6. Processing capacity calculationsheets & drawings of STPs

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1. Dinapur STP (Varanasi)

Item	Dinapur-STP

1. Desin Condition

(1) Design Flow Rate

	Flow Rate		
	m3/d	m3/h	m3/sec
Average Daily	80,000	3,333	0.926
Max Dayly	80,000	3,333	0.926
Max Hourly	160,000	6,667	1.852

(2) Design Sewage Quality and Effluent Quality

Unit : mg/L

	Water Quality						
	BOD	COD	SS	T-N			TP
				NH_4-N	org-N	NOx-N	
Inlet	250	450	400	37	13	0	-
Outlet	10	50	10	5	0	5	-
Removal rate	96.0%	88.9%	97.5%	####			

(3) Inlet Water Quality at Reactor

Unit : mg/L

	Water Quality Item						
	BOD	COD	SS	T-N			TP
				NH_4-N	org-N	NOx-N	
Inlet at Primary Clarifier	250	450	400	37	13	0	-
Removal rate	30%	30%	60%	####			-
Inlet at Reactor	175	315	160	33.3	11.7	0	-

2. Inlet Chamber

[1] Design Condition

(1) Design Wastewater Flow — Max Hourly = 160,000 m3/day
= 1.852 m3/sec

[2] Geometry

(1) Number of Basins: 1 Basin
(2) Depth of Basin: 2.500 m
(3) Width of Basin: 5.500 m
(4) Length of Basin: 4.500 m
(5) Volume required of Basin: 2.500 × 5.500 × 4.500 = 3.1 m3
(6) Retention Time: 2.500 × 5.500 × 4.500 ⁄ 1.852 × 1
= 33.4098272 sec
(7) Basin Demensions: Width 5.500 m × Length 4.500 m
× Depth 2.500 m

3. Fine Screen Channel	
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 160,000 m3/day
	= 1.852 m3/sec
[2] Geometry	
(1) Inlet Gate	
Number	2 Main + 2 Bypass
Width	1.000 m
Height	1.500 m
Floor Level	+ 81.900 m
Bottom	+ 77.900 m
Influent Water Level	+ 79.100 m
Velocity	1.852 ／ 1.000 ／ 1.200 ／ 2
	= 0.772 ≒ 1.000 m/sec
(2) Screen Channel	
Number	2 Main + 1 Standby + 1 Bypass
Width	1.500 m
Side Water Depth	1.300 m
Velocity	1.852 ／ 1.500 ／ 1.300 ／ 2
	= 0.475 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 1.5 m × Length 7.5 m
	× SWD 1.3 m (Freeboard 0.5m)
[3] Equipment	
(1) Inlet Gate	
Number	2 W + 2 S
Dimension	Width 1.0 m × Height 1.5 m
Design Water Level	4.00 m
(2) Fine Screens (Main Channel)	
Number	2 W + 1 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	1.5 m
Width of side plate	50 mm
Side Water Depth	1.3 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	1.852 ／ 1.400 ／ 1.250 ／ 2
	× (6 + 2) / 6
	= 0.706 < 0.800 m/sec
(3) Fine Screens (Bypass Channel)	
Number	0 W + 1 S
Open Space	20 mm
Bar Thickness	9 mm
Channel Width	1.5 m
Side Water Depth	1.3 m
Velocity through screen	1.852 ／ 1.500 ／ 1.300 ／ 2
	× (20 + 9) / 20
	= 0.689 < 0.800 m/sec

4.	**Grit Chamber**									
[1]	**Design Condition**									
(1)	Design Flow Rate	Max Hourly			=	160,000	m3/day			
					=	1.852	m3/sec			
(2)	Specific gravity of Sand	2.65								
(3)	Sedimentation Velocity	0.0521	m/sec		=	4500	m3/m2/day			
(4)	Average Velocity	0.3	m/sec							
[2]	**Grit Chamber**	**Vortex Grit Chamber**								
(1)	Required Surface Area	1.852	／	0.0521	=	35.558	m2			
(2)	Number of Basins	2	S	+	0	W				
(3)	Surface Area required/Basin	35.558	／	2	=	17.779	m2			
(4)	Required Diameter of Basin	(	4 ／	π	×	17.779	) ^0.5	=	4.758	m
								→	5.00	m
(5)	Basin Dimensions	Dia.	5.00	m	×	Depth	m	(Freeboard 0.3m)		
[3]	**Inlet Gate**									
	Number	2	Main	+	0	Bypass				
	Width	1.000	m							
	Height	1.000	m							
	Floor Level	+	81.200	m						
	Bottom	+	77.700	m						
	Influent Water Level	+	78.700	m						
	Velocity	1.852	／	1.000	／	1.000	／	2		
		=	0.926	≒	1.000	m/sec				

