APPENDIX B

SEWERAGE FACILITIES

Appendix B-1

Design Calculations for Sewage Treatment Plant

Appendix. B.1 CAPACITY CALCULATION OF SEWAGE TREATMENT PLANT

1 BASIC CONDITIONS

1.1 BASIC ITEMS

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

(2) Land Area : Approximately 43 ha

(3) Ground Level : +345.0～ +351.3 m

(4) Inlet Pipe Invert Level : +338.2 m

(5) Inlet Pipe Diameter : Dia 1400mm x 2

(6) Land Use : Exiting STP

(7) Collection System : Separate Sewer System

(8) Treatment Method : [Sewage Treatment] Conventional Activated Sludge
[Sludge Treatment] Thickening + Digestion + Dehydration

(9) Effluent Discharge Point : Taldy Kol Reservoir

(10) Discharge Point Water Level : +346.8 m

(11) Design Target Year : 2010

1.2 Design Population

Design Population : Proposed Project: 490,000 (2010)

Ultimate: 800,000 (2030)

1.3 Sewage

1.3.1 Design Sewage Flow

ITEM		m^3/day	m^3/hr	m^3/min	m^3/sec
Proposed Project	Daily Average Flow (Q_1)	114,000 ($Q_{1\text{-}D}$)	4,750.0 ($Q_{1\text{-}H}$)	79.17 ($Q_{1\text{-}M}$)	1.319 ($Q_{1\text{-}S}$)
	Design Daily Flow (Q_2)	136,000 ($Q_{2\text{-}D}$)	5,666.7 ($Q_{2\text{-}H}$)	94.44 ($Q_{2\text{-}M}$)	1.574 ($Q_{2\text{-}S}$)
	Design Maximum Flow (Q_3)	200,000 ($Q_{3\text{-}D}$)	8,333.3 ($Q_{3\text{-}H}$)	138.89 ($Q_{3\text{-}M}$)	2.315 ($Q_{3\text{-}S}$)
Ultimate	Daily Average Flow (Q'_1)	181,000	7,541.7	125.69	2.095
	Design Average Daily Flow (Q'_2)	217,000	9,041.7	150.69	2.512
	Maximum Flow (Q'_3)	319,000	13,291.7	221.53	3.692

[Sewage Flow Calculation]

(1) Proposed Project Flow

$Q_{1\text{-}D} = Q_2 / 1.2$ *1) = 113,333 m^3/day adopt 114,000 m^3/day

$Q_{2\text{-}D}$: Design Capacity for 2010 = 136,000 m^3/day adopt 136,000 m^3/day

$Q_{3\text{-}D} = Q_2 \times 1.47$ *2) = 199,920 m^3/day adopt 200,000 m^3/day

*1) : Peak Factor for Drinking Water Supply System (F/S p4-4)

*2) : SNiP 2.04.03-85, p4

(2) Ultimate Flow

$Q'_{1\text{-}D} = Q_2 / 1.2$ *1) = 180,702 m^3/day adopt 181,000 m^3/day

$Q'_{2\text{-}D}$: Design Capacity for 2030 *3) = 216,842 m^3/day adopt 217,000 m^3/day

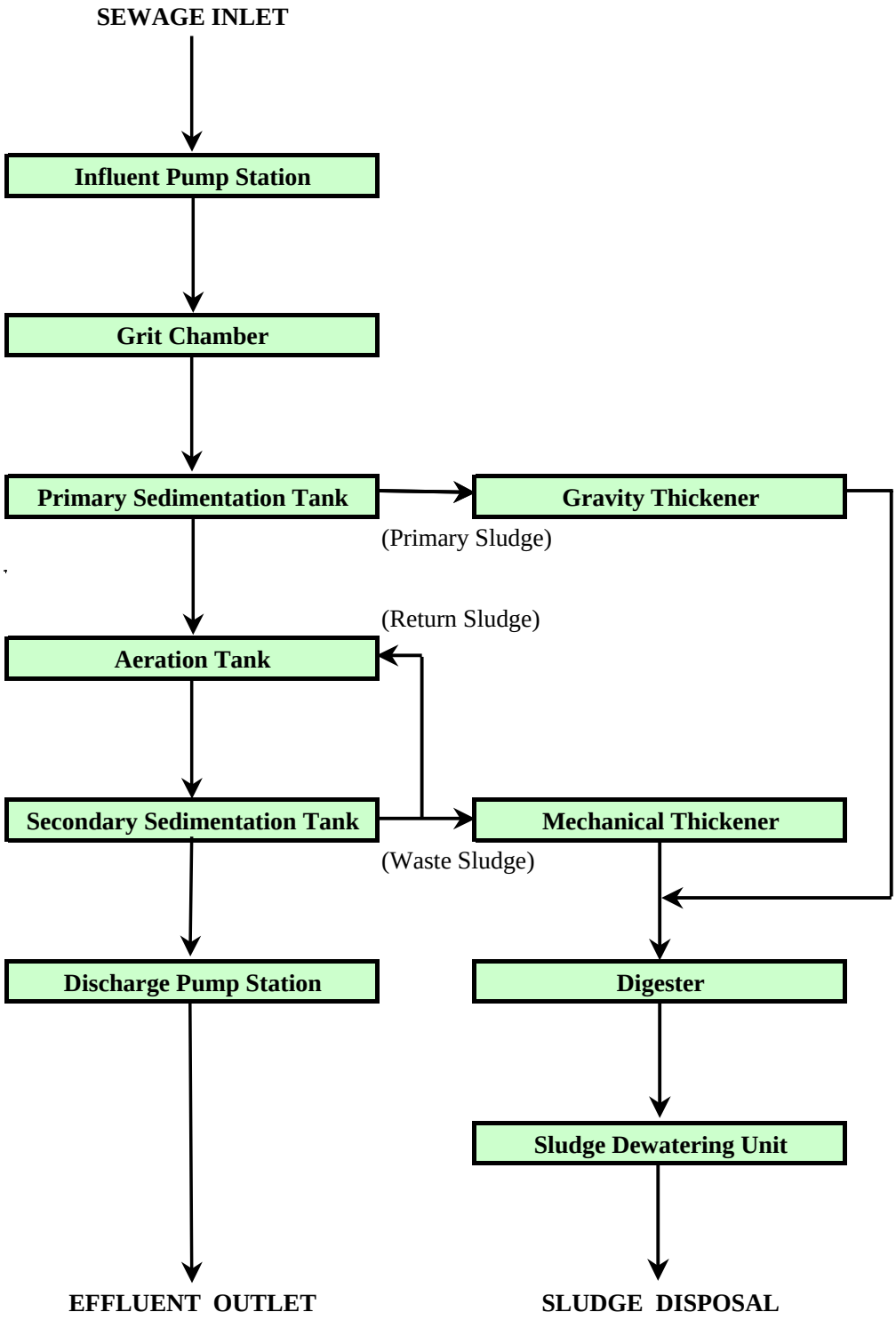
$Q'_{3\text{-}D} = Q_2 \times 1.47$ *2) = 318,758 m^3/day adopt 319,000 m^3/day

