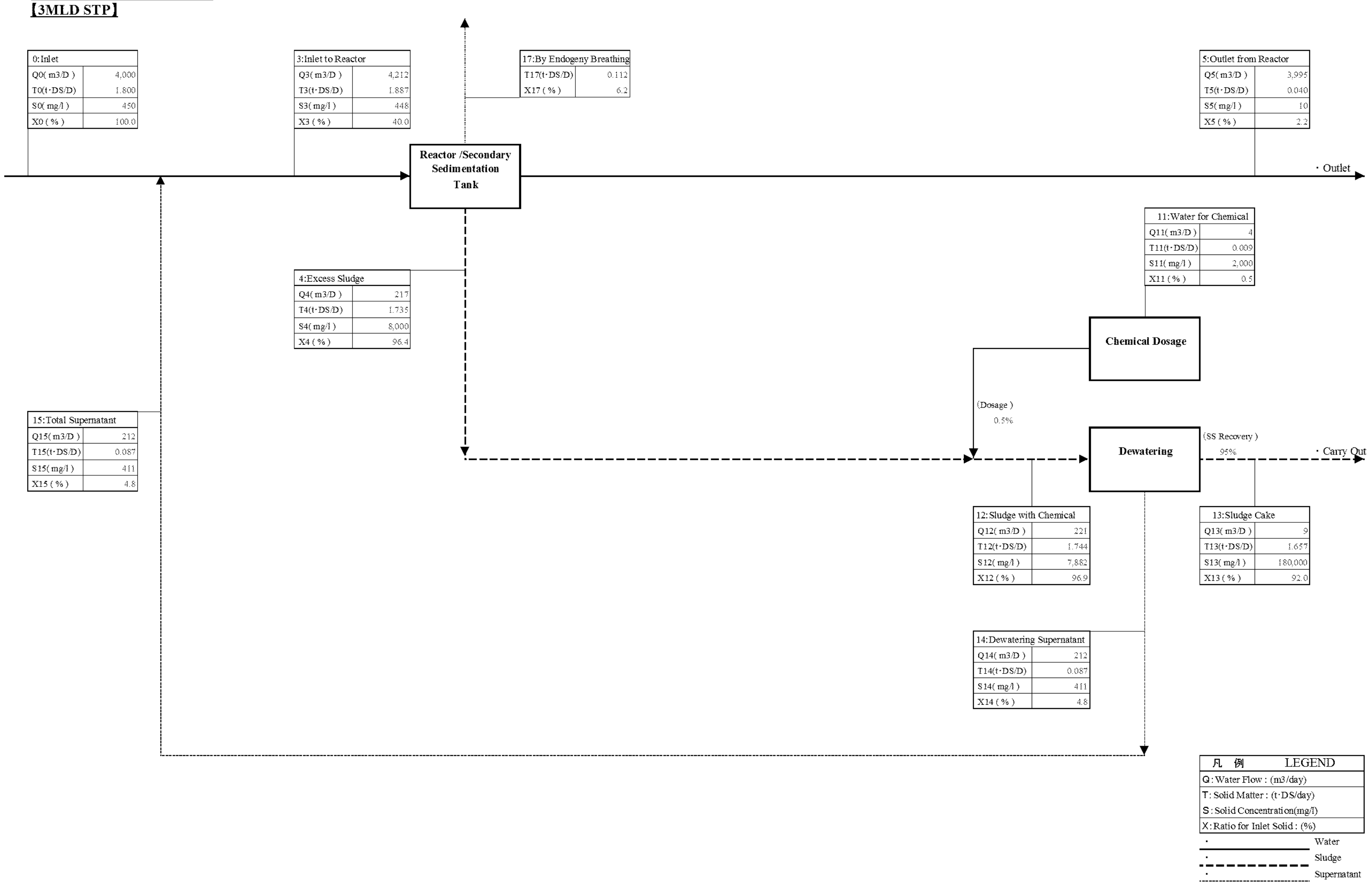
Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【3MLD STP】



C-2 Process Cal_EA&al 5MLD Talaghattapura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	5MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	8,000	333	0.093
Max Dayly	8,000	333	0.093
Max Hourly Peak factor 2.25	18,000	750	0.208

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	5,000	208	0.058
Max Dayly	5,000	208	0.058
Max Hourly Peak factor 2.5	12,500	521	0.145

1. Inlet Chamber

Item	5MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly ＝ 18,000 m3/d
	＝ 0.208 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 ＝ 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.208 × 1
	＝ 15.14 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

C-2 Process Cal_EA&al 5MLD Talaghattapura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	5MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	1 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.208 ／ 0.400 ／ 0.500 ／ 1
whe Design Flow for the year 2049	= 1.040 ＜ 1.000 m/sec OK
Velocity	0.145 ／ 0.400 ／ 0.500 ／ 1
whe Design Flow for the year 2034	= 0.725 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	1.0 Main + 1.0 Bypass
Width	0.800 m
Side Water Depth	0.600 m
Velocity	0.208 ／ 0.800 ／ 0.600 ／ 1
whe Design Flow for the year 2049	= 0.433 ≒ 0.450 m/sec OK
Velocity	0.145 ／ 0.800 ／ 0.600 ／ 1
whe Design Flow for the year 2034	= 0.302 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 0.8 m × Length 8.5 m × SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Units
Dimension	Width 0.4 m × Height 0.6 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	1 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.208 ／ 0.700 ／ 0.550 ／ 1 × (20 + 9) / 20
	= 0.783 ≒ 0.800 m/sec OK
Velocity through screen	0.145 ／ 0.700 ／ 0.550 ／ 1
whe Design Flow for the year 2034	× (20 + 9) / 20
	= 0.546 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.6 m
Velocity through screen	0.208 ／ 0.800 ／ 0.600 ／ 1
whe Design Flow for the year 2049	× (20 + 9) / 20
	= 0.628 ＜ 0.800 m/sec OK
Velocity through screen	0.145 ／ 0.800 ／ 0.600 ／ 1
whe Design Flow for the year 2034	× (20 + 9) / 20
	= 0.438 ＜ 0.800 m/sec OK

Coarse Screen 2/21

C-2 Process Cal_EA&al 5MLD Talaghattapura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item		5MLD STP-TSPS									
[2]	Geometory										
(1)	Raw Sewage Sump										
	Number	1	Basin								
	Dia	8.00	m								
	Pump Operating Depth	1.000	m								
	Retention Time	(	8.00	$^2\times$	π／4	×	1.000	)／	0.208	／60	
	whe Design Flow for the year 2049	＝	4.03	＞	3.75	min (=minimum time of one pump cycle '					OK
	Retention Time	(	8.00	$^2\times$	π／4	×	1.000	)／	0.145	／60	
	whe Design Flow for the year 2034	＝	5.78	＞	3.75	min (=minimum time of one pump cycle '					OK
	High Water Level	+	0.000		m						
	Pump Off Level	+	-1.000		m						
[3]	Equipment										
(1)	Sewage Pumps 1										
	Number	1	W	+	1	S					
	Bore Diameter	250	mm								
	Discharge Flow ： Q	0.145	×	3600	／	1.0					
	whe Design Flow for the year 2034	＝	522	⇒	522	m3/Hr					
	Total Head	15.0	m								
(2)	Sewage Pumps 2										
	Number		W	+		S					
	Bore Diameter		mm								
	Discharge Flow ： 0.5			／							
	whe Design Flow for the year 2034	＝		⇒		m3/Hr					
	Total Head		m								

Raw Sewage Sump 3/21

C-2 Process Cal_EA&al 5MLD Talaghattapura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	5MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	5,000	208.33	0.058
Max Daily	5,000	208.33	0.058
Max Hourly Peak factor 2.5	12,500	520.83	0.145

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 12,500 m3/day
= 0.145 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.000 m

(3) Width of Basin — 2.100 m

(4) Length of Basin — 1.500 m

(5) Volume required of Basin — 1.000 × 2.100 × 1.500 = 1.4 m3

(6) Retention Time — 1.000 × 2.100 × 1.500 ／ 0.145 × 1
= 21.72 sec

(7) Basin Dimensions — Width 2.100 m × Length 1.500 m
× Depth 1.000 m

STP basic &Stilling Chamber4/21

C-2 Process Cal_EA&al 5MLD Talaghattapura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

3. Fine Screen Channel

〔1〕Design Condition

(1)	Design Wastewater Flow		Max Hourly		=	12,500	m3/d				
					=	0.145	m3/sec				
[2]	Geometory										
(1)	Inlet Gate										
	Number	1	Main	+	1	Bypass					
	Width	0.400	m								
	Height	0.600	m								
	Floor Level	+	2.000	m							
	Bottom	+	0.000	m							
	Influent Water Level	+	0.500	m							
	Velocity	0.145	／	0.400	／	0.500	／	1			
		=	0.725	≒	1.000	m/sec					
(2)	Screen Channel										
	Number	1	Main	+	1	Bypass					
	Width	0.800	m								
	Side Water Depth	0.400	m								
	Velocity	0.145	／	0.800	／	0.400	／	1			
		=	0.453	≒	0.450	m/sec					
(3)	Channel Dimensions	Width	0.8	m	×	Length	6.0	m			
		×	SWD	0.4	m	(Freeboard 0.3m)					
[3]	Equipment										
(1)	Inlet Gate										
	Number	1	W	+	1	S					
	Dimension	Width	0.4	m	×	Height	0.60	m			
	Design Water Level	2.00	m								
(2)	Fine Screens (Main Channel)										
	Number	1	W	+	0	S					
	Open Space	6	mm								
	Bar Thickness	2	mm								
	Channel Width	0.8	m								
	Width of side plate	50	mm								
	Side Water Depth	0.4	m								
	Height of Blind Plate at the bottom	50	mm								
	Velocity through screen	0.145	／	0.700	／	0.350	／	1			
		×(	6	+	2	)/	6				
		=	0.789	＜	0.800	m/sec					
(3)	Fine Screens (Bypass Channel)										
	Number	0	W	+	1	S					
	Open Space	20	mm								
	Bar Thickness	9	mm								
	Channel Width	0.8	m								
	Side Water Depth	0.4	m								
	Velocity through screen	0.145	／	0.800	／	0.400	／	1			
		×(	20	+	9	)/	20				
		=	0.657	＜	0.800	m/sec					

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4. Grit Chamber

[1] Design Condition

(1)	Design Flow Rate	Max Hourly = 12,500 m^3/day
		= 0.145 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec

[2] Grit Chamber — **Square Grit Chamber**

(1)	Surface Area required	0.145 ／ 0.0111 = 13.06 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	13.1 ／ 1 = 13.06 m^2
(4)	Length of Basin	13.06 ^0.5 = 3.6 m → 4.0 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.145 × 60 sec ／ 1 = 8.7 m^3
(7)	Depth required	8.7 ／ 4.0 ／ 4.0 = 0.544 m
(8)	Basin Dimensions	Width 4.0 m × Length 4.0 m
		× Depth 0.5 m (Freeboard 0.3m)
(9)	Retention Time	4 × 4.0 × 0.5 ／ 0.145 × 1
		= 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	12,500 ／ 4.0 ／ 4.0 ／ 1
		= 781.25 ＜ 960 m^3/m^2/day

[3] Parshall Flume

(1)	Design Flow Rate	Q= 145.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
		Ha= 0.273 m
(4)	Crest Level	+ 75.400 m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 75.673 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.138 m/sec
(10)	Total Length of channel	10.000 m

[4] Inlet Weir Gate

(1)	Number	2 Units
(2)	Weir Width	0.400 m
(3)	Stroke	0.450 m
(4)	Overflow Height	0.400 m
(5)	Overflow Height (actual)	(0.145 ／ 1.840 ／ 0.400 ／ 2) $^{2/3}$
		= 0.213 ＜ 0.400 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	5,000	m^3/day (summer)	
	Q'=	5,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* =	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃ = 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃ = 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	1563.519	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	2060.500	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g･d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	903.725	kg VSS/d	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ +QYn(Nox)/[2+bAOB(SRT)]
			811.476		$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			73.033		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			19.216		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	3,434	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS} \cdot Va$	$X_{VSS} \cdot Va$=	7,818	kg VSS	$=Px,_{VSS} \cdot SRT$
	$X_{TSS} \cdot Va$	$X_{TSS} \cdot Va$=	10,302	kg TSS	$=Px,_{TSS} \cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3･d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	2,885	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g･d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g･d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g･d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g･d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = $Q \cdot (SRT)/V \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
= 1,181.47 mg/*l*

(2) IR ratio
IR = NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= (IR+R)・Q・Ne
= 191,553.05 kg/d

(4) The anoxic tank volume
Vnor= 343 m3 = Va× 10%
Vnor= 1,042 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb
SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.110 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - $0.029\ln(F/M_b)$-0.012 IR=3-4
=$SDNR_t$ - $0.0166\ln(F/M_b)$-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 260,496.54 kg/d =$N_{nox} \cdot SDNR \cdot X_b$
>Nox feed= 191,553 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk produce 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to maint 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 1563.519 kg /d
Rwmoval Phosphorus 15.63519013 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, $Al_2(SO_4)_3 \cdot 18H_2O$
(5) Required Aluminium Sulphate 214.89 kg/d
(6) Required Aluminium Sulphate solu 10% 2.05 m3/d
85.27 L/H
(7) Additional sludge 87.12 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins
V_A = Q'*θa/24
= 3,750 m^3

(2) Total volume of Anoxic Basins
V_{DN} = Q'*θ_{DN}/24
= 1,042 m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	310	1.50	1.50	0.30
Anoxic	V_{DN}	1,042	5.00	5.00	1.00
Aerobic	V_A	3,750	18.00	18.00	3.60
Total	V	5,102	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	63.0	5.5	2

Cross Section	8.0*5.5	=	44.0	m^2/Basin	
Hantzsch Subtraction		=	1.0	m^2/Basin	
after Subtraction	44.0-1.0	=	43.0	m^2/Basin	
Total Volume	43.0*63.0	=	2,709	m^2/Basin	5,418 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**3.6**	**12.1**	**43.6**	**59.3**
Volume required per Basin	m^3	155	521	1,875	2,551
Total Volume required	m^3	310	1,042	3,750	5,102
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	5.0	13.0	45.0	63.0
Actual Volume per Basin	m^3	215	559	1,935	2,709
Actual Total Volume	m^3	430	1,118	3,870	5,418
Actual Ratio of Volume		0.38	1.00	3.46	
Actual Retention Time	hour	2.06	5.37	18.58	26.01

[7] Equipment

(1) Ras Pumps
Ras Ratio 60%
Required Capacity 5,000 m3/day× 60% ／24 ／ 2
= 63 m3/Hr ⇒ 65 m3/Hr
Number 2 Work
2 Standby

(2) Circulation Pumps
Ras Ratio 366%
Required Capacity 5,000 m3/day× 366% ／24 ／ 4
= 190 m3/Hr ⇒ 190 m3/Hr
Number 4 Work
2 Standby

(3) SAS Pumps
Excess Sludge 271 m3/day
Sludge withdraw 12 Times/day
Running Time 0.5 Hr/Time
Required Capacity 271 m3/day ／ 12 ／ 0.50 ／ 2
= 22.60 m3/Hr ⇒ 23 m3/Hr
Number 2 Work
2 Standby

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(4)	Alum Solution Tank											
	Number	2	W	+	0	S						
	Alum concentration as crystal	10	%									
	Gravity of dissolved dechlorine	1.05										
	Required solution volume	214.89	kg / d	×	100	/	10	/	1.05	/	1000	
		＝	2.05	m3/d								
	Volume of Tank	1.5		m3/tank								
	Total Volume of Tanks	3.0		m3	(Duration=	1.47	day)					
(5)	Mixer for Alum Solution Tank											
	Number	2	W	+	0	S						
(6)	Alum Dosing Pump											
	Number	2	W	+	1	S						
	Capacity	2.05	m3/d	/	24	×	1000	/	2	×	2	
		85.27	l/h/unit	⇒	90	l/h/unit						

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6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR	AOR	=	2,163	kg/day
			=	90.1	kg/h
	Qin :Design Average Flow m^3/d	5,000			
	Inlet bCOD $:S_0$	578 mg/l			
	S=	S= 0.451 mg/l			
	Nox=	Nox 47.400 mg/l			
	$P_{X,bio}$=	$P_{X,b}$ 884.5 kg VSS/d does not include nitrifying bacteria			
	R_0=	$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$			
	R_0=	R_0= 2,163 kg O2/d			
		k= 2.86			

(2) SOR(Standard Oxygen Transfer Rate at site)

$$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \; (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		$1+0.40D_j/Pa$	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R*T]$	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{23,470}{4.2591} = 5,510.49 \text{ kg/day}$$

(3)	No. of Basins	2	Basin
(4)	Standard O2 required at Field Conditions per Bas	= 2,755	kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0	%
(6)	Fraction of O2 in Air	23.18	%
(7)	Specific Gravity of Air at Standard Condition	1.293	
(8)	Safety Factor	15%	
(9)	Air required at Field Conditions per Basins	= 40,522	m^3/day = 1,688.4 m^3/hr

[2] Equipment

Air Requirement at Average Flow12/21

(1) Air Blower						
Number	2	W	+	1	S	
Required Capacity	1688.4	m^3/Hr・Basin	／	1	unit/Basin	
	＝ 1688.4	m^3/h	⇒	1700	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	32.165	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	45.477	kW				
Rated Output of Motor	50.024	kW	⇒	55	kW	

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7.	**Final Clarifire**	
〔1〕	**Design Condition**	
(1)	Design Wastewater Flow	Q＝ 5,000 m^3/day
(2)	Water Temperature	T＝ 20.0 ℃
(3)	MLSS	Xef＝ 3,000 mg/*l*
(4)	SVI	SVI＝ 300
(5)	Sedimentation Velocity	*v* ＝ 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77) ＝ 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770 ＝ 20.7 m/day
(6)	Surface Overflow Rate required	*S'*＝ v/(1.5*1)＝ 20.7/(1.5*1.0) ＝ 13.8 $m^3/m^2\cdot day$ → 12.0 $m^3/m^2\cdot day$
[2]	**Geometory**	
(1)	Surface Area required	A＝ 5,000/12.0＝ ＝ 417 m^2
(2)	Demensions	Diameter **16.5** Depth **3.5** Basin **2**
(3)	Actual Surface Area	S＝ 16.5^2 * 3.14 /4 * 2.0 ＝ 428 m^2
(4)	Surface Overflow Rate	S＝ 5,000/428 ＝ 11.7 $m^3/m^2\cdot day$

C-2 Process Cal_EA&al 5MLD Talaghattapura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

8. Chlorination

[1] Design Condition

(1) Design Flow Rate	Average Flow	5,000	m^3/day	208.33	m^3/h	
	Peak Flow	12,500	m^3/day	520.83	m^3/h	
(2) Contact Time	30	min				
(3) Type of Chlorine	Cl_2-GAS					
(4) Design Chlorine Dosage Rate	10	mg/L				
(5) Required Chlorine per day	Average Daily Flow	／	1000	×	Design Chlorine Dosage Rate	
	=	50.0	kg/d			
	=	2.08	kg/h			

[2] Chlorination Contact Tank

(1) Volume required	Average Daily Flow	／	1440	×	Contact Time				
	=	104.2	m^3						
(2) Nos. of lanes	3	lanes							
(3) Width of lane	1.50	m							
(4) Length of lane	16.00	m							
(5) Side Water Depth	1.50	m							
(6) Nos. of Tanks	1	tank							
(7) Total Width of Tank	5.30	m Approx..							
(8) Average Velocity	Decant Flow	／	3600	／	Width	／	Depth		
	=	208.33	／	3600	／	1.50	／	1.50	
	=	0.026	m/sec						
(9) Total Volume	Width	×	Length	×	Depth	×	Nos. of lanes	×	Nos. of Tanks
	=	1.5	m	×	16.0	m	×	1.5	m
		×	3	×	1				
	=	108	m^3	>	104.2	m^3			

[3] Equipment

(1) Chlorine Dosing Condition

Operation Dosage Rate -1	DC1	1 mg/L	10 mg/L
Average Dosage Rate -1	DC2	10 mg/L	

(2) Chlorine Cylinder

Type	-	Cylindrical Convexsd Container
Cylinder Capacity	Cc	928 kg/cylinder
Average Dosage Rate -1	q1	Chlorine -1 : Q_{T-D} x DC2 x 10^{-6} x 10^3 = 50 kg/day
Storage day	T	More than 15 days
Required Storage Capacity	EC1	D x T = 750 kg
Unit Number	EN1	EC1 / Cc = 0.8 cylinders
Maximum Operation Numbers		
Cl_2-Gas Volatilize Rate	Vr1	#### @ 20^{O}C Standard temperature
Maximum Dosing Rate	DC1	10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = ####
Operation Numbers	EN2	DC1 / Vr1 = 0.7sets

(3) Chlorinator

Type	Solution Feed Vacuum Type					
Number	1	W	+	1	S	
Operation Dosage Rate -1	Dq1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =				
	5	kg/day to	125	kg/day		
Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =					
	Minimum		Maximum			
	0.21	kg/hr	5.2	kg/hr		

Chlorination Tank (gas)15/21

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STP Process Calculation_Supporting Report 12.2.3

(4) Chlorine Booster Pump	
Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori
Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
Water Demand	(L/min) 15 20 25 30 35 40
Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
Water Demand	(L/min) 45 50 60 300 600 1,200
Water requiamet	-
For Chlorin	Qp1 Maximum dosage ra 5.2 kg/hr
	therefore 45 L/min
Booster Pump Type	Single suction volute pump
Number	1 W + 1 S
9. Dechlorination	
〔1〕 Design Condition	
(1) Design Flow Rate	Average Daily Flow 5,000 m^3/day
(2) Contact Time	10 min
(3) Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3\ 5H_2O$)
(4) Free Residual Chlorine	1.0 mg/L assumed value
(5) Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
	× 1.5 (safety factor)
	＝ 13.13 kg/d
	＝ 0.547 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Flow Rate ／ 60 × Contact Time
	＝ 34.7 m^3
(2) Width of lane	5.30 m
(3) Length of lane	5.00 m
(4) Side Water Depth	1.50 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 5.3 m × 5.0 m × 1.5 m
	＝ 40 m^3 > 34.7 m^3
[3] Equipment	
(1) Dechlorine Solution Tank	
Number	1 W + 0 S
Dechlorine concentration	10 %
Gravity of dissolved dechlorine	1.10
Required solution volume	13.13 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.12 m3/d
Volume of Tank	0.2 m3/tank
Total Volume of Tanks	0.2 m3 (Duration= 1.68 day)
(2) Mixer for Dechlorine Solution Tank	
Number	1 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	0.30 m3/d / 24 × 1000 / 1
	12.43 l/h/unit ⇒ 13.0 l/h/unit

Chlorination Tank (gas)16/21

C-2 Process Cal_EA&al 5MLD Talaghattapura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Generated Sludge	2,169 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(4)	Volume of Thickend Sludge	271.2 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	12 hours/day (6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{271.2}{12 \times 1} \times \frac{7}{6} = 26.4$$

→ 27 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 2,169 × (1 + 0.0050)

= 2,180 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 2.180 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 14.13 t/day

apparent specific gravity 1.00

14.13 ／ 1.0 = 14.1 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(2)	Required Polyelectrolyte	10.85 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	5.42 m3/day

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STP Process Calculation_Supporting Report 12.2.3

[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	27 m^3/hr
	Number	1 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	27 m^3/hr
	Number	1 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	5.42 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	1 W + 1 S
	Required Capacity	5.42 m3/da; × 7 ／ 6 ／ 12 ／ 1
		＝ 0.53 m^3/Hr
	Specification Capacity	0.53 m^3/Hr × 1.5
		＝ 0.791 m^3/Hr ⇒ 0.80 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Tanks Dimensions	Width 1.5 m × Length 1.5 m
		× Depth 1.8 m × 2
		＝ 8.1 m^3
	Retention Time of Tanks	8.10 m^3 ／ 0.53 m^3/Hr ／ 1
		＝ 15.361 Hr
	Number	2 W + 0 S

Centrifuge 18/21

11. Centrifuge Feed Sump

[1] Design Condition

(1) Generated Thickend Sludge: 2,169 kg/day

(2) Solids Consistency: 0.80 %

(3) Volume of Excess Sludge:

$$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$$

$$= 2{,}169 \times \frac{100}{0.80} \times 10^{-3}$$

$= 271$ m^3/day

$= 11.30$ m^3/h

(4) Sludge feed flow rate: 27 m3/h × 1 = 27 m3/h

(5) Centrifuge Operation Time: 12 hours/day (6 days per week)

[2] Geometry

(1) Basin Dimensions: Width 4.5 m × Length 5.0 m × Depth 3.5 m × 2

$= 157.5$ m^3

[3] Equipment

(1) Mixers for Centrifuge Feed Sumps

Required Volume: 157.5 m^3

Number: 1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

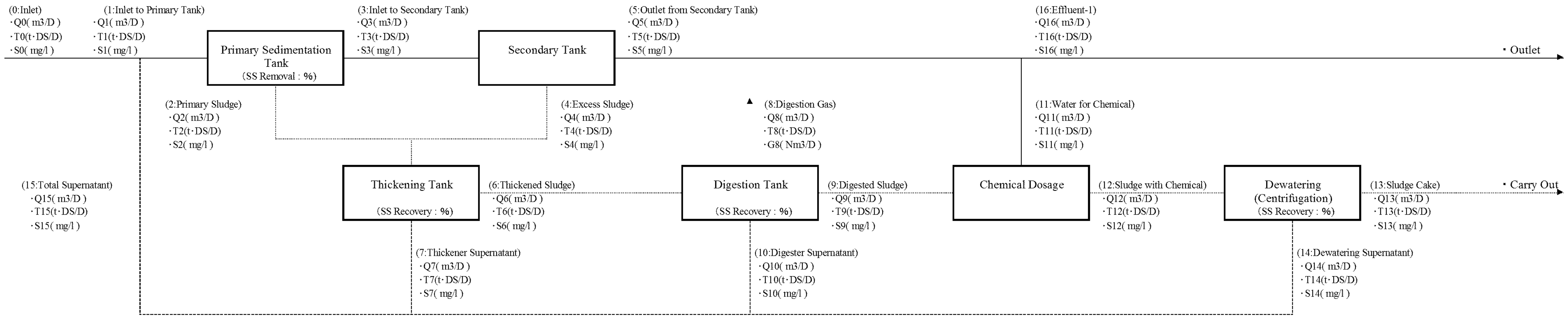
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	5,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	5,000	5,265	0	5,265	271	4,994	271	0	0	271	0	5	277	12	265	265	265			4,994	0
T(t･DS/day)	2.250	2.359	0.000	2.359	2.169	0.050	2.169	0.000	0.000	2.169	0.000	0.011	2.180	2.071	0.109	0.109	0.109			0.050	0.140
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model

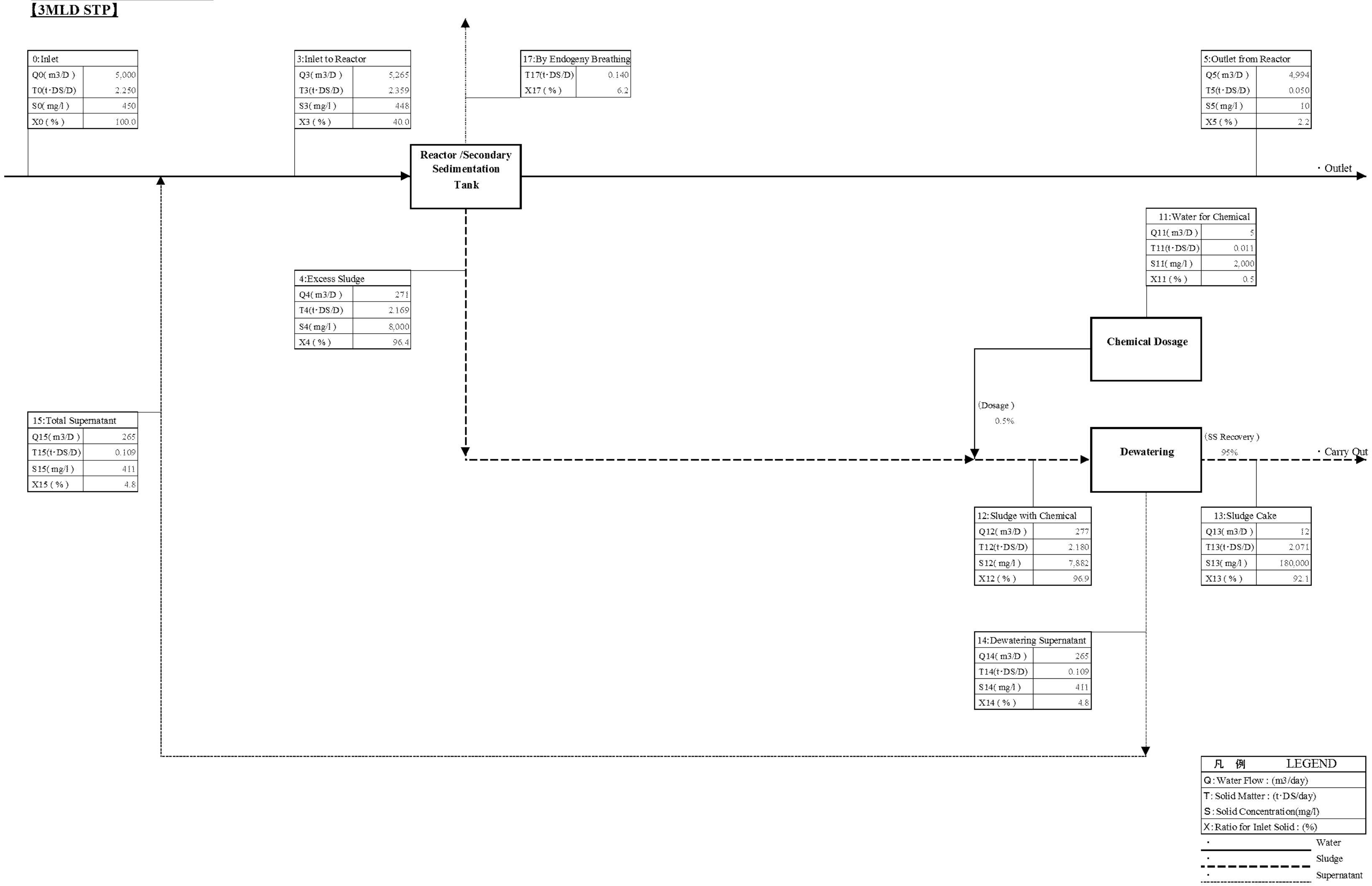


Calculation Formula						
･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【3MLD STP】



D-1 Process Cal_ EA&al 8MLD Somapura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	8MLD STP-MPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	####	500	0.139
Max Dayly	####	500	0.139
Max Hourly Peak factor 2.25	####	1125	0.313

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	8,000	333	0.093
Max Dayly	8,000	333	0.093
Max Hourly Peak factor 2.25	####	750	0.208

1. Inlet Chamber

Item	8MLD STP-MPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly ＝ 27,000 m3/d
	＝ 0.313 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 ＝ 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.313 × 1
	＝ 10.06 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

D-1 Process Cal_ EA&al 8MLD Somapura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	8MLD STP-MPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.500 m
Height	0.750 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.313 ／ 0.500 ／ 0.500 ／ 2
whe Design Flow for the year 2049	= 0.626 < 1.000 m/sec OK
Velocity	0.208 ／ 0.500 ／ 0.500 ／ 1
whe Design Flow for the year 2034	= 0.832 < 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	0.800 m
Side Water Depth	0.600 m
Velocity	0.313 ／ 0.800 ／ 0.600 ／ 2
whe Design Flow for the year 2049	= 0.326 ≒ 0.450 m/sec OK
Velocity	0.208 ／ 0.800 ／ 0.600 ／ 1
whe Design Flow for the year 2034	= 0.433 < 0.450 m/sec OK
(3) Channel Dimensions	Width 0.8 m × Length 6.0 m × SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.5 m × Height 0.75 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.313 ／ 0.700 ／ 0.550 ／ 2 × (20 + 9) / 20 = 0.589 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.208 ／ 0.700 ／ 0.550 ／ 1 × (20 + 9) / 20 = 0.783 < 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.6 m
Velocity through screen whe Design Flow for the year 2049	0.313 ／ 0.800 ／ 0.600 ／ 2 × (50 + 9) / 50 = 0.385 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.208 ／ 0.800 ／ 0.600 ／ 1 × (50 + 9) / 50 = 0.511 < 0.800 m/sec OK

Coarse Screen 2/21

D-1 Process Cal_ EA&al 8MLD Somapura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item	8MLD STP-MPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	9.50 m
Pump Operating Depth	1.000 m
Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.313 ／60
whe Design Flow for the year 2049	＝ 3.77 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
Retention Time	(9.50 ^{2}× π／4 × 1.000)／ 0.208 ／60
whe Design Flow for the year 2034	＝ 5.68 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	200 mm
Discharge Flow ： 40% Q* 2	0.208 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 300 ⇒ 300 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	150 mm
Discharge Flow ： 20% Q* 1	0.208 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 150 ⇒ 150 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/21

D-1 Process Cal_ EA&al 8MLD Somapura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	8MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	8,000	333.33	0.093
Max Daily	8,000	333.33	0.093
Max Hourly Peak factor 2.25	18,000	750.00	0.208

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 18,000 m3/day
= 0.208 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.500 m

(3) Width of Basin — 2.100 m

(4) Length of Basin — 2.000 m

(5) Volume required of Basin — 1.500 × 2.100 × 2.000 = 1.6 m3

(6) Retention Time — 1.500 × 2.100 × 2.000 ／ 0.208 × 1
= 30.29 sec

(7) Basin Dimensions — Width 2.100 m × Length 2.000 m
× Depth 1.500 m

STP basic &Stilling Chamber4/21

D-1 Process Cal_ EA&al 8MLD Somapura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

3. Fine Screen Channel

〔1〕Design Condition

(1)	Design Wastewater Flow	Max Hourly = 18,000 m3/d
		= 0.208 m3/sec
[2]	Geometory	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Width	0.400 m
	Height	0.600 m
	Floor Level	+ 2.000 m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.300 m
	Velocity	0.208 ／ 0.400 ／ 0.300 ／ 2
		= 0.867 ≒ 1.000 m/sec
(2)	Screen Channel	
	Number	2 Main + 1 Bypass
	Width	0.800 m
	Side Water Depth	0.400 m
	Velocity	0.208 ／ 0.800 ／ 0.400 ／ 2
		= 0.325 ≒ 0.450 m/sec
(3)	Channel Dimensions	Width 0.8 m × Length 6.0 m
		× SWD 0.4 m
[3]	Equipment	
(1)	Inlet Gate	
	Number	2 W + 1 S
	Dimension	Width 0.4 m × Height 0.60 m
	Design Water Level	2.00 m
(2)	Fine Screens (Main Channel)	
	Number	2 W + 0 S
	Open Space	6 mm
	Bar Thickness	2 mm
	Channel Width	0.8 m
	Width of side plate	50 mm
	Side Water Depth	0.4 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.208 ／ 0.700 ／ 0.350 ／ 2
		×(6 + 2)/ 6
		= 0.566 ＜ 0.800 m/sec
(3)	Fine Screens (Bypass Channel)	
	Number	0 W + 1 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	0.8 m
	Side Water Depth	0.4 m
	Velocity through screen	0.208 ／ 0.800 ／ 0.400 ／ 2
		×(20 + 9)/ 20
		= 0.471 ＜ 0.800 m/sec

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4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Peak flow = 18,000 m^3/day = 0.208 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec
[2]	**Grit Chamber**	**Square Grit Chamber**
(1)	Surface Area required	0.208 ／ 0.0111 = 18.74 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	18.7 ／ 1 = 18.74 m^2
(4)	Length of Basin	18.74 ^0.5 = 4.3 m → 4.5 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.208 × 60 sec ／ 1 = 12.5 m^3
(7)	Depth required	12.5 ／ 4.5 ／ 4.5 = 0.616 m
(8)	Basin Dimensions	Width 4.5 m × Length 4.5 m × Depth 0.6 m (Freeboard 0.3m)
(9)	Retention Time	4.5 × 4.5 × 0.6 ／ 0.208 × 1 = 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	18,000 ／ 4.5 ／ 4.5 ／ 1 = 888.9 < 960 m^3/m^2/day
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 208.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$ Ha= 0.347 m
(4)	Crest Level	+ m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 0.347 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.198 m/sec
(10)	Total Length of channel	10.000 m
[4]	**Inlet Weir Gate**	
(1)	Number	2 Units
(2)	Weir Width	0.600 m
(3)	Stroke	0.450 m
(4)	Overflow Height	0.400 m
(5)	Overflow Height (actual)	(0.208 ／ 1.840 ／ 0.600 ／ 2) $^{2/3}$ = 0.207 < 0.400 m

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5. Reactor

〔1〕 Design Condition

(1)	Design Wastewater Flow	Q=	8,000	m^3/day (summer)	
		Q'=	8,000	m^3/day(Winter)	
(2)	Design Sewage Quality				
	Inlet BOD		350	mg/*l*	
	Outlet BOD		10.0	mg/*l*	
	Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
	Inlet COD		800	mg/*l*	
	Inlet bCOD :S_0		578	mg/*l*	
	Inlet nbCOD		223	mg/*l*	
	bCOD/BOD		1.65		
	Inlet S-COD :sCOD		271	mg/*l*	
	Inlet rbCOD		231	mg/*l*	bCOD*40%
	Inlet sbCOD		347	mg/*l*	bCOD*60%
	Outlet S-COD :nbsCODe		40	mg/*l*	
	Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
	Inlet SS		450	mg/*l*	
	Inlet VSS		383	mg/*l*	assumed as 85% of TSS
	:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
	:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
	:iTSS		67.50	gnbVSS/m3	=TSS-VSS
	Inlet T-N		70	mg/*l*	
	Inlet TKN		70	mg/*l*	
	Inlet NH_4-N		45.0	mg/*l*	
	Inlet T-P		7	mg/*l*	
	Inlet D-P		5	mg/*l*	
	Inlet Alkalinity as CaCO3		380	mg/*l*	
	Outlet Kjeldahl N		1.0	mg/*l*	
	Outlet NH4-N		1.0	mg/*l*	
	Outlet NO3-N		9.0	mg/*l*	
	Outlet T-P		2	mg/*l*	
	Outlet D-P		1	mg/*l*	
(3)	Water Temperature	T=	20.0	℃	
(4)	Safety Factor for Nitrogen	SF=	1.5		
(5)	Return Sludge Concentration	*Rs* =	8,000	mg/*l*	
(6)	MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7)	DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2)	μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
	$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃= 0.900
	$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃= 0.170
	S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
	DO	DO=	2.0000	mg/*l*	
	$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2) Design SRT		SRT=	4.8387	day	=1/ μ_{AOB} × SF
		⇒	5.0000	day	
(3) Biomass production					
	$Px,_{VSS}$	$Px,_{VSS}$=	2501.630	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	3296.800	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al
	S	S=	0.4507	mg/*l*	=Ks[1+b_H(SRT)]/[SRT(μ_m-b_H)-1]
	b_H	b_H=	0.1200		=b*1.04$^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	=μ_{max}*1.04$^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1445.959	kg VSS/d	=Q・Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)] +QYn(Nox)/[2+bAOB(SRT)]
			1298.361		=Q・Y_H(S_0-S)/[1+b_H(SRT)]
			116.852		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]
			30.746		=QYn(Nox)/[1+b_{AOB}(SRT)]
	NOx	NOx=	47.311	mg/*l*	=TKN-Ne-0.12$P_{X,bio}$/Q
(4) Required Aeration Tank Volume					
	Va=	Va=	5,495	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	X_{VSS}・Va	X_{VSS}・Va=	12,508	kg VSS	=$Px,_{VSS}$・SRT
	X_{TSS}・Va	X_{TSS}・Va=	16,484	kg TSS	=$Px,_{TSS}$・SRT
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5) BODloading		BODloading	0.510	kg/m3・d	
(6) Observed Yield					
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	4,616	kg/d	
(7) effluent NO_2-N		NO_2-N=	0.2315	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*1.029$^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	=μ_{max}*1.04$^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8) effluent NH_4-N		NH_4-N=	0.5286	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*1.029$^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	=μ_{max}*1.072$^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	=$\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9) Ratio of Return Sludge		8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — X_b = Q・(SRT)/V・Y_H(S_0-S)/[1+b_H(SRT)]
= 1,181.47 mg/*l*

(2) IR ratio — IR= NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 306,484.88 kg/d

(4) The anoxic tank volume — Vnor= 549 m3 = Va× 10%
Vnor= 1,667 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb — SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.110 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 416,794.46 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 306,485 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk produce‹ 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to maint: 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P — 3.13 mg/l
P in waste sludge — px= 1.00%
Generated waste sludge — $Px_{,VSS}$= 2501.630 kg /d
Rwmoval Phosphorus — 25.01630421 kg /d
(2) Effluent T-P without Al — 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio — 1.00 mol/mol
(4) Required Al dosing rate — 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Alumnum Sulfate — 343.82 kg/d
(6) Required Alumnum Sulfate solutic 10% — 3.27 m3/d
136.44 L/H
(7) Additional sludge — 139.39 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

V_A = Q'*θa/24
= 6,000 m^3

(2) Total volume of Anoxic Basins

V_{DN} = Q'*$θ_{DN}$/24
= 1,667 m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	500	1.50	1.50	0.30
Anoxic	V_{DN}	1,667	5.00	5.00	1.00
Aerobic	V_A	6,000	18.00	18.00	3.60
Total	V	8,167	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	96.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin
Hantzsch Subtraction = 1.0 m^2/Basin
after Subtraction: 44.0-1.0 = 43.0 m^2/Basin
Total Volume: 43.0*96.0 = 4,128 m^2/Basin 8,256 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**5.8**	**19.4**	**69.8**	**95.0**
Volume required per Basin	m^3	250	834	3,000	4,084
Total Volume required	m^3	500	1,667	6,000	8,167
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	6.0	20.0	70.0	96.0
Actual Volume per Basin	m^3	258	860	3,010	4,128
Actual Total Volume	m^3	516	1,720	6,020	8,256
Actual Ratio of Volume		0.30	1.00	3.50	
Actual Retention Time	hour	1.55	5.16	18.06	24.77

[7] Equipment

(1) Ras Pumps

Ras Ratio: 60%
Required Capacity: 8,000 m3/day× 60% ／ 24 ／ 2
= 100 m3/Hr ⇒ 100 m3/Hr
Number: 2 Work
2 Stanby