5. Primary Clarifier (Existing structure)	
[1] Design Condition	
(1) Design Flow Rate	Average Daily = 80,000 m^3/day
	= 0.926 m^3/sec
	= 55.56 m^3/min
(2) Type	Circular Clarifire
(3) Surface Overflow Rate required	35 m^3/m^2/day
(4) Number of Basins	3 Basins
[2] Design	
(1) Surface Area required	80,000 ／ 35 = 2,286 m^2
(2) Surface Area required/Basin	2,286 ／ 3 = 762 m^2
(3) Side Water Depth	3.5 m
(4) Diameter required	31.1 m ＜ Existig structure 31.2 m **OK**
(5) Basin Demensions	Diameter 31.2 m × Depth 3.5 m
[3] Sludge generated per day	
(1) Inlet TSS	400 mg/L
(2) Reduction in TSS	60%
(3) Outlet TSS	160 mg/L
(4) Solids removed from Primary Clarifiers	23,122 kg/day
(5) Solids Consistency	3.0 %
(6) Volume of Primary Sludge	Solids removed × $\frac{100}{\text{Solids Consistency}}$ × 10^{-3}
	= 771 m^3/day
[4] Equipment	
(1) Primary Sludge Pumps	
Sludge withdrawal	12 Times/day
Running Time	0.50 hr/Time
Number	3 W + 3 S
Required Capacity	771 m^3/day ／ 12.0 ／ 0.5 ／ 3
	= 42.8 m^3/Hr ⇒ 50 m^3/h /unit

8. Reactor

[1] Design Condition

(1) Design Flow Rate

Q = 80,000 m^3/day (summer)
Q' = 80,000 m^3/day(Winter)

(2) Flow Split

Q_1 =	40,000	m3/day	α_1 =	0.500
Q_2 =	40,000	m3/day	α_2 =	0.500
Q_3 =	0	m3/day	α_3 =	0.000
Q_4 =	0	m3/day	α_4 =	0.000

(3) Reactor Volume Split

γ_{DN1} =	20.238%	6,401
γa_1 =	29.762%	9,413
γ_{DN2} =	20.238%	6,401
γa_2 =	29.762%	9,413
γ_{DN3} =	0.000%	0
γa_3 =	0.000%	0
γ_{DN4} =	0.000%	0
γa_4 =	0.000%	0
total	100.000%	31,626

(4) Determination of Dimensions of Basins

Item	unit	Pass 1		Pass 2		Total
		Anoxic	Aerobic	Anoxic	Aerobic	
Width	m^2	23.0	23.0	23.0	23.0	
Depth	m^2	5.5	5.5	5.5	5.5	
Cross Section	m^2	125.5	125.5	125.5	125.5	
Length	m	17.0	25.0	17.0	25.0	84.0
Volume per unit	m^3	2,134	3,138	2,134	3,138	10,542
Total Volume	m^3	6,401	9,413	6,401	9,413	31,626
Actual HRT	hour	1.92	2.82	1.92	2.82	9.49

Number of basins 3 Nos.

(5) Total Volume of Reactor

31,626 m3 τ= 0.395 day
9.488 h

(6) Reactor Volume Split

V_{DN1} =	6,400.500	m3
Va_1 =	9,412.500	m3
V_{DN2} =	6,400.500	m3
Va_2 =	9,412.500	m3
V_{DN3} =	0.000	m3
Va_3 =	0.000	m3
V_{DN4} =	0.000	m3
Va_4 =	0.000	m3
anoxic	12,801.000	m3
aerobic	18,825.000	m3
total	31,626.000	m3

(7) Design Water Quality

Inlet BOD		175	mg/l	
Outlet BOD		10.0	mg/l	
Inlet S-BOD		117	mg/l	assumed as 2/3 of BOD
Inlet COD		315	mg/l	
Inlet S-COD	:sCOD	210	mg/l	assumed as 2/3 of COD
Outlet S-COD	:nbsCODe	23	mg/l	=sCOD-1.6sBOD
Inlet rbCOD		47	mg/l	assumed as 15% of COD
bCOD/BOD		1.60		
Inlet bCOD	:S_0	280	mg/l	
Inlet nbCOD		35	mg/l	
	:nbpCOD	12	mg/l	=TCOD-bCOD-nbsCODe
Inlet TSS		160	mg/l	
Inlet VSS		112	mg/l	assumed as 70% of TSS
	:VSS_{COD}	0.94	gCOD/gVS	=TCOD-sCOD/VSS
	:nbVSS	12.44	gnbVSS/m.	=nbpCOD/VSS_{COD}
	:iTSS	48.00	gnbVSS/m.	=TSS-VSS
Inlet T-N		45	mg/l	