*3) : Projected Peak Day Wastewater Flow for 2030 (F/S p6-3)

1.3.2 Design Sewage Quality

ITEM	Influent	Primary Treatment		Secondary Treatment		Total Removal Ratio
	(mg/L)	Removal Ratio	Effluent (mg/L)	Removal Ratio	Effluent (mg/L)	
BOD	170	30%	119	83.2%	20	88%
SS	210	40%	126	84.1%	20	90%

1.4 System Flow Chart



1.5 Design Criteria

ITEMS	UNIT	Design Criteria	Application
1.5.1 Influent Pump Station *calculated by Design Maximum Flow*			
(1) Effluent Velocity	m/sec		1.5 to 3.0
(2) Retention Time	min		5
1.5.2 Grit Chamber *calculated by Design Maximum Flow*			
(1) Hydraulic Load	$m^3/m^2/day$	-	2,640
(2) Retention Time	sec	-	25
1.5.3 Primary Sedimentation Tank calculated by Design Daily Flow			
(1) Hydraulic Load	$m^3/m^2/day$		30.0
(2) Minimum Settling Time	hour	1.5	1.5
(3) Water Depth	m	2.5 - 4.0	3.5
(4) Liquid Temperature	ºC		15
(5) Weir Loading	$m^3/m/day$		250
(6) Solids Recovery	%		40
(7) Sludge Water Content	%		98.0
1.5.4 Aeration Tank calculated by Design Daily Flow			
(1) BOD-SS Load	kg/kg/day	0.1 - 0.25	0.1 - 0.25
(2) MLSS Concentration	mg/l	1,500 - 2,000	2,000
(3) Return Sludge Ratio	%		100
(4) Water Depth	m		4.0
(5) Hydraulic Retention Time (HRT)	hour	6.0 - 8.0	8.0
1.5.5 Secondary Sedimentation Tank *calculated by Design Daily Flow*			
(1) Hydraulic Load	$m^3/m^2/day$		25.0
(2) Minimum Settling Time	hour		2.0
(3) Water Depth	m		4.0
(4) Sludge Quality	mg/l		5,000
(5) Influent Sewage Temperature	degree		15
(6) Weir Loading	$m^3/m/day$	691 - 864	700
(7) Sludge Water Content	%		99.5
1.5.6 Discharge Pump Station *calculated by Maximum Flow*			
(1) Effluent Velocity	m/sec		1.5 to 3.0
(2) Retention Time	min		5

ITEMS	UNIT	Design Criteria	Application
1.5.7 Gravity Thickener *calculated by Design Daily Flow*			
(1) Retention Time	hr	12 to 15	15
(2) Water Depth	m		3.5
(3) Solids Recovery	%		90
(4) Water Content	%		95.0
1.5.8 Sludge Holding Tank *calculated by Design Daily Flow*			
(1) Retention Time	hr		3
1.5.9 Mechanical Thickener *calculated by Design Daily Flow*			
(1) Solids Loading (Screw Press Type)	m^3/hr		75
(2) Solids Recovery	%		95
(3) Water Content	%		95.0
1.5.10 Thickened Sludge Holding Tank			
(1) Retention Time	hr		3
1.5.11 Digester *calculated by Design Daily Flow*			
(1) Digestion Time	day		6
(2) Digestion Ratio	%		50
(3) Organic Ratio	%		80.0
(4) Water Content	%		97.0
1.5.12 Digested Sludge Holding Tank *calculated by Design Daily Flow*			
(1) Retention Time	hr		3
1.5.13 Sludge Dewatering Unit *calculated by Design Daily Flow*			
(1) Solids Loading (Screw Press Type)	kg/hr		450
(2) Water Content	%		80.0
(3) Sludge Recovery	%		90
1.5.14 Waste Water Tank *calculated by Design Daily Flow*			
(1) Retention Time	hr		1
1.5.15 Hopper *calculated by Design Daily Flow*			
(1) Retention Time	day		0.5
1.5.16 Treated Water Tank *calculated by Utility Water Flow*			
(1) Retention Time	min		1
1.5.17 Utility Water Tank *calculated by Utility Water Flow*			
(1) Retention Time	hr		2
1.5.18 Potable Water Tank *calculated by Utility Water Flow*			
(1) Retention Time	hr		2