(2) Circulation Pumps

Ras Ratio: 366%
Required Capacity: 8,000 m3/day× 366% ／ 24 ／ 4
= 305 m3/Hr ⇒ 305 m3/Hr
Number: 4 Work
2 Stanby

(3) SAS Pumps

Excess Sludge: 434 m3/day
Sludge withdraw: 12 Times/day
Running Time: 0.5 Hr/Time
Required Capacity: 434 m3/day ／ 12 ／ 0.50 ／ 2
= 36.15 m3/Hr ⇒ 40 m3/Hr
Number: 2 Work
2 Stanby

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(4) Alum Solution Tank											
Number	2	W	+		0	S					
Alum concentration as crystal	10	%									
Gravity of dissolved dechlorine	1.05										
Required solution volume	343.82	kg / d	×	100	/	10	/	1.05	/	1000	
	=	3.27	m3/d								
Volume of Tank	2.6		m3/tank								
Total Volume of Tanks	5.2		m3		(Duration=	1.59	day)				
(5) Mixer for Alum Solution Tank											
Number	2	W	+	0		S					
(6) Alum Dosing Pump											
Number	2	W	+	1		S					
Capacity	3.27	m3/d	/	24	×	1000	/	2	×	2	
	136.44	l/h/unit	⇒	140	l/h/unit						

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6. Air Requirement at Average Flow	
〔1〕Design Condition	
(1) AOR	AOR = 3,461 kg/day
	= 144.2 kg/h
Qin :Design Average Flow m^3/d	8,000
Inlet bCOD :S_0	578 mg/*l*
S=	S= 0.451 mg/*l*
Nox=	Nox 47.400 mg/*l*
$P_{X,bio}$=	$P_{X,b}$ 1,415.2 kg VSS/d does not include nitrifying bacteria
R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx
R_0=	R_0= 3,461 kg O2/d
	k= 2.86
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃ 9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature 9.09 mg/L at 20 ℃
	20-T : 0.0 1.024^{20-T} : 1.0000
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth 1+0.40D_j/Pa 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at s 10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : exp[-gM(z_b-z_a)/R*T] 0.900
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t = 293.15 Kelvin
	α : relative Transfer Rate to clean Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \dfrac{37,552}{4.2591} =$ 8,816.79 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas	= 4,408 kg/day
(5) SOTE for the above Effective Aeration Depth	28.0 %
(6) Fraction of O2 in Air	23.18 %
(7) Specific Gravity of Air at Standard Condition	1.293
(8) Safety Factor	15%
(9) Air required at Field Conditions per Basins	= 64,836 m^3/day = 2,701.5 m^3/hr
[2] Equipment	

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(1) Air Blower						
Number	4	W	+	2	S	
Required Capacity	2701.5	m^3/Hr・Basin	／	2	unit/Basin	
	＝ 1350.7	m^3/h	⇒	1400	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	26.488	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	37.451	kW				
Rated Output of Motor	41.196	kW	⇒	45	kW	

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7. **Final Clarifire**					
〔1〕 **Design Condition**					
(1) Design Wastewater Flow	Q= 8,000 m^3/day				
(2) Water Temperature	T= 20.0 ℃				
(3) MLSS	Xef= 3,000 mg/*l*				
(4) SVI	SVI= 300				
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)				
	= 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770				
	= 20.7 m/day				
(6) Surface Overflow Rate required	*S*'= v/(1.5*1)=	20.7/(1.5*1.0)		=	13.8 m^3/m^2·day
				→	12.0 m^3/m^2·day
[2] Geometory					
(1) Surface Area required	A= 8,000/12.0=			=	667 m^2
(2) Demensions	Diameter	Depth	Basin		
	21.0	**3.5**	**2**		
(3) Actual Surface Area	S= 21.0^2 * 3.14 /4 * 2.0			=	693 m^2
(4) Surface Overflow Rate	S= 8,000/693			=	11.5 m^3/m^2·day

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow 8,000 m^3/day 333.33 m^3/h
		Peak Flow 18,000 m^3/day 750.00 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 80.0 kg/d
		＝ 3.33 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 166.7 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	2.00 m
(4)	Length of lane	14.00 m
(5)	Side Water Depth	2.00 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	6.80 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 333.33 ／ 3600 ／ 2.00 ／ 2.00
		＝ 0.023 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 2.0 m × 14.0 m × 2.0 m
		× 3 × 1
		＝ 168 m^3 > 166.7 m^3

[3] Equipment

(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 80 kg/day
	Maximum Dosage Rate -1	q3 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 180 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 1,200 kg
	Unit Number	EN1 EC1 / Cc = 1.3 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vr1 #### @ 20°C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = 7.50 kg/h
	Operation Numbers	EN2 DC1 / Vr1 = 0.9sets
	Number	2 W + 2 S
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
		180 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.00 kg/hr 7.5 kg/hr

Chlorination Tank (gas) 15/21

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(4)	Chlorine Booster Pump	
	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 7.5 kg/hr
		therefore 60 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 8,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 21.0 kg/d
		＝ 0.88 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 55.6 m^3
(2)	Width of lane	6.80 m
(3)	Length of lane	5.00 m
(4)	Side Water Depth	2.00 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 6.8 m × 5.0 m × 2.0 m
		＝ 68 m^3 > 55.6 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	1 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	21.00 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.19 m3/d
	Volume of Tank	0.200 m3/tank (= 0.5 mW× 0.5 mL× 0.8 mH)
	Total Volume of Tanks	0.200 m3 (Duration= 1.05 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	2 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	1 W + 1 S
	Capacity	0.43 m3/d / 24 × 1000 / 1
		17.90 l/h/unit ⇒ 18 l/h/unit

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STP Process Calculation_Supporting Report 12.2.3

10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Generated Sludge	3,471 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(4)	Volume of Thickend Sludge	433.8 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	12 hours/day (6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{433.8}{12 \times 2} \times \frac{7}{6} = 21.1$$

$\rightarrow$ 22 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 ＋ Injection Rate)

$= 3{,}471 \times (1 + 0.0050)$

$= 3{,}488$ kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{6 \text{ days per week}}$$

$$= 3.488 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

$=$ 22.61 t/day

apparent specific gravity 1.00

22.61 ／ 1.0 ＝ 22.6 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(2)	Required Polyelectrolyte	17.35 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	8.68 m3/day

Centrifuge 17/21

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[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	22 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	22 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	8.68 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	8.68 m3/day × 7 ／ 6 ／ 12 ／ 2
		＝ 0.42 m^3/Hr
	Specification Capacity	0.42 m^3/Hr × 1.5
		＝ 0.633 m^3/Hr ⇒ 0.70 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	17.35 kg/day × 7 ／ 6 ／ 12
		＝ 1.69 kg/hr
		＝ 5.06 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	10 kg/h
	Tanks Dimensions	Width 1.5 m × Length 1.5 m × Depth 1.5 m × 2
		＝ 6.8 m^3
	Retention Time of Tank	3.40 m^3 /tank ／ 0.42 m^3/Hr ／ 2
		＝ 4.030 Hr > 3 Hr
	Number	2 W + 0 S

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11. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	3,471 kg/day
(2) Solids Consistency	0.80 %
(3) Volume of Thickened Sludge	Total Solids × $\frac{100}{\text{Solids Consistency}}$ × 10^{-3}
	= 3,471 × $\frac{100}{0.80}$ × 10^{-3}
	= 434 m^3/day
	= 18.08 m^3/h
(4) Sludge feed flow rate	22 m3/h × 2 = 44 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Basin Dimensions	Width 6.0 m × Length 6.0 m
	× Depth 4.0 m × 2
	= 288.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	288.0 m^3
Number	1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

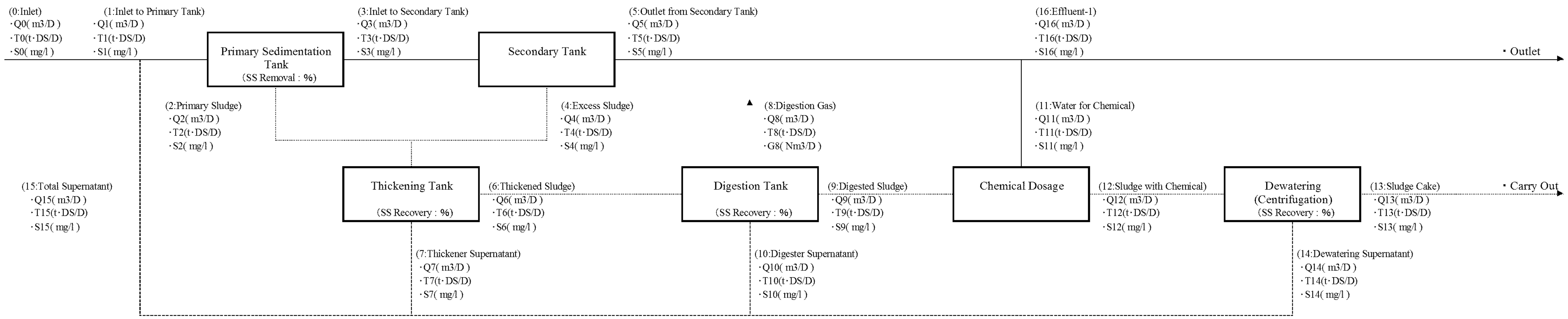
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	8,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	8,000	8,424	0	8,424	434	7,990	434	0	0	434	0	9	443	18	424	424	424			7,990	0
T(t･DS/day)	3.600	3.774	0.000	3.774	3.471	0.080	3.471	0.000	0.000	3.471	0.000	0.017	3.488	3.314	0.174	0.174	0.174			0.080	0.223
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.0	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

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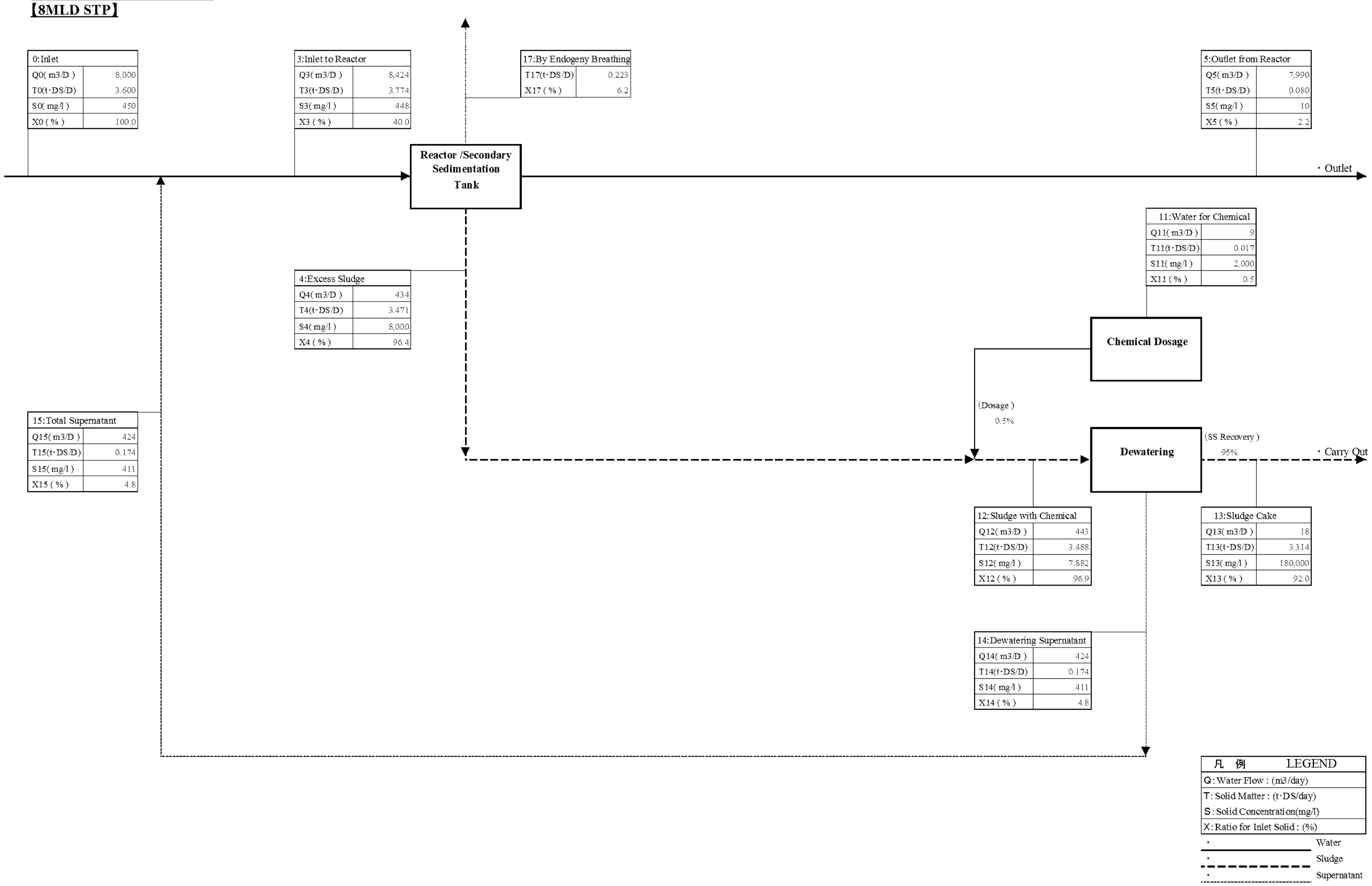
Material Balance Sheet
【8MLD STP】



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Design Condition

Item	13MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	####	833	0.231
Max Dayly	####	833	0.231
Max Hourly Peak factor 2.25	####	1875	0.521

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Average Daily	####	542	0.150
Max Dayly	####	542	0.150
Max Hourly Peak factor 2.25	####	1219	0.339

1. Inlet Chamber

Item	13MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly ＝ 45,000 m3/d
	＝ 0.521 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.500 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.500 × 2.500 ＝ 0.6 m3
(6) Retention Time	0.600 × 2.500 × 2.500 ／ 0.521 × 1
	＝ 7.20 sec
(7) Basin Demensions	Width 2.500 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/23

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STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	13MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.600 m
Velocity	0.521 ／ 0.600 ／ 0.600 ／ 2
whe Design Flow for the year 2049	= 0.724 < 1.000 m/sec OK
Velocity	0.339 ／ 0.600 ／ 0.600 ／ 2
whe Design Flow for the year 2034	= 0.471 < 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	1.000 m
Side Water Depth	0.600 m
Velocity	0.521 ／ 1.000 ／ 0.600 ／ 2
whe Design Flow for the year 2049	= 0.434 ≒ 0.450 m/sec OK
Velocity	0.339 ／ 1.000 ／ 0.600 ／ 2
whe Design Flow for the year 2034	= 0.283 < 0.450 m/sec OK
(3) Channel Dimensions	Width 1.0 m × Length 6.0 m
	× SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	8.0 m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.521 ／ 0.900 ／ 0.550 ／ 2
	× (20 + 9) / 20
	= 0.763 < 0.800 m/sec OK
Velocity through screen	0.339 ／ 0.900 ／ 0.550 ／ 2
whe Design Flow for the year 2034	× (20 + 9) / 20
	= 0.497 < 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Side Water Depth	0.6 m
Velocity through screen	0.521 ／ 1.000 ／ 0.600 ／ 2
whe Design Flow for the year 2049	× (50 + 9) / 50
	= 0.512 < 0.800 m/sec OK
Velocity through screen	0.339 ／ 1.000 ／ 0.600 ／ 2
whe Design Flow for the year 2034	× (50 + 9) / 50
	= 0.333 < 0.800 m/sec OK

Coarse Screen 2/23

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3. Raw Sewage Sump

Item	13MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	11.00 m
Pump Operating Depth	1.300 m
Retention Time	(11.00 ²× π／4 × 1.300)／ 0.521 ／60
whe Design Flow for the year 2049	＝ 3.95 ＞ 3.75 min (=minimum time of one pump cycle) OK
Retention Time	(11.00 ²× π／4 × 1.300)／ 0.339 ／60
whe Design Flow for the year 2034	＝ 6.07 ＞ 3.75 min (=minimum time of one pump cycle) OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.300 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	300 mm
Discharge Flow : 40% Q* 2	0.339 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 488 ⇒ 490 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	200 mm
Discharge Flow : 20% Q* 1	0.339 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 244 ⇒ 245 m3/Hr
Total Head	15.0 m

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Item	13MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	13,000	541.67	0.150
Max Daily	13,000	541.67	0.150
Max Hourly Peak factor 2.25	29,250	1218.75	0.339

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45	25	0	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 29,250 m3/day
= 0.339 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 2.000 m

(3) Width of Basin — 2.100 m

(4) Length of Basin — 2.500 m

(5) Volume required of Basin — 2.000 × 2.100 × 2.500 = 1.7 m3

(6) Retention Time — 2.000 × 2.100 × 2.500 ⁄ 0.339 × 1
= 30.97 sec

(7) Basin Dimensions — Width 2.100 m × Length 2.500 m
× Depth 2.000 m

STP basic &Stilling Chamber4/23

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3. Fine Screen Channel

〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 29,250 m3/d
	= 0.339 m3/sec
[2] Geometory	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.500 m
Height	0.750 m
Floor Level	+ 2.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.339 ／ 0.500 ／ 0.500 ／ 2
	= 0.678 ≒ 1.000 m/sec
(2) Screen Channel	
Number	2 Main + 1 Bypass
Width	0.800 m
Side Water Depth	0.500 m
Velocity	0.339 ／ 0.800 ／ 0.500 ／ 2
	= 0.424 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 0.8 m × Length 6.0 m
	× SWD 0.5 m
[3] Equipment	
(1) Inlet Gate	
Number	2 W + 1 S
Dimension	Width 0.5 m × Height 0.75 m
Design Water Level	2.00 m
(2) Fine Screens (Main Channel)	
Number	2 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.339 ／ 0.700 ／ 0.450 ／ 2
	×(6 + 2)/ 6
	= 0.717 ＜ 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.5 m
Velocity through screen	0.339 ／ 0.800 ／ 0.500 ／ 2
	×(20 + 9)/ 20
	= 0.614 ＜ 0.800 m/sec

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4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Peak flow ＝ 29,250 m^3/day
		＝ 0.339 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec ＝ 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec
[2]	**Grit Chamber**	**Square Grit Chamber**
(1)	Surface Area required	0.339 ／ 0.0111 ＝ 30.54 m^2
(2)	Number of Basins	1 S ＋ 1 W
(3)	Surface Area required/Basin	30.5 ／ 1 ＝ 30.54 m^2
(4)	Length of Basin	30.54 ^0.5 ＝ 5.526 m → 6.0 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.339 × 60 sec ／ 1 ＝ 20.3 m^3
(7)	Depth required	20.3 ／ 6.0 ／ 6.0 ＝ 0.565 m
(8)	Basin Dimensions	Width 6.0 m × Length 6.0 m
		× Depth 0.6 m (Freeboard 0.3m)
(9)	Retention Time	6 × 6.0 × 0.6 ／ 0.339 × 1
		＝ 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	29,250 ／ 6.0 ／ 6.0 ／ 1
		＝ 812.5 ＜ 960 m^3/m^2/day
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 339.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
		Ha= 0.480 m
(4)	Crest Level	＋ m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	＋ 0.480 m
(6)	Channel bottom level	＋ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.323 m/sec
(10)	Total Length of channel	10.000 m
[4]	**Inlet Weir Gate**	
(1)	Number	2 Units
(2)	Weir Width	0.800 m
(3)	Stroke	0.550 m
(4)	Overflow Height	0.500 m
(5)	Overflow Height (actual)	(0.339 ／ 1.840 ／ 0.800 ／ 2) $^{2/3}$
		＝ 0.237 ＜ 0.500 m

Grit Chamber 6/23

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	13,000	m^3/day (summer)	
	Q'=	13,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	assumed as 33% of BOD
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=(TCOD-sCOD)/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45.0	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* =	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃= 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃= 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2) Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
	⇒	5.0000	day	
(3) Biomass production				
$Px,_{VSS}$	$Px,_{VSS}$=	4065.149	kg /d	=Px,bio+Q(nbVSS)
$Px,_{TSS}$	$Px,_{TSS}$=	5583.803	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
Y_H	Y_H=	0.4500	gVSS/g bCOD	
$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
Yn	Yn=	0.150	gVSS/g Nox	
NOx	NOx=	47.400	mg/*l*	
$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	2349.684	kg VSS/d	$=Q・Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
		2109.836		$=Q・Y_H(S_0-S)/[1+b_H(SRT)]$
		189.885		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
		49.962		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$
(4) Required Aeration Tank Volume				
Va=	Va=	9,306	m3	
τ =	τ =	17.18	hr	=Va/Q×24
	⇒	18.00	hr	
X_{VSS}・Va	X_{VSS}・Va=	20,326	kg VSS	$=Px,_{VSS}$・SRT
X_{TSS}・Va	X_{TSS}・Va=	27,919	kg TSS	$=Px,_{TSS}$・SRT
F/M	F/M=	0.224	kgBOD/kgMLVSS	
FractionVSS=	FractionVSS	0.728		
MLVSS=	MLVSS=	2184	mg/L	
(5) BODloading	BODloading	0.489	kg/m3・d	
(6) Observed Yield				
$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.228	gTSS/gBOD	
$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
bCODremoved=	bCODremov	7,502	kg/d	
(7) effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
	S_0=	2.000	mg/*l*	
	$K_{O2,NOB}$=	0.900	mg/*l*	
(8) effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
	S_0=	2.000	mg/*l*	
	$K_{O2,NOB}$=	0.500	mg/*l*	
(9) Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
	3,000/(8,000-3,000)＝	0.60		
	Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — X_b = Q・(SRT)/V・Y_H(S_0-S)/[1+b_H(SRT)]
= 1,133.55 mg/*l*

(2) IR ratio — IR= NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 498,037.93 kg/d

(4) The anoxic tank volume — Vnor= 931 m3 = Va× 10%
Vnor= 2,708 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.48 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients	
	b0	b1
10	0.186	0.078
20	0.213	0.118
30	0.235	0.141
40	0.242	0.152
50	0.270	0.162

(8) SDNRb — SDNRb= 0.302 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.113 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.217 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.302 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 667,030.53 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 498,038 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 4065.149 kg /d
Rwmoval Phosphorus 40.65149435 kg /d

(2) Effluent T-P without Al 3.87 mg/l

(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol

(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O

(5) Required Alumnum Sulfate 558.71 kg/d

(6) Required Alumnum Sulfate solutic 10% 5.32 m3/d
221.71 L/H

(7) Additional sludge 226.50 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

V_A = Q'*θa/24

= 9,750 m^3

(2) Total volume of Anoxic Basins

V_{DN} = Q'*θ_{DN}/24

= 2,708 m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	810	1.50	1.50	0.30
Anoxic	V_{DN}	2,708	5.00	5.00	1.00
Aerobic	V_A	9,750	18.00	18.00	3.60
Total	V	13,268	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

	Width	Length	Depth	Basins
	8.0	156.0	5.5	2

Cross Section 8.0*5.5 = 44.0 m^2/Basin

Hantzsch Subtraction = 1.0 m^2/Basin

after Subtraction 44.0-1.0 = 43.0 m^2/Basin

Total Volume 43.0*156.0 = 6,708 m^2/Basin 13,416 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**9.4**	**31.5**	**113.4**	**154.3**
Volume required per Basin	m^3	405	1,354	4,875	6,634
Total Volume required	m^3	810	2,708	9,750	13,268
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	10.0	32.0	114.0	156.0
Actual Volume per Basin	m^3	430	1,376	4,902	6,708
Actual Total Volume	m^3	860	2,752	9,804	13,416
Actual Ratio of Volume		0.31	1.00	3.56	
Actual Retention Time	hour	1.59	5.08	18.10	24.77

[7] Equipment

(1) Ras Pumps

Ras Ratio 60%

Required Capacity 13,000 m3/day× 60% ／24 ／ 2

= 163 m3/Hr ⇒ 170 m3/Hr

Number 2 Work

2 Stanby

(2) Circulation Pumps

Ras Ratio 366%

Required Capacity 13,000 m3/day× 366% ／24 ／ 4

= 495 m3/Hr ⇒ 500 m3/Hr

Number 4 Work

2 Stanby

(3) SAS Pumps

Excess Sludge 817 m3/day

Sludge withdraw 12 Times/day

Running Time 0.5 Hr/Time

Required Capacity 817 m3/day ／ 12 ／ 0.50 ／ 2

= 68.05 m3/Hr ⇒ 70 m3/Hr

Number 2 Work

2 Stanby

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(4)	Alum Solution Tank												
	Number	2	W	+		0	S						
	Alum concentration as crystal	10	%										
	Gravity of dissolved dechlorine	1.05											
	Required solution volume	558.71	kg / d	×	100	/	10	/	1.05	/	1000		
		＝	5.32	m3/d									
	Volume of Tank	3.5	m3/tank	(=	1.4	mW×	1.4	mL×	1.8	mH)			
	Total Volume of Tanks	7.1		m3		(Duration=		1.33	day)				
(5)	Mixer for Alum Solution Tank												
	Number	2	W	+	0		S						
(6)	Alum Dosing Pump												
	Number	2	W	+	1		S						
	Capacity	5.32	m3/d	/	24	×	1000	/	2	×	2		
		221.71	l/h/unit	⇒	230	l/h/unit							

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6. Air Requirement at Average Flow	
〔1〕Design Condition	
(1) AOR	AOR ＝ 5,624 kg/day
	＝ 234.3 kg/h
Qin :Design Average Flow m^3/d	13,000
Inlet bCOD :S_0	578 mg/l
S=	S= 0.451 mg/l
Nox=	Nox 47.400 mg/l
$P_{X,bio}$=	$P_{X,b}$ 2,299.7 kg VSS/d does not include nitrifying bacteria
R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx
R_0=	R_0= 5,624 kg O2/d
	k= 2.86
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \; (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃
	9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature
	9.09 mg/L at 20 ℃
	20-T : 0.0 1.024^{20-T} : 1.0000
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth
	1+0.40D_j/Pa 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at s
	10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : exp[-gM(z_b-z_a)/R*T] 0.900
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t ＝ 293.15 Kelvin
	α : relative Transfer Rate to clean Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \frac{61,022}{4.2591} =$ 14,327.28 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas	＝ 7,164 kg/day
(5) SOTE for the above Effective Aeration Depth	28.0 %
(6) Fraction of O2 in Air	23.18 %
(7) Specific Gravity of Air at Standard Condition	1.293
(8) Safety Factor	15%
(9) Air required at Field Conditions per Basins	＝ 105,358 m^3/day ＝ 4,389.9 m^3/hr
[2] Equipment	

Air Requirement at Average Flow12/23

(1)	Air Blower							
	Number		4	W	+	2	S	
	Required Capacity		4389.9	m^3/Hr・Basin	／	2	unit/Basin	
		＝	2195.0	m^3/h	⇒	2200	m^3/h /Unit	
	Pressure		65	kPa				
	Safty Factor		10	%				
	Heat capacity ratio		1.4					
	Atmospheric pressuer at site elevation		91.234	kPa				
	Total inlet pressure		89.234	kPa				
	Volume rate of flow at inlet point		41.625	m3/min				
	Total discharge pressure		156.234	kPa				
	Overall adiabatic effeciency		0.65					
	Inlet air temperature (min.)		15	℃				
	Shaft power		58.852	kW				
	Rated Output of Motor		64.737	kW	⇒	75	kW	

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7.	**Final Clarifire**		
〔1〕	**Design Condition**		
(1)	Design Wastewater Flow	Q= 13,000 m^3/day	
(2)	Water Temperature	T= 20.0 ℃	
(3)	MLSS	Xef= 3,000 mg/*l*	
(4)	SVI	SVI= 300	
(5)	Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)	
		= 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770	
		= 20.7 m/day	
(6)	Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0)	= 13.8 m^3/m^2·day
		→	12.0 m^3/m^2·day
[2]	**Geometory**		
(1)	Surface Area required	A= 13,000/12.0=	= 1,083 m^2
(2)	Demensions	Diameter / Depth / Basin	
		26.5 / **3.5** / **2**	
(3)	Actual Surface Area	S= 26.5^2 * 3.14 /4 * 2.0	= 1,103 m^2
(4)	Surface Overflow Rate	S= 13,000/1,103	= 11.8 m^3/m^2·day

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow	13,000	m^3/day	541.67	m^3/h		
		Peak Flow	29,250	m^3/day	1218.75	m^3/h		
(2)	Contact Time	30	min					
(3)	Type of Chlorine	Cl_2-GAS						
(4)	Design Chlorine Dosage Rate	10	mg/L					
(5)	Required Chlorine per day	Average Daily Flow	／	1000	×	Design Chlorine Dosage Rate		
		＝	130.0	kg/d				
		＝	5.42	kg/h				

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow	／	1440	×	Contact Time					
		＝	270.8	m^3							
(2)	Nos. of lanes	3	lanes								
(3)	Width of lane	2.00	m								
(4)	Length of lane	24.00	m								
(5)	Side Water Depth	2.00	m								
(6)	Nos. of Tanks	1	tank								
(7)	Total Width of Tank	6.80	m Approx..								
(8)	Average Velocity	Decant Flow	／	3600	／	Width	／	Depth			
		＝	541.67	／	3600	／	2.00	／	2.00		
		＝	0.038	m/sec							
(9)	Total Volume	Width	×	Length	×	Depth	×	Nos. of lanes	×	Nos. of Tanks	
		＝	2.0	m	×	24.0	m	×	2.0	m	
		×	3	×	1						
		＝	288	m^3	>	270.8	m^3				

[3] Equipment

(1)	Chlorine Dosing Condition					
	Operation Dosage Rate -1	DC1	10 mg/L			
(2)	Chlorine Cylinder					
	Type	-	Cylindrical Convexsd Container			
	Cylinder Capacity	Cc	928 kg/cylinder			
	Average Dosage Rate -1	q1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =	130	kg/day	
	Maximum Dosage Rate -1	q3	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =	293	kg/day	
	Storage day	T	More than 15 days			
	Required Storage Capacity	EC1	D x T = 1,950 kg			
	Unit Number	EN1	EC1 / Cc = 2.1 cylinders			
	Maximum Operation Numbers					
	Cl_2-Gas Volatilize Rate	Vr1	#### @ 20^{O}C Standard temperature			
	Maximum Dosing Rate	DC1	10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 =	12.19	kg/h	
	Operation Numbers	EN2	DC1 / Vr1 = 1.5sets			
	Number	2	W + 2 S			
(3)	Chlorinator					
	Type	Solution Feed Vacuum Type				
	Number	1	W + 1 S			
	Operation Dosage Rate -1	Dq1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =			
			292.5 kg/day			
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =				
		Minimum		Maximum		
		0.00 kg/hr		12.2 kg/hr		
(4)	Chlorine Booster Pump					

Chlorination Tank (gas)15/23

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	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 12.2 kg/hr
		therefore 90 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 13,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 34.1 kg/d
		＝ 1.42 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 90.3 m^3
(2)	Width of lane	6.80 m
(3)	Length of lane	7.00 m
(4)	Side Water Depth	2.00 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 6.8 m × 7.0 m × 2.0 m
		＝ 95 m^3 > 90.3 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	2 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	34.13 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.31 m3/d
	Volume of Tank	0.200 m3/tank (= 0.5 mW× 0.5 mL× 0.8 mH)
	Total Volume of Tanks	0.400 m3 (Duration= 1.29 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	2 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	2 W + 1 S
	Capacity	0.70 m3/d / 24 × 1000 / 2
		14.54 l/h/unit ⇒ 15 l/h/unit

Chlorination Tank (gas)16/23

D-2 Process Cal_EA&al 13MLD Hemigepura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

10. Sludge Thikener

[1] Design Condition

(1) Primary Sludge	0	kg/day	0	m3/day
(2) Secondary Sludge	6,533	kg/day	817	m3/day
(3) Total Solids	6,533	kg/day	817	m3/day
(4) Operation Time	24	hours/day		
(5) Thikened Sludge Moisture Content	97.5	%		

[2] Geometory

(1) Type

(2) Number: 2 W + 0 S

(3) Design Solid Loadong: 40 kg / m2/d

(4) Required Surface Area

$$6533 \times \frac{1}{40} = 163.30 \text{ m2}$$

(5) Required diameter

$$\left(\frac{4}{\pi} \times 163.30 \times \frac{1}{2} \right)^{1/2} = 10.20 \text{ m}$$

$$\rightarrow 10.50 \text{ m}$$

(6) Side Water Depth: 4 m

(7) Actual Volume of Tank

$$\frac{\pi}{4} \times 10.50^{2} = 86.59 \text{ m3}$$

(8) Retention Time

$$\frac{86.59}{817} \times 4 \times 2 \times 24 = 20.36 \text{ Hr}$$

[3] Volume of Thikened Sludge

$= 235$ m^3/d

[4] **Quantity of Separation Liquid**

Inlet Sludge Volume − Thikened Sludge Volume

$= 816.6 - 235.2 = 581.4$ m^3/day

Gravity Sludge Thikener17/23

D-2 Process Cal_EA&al 13MLD Hemigepura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

11.	**Thickened Sludge Sump**								
[1]	**Design Condition**								
(1)	Inlet Solids	6,533	kg/day						
(2)	Inlet Sludge Volume	817	m^3/d						
[2]	**Geometory**								
(1)	Sludge withdrawl	12	Times/day						
(2)	Required Sump Volume	68	m^3/d						
(3)	Number	2	Basins						
(4)	Width	3.5	m						
(5)	Length	4.0	m						
(6)	Side Water Depth	3.0	m						
(7)	Actual Sump Volume	3.5	×	4.0	×	3.0	×	2	
		=	84.0	m^3					
[3]	**Equipment**								
(1)	Thickened Sludge Transfer Pumps								
	Transfer Time	6.00	Hr						
	Number	2	W	+	2	S			
	Required Capacity	817	m^3	／	6.0	／	2		
		＝	68.1	m^3/Hr	⇒	70	m^3/Hr /Unit		

Thickened Sludge Sump18/23

D−2 Process Cal_EA&al 13MLD Hemigepura_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

12.	**Centrifuge**	
[1]	**Design Condition**	
(1)	Type of Dewatering	Centrifuge
(2)	Generated Sludge	5,880 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(4)	Volume of Thickend Sludge	235.2 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	12 hours/day (6 days per week)
[2]	**Volume of Centrifuges**	$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$ $= \frac{235.2}{12 \times 2} \times \frac{7}{6} = 11.4$ → 12 m^3/hour
[3]	**Dewatered Solids**	Digested Sludge × (1 ＋ Injection Rate) ＝ 5,880 × (1 ＋ 0.0050) ＝ 5,909 kg/day
[4]	**Dewatered Cake Volume**	$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$ $= 5.909 \times \frac{100}{100 - 82} \times \frac{7}{6}$ ＝ 38.30 t/day apparent specific gravity 1.00 38.30 ／ 1.0 ＝ 38.3 m^3/day
[5]	**Polyelectrolyte**	
(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(2)	Required Polyelectrolyte	29.40 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	14.70 m3/day

Centrifuge 19/23

D-2 Process Cal_EA&al 13MLD Hemigepura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	12 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	12 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	14.70 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	14.70 m3/da; × 7 ／ 6 ／ 12 ／ 2
		＝ 0.71 m^3/Hr
	Specification Capacity	0.71 m^3/Hr × 1.5
		＝ 1.072 m^3/Hr ⇒ 1.10 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	29.40 kg/day × 7 ／ 6 ／ 12
		＝ 2.86 kg/hr
		＝ 8.57 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	17 kg/h
	Tanks Dimensions	Width 1.5 m × Length 1.5 m
		× Depth 2.0 m × 2
		＝ 9 m^3
	Retention Time of Tank	4.50 m^3 /tank ／ 0.71 m^3/Hr ／ 2
		＝ 3.149 Hr > 3 Hr
	Number	2 W + 0 S

Centrifuge 20/23

D-2 Process Cal_EA&al 13MLD Hemigepura_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

11. Centrifuge Feed Sump

[1] Design Condition

(1) Generated Thickend Sludge: 5,880 kg/day

(2) Solids Consistency: 2.50 %

(3) Volume of Thickened Sludge

$$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$$

$$= 5,880 \times \frac{100}{2.50} \times 10^{-3}$$

= 235 m^3/day

= 9.80 m^3/h

(4) Sludge feed flow rate: 12 m3/h × 2 = 24 m3/h

(5) Centrifuge Operation Time: 12 hours/day (6 days per week)

[2] Geometry

(1) Basin Dimensions: Width 5.0 m × Length 6.0 m × Depth 4.0 m × 2

= 240.0 m^3

[3] Equipment

(1) Mixers for Centrifuge Feed Sumps

Required Volume: 240.0 m^3

Number: 1 W + 1 S

Centrifuge Feed Sump 21/23

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

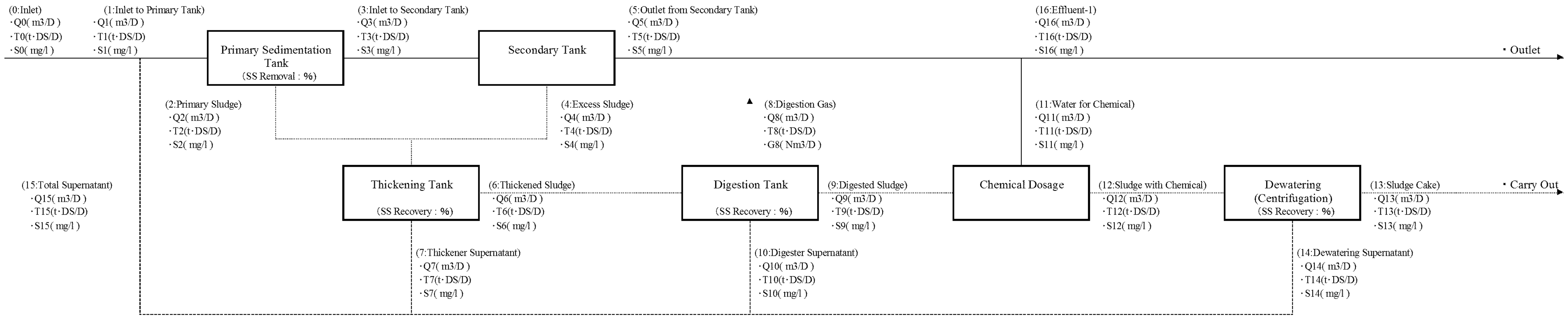
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	13,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	90.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	97.5	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	97.5	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	13,000	13,800	0	13,800	817	12,983	235	581	0	235	0	15	250	31	219	800	800			12,983	0
T(t･DS/day)	5.850	6.799	0.000	6.799	6.533	0.130	5.880	0.653	0.000	5.880	0.000	0.029	5.909	5.613	0.295	0.949	0.949			0.130	0.136
S(mg/l)	450	493	0	493	8,000	10	25,000	1,124	0	25,000	0	2,000	23,647	180,000	1,351	1,186				10	
X(Ti/T0*100)	100	116.2	0.0	116.2	111.7	2.2	100.5	11.2	0.0	100.5	0.0	0.5	101.0	96.0	5.1	16.2				2.2	2.3

Figure -1 Material Balance Model



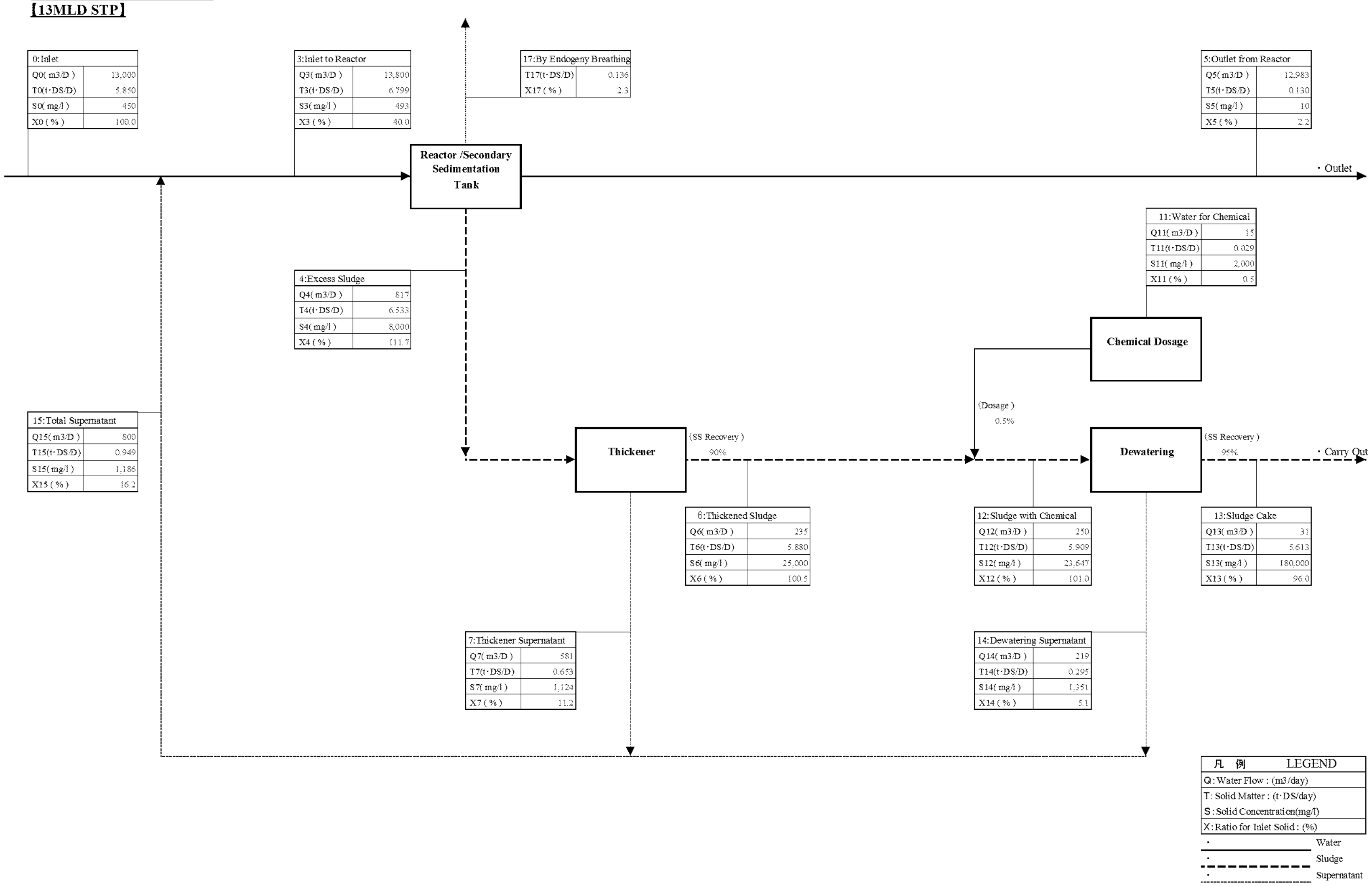
Calculation Formula

･Q0=Input Data	･Q3=Q1-Q2	･Q6=T6*100/(100-W3)	･Q9=Q6	･Q12=Q9+Q11	･Q15=Q7+Q10+Q14	･Q5-1=Q5-Q11
･T0=Q0*S0*10^(-6)	･T3=T0*(100-A2)/100	･T6=(T2+T4)*A3/100	･T9=(T6-T8)*A4/100	･T12=T9+T11	･T15=T7+T10+T14	･T5-1=T5-T11
･S0=Input Data	･S3=T3*10^6/Q3	･S6=10^6*(100-W3)/100	･S9=T9*10^6/Q9	･S12=T12*10^6/Q12	･S15=T15*10^6/Q15	･S5-1=S5
･Q1=Q0+Q15	･Q4=T4*100/(100-W2)	･Q7=(Q2+Q4)-Q6	･Q10=Q6-Q8-Q9	･Q13=T13*100/(100-W5)		
･T1=T0+T15	･T4=余剰汚泥発生式による	･T7=(T2+T4)-T6	･T10=T6-T8-T9	･T13=T12*A5/100		
･S1=T1*10^6/Q1	･S4=10^6*(100-W2)/100	･S7=T7*10^6/Q7	･S10=T10*10^6/Q10	･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1)	･Q5=Q3-Q4*(T3-T5)/T4	･Q8=0	･Q11=T10*A9/A10	･Q14=Q12-Q13		
･T2=T1-T3	･T5=Q5*ST/10^6	･T8=T6*A6*A7/10^4	･T11=Q11*S11/10^6	･T14=T12-T13		
･S2=10^6*(100-W1)/100	･S5=St	#REF!	･S11=10^4*A10	･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【13MLD STP】