Inlet TKN		45	mg/l	
Inlet NH_4-N		33.3	mg/l	
Inlet T-P		-	mg/l	
Inlet Alkalinity as CaCO3		380	mg/l	assumed
Outlet Kjeldahl N		2.0	mg/l	
Outlet NH4-N		2.0	mg/l	
Outlet NO3-N		8.0	mg/l	
(8) Water Temperature	T=	20.0	℃	
(9) Return Sludge Concentration	Rs =	8,000	mg/l	
(10) MLSS	X_{TSS} =	3,000	mg/l	at final aerobic zone
(11) Ratio of Return Sludge	8,000*Rr/(1+Rr)=			3,000 mg/L
	3,000/(8,000-3,000)=			0.60
	Rr=	0.60		
	Rc=	0.60		
	X_{TSS1} =	3,882	mg/l	
	X_{TSS2} =	3,000	mg/l	
	~~X_{TSS3}=~~	~~3,000~~	~~mg/l~~	
	~~X_{TSS4}=~~	~~3,000~~	~~mg/l~~	
(12) DO in aeration tank		2.00	mg/L	

[2] Design of Nitrification Process

(1) Activated sludge design kinwtic coefficients at 20℃

Coefficient	Unit	COD oxidation	NH4 oxidation	NO2 oxidation
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	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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(2) μ_{AOB}

μ_{AOB}= 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	$=\mu_{max}*1.072^{(T-20)}$	μmax at20℃=	0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$	b at20℃=	0.170
S_{NH4}	S_{NH4}=		mg/l			
DO	DO=	2.0000	mg/l			
$K_{NH4,AOB}$	$K_{NH4,AOB}$=	0.5000	mg/l			
$K_{0,AOB}$	$K_{0,AOB}$=	0.5000	mg/l			

(3) Design SRT

Design SRT=	4.9000	day	
Actual ($Px,_{TSS}$)SRT=	64,780.147	kg	$=\Sigma(Vai \cdot X_{MLSSi})$
Required ($Px,_{TSS}$)SRT=	64,669.191	kg	=SUM(①:⑤)
①=	36,532.393	kg	$=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]/0.85$
②=	4,878.222	kg	=Q(SRT)nbVSS
③=	1,220.419	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]/0.85$
④=	3,222.157	kg	$=f_d.b_H.QY_H(S_0-S)SRT^2/[1+b_H(SRT)]/0.85$
⑤=	18,816.000	kg	=Q(SRT)(TSS0-VSS0)

(4) Biomass production

$Px,_{VSS}$	$Px,_{VSS}$=	8103.458	kg/d	=Px,bio+Q(nbVSS)		
$Px,_{TSS}$	$Px,_{TSS}$=	13197.794	kg/d			
S	S=	0.4568	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= 36.000 mg/l =Inlet TKN·80%

NOx= 32.338 mg/l corrected

$P_{X,bio,VSS}$

$P_{X,bio,VSS}$= 7107.903 kg VSS/d $=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]+f_d b_H QY_H(S_0-S)SRT/[1+b_H(SRT)]$
$+QYn(Nox)/[1+b_{AOB}(SRT)]$

6337.252 $=Q\cdot Y_H(S_0-S)/[1+b_H(SRT)]$

558.946 $=f_d b_H QY_H(S_0-S)SRT/[1+b_H(SRT)]$

211.705 $=QYn(Nox)/[1+b_{AOB}(SRT)]$

(5) Nitrogen for nitrifier growth NOx

NOx= 32.338 mg/l $=TKN-Ne-0.12P_{X,bio}/Q$

(6) Components of MLVSS

Item	MLVSS kg/d	Fraction
Heterktrophs	6,337.252	0.782
Cell debris	558.946	0.069
Nitrifiers	211.705	0.026
nbVSS	995.556	0.123
Inert inorganics		
total	8,103.458	