1.6 Material Balance Calculation

1.6.1 Design Condition

Incoming Sewage Flow	m^3/d	136,000
Inlet SS	mg/l	210
Outlet SS	mg/l	20
Solids Removal Efficiency of Primary Sedimentation Tank	%	40
Solids Content of Primary Sludge	%	2.0
Solids Yield Coefficient (Gross)	%	100.0
Solids Content of Waste Sludge	%	0.5
Recovery Ratio of Gravity Thickener	%	90.0
Solids Content of Gravity Thickened Sludge	%	95.0
Solids Recovery of Mechanical Thickener	%	95.0
Solids Content of Mechanically Thickened Sludge	%	5.0
Sludge Digestion Ratio	%	50.0
Feed Sludge Organic Content	%	80.0
Digestion Gas Generation per Organic Load	m^3/kg	0.5
Solids Recovery of Sludge Dewatering	%	90.0
Water Content of Sludge Cake	%	80.0

1.6.2 Result

(1) Primary Sedimentation Tank

Primary Sludge Solids Content	%	2.0
Primary Sludge Generation (dry solid)	kg/d	12,932
Primary Sludge Volume	m^3/d	647

(2) Secondary Sedimentation Tank

Secondary Sludge Concentration	%	0.5
Waste Sludge Generation (dry solid)	kg/d	16,612
Waste Sludge Volume	m^3/d	3,322

(3) Gravity Thickener

Thickened Sludge Generation (dry solid)	kg/d	11,638
Thickened Sludge Volume	m^3/d	233
Supernatant SS	kg/d	1,293
Supernatant Flow	m^3/d	414

(4) Mechanical Thickener

Thickened Sludge Generation (dry solid)	kg/d	15,781
Thickened Sludge Quantity	m^3/d	316
Supernatant SS	kg/d	831
Supernatant Flow	m^3/d	3,007

(5) THICKENED MIXED SLUDGE TANK

Thickened Mixed Sludge Solids Content	%	5.0
Thickened Mixed Sludge Generation (dry solid)	kg/d	27,420
Thickened Mixed Sludge Volume	m^3/d	548

(6) Digester

Digested Sludge Solids Content	%	3.0
Digested Sludge Generation (dry solid)	kg/d	16,452
Digested Sludge Volume	m^3/d	548
Digestion Gas Generation	m^3/d	10,968

(7) Dewatering Unit

Water Content of Cake	%	80.0
Sludge Cake Generation (dry solid)	kg/d	14,807
Sludge Cake Volume	m^3/d	74
Supernatant SS	kg/d	1,645
Supernatant Flow	m^3/d	474