E-1 Process Cal_ EA&al 9MLD Nagasandra_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	9MLD STP-MPS			
(1) Design Flow for the year 2049		Flow Rate		
		m3/d	m3/h	m3/s
	Daily Average	13,000	542	0.150
	Daily Maximum	13,000	542	0.150
	Hourly Max. Peak factor 2.25	29,250	1219	0.339
(1) Design Flow for the year 2034		Flow Rate		
		m3/d	m3/h	m3/s
	Daily Average	9,000	375	0.104
	Daily Maximum	9,000	375	0.104
	Hourly Max. Peak factor 2.25	20,250	844	0.234

1. Inlet Chamber

Item	9MLD STP-MPS
[1] Design Condition	
(1) Design Flow for the year 2049	Hourly Maximum ＝ 29,250 m3/d
	＝ 0.339 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.500 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.500 × 2.500 ＝ 0.6 m3
(6) Retention Time	0.600 × 2.500 × 2.500 ／ 0.339 × 1
	＝ 11.06 sec
(7) Basin Demensions	Width 2.500 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

E-1 Process Cal_ EA&al 9MLD Nagasandra_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

	Item	9MLD STP-MPS
[1]	Geometry	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Width	0.600 m
	Height	0.900 m
	Floor Level	+ 5.000 m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.339 ／ 0.600 ／ 0.500 ／ 2
	whe Design Flow for the year 2049	= 0.565 < 1.000 m/sec OK
	Velocity	0.234 ／ 0.600 ／ 0.500 ／ 1
	whe Design Flow for the year 2034	= 0.780 < 1.000 m/sec OK
(2)	Screen Channel	
	Number	2.0 Main + 1.0 Bypass
	Width	1.000 m
	Side Water Depth	0.600 m
	Velocity	0.339 ／ 1.000 ／ 0.600 ／ 2
	whe Design Flow for the year 2049	= 0.283 ≒ 0.450 m/sec OK
	Velocity	0.234 ／ 1.000 ／ 0.600 ／ 1
	whe Design Flow for the year 2034	= 0.390 < 0.450 m/sec OK
(3)	Channel Dimensions	Width 1.0 m × Length 6.0 m
		× SWD 0.6 m
[3]	Equipment	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Dimension	Width 0.6 m × Height 0.9 m
	Design Water Level	m
(2)	Coarse Screens (Main Channel)	
	Number	2 W + 0 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	1.0 m
	Width of side plate	50 mm
	Side Water Depth	0.6 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.339 ／ 0.900 ／ 0.550 ／ 2
		× (20 + 9) / 20
		= 0.497 ≒ 0.800 m/sec OK
	Velocity through screen	0.234 ／ 0.900 ／ 0.550 ／ 1
	whe Design Flow for the year 2034	× (20 + 9) / 20
		= 0.685 < 0.800 m/sec OK
(3)	Coarse Screens (Bypass Channel)	
	Number	0 W + 1 S
	Open Space	50 mm
	Bar Thickness	9 mm
	Channel Width	1.0 m
	Side Water Depth	0.6 m
	Velocity through screen	0.339 ／ 1.000 ／ 0.600 ／ 2
	whe Design Flow for the year 2049	× (50 + 9) / 50
		= 0.333 < 0.800 m/sec OK
	Velocity through screen	0.234 ／ 1.000 ／ 0.600 ／ 1
	whe Design Flow for the year 2034	× (50 + 9) / 50
		= 0.460 < 0.800 m/sec OK

Coarse Screen 2/21

E-1 Process Cal_ EA&al 9MLD Nagasandra_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item	9MLD STP-MPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	10.00 m
Pump Operating Depth	1.000 m
Retention Time	(10.00 ²× π／4 × 1.000)／ 0.339 ／60
whe Design Flow for the year 2049	＝ 3.86 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
Retention Time	(10.00 ²× π／4 × 1.000)／ 0.234 ／60
whe Design Flow for the year 2034	＝ 5.59 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	200 mm
Discharge Flow : 40% Q* 2	0.234 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 337 ⇒ 340 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	150 mm
Discharge Flow : 20% Q* 1	0.234 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 168 ⇒ 170 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/21

E-1 Process Cal_ EA&al 9MLD Nagasandra_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	9MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	9,000	375.00	0.104
Max Daily	9,000	375.00	0.104
Max Hourly Peak factor 2.25	20,250	843.75	0.234

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 20,250 m3/day
= 0.234 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.500 m

(3) Width of Basin — 2.100 m

(4) Length of Basin — 2.000 m

(5) Volume required of Basin — 1.500 × 2.100 × 2.000 = 1.6 m3

(6) Retention Time — 1.500 × 2.100 × 2.000 ／ 0.234 × 1
= 26.92 sec

(7) Basin Dimensions — Width 2.100 m × Length 2.000 m × Depth 1.500 m

STP basic &Stilling Chamber4/21

3. Fine Screen Channel									
〔1〕Design Condition									
(1) Design Wastewater Flow	Max Hourly			＝	20,250	m3/d			
				＝	0.234	m3/sec			
[2] Geometory									
(1) Inlet Gate									
Number	2	Main		＋	1	Bypass			
Width	0.400	m							
Height	0.600	m							
Floor Level	＋	2.000	m						
Bottom	＋	0.000	m						
Influent Water Level	＋	0.300	m						
Velocity	0.234	／	0.400	／	0.300	／	2		
	＝	0.975	≒	1.000	m/sec				
(2) Screen Channel									
Number	2	Main		＋	1	Bypass			
Width	0.800	m							
Side Water Depth	0.400	m							
Velocity	0.234	／	0.800	／	0.400	／	2		
	＝	0.366	≒	0.450	m/sec				
(3) Channel Dimensions	Width	0.8	m	×	Length	6.0	m		
		×	SWD	0.4	m				
[3] Equipment									
(1) Inlet Gate									
Number	2	W		＋	1	S			
Dimension	Width	0.4	m	×	Height	0.60	m		
Design Water Level	2.00	m							
(2) Fine Screens (Main Channel)									
Number	2	W		＋	0	S			
Open Space	6	mm							
Bar Thickness	2	mm							
Channel Width	0.8	m							
Width of side plate	50	mm							
Side Water Depth	0.4	m							
Height of Blind Plate at the bottom	50	mm							
Velocity through screen	0.234	／	0.700	／	0.350	／	2		
	×(	6	＋	2	)/	6			
	＝	0.637	＜	0.800	m/sec				
(3) Fine Screens (Bypass Channel)									
Number	0	W		＋	1	S			
Open Space	20	mm							
Bar Thickness	9	mm							
Channel Width	0.8	m							
Side Water Depth	0.4	m							
Velocity through screen	0.234	／	0.800	／	0.400	／	2		
	×(	20	＋	9	)/	20			
	＝	0.530	＜	0.800	m/sec				

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Peak flow ＝ 20,250 m^3/day
	＝ 0.234 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec ＝ 960 $m^3/m^2/day$
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.234 ／ 0.0111 ＝ 21.08 m^2
(2) Number of Basins	1 S ＋ 1 W
(3) Surface Area required/Basin	21.1 ／ 1 ＝ 21.08 m^2
(4) Length of Basin	21.08 ^0.5 ＝ 4.6 m → 5.0 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.234 × 60 sec ／ 1 ＝ 14.0 m^3
(7) Depth required	14.0 ／ 5.0 ／ 5.0 ＝ 0.562 m
(8) Basin Dimensions	Width 5.0 m × Length 5.0 m
	× Depth 0.6 m (Freeboard 0.3m)
(9) Retention Time	5 × 5.0 × 0.6 ／ 0.234 × 1
	＝ 60.00 sec
(10) Surface Overflow Rate at Peak Flow	20,250 ／ 5.0 ／ 5.0 ／ 1
	＝ 810 ＜ 960 $m^3/m^2/day$
[3] Parshall Flume	
(1) Design Flow Rate	Q= 234.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
	Ha= 0.375 m
(4) Crest Level	＋ m ≒ Minimum water level at downstream channel
(5) Water level at the crest	＋ 0.375 m
(6) Channel bottom level	＋ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.223 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.600 m
(3) Stroke	0.450 m
(4) Overflow Height	0.400 m
(5) Overflow Height (actual)	(0.234 ／ 1.840 ／ 0.600 ／ 2) $^{2/3}$
	＝ 0.224 ＜ 0.400 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow — Q= 9,000 m^3/day (summer)
Q'= 9,000 m^3/day(Winter)

(2) Design Sewage Quality

Item	Symbol	Value	Unit	Remark
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD	:S_0	578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD	:sCOD	271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD	:nbsCODe	40	mg/*l*	
Inlet nbpCOD	:nbpCOD	183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
	:VSS_{COD}	1.38	gCOD/gVSS	=TCOD-sCOD/VSS
	:nbVSS	131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
	:iTSS	67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45.0	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	

(3) Water Temperature — T= 20.0 ℃
(4) Safety Factor for Nitrogen — SF= 1.5
(5) Return Sludge Concentration — *Rs* = 8,000 mg/*l*
(6) MLSS MLVSS — X_{TSS} = 3,000 mg/*l*
(7) DO in the Reactor — 2 mg/L

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}

Item	Symbol	Value	Unit	Remark
μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	=1/ μ_{AOB} × SF
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	2814.334	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	3708.900	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al
	S	S=	0.4507	mg/*l*	=Ks[1+b_H(SRT)]/[SRT(μ_m-b_H)-1]
	b_H	b_H=	0.1200		=b*$1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g･d	= μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1626.704	kg VSS/d	=Q･Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)] +QYn(Nox)/[2+bAOB(SRT)]
			1460.656		=Q･Y_H(S_0-S)/[1+b_H(SRT)]
			131.459		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]
			34.589		=QYn(Nox)/[1+b_{AOB}(SRT)]
	NOx	NOx=	47.311	mg/*l*	=TKN-Ne-0.12$P_{X,bio}$/Q
(4)	Required Aeration Tank Volume				
	Va=	Va=	6,181	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	X_{VSS}･Va	X_{VSS}･Va=	14,072	kg VSS	=$Px,_{VSS}$･SRT
	X_{TSS}･Va	X_{TSS}･Va=	18,544	kg TSS	=$Px,_{TSS}$･SRT
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3･d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	5,193	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g･d	= μ_{max}*$1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g･d	= $\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	=Ks[1+b_{NOB}(SRT)]/[SRT(μ_{NOB}-b_{NOB})-1]
	b_{NOB}	b_{NOB}=	0.1700		=b*$1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g･d	= μ_{max}*$1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g･d	= $\mu_{max,NOB}$[S_0/(S_0+$K_{O2,NOB}$)]
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — X_b = $Q \cdot (SRT)/V \cdot Y_H(S_0\text{-}S)/[1+b_H(SRT)]$
= 1,181.47 mg/*l*

(2) IR ratio — IR = NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 344,795.49 kg/d

(4) The anoxic tank volume — Vnor= 618 m3 = Va× 10%
Vnor= 1,875 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb — SDNRb= 0.296 g/g・d $= b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.110 g/g・d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d $=SDNR_t - 0.029\ln(F/M_b)-0.012$ IR=3-4
$=SDNR_t - 0.0166\ln(F/M_b)-0.078$ IR=2

SDNRt= 0.296 g/g・d $=SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 468,893.77 kg/d $=N_{nox} \cdot SDNR \cdot X_b$
>Nox feed= 344,795 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 2814.334 kg /d
Rwmoval Phosphorus 28.14334224 kg /d

(2) Effluent T-P without Al 3.87 mg/l

(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol

(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O

(5) Required Alumnum Sulfate 386.80 kg/d

(6) Required Alumnum Sulfate solutic 10% 3.68 m3/d
153.49 L/H

(7) Additional sludge 156.81 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins
V_A = Q'*θa/24
= 6,750 m^3

(2) Total volume of Anoxic Basins
V_{DN} = Q'*$θ_{DN}$/24
= 1,875 m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	560	1.50	1.50	0.30
Anoxic	V_{DN}	1,875	5.00	5.00	1.00
Aerobic	V_A	6,750	18.00	18.00	3.60
Total	V	9,185	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	108.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin
Hantzsch Subtraction = 1.0 m^2/Basin
after Subtraction: 44.0-1.0 = 43.0 m^2/Basin
Total Volume: 43.0*108.0 = 4,644 m^2/Basin 9,288 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**6.5**	**21.8**	**78.5**	**106.8**
Volume required per Basin	m^3	280	938	3,375	4,593
Total Volume required	m^3	560	1,875	6,750	9,185
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	7.0	22.0	79.0	108.0
Actual Volume per Basin	m^3	301	946	3,397	4,644
Actual Total Volume	m^3	602	1,892	6,794	9,288
Actual Ratio of Volume		0.32	1.00	3.59	
Actual Retention Time	hour	1.61	5.05	18.12	24.78

[7] Equipment

(1) Ras Pumps
Ras Ratio: 60%
Required Capacity: 9,000 m3/day× 60% ／24 ／ 2
= 113 m3/Hr ⇒ 115 m3/Hr
Number: 2 Work
2 Stanby

(2) Circulation Pumps
Ras Ratio: 366%
Required Capacity: 9,000 m3/day× 366% ／24 ／ 4
= 343 m3/Hr ⇒ 345 m3/Hr
Number: 4 Work
2 Stanby

(3) SAS Pumps
Excess Sludge: 488 m3/day
Sludge withdraw: 12 Times/day
Running Time: 0.5 Hr/Time
Required Capacity: 488 m3/day ／ 12 ／ 0.50 ／ 2
= 40.68 m3/Hr ⇒ 45 m3/Hr
Number: 2 Work
2 Stanby

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(4)	Alum Solution Tank											
	Number	2	W	+	0	S						
	Alum concentration as crystal	10	%									
	Gravity of dissolved dechlorine	1.05										
	Required solution volume	386.80	kg / d	×	100	/	10	/	1.05	/	1000	
		＝	3.68	m3/d								
	Volume of Tank		2.6	m3/tank								
	Total Volume of Tanks		5.2	m3	(Duration=	1.41	day)					
(5)	Mixer for Alum Solution Tank											
	Number	2	W	+	0	S						
(6)	Alum Dosing Pump											
	Number	2	W	+	1	S						
	Capacity	3.68	m3/d	/	24	×	1000	/	2	×	2	
		153.49	l/h/unit	⇒	160	l/h/unit						

6.	**Air Requirement at Average Flow**		
[1]Design Condition			
(1)	AOR	AOR	= 3,894 kg/day
			= 162.2 kg/h
	Qin :Design Average Flow m^3/d	9,000	
	Inlet bCOD : S_0	578 mg/l	
	S=	S= 0.451 mg/l	
	Nox=	Nox 47.400 mg/l	
	$P_{X,bio}$=	$P_{X,b}$ 1,592.1 kg VSS/d	does not include nitrifying bacteria
	R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx	
	R_0=	R_0= 3,894 kg O2/d	
		k= 2.86	
(2)	SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$	

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		1+0.40D_j/Pa	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	exp[-gM(z_b-z_a)/R*T]	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{42,246}{4.2591} = 9,918.89 \text{ kg/day}$$

(3)	No. of Basins	2	Basin
(4)	Standard O2 required at Field Conditions per Bas	= 4,959	kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0	%
(6)	Fraction of O2 in Air	23.18	%
(7)	Specific Gravity of Air at Standard Condition	1.293	
(8)	Safety Factor	15%	
(9)	Air required at Field Conditions per Basins	= 72,940 m^3/day = 3,039.2	m^3/hr
[2]	Equipment		

(1)	Air Blower						
	Number	4	W	+	2	S	
	Required Capacity	3039.2	m^3/Hr・Basin	／	2	unit/Basin	
		＝ 1519.6	m^3/h	⇒	1600	m^3/h /Unit	
	Pressure	65	kPa				
	Safty Factor	10	%				
	Heat capacity ratio	1.4					
	Atmospheric pressuer at site elevation	91.234	kPa				
	Total inlet pressure	89.234	kPa				
	Volume rate of flow at inlet point	30.273	m3/min				
	Total discharge pressure	156.234	kPa				
	Overall adiabatic effeciency	0.65					
	Inlet air temperature (min.)	15	℃				
	Shaft power	42.801	kW				
	Rated Output of Motor	47.082	kW	⇒	55	kW	

7. Final Clarifire	
〔1〕 Design Condition	
(1) Design Wastewater Flow	Q= 9,000 m^3/day
(2) Water Temperature	T= 20.0 ℃
(3) MLSS	Xef= 3,000 mg/*l*
(4) SVI	SVI= 300
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77) = 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770 = 20.7 m/day
(6) Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0) = 13.8 m^3/m^2·day → 12.0 m^3/m^2·day
[2] Geometory	
(1) Surface Area required	A= 9,000/12.0= = 750 m^2
(2) Demensions	Diameter **22.0** Depth **3.5** Basin **2**
(3) Actual Surface Area	S= 22.0^2 * 3.14 /4 * 2.0 = 760 m^2
(4) Surface Overflow Rate	S= 9,000/760 = 11.8 m^3/m^2·day

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow 9,000 m^3/day 375.00 m^3/h
		Peak Flow 20,250 m^3/day 843.75 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 90.0 kg/d
		＝ 3.75 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 187.5 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	2.00 m
(4)	Length of lane	16.00 m
(5)	Side Water Depth	2.00 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	6.80 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 375.00 ／ 3600 ／ 2.00 ／ 2.00
		＝ 0.026 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 2.0 m × 16.0 m × 2.0 m
		× 3 × 1
		＝ 192 m^3 ＞ 187.5 m^3

[3] Equipment

(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 90 kg/day
	Maximum Dosage Rate -1	q3 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 203 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 1,350 kg
	Unit Number	EN1 EC1 / Cc = 1.5 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vrl #### @ 20^{O}C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = 8.44 kg/h
	Operation Numbers	EN2 DC1 / Vrl = 1.1sets
	Number	2 W + 2 S
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
		202.5 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.00 kg/hr 8.5 kg/hr

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(4)	Chlorine Booster Pump	
	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 8.5 kg/hr
		therefore 60 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 9,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ⁄ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 23.6 kg/d
		＝ 0.98 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ⁄ 60 × Contact Time
		＝ 62.5 m^3
(2)	Width of lane	6.80 m
(3)	Length of lane	5.00 m
(4)	Side Water Depth	2.00 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 6.8 m × 5.0 m × 2.0 m
		＝ 68 m^3 > 62.5 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	1 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	23.63 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.21 m3/d
	Volume of Tank	0.360 m3/tank (= 0.6 mW× 0.6 mL× 1.0 mH)
	Total Volume of Tanks	0.360 m3 (Duration= 1.68 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	2 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	1 W + 1 S
	Capacity	0.48 m3/d / 24 × 1000 / 1
		20.13 l/h/unit ⇒ 21 l/h/unit

Chlorination Tank (gas) 16/21

E-1 Process Cal_ EA&al 9MLD Nagasandra_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge			
(2)	Generated Sludge	3,905	kg/day		
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte		5	kg/t-DS・day
(4)	Volume of Thickend Sludge	488.1	m^3/day		
(5)	Consistency of Dewatered Sludge	82	%		
(6)	Operation Time	12	hours/day	(6 days per week)	

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{488.1}{12 \times 2} \times \frac{7}{6} = 23.7$$

$\rightarrow$ 24 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 ＋ Injection Rate)

＝ 3,905 × (1 ＋ 0.0050)

＝ 3,924 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 3.924 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

＝ 25.43 t/day

apparent specific gravity 1.00

25.43 ／ 1.0 ＝ 25.4 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS・day
(2)	Required Polyelectrolyte		19.52	kg/day
(3)	Dissolving concentration		0.20	%
(4)	Volume of Polyelectrolyte solution		9.76	m3/day

Centrifuge 17/21

E-1 Process Cal_ EA&al 9MLD Nagasandra_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

[6]	**Equipment**											
(1)	Centrifuge											
	Capacity	24	m^3/hr									
	Number	2	W		+		1	S				
(2)	Centrifuge Feed Pumps											
	Capacity	24	m^3/hr									
	Number	2	W		+		1	S				
(3)	Polyelectrolyte Dosing Pumps											
	Volume of Polyelectrolyte solution	9.76	m3/day									
	Operation Time	12	hours/day		(6 days per week)							
	Safety Factor	1.5										
	Number	2	W		+		1	S				
	Required Capacity	9.76	m3/da; ×	7	／	6	／	12	／	2		
		＝	0.47	m^3/Hr								
	Specification Capacity	0.47	m^3/Hr	×		1.5						
		＝	0.712	m^3/Hr	⇒		0.80	m^3/Hr /Unit				
(4)	Polyelectrolyte dosing System											
	Preparation time for solution	3	hr									
	Required dry polymer	19.52	kg/day ×	7	／	6	／	12				
		＝	1.90	kg/hr								
		＝	5.69	kg per one batch								
	Feedong time per one batch	30	min									
	Capacity of Dry polymer Feeder	11	kg/h									
	Tanks Dimensions	Width	1.5	m	×	Length		1.5	m			
		×	Depth		1.5	m	×	2	(Freeboard 0.5m)			
		＝	6.8	m^3								
	Retention Time of Tank	3.40	m^3 /tank	／		0.47	m^3/Hr	／	2			
		＝	3.582	Hr	>	3	Hr					
	Number	2	W		+		0	S				

Centrifuge 18/21

11. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	3,905 kg/day
(2) Solids Consistency	0.80 %
(3) Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
	$= 3,905 \times \frac{100}{0.80} \times 10^{-3}$
	= 488 m^3/day
	= 20.34 m^3/h
(4) Sludge feed flow rate	24 m3/h × 2 = 48 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Basin Dimensions	Width 6.0 m × Length 6.0 m
	× Depth 4.0 m × 2
	= 288.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	288.0 m^3
Number	1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency	2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data		(%)
In case of 2 : input data	#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4・S4=(a・S_{BOD}+b・S1-c・θ・XA)・Q3/10^6・・(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

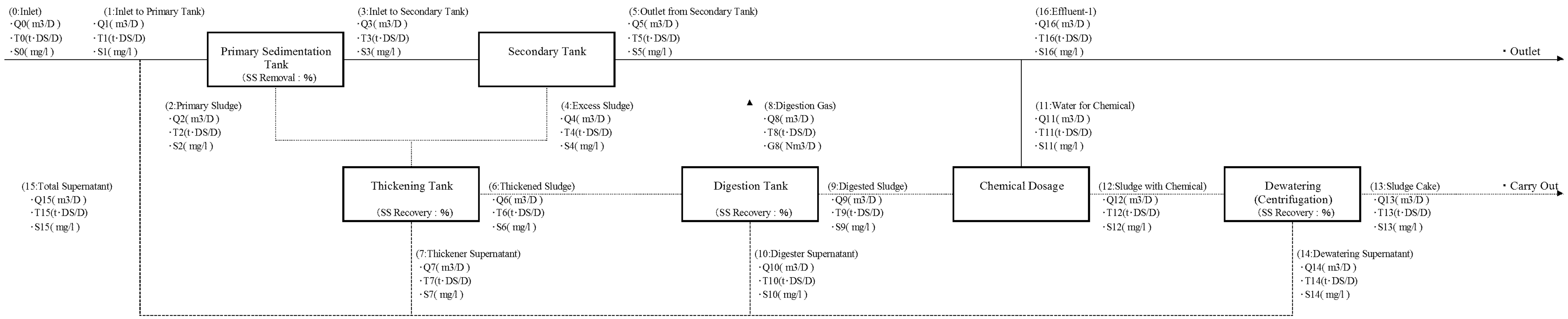
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
・Inlet flow : Q_0(m3/D)	9,000	・Primary sludge moisture ratio : W1(%)	0.0	・Removal ratio in primary tank : A2(%)	0.0	・Content of organics in thickened sludge : A6(%)	75.0	・Chemical dosage : A9(%)	0.5	
・Inlet quality : S_0(mg/l)	450	・Excess sludge moisture ratio : W2(%)	99.2	・Recovery ratio in sludge thickener : A3(%)	100.0	・Digestion ratio : A7(%)	#REF!	・Chemical dissolve concentration : A10(%)	0.2	
・Total removal ratio : A1(%)	-	・Thickened sludge moisture ratio : W3(%)	99.2	・Recovery ratio in sludge digester : A4(%)	100.0	・Digestion gas generation : A8(Nm3/kgVS)				
・Effluent quality : St(mg/l)	10.0	・Digested sludge moisture ratio : W4(%)	99.2	・Recovery ratio in dewatering : A5(%)	95.0					
・Sludge generation ratio per removal SS : Si(%)	-	・Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	9,000	9,477	0	9,477	488	8,989	488	0	0	488	0	10	498	21	477	477	477			8,989	0
T(t・DS/day)	4.050	4.246	0.000	4.246	3.905	0.090	3.905	0.000	0.000	3.905	0.000	0.020	3.924	3.728	0.196	0.196	0.196			0.090	0.251
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



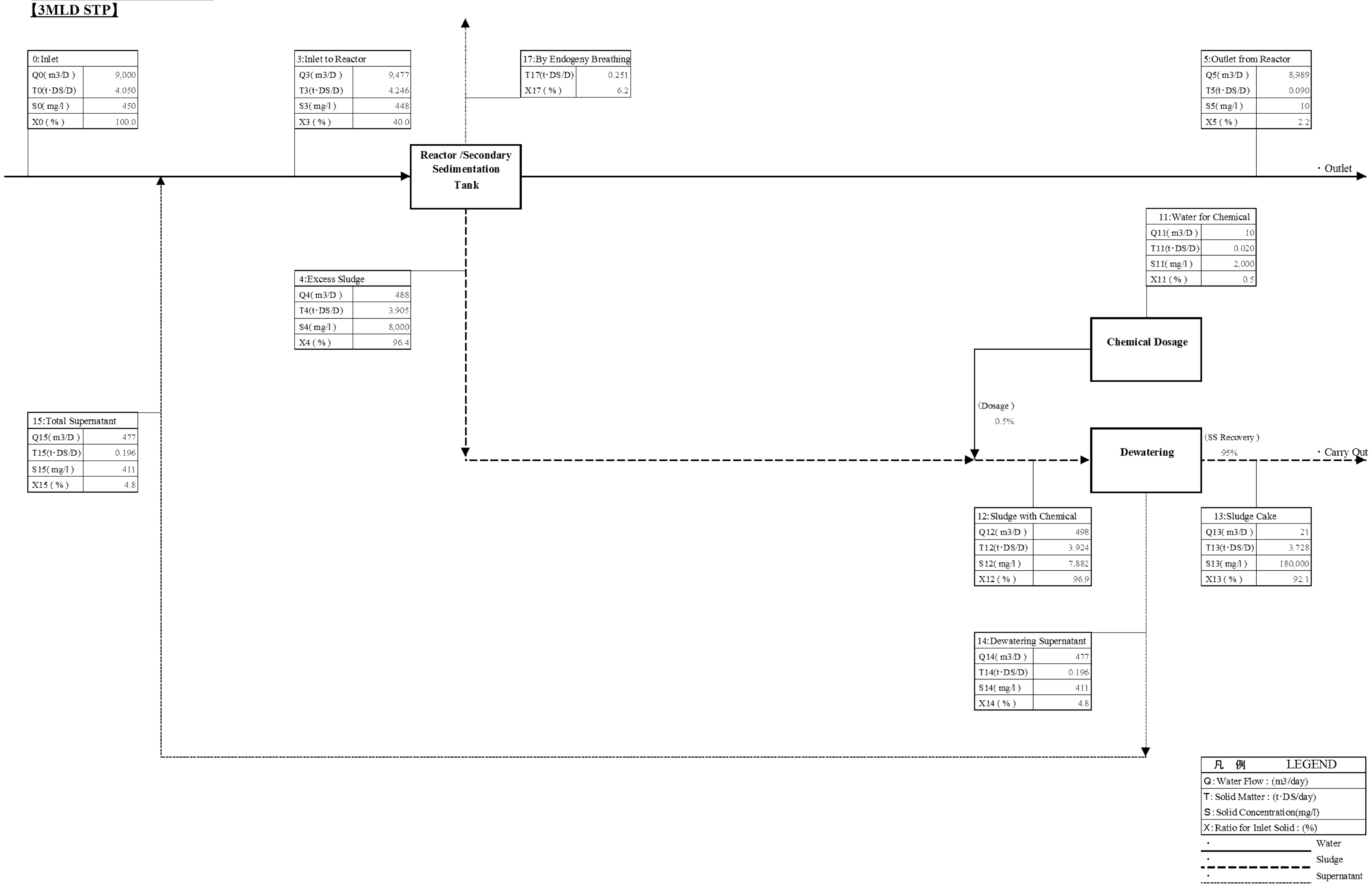
Calculation Formula

・Q0=Input Data ・T0=Q0*S0*10^(-6) ・S0=Input Data	・Q3=Q1-Q2 ・T3=T0*(100-A2)/100 ・S3=T3*10^6/Q3	・Q6=T6*100/(100-W3) ・T6=(T2+T4)*A3/100 ・S6=10^6*(100-W3)/100	・Q9=Q6 ・T9=(T6-T8)*A4/100 ・S9=T9*10^6/Q9	・Q12=Q9+Q11 ・T12=T9+T11 ・S12=T12*10^6/Q12	・Q15=Q7+Q10+Q14 ・T15=T7+T10+T14 ・S15=T15*10^6/Q15	・Q5-1=Q5-Q11 ・T5-1=T5-T11 ・S5-1=S5
・Q1=Q0+Q15 ・T1=T0+T15 ・S1=T1*10^6/Q1	・Q4=T4*100/(100-W2) ・T4=余剰汚泥発生式による ・S4=10^6*(100-W2)/100	・Q7=(Q2+Q4)-Q6 ・T7=(T2+T4)-T6 ・S7=T7*10^6/Q7	・Q10=Q6-Q8-Q9 ・T10=T6-T8-T9 ・S10=T10*10^6/Q10	・Q13=T13*100/(100-W5) ・T13=T12*A5/100 ・S13=10^6*(100-W5)/100		
・Q2=T2*100/(100-W1) ・T2=T1-T3 ・S2=10^6*(100-W1)/100	・Q5=Q3-Q4*(T3-T5)/T4 ・T5=Q5*ST/10^6 ・S5=St	・Q8=0 ・T8=T6*A6*A7/10^4 #REF!	・Q11=T10*A9/A10 ・T11=Q11*S11/10^6 ・S11=10^4*A10	・Q14=Q12-Q13 ・T14=T12-T13 ・S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【3MLD STP】



E-2 Process Cal_ EA&al 10MLD Karivobanahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	10MLD STP-MPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	16,000	667	0.185
Daily Maximum	16,000	667	0.185
Hourly Max. Peak factor 2.25	36,000	1500	0.417

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	####	417	0.116
Daily Maximum	####	417	0.116
Hourly Max. Peak factor 2.25	####	938	0.260

1. Inlet Chamber

Item	10MLD STP-MPS
[1] Design Condition	
(1) Design Flow for the year 2049	Hourly Maximum = 36,000 m3/d
	= 0.417 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.000 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.000 × 2.500 = 0.5 m3
(6) Retention Time	0.600 × 2.000 × 2.500 ⁄ 0.417 × 1
	= 7.19 sec
(7) Basin Demensions	Width 2.000 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

E-2 Process Cal_ EA&al 10MLD Karivobanahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	10MLD STP-MPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.600 m
Velocity	0.417 ／ 0.600 ／ 0.600 ／ 2
whe Design Flow for the year 2049	= 0.579 ＜ 1.000 m/sec OK
Velocity	0.260 ／ 0.600 ／ 0.600 ／ 1
whe Design Flow for the year 2034	= 0.722 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	1.000 m
Side Water Depth	0.600 m
Velocity	0.417 ／ 1.000 ／ 0.600 ／ 2
whe Design Flow for the year 2049	= 0.348 ≒ 0.450 m/sec OK
Velocity	0.260 ／ 1.000 ／ 0.600 ／ 1
whe Design Flow for the year 2034	= 0.433 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 1.0 m × Length 6.0 m × SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.417 ／ 0.900 ／ 0.550 ／ 2 × (20 + 9) / 20
	= 0.611 ≒ 0.800 m/sec OK
Velocity through screen	0.260 ／ 0.900 ／ 0.550 ／ 1
whe Design Flow for the year 2034	× (20 + 9) / 20
	= 0.762 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Side Water Depth	0.6 m
Velocity through screen	0.417 ／ 1.000 ／ 0.600 ／ 2
whe Design Flow for the year 2049	× (50 + 9) / 50
	= 0.410 ＜ 0.800 m/sec OK
Velocity through screen	0.260 ／ 1.000 ／ 0.600 ／ 1
whe Design Flow for the year 2034	× (50 + 9) / 50
	= 0.511 ＜ 0.800 m/sec OK

Coarse Screen 2/21

E-2 Process Cal_ EA&al 10MLD Karivobanahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item	10MLD STP-MPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	11.00 m
Pump Operating Depth	1.000 m
Retention Time whe Design Flow for the year 2049	(11.00 ^{2}× π／4 × 1.000)／ 0.417 ／60 ＝ 3.80 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
Retention Time whe Design Flow for the year 2034	(11.00 ^{2}× π／4 × 1.000)／ 0.260 ／60 ＝ 6.09 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	200 mm
Discharge Flow : 40% Q* 2 whe Design Flow for the year 2034	0.260 × 3600 × 40.0% Q ＝ 374 ⇒ 380 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	150 mm
Discharge Flow : 20% Q* 1 whe Design Flow for the year 2034	0.260 × 3600 × 20.0% Q ＝ 187 ⇒ 190 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/21

E-2 Process Cal_ EA&al 10MLD Karivobanahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	10MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	10,000	416.67	0.116
Max Daily	10,000	416.67	0.116
Max Hourly Peak factor 2.25	22,500	937.50	0.260

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 22,500 m3/day
= 0.260 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin
(2) Depth of Basin — 1.500 m
(3) Width of Basin — 2.000 m
(4) Length of Basin — 2.000 m
(5) Volume required of Basin — 1.500 × 2.000 × 2.000 = 1.5 m3
(6) Retention Time — 1.500 × 2.000 × 2.000 ／ 0.260 × 1
= 23.08 sec
(7) Basin Dimensions — Width 2.000 m × Length 2.000 m
× Depth 1.500 m

STP basic &Stilling Chamber4/21

3.	**Fine Screen Channel**											
〔1〕Design Condition												
(1)	Design Wastewater Flow		Max Hourly			=		22,500	m3/d			
						=	0.260	m3/sec				
[2]	Geometory											
(1)	Inlet Gate											
	Number	2	Main		+		1	Bypass				
	Width	0.400	m									
	Height	0.600	m									
	Floor Level	+	2.000	m								
	Bottom	+	0.000	m								
	Influent Water Level	+	0.300	m								
	Velocity	0.260	／	0.400	／	0.300	／	2				
		=	1.083	≒	1.000	m/sec						
(2)	Screen Channel											
	Number	2	Main		+		1	Bypass				
	Width	0.800	m									
	Side Water Depth	0.400	m									
	Velocity	0.260	／	0.800	／	0.400	／	2				
		=	0.406	≒	0.450	m/sec						
(3)	Channel Dimensions	Width	0.8	m	×	Length	6.0	m				
			×	SWD	0.4	m						
[3]	Equipment											
(1)	Inlet Gate											
	Number	2	W		+		1	S				
	Dimension	Width	0.4	m	×	Height	0.60	m				
	Design Water Level	2.00	m									
(2)	Fine Screens (Main Channel)											
	Number	2	W		+		0	S				
	Open Space	6	mm									
	Bar Thickness	2	mm									
	Channel Width	0.8	m									
	Width of side plate	50	mm									
	Side Water Depth	0.4	m									
	Height of Blind Plate at the bottom	50	mm									
	Velocity through screen	0.260	／	0.700	／	0.350	／	2				
		×(	6	+	2	)/	6					
		=	0.707	＜	0.800	m/sec						
(3)	Fine Screens (Bypass Channel)											
	Number	0	W		+		1	S				
	Open Space	20	mm									
	Bar Thickness	9	mm									
	Channel Width	0.8	m									
	Side Water Depth	0.4	m									
	Velocity through screen	0.260	／	0.800	／	0.400	／	2				
		×(	20	+	9	)/	20					
		=	0.589	＜	0.800	m/sec						

E-2 Process Cal_ EA&al 10MLD Karivobanahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Peak flow = 22,500 m^3/day
	= 0.260 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec = 960 $m^3/m^2/day$
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.260 ⁄ 0.0111 = 23.42 m^2
(2) Number of Basins	1 S + 1 W
(3) Surface Area required/Basin	23.4 ⁄ 1 = 23.42 m^2
(4) Length of Basin	23.42 ^0.5 = 4.8 m → 5.0 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.260 × 60 sec ⁄ 1 = 15.6 m^3
(7) Depth required	15.6 ⁄ 5.0 ⁄ 5.0 = 0.624 m
(8) Basin Dimensions	Width 5.0 m × Length 5.0 m
	× Depth 0.6 m (Freeboard 0.3m)
(9) Retention Time	5 × 5.0 × 0.6 ⁄ 0.260 × 1
	= 60.00 sec
(10) Surface Overflow Rate at Peak Flow	22,500 ⁄ 5.0 ⁄ 5.0 ⁄ 1
	= 900 < 960 $m^3/m^2/day$
[3] Parshall Flume	
(1) Design Flow Rate	Q= 260.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ⁄ 2264 ⁄ W) $^{2/3}$
	Ha= 0.402 m
(4) Crest Level	+ m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 0.402 m
(6) Channel bottom level	+ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.248 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.800 m
(3) Stroke	0.450 m
(4) Overflow Height	0.400 m
(5) Overflow Height (actual)	(0.260 ⁄ 1.840 ⁄ 0.800 ⁄ 2) $^{2/3}$
	= 0.198 < 0.400 m

E-2 Process Cal_ EA&al 10MLD Karivobanahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	10,000	m^3/day (summer)	
	Q'=	10,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/l	
Outlet BOD		10.0	mg/l	
Inlet S-BOD		235	mg/l	assumed as 67% of BOD
Inlet COD		800	mg/l	
Inlet bCOD :S_0		578	mg/l	
Inlet nbCOD		223	mg/l	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/l	
Inlet rbCOD		231	mg/l	bCOD*40%
Inlet sbCOD		347	mg/l	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/l	
Inlet nbpCOD :nbpCOD		183	mg/l	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/l	
Inlet VSS		383	mg/l	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/l	
Inlet TKN		70	mg/l	
Inlet NH_4-N		45.0	mg/l	
Inlet T-P		7	mg/l	
Inlet D-P		5	mg/l	
Inlet Alkalinity as CaCO3		380	mg/l	
Outlet Kjeldahl N		1.0	mg/l	
Outlet NH4-N		1.0	mg/l	
Outlet NO3-N		9.0	mg/l	
Outlet T-P		2	mg/l	
Outlet D-P		1	mg/l	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* =	8,000	mg/l	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/l	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃ = 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃ = 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/l	
DO	DO=	2.0000	mg/l	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/l	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	3127.038	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	4121.000	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1807.449	kg VSS/d	$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
			1622.951		$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			146.066		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			38.432		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	6,868	m3	
	τ =	τ =	16.48	hr	$=Va/Q\times 24$
		⇒	18.00	hr	
	$X_{VSS}\cdot Va$	$X_{VSS}\cdot Va$=	15,635	kg VSS	$=Px,_{VSS}\cdot SRT$
	$X_{TSS}\cdot Va$	$X_{TSS}\cdot Va$=	20,605	kg TSS	$=Px,_{TSS}\cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	5,770	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — X_b = Q・(SRT)/V・$Y_H(S_0$-S)/[1+b_H(SRT)]
= 1,181.47 mg/*l*

(2) IR ratio — IR = NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 383,106.10 kg/d

(4) The anoxic tank volume — Vnor= 687 m3 = Va× 10%
Vnor= 2,083 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb — SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.110 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 520,993.08 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 383,106 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P — 3.13 mg/l
P in waste sludge — px= 1.00%
Generated waste sludge — $Px_{,VSS}$= 3127.038 kg /d
Rwmoval Phosphorus — 31.27038027 kg /d
(2) Effluent T-P without Al — 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio — 1.00 mol/mol
(4) Required Al dosing rate — 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Alumnum Sulfate — 429.78 kg/d
(6) Required Alumnum Sulfate solutic 10% — 4.09 m3/d
170.55 L/H
(7) Additional sludge — 174.23 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