(7) Fraction of biomass solids

$X_{VSS}\cdot Va$

$X_{TSS}\cdot Va$

FractionVSS=

$X_{VSS}\cdot Va$= 39,707 kg VSS $=Px_{,VSS}\cdot SRT$

$X_{TSS}\cdot Va$= 64,669 kg TSS $=Px_{,TSS}\cdot SRT$

FractionVSS= 0.614

(8) Summary of biomass/nitrifier concentrations

Pass	MLSS g/m^3	MLVSS g/m^3	Nitrifiers $gVSS/m^3$	Biomass $gVSS/m^3$
1	3,882	2,384	62.277	1,864
2	3,000	1,842	48.123	1,441
~~3~~	~~3,000~~	~~1,842~~	~~48.123~~	~~1,441~~
4	~~3,000~~	~~1,842~~	~~48.123~~	~~1,441~~

(9) Summary of flowrate

Pass	Influent Flow Q	Previous Flow Q	Total Flow Q
1	0.500	1.200	1.700
2	0.500	1.700	2.200
3	~~0.000~~	~~2.200~~	~~2.200~~
4	~~0.000~~	~~2.200~~	~~2.200~~

(10) Summary of step-feed solution for NH4-N

Pass	Influent Flow m3/d	Previous Flow m3/d	NH4-N g/m3	Rn g/d
1	40,000	96,000	0.430	1,298,496
2	40,000	136,000	0.659	1,236,085
~~3~~	~~0~~	~~176,000~~	~~0.659~~	~~0~~
4	~~0~~	~~176,000~~	~~0.659~~	~~0~~

[3] Design for Denitrification Process

(1) Fraction of rbCOD

rbCOD/bCOD= 16.88%

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

(2) SDNRb

SDNRb= 0.150 g/g·d $= b_0+b_1[\ln(F/M_b)]$

b_0= 0.213

b_1= 0.118

(3) SDNR

SDNRt $=SDNR_b \cdot \theta^{(t-20)}$ θ= 1.026

Pass	Biomass	Influent Flow rate	Anoxic Volume	F/M_b	SDNR
	$gVSS/m^3$	m3/d	m^3	$gVSS/m^3$	g/g·d
1	1,864	40,000	6,401	0.587	0.150
2	1,441	40,000	6,401	0.759	0.180
~~3~~	~~1,441~~	~~0~~	~~0~~	~~0.000~~	~~0.000~~
4	~~1,441~~	~~0~~	~~0~~	~~0.000~~	~~0.000~~

(4) NO3-N balance

Pass	Total NO3-N	Anoxic remova	NO3-N remaining	NO3-N produced	NO3-N effluent
	g/d	g/d	g/d	g/d	g/d
1	674,228	1,790,619	0	1,298,496	1,298,496
2	1,298,496	1,664,170	0	1,236,085	1,236,085
3	1,236,085	0	1,236,085	0	1,236,085
4	1,236,085	0	1,236,085	0	1,236,085

(5) Effluent NO3-N

Ne= 7.023 g/m3

(6) Alkalinity to be added to maintain pH7

-165.99 mg/*l*

Influent Alk 380.00 mg/*l*

Alk used 230.89 mg/*l* =7.14×Nox

Alk produced 86.89 mg/*l* =3.57×(NOx-NOxe)

Alk to maintair 70.00 mg/*l*

[4] Equipment

(1) Ras Pumps

Ras Ratio 60 %

Required Capacity 80,000 m3/day × 60% ／ 24 ／ 3

= 667 m3/Hr ⇒ 670 m3/Hr

Number 3 Work + 3 Standby

(2) Circulation Pumps

Circulation Ratio 60 %

Required Capacity 80,000 m3/day× 60% ／ 24 ／ 3

= 667 m3/Hr ⇒ 670 m3/Hr

Number 3 Work + 3 Standby

7.	**Air Requirement at Average Flow**	
[1]	**Design Condition**	
(1)	AOR : R_0	R0= = 18,825 kg/day
		= 784.4 kg/h
	Qin : Design Average Flow	80,000 m3/d
	Inlet bCOD : S0	280 mg/l
	S=	S= 0.457 mg/l
	Nox=	Nox= 32.338 mg/l
	$P_{X,bio}$=	$P_{X,bio}$= 6,896.2 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= 18,825 kg O2/d
		k= 2.86
(2)	SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{AOR \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \ (\beta \cdot C_{SW}/C_S \cdot (P_b/P_a)a - C_A)}$