(8) Inlet Condition to Primary Sedimentation Tank

Sewage Flow	m^3/d	139,895
SS Loading	kg/d	32,329

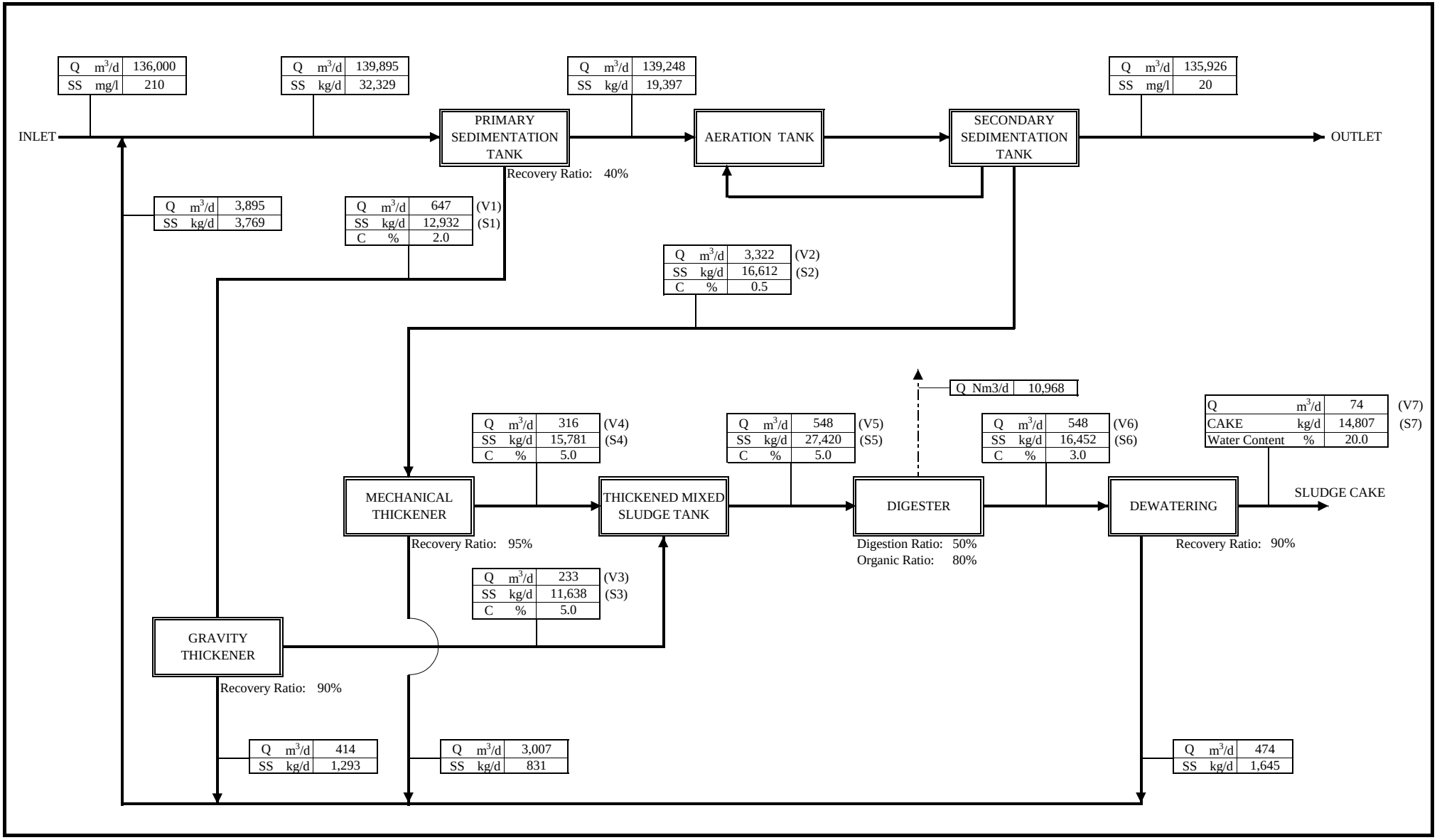
(9) Inlet Condition to Aeration Tank

Sewage Flow	m^3/d	139,248
SS Loading	kg/d	19,397

(10) Return from Thickener & Dewatering Units

Return Flow	m^3/d	3,895
SS Loading	kg/d	3,769

1.7 Material Balance Flowsheet



2. CAPACITY CALCULATION

2.1 Influent Pump Station

2.1.1 Design Condition

(1) Design Flow

$Q_{3\text{-}D}$ = 200,000 m^3/day

$Q_{3\text{-}M}$ = 138.9 m^3/min

(2) Inlet Pipe Diameter Dia 1,400 mm x 2

2.1.2 Design Criteria

(1) Effluent Velocity v = 1.5 m/sec to 3.0 m/sec

(2) Retention Time T ≥ 5 min

2.1.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
(1) Pump		See mechanical equipment calculation
(2) Effluent Pipe		
Pipe Number	PN	3 pipes
Diameter		146 x $\{Q_{3\text{-}M}$ / PN x (1/v)$\}^{1/2}$
		D = 811 mm to 574 mm
		adopt 800 mm
(3) Pump Pit		
Unit Number	UN	1 units
Required Pit Volume	V	$Q_{3\text{-}M}$ x T ≥ 694 m^3
Diameter	D	24.0 m
Depth	H	3.9 m
		(Half of volume is used for pump pit.)
Check		
Retention Time	T'	(D^2 x 3.14 / 4 x H) / 2 / $Q_{3\text{-}M}$ = 6.3 min
		More than 5 …OK

2.2 Grit Chamber

2.2.1 Design Condition

(1) Design Flow $Q_{3\text{-}D}$ = 200,000 m^3/day

$Q_{3\text{-}S}$ = 2.315 m^3/sec

2.2.2 Design Criteria

(1) Hydraulic Load HL ≤ 2,640 m^3/m^2/day

(2) Retention Time T≧ 25 sec

2.2.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Structure		
Type		Vortex Circle Radiation-Flow Type
Required Surface Area	A	$Q_{3\text{-}D}$ / HL ≥ 75.8 m^2
Channel Number	CN	2
Diameter	D	$(A / CAN \times 4 / 3.14)^{1/2}$= 6.95 m adopt 7.3 m
Depth	H	$Q_{3\text{-}S} \times T / (D^2 \times 3.14 / 4)$ = 1.38 m adopt 1.8 m
Check		
Hydraulic Load	HL'	$Q_{3\text{-}D} /(D^2 \times 3.14 / 4) / CN$ = 2,390 m^3/m^2/day
		Less than 2,640 …OK
Retention Time	T'	(D2 x 3.14 / 4 x H) x CAN / $Q_{3\text{-}S}$ 33 sec
		More than 25 …OK