$V_A = Q'*\theta a/24$

$= 7,500$ m^3

(2) Total volume of Anoxic Basins

$V_{DN} = Q'*\theta_{DN}/24$

$= 2,083$ m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	630	1.50	1.50	0.30
Anoxic	V_{DN}	2,083	5.00	5.00	1.00
Aerobic	V_A	7,500	18.00	18.00	3.60
Total	V	10,213	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	123.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin

Hantzsch Subtraction = 1.0 m^2/Basin

after Subtraction: 44.0-1.0 = 43.0 m^2/Basin

Total Volume: 43.0*123.0 = 5,289 m^2/Basin 10,578 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**7.3**	**24.2**	**87.2**	**118.8**
Volume required per Basin	m^3	315	1,042	3,750	5,107
Total Volume required	m^3	630	2,083	7,500	10,213
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	8.0	25.0	90.0	123.0
Actual Volume per Basin	m^3	344	1,075	3,870	5,289
Actual Total Volume	m^3	688	2,150	7,740	10,578
Actual Ratio of Volume		0.32	1.00	3.60	
Actual Retention Time	hour	1.65	5.16	18.58	25.39

[7] Equipment

(1) Ras Pumps

Ras Ratio: 60%

Required Capacity: 10,000 m3/day× 60% ／24 ／ 2

= 125 m3/Hr ⇒ 125 m3/Hr

Number: 2 Work

2 Stanby

(2) Circulation Pumps

Ras Ratio: 366%

Required Capacity: 10,000 m3/day× 366% ／24 ／ 4

= 381 m3/Hr ⇒ 385 m3/Hr

Number: 4 Work

2 Stanby

(3) SAS Pumps

Excess Sludge: 542 m3/day

Sludge withdraw: 12 Times/day

Running Time: 0.5 Hr/Time

Required Capacity: 542 m3/day ／ 12 ／ 0.50 ／ 2

= 45.20 m3/Hr ⇒ 50 m3/Hr

Number: 2 Work

2 Stanby

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(4)	Alum Solution Tank											
	Number	2	W	+	0	S						
	Alum concentration as crystal	10	%									
	Gravity of dissolved dechlorine	1.05										
	Required solution volume	429.78	kg / d	×	100	/	10	/	1.05	/	1000	
		＝	4.09	m3/d								
	Volume of Tank	2.6		m3/tank								
	Total Volume of Tanks	5.2		m3	(Duration=		1.27	day)				
(5)	Mixer for Alum Solution Tank											
	Number	2	W	+	0	S						
(6)	Alum Dosing Pump											
	Number	2	W	+	1	S						
	Capacity	4.09	m3/d	/	24	×	1000	/	2	×	2	
		170.55	l/h/unit	⇒	180	l/h/unit						

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6. Air Requirement at Average Flow	
〔1〕Design Condition	
(1) AOR	AOR = 4,326 kg/day
	= 180.3 kg/h
Qin :Design Average Flow m^3/d	10,000
Inlet bCOD : S_0	578 mg/*l*
S=	S= 0.451 mg/*l*
Nox=	Nox 47.400 mg/*l*
$P_{X,bio}$=	$P_{X,b}$ 1,769.0 kg VSS/d does not include nitrifying bacteria
R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx
R_0=	R_0= 4,326 kg O2/d
	k= 2.86
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \, (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃ 9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature 9.09 mg/L at 20 ℃
	20-T : 0.0 1.024^{20-T} : 1.0000
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth 1+0.40D_j/Pa 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at s 10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : exp[-gM(z_b-z_a)/R*T] 0.900
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t = 293.15 Kelvin
	α : relative Transfer Rate to clean Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \frac{46,940}{4.2591}$ = 11,020.99 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas	= 5,510 kg/day
(5) SOTE for the above Effective Aeration Depth	28.0 %
(6) Fraction of O2 in Air	23.18 %
(7) Specific Gravity of Air at Standard Condition	1.293
(8) Safety Factor	15%
(9) Air required at Field Conditions per Basins	= 81,044 m^3/day = 3,376.9 m^3/hr
[2] Equipment	

Air Requirement at Average Flow12/21

(1) Air Blower						
Number	4	W	+	2	S	
Required Capacity	3376.9	m^3/Hr・Basin	／	2	unit/Basin	
	＝ 1688.4	m^3/h	⇒	1700	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	32.165	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	45.477	kW				
Rated Output of Motor	50.024	kW	⇒	55	kW	

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7. Final Clarifire	
〔1〕 Design Condition	
(1) Design Wastewater Flow	Q= 10,000 m^3/day
(2) Water Temperature	T= 20.0 ℃
(3) MLSS	Xef= 3,000 mg/*l*
(4) SVI	SVI= 300
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77) = 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770 = 20.7 m/day
(6) Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0) = 13.8 m^3/m^2·day → 12.0 m^3/m^2·day
[2] Geometory	
(1) Surface Area required	A= 10,000/12.0= = 833 m^2
(2) Demensions	Diameter **23.0** Depth **3.5** Basin **2**
(3) Actual Surface Area	S= 23.0^2 * 3.14 /4 * 2.0 = 831 m^2
(4) Surface Overflow Rate	S= 10,000/831 = 12.0 m^3/m^2·day

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow 10,000 m^3/day 416.67 m^3/h
		Peak Flow 22,500 m^3/day 937.50 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 100.0 kg/d
		＝ 4.17 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 208.3 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	2.00 m
(4)	Length of lane	18.00 m
(5)	Side Water Depth	2.00 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	6.80 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 416.67 ／ 3600 ／ 2.00 ／ 2.00
		＝ 0.029 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 2.0 m × 18.0 m × 2.0 m
		× 3 × 1
		＝ 216 m^3 > 208.3 m^3

[3] Equipment

(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 100 kg/day
	Maximum Dosage Rate -1	q3 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 225 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 1,500 kg
	Unit Number	EN1 EC1 / Cc = 1.6 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vr1 #### @ 20°C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = 9.38 kg/h
	Operation Numbers	EN2 DC1 / Vr1 = 1.2sets
	Number	2 W + 2 S
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
		225 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.00 kg/hr 9.4 kg/hr
(4)	Chlorine Booster Pump	

Chlorination Tank (gas) 15/21

Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori
Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
Water Demand	(L/min) 15 20 25 30 35 40
Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
Water Demand	(L/min) 45 50 60 300 600 1,200
Water requiamet	-
For Chlorin	Qp1 Maximum dosage ra 9.4 kg/hr
	therefore 60 L/min
Booster Pump Type	Single suction volute pump
Number	1 W + 1 S

9. Dechlorination

〔1〕 Design Condition

(1) Design Flow Rate — Average Daily Flow 10,000 m^3/day

(2) Contact Time — 10 min

(3) Type of Dechlorine — Sodium Thiosulfate ($Na_2S_2O_3\ 5H_2O$)

(4) Free Residual Chlorine — 1.0 mg/L assumed value

(5) Consumption per day — Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
× 1.5 (safety factor)
＝ 26.3 kg/d
＝ 1.09 kg/h

[2] Dechlorination Contact Tank

(1) Volume required — Average Flow Rate ／ 60 × Contact Time
＝ 69.4 m^3

(2) Width of lane — 6.80 m

(3) Length of lane — 5.50 m

(4) Side Water Depth — 2.00 m

(5) Nos. of Tanks — 1 tank

(6) Total Volume — Width × Length × Depth
＝ 6.8 m × 5.5 m × 2.0 m
＝ 75 m^3 > 69.4 m^3

[3] Equipment

(1) Dechlorine Solution Tank

Number — 1 W + 0 S

Dechlorine concentration — 10 %

Gravity of dissolved dechlorine — 1.10

Required solution volume — 26.25 kg / d × 100 / 10 / 1.10 / 1000
＝ 0.24 m3/d

Volume of Tank — 0.360 m3/tank (= 0.6 mW× 0.6 mL× 1.0 mH)

Total Volume of Tanks — 0.360 m3 (Duration= 1.51 day)

(2) Mixer for Dechlorine Solution Tank

Number — 2 W + 0 S

(3) Dechlorine Dosing Pump

Number — 1 W + 1 S

Capacity — 0.54 m3/d / 24 × 1000 / 1
22.37 l/h/unit ⇒ 23 l/h/unit

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10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Generated Sludge	4,339 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(4)	Volume of Thickend Sludge	542.4 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	12 hours/day (6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{542.4}{12 \times 2} \times \frac{7}{6} = 26.4$$

$\rightarrow$ 27 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 ＋ Injection Rate)

＝ 4,339 × (1 ＋ 0.0050)

＝ 4,361 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 4.361 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

＝ 28.27 t/day

apparent specific gravity 1.00

28.27 ／ 1.0 ＝ 28.3 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS･day
(2)	Required Polyelectrolyte	21.69 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	10.85 m3/day

Centrifuge 17/21

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[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	27 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	27 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	10.85 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	10.85 m3/da; × 7 ／ 6 ／ 12 ／ 2
		＝ 0.53 m^3/Hr
	Specification Capacity	0.53 m^3/Hr × 1.5
		＝ 0.791 m^3/Hr ⇒ 0.80 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	21.69 kg/day × 7 ／ 6 ／ 12
		＝ 2.11 kg/hr
		＝ 6.33 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	13 kg/h
	Tanks Dimensions	Width 1.5 m × Length 1.5 m
		× Depth 2.0 m × 2 (Freeboard 0.5m)
		＝ 9 m^3
	Retention Time of Tank	4.50 m^3 /tank ／ 0.53 m^3/Hr ／ 2
		＝ 4.267 Hr > 3 Hr
	Number	2 W + 0 S

Centrifuge 18/21

11. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	4,339 kg/day
(2) Solids Consistency	0.80 %
(3) Volume of Thickened Sludge	$\text{Total Solids} \times \dfrac{100}{\text{Solids Consistency}} \times 10^{-3}$
	$= 4{,}339 \times \dfrac{100}{0.80} \times 10^{-3}$
	$=$ 542 m^3/day
	$=$ 22.60 m^3/h
(4) Sludge feed flow rate	27 m3/h × 2 = 54 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Basin Dimensions	Width 6.0 m × Length 7.0 m
	× Depth 4.0 m × 2
	= 336.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	336.0 m^3
Number	1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

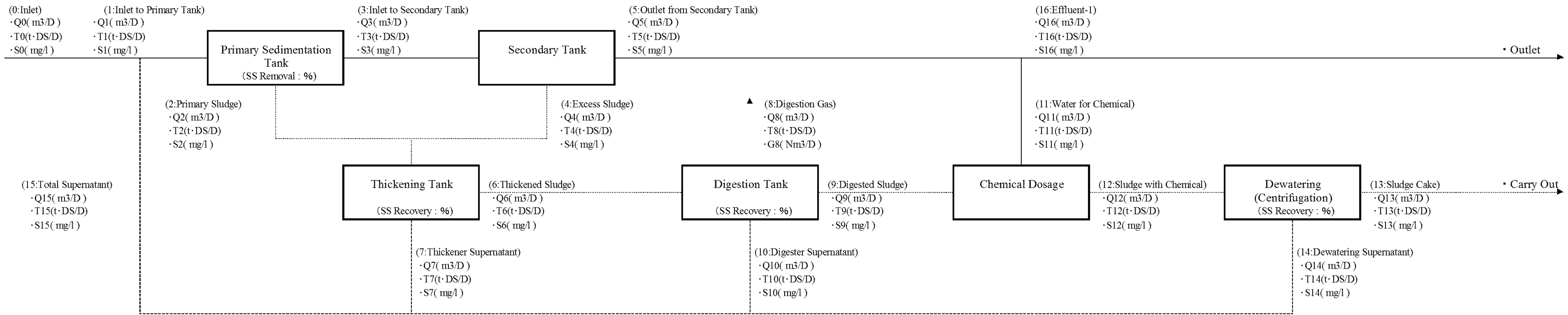
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	10,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力（要収束）			16	17
Q(m^3/day)	10,000	10,530	0	10,530	542	9,988	542	0	0	542	0	11	553	23	530	530	530			9,988	0
T(t･DS/day)	4.500	4.718	0.000	4.718	4.339	0.100	4.339	0.000	0.000	4.339	0.000	0.022	4.361	4.143	0.218	0.218	0.218			0.100	0.279
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model

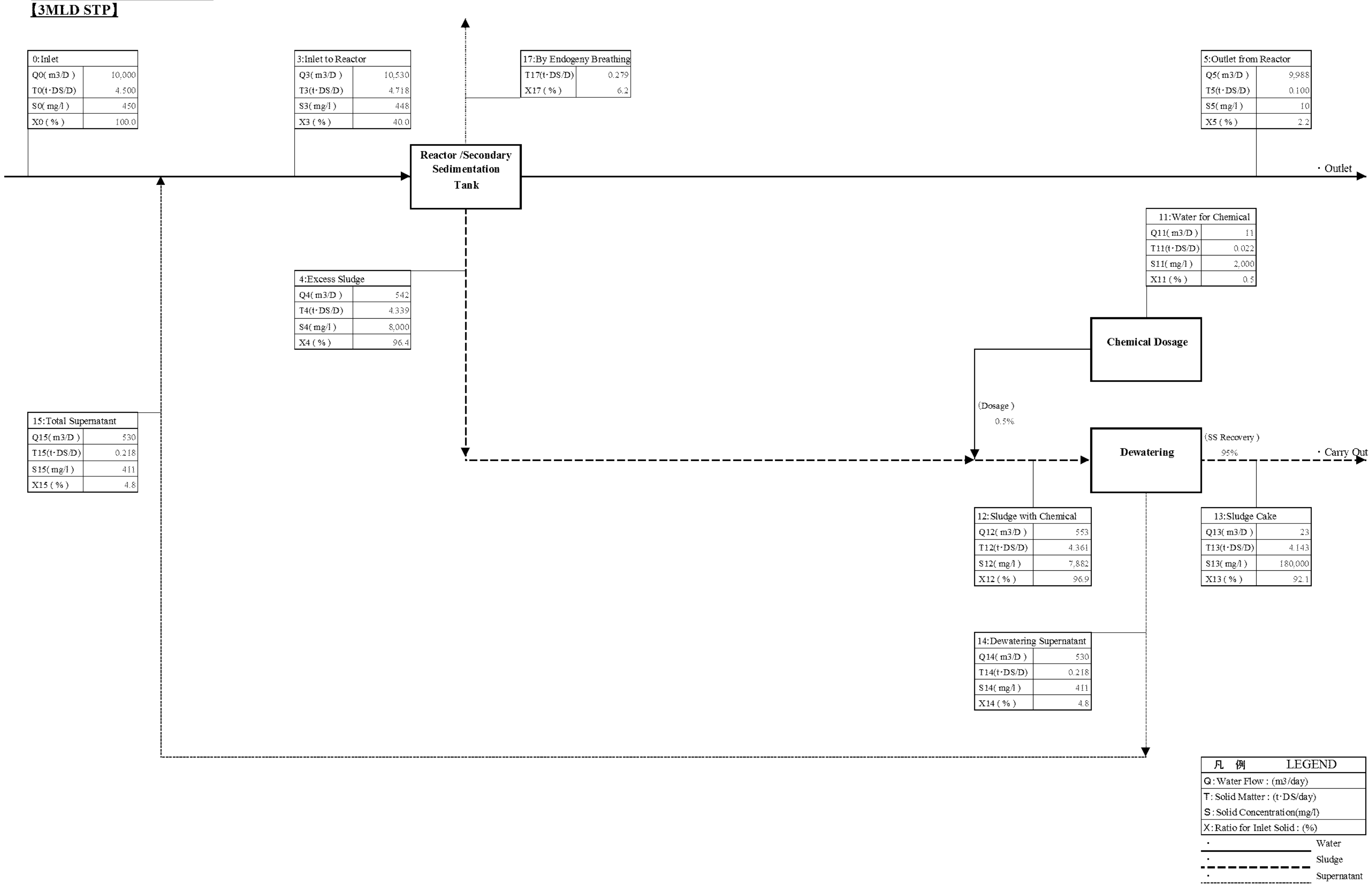


Calculation Formula						
･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【3MLD STP】



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STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	10MLD STP-MPS
(1) Design Flow for the year 2049	

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	16,000	667	0.185
Daily Maximum	16,000	667	0.185
Hourly Max. Peak factor 2.25	36,000	1500	0.417

Item	10MLD STP-MPS
(1) Design Flow for the year 2034	

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	10,000	417	0.116
Daily Maximum	10,000	417	0.116
Hourly Max. Peak factor 2.25	22,500	938	0.260

1. Inlet Chamber

Item	10MLD STP-MPS
[1] Design Condition	
(1) Design Flow for the year 2049	Hourly Maximum = 36,000 m3/d
	= 0.417 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.000 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.000 × 2.500 = 0.5 m3
(6) Retention Time	0.600 × 2.000 × 2.500 ／ 0.417 × 1
	= 7.19 sec
(7) Basin Demensions	Width 2.000 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	10MLD STP-MPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.600 m
Velocity	0.417 ／ 0.600 ／ 0.600 ／ 2
whe Design Flow for the year 2049	＝ 0.579 ＜ 1.000 m/sec OK
Velocity	0.260 ／ 0.600 ／ 0.600 ／ 1
whe Design Flow for the year 2034	＝ 0.722 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	1.000 m
Side Water Depth	0.600 m
Velocity	0.417 ／ 1.000 ／ 0.600 ／ 2
whe Design Flow for the year 2049	＝ 0.348 ≒ 0.450 m/sec OK
Velocity	0.260 ／ 1.000 ／ 0.600 ／ 1
whe Design Flow for the year 2034	＝ 0.433 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 1.0 m × Length 6.0 m × SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.417 ／ 0.900 ／ 0.550 ／ 2 × (20 + 9) / 20
	＝ 0.611 ≒ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.260 ／ 0.900 ／ 0.550 ／ 1 × (20 + 9) / 20
	＝ 0.762 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	1.0 m
Side Water Depth	0.6 m
Velocity through screen whe Design Flow for the year 2049	0.417 ／ 1.000 ／ 0.600 ／ 2 × (50 + 9) / 50
	＝ 0.410 ＜ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.260 ／ 1.000 ／ 0.600 ／ 1 × (50 + 9) / 50
	＝ 0.511 ＜ 0.800 m/sec OK

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3. Raw Sewage Sump

Item	10MLD STP-MPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	11.00 m
Pump Operating Depth	1.000 m
Retention Time	(11.00 ²× π／4 × 1.000)／ 0.417 ／60
whe Design Flow for the year 2049	＝ 3.80 ＞ 3.75 min (=minimum time of one pump cycle ¨OK
Retention Time	(11.00 ²× π／4 × 1.000)／ 0.260 ／60
whe Design Flow for the year 2034	＝ 6.09 ＞ 3.75 min (=minimum time of one pump cycle ¨OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	200 mm
Discharge Flow : 40% Q* 2	0.260 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 374 ⇒ 380 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	150 mm
Discharge Flow : 20% Q* 1	0.260 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 187 ⇒ 190 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/21

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STP Process Calculation_Supporting Report 12.2.3

Item	10MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	10,000	416.67	0.116
Max Daily	10,000	416.67	0.116
Max Hourly Peak factor 2.25	22,500	937.50	0.260

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 22,500 m3/day
= 0.260 m3/sec

[2] Geometry

(1) Number of Basins: 1 Basin
(2) Depth of Basin: 1.500 m
(3) Width of Basin: 2.000 m
(4) Length of Basin: 2.000 m
(5) Volume required of Basin: 1.500 × 2.000 × 2.000 = 1.5 m3
(6) Retention Time: 1.500 × 2.000 × 2.000 ⁄ 0.260 × 1
= 23.08 sec
(7) Basin Dimensions: Width 2.000 m × Length 2.000 m
× Depth 1.500 m

STP basic &Stilling Chamber4/21

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3.	**Fine Screen Channel**									
〔1〕Design Condition										
(1)	Design Wastewater Flow		Max Hourly		=		22,500	m3/d		
					=	0.260	m3/sec			
[2]	Geometory									
(1)	Inlet Gate									
	Number	2	Main		+	1	Bypass			
	Width	0.400	m							
	Height	0.600	m							
	Floor Level	+	2.000	m						
	Bottom	+	0.000	m						
	Influent Water Level	+	0.300	m						
	Velocity	0.260	／	0.400	／	0.300	／	2		
		=	1.083	≒	1.000	m/sec				
(2)	Screen Channel									
	Number	2	Main		+	1	Bypass			
	Width	0.800	m							
	Side Water Depth	0.400	m							
	Velocity	0.260	／	0.800	／	0.400	／	2		
		=	0.406	≒	0.450	m/sec				
(3)	Channel Dimensions	Width	0.8	m	×	Length	6.0	m		
			×	SWD	0.4	m				
[3]	Equipment									
(1)	Inlet Gate									
	Number	2	W		+	1	S			
	Dimension	Width	0.4	m	×	Height	0.60	m		
	Design Water Level	2.00	m							
(2)	Fine Screens (Main Channel)									
	Number	2	W		+	0	S			
	Open Space	6	mm							
	Bar Thickness	2	mm							
	Channel Width	0.8	m							
	Width of side plate	50	mm							
	Side Water Depth	0.4	m							
	Height of Blind Plate at the bottom	50	mm							
	Velocity through screen	0.260	／	0.700	／	0.350	／	2		
		×(	6	+	2	)/	6			
		=	0.707	＜	0.800	m/sec				
(3)	Fine Screens (Bypass Channel)									
	Number	0	W		+	1	S			
	Open Space	20	mm							
	Bar Thickness	9	mm							
	Channel Width	0.8	m							
	Side Water Depth	0.4	m							
	Velocity through screen	0.260	／	0.800	／	0.400	／	2		
		×(	20	+	9	)/	20			
		=	0.589	＜	0.800	m/sec				

Fine Screen5/21

4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Peak flow = 22,500 m^3/day
		= 0.260 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec
[2]	**Grit Chamber**	**Square Grit Chamber**
(1)	Surface Area required	0.260 ／ 0.0111 = 23.42 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	23.4 ／ 1 = 23.42 m^2
(4)	Length of Basin	23.42 ^0.5 = 4.8 m → 5.0 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.260 × 60 sec ／ 1 = 15.6 m^3
(7)	Depth required	15.6 ／ 5.0 ／ 5.0 = 0.624 m
(8)	Basin Dimensions	Width 5.0 m × Length 5.0 m
		× Depth 0.6 m (Freeboard 0.3m)
(9)	Retention Time	5 × 5.0 × 0.6 ／ 0.260 × 1
		= 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	22,500 ／ 5.0 ／ 5.0 ／ 1
		= 900 < 960 m^3/m^2/day
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 260.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
		Ha= 0.402 m
(4)	Crest Level	+ m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 0.402 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.248 m/sec
(10)	Total Length of channel	10.000 m
[4]	**Inlet Weir Gate**	
(1)	Number	2 Units
(2)	Weir Width	0.800 m
(3)	Stroke	0.450 m
(4)	Overflow Height	0.400 m
(5)	Overflow Height (actual)	(0.260 ／ 1.840 ／ 0.800 ／ 2) $^{2/3}$
		= 0.198 < 0.400 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q＝	10,000	m^3/day (summer)	
	Q'＝	10,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45.0	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T＝	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* ＝	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} ＝	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB}\times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	3127.038	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	4121.000	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/l	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/l	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1807.449	kg VSS/d	$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
			1622.951		$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			146.066		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			38.432		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/l	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	6,868	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS}\cdot Va$	$X_{VSS}\cdot Va$=	15,635	kg VSS	$=Px,_{VSS}\cdot SRT$
	$X_{TSS}\cdot Va$	$X_{TSS}\cdot Va$=	20,605	kg TSS	$=Px,_{TSS}\cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	5,770	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.900	mg/l	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.500	mg/l	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — $X_b = Q\cdot(SRT)/V\cdot Y_H(S_0\text{-}S)/[1+b_H(SRT)]$
= 1,181.47 mg/*l*

(2) IR ratio — IR = NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 383,106.10 kg/d

(4) The anoxic tank volume — Vnor= 687 m3 = Va× 10%
Vnor= 2,083 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb — SDNRb= 0.296 g/g・d $= b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.110 g/g・d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d $=SDNR_t - 0.029\ln(F/M_b)-0.012$ IR=3-4
$=SDNR_t - 0.0166\ln(F/M_b)-0.078$ IR=2

SDNRt= 0.296 g/g・d $=SDNR_b\cdot\theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 520,993.08 kg/d $=N_{nox}\cdot SDNR\cdot X_b$
>Nox feed= 383,106 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk produce(136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px,_{VSS}$= 3127.038 kg /d
Rwmoval Phosphorus 31.27038027 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Alumnum Sulfate 429.78 kg/d
(6) Required Alumnum Sulfate solutic 10% 4.09 m3/d
170.55 L/H
(7) Additional sludge 174.23 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins $V_A =$ Q'*θa/24
= 7,500 m^3

(2) Total volume of Anoxic Basins $V_{DN} =$ Q'*θ_{DN}/24
= 2,083 m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	630	1.50	1.50	0.30
Anoxic	V_{DN}	2,083	5.00	5.00	1.00
Aerobic	V_A	7,500	18.00	18.00	3.60
Total	V	10,213	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	123.0	5.5	2

Cross Section 8.0*5.5 = 44.0 m^2/Basin
Hantzsch Subtraction = 1.0 m^2/Basin
after Subtraction 44.0-1.0 = 43.0 m^2/Basin
Total Volume 43.0*123.0 = 5,289 m^2/Basin 10,578 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2		43.0		
Length required	m	**7.3**	**24.2**	**87.2**	**118.8**
Volume required per Basin	m^3	315	1,042	3,750	5,107
Total Volume required	m^3	630	2,083	7,500	10,213
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	8.0	25.0	90.0	123.0
Actual Volume per Basin	m^3	344	1,075	3,870	5,289
Actual Total Volume	m^3	688	2,150	7,740	10,578
Actual Ratio of Volume		0.32	1.00	3.60	
Actual Retention Time	hour	1.65	5.16	18.58	25.39

[7] Equipment

(1) Ras Pumps
Ras Ratio 60%
Required Capacity 10,000 m3/day× 60% ／24 ／ 2
= 125 m3/Hr ⇒ 125 m3/Hr
Number 2 Work
2 Stanby

(2) Circulation Pumps
Ras Ratio 366%
Required Capacity 10,000 m3/day× 366% ／24 ／ 4
= 381 m3/Hr ⇒ 385 m3/Hr
Number 4 Work
2 Stanby

(3) SAS Pumps
Excess Sludge 542 m3/day
Sludge withdraw 12 Times/day
Running Time 0.5 Hr/Time
Required Capacity 542 m3/day ／ 12 ／ 0.50 ／ 2
= 45.20 m3/Hr ⇒ 50 m3/Hr
Number 2 Work
2 Stanby

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(4)	Alum Solution Tank												
	Number	2	W	+	0	S							
	Alum concentration as crystal	10	%										
	Gravity of dissolved dechlorine	1.05											
	Required solution volume	429.78	kg / d	×	100	/	10	/	1.05	/	1000		
		＝	4.09	m3/d									
	Volume of Tank	2.6		m3/tank									
	Total Volume of Tanks	5.2		m3	(Duration=	1.27	day)						
(5)	Mixer for Alum Solution Tank												
	Number	2	W	+	0	S							
(6)	Alum Dosing Pump												
	Number	2	W	+	1	S							
	Capacity	4.09	m3/d	/	24	×	1000	/	2	×	2		
		170.55	l/h/unit	⇒	180	l/h/unit							

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6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR	AOR	=	4,326	kg/day
			=	180.3	kg/h
	Qin :Design Average Flow m^3/d	10,000			
	Inlet bCOD $:S_0$	578 mg/l			
	S=	S= 0.451 mg/l			
	Nox=	Nox 47.400 mg/l			
	$P_{X,bio}$=	$P_{X,b}$ 1,769.0 kg VSS/d	does not include nitrifying bacteria		
	R_0=	$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$			
	R_0=	R_0= 4,326 kg O2/d			
		k= 2.86			

(2) SOR(Standard Oxygen Transfer Rate at site)

$$= \frac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		$1+0.40D_j/Pa$	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R*T]$	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{46,940}{4.2591} = 11,020.99 \text{ kg/day}$$

(3)	No. of Basins	2	Basin	
(4)	Standard O2 required at Field Conditions per Bas	=	5,510	kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0	%	
(6)	Fraction of O2 in Air	23.18	%	
(7)	Specific Gravity of Air at Standard Condition	1.293		
(8)	Safety Factor	15%		
(9)	Air required at Field Conditions per Basins	= 81,044	m^3/day =	3,376.9 m^3/hr

Air Requirement at Average Flow12/21

[2]	Equipment							
(1)	Air Blower							
	Number		4	W	+	2	S	
	Required Capacity		3376.9	m^3/Hr・Basin	／	2	unit/Basin	
		＝	1688.4	m^3/h	⇒	1700	m^3/h /Unit	
	Pressure		65	kPa				
	Safty Factor		10	%				
	Heat capacity ratio		1.4					
	Atmospheric pressuer at site elevation		91.234	kPa				
	Total inlet pressure		89.234	kPa				
	Volume rate of flow at inlet point		32.165	m3/min				
	Total discharge pressure		156.234	kPa				
	Overall adiabatic effeciency		0.65					
	Inlet air temperature (min.)		15	℃				
	Shaft power		45.477	kW				
	Rated Output of Motor		50.024	kW	⇒	55	kW	

7. Final Clarifire

〔1〕 Design Condition

(1)	Design Wastewater Flow	Q=	10,000 m^3/day		
(2)	Water Temperature	T=	20.0 ℃		
(3)	MLSS	Xef=	3,000 mg/l		
(4)	SVI	SVI=	300		
(5)	Sedimentation Velocity	v =	4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)		
		=	4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770		
		=	20.7 m/day		
(6)	Surface Overflow Rate required	S'=	v/(1.5*1)= 20.7/(1.5*1.0)	=	13.8 m^3/m^2·day
				→	12.0 m^3/m^2·day

[2] Geometory

(1)	Surface Area required	A=	10,000/12.0=	=	833 m^2
(2)	Demensions		Diameter / Depth / Basin		
			23.0 / **3.5** / **2**		
(3)	Actual Surface Area	S=	23.0^2 * 3.14 /4 * 2.0	=	831 m^2
(4)	Surface Overflow Rate	S=	10,000/831	=	12.0 m^3/m^2·day

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8. Chlorination	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 10,000 m^3/day 416.67 m^3/h
	Peak Flow 22,500 m^3/day 937.50 m^3/h
(2) Contact Time	30 min
(3) Type of Chlorine	Cl_2-GAS
(4) Design Chlorine Dosage Rate	10 mg/L
(5) Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
	＝ 100.0 kg/d
	＝ 4.17 kg/h
[2] Chlorination Contact Tank	
(1) Volume required	Average Daily Flow ／ 1440 × Contact Time
	＝ 208.3 m^3
(2) Nos. of lanes	3 lanes
(3) Width of lane	2.00 m
(4) Length of lane	18.00 m
(5) Side Water Depth	2.00 m
(6) Nos. of Tanks	1 tank
(7) Total Width of Tank	6.80 m Approx..
(8) Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
	＝ 416.67 ／ 3600 ／ 2.00 ／ 2.00
	＝ 0.029 m/sec
(9) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
	＝ 2.0 m × 18.0 m × 2.0 m
	× 3 × 1
	＝ 216 m^3 > 208.3 m^3
[3] Equipment	
(1) Chlorine Dosing Condition	
Operation Dosage Rate -1	DC1 10 mg/L
(2) Chlorine Cylinder	
Type	- Cylindrical Convexsd Container
Cylinder Capacity	Cc 928 kg/cylinder
Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 100 kg/day
Maximum Dosage Rate -1	q3 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 = 225 kg/day
Storage day	T More than 15 days
Required Storage Capacity	EC1 D x T = 1,500 kg
Unit Number	EN1 EC1 / Cc = 1.6 cylinders
Maximum Operation Numbers	
Cl_2-Gas Volatilize Rate	Vr1 #### @ 20^{O}C Standard temperature
Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = 9.38 kg/h
Operation Numbers	EN2 DC1 / Vr1 = 1.2sets
Number	2 W + 2 S
(3) Chlorinator	
Type	Solution Feed Vacuum Type
Number	1 W + 1 S
Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
	225 kg/day
Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
	Minimum Maximum
	0.00 kg/hr 9.4 kg/hr

Chlorination Tank (gas) 15/21

(4)	Chlorine Booster Pump	
	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 9.4 kg/hr
		therefore 60 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 10,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 26.3 kg/d
		＝ 1.09 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 69.4 m^3
(2)	Width of lane	6.80 m
(3)	Length of lane	5.50 m
(4)	Side Water Depth	2.00 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 6.8 m × 5.5 m × 2.0 m
		＝ 75 m^3 > 69.4 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	1 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	26.25 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.24 m3/d
	Volume of Tank	0.360 m3/tank (= 0.6 mW× 0.6 mL× 1.0 mH)
	Total Volume of Tanks	0.360 m3 (Duration= 1.51 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	2 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	1 W + 1 S
	Capacity	0.54 m3/d / 24 × 1000 / 1
		22.37 l/h/unit ⇒ 23 l/h/unit

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10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge			
(2)	Generated Sludge	4,339	kg/day		
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte		5	kg/t-DS･day
(4)	Volume of Thickend Sludge	542.4	m^3/day		
(5)	Consistency of Dewatered Sludge	82	%		
(6)	Operation Time	12	hours/day	(6 days per week)	

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{542.4}{12 \times 2} \times \frac{7}{6} = 26.4$$

$$\rightarrow 27 \ m^3/\text{hour}$$

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 4,339 × (1 + 0.0050)

= 4,361 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 4.361 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 28.27 t/day

apparent specific gravity 1.00

28.27 ／ 1.0 = 28.3 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS･day
(2)	Required Polyelectrolyte		21.69	kg/day
(3)	Dissolving concentration		0.20	%
(4)	Volume of Polyelectrolyte solution		10.85	m3/day

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[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	27 m^3/hr
	Number	2 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	27 m^3/hr
	Number	2 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	10.85 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	2 W + 1 S
	Required Capacity	10.85 m3/da; × 7 ／ 6 ／ 12 ／ 2
		＝ 0.53 m^3/Hr
	Specification Capacity	0.53 m^3/Hr × 1.5
		＝ 0.791 m^3/Hr ⇒ 0.80 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Preparation time for solution	3 hr
	Required dry polymer	21.69 kg/day × 7 ／ 6 ／ 12
		＝ 2.11 kg/hr
		＝ 6.33 kg per one batch
	Feedong time per one batch	30 min
	Capacity of Dry polymer Feeder	13 kg/h
	Tanks Dimensions	Width 1.5 m × Length 1.5 m
		× Depth 2.0 m × 2 (Freeboard 0.5m)
		＝ 9 m^3
	Retention Time of Tank	4.50 m^3 /tank ／ 0.53 m^3/Hr ／ 2
		＝ 4.267 Hr > 3 Hr
	Number	2 W + 0 S

Centrifuge 18/21

E-2 Process Cal_ EA&al 10MLD Karivobanahalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

11. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	4,339 kg/day
(2) Solids Consistency	0.80 %
(3) Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
	$= 4{,}339 \times \frac{100}{0.80} \times 10^{-3}$
	= 542 m^3/day
	= 22.60 m^3/h
(4) Sludge feed flow rate	27 m3/h × 2 = 54 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Basin Dimensions	Width 6.0 m × Length 7.0 m
	× Depth 4.0 m × 2
	= 336.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	336.0 m^3
Number	1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

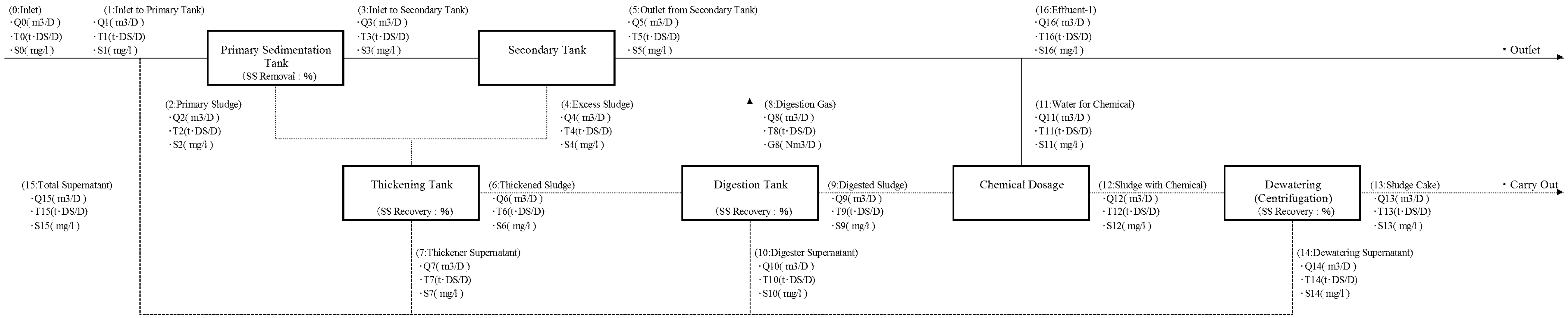
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	10,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	10,000	10,530	0	10,530	542	9,988	542	0	0	542	0	11	553	23	530	530	530			9,988	0
T(t･DS/day)	4.500	4.718	0.000	4.718	4.339	0.100	4.339	0.000	0.000	4.339	0.000	0.022	4.361	4.143	0.218	0.218	0.218			0.100	0.279
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



Calculation Formula

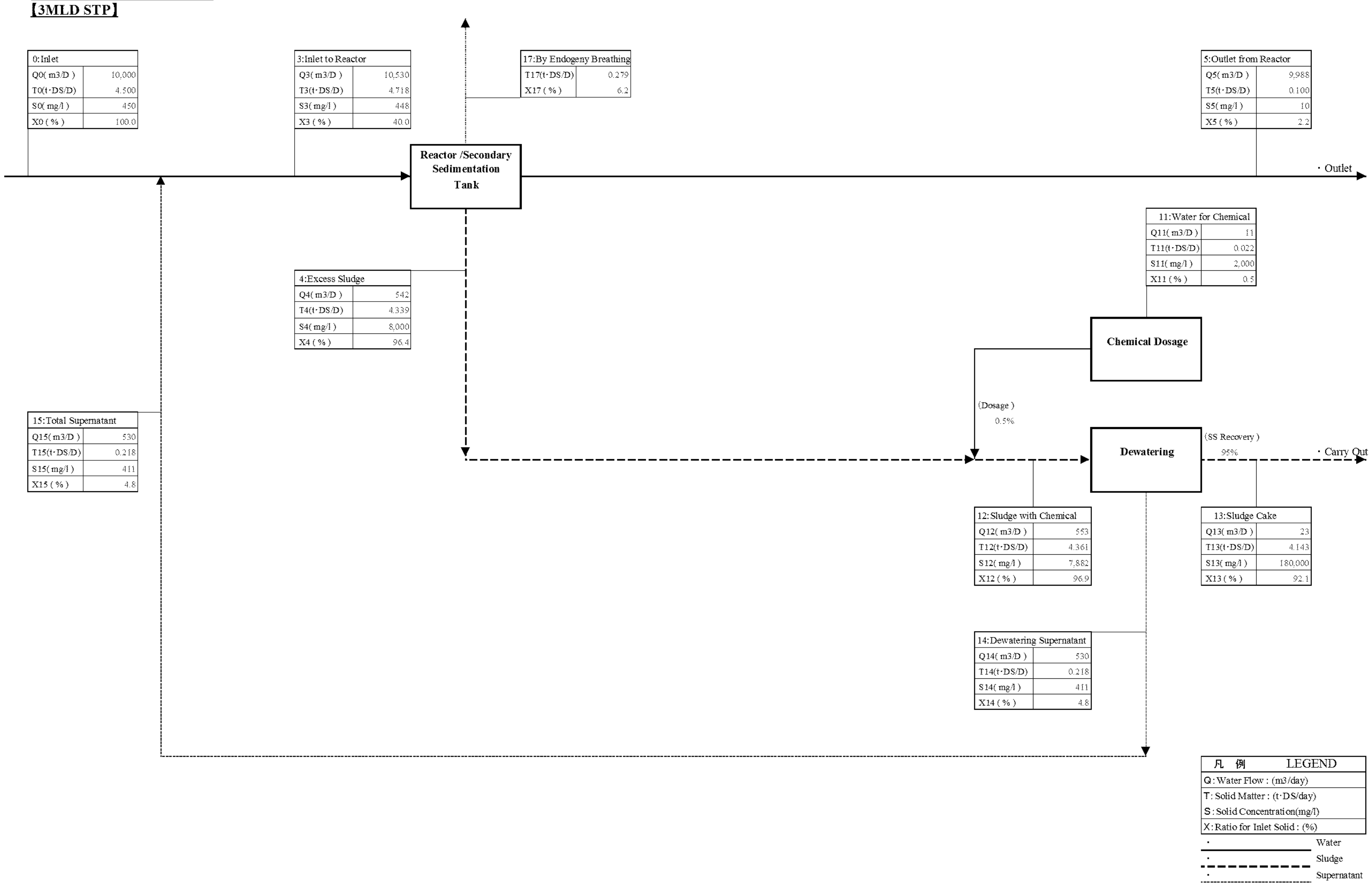
･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet

【3MLD STP】



E-3 Process Cal_ EA&al 3MLD Herohalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	3MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	5,000	208	0.058
Daily Maximum	5,000	208	0.058
Hourly Max. Peak factor 2.5	####	521	0.145

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	3,000	125	0.035
Daily Maximum	3,000	125	0.035
Hourly Max. Peak factor 2.5	7,500	313	0.087

1. Inlet Chamber

Item	3MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly = 12,500 m3/d
	= 0.145 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	1.800 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 1.800 × 2.500 = 0.4 m3
(6) Retention Time	0.600 × 1.800 × 2.500 ⁄ 0.145 × 1
	= 18.62 sec
(7) Basin Demensions	Width 1.800 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