2.2.4 Result

Dimension **Diameter 7.3m x Depth 1.8m x 2 chambers**

2.3 Primary Sedimentation Tank

2.3.1 Design Condition

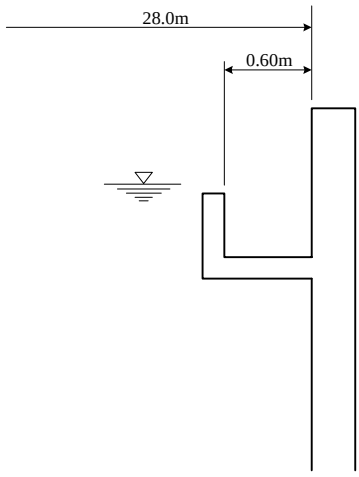
(1) Design Flow $Q_{2\text{-}D}$ = 136,000 m^3/day

2.3.2 Design Criteria

(1) Hydraulic Load	HL	≤	30 m^3/m^2/day
(2) Settling Time	T	≥	1.5 hr
(3) Water Depth	H	=	3.5 m
(4) Influent Sewage Temperature	TT	=	15 ºC
(5) Weir Loading	WL	≤	250 m^3/m/day

2.3.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Structure		
Type	-	Circular Radiation-Flow Type
Tank number	TN	8 tanks
Required Surface Area	A	$Q_{2\text{-}D}$ / HL ≥ 4,533 m^2
Diameter	D	$(A / TN \times 4 / 3.14)^{1/2}$ = 26.9 m adopt 28.0 m
Water Depth	H	3.5 m
Weir Length	L	(D - 0.6 x 2) x 3.14 x TN = 673.2 m



ITEM	SYMBOL	DESIGN
Check		
Hydraulic Load	HL'	$Q_{2\text{-}D}$ / (D^2 x 3.14 / 4) / TN = 27.6 m^3/m^2/day
		Less than 30.0 …OK
Settling Time	T'	TN x D^2 x 3.14 / 4 x H x 24 / $Q_{2\text{-}D}$ = 3.04 hr
		More than 1.5 …OK
Weir Loading	WL'	$Q_{2\text{-}D}$ / L = 202.0 m^3/m/day
		Less than 250 …OK

2.3.4 Result

Dimension **Diameter 28m x Depth 3.5m x 8 tanks**

Weir Length for 1 tank : 84.2m

2.4 Aeration Tank

2.4.1 Design Condition

(1) Design Flow $Q_{2\text{-}D}$ = 136,000 m^3/day

(2) Tank Inlet BOD Sc = 119 mg/L

2.4.2 Design Criteria

(1) BOD-SS Load BSL = 0.1 - 0.25 kg/kg/day

(2) MLSS Concentration Ca = 2,000 mg/l

(3) Return Sludge Ratio R = 100 %

(4) Water Depth H = 4.0 m

(5) Hydraulic Retention Time HRT ≥ 8 hours

2.4.3 Capacity Calculation

ITEM	SYMBOL	DESIGN			
Structure					
Treatment Method	-	Conventional Activated Sludge Process			
Tank Number	TN		4	tanks	
Tank Inlet Soluble BOD Quality	Scs	Sc x 0.67 =	80	mg/L	
Return Sludge Concentration	Cr		5,000	mg/L	
Required Volume	Vol	$Q_{2\text{-}D}$ x HRT / 24 ≥	45,333	m^3	
Water Depth	H		4.0	m	
Width	W		32.0	m	
Length	L		119.0	m	
Check					
Tank Volume	V'	W x L x H =	15,232	m^3	
Return Sludge Ratio	R'	Ca / (Cr- Ca) =	67	%	
			less than	100	…OK
Retention Time	HRT'	(V x TN) / $Q_{2\text{-}D}$ x 24 hr =	10.75	hr	
			more than	8	…OK
BOD-SS loading	BSL'	($Q_{2\text{-}D}$ x Sc) / (V x TN x Ca) =	0.13	kg/kg/day	
			0.1 - 0.25		…OK

2.4.4 Result

Dimension **Width 32m x Length 119m x Depth 4m (15232m3) x 4 tanks**

2.5 Secondary Sedimentation Tank

2.5.1 Design Condition

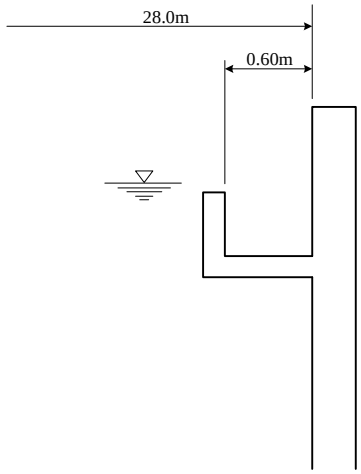
(1) Design Flow $Q_{2\text{-}D}$ = 136,000 m^3/day

2.5.2 Design Criteria

(1) Hydraulic Load	HL	≤	25.0	m^3/m^2/day
(2) Settling Time	T	≥	2.0	hr
(3) Water Depth	H	=	4.0	m
(4) Influent Sewage Temperature	TT	=	15	ºC
(5) Weir Loading	WL	≤	700	m^3/m/day

2.5.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Structure		
Type	-	Circular Radiation-Flow Type
Tank number	TN	12 tanks
Required Surface Area	A	$Q_{2\text{-}D}$ / HL ≥ 5,440 m^2
Diameter	D	$(A / TN \times 4 / 3.14)^{1/2}$ = 24.0 m adopt 28.0 m
Water Depth	H	4.0 m
Weir Length	L	(D - 0.6 x 2) x 3.14 x TN = 1,009.8 m



ITEM	SYMBOL	DESIGN
Check		
Hydraulic Load	HL'	$Q'_{2\text{-}D}$ / (D^2 x 3.14 / 4) / TN = 18.4 m^3/m^2/day
		Less than 25.0 …OK
Settling Time	T'	TN x D^2 x 3.14 / 4 x H x 24 / $Q_{2\text{-}D}$ = 5.21 hr
		More than 2.0 …OK
Weir Loading	WL'	$Q_{2\text{-}D}$ / L = 134.7 m^3/m/day
		Less than 700 …OK

2.5.4 Result

Dimension **Diameter 28m x Depth 4m x 12 tanks**

Weir Length for 1 tank : 84.2m

2.6 Discharge Pump Station

2.6.1 Design Condition

(1) Design Flow

$Q_{3\text{-}D}$ = 200,000 m^3/day

$Q_{3\text{-}M}$ = 138.9 m^3/min

(2) Inlet Pipe Diameter Dia 1,500 mm x 1

2.6.2 Design Criteria

(1) Effluent Velocity v = 1.5 m/sec to 3.0 m/sec

(2) Retention Time T ≥ 5 min

2.6.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
(1) Pump		See mechanical equipment calculation
(2) Effluent Pipe		
Pipe Number	PN	3 pipes
Diameter		146 x $\{Q_{3\text{-}M}$ / PN x (1/v)$\}^{1/2}$
		D = 811 mm to 574 mm
		adopt 800 mm
(3) Pump Pit		
Unit Number	UN	1 unit
Required Pit Volume	V	$Q_{3\text{-}M}$ x T ≥ 694 m^3
Diameter	D	24.0 m
Depth	H	3.65 m
		(Half of volume is used for pump pit.)
Check		
Retention Time	T'	(D^2 x 3.14 / 4 x H) / 2 / $Q_{2\text{-}M}$ = 5.9 min
		More than 5 …OK

2.7 Sludge Thickener

2.7.1 Gravity Thickener

2.7.1.1 Design Condition

Primary Sludge

(1) Solid	S1 =	12,932	kg/day
(2) Sludge	V1 =	647	m^3/day
(3) Water Content	Swc =	98.0	%

(From Balance Sheet)

2.7.1.2 Design Criteria

(1) Retention Time	T ≥	15	hours
(2) Water Depth	H =	3.5	m
(3) Sludge Recovery	Sr =	90	%
(4) Thickened Sludge Water Content	TSwc =	95.0	%

2.7.1.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
1. Primary Sludge Thickener		
Structure		
Type	-	Circular Radiation-Flow Type
Tank Number	TN	2 tanks
Required Tank Volume	Vol	V1 / 24 x T / TN = 202 m^2
Diameter	D	20.0 m
Depth	H	3.5 m
Check		
Retention Time	T'	(D^2 x 3.14 / 4 x H x TN) / (V1 / 24) = 81.6 hr
		More than 15 …OK

2.7.1.4 Result

Dimension **Diameter 20m x Depth 3.5m (1099m3) x 2 tanks**

2.7.2 Sludge Holding Tank

2.7.2.1 Design Condition

Waste Sludge

(1) Solid S2 = 16,612 kg/day = 16.612 t/day

(2) Sludge V2 = 3,322 m^3/day

(From Balance Sheet)

2.7.2.2 Design Criteria

(1) Retention Time T ≥ 3 hr/day

2.7.2.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Waste Sludge Holding Tank		
Type	-	RC Rectangular Tank (A-Tank & B-Tank)
Required Tank Volume	Vol	V2 x T / 24 ≥ 415.3 m^3
<A-Tank>		
Unit Number	UN1	1 unit
Width	W1	6.7 m
Length	L1	8.95 m
Depth	H1	4.2 m
<B-Tank>		
Unit Number	UN2	1 unit
Width	W2	6.7 m
Length	L2	9.1 m
Depth	H2	4.2 m
Check		
Retention Time	T'	{(W1 x L1 x H1 x UN1) + (W2 x L2 x H2 x UN2)} / V2 = 3.7 hr
		More than 3 …OK

2.7.2.4 Result

Dimension A-Tank **Width 6.7m x Length 8.95m x Depth 4.2m (252m3) x 1 unit**

B-Tank **Width 6.7m x Length 9.1m x Depth 4.2m (256m3) x 1 unit**

2.7.3 Mechanical Thickener

2.7.3.1 Design Condition

Waste Sludge

(1) Solid	S2 =	16,612 kg/day	= 16.612 t/day	
(2) Sludge	V2 =	3,322 m^3/day		
(3) Water Content	Swc =	99.5 %		(From Balance Sheet)

2.7.3.2 Design Criteria

(1) Solid Recovery	Sr =	95%
(2) Thickened Sludge Water Content	TSwc =	95.0 %

2.7.3.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Mechanical Thickener		
Type	-	Screw Press Thickener
Solid Loading per Unit	SL	75 m^3/hr/unit ($25m^3/m^2$/hr x 3 m^2)
Operation Time	T1	7 days/week
	T2	24 hours/day
Thickened Sludge Volume	Vol	V2 x (7 / T1) / T2 ≥ 138 m^3/hr
Unit Number	UN	Vol / SL = 1.85 units, therefore 2 + 1 stand-by

2.7.3.4 Result

Screw Press Thickener 75m^3/hr x 3 units (including 1 stand-by)