E-3 Process Cal_ EA&al 3MLD Herohalli_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	3MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	1 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.145 ／ 0.400 ／ 0.500 ／ 1
whe Design Flow for the year 2049	= 0.725 ＜ 1.000 m/sec OK
Velocity	0.087 ／ 0.400 ／ 0.500 ／ 1
whe Design Flow for the year 2034	= 0.435 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	1.0 Main + 1.0 Bypass
Width	0.800 m
Side Water Depth	0.500 m
Velocity	0.145 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2049	= 0.363 ≒ 0.450 m/sec OK
Velocity	0.087 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2034	= 0.218 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 0.8 m × Length 8.5 m
	× SWD 0.5 m (Freeboard 0.3m)
[3] Equipment	
(1) Inlet Gate	
Number	2 Units
Dimension	Width 0.4 m × Height 0.6 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	1 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.145 ／ 0.700 ／ 0.450 ／ 1
	× (20 + 9) / 20
	= 0.667 ≒ 0.800 m/sec OK
Velocity through screen	0.087 ／ 0.700 ／ 0.450 ／ 1
whe Design Flow for the year 2034	× (20 + 9) / 20
	= 0.400 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.5 m
Velocity through screen	0.145 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2049	× (50 + 9) / 50
	= 0.428 ＜ 0.800 m/sec OK
Velocity through screen	0.087 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2034	× (50 + 9) / 50
	= 0.257 ＜ 0.800 m/sec OK

Coarse Screen 2/21

E-3 Process Cal_ EA&al 3MLD Herohalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item	3MLD STP-TSPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	6.50 m
Pump Operating Depth	1.000 m
Retention Time	(6.50 ^{2}× π／4 × 1.000)／ 0.145 ／60
whe Design Flow for the year 2049	＝ 3.81 ＞ 3.75 min (=minimum time of one pump cycle OK
Retention Time	(6.50 ^{2}× π／4 × 1.000)／ 0.087 ／60
whe Design Flow for the year 2034	＝ 6.36 ＞ 3.75 min (=minimum time of one pump cycle OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.000 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	1 W + 1 S
Bore Diameter	200 mm
Discharge Flow : Q	0.087 × 3600 ／ 1.0
whe Design Flow for the year 2034	＝ 313 ⇒ 315 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	W + S
Bore Diameter	mm
Discharge Flow : 0.5	／
whe Design Flow for the year 2034	＝ ⇒ m3/Hr
Total Head	m

Raw Sewage Sump 3/21

E-3 Process Cal_ EA&al 3MLD Herohalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	3MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	3,000	125.00	0.035
Max Daily	3,000	125.00	0.035
Max Hourly Peak factor 2.5	7,500	312.50	0.087

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 7,500 m3/day
= 0.087 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.000 m

(3) Width of Basin — 1.800 m

(4) Length of Basin — 1.500 m

(5) Volume required of Basin — 1.000 × 1.800 × 1.500 = 1.2 m3

(6) Retention Time — 1.000 × 1.800 × 1.500 ∕ 0.087 × 1
= 31.03 sec

(7) Basin Dimensions — Width 1.800 m × Length 1.500 m
× Depth 1.000 m

STP basic &Stilling Chamber4/21

E-3 Process Cal_ EA&al 3MLD Herohalli_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

3. Fine Screen Channel	
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 7,500 m3/d
	= 0.087 m3/sec
[2] Geometory	
(1) Inlet Gate	
Number	1 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 2.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.087 ／ 0.400 ／ 0.500 ／ 1
	= 0.435 ≒ 1.000 m/sec
(2) Screen Channel	
Number	1 Main + 1 Bypass
Width	0.600 m
Side Water Depth	0.400 m
Velocity	0.087 ／ 0.600 ／ 0.400 ／ 1
	= 0.363 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 0.6 m × Length 6.0 m
	× SWD 0.4 m (Freeboard 0.3m)
[3] Equipment	
(1) Inlet Gate	
Number	1 W + 1 S
Dimension	Width 0.4 m × Height 0.60 m
Design Water Level	2.00 m
(2) Fine Screens (Main Channel)	
Number	1 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	0.6 m
Width of side plate	50 mm
Side Water Depth	0.4 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.087 ／ 0.500 ／ 0.350 ／ 1
	× (6 + 2) / 6
	= 0.663 < 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.6 m
Side Water Depth	0.4 m
Velocity through screen	0.087 ／ 0.600 ／ 0.400 ／ 1
	× (20 + 9) / 20
	= 0.526 < 0.800 m/sec

Fine Screen5/21

E-3 Process Cal_ EA&al 3MLD Herohalli_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Max Hourly = 7,500 m^3/day
		= 0.087 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec
[2]	**Grit Chamber**	**Square Grit Chamber**
(1)	Surface Area required	0.087 ／ 0.0111 = 7.84 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	7.8 ／ 1 = 7.84 m^2
(4)	Length of Basin	7.84 ^0.5 = 2.8 m → 3.0 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.087 × 60 sec ／ 1 = 5.2 m^3
(7)	Depth required	5.2 ／ 3.0 ／ 3.0 = 0.580 m
(8)	Basin Dimensions	Width 3.0 m × Length 3.0 m
		× Depth 0.6 m (Freeboard 0.3m)
(9)	Retention Time	3 × 3.0 × 0.6 ／ 0.087 × 1
		= 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	7,500 ／ 3.0 ／ 3.0 ／ 1
		= 833.333333 < 960 m^3/m^2/day
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 87.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
		Ha= 0.194 m
(4)	Crest Level	+ 75.400 m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 75.594 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.083 m/sec
(10)	Total Length of channel	10.000 m
[4]	**Inlet Weir Gate**	
(1)	Number	2 Units
(2)	Weir Width	0.300 m
(3)	Stroke	0.350 m
(4)	Overflow Height	0.300 m
(5)	Overflow Height (actual)	(0.087 ／ 1.840 ／ 0.300 ／ 2) $^{2/3}$
		= 0.184 < 0.300 m

Grit Chamber 6/21

5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q＝	3,000	m^3/day (summer)	
	Q'＝	3,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/l	
Outlet BOD		10.0	mg/l	
Inlet S-BOD		235	mg/l	assumed as 67% of BOD
Inlet COD		800	mg/l	
Inlet bCOD :S_0		578	mg/l	
Inlet nbCOD		223	mg/l	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/l	
Inlet rbCOD		231	mg/l	bCOD*40%
Inlet sbCOD		347	mg/l	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/l	
Inlet nbpCOD :nbpCOD		183	mg/l	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/l	
Inlet VSS		383	mg/l	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/l	
Inlet TKN		70	mg/l	
Inlet NH_4-N		45	mg/l	
Inlet T-P		7	mg/l	
Inlet D-P		5	mg/l	
Inlet Alkalinity as CaCO3		380	mg/l	
Outlet Kjeldahl N		1.0	mg/l	
Outlet NH4-N		1.0	mg/l	
Outlet NO3-N		9.0	mg/l	
Outlet T-P		2	mg/l	
Outlet D-P		1	mg/l	
(3) Water Temperature	T＝	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	Rs ＝	8,000	mg/l	
(6) MLSS MLVSS	X_{TSS} ＝	3,000	mg/l	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/l	
DO	DO=	2.0000	mg/l	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/l	

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E-3 Process Cal_ EA&al 3MLD Herohalli_Appendix 12.2.3

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	938.111	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	1236.300	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/l	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/l	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	542.235	kg VSS/d	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
			486.885		$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			43.820		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			11.530		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/l	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	2,060	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS} \cdot Va$	$X_{VSS} \cdot Va$=	4,691	kg VSS	$=Px,_{VSS} \cdot SRT$
	$X_{TSS} \cdot Va$	$X_{TSS} \cdot Va$=	6,181	kg TSS	$=Px,_{TSS} \cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	1,731	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.900	mg/l	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.500	mg/l	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — X_b = Q・(SRT)/V・Y_H(S_0-S)/[1+b_H(SRT)]
= 1,181.47 mg/l

(2) IR ratio — IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 114,931.83 kg/d

(4) The anoxic tank volume — Vnor= 206 m3 = Va× 10%
Vnor= 625 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb — SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.110 g/g・d =$SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 156,297.92 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 114,932 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/l

Influent Alk 380.00 mg/l
Alk used 338.44 mg/l =7.14×Nox
Alk produce(136.77 mg/l =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/l

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 938.111 kg /d
Rwmoval Phosphorus 9.38111408 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Aluminium Sulphate 128.93 kg/d
(6) Required Aluminium Sulphate solu 10% 1.23 m3/d
51.16 L/H
(7) Additional sludge 52.27 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

$V_A = Q'*\theta a/24$

$= 2,250$ m^3

(2) Total volume of Anoxic Basins

$V_{DN} = Q'*\theta_{DN}/24$

$= 625$ m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	190	1.50	1.50	0.30
Anoxic	V_{DN}	625	5.00	5.00	1.00
Aerobic	V_A	2,250	18.00	18.00	3.60
Total	V	3,065	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	39.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin

Hantzsch Subtraction = 1.0 m^2/Basin

after Subtraction: 44.0-1.0 = 43.0 m^2/Basin

Total Volume: 43.0*39.0 = 1,677 m^2/Basin 3,354 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**2.2**	**7.3**	**26.2**	**35.6**
Volume required per Basin	m^3	95	313	1,125	1,533
Total Volume required	m^3	190	625	2,250	3,065
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	3.0	8.0	28.0	39.0
Actual Volume per Basin	m^3	129	344	1,204	1,677
Actual Total Volume	m^3	258	688	2,408	3,354
Actual Ratio of Volume		0.38	1.00	3.50	
Actual Retention Time	hour	2.06	5.50	19.26	26.82

[7] Equipment

(1) Ras Pumps

Ras Ratio: 60%

Required Capacity: 3,000 m3/day× 60% ／24 ／ 2

= 38 m3/Hr ⇒ 40 m3/Hr

Number: 2 Work

2 Standby

(2) Circulation Pumps

Ras Ratio: 366%

Required Capacity: 3,000 m3/day× 366% ／24 ／ 4

= 114 m3/Hr ⇒ 120 m3/Hr

Number: 4 Work

2 Standby

(3) SAS Pumps

Excess Sludge: 163 m3/day

Sludge withdraw: 12 Times/day

Running Time: 0.5 Hr/Time

Required Capacity: 163 m3/day ／ 12 ／ 0.50 ／ 2

= 13.56 m3/Hr ⇒ 14 m3/Hr

Number: 2 Work

2 Standby

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(4)	Alum Solution Tank												
	Number	2	W	+		0	S						
	Alum concentration as crystal	10	%										
	Gravity of dissolved dechlorine	1.05											
	Required solution volume	128.93	kg / d	×	100	/	10	/	1.05	/	1000		
		＝	1.23	m3/d									
	Volume of Tank		1.0	m3/tank									
	Total Volume of Tanks		2.0	m3		(Duration=		1.63	day)				
(5)	Mixer for Alum Solution Tank												
	Number	2	W	+	0	S							
(6)	Alum Dosing Pump												
	Number	2	W	+	1	S							
	Capacity	1.23	m3/d	/	24	×	1000	/	2	×	2		
		51.16	l/h/unit	⇒	60	l/h/unit							

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6. Air Requirement at Average Flow	
〔1〕Design Condition	
(1) AOR	AOR = 1,298 kg/day
	= 54.1 kg/h
Qin :Design Average Flow m^3/d	3,000
Inlet bCOD :S_0	578 mg/l
S=	S= 0.451 mg/l
Nox=	Nox 47.400 mg/l
$P_{X,bio}$=	$P_{X,b}$ 530.7 kg VSS/d does not include nitrifying bacteria
R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx
R_0=	R_0= 1,298 kg O2/d
	k= 2.86
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃
	9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature
	9.09 mg/L at 20 ℃
	20-T : 0.0 1.024^{20-T} : 1.0000
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth
	1+0.40D_j/Pa 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at s
	10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : exp[-gM(z_b-z_a)/R*T] 0.900
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t = 293.15 Kelvin
	α : relative Transfer Rate to clean Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \dfrac{14,082}{4.2591} =$ 3,306.30 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas	= 1,653 kg/day
(5) SOTE for the above Effective Aeration Depth	28.0 %
(6) Fraction of O2 in Air	23.18 %
(7) Specific Gravity of Air at Standard Condition	1.293
(8) Safety Factor	15%
(9) Air required at Field Conditions per Basins	= 24,313 m^3/day = 1,013.1 m^3/hr

[2] Equipment	
(1) Air Blower	
Number	2 W + 1 S
Required Capacity	1013.1 m^3/Hr・Basin ／ 1 unit/Basin
	＝ 1013.1 m^3/h ⇒ 1000 m^3/h /Unit
Pressure	65 kPa
Safty Factor	10 %
Heat capacity ratio	1.4
Atmospheric pressuer at site elevation	91.234 kPa
Total inlet pressure	89.234 kPa
Volume rate of flow at inlet point	18.920 m3/min
Total discharge pressure	156.234 kPa
Overall adiabatic effeciency	0.65
Inlet air temperature (min.)	15 ℃
Shaft power	26.751 kW
Rated Output of Motor	29.426 kW ⇒ 30 kW

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7.	**Final Clarifire**			
〔1〕	**Design Condition**			
(1)	Design Wastewater Flow	Q＝ 3,000 m^3/day		
(2)	Water Temperature	T＝ 20.0 ℃		
(3)	MLSS	Xef＝ 3,000 mg/*l*		
(4)	SVI	SVI＝ 300		
(5)	Sedimentation Velocity	*v* ＝ 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)		
		＝ 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770		
		＝ 20.7 m/day		
(6)	Surface Overflow Rate required	*S'*＝ v/(1.5*1)＝ 20.7/(1.5*1.0)	＝	13.8 m^3/m^2·day
			→	12.0 m^3/m^2·day
[2]	**Geometory**			
(1)	Surface Area required	A＝ 3,000/12.0＝	＝	250 m^2
(2)	Demensions	Diameter / Depth / Basin		
		13.0 / **3.5** / **2**		
(3)	Actual Surface Area	S＝ 13.0^2 * 3.14 /4 * 2.0	＝	265 m^2
(4)	Surface Overflow Rate	S＝ 3,000/265	＝	11.3 m^3/m^2·day

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8.	**Chlorination**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Average Flow 3,000 m^3/day 125.00 m^3/h
		Peak Flow 7,500 m^3/day 312.50 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 30.0 kg/d
		＝ 1.25 kg/h
[2]	**Chlorination Contact Tank**	
(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 62.5 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	1.50 m
(4)	Length of lane	10.00 m
(5)	Side Water Depth	1.50 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	5.30 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 125.00 ／ 3600 ／ 1.50 ／ 1.50
		＝ 0.015 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 1.5 m × 10.0 m × 1.5 m
		× 3 × 1
		＝ 68 m^3 > 62.5 m^3
[3]	**Equipment**	
(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 1 mg/L 10 mg/L
	Average Dosage Rate -1	DC2 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : $Q_{T\text{-}D}$ x DC2 x 10^{-6} x 10^3 = 30 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 450 kg
	Unit Number	EN1 EC1 / Cc = 0.5 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vr1 #### @ 20°C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, $Q_{T\text{-}D}$ x q3 x 10^{-3} / 24 = ####
	Operation Numbers	EN2 DC1 / Vr1 = 0.4sets
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : $Q_{T\text{-}D}$ x DC1 x 10^{-6} x 10^3 =
		3 kg/day to 75 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.13 kg/hr 3.1 kg/hr

(4) Chlorine Booster Pump

Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori

Chlorinator Discharge	(kg/hr)	1.0	1.5	2.0	2.5	3.0	4.0
Water Demand	(L/min)	15	20	25	30	35	40
Chlorinator Discharge	(kg/hr)	5.0	6.0	10.0	50.0	100.0	200.0
Water Demand	(L/min)	45	50	60	300	600	1,200

Water requiamet -

For Chlorin: Qp1 Maximum dosage ra 3.1 kg/hr

therefore 35 L/min

Booster Pump Type: Single suction volute pump

Number: 1 W + 1 S

9. Dechlorination

〔1〕 Design Condition

(1) Design Flow Rate: Average Daily Flow 3,000 m^3/day

(2) Contact Time: 10 min

(3) Type of Dechlorine: Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)

(4) Free Residual Chlorine: 1.0 mg/L assumed value

(5) Consumption per day: Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.19

× 2 (safety factor)

＝ 7.1 kg/d

＝ 0.30 kg/h

9. Dechlorination

〔1〕 Design Condition

(1) Design Flow Rate: Average Daily Flow 3,000 m^3/day

(2) Contact Time: 10 min

(3) Type of Dechlorine: Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)

(4) Free Residual Chlorine: 1.0 mg/L assumed value

(5) Consumption per day: Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75

× 1.5 (safety factor)

＝ 7.88 kg/d

＝ 0.328 kg/h

[2] Dechlorination Contact Tank

(1) Volume required: Average Flow Rate ／ 60 × Contact Time

＝ 20.8 m^3

(2) Width of lane: 5.30 m

(3) Length of lane: 3.00 m

(4) Side Water Depth: 1.50 m

(5) Nos. of Tanks: 1 tank

(6) Total Volume: Width × Length × Depth

＝ 5.3 m × 3.0 m × 1.5 m

＝ 24 m^3 > 20.8 m^3

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[3]	**Equipment**											
(1)	Dechlorine Solution Tank											
	Number	1	W		+	0	S					
	Dechlorine concentration	10	%									
	Gravity of dissolved dechlorine	1.10										
	Required solution volume	7.88	kg / d	×	100	/	10	/	1.10	/	1000	
		=	0.07	m3/d								
	Volume of Tank	0.2	m3/tank									
	Total Volume of Tanks	0.2	m3		(Duration=	2.79	day)					
(2)	Mixer for Dechlorine Solution Tank											
	Number	1	W		+	0	S					
(3)	Dechlorine Dosing Pump											
	Number	1	W		+	1	S					
	Capacity	0.18	m3/d	/	24	×	1000	/	1			
		7.46	l/h/unit	⇒	7.5	l/h/unit						

Chlorination Tank (gas)17/21

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10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Generated Sludge	1,301 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(4)	Volume of Thickend Sludge	162.7 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	12 hours/day (6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \frac{\text{Operation/week}}{}$$

$$= \frac{162.7}{12 \times 1} \times \frac{7}{6} = 15.8$$

→ 16 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 ＋ Injection Rate)

＝ 1,301 × (1 ＋ 0.0050)

＝ 1,308 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 1.308 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

＝ 8.48 t/day

apparent specific gravity 1.00

8.48 ／ 1.0 ＝ 8.5 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(2)	Required Polyelectrolyte	6.51 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	3.25 m3/day

[6] Equipment

(1) Centrifuge

- Capacity: 16 m^3/hr
- Number: 1 W ＋ 1 S

(2) Centrifuge Feed Pumps

- Capacity: 16 m^3/hr
- Number: 1 W ＋ 1 S

(3) Polyelectrolyte Dosing Pumps

- Volume of Polyelectrolyte solution: 3.25 m3/day
- Operation Time: 12 hours/day (6 days per week)
- Safety Factor: 1.5
- Number: 1 W ＋ 1 S
- Required Capacity: 3.25 m3/day × 7 ／ 6 ／ 12 ／ 1
  ＝ 0.32 m^3/Hr
- Specification Capacity: 0.32 m^3/Hr × 1.5
  ＝ 0.474 m^3/Hr ⇒ 0.50 m^3/Hr /Unit

(4) Polyelectrolyte dosing System

- Tanks Dimensions: Width 1.5 m × Length 1.0 m
  × Depth 1.8 m × 2 (Freeboard 0.5m)
  ＝ 5.4 m^3
- Retention Time of Tanks: 5.40 m^3 ／ 0.32 m^3/Hr ／ 1
  ＝ 17.073 Hr
- Number: 2 W ＋ 0 S

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11. Centrifuge Feed Sump

[1] Design Condition

(1)	Generated Thickend Sludge	1,301 kg/day
(2)	Solids Consistency	0.80 %
(3)	Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
		$= 1,301 \times \frac{100}{0.80} \times 10^{-3}$
		= 163 m^3/day
		= 6.78 m^3/h
(4)	Sludge feed flow rate	16 m3/h × 1 = 16 m3/h
(5)	Centrifuge Operation Time	12 hours/day (6 days per week)

[2] Geometry

(1)	Basin Dimensions	Width 4.0 m × Length 4.5 m
		× Depth 3.0 m × 2
		= 108.0 m^3

[3] Equipment

(1)	Mixers for Centrifuge Feed Sumps	
	Required Volume	108.0 m^3
	Number	1 W + 1 S

Centrifuge Feed Sump 19/21

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4·S4=(a·S_{BOD}+b·S1-c·θ·XA)·Q3/10^6··(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

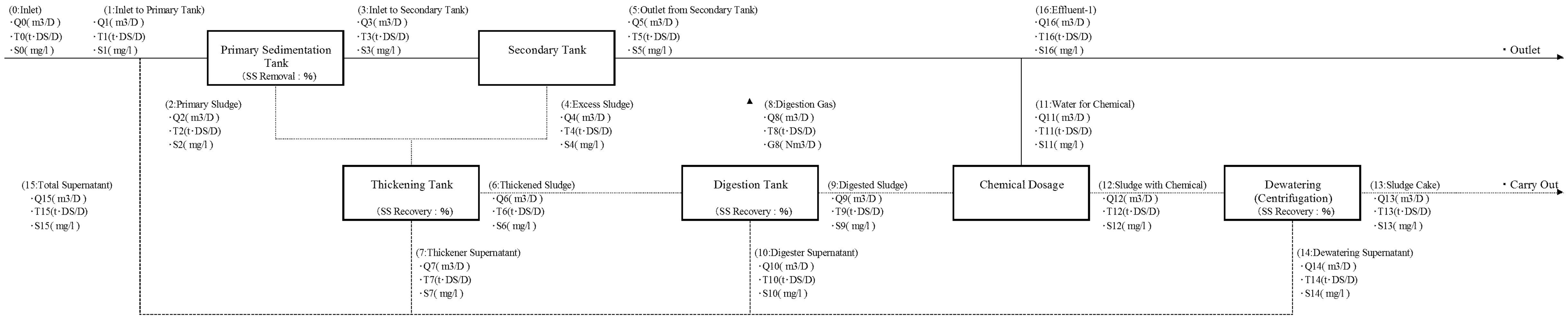
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
·Inlet flow : Q_0(m3/D)	3,000	·Primary sludge moisture ratio : W1(%)	0.0	·Removal ratio in primary tank : A2(%)	0.0	·Content of organics in thickened sludge : A6(%)	75.0	·Chemical dosage : A9(%)	0.5	
·Inlet quality : S_0(mg/l)	450	·Excess sludge moisture ratio : W2(%)	99.2	·Recovery ratio in sludge thickener : A3(%)	100.0	·Digestion ratio : A7(%)	#REF!	·Chemical dissolve concentration : A10(%)	0.2	
·Total removal ratio : A1(%)	-	·Thickened sludge moisture ratio : W3(%)	99.2	·Recovery ratio in sludge digester : A4(%)	100.0	·Digestion gas generation : A8(Nm3/kgVS)				
·Effluent quality : St(mg/l)	10.0	·Digested sludge moisture ratio : W4(%)	99.2	·Recovery ratio in dewatering : A5(%)	95.0					
·Sludge generation ratio per removal SS : Si(%)	-	·Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	3,000	3,159	0	3,159	163	2,996	163	0	0	163	0	3	166	7	159	159	159			2,996	0
T(t·DS/day)	1.350	1.415	0.000	1.415	1.301	0.030	1.301	0.000	0.000	1.301	0.000	0.007	1.308	1.242	0.065	0.065	0.065			0.030	0.084
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.0	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



Calculation Formula

·Q0=Input Data ·T0=Q0*S0*10^(-6) ·S0=Input Data	·Q3=Q1-Q2 ·T3=T0*(100-A2)/100 ·S3=T3*10^6/Q3	·Q6=T6*100/(100-W3) ·T6=(T2+T4)*A3/100 ·S6=10^6*(100-W3)/100	·Q9=Q6 ·T9=(T6-T8)*A4/100 ·S9=T9*10^6/Q9	·Q12=Q9+Q11 ·T12=T9+T11 ·S12=T12*10^6/Q12	·Q15=Q7+Q10+Q14 ·T15=T7+T10+T14 ·S15=T15*10^6/Q15	·Q5-1=Q5-Q11 ·T5-1=T5-T11 ·S5-1=S5
·Q1=Q0+Q15 ·T1=T0+T15 ·S1=T1*10^6/Q1	·Q4=T4*100/(100-W2) ·T4=余剰汚泥発生式による ·S4=10^6*(100-W2)/100	·Q7=(Q2+Q4)-Q6 ·T7=(T2+T4)-T6 ·S7=T7*10^6/Q7	·Q10=Q6-Q8-Q9 ·T10=T6-T8-T9 ·S10=T10*10^6/Q10	·Q13=T13*100/(100-W5) ·T13=T12*A5/100 ·S13=10^6*(100-W5)/100		
·Q2=T2*100/(100-W1) ·T2=T1-T3 ·S2=10^6*(100-W1)/100	·Q5=Q3-Q4*(T3-T5)/T4 ·T5=Q5*ST/10^6 ·S5=St	·Q8=0 ·T8=T6*A6*A7/10^4 #REF!	·Q11=T10*A9/A10 ·T11=Q11*S11/10^6 ·S11=10^4*A10	·Q14=Q12-Q13 ·T14=T12-T13 ·S14=T14*10^6/Q14		

Material Balance Sheet SD4

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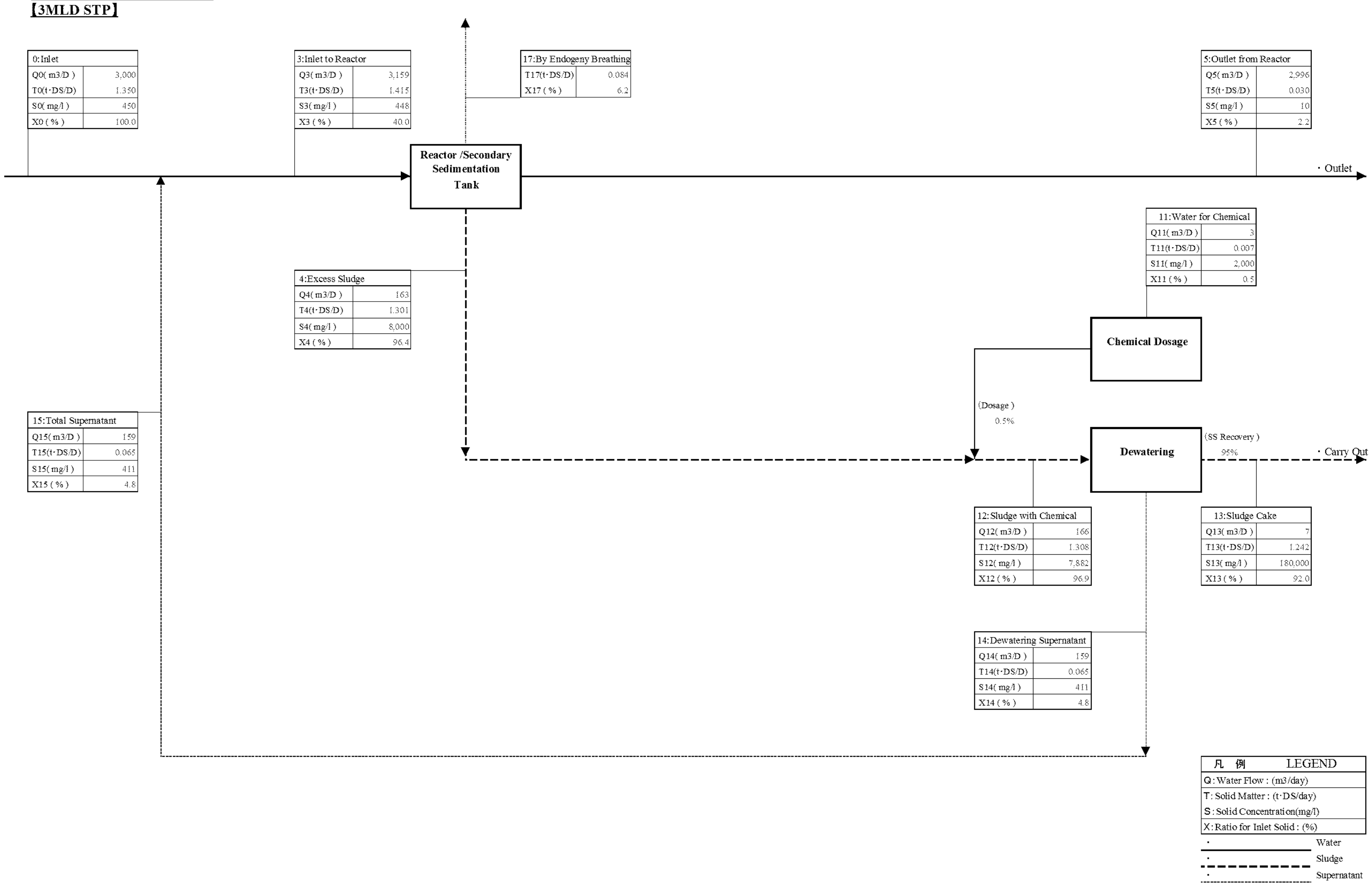
Material Balance Sheet
【3MLD STP】



E-4 Process Cal_ EA&al 6MLD Hosahalli_Appendix 12.2.3

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Design Condition

Item	6MLD STP-TSPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049:

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	10,000	417	0.116
Daily Maximum	10,000	417	0.116
Hourly Max. Peak factor 2.25	22,500	938	0.260

Design Flow for the year 2034:

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	6,000	250	0.069
Daily Maximum	6,000	250	0.069
Hourly Max. Peak factor 2.5	15,000	625	0.174

1. Inlet Chamber

Item	6MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly ＝ 22,500 m3/d ＝ 0.260 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 （Manning Fornula）
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 ＝ 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.260 × 1 ＝ 12.12 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m × Depth 0.600 m

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2. Coarse Screen Channel

Item	6MLD STP-TSPS
[1] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.400 m
Velocity	0.260 ／ 0.400 ／ 0.400 ／ 2
whe Design Flow for the year 2049	= 0.813 ＜ 1.000 m/sec OK
Velocity	0.174 ／ 0.400 ／ 0.400 ／ 1
whe Design Flow for the year 2034	= 1.088 ＜ 1.000 m/sec OK
(2) Screen Channel	
Number	2.0 Main + 1.0 Bypass
Width	0.800 m
Side Water Depth	0.500 m
Velocity	0.260 ／ 0.800 ／ 0.500 ／ 2
whe Design Flow for the year 2049	= 0.325 ≒ 0.450 m/sec OK
Velocity	0.174 ／ 0.800 ／ 0.500 ／ 1
whe Design Flow for the year 2034	= 0.435 ＜ 0.450 m/sec OK
(3) Channel Dimensions	Width 0.8 m × Length 8.5 m × SWD 0.5 m
[3] Equipment	
(1) Inlet Gate	
Number	3 Units
Dimension	Width 0.4 m × Height 0.6 m
Design Water Level	m
(2) Coarse Screens (Main Channel)	
Number	2 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.260 ／ 0.700 ／ 0.450 ／ 2 × (20 + 9) / 20
	= 0.598 ≒ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.174 ／ 0.700 ／ 0.450 ／ 1 × (20 + 9) / 20
	= 0.801 ＜ 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.5 m
Velocity through screen whe Design Flow for the year 2049	0.260 ／ 0.800 ／ 0.500 ／ 2 × (20 + 9) / 20
	= 0.471 ＜ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.174 ／ 0.800 ／ 0.500 ／ 1 × (20 + 9) / 20
	= 0.631 ＜ 0.800 m/sec OK

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E-4 Process Cal_ EA&al 6MLD Hosahalli_Appendix 12.2.3

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3. Raw Sewage Sump

Item		6MLD STP-TSPS								
[2]	Geometory									
(1)	Raw Sewage Sump									
	Number	1	Basin							
	Dia	9.00	m							
	Pump Operating Depth	1.000	m							
	Retention Time	(	9.00	$^2\times$	π／4	×	1.000) ／	0.260	／60	
	whe Design Flow for the year 2049	＝	4.08	＞	3.75	min (=minimum time of one pump cycle OK				
	Retention Time	(	9.00	$^2\times$	π／4	×	1.000) ／	0.174	／60	
	whe Design Flow for the year 2034	＝	6.09	＞	3.75	min (=minimum time of one pump cycle OK				
	High Water Level	+	0.000	m						
	Pump Off Level	+	-1.000	m						
[3]	Equipment									
(1)	Sewage Pumps 1									
	Number	2	W	+	1	S				
	Bore Diameter	250	mm							
	Discharge Flow : Q	0.174	×	3600	／	2.0				
	whe Design Flow for the year 2034	＝	313	⇒	315	m3/Hr				
	Total Head	15.0	m							
(2)	Sewage Pumps 2									
	Number		W	+		S				
	Bore Diameter		mm							
	Discharge Flow : 0.5			／						
	whe Design Flow for the year 2034	＝		⇒		m3/Hr				
	Total Head		m							

Raw Sewage Sump 3/21

E-4 Process Cal_ EA&al 6MLD Hosahalli_Appendix 12.2.3

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Item	6MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	6,000	250.00	0.069
Max Daily	6,000	250.00	0.069
Max Hourly Peak factor 2.5	15,000	625.00	0.174

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 15,000 m3/day
= 0.174 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.000 m

(3) Width of Basin — 2.100 m

(4) Length of Basin — 1.500 m

(5) Volume required of Basin — 1.000 × 2.100 × 1.500 = 1.4 m3

(6) Retention Time — 1.000 × 2.100 × 1.500 ／ 0.174 × 1
= 18.10 sec

(7) Basin Dimensions — Width 2.100 m × Length 1.500 m
× Depth 1.000 m

STP basic &Stilling Chamber4/21

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3. Fine Screen Channel	
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 15,000 m3/d
	= 0.174 m3/sec
[2] Geometory	
(1) Inlet Gate	
Number	1 Main + 1 Bypass
Width	0.400 m
Height	0.600 m
Floor Level	+ 2.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.500 m
Velocity	0.174 ／ 0.400 ／ 0.500 ／ 1
	= 0.870 ≒ 1.000 m/sec
(2) Screen Channel	
Number	1 Main + 1 Bypass
Width	0.800 m
Side Water Depth	0.500 m
Velocity	0.174 ／ 0.800 ／ 0.500 ／ 1
	= 0.435 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 0.8 m × Length 6.0 m
	× SWD 0.5 m (Freeboard 0.3m)
[3] Equipment	
(1) Inlet Gate	
Number	1 W + 1 S
Dimension	Width 0.4 m × Height 0.60 m
Design Water Level	2.00 m
(2) Fine Screens (Main Channel)	
Number	1 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.5 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.174 ／ 0.700 ／ 0.450 ／ 1
	× (6 + 2) / 6
	= 0.737 < 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.5 m
Velocity through screen	0.174 ／ 0.800 ／ 0.500 ／ 1
	× (20 + 9) / 20
	= 0.631 < 0.800 m/sec

E-4 Process Cal_ EA&al 6MLD Hosahalli_Appendix 12.2.3

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4. Grit Chamber

[1] Design Condition

(1)	Design Flow Rate	Max Hourly = 15,000 m^3/day
		= 0.174 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 $m^3/m^2/day$
(4)	Average Velocity	0.3 m/sec

[2] Grit Chamber — **Square Grit Chamber**

(1)	Surface Area required	0.174 ／ 0.0111 = 15.68 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	15.7 ／ 1 = 15.68 m^2
(4)	Length of Basin	15.68 ^0.5 = 4.0 m → 4.0 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.174 × 60 sec ／ 1 = 10.4 m^3
(7)	Depth required	10.4 ／ 4.0 ／ 4.0 = 0.653 m
(8)	Basin Dimensions	Width 4.0 m × Length 4.0 m
		× Depth 0.7 m (Freeboard 0.3m)
(9)	Retention Time	4 × 4.0 × 0.7 ／ 0.174 × 1
		= 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	15,000 ／ 4.0 ／ 4.0 ／ 1
		= 937.5 ＜ 960 $m^3/m^2/day$

[3] Parshall Flume

(1)	Design Flow Rate	Q= 174.000 l/sec
(2)	Throat width	W= 0.450 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
		Ha= 0.308 m
(4)	Crest Level	+ 75.400 m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 75.708 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.166 m/sec
(10)	Total Length of channel	10.000 m

[4] Inlet Weir Gate

(1)	Number	2 Units
(2)	Weir Width	0.400 m
(3)	Stroke	0.450 m
(4)	Overflow Height	0.400 m
(5)	Overflow Height (actual)	(0.174 ／ 1.840 ／ 0.400 ／ 2) $^{2/3}$
		= 0.241 ＜ 0.400 m

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	6,000	m^3/day (summer)	
	Q'=	6,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* =	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃ = 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃ = 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB}\times SF$
		⇒	5.0000	day	
(3)	Biomass production				
	$Px,_{VSS}$	$Px,_{VSS}$=	1876.223	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	2472.600	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/l	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μmax at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/l	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1084.470	kg VSS/d	$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
			973.771		$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			87.639		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			23.059		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/l	$=TKN-Ne-0.12P_{X,bio}/Q$
(4)	Required Aeration Tank Volume				
	Va=	Va=	4,121	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS}\cdot Va$	$X_{VSS}\cdot Va$=	9,381	kg VSS	$=Px,_{VSS}\cdot SRT$
	$X_{TSS}\cdot Va$	$X_{TSS}\cdot Va$=	12,363	kg TSS	$=Px,_{TSS}\cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5)	BODloading	BODloading	0.510	kg/m3・d	
(6)	Observed Yield				
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	3,462	kg/d	
(7)	effluent NO_2-N	NO_2-N=	0.2315	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μmax at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.900	mg/l	
(8)	effluent NH_4-N	NH_4-N=	0.5286	mg/l	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μmax at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/l	
		$K_{O2,NOB}$=	0.500	mg/l	
(9)	Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = Q・(SRT)/V・Y_H(S_0-S)/[1+b_H(SRT)]
= 1,181.47 mg/*l*

(2) IR ratio
IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= (IR+R)・Q・Ne
= 229,863.66 kg/d

(4) The anoxic tank volume
Vnor= 412 m3 = Va× 10%
Vnor= 1,250 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb
SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.110 g/g・d =$SDNR_b$($MLVSS_b$/MLVSS)

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 312,595.85 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 229,864 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 1876.223 kg /d
Rwmoval Phosphorus 18.76222816 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Aluminium Sulphate 257.87 kg/d
(6) Required Aluminium Sulphate solı 10% 2.46 m3/d
102.33 L/H
(7) Additional sludge 104.54 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

V_A = Q'*θa/24

= 4,500 m^3

(2) Total volume of Anoxic Basins

V_{DN} = Q'*$θ_{DN}$/24

= 1,250 m3

Item		Volume required	Retention Time required		Ratio of Volume
			Summer	Winter	
unit		m^3	hour	hour	
Anaerobic	V_{AN}	380	1.50	1.50	0.30
Anoxic	V_{DN}	1,250	5.00	5.00	1.00
Aerobic	V_A	4,500	18.00	18.00	3.60
Total	V	6,130	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

	Width	Length	Depth	Basins
	8.0	75.0	5.5	2

Cross Section 8.0*5.5 = 44.0 m^2/Basin

Hantzsch Subtraction = 1.0 m^2/Basin

after Subtraction 44.0-1.0 = 43.0 m^2/Basin

Total Volume 43.0*75.0 = 3,225 m^2/Basin 6,450 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**4.4**	**14.5**	**52.3**	**71.3**
Volume required per Basin	m^3	190	625	2,250	3,065
Total Volume required	m^3	380	1,250	4,500	6,130
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	6.0	15.0	54.0	75.0
Actual Volume per Basin	m^3	258	645	2,322	3,225
Actual Total Volume	m^3	516	1,290	4,644	6,450
Actual Ratio of Volume		0.40	1.00	3.60	
Actual Retention Time	hour	2.06	5.16	18.58	25.80

[7] Equipment

(1) Ras Pumps

Ras Ratio 60%

Required Capacity 6,000 m3/day× 60% ／24 ／ 2

= 75 m3/Hr ⇒ 75 m3/Hr

Number 2 Work

2 Standby

(2) Circulation Pumps

Ras Ratio 366%

Required Capacity 6,000 m3/day× 366% ／24 ／ 4

= 229 m3/Hr ⇒ 230 m3/Hr

Number 4 Work

2 Standby

(3) SAS Pumps

Excess Sludge 325 m3/day

Sludge withdraw 12 Times/day

Running Time 0.5 Hr/Time

Required Capacity 325 m3/day ／ 12 ／ 0.50 ／ 2

= 27.12 m3/Hr ⇒ 28 m3/Hr

Number 2 Work

2 Standby

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(4)	Alum Solution Tank	
	Number	2 W + 0 S
	Alum concentration as crystal	10 %
	Gravity of dissolved dechlorine	1.05
	Required solution volume	257.87 kg / d × 100 / 10 / 1.05 / 1000
		＝ 2.46 m3/d
	Volume of Tank	1.5 m3/tank
	Total Volume of Tanks	3.0 m3 (Duration= 1.22 day)
(5)	Mixer for Alum Solution Tank	
	Number	2 W + 0 S
(6)	Alum Dosing Pump	
	Number	2 W + 1 S
	Capacity	2.46 m3/d / 24 × 1000 / 2 × 2
		102.33 l/h/unit ⇒ 110 l/h/unit

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6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR	AOR = 2,596 kg/day
		= 108.2 kg/h
	Qin :Design Average Flow m^3/d	6,000
	Inlet bCOD : S_0	578 mg/*l*
	S=	S= 0.451 mg/*l*
	Nox=	Nox 47.400 mg/*l*
	$P_{X,bio}$=	$P_{X,b}$ 1,061.4 kg VSS/d does not include nitrifying bacteria
	R_0=	$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$
	R_0=	R_0= 2,596 kg O2/d
		k= 2.86
(2)	SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$

C_S	:	Saturated DO at sea level and 20 ℃	9.09 mg/L
C_{SW}	:	Saturated DO at sea level and operating Temperature	9.09 mg/L at 20 ℃
20-T	:	0.0 1.024^{20-T} :	1.0000
C_A	:	operating DO in Basin	2.0 mg/L
a	:	Correction Factor by the Water Depth $1+0.40D_j/Pa$	1.19357
D_j	:	Tank Liquid Depth	5.00 m
P_a	:	Standard absolute pressure at s	10.332 m
P_b	:	Absolute pressure at Plant Site Elevation	m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R^*T]$	0.900
g	:	Acceleration due to Gravity	9.80665 m/s^2
M	:	Mole of Air	28.97 kg/kg-mole
z_b	:	Plant Site Elevation	900 m
z_a	:	Sea Elevation	0 m
R	:	Universal Gas Constant	8314 Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15 Kelvin
α	:	relative Transfer Rate to clean Wa	0.65
β	:	relative DO Saturation to clean Wa	0.95
F	:	Diffuser Fouling Factor	0.90

$$= \frac{28,164}{4.2591} = 6,612.59 \text{ kg/day}$$

(3)	No. of Basins	2 Basin
(4)	Standard O2 required at Field Conditions per Bas	= 3,306 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	15%
(9)	Air required at Field Conditions per Basins	= 48,627 m^3/day = 2,026.1 m^3/hr