2.7.4 Thickened Sludge Holding Tank

2.7.4.1 Design Condition

(1) Solid	S3 + S4 =	11,638	+	15,781	=	27,420	kg/day
					=	27.420	t/day
(2) Sludge	V3 + V4 =	233	+	316	=	548	m^3/day

(From Balance Sheet)

2.7.4.2 Design Criteria

(1) Retention Time T ≥ 3 hr/day

2.7.4.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Thickened Sludge Holding Tank		
Structure		
Type	-	RC Rectangular Tank (A-Tank & B-Tank)
Required Tank Volume	Vol	(V3 + V4) x T / 24 ≥ 68.5 m^3
<A-Tank>		
Unit Number	UN1	1 unit
Width	W1	3.5 m
Length	L1	5.85 m
Depth	H1	2.5 m
<B-Tank>		
Unit Number	UN2	1 unit
Width	W2	3.5 m
Length	L2	7.6 m
Depth	H2	2.5 m
Check		
Retention Time	T'	{(W1 x L1 x H1 x UN1) + (W2 x L2 x H2 x UN2)} / (V3 + V4)
		= 5.1 hr
		More than 3 …OK

2.7.4.4 Result

Dimension	A-Tank	**Width 3.5m x Length 5.85m x Depth 2.5m (51m3) x 1 unit**
	B-Tank	**Width 3.5m x Length 7.55m x Depth 2.5m (66m3) x 1 unit**

2.8 Digester

2.8.1 Design Condition

Thickened Sludge

(1) Solid	S5 =	27,420 kg/day =	27.420 t/day	
(2) Sludge	V5 =	548 m^3/day		
(3) Water Content	Swc =	95.0 %		(From Balance Sheet)

2.8.2 Design Criteria

(1) Digestion Time	T1 ≥	6.0	days
(2) Digestion Ratio for Organic Matter	Dr =	50	%
(3) Organic Ratio	Or =	80	%
(4) Digested Sludge Water Content	Swc =	97.0	%

2.8.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Structure		
Type	-	Anaerobic Unheated Digestion with gas agitation
Tank Number	TN1	2 tanks
Depth	H1	8 m
Required Volume	Vol	V5 x T1 = 3288 m^2
Diameter	D1	{V * 4 / (TN1 x 3.14 x H1} $\wedge^{1/2}$ 16.18 m
		therefore 17.0 m
Check		
Digestion Time	T1'	($D1^2$ x 3.14 / 4 x H1 x TN1) / V5 = 6.6 days
		More than 6 …OK
(2) Digested Sludge Volume		
Sludge Volume (Solid)	S6	S5 x (100 + 100 - Or) x Dr x 10^{-4} = 16.452 t/day
Sludge Volume (Sludge)	V6	S4 x {100 / (100 - Swc)} = 548 m^3/day
Digestion Gas	Gv	S5 x Or x Gr = 10,968 m^3/day
		Digestion Gas Volume per Organics kg Gr = 0.5 m^3/kg

ITEM	SYMBOL	DESIGN
(3) Gas Holder		
Type	-	Dry Seal Type
Tank Number	TN2	2 tanks
Storage Time	T2	2 - 4 hr/day
Depth	H2	6 m
Diameter	D2	13.0 m
Check		
Storage Time	T2'	$(D2^2 \times 3.14 / 4 \times H2 \times TN2) / GV$ = 3.5 hr
		Between 2 - 4 …OK

2.8.4 Result

2.8.4.1 Digester

Dimension **Diameter 17m x Depth 8m (1815m3) x 2 tanks**

2.8.4.2 Gas Holder

Dimension **Diameter 13m x Depth 6m (796m3) x 2 tanks**

2.9 Sludge Dewatering Unit

2.9.1 Digested Sludge Holding Tank

2.9.1.1 Design Condition

Digester Sludge

(1) Solid S6 = 16,452 kg/day = 16.452 t/day

(2) Sludge V6 = 548 m^3/day

(From Balance Sheet)

2.9.1.2 Design Criteria

(1) Retention Time T1 = 3 hr/day

2.9.1.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Sludge Storage Tank		
Type		RC Rectangular Tank
Operation Time	T2	7 days/week
Unit Number	UN1	2 unit
Required Tank Volume	Vol	V6 x (T1 / 24) x (7 / T2) = 68.5 m^3
Width	W	7.7 m
Length	L	3.5 m
Depth	H	2.5 m
Check		
Retention Time	T1'	(W x H x L x UN) / (7 / T2 x V6) = 5.9 hr
		more than 3 …OK

2.9.1.4 Result

Dimension **Width 7.7m x Length 3.5m x Depth 2.5m (67m3) x 2 unit**

2.9.2 Sludge Dewatering Units

2.9.2.1 Design Condition

Digester Sludge

(1) Solid S6 = 16,452 kg/day = 16.452 t/day

(2) Sludge V6 = 548 m^3/day

(From Balance Sheet)

2.9.2.2 Design Criteria

(1) Sludge Recovery 90 %

(2) Dewatered Sludge Water Content 20.0 %

2.9.2.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Sludge Dehydrator		
Type		Screw Press Type
Solid Loading per Unit	SL	450 kg/hr/unit
Operation Time	T1	7 days/week
	T2	24 hours/day
Sludge Dewatering Volume	Vol	S6 x (7 / T1) / T2 ≥ 685 kg/hr
Unit Number	UN	Vol / SL = 1.52 units
		therefore 2 + 1 stand-by