[2] Equipment	
(1) Air Blower	
Number	2 W + 1 S
Required Capacity	2026.1 m^3/Hr・Basin ／ 1 unit/Basin
	＝ 2026.1 m^3/h ⇒ 2100 m^3/h /Unit
Pressure	65 kPa
Safty Factor	10 %
Heat capacity ratio	1.4
Atmospheric pressuer at site elevation	91.234 kPa
Total inlet pressure	89.234 kPa
Volume rate of flow at inlet point	39.733 m3/min
Total discharge pressure	156.234 kPa
Overall adiabatic effeciency	0.65
Inlet air temperature (min.)	15 ℃
Shaft power	56.177 kW
Rated Output of Motor	61.795 kW ⇒ 75 kW

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7.	**Final Clarifire**			
〔1〕	**Design Condition**			
(1)	Design Wastewater Flow	Q= 6,000 m^3/day		
(2)	Water Temperature	T= 20.0 ℃		
(3)	MLSS	Xef= 3,000 mg/*l*		
(4)	SVI	SVI= 300		
(5)	Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)		
		= 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770		
		= 20.7 m/day		
(6)	Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0)	=	13.8 m^3/m^2·day
			→	12.0 m^3/m^2·day
[2]	**Geometory**			
(1)	Surface Area required	A= 6,000/12.0=	=	500 m^2
(2)	Demensions	Diameter / Depth / Basin		
		18.0 / **3.5** / **2**		
(3)	Actual Surface Area	S= 18.0^2 * 3.14 /4 * 2.0	=	509 m^2
(4)	Surface Overflow Rate	S= 6,000/509	=	11.8 m^3/m^2·day

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Flow 6,000 m^3/day 250.00 m^3/h
		Peak Flow 15,000 m^3/day 625.00 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 60.0 kg/d
		＝ 2.50 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 125.0 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	1.50 m
(4)	Length of lane	19.00 m
(5)	Side Water Depth	1.50 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	5.30 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 250.00 ／ 3600 ／ 1.50 ／ 1.50
		＝ 0.031 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 1.5 m × 19.0 m × 1.5 m
		× 3 × 1
		＝ 128 m^3 > 125.0 m^3

[3] Equipment

(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 1 mg/L 10 mg/L
	Average Dosage Rate -1	DC2 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC2 x 10^{-6} x 10^3 = 60 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 900 kg
	Unit Number	EN1 EC1 / Cc = 1.0 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vr1 #### @ 20°C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = ####
	Operation Numbers	EN2 DC1 / Vr1 = 0.8sets
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
		6 kg/day to 150 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.25 kg/hr 6.3 kg/hr

Chlorination Tank (gas)15/21

(4)	Chlorine Booster Pump	
	Type	Branchy on the water supply pipe
	Water Demand	Water requiamet for mixsed Chlori
	Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
	Water Demand	(L/min) 15 20 25 30 35 40
	Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
	Water Demand	(L/min) 45 50 60 300 600 1,200
	Water requiamet	-
	For Chlorin	Qp1 Maximum dosage ra 6.3 kg/hr
		therefore 50 L/min
	Booster Pump Type	Single suction volute pump
	Number	1 W + 1 S
9.	**Dechlorination**	
〔1〕	**Design Condition**	
(1)	Design Flow Rate	Average Daily Flow 6,000 m^3/day
(2)	Contact Time	10 min
(3)	Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4)	Free Residual Chlorine	1.0 mg/L assumed value
(5)	Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
		× 1.5 (safety factor)
		＝ 15.75 kg/d
		＝ 0.656 kg/h
[2]	**Dechlorination Contact Tank**	
(1)	Volume required	Average Flow Rate ／ 60 × Contact Time
		＝ 41.7 m^3
(2)	Width of lane	5.30 m
(3)	Length of lane	6.00 m
(4)	Side Water Depth	1.50 m
(5)	Nos. of Tanks	1 tank
(6)	Total Volume	Width × Length × Depth
		＝ 5.3 m × 6.0 m × 1.5 m
		＝ 48 m^3 > 41.7 m^3
[3]	**Equipment**	
(1)	Dechlorine Solution Tank	
	Number	1 W + 0 S
	Dechlorine concentration	10 %
	Gravity of dissolved dechlorine	1.10
	Required solution volume	15.75 kg / d × 100 / 10 / 1.10 / 1000
		＝ 0.14 m3/d
	Volume of Tank	0.2 m3/tank
	Total Volume of Tanks	0.2 m3 (Duration= 1.40 day)
(2)	Mixer for Dechlorine Solution Tank	
	Number	1 W + 0 S
(3)	Dechlorine Dosing Pump	
	Number	1 W + 1 S
	Capacity	0.36 m3/d / 24 × 1000 / 1
		14.91 l/h/unit ⇒ 15.0 l/h/unit

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10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge	
(2)	Generated Sludge	2,604	kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte	5 kg/t-DS・day
(4)	Volume of Thickend Sludge	325.4	m^3/day
(5)	Consistency of Dewatered Sludge	82	%
(6)	Operation Time	12	hours/day (6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{325.4}{12 \times 1} \times \frac{7}{6} = 31.6$$

$$\rightarrow 32 \ m^3/\text{hour}$$

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

$= 2,604 \times (1 + 0.0050)$

$= 2,617$ kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 2.617 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

$= 16.96$ t/day

apparent specific gravity 1.00

$16.96 / 1.0 = 17.0 \ m^3$/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 5	kg/t-DS・day
(2)	Required Polyelectrolyte	13.02	kg/day
(3)	Dissolving concentration	0.20	%
(4)	Volume of Polyelectrolyte solution	6.51	m3/day

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[6]	**Equipment**											
(1)	Centrifuge											
	Capacity		32	m^3/hr								
	Number		1	W		+	1	S				
(2)	Centrifuge Feed Pumps											
	Capacity		32	m^3/hr								
	Number		1	W		+	1	S				
(3)	Polyelectrolyte Dosing Pumps											
	Volume of Polyelectrolyte solution		6.51	m3/day								
	Operation Time		12	hours/day		(6 days per week)						
	Safety Factor		1.5									
	Number		1	W		+	1	S				
	Required Capacity		6.51	m3/da; ×		7	／	6	／	12	／	1
			＝	0.63	m^3/Hr							
	Specification Capacity		0.63	m^3/Hr		×		1.5				
			＝	0.949	m^3/Hr	⇒		1.00	m^3/Hr /Unit			
(4)	Polyelectrolyte dosing System											
	Tanks Dimensions	Width	1.5	m	×	Length		1.5	m			
		×	Depth		1.8	m	×	2				
			＝	8.1	m^3							
	Retention Time of Tanks		8.10	m^3	／		0.63	m^3/Hr		／		1
			＝	12.800	Hr							
	Number		2	W		+	0	S				

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11. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	2,604 kg/day
(2) Solids Consistency	0.80 %
(3) Volume of Excess Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
	$= 2{,}604 \times \frac{100}{0.80} \times 10^{-3}$
	= 325 m^3/day
	= 13.56 m^3/h
(4) Sludge feed flow rate	32 m3/h × 1 = 32 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Basin Dimensions	Width 5.0 m × Length 5.0 m
	× Depth 4.0 m × 2
	= 200.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	200.0 m^3
Number	1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation （Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process
2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)
3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

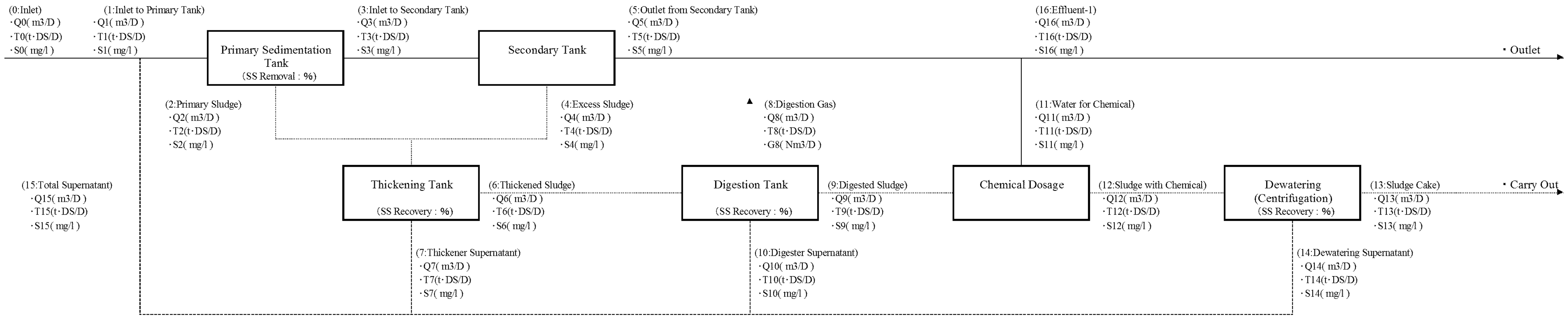
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	6,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	6,000	6,318	0	6,318	325	5,993	325	0	0	325	0	7	332	14	318	318	318			5,993	0
T(t･DS/day)	2.700	2.831	0.000	2.831	2.604	0.060	2.604	0.000	0.000	2.604	0.000	0.013	2.617	2.486	0.131	0.131	0.131			0.060	0.167
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.9	0.0	104.9	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.1	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



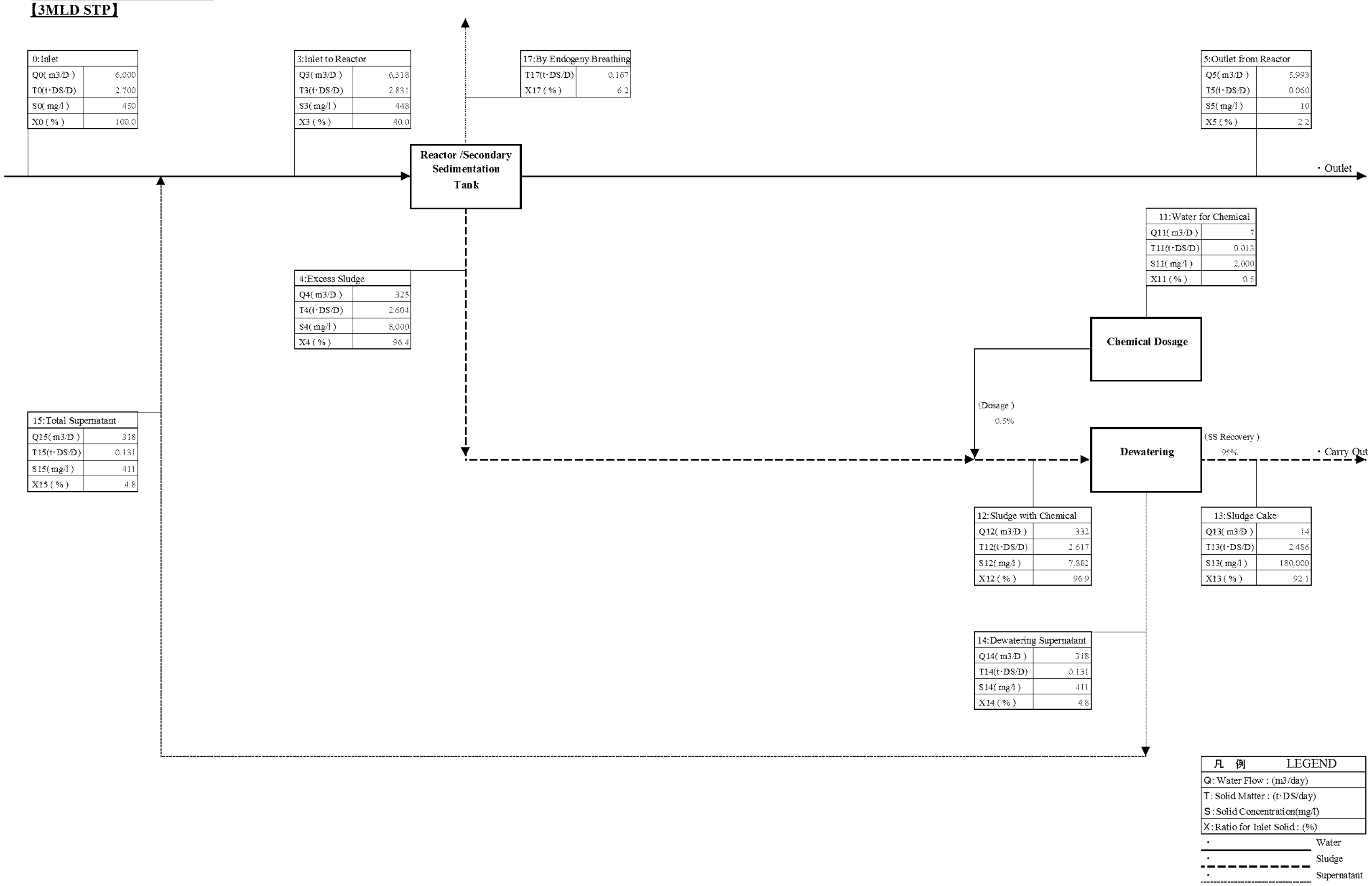
Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【3MLD STP】



E-5 Process Cal_ EA&al 4MLD Chikkabanavara_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	4MLD STP-TSPS			
(1) Design Flow for the year 2049		Flow Rate		
		m3/d	m3/h	m3/s
	Daily Average	####	417	0.116
	Daily Maximum	####	417	0.116
	Hourly Max. Peak factor 2.25	####	938	0.260
(1) Design Flow for the year 2034		Flow Rate		
		m3/d	m3/h	m3/s
	Daily Average	4,000	167	0.046
	Daily Maximum	4,000	167	0.046
	Hourly Max. Peak factor 2.5	####	417	0.116

1. Inlet Chamber

Item	4MLD STP-TSPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly = 22,500 m3/d
	= 0.260 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometry	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	2.100 m Approx.
(4) Length of Basin	2.500 m Approx.
(5) Volume required of Basin	0.600 × 2.100 × 2.500 = 0.5 m3
(6) Retention Time	0.600 × 2.100 × 2.500 ／ 0.260 × 1
	= 12.12 sec
(7) Basin Demensions	Width 2.100 m × Length 2.500 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/21

E-5 Process Cal_ EA&al 4MLD Chikkabanavara_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

	Item	4MLD STP-TSPS
[1]	Geometry	
(1)	Inlet Gate	
	Number	2 Main + 1 Bypass
	Width	0.400 m
	Height	0.600 m
	Floor Level	+ 5.000 m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.260 ／ 0.400 ／ 0.500 ／ 2
	whe Design Flow for the year 2049	＝ 0.650 ＜ 1.000 m/sec OK
	Velocity	0.116 ／ 0.400 ／ 0.500 ／ 1
	whe Design Flow for the year 2034	＝ 0.580 ＜ 1.000 m/sec OK
(2)	Screen Channel	
	Number	2.0 Main + 1.0 Bypass
	Width	0.800 m
	Side Water Depth	0.500 m
	Velocity	0.260 ／ 0.800 ／ 0.500 ／ 2
	whe Design Flow for the year 2049	＝ 0.325 ≒ 0.450 m/sec OK
	Velocity	0.116 ／ 0.800 ／ 0.500 ／ 1
	whe Design Flow for the year 2034	＝ 0.290 ＜ 0.450 m/sec OK
(3)	Channel Dimensions	Width 0.8 m × Length 8.5 m
		× SWD 0.5 m
[3]	Equipment	
(1)	Inlet Gate	
	Number	2 Units
	Dimension	Width 0.4 m × Height 0.6 m
	Design Water Level	m
(2)	Coarse Screens (Main Channel)	
	Number	2 W + 0 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	0.8 m
	Width of side plate	50 mm
	Side Water Depth	0.5 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.260 ／ 0.700 ／ 0.450 ／ 2
		× (20 + 9) / 20
		＝ 0.598 ≒ 0.800 m/sec OK
	Velocity through screen	0.116 ／ 0.700 ／ 0.450 ／ 1
	whe Design Flow for the year 2034	× (20 + 9) / 20
		＝ 0.534 ＜ 0.800 m/sec OK
(3)	Coarse Screens (Bypass Channel)	
	Number	0 W + 1 S
	Open Space	50 mm
	Bar Thickness	9 mm
	Channel Width	0.8 m
	Side Water Depth	0.5 m
	Velocity through screen	0.260 ／ 0.800 ／ 0.500 ／ 2
	whe Design Flow for the year 2049	× (50 + 9) / 50
		＝ 0.384 ＜ 0.800 m/sec OK
	Velocity through screen	0.116 ／ 0.800 ／ 0.500 ／ 1
	whe Design Flow for the year 2034	× (50 + 9) / 50
		＝ 0.342 ＜ 0.800 m/sec OK

Coarse Screen 2/21

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STP Process Calculation_Supporting Report 12.2.3

3. Raw Sewage Sump

Item		4MLD STP-TSPS								
[2]	Geometory									
(1)	Raw Sewage Sump									
	Number	1	Basin							
	Dia	9.00	m							
	Pump Operating Depth	1.000	m							
	Retention Time	(	9.00	$^2\times$	π／4	×	1.000) ／	0.260	／60	
	whe Design Flow for the year 2049	＝	4.08	＞	3.75	min (=minimum time of one pump cycle ˈ				OK
	Retention Time	(	9.00	$^2\times$	π／4	×	1.000) ／	0.116	／60	
	whe Design Flow for the year 2034	＝	9.14	＞	3.75	min (=minimum time of one pump cycle ˈ				OK
	High Water Level	+	0.000		m					
	Pump Off Level	+	-1.000		m					
[3]	Equipment									
(1)	Sewage Pumps 1									
	Number	1	W	+	1	S				
	Bore Diameter	250	mm							
	Discharge Flow : Q	0.116	×	3600	／	1.0				
	whe Design Flow for the year 2034	＝	418	⇒	418	m3/Hr				
	Total Head	15.0	m							
(2)	Sewage Pumps 2									
	Number		W	+		S				
	Bore Diameter		mm							
	Discharge Flow : 0.5			／						
	whe Design Flow for the year 2034	＝		⇒		m3/Hr				
	Total Head		m							

Raw Sewage Sump 3/21

E-5 Process Cal_ EA&al 4MLD Chikkabanavara_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	4MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	4,000	166.67	0.046
Max Daily	4,000	166.67	0.046
Max Hourly Peak factor 2.5	10,000	416.67	0.116

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 10,000 m3/day
= 0.116 m3/sec

[2] Geometry

(1) Number of Basins: 1 Basin

(2) Depth of Basin: 1.000 m

(3) Width of Basin: 1.800 m

(4) Length of Basin: 1.500 m

(5) Volume required of Basin: 1.000 × 1.800 × 1.500 = 1.2 m3

(6) Retention Time: 1.000 × 1.800 × 1.500 ／ 0.116 × 1
= 23.28 sec

(7) Basin Dimensions: Width 1.800 m × Length 1.500 m
× Depth 1.000 m

STP basic &Stilling Chamber4/21

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STP Process Calculation_Supporting Report 12.2.3

3.	**Fine Screen Channel**	
〔1〕Design Condition		
(1)	Design Wastewater Flow	Max Hourly ＝ 10,000 m3/d
		＝ 0.116 m3/sec
[2]	Geometory	
(1)	Inlet Gate	
	Number	1 Main + 1 Bypass
	Width	0.400 m
	Height	0.600 m
	Floor Level	+ 2.000 m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.116 ／ 0.400 ／ 0.500 ／ 1
		＝ 0.580 ≒ 1.000 m/sec
(2)	Screen Channel	
	Number	1 Main + 1 Bypass
	Width	0.800 m
	Side Water Depth	0.400 m
	Velocity	0.116 ／ 0.800 ／ 0.400 ／ 1
		＝ 0.363 ≒ 0.450 m/sec
(3)	Channel Dimensions	Width 0.8 m × Length 6.0 m
		× SWD 0.4 m (Freeboard 0.3m)
[3]	Equipment	
(1)	Inlet Gate	
	Number	1 W + 1 S
	Dimension	Width 0.4 m × Height 0.60 m
	Design Water Level	2.00 m
(2)	Fine Screens (Main Channel)	
	Number	1 W + 0 S
	Open Space	6 mm
	Bar Thickness	2 mm
	Channel Width	0.8 m
	Width of side plate	50 mm
	Side Water Depth	0.4 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.116 ／ 0.700 ／ 0.350 ／ 1
		×(6 + 2)/ 6
		＝ 0.631 ＜ 0.800 m/sec
(3)	Fine Screens (Bypass Channel)	
	Number	0 W + 1 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	0.8 m
	Side Water Depth	0.4 m
	Velocity through screen	0.116 ／ 0.800 ／ 0.400 ／ 1
		×(20 + 9)/ 20
		＝ 0.526 ＜ 0.800 m/sec

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STP Process Calculation_Supporting Report 12.2.3

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Max Hourly ＝ 10,000 m^3/day
	＝ 0.116 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec ＝ 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Grit Chamber**
(1) Surface Area required	0.116 ／ 0.0111 ＝ 10.45 m^2
(2) Number of Basins	1 S ＋ 1 W
(3) Surface Area required/Basin	10.5 ／ 1 ＝ 10.45 m^2
(4) Length of Basin	10.45 ^0.5 ＝ 3.2 m → 3.5 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.116 × 60 sec ／ 1 ＝ 7.0 m^3
(7) Depth required	7.0 ／ 3.5 ／ 3.5 ＝ 0.568 m
(8) Basin Dimensions	Width 3.5 m × Length 3.5 m
	× Depth 0.6 m (Freeboard 0.3m)
(9) Retention Time	3.5 × 3.5 × 0.6 ／ 0.116 × 1
	＝ 60.00 sec
(10) Surface Overflow Rate at Peak Flow	10,000 ／ 3.5 ／ 3.5 ／ 1
	＝ 816.326531 ＜ 960 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 116.000 l/sec
(2) Throat width	W= 0.450 m
(3) Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
	Ha= 0.235 m
(4) Crest Level	＋ 75.400 m ≒ Minimum water level at downstream channel
(5) Water level at the crest	＋ 75.635 m
(6) Channel bottom level	＋ m
(7) Upstream Channel width	1.500 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.110 m/sec
(10) Total Length of channel	10.000 m
[4] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	0.400 m
(3) Stroke	0.450 m
(4) Overflow Height	0.400 m
(5) Overflow Height (actual)	(0.116 ／ 1.840 ／ 0.400 ／ 2) $^{2/3}$
	＝ 0.184 ＜ 0.400 m

Grit Chamber 6/21

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STP Process Calculation_Supporting Report 12.2.3

5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	4,000	m^3/day (summer)	
	Q'=	4,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
Inlet nbpCOD :nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	*Rs* =	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2) Design SRT		SRT=	4.8387	day	$=1/\mu_{AOB} \times SF$
		⇒	5.0000	day	
(3) Biomass production					
	$Px,_{VSS}$	$Px,_{VSS}$=	1250.815	kg /d	=Px,bio+Q(nbVSS)
	$Px,_{TSS}$	$Px,_{TSS}$=	1648.400	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$
	S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$
	b_H	b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
	Y_H	Y_H=	0.4500	gVSS/g bCOD	
	$\mu_{m,T}$	$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 6.000
	Yn	Yn=	0.150	gVSS/g Nox	
	NOx	NOx=	47.400	mg/*l*	
	$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	722.980	kg VSS/d	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$
			649.180		$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
			58.426		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$
			15.373		$=QYn(Nox)/[1+b_{AOB}(SRT)]$
	NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$
(4) Required Aeration Tank Volume					
	Va=	Va=	2,747	m3	
	τ =	τ =	16.48	hr	=Va/Q×24
		⇒	18.00	hr	
	$X_{VSS} \cdot Va$	$X_{VSS} \cdot Va$=	6,254	kg VSS	$=Px,_{VSS} \cdot SRT$
	$X_{TSS} \cdot Va$	$X_{TSS} \cdot Va$=	8,242	kg TSS	$=Px,_{TSS} \cdot SRT$
	F/M	F/M=	0.224	kgBOD/kgMLVSS	
	FractionVSS=	FractionVSS	0.759		
	MLVSS=	MLVSS=	2276	mg/L	
(5) BODloading		BODloading	0.510	kg/m3・d	
(6) Observed Yield					
	$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.178	gTSS/gBOD	
	$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.894	gVSS/gBOD	
	bCODremoved=	bCODremov	2,308	kg/d	
(7) effluent NO_2-N		NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μ max at20℃＝ 1.000
	μ_{AOB}	$\mu_{NOB,T}$=	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.900	mg/*l*	
(8) effluent NH_4-N		NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$
	b_{NOB}	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
	$\mu_{m,T}$	$\mu_{max,NOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
	μ_{AOB}	$\mu_{NOB,T}$=	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
		S_0=	2.000	mg/*l*	
		$K_{O2,NOB}$=	0.500	mg/*l*	
(9) Ratio of Return Sludge		8,000*Rr/(1+Rr)＝	3,000	mg/L	
		3,000/(8,000-3,000)＝	0.60		
		Rr ＝	0.60		

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration — X_b = Q・(SRT)/V・Y_H(S_0-S)/[1+b_H(SRT)]
= 1,181.47 mg/*l*

(2) IR ratio — IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank — Nox feed= (IR+R)・Q・Ne
= 153,242.44 kg/d

(4) The anoxic tank volume — Vnor= 275 m3 = Va× 10%
Vnor= 833 m3 τ_{DN}= 5.000 h

(5) F/M_b — F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients			
	b0		b1	
10		0.186		0.078
20		0.213		0.118
30		0.235		0.141
40		0.242		0.152
50		0.270		0.162

(8) SDNRb — SDNRb= 0.296 g/g・d = b_0+b_1[ln(F/M_b)]

b_0= 0.242
b_1= 0.152

(8) SDNR — SDNR= 0.110 g/g・d =$SDNR_b$($MLVSS_b$/MLVSS)

$SDNR_{adj}$= 0.212 g/g・d =$SDNR_t$ - 0.029ln(F/M_b)-0.012 IR=3-4
=$SDNR_t$ - 0.0166ln(F/M_b)-0.078 IR=2

SDNRt= 0.296 g/g・d =$SDNR_b$・$\theta^{(t-20)}$ θ = 1.026

(9) NOr — NOr= 208,397.23 kg/d =N_{nox}・SDNR・X_b
>Nox feed= 153,242 kg/d

(10) Alkalinity to be added to maintain pH7 — -108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P — 3.13 mg/l
P in waste sludge — px= 1.00%
Generated waste sludge — $Px_{,VSS}$= 1250.815 kg /d
Rwmoval Phosphorus — 12.50815211 kg /d
(2) Effluent T-P without Al — 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio — 1.00 mol/mol
(4) Required Al dosing rate — 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Aluminium Sulphate — 171.91 kg/d
(6) Required Aluminium Sulphate solı 10% — 1.64 m3/d
68.22 L/H
(7) Additional sludge — 69.69 kg/d

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[5] Reactor

(1) Total volume of Aeration Basins

$V_A = Q'*\theta a/24$

$= 3{,}000$ m^3

(2) Total volume of Anoxic Basins

$V_{DN} = Q'*\theta_{DN}/24$

$= 833$ m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	250	1.50	1.50	0.30
Anoxic	V_{DN}	833	5.00	5.00	1.00
Aerobic	V_A	3,000	18.00	18.00	3.60
Total	V	4,083	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	51.0	5.5	2

Cross Section: 8.0*5.5 = 44.0 m^2/Basin

Hantzsch Subtraction = 1.0 m^2/Basin

after Subtraction: 44.0-1.0 = 43.0 m^2/Basin

Total Volume: 43.0*51.0 = 2,193 m^2/Basin 4,386 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**2.9**	**9.7**	**34.9**	**47.5**
Volume required per Basin	m^3	125	417	1,500	2,042
Total Volume required	m^3	250	833	3,000	4,083
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	4.0	10.0	37.0	51.0
Actual Volume per Basin	m^3	172	430	1,591	2,193
Actual Total Volume	m^3	344	860	3,182	4,386
Actual Ratio of Volume		0.40	1.00	3.70	
Actual Retention Time	hour	2.06	5.16	19.09	26.31

[7] Equipment

(1) Ras Pumps

Ras Ratio: 60%

Required Capacity: 4,000 m3/day× 60% ／ 24 ／ 2

= 50 m3/Hr ⇒ 50 m3/Hr

Number: 2 Work

2 Standby

(2) Circulation Pumps

Ras Ratio: 366%

Required Capacity: 4,000 m3/day× 366% ／ 24 ／ 4

= 152 m3/Hr ⇒ 155 m3/Hr

Number: 4 Work

2 Standby

(3) SAS Pumps

Excess Sludge: 217 m3/day

Sludge withdraw: 12 Times/day

Running Time: 0.5 Hr/Time

Required Capacity: 217 m3/day ／ 12 ／ 0.50 ／ 2

= 18.08 m3/Hr ⇒ 18 m3/Hr

Number: 2 Work

2 Standby

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(4)	Alum Solution Tank												
	Number	2	W	+	0	S							
	Alum concentration as crystal	10	%										
	Gravity of dissolved dechlorine	1.05											
	Required solution volume	171.91	kg / d	×	100	/	10	/	1.05	/	1000		
		＝	1.64	m3/d									
	Volume of Tank	1.0	m3/tank										
	Total Volume of Tanks	2.0	m3	(Duration=	1.22	day)							
(5)	Mixer for Alum Solution Tank												
	Number	2	W	+	0	S							
(6)	Alum Dosing Pump												
	Number	2	W	+	1	S							
	Capacity	1.64	m3/d	/	24	×	1000	/	2	×	2		
		68.22	l/h/unit	⇒	70	l/h/unit							

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E-5 Process Cal_EA&al 4MLD Chikkabanavara_Appendix 12.2.3

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6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR	AOR = 1,731 kg/day
		= 72.1 kg/h
	Qin :Design Average Flow m^3/d	4,000
	Inlet bCOD :S_0	578 mg/*l*
	S=	S= 0.451 mg/*l*
	Nox=	Nox 47.400 mg/*l*
	$P_{X,bio}$=	$P_{X,b}$ 707.6 kg VSS/d does not include nitrifying bacteria
	R_0=	$R_0 = Q(S_0 - S - k(Nox - NOxe) - 1.42P_{X,bio} + 4.57Q \cdot NOx$
	R_0=	R_0= 1,731 kg O2/d
		k= 2.86
(2)	SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		$1+0.40D_j/Pa$	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R*T]$	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{18,776}{4.2591} = 4,408.40 \text{ kg/day}$$

(3)	No. of Basins	2 Basin
(4)	Standard O2 required at Field Conditions per Bas	= 2,204 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	15%
(9)	Air required at Field Conditions per Basins	= 32,418 m^3/day = 1,350.7 m^3/hr

Air Requirement at Average Flow12/21

[2]	Equipment						
(1)	Air Blower						
	Number	2	W	+	1	S	
	Required Capacity	1350.7	m^3/Hr・Basin	／	1	unit/Basin	
		＝ 1350.7	m^3/h	⇒	1400	m^3/h /Unit	
	Pressure	65	kPa				
	Safty Factor	10	%				
	Heat capacity ratio	1.4					
	Atmospheric pressuer at site elevation	91.234	kPa				
	Total inlet pressure	89.234	kPa				
	Volume rate of flow at inlet point	26.488	m3/min				
	Total discharge pressure	156.234	kPa				
	Overall adiabatic effeciency	0.65					
	Inlet air temperature (min.)	15	℃				
	Shaft power	37.451	kW				
	Rated Output of Motor	41.196	kW	⇒	45	kW	

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7. Final Clarifire	
〔1〕 Design Condition	
(1) Design Wastewater Flow	Q= 4,000 m^3/day
(2) Water Temperature	T= 20.0 ℃
(3) MLSS	Xef= 3,000 mg/*l*
(4) SVI	SVI= 300
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)
	= 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770
	= 20.7 m/day
(6) Surface Overflow Rate required	*S'*= v/(1.5*1)= 20.7/(1.5*1.0) = 13.8 m^3/m^2·day
	→ 12.0 m^3/m^2·day
[2] Geometory	
(1) Surface Area required	A= 4,000/12.0= = 333 m^2
(2) Demensions	Diameter **15.0**, Depth **3.5**, Basin **2**
(3) Actual Surface Area	S= 15.0^2 * 3.14 /4 * 2.0 = 353 m^2
(4) Surface Overflow Rate	S= 4,000/353 = 11.3 m^3/m^2·day

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8. Chlorination

[1] Design Condition

(1)	Design Flow Rate	Average Flow 4,000 m^3/day 166.67 m^3/h
		Peak Flow 10,000 m^3/day 416.67 m^3/h
(2)	Contact Time	30 min
(3)	Type of Chlorine	Cl_2-GAS
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 40.0 kg/d
		＝ 1.67 kg/h

[2] Chlorination Contact Tank

(1)	Volume required	Average Daily Flow ／ 1440 × Contact Time
		＝ 83.3 m^3
(2)	Nos. of lanes	3 lanes
(3)	Width of lane	1.50 m
(4)	Length of lane	14.00 m
(5)	Side Water Depth	1.50 m
(6)	Nos. of Tanks	1 tank
(7)	Total Width of Tank	5.30 m Approx..
(8)	Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
		＝ 166.67 ／ 3600 ／ 1.50 ／ 1.50
		＝ 0.021 m/sec
(9)	Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
		＝ 1.5 m × 14.0 m × 1.5 m
		× 3 × 1
		＝ 95 m^3 > 83.3 m^3

[3] Equipment

(1)	Chlorine Dosing Condition	
	Operation Dosage Rate -1	DC1 1 mg/L 10 mg/L
	Average Dosage Rate -1	DC2 10 mg/L
(2)	Chlorine Cylinder	
	Type	- Cylindrical Convexsd Container
	Cylinder Capacity	Cc 928 kg/cylinder
	Average Dosage Rate -1	q1 Chlorine -1 : Q_{T-D} x DC2 x 10^{-6} x 10^3 = 40 kg/day
	Storage day	T More than 15 days
	Required Storage Capacity	EC1 D x T = 600 kg
	Unit Number	EN1 EC1 / Cc = 0.6 cylinders
	Maximum Operation Numbers	
	Cl_2-Gas Volatilize Rate	Vr1 #### @ 20^{O}C Standard temperature
	Maximum Dosing Rate	DC1 10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 = ####
	Operation Numbers	EN2 DC1 / Vr1 = 0.5sets
(3)	Chlorinator	
	Type	Solution Feed Vacuum Type
	Number	1 W + 1 S
	Operation Dosage Rate -1	Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^3 =
		4 kg/day to 100 kg/day
	Required Dosage Rate	Chlorine -1 : Dq1 / (EN1x 24) =
		Minimum Maximum
		0.17 kg/hr 4.2 kg/hr

Chlorination Tank (gas)15/21

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(4) Chlorine Booster Pump	
Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori
Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
Water Demand	(L/min) 15 20 25 30 35 40
Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
Water Demand	(L/min) 45 50 60 300 600 1,200
Water requiamet	-
For Chlorin	Qp1 Maximum dosage ra 4.2 kg/hr
	therefore 40 L/min
Booster Pump Type	Single suction volute pump
Number	1 W + 1 S

9. Dechlorination	
〔1〕 Design Condition	
(1) Design Flow Rate	Average Daily Flow 4,000 m^3/day
(2) Contact Time	10 min
(3) Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4) Free Residual Chlorine	1.0 mg/L assumed value
(5) Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
	× 1.5 (safety factor)
	＝ 10.50 kg/d
	＝ 0.438 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Flow Rate ／ 60 × Contact Time
	＝ 27.8 m^3
(2) Width of lane	5.30 m
(3) Length of lane	4.00 m
(4) Side Water Depth	1.50 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 5.3 m × 4.0 m × 1.5 m
	＝ 32 m^3 > 27.8 m^3
[3] Equipment	
(1) Dechlorine Solution Tank	
Number	1 W + 0 S
Dechlorine concentration	10 %
Gravity of dissolved dechlorine	1.10
Required solution volume	10.50 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.10 m3/d
Volume of Tank	0.2 m3/tank
Total Volume of Tanks	0.2 m3 (Duration= 2.10 day)
(2) Mixer for Dechlorine Solution Tank	
Number	1 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	0.24 m3/d / 24 × 1000 / 1
	9.94 l/h/unit ⇒ 10.0 l/h/unit

Chlorination Tank (gas)16/21

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10. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge		
(2)	Generated Sludge	1,735	kg/day	
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS・day
(4)	Volume of Thickend Sludge	216.9	m^3/day	
(5)	Consistency of Dewatered Sludge	82	%	
(6)	Operation Time	12	hours/day	(6 days per week)

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{216.9}{12 \times 1} \times \frac{7}{6} = 21.1$$

$$\rightarrow 22 \ m^3/\text{hour}$$

[3] Dewatered Solids

$$\text{Digested Sludge} \times (1 + \text{Injection Rate})$$

$$= 1{,}735 \times (1 + 0.0050)$$

$$= 1{,}744 \ \text{kg/day}$$

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 1.744 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

$$= 11.30 \ \text{t/day}$$

apparent specific gravity 1.00

$$11.30 \ / \ 1.0 = 11.3 \ m^3/\text{day}$$

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS・day
(2)	Required Polyelectrolyte		8.68	kg/day
(3)	Dissolving concentration		0.20	%
(4)	Volume of Polyelectrolyte solution		4.34	m3/day

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[6]	**Equipment**	
(1)	Centrifuge	
	Capacity	22 m^3/hr
	Number	1 W + 1 S
(2)	Centrifuge Feed Pumps	
	Capacity	22 m^3/hr
	Number	1 W + 1 S
(3)	Polyelectrolyte Dosing Pumps	
	Volume of Polyelectrolyte solution	4.34 m3/day
	Operation Time	12 hours/day (6 days per week)
	Safety Factor	1.5
	Number	1 W + 1 S
	Required Capacity	4.34 m3/da; × 7 ／ 6 ／ 12 ／ 1
		＝ 0.42 m^3/Hr
	Specification Capacity	0.42 m^3/Hr × 1.5
		＝ 0.633 m^3/Hr ⇒ 0.65 m^3/Hr /Unit
(4)	Polyelectrolyte dosing System	
	Tanks Dimensions	Width 1.5 m × Length 1.0 m
		× Depth 1.8 m × 2
		＝ 5.4 m^3
	Retention Time of Tanks	5.40 m^3 ／ 0.42 m^3/Hr ／ 1
		＝ 12.802 Hr
	Number	2 W + 0 S

Centrifuge 18/21

11. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	1,735 kg/day
(2) Solids Consistency	0.80 %
(3) Volume of Excess Sludge	$\text{Total Solids} \times \dfrac{100}{\text{Solids Consistency}} \times 10^{-3}$
	$= 1{,}735 \times \dfrac{100}{0.80} \times 10^{-3}$
	= 217 m^3/day
	= 9.04 m^3/h
(4) Sludge feed flow rate	22 m3/h × 1 = 22 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Basin Dimensions	Width 4.5 m × Length 4.5 m
	× Depth 3.0 m × 2
	= 121.5 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	121.5 m^3
Number	1 W + 1 S

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

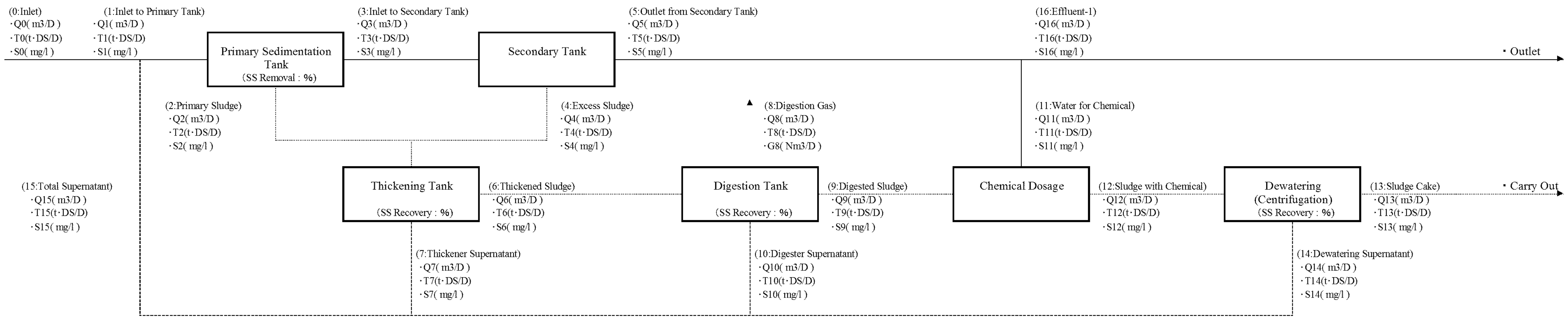
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	4,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	4,000	4,212	0	4,212	217	3,995	217	0	0	217	0	4	221	9	212	212	212			3,995	0
T(t･DS/day)	1.800	1.887	0.000	1.887	1.735	0.040	1.735	0.000	0.000	1.735	0.000	0.009	1.744	1.657	0.087	0.087	0.087			0.040	0.112
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.8	0.0	104.8	96.4	2.2	96.4	0.0	0.0	96.4	0.0	0.5	96.9	92.0	4.8	4.8				2.2	6.2