2.9.2.4 Result

Screw Press Type 450 kg/hr x 3 units (including 1 stand-by)

2.9.3 Waste Water Tank

2.9.3.1 Design Condition

(1) Design Flow

Supernatant from Mechanical Thickener		3,007 m^3/day
Supernatant from Dewatering Unit		474 m^3/day
Chemical Dissolved Water		200 m^3/day
Total	V_{total} =	3,681 m^3/day

(2) Operation Time

Mechanical Thickener (for V4)	T2 =	7 days/week
	T3 =	24 hours/day
Sludge Dewatering Units (for V6)	T4 =	7 days/week
	T5 =	24 hours/day

2.9.3.2 Design Criteria

(1) Retention Time T1 = 1 hr

2.9.3.3 Capacity Calculation

ITEM	SYMBOL	DESIGN		
Waste Water Tank				
Type		RC Rectangular Tank		
Unit Number	UN		1	unit
Sludge Volume	V		3681	m^3/day
Required Tank Volume	Vo1	V-total x T7 / 24 =	153	m^3
Width	W		7.7	m
Length	L		8.0	m
Depth	H		2.5	m
Check				
Retention Time	T'	(W x L x H x UN) / V x 24 =	1.004	hr
			More than 1	…OK

2.9.3.4 Result

Dimension **Width 7.7m x Length 8m x Depth 2.5m (154m3) x 1 unit**

2.9.4 Hopper House

2.9.4.1 Design Condition

(1) Sludge Cake Volume V7 = 74 m^3/day (From Balance Sheet)

2.9.4.2 Design Criteria

(1) Retention Time T = 0.5 days

2.9.4.3 Capacity Calculation

ITEM	SYMBOL	DESIGN		
Sludge Hopper				
Type		RC Rectangular Yard		
Unit Number	UN		4 unit s	+ 2 stand-by
Required Tank Volume	Vol	V7 x T / UN	9.25 m^3	
Width	W		3.0 m	
Length	L		3.0 m	
Height	H		1.7 m	
Hopper Volume	V	W x L x H =	15.3 adopt	15 m^3
Check				
Retention Time	T'	V x UN / V7 =	0.8 days	
			More than 0.5	…OK

2.9.4.4 Result

Dimension **Hopper Volume 15m3 x 6units (including 2 stand-by)**

2.10 Utility Water

2.10.1 Treated Water Tank

2.10.1.1 Design Condition

(1) Automatic Strainer Capacity $q = 6.2\ m^3/min$

(See Mechanical Equipment Calculation)

2.10.1.2 Design Criteria

(1) Retention Time $T \geq 1\ min$

2.10.1.3 Capacity Calculation

ITEM	SYMBOL	DESIGN		
Treated Water Tank				
Type		RC Rectangular Tank		
Unit Number	UN		1	unit
Required Tank Volume	Vol	q x T =	6.2	m^3
Width	W		3.6	m
Length	L		1.1	m
Depth	H		1.8	m
Check				
Retention Time	T'	(W x H x L x UN) / q =	1.1	min
			More than 1	…OK

2.10.1.4 Result

Dimension **Width 3.6m x Length 1.1m x Depth 1.8m (7m3) x 1 unit**

2.10.2 Utility Water Tank

2.10.2.1 Design Condition

(1) Filtered Water Consumption	Wash for Mechanical Thickener	0.04 x 3 units =	0.12	m^3/min
	Wash for Dewatering Unit	0.11 x 3 units =	0.33	m^3/min
	Total	q =	0.450	m^3/min

2.10.2.2 Design Criteria

(1) Retention Time	T ≥	2	hr
(2) Washing Time	t ≥	8 times x 1 hr/time	

2.10.2.3 Capacity Calculation

ITEM	SYMBOL	DESIGN		
Filtered Water Tank				
Type		RC Rectangular Tank		
Unit Number	UN		1	unit
Required Tank Volume	Vol	q x t x 60 x T / 24 =	18.0	m^3
Width	W		4.7	m
Length	L		3.3	m
Depth	H		4.2	m
Check				
Retention Time	T'	(W x H x L x UN) / (q x t x 60) x 24 =	7.2	hr
		More than	2	…OK

2.10.2.4 Result

Dimension **Width 4.7m x Length 3.3m x Depth 4.2m (65m3) x 1 unit**

2.10.3 Potable Water Tank

2.10.3.1 Design Condition

(1) Potable Water Consumption q = 200 m^3/day (See Mechanical Equipment Calculation)

2.10.3.2 Design Criteria

(1) Retention Time T ≥ 2 hr

2.10.3.3 Capacity Calculation

ITEM	SYMBOL	DESIGN
Utility Water Tank		
Type		RC Rectangular Tank
Unit Number	UN	1 unit
Required Tank Volume	Vol	q x T / 24 = 16.7 m^3
Width	W	4.7 m
Length	L	3.3 m
Depth	H	4.2 m
Check		
Retention Time	T'	(W x H x L x UN) / q x 24 = 7.8 hr
		More than 2 …OK

2.10.3.4 Result

Dimension **Width 4.7m x Length 3.3m x Depth 4.2m (65m3) x 1 unit**