Figure -1 Material Balance Model



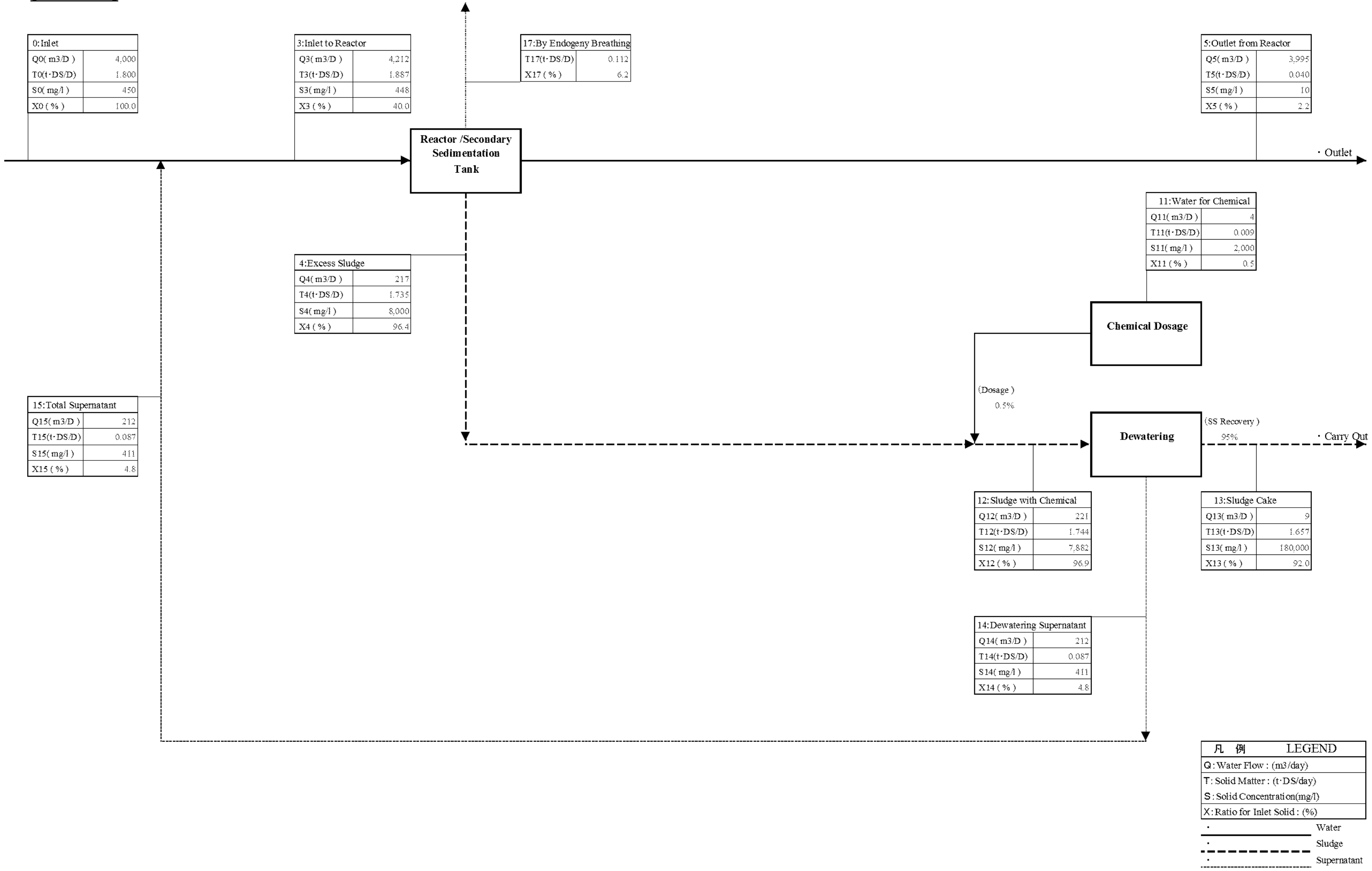
Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【3MLD STP】



Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Design Condition

Item	24MLD STP-MPS
(1) Design Flow for the year 2049	see table below
(1) Design Flow for the year 2034	see table below

Design Flow for the year 2049

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	####	1458	0.405
Daily Maximum	####	1458	0.405
Hourly Max. Peak factor 2.25	####	3281	0.911

Design Flow for the year 2034

	Flow Rate		
	m3/d	m3/h	m3/s
Daily Average	####	1000	0.278
Daily Maximum	####	1000	0.278
Hourly Max. Peak factor 2.25	####	2250	0.625

1. Inlet Chamber

Item	24MLD STP-MPS
[1] Design Condition	
(1) Design Flow for the year 2049	Max Hourly = 78,750 m3/d
	= 0.911 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• ×
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m3/s
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	0.600 m Approx.
(3) Width of Basin	4.400 m Approx.
(4) Length of Basin	2.800 m Approx.
(5) Volume required of Basin	0.600 × 4.400 × 2.800 = 0.9 m3
(6) Retention Time	0.600 × 4.400 × 2.800 ⁄ 0.911 × 1
	= 8.11 sec
(7) Basin Demensions	Width 4.400 m × Length 2.800 m
	× Depth 0.600 m

PS basic & Inlet Chamber1/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

2. Coarse Screen Channel

Item	24MLD STP-MPS
[1] Geometry	
(1) Inlet Gate	
Number	3 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 5.000 m
Bottom	+ 0.000 m
Influent Water Level	+ 0.600 m
Velocity whe Design Flow for the year 2049	0.911 ／ 0.600 ／ 0.600 ／ 3 = 0.844 < 1.000 m/sec OK
Velocity whe Design Flow for the year 2034	0.625 ／ 0.600 ／ 0.600 ／ 2 = 0.868 < 1.000 m/sec OK
(2) Screen Channel	
Number	3.0 Main + 1.0 Bypass
Width	1.200 m
Side Water Depth	0.600 m
Velocity whe Design Flow for the year 2049	0.911 ／ 1.200 ／ 0.600 ／ 3 = 0.422 ≒ 0.450 m/sec OK
Velocity whe Design Flow for the year 2034	0.625 ／ 1.200 ／ 0.600 ／ 2 = 0.434 < 0.450 m/sec OK
(3) Channel Dimensions	Width 1.2 m × Length 6.0 m × SWD 0.6 m
[3] Equipment	
(1) Inlet Gate	
Number	3 Main + 1 Bypass
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	8.0 m
(2) Coarse Screens (Main Channel)	
Number	3 W + 0 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Width of side plate	50 mm
Side Water Depth	0.6 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.911 ／ 1.100 ／ 0.550 ／ 3 × (20 + 9) / 20 = 0.728 ≒ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.625 ／ 1.100 ／ 0.550 ／ 2 × (20 + 9) / 20 = 0.749 < 0.800 m/sec OK
(3) Coarse Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	50 mm
Bar Thickness	9 mm
Channel Width	1.2 m
Side Water Depth	0.6 m
Velocity through screen whe Design Flow for the year 2049	0.911 ／ 1.200 ／ 0.600 ／ 3 × (50 + 9) / 50 = 0.498 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2034	0.625 ／ 1.200 ／ 0.600 ／ 2 × (50 + 9) / 50 = 0.512 < 0.800 m/sec OK

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

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3. Raw Sewage Sump

Item	24MLD STP-MPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	14.00 m
Pump Operating Depth	1.500 m
Retention Time	(14.00 ^{2}× π／4 × 1.500)／ 0.911 ／60
whe Design Flow for the year 2049	＝ 4.22 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
Retention Time	(14.00 ^{2}× π／4 × 1.500)／ 0.625 ／60
whe Design Flow for the year 2034	＝ 6.16 ＞ 3.75 min (=minimum time of one pump cycle ˙OK
High Water Level	+ 0.000 m
Pump Off Level	+ -1.500 m
[3] Equipment	
(1) Sewage Pumps 1	
Number	2 W + 1 S
Bore Diameter	350 mm
Discharge Flow ： 40% Q* 2	0.625 × 3600 × 40.0% Q
whe Design Flow for the year 2034	＝ 900 ⇒ 900 m3/Hr
Total Head	15.0 m
(2) Sewage Pumps 2	
Number	1 W + 1 S
Bore Diameter	250 mm
Discharge Flow ： 20% Q* 1	0.625 × 3600 × 20.0% Q
whe Design Flow for the year 2034	＝ 450 ⇒ 450 m3/Hr
Total Head	15.0 m

Raw Sewage Sump 3/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

Item	24MLD STP

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	24,000	1000.00	0.278
Max Daily	24,000	1000.00	0.278
Max Hourly Peak factor 2.25	54,000	2250.00	0.625

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP	
				NH_4-N	Org-N	NOx-N	D-P	P-P
Inlet	350	800	450	45.5	17.5	7	5	2
Outlet	10	50	10	1	0	9	1	1
Removal rate	97.1%	93.7%	97.8%	85.7%			71.4%	

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 54,000 m3/day
= 0.625 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.500 m

(3) Width of Basin — 2.800 m

(4) Length of Basin — 2.800 m

(5) Volume required of Basin — 1.500 × 2.800 × 2.800 = 1.5 m3

(6) Retention Time — 1.500 × 2.800 × 2.800 ／ 0.625 × 1
= 18.82 sec

(7) Basin Dimensions — Width 2.800 m × Length 2.800 m
× Depth 1.500 m

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3.	**Fine Screen Channel**	
〔1〕Design Condition		
(1)	Design Wastewater Flow	Max Hourly ＝ 54,000 m3/d
		＝ 0.625 m3/sec
[2]	Geometory	
(1)	Inlet Gate	
	Number	2 Main ＋ 1 Bypass
	Width	0.600 m
	Height	0.900 m
	Floor Level	＋ 2.000 m
	Bottom	＋ 0.000 m
	Influent Water Level	＋ 0.600 m
	Velocity	0.625 ／ 0.600 ／ 0.600 ／ 2
		＝ 0.868 ≒ 1.000 m/sec
(2)	Screen Channel	
	Number	2 Main ＋ 1 Bypass
	Width	1.200 m
	Side Water Depth	0.600 m
	Velocity	0.625 ／ 1.200 ／ 0.600 ／ 2
		＝ 0.434 ≒ 0.450 m/sec
(3)	Channel Dimensions	Width 1.2 m × Length 6.0 m
		× SWD 0.6 m
[3]	Equipment	
(1)	Inlet Gate	
	Number	2 W ＋ 1 S
	Dimension	Width 0.6 m × Height 0.90 m
	Design Water Level	2.00 m
(2)	Fine Screens (Main Channel)	
	Number	2 W ＋ 0 S
	Open Space	6 mm
	Bar Thickness	2 mm
	Channel Width	1.2 m
	Width of side plate	50 mm
	Side Water Depth	0.6 m
	Height of Blind Plate at the bottom	50 mm
	Velocity through screen	0.625 ／ 1.100 ／ 0.550 ／ 2
		×(6 ＋ 2)/ 6
		＝ 0.689 ＜ 0.800 m/sec
(3)	Fine Screens (Bypass Channel)	
	Number	0 W ＋ 1 S
	Open Space	20 mm
	Bar Thickness	9 mm
	Channel Width	1.2 m
	Side Water Depth	0.6 m
	Velocity through screen	0.625 ／ 1.200 ／ 0.600 ／ 2
		×(20 ＋ 9)/ 20
		＝ 0.629 ＜ 0.800 m/sec

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4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	Peak flow = 54,000 m^3/day
		= 0.625 m^3/sec
(2)	Specific gravity of Sand	2.65
(3)	Sedimentation Velocity	0.0111 m/sec = 960 m^3/m^2/day
(4)	Average Velocity	0.3 m/sec
[2]	**Grit Chamber**	**Square Grit Chamber**
(1)	Surface Area required	0.625 ／ 0.0111 = 56.31 m^2
(2)	Number of Basins	1 S + 1 W
(3)	Surface Area required/Basin	56.3 ／ 1 = 56.31 m^2
(4)	Length of Basin	56.31 ^0.5 = 7.504 m → 7.5 m
(5)	HRT in Grit Chamber	60 sec
(6)	Volume required of Basin	0.625 × 60 sec ／ 1 = 37.5 m^3
(7)	Depth required	37.5 ／ 7.5 ／ 7.5 = 0.667 m
(8)	Basin Dimensions	Width 7.5 m × Length 7.5 m
		× Depth 0.7 m (Freeboard 0.3m)
(9)	Retention Time	7.5 × 7.5 × 0.7 ／ 0.625 × 1
		= 60.00 sec
(10)	Surface Overflow Rate at Peak Flow	54,000 ／ 7.5 ／ 7.5 ／ 1
		= 960 < 960 m^3/m^2/day
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 625.000 l/sec
(2)	Throat width	W= 0.600 m
(3)	Water depth Ha	Ha= (Q ／ 2264 ／ W) $^{2/3}$
		Ha= 0.596 m
(4)	Crest Level	+ m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 0.596 m
(6)	Channel bottom level	+ m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.700 m
(9)	Average velocity at upstream channel	0.595 m/sec
(10)	Total Length of channel	12.000 m
[4]	**Inlet Weir Gate**	
(1)	Number	4 Units
(2)	Weir Width	0.800 m
(3)	Stroke	0.450 m
(4)	Overflow Height	0.400 m
(5)	Overflow Height (actual)	(0.625 ／ 1.840 ／ 0.800 ／ 4) $^{2/3}$
		= 0.224 < 0.400 m

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

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5. Reactor

〔1〕 Design Condition

(1) Design Wastewater Flow	Q=	24,000	m^3/day (summer)	
	Q'=	24,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		350	mg/*l*	
Outlet BOD		10.0	mg/*l*	
Inlet S-BOD		235	mg/*l*	assumed as 67% of BOD
Inlet COD		800	mg/*l*	
Inlet bCOD :S_0		578	mg/*l*	
Inlet nbCOD		223	mg/*l*	
bCOD/BOD		1.65		
Inlet S-COD :sCOD		271	mg/*l*	
Inlet rbCOD		231	mg/*l*	bCOD*40%
Inlet sbCOD		347	mg/*l*	bCOD*60%
Outlet S-COD :nbsCODe		40	mg/*l*	
:nbpCOD		183	mg/*l*	=TCOD-bCOD-nbsCODe
Inlet SS		450	mg/*l*	
Inlet VSS		383	mg/*l*	assumed as 85% of TSS
:VSS_{COD}		1.38	gCOD/gVSS	=(TCOD-sCOD)/VSS
:nbVSS		131.96	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		67.50	gnbVSS/m3	=TSS-VSS
Inlet T-N		70	mg/*l*	
Inlet TKN		70	mg/*l*	
Inlet NH_4-N		45.0	mg/*l*	
Inlet T-P		7	mg/*l*	
Inlet D-P		5	mg/*l*	
Inlet Alkalinity as CaCO3		380	mg/*l*	
Outlet Kjeldahl N		1.0	mg/*l*	
Outlet NH4-N		1.0	mg/*l*	
Outlet NO3-N		9.0	mg/*l*	
Outlet T-P		2	mg/*l*	
Outlet D-P		1	mg/*l*	
(3) Water Temperature	T=	20.0	℃	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	Rs =	8,000	mg/*l*	
(6) MLSS MLVSS	X_{TSS} =	3,000	mg/*l*	
(7) DO in the Reactor		2	mg/L	

[2] Design Value for perfect Nitrification of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s,K_{NH4},K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θ Value				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s,K_{NH4},K_{NO2}	unitless	1.000	1.000	1.000

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(2) μ_{AOB}	μ_{AOB}=	0.3100	g/g・d	$=\mu_{max,AOB}[S_{NH4}/(S_{NH4}+K_{NH4})][S_0/(S_0+K_{0,AOB})]-b_{AOB}$
$\mu_{max,AOB,T}$	$\mu_{max,AOB,T}$=	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$ μ max at20℃＝ 0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
S_{NH4}	S_{NH4}=	1.0000	mg/*l*	
DO	DO=	2.0000	mg/*l*	
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/*l*	

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(2) Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB}\times SF$	
	⇒	5.0000	day		
(3) Biomass production					
$Px,_{VSS}$	$Px,_{VSS}=$	7504.891	kg /d	=Px,bio+Q(nbVSS)	
$Px,_{TSS}$	$Px,_{TSS}=$	9890.399	kg /d	$=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)+5*Q*Al$	
S	S=	0.4507	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m-b_H)-1]$	
b_H	$b_H=$	0.1200		$=b*1.04^{(T-20)}$	b at20℃＝ 0.120
Y_H	$Y_H=$	0.4500	gVSS/g bCOD		
$\mu_{m,T}$	$\mu_{m,T}=$	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$	μ max at20℃＝ 6.000
Yn	Yn=	0.150	gVSS/g Nox		
NOx	NOx=	47.400	mg/*l*		
$P_{X,bio,VSS}$	$P_{X,bio,VSS}=$	4337.878	kg VSS/d	$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$ $+QYn(Nox)/[2+bAOB(SRT)]$	
		3895.083		$=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]$	
		350.557		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$	
		92.238		$=QYn(Nox)/[1+b_{AOB}(SRT)]$	
NOx	NOx=	47.311	mg/*l*	$=TKN-Ne-0.12P_{X,bio}/Q$	
(4) Required Aeration Tank Volume					
Va=	Va=	16,484	m3		
τ =	τ =	16.48	hr	=Va/Q×24	
	⇒	18.00	hr		
$X_{VSS}\cdot Va$	$X_{VSS}\cdot Va=$	37,524	kg VSS	$=Px,_{VSS}\cdot SRT$	
$X_{TSS}\cdot Va$	$X_{TSS}\cdot Va=$	49,452	kg TSS	$=Px,_{TSS}\cdot SRT$	
F/M	F/M=	0.224	kgBOD/kgMLVSS		
FractionVSS=	FractionVSS	0.759			
MLVSS=	MLVSS=	2276	mg/L		
(5) BODloading	BODloading	0.510	kg/m3・d		
(6) Observed Yield					
$Y_{obs,TSS}=$	$Y_{obs,TSS}=$	1.178	gTSS/gBOD		
$Y_{obs,VSS}=$	$Y_{obs,VSS}=$	0.894	gVSS/gBOD		
bCODremoved=	bCODremov	13,849	kg/d		
(7) effluent NO_2-N	NO_2-N=	0.2315	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$	
b_{NOB}	$b_{NOB}=$	0.1700		$=b*1.029^{(T-20)}$	b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}=$	1.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$	μ max at20℃＝ 1.000
μ_{AOB}	$\mu_{NOB,T}=$	0.6897	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$	
	$S_0=$	2.000	mg/*l*		
	$K_{O2,NOB}=$	0.900	mg/*l*		
(8) effluent NH_4-N	NH_4-N=	0.5286	mg/*l*	$=Ks[1+b_{NOB}(SRT)]/[SRT(\mu_{NOB}-b_{NOB})-1]$	
b_{NOB}	$b_{NOB}=$	0.1700		$=b*1.029^{(T-20)}$	b at20℃＝ 0.170
$\mu_{m,T}$	$\mu_{max,NOB,T}=$	0.9000	g/g・d	$=\mu_{max}*1.072^{(T-20)}$	μ max at20℃＝ 0.900
μ_{AOB}	$\mu_{NOB,T}=$	0.7200	g/g・d	$=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$	
	$S_0=$	2.000	mg/*l*		
	$K_{O2,NOB}=$	0.500	mg/*l*		
(9) Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L		
	3,000/(8,000-3,000)＝	0.60			
	Rr ＝	0.60			

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[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration
X_b = $Q \cdot (SRT)/V \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
= 1,181.47 mg/*l*

(2) IR ratio
IR＝ NOx/Ne-1.0-R
= 3.66

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= (IR+R)・Q・Ne
= 919,454.64 kg/d

(4) The anoxic tank volume
Vnor= 1,648 m3 = Va× 10%
Vnor= 5,000 m3 τ_{DN}= 5.000 h

(5) F/M_b
F/M_b= 1.42 g/g・d

(6) Fraction of rbCOD
40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients	
	b0	b1
10	0.186	0.078
20	0.213	0.118
30	0.235	0.141
40	0.242	0.152
50	0.270	0.162

(8) SDNRb
SDNRb= 0.296 g/g・d = $b_0+b_1[\ln(F/M_b)]$

b_0= 0.242
b_1= 0.152

(8) SDNR
SDNR= 0.110 g/g・d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.212 g/g・d $=SDNR_t - 0.029\ln(F/M_b)-0.012$ IR=3-4
$=SDNR_t - 0.0166\ln(F/M_b)-0.078$ IR=2

SDNRt= 0.296 g/g・d $=SDNR_b \cdot \theta^{(t-20)}$ θ = 1.026

(9) NOr
NOr= 1,250,383.39 kg/d $=N_{nox} \cdot SDNR \cdot X_b$
>Nox feed= 919,455 kg/d

(10) Alkalinity to be added to maintain pH7
-108.33 mg/*l*

Influent Alk 380.00 mg/*l*
Alk used 338.44 mg/*l* =7.14×Nox
Alk producec 136.77 mg/*l* =3.57×(NOx-NOxe)
Alk to mainta 70.00 mg/*l*

[4] Design of Phosphourus Removal Process

(1) Removal T-P 3.13 mg/l
P in waste sludge px= 1.00%
Generated waste sludge $Px_{,VSS}$= 7504.891 kg /d
Rwmoval Phosphorus 75.04891264 kg /d
(2) Effluent T-P without Al 3.87 mg/l
(3) Required Al toinitial soluble phosphourus ratio 1.00 mol/mol
(4) Required Al dosing rate 3.48 mg/l as Al
42.98 mg/l as crystal, Al2(SO4)3・18H2O
(5) Required Alumnum Sulfate 1,031.46 kg/d
(6) Required Alumnum Sulfate solutic 10% 9.82 m3/d
409.31 L/H
(7) Additional sludge 418.16 kg/d

Reactor9/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

[5] Reactor

(1) Total volume of Aeration Basins

V_A = Q'*θa/24
= 18,000 m^3

(2) Total volume of Anoxic Basins

V_{DN} = Q'*θ_{DN}/24
= 5,000 m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	1,500	1.50	1.50	0.30
Anoxic	V_{DN}	5,000	5.00	5.00	1.00
Aerobic	V_A	18,000	18.00	18.00	3.60
Total	V	24,500	24.50	24.50	

[6] Geometry

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	147.0	5.5	4

Cross Section	8.0*5.5	=	44.0 m^2/Basin	
Hantzsch Subtraction		=	1.0 m^2/Basin	
after Subtraction	44.0-1.0	=	43.0 m^2/Basin	
Total Volume	43.0*147.0	=	6,321 m^2/Basin	25,284 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2	43.0			
Length required	m	**8.7**	**29.1**	**104.7**	**142.4**
Volume required per Basin	m^3	375	1,250	4,500	6,125
Total Volume required	m^3	1,500	5,000	18,000	24,500
Actual Cross Section	m^2	43.0	43.0	43.0	
Actual Length	m	10.0	30.0	107.0	147.0
Actual Volume per Basin	m^3	430	1,290	4,601	6,321
Actual Total Volume	m^3	1,720	5,160	18,404	25,284
Actual Ratio of Volume		0.33	1.00	3.57	
Actual Retention Time	hour	1.72	5.16	18.40	25.28

[7] Equipment

(1) Ras Pumps

Ras Ratio: 60%

Required Capacity: 24,000 m3/day× 60% ／ 24 ／ 4
= 150 m3/Hr ⇒ 150 m3/Hr

Number: 4 Work
4 Stanby

(2) Circulation Pumps

Ras Ratio: 366%

Required Capacity: 24,000 m3/day× 366% ／ 24 ／ 8
= 457 m3/Hr ⇒ 460 m3/Hr

Number: 8 Work
4 Stanby

(3) SAS Pumps

Excess Sludge: 1,446 m3/day

Sludge withdraw: 12 Times/day

Running Time: 0.5 Hr/Time

Required Capacity: 1,446 m3/day ／ 12 ／ 0.50 ／ 4
= 60.26 m3/Hr ⇒ 65 m3/Hr

Number: 4 Work
4 Stanby

Reactor10/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

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(4)	Alum Solution Tank	
	Number	2 W + 0 S
	Alum concentration as crystal	10 %
	Gravity of dissolved dechlorine	1.05
	Required solution volume	1031.46 kg / d × 100 / 10 / 1.05 / 1000
		＝ 9.82 m3/d
	Volume of Tank	5.1 m3/tank (= 1.6 mW× 1.6 mL× 2.0 mH)
	Total Volume of Tanks	10.2 m3 (Duration= 1.04 day)
(5)	Mixer for Alum Solution Tank	
	Number	2 W + 0 S
(6)	Alum Dosing Pump	
	Number	2 W + 1 S
	Capacity	9.82 m3/d / 24 × 1000 / 2 × 2
		409.31 l/h/unit ⇒ 410 l/h/unit

Reactor11/23

Reference_Process Cal_EA&al 24MLD_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

6. Air Requirement at Average Flow

〔1〕Design Condition

(1)	AOR	AOR = 10,383 kg/day
		= 432.6 kg/h
	Qin :Design Average Flow m^3/d	24,000
	Inlet bCOD : S_0	578 mg/*l*
	S=	S= 0.451 mg/*l*
	Nox=	Nox 47.400 mg/*l*
	$P_{X,bio}$=	$P_{X,b}$ 4,245.6 kg VSS/d does not include nitrifying bacteria
	R_0=	R_0= Q(S_0-S-k(Nox-NOxe)-1.42$P_{X,bio}$+4.57Q・NOx
	R_0=	R_0= 10,383 kg O2/d
		k= 2.86
(2)	SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \; (\beta \cdot C_{SW}/C_S \cdot (Pb/Pa)a - C_A)}$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		9.09 mg/L at 20 ℃		
20-T	:	0.0 1.024^{20-T} : 1.0000		
C_A	:	operating DO in Basin	2.0	mg/L
a	:	Correction Factor by the Water Depth		
		1+0.40D_j/Pa	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s		
			10.332	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	exp[-gM(z_b-z_a)/R*T]	0.900	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	900	m
z_a	:	Sea Elevation	0	m
R	:	Universal Gas Constant	8314	Nm/kg-mole.K
T	:	Temperature 273.15+t =	293.15	Kelvin
α	:	relative Transfer Rate to clean Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{112,656}{4.2591} = 26,450.37 \text{ kg/day}$$

(3)	No. of Basins	4 Basin
(4)	Standard O2 required at Field Conditions per Bas	= 6,613 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.0 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	15%
(9)	Air required at Field Conditions per Basins	= 97,253 m^3/day = 4,052.2 m^3/hr

Air Requirement at Average Flow12/23

Reference_Process Cal_EA&al 24MLD_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

[2] Equipment						
(1) Air Blower						
Number	4	W	+	2	S	
Required Capacity	4052.2	m^3/Hr・Basin	／	1	unit/Basin	
	＝ 4052.2	m^3/h	⇒	4100	m^3/h /Unit	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	91.234	kPa				
Total inlet pressure	89.234	kPa				
Volume rate of flow at inlet point	77.573	m3/min				
Total discharge pressure	156.234	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	109.679	kW				
Rated Output of Motor	120.647	kW	⇒	130	kW	

Air Requirement at Average Flow13/23

Reference_Process Cal_EA&al 24MLD_Appendix 12.2.3
STP Process Calculation_Supporting Report 12.2.3

7. Final Clarifire					
〔1〕 Design Condition					
(1) Design Wastewater Flow	Q= 24,000 m^3/day				
(2) Water Temperature	T= 20.0 ℃				
(3) MLSS	Xef= 3,000 mg/*l*				
(4) SVI	SVI= 300				
(5) Sedimentation Velocity	*v* = 4.899*10^6*T^(0.954)*Xef^(-1.354)*SVI^(-0.77)				
	= 4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770				
	= 20.7 m/day				
(6) Surface Overflow Rate required	*S*'= v/(1.5*1)=	20.7/(1.5*1.0)		=	13.8 m^3/m^2·day
				→	12.0 m^3/m^2·day
[2] Geometory					
(1) Surface Area required	A= 24,000/12.0=			=	2,000 m^2
(2) Demensions	Diameter	Depth	Basin		
	26.0	**3.5**	**4**		
(3) Actual Surface Area	S= 26.0^2 * 3.14 /4 * 4.0			=	2,124 m^2
(4) Surface Overflow Rate	S= 24,000/2,124			=	11.3 m^3/m^2·day

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Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

8. Chlorination

[1] Design Condition

(1) Design Flow Rate — Average Daily Flow 24,000 m^3/day 1000.00 m^3/h

Peak Flow 54,000 m^3/day 2250.00 m^3/h

(2) Contact Time — 30 min

(3) Type of Chlorine — Cl_2-GAS

(4) Design Chlorine Dosage Rate — 10 mg/L

(5) Required Chlorine per day — Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate

＝ 240.0 kg/d

＝ 10.00 kg/h

[2] Chlorination Contact Tank

(1) Volume required — Average Daily Flow ／ 1440 × Contact Time

＝ 500.0 m^3

(2) Nos. of lanes — 5 lanes

(3) Width of lane — 2.00 m

(4) Length of lane — 26.00 m

(5) Side Water Depth — 2.00 m

(6) Nos. of Tanks — 1 tank

(7) Total Width of Tank — 11.60 m Approx..

(8) Average Velocity — Decant Flow ／ 3600 ／ Width ／ Depth

＝ 1000.00 ／ 3600 ／ 2.00 ／ 2.00

＝ 0.069 m/sec

(9) Total Volume — Width × Length × Depth × Nos. of lanes × Nos. of Tanks

＝ 2.0 m × 26.0 m × 2.0 m

× 5 × 1

＝ 520 m^3 > 500.0 m^3

[3] Equipment

(1) Chlorine Dosing Condition

Operation Dosage Rate -1 — DC1 10 mg/L

(2) Chlorine Cylinder

Type	-	Cylindrical Convexsd Container	
Cylinder Capacity	Cc	928 kg/cylinder	
Average Dosage Rate -1	q1	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^{3} =	240 kg/day
Maximum Dosage Rate -1	q3	Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^{3} =	540 kg/day
Storage day	T	More than 15 days	
Required Storage Capacity	EC1	D x T = 3,600 kg	
Unit Number	EN1	EC1 / Cc = 3.9 cylinders	
Maximum Operation Numbers			
Cl_2-Gas Volatilize Rate	Vr1	#### @ 20°C Standard temperature	
Maximum Dosing Rate	DC1	10 mg/L, Q_{T-D} x q3 x 10^{-3} / 24 =	22.50 kg/h
Operation Numbers	EN2	DC1 / Vr1 = 2.8sets	
Number	3	W + 2 S	

(3) Chlorinator

Type — Solution Feed Vacuum Type

Number — 1 W + 1 S

Operation Dosage Rate -1 — Dq1 Chlorine -1 : Q_{T-D} x DC1 x 10^{-6} x 10^{3} =

540 kg/day

Required Dosage Rate — Chlorine -1 : Dq1 / (EN1x 24) =

Minimum		Maximum	
0.00	kg/hr	22.5	kg/hr

Chlorination Tank (gas)15/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

(4) Chlorine Booster Pump	
Type	Branchy on the water supply pipe
Water Demand	Water requiamet for mixsed Chlori
Chlorinator Discharge	(kg/hr) 1.0 1.5 2.0 2.5 3.0 4.0
Water Demand	(L/min) 15 20 25 30 35 40
Chlorinator Discharge	(kg/hr) 5.0 6.0 10.0 50.0 100.0 200.0
Water Demand	(L/min) 45 50 60 300 600 1,200
Water requiamet	-
For Chlorin	Qp1 Maximum dosage ra 22.5 kg/hr
	therefore 135 L/min
Booster Pump Type	Single suction volute pump
Number	1 W + 1 S
9. Dechlorination	
〔1〕 Design Condition	
(1) Design Flow Rate	Average Daily Flow 24,000 m^3/day
(2) Contact Time	10 min
(3) Type of Dechlorine	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$)
(4) Free Residual Chlorine	1.0 mg/L assumed value
(5) Consumption per day	Average Daily Flow ／ 1000 × Free Residual Chlorine × 1.75
	× 1.5 (safety factor)
	＝ 63.0 kg/d
	＝ 2.63 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Flow Rate ／ 60 × Contact Time
	＝ 166.7 m^3
(2) Width of lane	11.60 m
(3) Length of lane	8.00 m
(4) Side Water Depth	2.00 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 11.6 m × 8.0 m × 2.0 m
	＝ 186 m^3 > 166.7 m^3
[3] Equipment	
(1) Dechlorine Solution Tank	
Number	2 W + 0 S
Dechlorine concentration	10 %
Gravity of dissolved dechlorine	1.10
Required solution volume	63.00 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.57 m3/d
Volume of Tank	0.360 m3/tank (= 0.6 mW× 0.6 mL× 1.0 mH)
Total Volume of Tanks	0.720 m3 (Duration= 1.26 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	2 W + 1 S
Capacity	1.29 m3/d / 24 × 1000 / 2
	26.85 l/h/unit ⇒ 27 l/h/unit

Chlorination Tank (gas)16/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

10.	**Sludge Thikener**					
[1]	**Design Condition**					
(1)	Primary Sludge	0	kg/day		0	m3/day
(2)	Secondary Sludge	11,570	kg/day		1,446	m3/day
(3)	Total Solids	11,570	kg/day		1,446	m3/day
(4)	Operation Time	24	hours/day			
(5)	Thikened Sludge Moisture Content	97.5	%			
[2]	**Geometory**					
(1)	Type					
(2)	Number	2	W	+	0	S
(3)	Design Solid Loadong	40	kg / m2/d			
(4)	Required Surface Area	$11570 \times \frac{1}{40} = 289.30$ m2				
(5)	Required diameter	$\left(\frac{4}{\pi} \times 289.30 \times \frac{1}{2}\right)^{1/2} = 13.57$ m → 14.00 m				
(6)	Side Water Depth	4	m			
(7)	Actual Volume of Tank	$\frac{\pi}{4} \times 14.00^{2} = 153.94$ m3				
(8)	Retention Time	$\frac{153.94}{1446} \times 4 \times 2 \times 24 = 20.44$ Hr				
[3]	**Volume of Thikened Sludge**	= 417 m^3/d				
[4]	**Quantity of Separation Liquid**	Inlet Sludge Volume − Thikened Sludge Volume = 1446.3 − 416.5 = 1,029.8 m^3/day				

Gravity Sludge Thikener17/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

11.	**Thickened Sludge Sump**								
[1]	**Design Condition**								
(1)	Inlet Solids	11,570	kg/day						
(2)	Inlet Sludge Volume	1,446	m^3/d						
[2]	**Geometory**								
(1)	Sludge withdrawl	15	Times/day						
(2)	Required Sump Volume	96	m^3/d						
(3)	Number	2	Basins						
(4)	Width	3.5	m						
(5)	Length	4.0	m						
(6)	Side Water Depth	3.0	m						
(7)	Actual Sump Volume	3.5	×	4.0	×	3.5	×	2	
		=	98.0	m^3					
[3]	**Equipment**								
(1)	Thickened Sludge Transfer Pumps								
	Transfer Time	6.00	Hr						
	Number	2	W	+	2	S			
	Required Capacity	1446	m^3	／	6.0	／	2		
		=	120.5	m^3/Hr	⇒	120	m^3/Hr /Unit		

Thickened Sludge Sump18/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

12. Centrifuge

[1] Design Condition

(1) Type of Dewatering	Centrifuge			
(2) Generated Sludge	10,413	kg/day		
(3) Design Polyelectrolyte Dosage	Polyelectrolyte		5	kg/t-DS･day
(4) Volume of Thickend Sludge	416.5	m^3/day		
(5) Consistency of Dewatered Sludge	82	%		
(6) Operation Time	12	hours/day	(6 days per week)	

[2] Volume of Centrifuges

$$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$$

$$= \frac{416.5}{12 \times 2} \times \frac{7}{6} = 20.2$$

→ 21 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 10,413 × (1 + 0.0050)

= 10,465 kg/day

[4] Dewatered Cake Volume

$$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$$

$$= 10.465 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 67.83 t/day

apparent specific gravity 1.00

67.83 ／ 1.0 = 67.8 m^3/day

[5] Polyelectrolyte

(1) Design Polyelectrolyte Dosage	Polyelectrolyte	5	kg/t-DS･day
(2) Required Polyelectrolyte		52.07	kg/day
(3) Dissolving concentration		0.20	%
(4) Volume of Polyelectrolyte solution		26.03	m3/day

Centrifuge 19/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

[6]	**Equipment**									
(1)	Centrifuge									
	Capacity	21	m^3/hr							
	Number	2	W	+	1	S				
(2)	Centrifuge Feed Pumps									
	Capacity	21	m^3/hr							
	Number	2	W	+	1	S				
(3)	Polyelectrolyte Dosing Pumps									
	Volume of Polyelectrolyte solution	26.03	m3/day							
	Operation Time	12	hours/day	(6 days per week)						
	Safety Factor	1.5								
	Number	2	W	+	1	S				
	Required Capacity	26.03	m3/da; ×	7	／	6	／	12	／	2
		＝	1.27	m^3/Hr						
	Specification Capacity	1.27	m^3/Hr	×	1.5					
		＝	1.898	m^3/Hr	⇒	1.90	m^3/Hr /Unit			
(4)	Polyelectrolyte dosing System									
	Preparation time for solution	3	hr							
	Required dry polymer	52.07	kg/day ×	7	／	6	／	12		
		＝	5.06	kg/hr						
		＝	15.19	kg per one batch						
	Feedong time per one batch	30	min							
	Capacity of Dry polymer Feeder	30	kg/h							
	Tanks Dimensions	Width	2.0	m	×	Length	2.0	m		
		×	Depth	2.5	m	×	2 (Freeboard 0.5m)			
		＝	20	m^3						
	Retention Time of Tank	10.00	m^3 /tank	／	1.27	m^3/Hr	／	2		
		＝	3.951	Hr	>	3	Hr			
	Number	2	W	+	0	S				

Centrifuge 20/23

Reference_ Process Cal_ EA&al 24MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

11. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	10,413 kg/day
(2) Solids Consistency	2.50 %
(3) Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
	$= 10{,}413 \times \frac{100}{2.50} \times 10^{-3}$
	= 417 m^3/day
	= 17.36 m^3/h
(4) Sludge feed flow rate	21 m3/h × 2 = 42 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Basin Dimensions	Width 6.0 m × Length 7.0 m
	× Depth 4.0 m × 2
	= 336.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	336.0 m^3
Number	1 W + 1 S

Centrifuge Feed Sump 21/23

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		#REF!	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	234.50	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	1	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

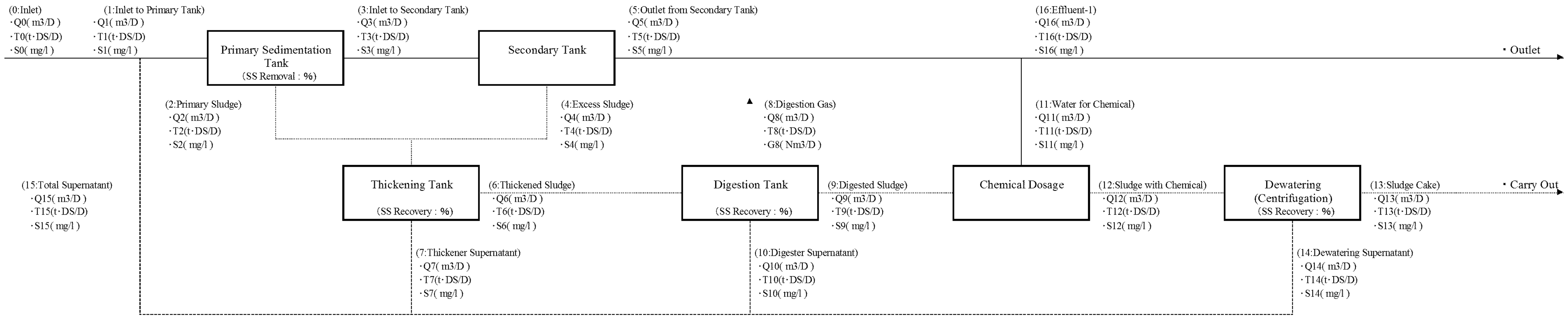
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	24,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	90.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	97.5	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	97.5	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	24,000	25,417	0	25,417	1,446	23,971	417	1,030	0	417	0	26	443	55	387	1,417	1,417			23,971	0
T(t･DS/day)	10.800	12.480	0.000	12.480	11.570	0.240	10.413	1.157	0.000	10.413	0.000	0.052	10.465	9.942	0.523	1.680	1.680			0.240	0.670
S(mg/l)	450	491	0	491	8,000	10	25,000	1,124	0	25,000	0	2,000	23,647	180,000	1,351	1,186				10	
X(Ti/T0*100)	100	115.6	0.0	115.6	107.1	2.2	96.4	10.7	0.0	96.4	0.0	0.5	96.9	92.1	4.8	15.6				2.2	6.2

Figure -1 Material Balance Model



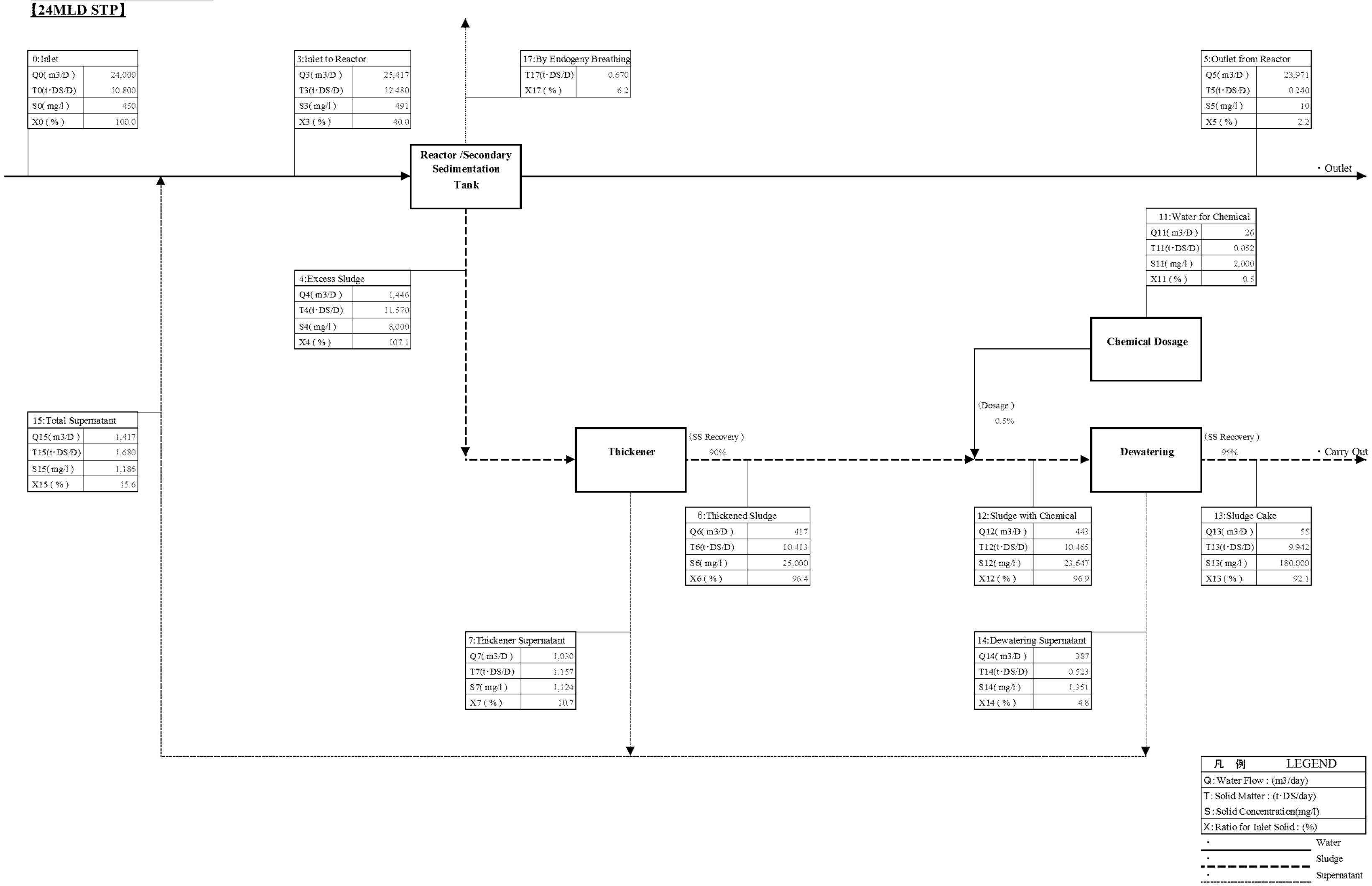
Calculation Formula

･Q0=Input Data ･T0=Q0*S0*10^(-6) ･S0=Input Data	･Q3=Q1-Q2 ･T3=T0*(100-A2)/100 ･S3=T3*10^6/Q3	･Q6=T6*100/(100-W3) ･T6=(T2+T4)*A3/100 ･S6=10^6*(100-W3)/100	･Q9=Q6 ･T9=(T6-T8)*A4/100 ･S9=T9*10^6/Q9	･Q12=Q9+Q11 ･T12=T9+T11 ･S12=T12*10^6/Q12	･Q15=Q7+Q10+Q14 ･T15=T7+T10+T14 ･S15=T15*10^6/Q15	･Q5-1=Q5-Q11 ･T5-1=T5-T11 ･S5-1=S5
･Q1=Q0+Q15 ･T1=T0+T15 ･S1=T1*10^6/Q1	･Q4=T4*100/(100-W2) ･T4=余剰汚泥発生式による ･S4=10^6*(100-W2)/100	･Q7=(Q2+Q4)-Q6 ･T7=(T2+T4)-T6 ･S7=T7*10^6/Q7	･Q10=Q6-Q8-Q9 ･T10=T6-T8-T9 ･S10=T10*10^6/Q10	･Q13=T13*100/(100-W5) ･T13=T12*A5/100 ･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1) ･T2=T1-T3 ･S2=10^6*(100-W1)/100	･Q5=Q3-Q4*(T3-T5)/T4 ･T5=Q5*ST/10^6 ･S5=St	･Q8=0 ･T8=T6*A6*A7/10^4 #REF!	･Q11=T10*A9/A10 ･T11=Q11*S11/10^6 ･S11=10^4*A10	･Q14=Q12-Q13 ･T14=T12-T13 ･S14=T14*10^6/Q14		

Material Balance Sheet SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Sheet
【24MLD STP】



Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

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Design Condition

Item	Gazipur-MPS
(1) Design Flow for the year 2045	see table below
(1) Design Flow for the year 2030	see table below

Design Flow for the year 2045:

	Flow Rate		
	m3/d	m3/h	m3/sec
Daily Average	####	1015	0.282
Daily Maximum	####	1015	0.282
Hourly Max. Peak factor 2.25	####	2283	0.634

Design Flow for the year 2030:

	Flow Rate		
	m3/d	m3/h	m3/sec
Daily Average	####	817	0.227
Daily Maximum	####	817	0.227
Hourly Max. Peak factor 2.25	####	1838	0.510

1. Inlet Chamber

Item	Gazipur-MPS
〔1〕Design Condition	
(1) Design Flow for the year 2045	Max Hourly ＝ 54,797 m3/d
	＝ 0.634 m3/sec
(2) Inlet Pipe	
Pipe Diameter	• × mm
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Fornula)
Full Pipe Flow Rate	m^3/sec
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	2.000 m
(3) Width of Basin	2.500 m
(4) Length of Basin	3.700 m
(5) Volume required of Basin	2.000 × 2.500 × 3.700 ＝ 1.4 m3
(6) Retention Time	2.000 × 2.500 × 3.700 ／ 0.634 × 1
	＝ 29.18 sec
(7) Basin Demensions	Width 2.500 m × Length 3.700 m
	× Depth 2.000 m

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Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

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2.	**Coarse Screen Channel**									
[1]	**Design Flow Rate**									
(1)	Design Flow for the year 2045	Max Hourly		=	54,797	m3/day				
				=	0.634	m3/sec				
(2)	Design Flow for the year 2030	Max Hourly		=	44,105	m3/day				
				=	0.510	m3/sec				
[2]	**Geometry**									
(1)	Inlet Gate									
	Number	2	Main	+	1	Bypass				
	Width	0.600	m							
	Height	0.900	m							
	Floor Level	+	0.000	m						
	Bottom	+	0.000	m						
	Influent Water Level	+	0.600	m						
	Velocity	0.634	／	0.600	／	0.600	／	2		
	whe Design Flow for the year 2045	=	0.881	<	1.000	m/sec				OK
	Velocity	0.510	／	0.600	／	0.600	／	2		
	whe Design Flow for the year 2030	=	0.708	<	1.000	m/sec				OK
(2)	Screen Channel									
	Number	2.0	Main	+	1.0	Bypass				
	Width	1.000	m							
	Side Water Depth	0.700	m							
	Velocity	0.634	／	1.000	／	0.700	／	2		
	whe Design Flow for the year 2045	=	0.453	≒	0.450	m/sec				OK
	Velocity	0.510	／	1.000	／	0.700	／	2		
	whe Design Flow for the year 2030	=	0.364	<	0.450	m/sec				OK
(3)	Channel Dimensions	Width	1.0	m	×	Length	7.5	m		
			×	SWD	0.7	m	(Freeboard 0.3m)			
[3]	**Equipment**									
(1)	Inlet Gate									
	Number	2	Units							
	Dimension	Width	0.6	m	×	Height	0.9	m		
	Design Water Level		m							
(2)	Coarse Screens (Main Channel)									
	Number	2	W	+	0	S				
	Open Space	20	mm							
	Bar Thickness	9	mm							
	Channel Width	1.0	m							
	Width of side plate	50	mm							
	Side Water Depth	0.7	m							
	Height of Blind Plate at the bottom	50	mm							
	Velocity through screen	0.634	／	0.900	／	0.650	／	2		
		× (	20	+	9	) /	20			
		=	0.786	≒	0.800	m/sec				OK
	Velocity through screen	0.510	／	0.900	／	0.650	／	2		
	whe Design Flow for the year 2030	× (	20	+	9	) /	20			
		=	0.632	<	0.800	m/sec				OK
(3)	Coarse Screens (Bypass Channel)									
	Number	0	W	+	1	S				
	Open Space	50	mm							
	Bar Thickness	9	mm							
	Channel Width	1.0	m							
	Side Water Depth	0.7	m							
	Velocity through screen	0.634	／	1.000	／	0.700	／	2		
	whe Design Flow for the year 2045	× (	50	+	9	) /	50			
		=	0.534	<	0.800	m/sec				OK
	Velocity through screen	0.510	／	1.000	／	0.700	／	2		
	whe Design Flow for the year 2030	× (	50	+	9	) /	50			
		=	0.430	<	0.800	m/sec				OK

Coarse Screen 2/16

Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

3.	**Raw Sewage Sump**												
[1]	**Geometry**												
(1)	Raw Sewage Sump												
	Number	1	Basin										
	Dia	12.00	m										
	Pump Operating Depth	1.700	m										
	Retention Time	(	12.00	^{2}×		π／4	×	1.700	)／	0.634	／60		
	whe Design Flow for the year 2045	＝	5.05	＞	3.75		min (=minimum time of one pump cycle ˙					OK	
	Retention Time	(	12.00	^{2}×		π／4	×	1.700	)／	0.510	／60		
	whe Design Flow for the year 2030	＝	6.28	＞	3.75		min (=minimum time of one pump cycle ˙					OK	
	High Water Level	+			m								
	Pump Off Level	+			m								
[2]	**Equipment**												
(1)	Sewage Pumps												
	Number	4	W		+		2	S					
	Bore Diameter	150	mm										
	Discharge Flow	0.510		×	3600		／	4					
	whe Design Flow for the year 2030	＝	459	⇒	460	m3/Hr							
	Total Head	22.0	m										

Raw Sewage Sump 3/16

Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

1. STP Design Condition

Item	Gazipur-STP 18MLD
(1) Design Average Daily Wastewater Flow	see table below
(2) Design Sewage Quality and Effuluent Quality	see table below

(1) Design Average Daily Wastewater Flow

	Flow Rate		
	m^3/d	m3/h	m^3/s
Average Daily	####	750	0.208
Max Dayly	####	750	0.208
Max Hourly Peak factor 2.25	####	1688	0.469

(2) Design Sewage Quality and Effuluent Quality

Unit: mg/L

	Water Quality Item						
	BOD	COD	SS	T-N			TP
				NH_4-N	Org-N	NOx-N	
Inlet	250	450	250	25	10	5	
Outlet	10	50	20	2	0	8	
Removal rate	####	####	####	####			####

4. Stilling Chamber

Item	Gazipur-STP 18MLD
[1]Design Condition	
(1) Design Wastewater Flow	Max Hourly = 40,500 m^3/day
	= 0.469 m^3/sec
[2] Geometry	
(1) Number of Basins	1 Basin
(2) Depth of Basin	2.000 m
(3) Width of Basin	3.200 m
(4) Length of Basin	4.500 m
(5) Volume required of Basin	2.000 × 3.200 × 4.500 = 1.4 m^3
(6) Retention Time	2.000 × 3.200 × 4.500 ／ 0.469 × 1
	= 61.4072495 sec
(7) Basin Demensions	Width 3.200 m × Length 4.500 m
	× Depth 2.000 m

STP basic &Stilling Chamber4/16

Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

5. Fine Screen Channel

Item	Gazipur-STP 18MLD
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 40,500 m^3/day
	= 0.469 m^3/sec
[2] Geometory	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 107.100 m
Bottom	+ 104.600 m
Influent Water Level	+ 105.200 m
Velocity	0.469 ／ 0.600 ／ 0.600 ／ 2
	= 0.651 ＜ 1.000 m/sec
(2) Screen Channel	
Number	2 Main + 1 Bypass
Width	0.800 m
Side Water Depth	0.700 m
Velocity	0.469 ／ 0.800 ／ 0.700 ／ 2
	= 0.419 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 0.8 m × Length 8.5 m
	× SWD 0.7 m (Freeboard 0.3m)
[3] Equipment	
(1) Inlet Gate	
Number	2 Units
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	2.50 m
(2) Fine Screens (Main Channel)	
Number	2 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	0.8 m
Width of side plate	50 mm
Side Water Depth	0.7 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.469 ／ 0.700 ／ 0.650 ／ 2
	×(6 + 2)/ 6
	= 0.687 ＜ 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	0.8 m
Side Water Depth	0.7 m
Velocity through screen	0.469 ／ 0.800 ／ 0.700 ／ 2
	×(20 + 9)/ 20
	= 0.607 ＜ 0.800 m/sec

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Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

6. Grit Chamber

Item	Gazipur-STP 18MLD
〔1〕 Design Condition	
(1) Design Wastewater Flow	Max Hourly ＝ 40,500 m^3/day
	＝ 0.469 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.0111 m/sec ＝ 960 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	Square Grit Chamber
(1) Surface Area required	0.469 ／ 0.0111 ＝ 42.25 m^2
(2) Number of Basins	2 S ＋ 0 W
(3) Surface Area required/Basin	42.3 ／ 2 ＝ 21.13 m^2
(4) Length of Basin	21.1261261 ^0.5 ＝ 4.6 m → 5.0 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.469 × 60 sec ／ 2 ＝ 14.1 m^3
(7) Depth required	14.1 ／ 5.0 ／ 5.0 ＝ 0.563 m
(8) Basin Dimensions	Width 5.0 m × Length 5.0 m
	× Depth 0.6 m (Freeboard 0.3m)
(9) Retention Time	5 × 5.0 × 0.6 ／ 0.469 × 2
	＝ 60.00 sec
(10) Surface Overflow Rate at Peak Flow	40,500 ／ 5.0 ／ 5.0 ／ 2
	＝ 810 ＜ 960 m^3/m^2/day

Grit Chamber6/16

STP Process Calculation_Supporting Report 12.2.3

8. Air Requirement at Average Flow

Item	STP 10MLD
〔1〕Design Condition	
(1) O2 demand	
R_0=	R_0= $Q(S_0\text{-}S\text{-}2.86(Nox\text{-}NOxe))\text{-}1.42P_{X,bio}+4.57Q\cdot NOx$
R_0=	R_0= 6,214 kg O2/d
Qin : Design Average Flow m^3/d	10,000
Inlet bCOD	S0= 578 mg/*l*
S=	S= 0.291 mg/*l*
Nox=	NOx= 52.471 mg/*l*
$P_{X,bio}$=	$P_{X,bio}$= 1,377.5 kg VSS/d *does not include nitrifying bacteria
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{R0 \times C_S\cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta\cdot C_{SW/CS}\cdot(Pb/Pa)a - C_A)}$
	C_S : Saturated DO at sea level and 20 ℃ degrees Celsius
	9.09 mg/L
	C_{SW} : Saturated DO at sea level and operating Temperature
	6.93 mg/L at 35 degrees Celsius
	20-T : -15.0 1.024^{20-T} : 0.7006
	C_A : operating DO in Basin 2.0 mg/L
	a : Correction Factor by the Water Depth
	$1+0.40D_j/Pa$ 1.19357
	D_j : Tank Liquid Depth 5.00 m
	P_a : Standard absolute pressure at sea level 10.332 m
	P_b : Absolute pressure at Plant Site Elevation m
	P_b/P_a : $\exp[-gM(z_b\text{-}z_a)/R^*T]$ 0.905
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 900 m
	z_a : Sea Elevation 0 m
	R : Universal Gas Constant 8314 Nm/kg-mole.K
	T : Temperature 273.15+t = 308.15 Kelvin
	α : relative Transfer Rate to clean Water 0.65
	β : relative DO Saturation to clean Water 0.95
	F : Diffuser Fouling Factor 0.90
	$= \dfrac{47{,}237}{2.9902} =$ 15,797.15 kg/day
(3) No. of Basins	3 Basin
(4) Number of cycles	5.0 cycles/basin・day × 3
	total 15 cycles/day
(5) Standard O2 required at Field Conditions per cycle	= 1,053.1 kg/cycle/basin/day
(6) SOTE for the above Effective Aeration Depth	28.0 %
(7) Fraction of O2 in Air	23.18 %
(8) Specific Gravity of Air at Standard Condition	1.293
(9) Safety Factor	10%
(10) Air required at Field Conditions per cycle	= 14,815 m3/cycle/basin/day
(11) Aeration time per cycle t_A	1.80 h
	= 8,230.8 m^3/hr/basin

Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

[2] Equipment

(1) Air Blower

Operating No. per basin	2	unit/Basin					
Operating No. per set of blowers	1	basin/set					
Required Capacity	8230.8	m^3/Hr·Basin	／	2	unit/Basin		
	= 4115.4	m^3/Hr	⇒	4200	m^3/Hr /Unit		
Number	6	W	+	3	S		
Pressure	65	kPa					
Safty Factor	10	%					
Heat capacity ratio	1.4						
Atmospheric pressuer at site elevation	91.701	kPa					
Total inlet pressure	89.701	kPa					
Volume rate of flow at inlet point	79.052	m3/min					
Total discharge pressure	156.701	kPa					
Overall adiabatic effeciency	0.65						
Inlet air temperature (min.)	15	℃					
Shaft power	111.869	kW					
Rated Output of Motor	123.056	kW	⇒	130	kW		

Reference_Process Cal_ SBR&al 10MLD_Appendix 12.2.3

STP Process Calculation_Supporting Report 12.2.3

13. Centrifuge

Item	STP 10MLD
〔1〕 Design Condition	
(1) Type of Dewatering	Centrifuge
(2) Quantity of Thickend Sludge generated	3,823 kg/day
(3) Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(4) Volume of Thickend Sludge	477.9 m^3/day
(5) Consistency of Dewatered Sludge	82 %
(6) Operation Time	12 hours/day (6 days per week)
〔2〕 Volume of Centrifuges	$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$
	$= \frac{477.9}{12 \times 2} \times \frac{7}{6} = 23.2$
	→ 30 m^3/hour
〔3〕 Dewatered Solids	Digested Sludge × (1 ＋ Injection Rate)
	＝ 3,823 × (1 ＋ 0.0050)
	＝ 3,842 kg/day
〔4〕 Dewatered Cake Volume	$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$
	$= 3.842 \times \frac{100}{100 - 82} \times \frac{7}{6}$
	＝ 24.90 t/day
	apparent specific gravity 1.00
	24.90 ／ 1.0 ＝ 24.9 m^3/day
〔5〕 Polyelectrolyte	
(1) Design Polyelectrolyte Dosage	Polyelectrolyte 5 kg/t-DS・day
(2) Required Polyelectrolyte	19.11 kg/day
(3) Dissolving concentration	0.20 %
(4) Volume of Polyelectrolyte solution	9.56 m3/day
〔6〕 Equipment	
(1) Centrifuge	
Capacity	30 m^3/hr
Number	2 W + 1 S
(2) Centrifuge Feed Pumps	
Capacity	30 m^3/hr
Number	2 W + 1 S
(3) Polyelectrolyte Dosing Pumps	
Volume of Polyelectrolyte solution	9.56 m3/day
Operation Time	8 hours/day (6 days per week)
Safety Factor	1.5
Number	2 W + 1 S
Required Capacity	9.56 m^3/Hr × 7 ／ 6 ／ 8 ／ 2
	＝ 0.70 m^3/Hr
Specification Capacity	0.70 m^3/Hr × 1.5
	＝ 1.045 m^3/Hr ⇒ 0.26 m^3/Hr /Unit
(4) Polyelectrolyte dosing System	
Tanks Dimensions	Width 1.5 m × Length 1.5 m
	× Depth 2.0 m × 2 (Freeboard 0.5m)
	＝ 9 m^3
Retention Time of Tanks	9.00 m^3 ／ 0.70 m^3/Hr ／ 2
	＝ 6.457 Hr
Number	2 W + 0 S

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14. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	3,823 kg/day
(2) Solids Consistency	2.50 %
(3) Volume of Thickened Sludge	Total Solids × $\frac{100}{\text{Solids Consistency}}$ × 10^{-3}
	= 3,823 × $\frac{100}{2.50}$ × 10^{-3}
	= 153 m^3/day
	= 6.37 m^3/h
(4) Sludge feed flow rate	30 m3/h × 2 = 60 m3/h
(5) Centrifuge Operation Time	12 hours/day (6 days per week)
[2] Geometry	
(1) Required sludge volume for continuation	(60 - 6.37) x 12
	= 643.54 m^3
(2) Basin Dimensions	Width 4.0 m × Length 5.0 m
	× Depth 3.0 m × 2
	= 120.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	120.0 m^3
Number	1 W + 1 S

Centrifuge Feed Sump 14/16

Material Balance SD4

STP Process Calculation_Supporting Report 12.2.3

Material Balance Calculation（Primary and Secondary Sedimentation Tank + Thickening Tank + Digestion Tank + Centrifugal Dewatering）

Table -1 Input Data

1. Calculation Manner		2	1:Premise that the quality of supernaitants are same level removed with inlet sewage
			2:Premise that the entire supernatants are removed at treatment process

2. Selection of Treatment Efficiency		2	1:Total Removal Ratio 2:Outlet Water Quality(input 1or2)
In case of 1 : input data			(%)
In case of 2 : input data		10	(mg/l)

3. Selection of Excess Sludge Generation		2	1:Consideration of Solid Matter Only 2:Consideration of Converting of Solved BOD(input 1or2)
In case of 1 : input data (Sludge generation)			Sludge generation ratio per removal SS(%)
In case of 2 : input data	a	0.4	T2=Q4･S4=(a･S_{BOD}+b･S1-c･θ･XA)･Q3/10^6･･(Excess sludge generation formula)
	b	0.9	a:Converting ratio of solved BOD(mgMLSS/mgBOD)
	c	0.05	b:Converting ratio of SS(mgMLSS/mgSS)
	SBOD	167.00	c:Sludge reduction ratio caused by endogenous respiration of activated sludge(1/day)
	XA	3,000	S_{BOD}:Solved BOD quality at inlet reactor
	θ	0.667	XA:MLSS concentration(mg/l)
			θ:Hydraulic retention time(day)

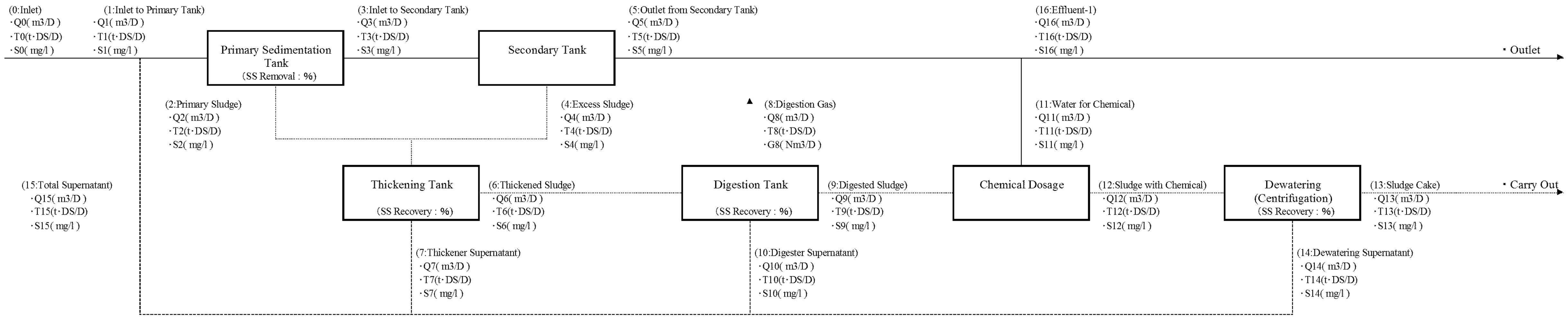
Table -2 Basic Conditions

Sewage Flow and Quality		Sludge Moisture and Recovery Ratio				Digestion Tank Conditions		Chemical Conditions for Dewatering		
･Inlet flow : Q_0(m3/D)	10,000	･Primary sludge moisture ratio : W1(%)	0.0	･Removal ratio in primary tank : A2(%)	0.0	･Content of organics in thickened sludge : A6(%)	75.0	･Chemical dosage : A9(%)	0.5	
･Inlet quality : S_0(mg/l)	450	･Excess sludge moisture ratio : W2(%)	99.2	･Recovery ratio in sludge thickener : A3(%)	100.0	･Digestion ratio : A7(%)	#REF!	･Chemical dissolve concentration : A10(%)	0.2	
･Total removal ratio : A1(%)	-	･Thickened sludge moisture ratio : W3(%)	99.2	･Recovery ratio in sludge digester : A4(%)	100.0	･Digestion gas generation : A8(Nm3/kgVS)				
･Effluent quality : St(mg/l)	10.0	･Digested sludge moisture ratio : W4(%)	99.2	･Recovery ratio in dewatering : A5(%)	95.0					
･Sludge generation ratio per removal SS : Si(%)	-	･Dewatered sludge moisture ratio : W5(%)	82.0							

Table -3 Material Balance Calculation

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	手入力(要収束)			16	17
Q(m^3/day)	10,000	10,467	0	10,467	478	9,989	478	0	0	478	0	10	487	20	467	467	467			9,989	0
T(t･DS/day)	4.500	4.692	0.000	4.692	3.823	0.100	3.823	0.000	0.000	3.823	0.000	0.019	3.842	3.650	0.192	0.192	0.192			0.100	0.769
S(mg/l)	450	448	0	448	8,000	10	8,000	#DIV/0!	0	8,000	0	2,000	7,882	180,000	411	411				10	
X(Ti/T0*100)	100	104.3	0.0	104.3	85.0	2.2	85.0	0.0	0.0	85.0	0.0	0.4	85.4	81.1	4.3	4.3				2.2	17.1

Figure -1 Material Balance Model



Calculation Formula

･Q0=Input Data	･Q3=Q1-Q2	･Q6=T6*100/(100-W3)	･Q9=Q6	･Q12=Q9+Q11	･Q15=Q7+Q10+Q14	･Q5-1=Q5-Q11
･T0=Q0*S0*10^(-6)	･T3=T0*(100-A2)/100	･T6=(T2+T4)*A3/100	･T9=(T6-T8)*A4/100	･T12=T9+T11	･T15=T7+T10+T14	･T5-1=T5-T11
･S0=Input Data	･S3=T3*10^6/Q3	･S6=10^6*(100-W3)/100	･S9=T9*10^6/Q9	･S12=T12*10^6/Q12	･S15=T15*10^6/Q15	･S5-1=S5
･Q1=Q0+Q15	･Q4=T4*100/(100-W2)	･Q7=(Q2+Q4)-Q6	･Q10=Q6-Q8-Q9	･Q13=T13*100/(100-W5)		
･T1=T0+T15	･T4=余剰汚泥発生式による	･T7=(T2+T4)-T6	･T10=T6-T8-T9	･T13=T12*A5/100		
･S1=T1*10^6/Q1	･S4=10^6*(100-W2)/100	･S7=T7*10^6/Q7	･S10=T10*10^6/Q10	･S13=10^6*(100-W5)/100		
･Q2=T2*100/(100-W1)	･Q5=Q3-Q4*(T3-T5)/T4	･Q8=0	･Q11=T10*A9/A10	･Q14=Q12-Q13		
･T2=T1-T3	･T5=Q5*ST/10^6	･T8=T6*A6*A7/10^4	･T11=Q11*S11/10^6	･T14=T12-T13		
･S2=10^6*(100-W1)/100	･S5=St	#REF!	･S11=10^4*A10	･S14=T14*10^6/Q14		

Material Balance Sheet SD4

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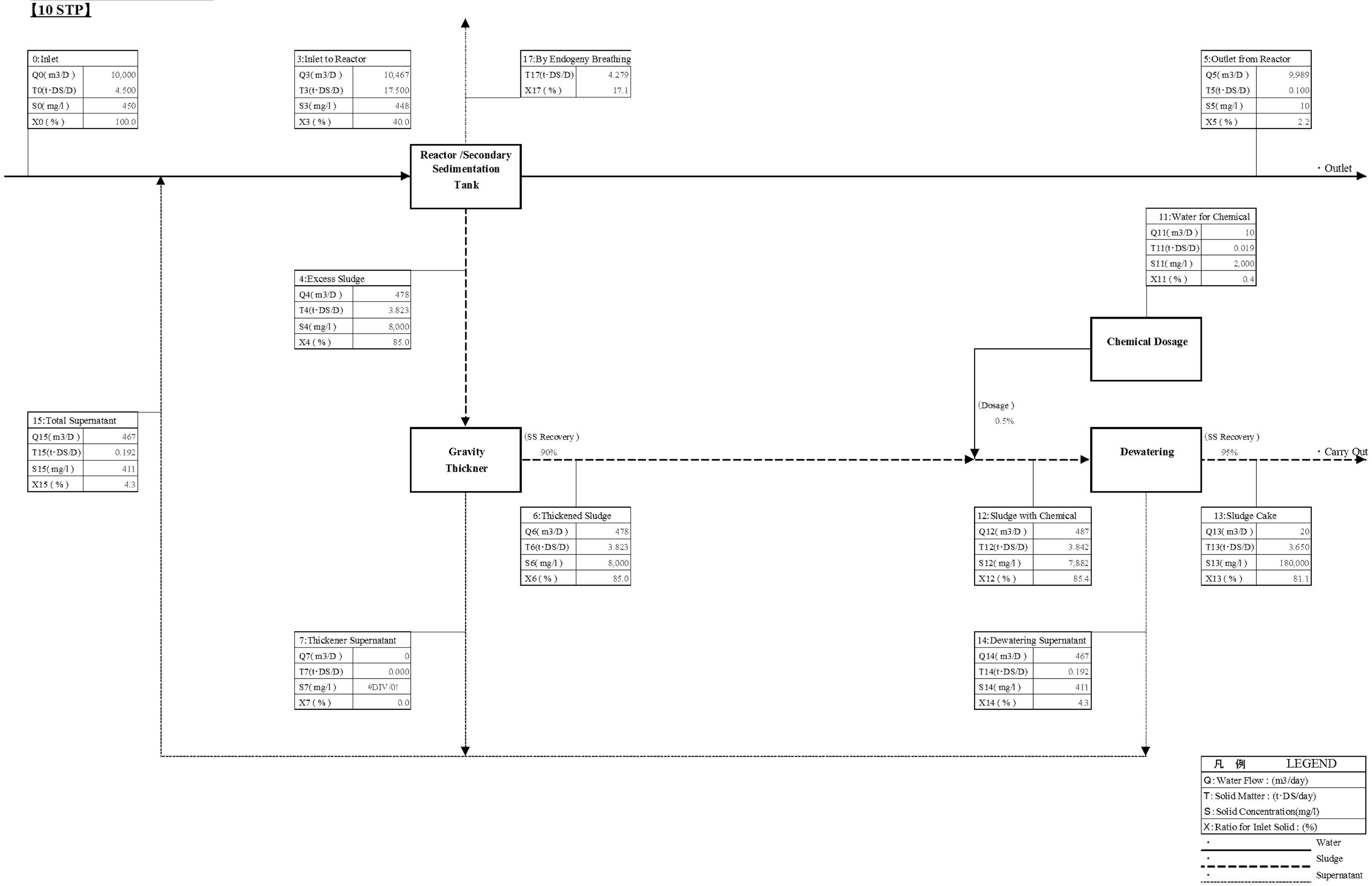
Material Balance Sheet
【10 STP】



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7. SBR 10MLD

No.	Item		STP 10MLD								
[1]	**Design Condition**										
(1)	Design Wastewater Flow			Q＝	10,000	m^3/day (summer)					
				Q'＝	10,000	m^3/day(Winter)					
(2)	Design Sewage Quality										
	Inlet BOD				350	mg/*l*					
	Inlet COD				800	mg/*l*					
	Inlet TSS				450	mg/*l*					
	Inlet T-N				70.0	mg/*l*					
	Inlet TKN				70.0	mg/*l*					
	Inlet NH_4-N				45.0	mg/*l*					
	Inlet T-P				7	mg/*l*					
	Inlet Alkalinity as CaCO3				380	mg/*l*					
	Outlet BOD				10.0	mg/*l*					
	Outlet COD				50	mg/*l*					
	Outlet TSS				10	mg/*l*					
	Outlet T-N				10.0	mg/*l*					
	Outlet TKN				5.0	mg/*l*					
	Outlet T-P				2	mg/*l*					
	Inlet S-BOD				235	mg/*l*					
	Inlet S-COD	:sCOD			271	mg/*l*					
	Outlet S-COD	:nbsCODe			40	mg/*l*		=sCOD-1.6sBOD			
	Inlet rbCOD				231	mg/*l*					
	bCOD/BOD				1.65						
	Inlet bCOD	:S_0			578	mg/*l*		=1.6BOD			
	Inlet nbCOD				223	mg/*l*					
		:nbpCOD			183	mg/*l*		=TCOD-bCOD-nbsCODe			
	Inlet VSS				383	mg/*l*					
		:VSS_{COD}			1.38	gCOD/gVSS		=TCOD-sCOD/VSS			
		:nbVSS			131.96	gnbVSS/m3		=nbpCOD/VSS_{COD}			
		:iTSS			67.50	gnbTSS/m3		=TSS-VSS			
	Inlet D-P				5	mg/*l*					
	Outlet Kjeldahl N				1.0	mg/*l*					
	Outlet NH4-N				1.0	mg/*l*					
	Outlet NO3-N				9.0	mg/*l*					
	Outlet D-P				1	mg/*l*					
(3)	Water Temperature			T＝	20.0	℃					
(4)	Safety Factor for Nitrogen			SF=	1.5						
(5)	Excess Sludge Concentration			*Rs* ＝	8,000	mg/*l*					
(6)	MLSS		At tank full	X_{TSS} ＝	3,000	mg/*l*					
(7)	DO in the Reactor				2	mg/L					
(8)	Operating Cycle										
	Tc	Total time			4.80	h					
	t_f	Fill time			1.60	h					
	td	Anoxic(denitrification) time			1.25	h					
	t_A	Aeration time			1.80	h					
	t_S	Settlement time			1.00	h					
	t_D	Decanting time			0.75	h					
(9)	Number of cycles				5.0	cycles/basin・day		×	3	tanks	
				total	15	cycles/day					
(10)	Full volume per cycle				666.667	m3/fill					
(11)	Full liquid depth				5.00	m					
(12)	Decant depth				0.75	m	15.0%	of full tank depth			
(13)	Required aeration tank volume				4444.44	m3/tank		τa=	1.3333	day	
									32	h	
(14)	Decant flow rate			666.667	m3/fill	/	0.75	h	=	888.89	m3/h
(15)	No. of basins receiving flow simultaneously				1	nos.					
(16)	No. of basins Aerating simultaneously				1	nos.					
(17)	No. of basins Decanting simultaneously				1	nos.					
(18)	Flow rate				416.6666667	m3/h					
(19)	Flow rate to each baisin				416.6666667	m3/h					

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[2] Design for Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidatio	NH4 oxidatio	NO2 oxidatio
μ_{max}	gVSS/gVSS・d	6.000	0.900	1.000
K_s, K_{NH4}, K_{NO2}	mg/L	8.000	0.500	0.200
Y	gVSS/g substrate oxidized	0.450	0.150	0.050
b	gVSS/gVSS・d	0.120	0.170	0.170
fd	unitless	0.150	0.150	0.150
K_{O2}	mg/L	0.200	0.500	0.900
θValue				
μ_{max}	unitless	1.070	1.072	1.063
b	unitless	1.040	1.029	1.029
K_s, K_{NH4}, K_{NO2}	unitless	1.000	1.000	1.000

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(3) SRT calculated with the assumed operating condition

SRT=	11.0000	day	
a: $(Px_{,TSS})$SRT	40,000.000	kg	$=V \cdot X_{MLSS}$
b: $(Px_{,TSS})$SRT	39,940.636	kg	=SUM(①:⑥)
①=	14,488.754	kg	$=Q(SRT) \cdot Y_H(S_0\text{-}S)/[1+b_H(SRT)]/0.85$
②=	14,515.477	kg	=Q(SRT)nbVSS
③=	466.950	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]/0.85$
④=	2,870.222	kg	$=f_d.b_H.QY_H(S_0\text{-}S)SRT^2/[1+b_H(SRT)]/0.85$
⑤=	7,425.000	kg	=Q(SRT)(TSS0-VSS0)
⑥=	174.23	kg	=5*Q*Al

(4) Sludge production $Px_{,TSS=}$

$Px_{,TSS}$= 3,630.967 kg/day

(5) Detemine MLVSS concentration

$Px_{,VSS}$	$Px_{,VSS}$=	2697.047	kg /d	
$(Px_{,VSS})$SRT=	$(Px_{,VSS})$SRT	29,667.514	kg	=SUM(①:④)
	①=	12,315.441	kg	$=Q(SRT) \cdot Y_H(S_0\text{-}S)/[1+b_H(SRT)]$
	②=	14,515.477	kg	=Q(SRT)nbVSS
	③=	396.907	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]$
	④=	2,439.689	kg	$=f_d.b_H.QY_H(S_0\text{-}S)SRT^2/[1+b_H(SRT)]$

X_{MLVSS}=		X_{MLVSS}=	2,225	mg/*l*	
NOx		NOx=	52.500	mg/*l*	
S		S=	0.2915	mg/*l*	$=Ks[1+b_H(SRT)]/[SRT(\mu_m\text{-}b_H)\text{-}1]$
b_H		b_H=	0.1200		$=b*1.04^{(T-20)}$ b at20℃＝ 0.120
Y_H		Y_H=	0.4500	gVSS/g bCOD	
$\mu_{m,T}$		$\mu_{m,T}$=	6.0000	g/g・d	$=\mu_{max}*1.04^{(T-20)}$ μmax at20℃＝ 6.000
Yn		Yn=	0.150	gVSS/g Nox	
bn	average	b_n=	0.1075		$=b_{NOB1} \cdot (ta/Tc)+b_{NOB2} \cdot (1\text{-}ta/Tc)$
b_{NOB1}	at aerobic	b_{NOB}=	0.1700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.170
b_{NOB2}	at anoxic	b_{NOB}=	0.0700		$=b*1.029^{(T-20)}$ b at20℃＝ 0.070
FractionVSS=		FractionVSS	0.742	=MLVSS/MLSS	

(6) Determine amount of NH4-N oxidized

Biomass production Px,bio=	Px,bio=	1,377.458	kg	=SUM(①:③)
	①=	1,119.586	kg	$=Q \cdot Y_H(S_0\text{-}S)/[1+b_H(SRT)]$
	②=	36.082	kg	$=QYn(NOx)/[1+b_{AOB}(SRT)]$
	③=	221.790		$=f_d.b_H.QY_H(S_0\text{-}S)SRT/[1+b_H(SRT)]$

NOx= 52.471 mg/*l* $=TN_0\text{-}N_e\text{-}0.12P_{x,bio}/Q$

< 52.500 mg/*l* (assumed Nox) **OK**

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(7) NO3-N Produced per cycles
At tank full NO3-N = 34,980 gNOx/fill
7.871 g/m3 concentration
< 9.0 g/m3 **OK**
After decant NO3-N = 29,733 gNOx/decant
7.871 g/m3 concentration

At tank full Xb= 923.658 g/m3 $=Px,bio*SRT/V_T$
Biomass= 4,105 kg

$Q_F=$ 10,000 m3/d $=V_F/t_F$
$Q_F \cdot S_O=$ 3,500 kg/day

(8) Initial NH4-N
$N_O=$ 8.721 mg/*l* $=[V_F(NOx)+V_{S(Ne)}]/V_T$

$V_F(NOx)=$ — $V_F(NOx)=$ 34.980 kg
Vs(Ne)= — Vs(Ne)= 3.778 kg

(9) Nitrifier concentration
Xn= 29.8 mg/*l* $=Q \cdot Yn \cdot NOx \cdot SRT/[1+b_{NOB}(SRT)]/V$

b_{NOB} — $b_{NOB}=$ 0.1075

(10) Review of Aeration time for nitrification

$$t = \frac{8.80341845}{142.8063241} = \frac{K_{NH4}\ln(N_o/N_t)+(N_o-N_t)}{X_n(\mu_{max,AOB}/Y_n)[S_o/(K_{o,AOB}+S_o)]}$$

t= 0.062 day
1.480 h
< 1.80 h (Aeration time) **OK**

$\mu_{max,NOB,T}=$ 0.9000 g/g・d $=\mu_{max}*1.072^{(T-20)}$ μmax at20℃＝ 0.900
$\mu_{NOB,T}=$ 0.7200 g/g・d $=\mu_{max,NOB}[S_0/(S_0+K_{O2,NOB})]$
$S_0=$ 2.000 mg/*l*
$K_{O2,NOB}=$ 0.500 mg/*l*
$K_{NH4}=$ 0.500 mg/*l*

[3] Design for Denitrification Process

(1) F/M_b — $F/M_b=$ 0.853 g/g・d

(2) Fraction of rbCOD — 40.00% =rbCOD/bCOD

Percent rdCOD(%)	SDNR equation coefficients	
	b0	b1
10	0.186	0.078
20	0.213	0.118
30	0.235	0.141
40	0.242	0.152
50	0.270	0.162

(3) SDNRb
SDNRt= 0.194 g/g・d $=SDNR_b \cdot \theta^{(t-20)}$ θ= 1.026

SDNRb= 0.194 g/g・d $= b_0+b_1[\ln(F/M_b)]$
$b_0=$ 0.213
$b_1=$ 0.118

(4) NO3-N removal capacityduring the fill period (per tank)
NOx= 797,144 g/g・d $=SDNR_t(X_b)(V_T)$

(5) NO3-N removal capacity :NOr
NOr= 41,518 g $=NO_x \cdot td/24$
>Nox feed= 29,733 g **OK**
td= 1.250 hr

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[4]	**Design of Phosphourus Removal Process**					
(1)	Removal T-P		2.70	mg/l		
	P in waste sludge	px=	1.00%			
	Generated waste sludge	$Px_{,VSS}$=	2697.047	kg /d		
	Rwmoval Phosphorus		26.970	kg /d		
(2)	Effluent T-P without Al		4.30	mg/l		
(3)	Required Al toinitial soluble phosphourus ratio		1.00	mol/mol		
(4)	Required Al dosing rate		3.48	mg/l	as Al	
			42.98	mg/l	as crystal, Al2(SO4)3・18H2O	
(5)	Required Alumnum Sulfate		429.78	kg/d		
(6)	Required Alumnum Sulfate solutio 10%		4.09	m3/d		
			170.55	L/H		
(7)	Additional sludge		174.23	kg/d		

[5]	**Geometry**						
(1)	Basin Dimensions	Width	Length	Depth	Basins		
		16.0	56.0	5.0	3		
	Cross Section	16.0*5.0	＝	80.0	m^2/Basin		
	Total Volume	80.0*56.0	＝	4,480	m3/Basin >	4,444	m3
				13,440	m^3/Total		
[6]	**Equipment**						
(1)	RAS Pumps						
	RAS Ratio	10	%				
	Required Capacity	417	m3/h×	10%			
		= 42	m3/Hr ⇒	45	m3/Hr		
	Number	3	Work				
		3	Stanby (Spare)				
(2)	SAS Pumps						
	Excess Sludge	478	m3/day				
	Sludge withdraw	5	cycles/day				
	Running Time	1.0	Hr/Time				
	Required Capacity	478	m3/day ／	5 ／	1.00 ／	3	
		= 31.86	m3/Hr ⇒	40	m3/Hr		
	Number	3	Work				
		3	Stanby (Spare)				

(4)	Alum Solution Tank										
	Number	2	W	+	0	S					
	Alum concentration as crystal	10	%								
	Gravity of dissolved dechlorine	1.05									
	Required solution volume	429.78	kg / d	×	100	/	10	/	1.05	/	1000
		＝	4.09	m3/d							
	Volume of Tank		2.6	m3/tank							
	Total Volume of Tanks		5.2	m3	(Duration=	1.27	day)				
(5)	Mixer for Alum Solution Tank										
	Number	2	W	+	0	S					
(6)	Alum Dosing Pump										
	Number	3	W	+	1	S					
	Capacity	4.09	m3/d	/	24	×	1000	/	3	×	2
		113.70	l/h/unit	⇒	120	l/h/unit					

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