C_S	:	Saturated DO at sea level and 20 ℃		
		9.09 mg/L		
C_{SW}	:	Saturated DO at sea level and operating Temperature		
		6.93 mg/L at 35 ℃		
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		
		$1+0.40D_j/P_a$	1.19357	
D_j	:	Tank Liquid Depth 5.00 m		
P_a	:	Standard absolute pressure at s	10.33	m
P_b	:	Absolute pressure at Plant Site Elevation		m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R*T]$	0.992	
g	:	Acceleration due to Gravity	9.80665	m/s^2
M	:	Mole of Air	28.97	kg/kg-mole
z_b	:	Plant Site Elevation	70	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 Wa	0.65	
β	:	relative DO Saturation to clean Wa	0.95	
F	:	Diffuser Fouling Factor	0.90	

$$= \frac{143,104}{3.3913} = 42,197.03 \text{ kg/day}$$

(3)	No. of Basins	3 Basin
(4)	Standard O2 required at Field Conditions per Bas =	14,066 kg/day
(5)	SOTE for the above Effective Aeration Depth	30.5 %
(6)	Fraction of O2 in Air	23.18 %
(7)	Specific Gravity of Air at Standard Condition	1.293
(8)	Safety Factor	10%
(9)	Air required at Field Conditions per Basins	= 181,655 m^3/day = 7,568.9 m^3/hr

Air Requirement at Average Flow1/2

[2] Equipment

(1) Air Blower

Number	6	W +		3	S
Required Capacity	7,569	m^3/Hr・Basin ／		2	unit/Basin
	＝ 3,784	m^3/h	⇒	3,800	m^3/h /unit
Pressure	65	kPa			
Safty Factor	10	%			
Heat capacity ratio	1.4				
Atmospheric pressuer at site elevation	100.542	kPa			
Total inlet pressure	98.542	kPa			
Volume rate of flow at inlet point	65.106	m3/min			
Total discharge pressure	165.542	kPa			
Overall adiabatic effeciency	0.65				
Inlet air temperature (min.)	15	℃			
Shaft power	93.580	kW			
Rated Output of Motor	102.938	kW	⇒	110	kW

8.	**Secondary Clarifier (Existing structure)**							
[1]	**Design Condition**							
(1)	Design Flow Rate	Average Daily		=	80,000	m^3/day		
				=	0.926	m^3/sec		
				=	55.56	m^3/min		
(2)	Type	Circular Clarifier						
(3)	Surface Overflow Rate required	25	$m^3/m^2/day$					
(4)	Number of Basins	3	Basins					
[2]	**Geometry**							
(1)	Surface Area required	80,000	/	25	=	3,200	m^2	
(2)	Surface Area required per Basin	3,200	/	3	=	1,067	m^2	
(3)	Side Water Depth	3.5	m					
(4)	Diameter required	36.9	m	<	Existing structure	40.0	m	**OK**
(5)	Dimensions	Diameter	40.0 m	×	Depth	3.5 m		
[3]	**Sludge generated per day**							
(1)	Inlet TSS	400	mg/L					
(2)	Reduction in TSS	60%						
(3)	Outlet TSS	160	mg/L					
(4)	Solids removed from Primary Clarifiers	23,122	kg/day					
(5)	Solids Consistency	3.0	%					
(6)	Volume of Primary Sludge							

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

$= 771 \; m^3/day$

9. Chlorination Tank (not in scope of project)

[1] Design Condition

(1)	Design Flow Rate	Average Daily Flow 80,000 m^3/day
(2)	Contact Time	30 min
(3)	Type of Chlorine	Chlorine gas
(4)	Design Chlorine Dosage Rate	10 mg/L
(5)	Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
		＝ 800.0 kg/d
		＝ 33.33 kg/h

~~[2]Geometry~~

~~(1)~~	~~Volume required~~	~~Average Daily Flow ／ 1440 × Contact Time~~
		~~＝ 1666.7 m^3~~
		~~Contact Time 30 min~~
~~(2)~~	~~Nos. of lanes~~	~~11 lanes~~
~~(3)~~	~~Width of lane~~	~~2.00 m~~
~~(4)~~	~~Length of lane~~	~~39.00 m~~
~~(5)~~	~~Side Water Depth~~	~~2.00 m~~
~~(6)~~	~~Nos. of Tanks~~	~~1 tank~~
~~(7)~~	~~Total Width of Tank~~	~~27.40 m Approx.~~
~~(8)~~	~~Average Velocity~~	~~Average Daily Flow ／ 86400 ／ Width ／ Depth~~
		~~＝ 80,000 ／ 86400 ／ 2.00 ／ 2.00~~
		~~＝ 0.231 m/sec~~
~~(9)~~	~~Total Volume~~	~~Width × Length × Depth × Nos. of lanes × Nos. of Tanks~~
		~~＝ 2.0 m × 39.0 m × 2.0 m~~
		~~× 11 × 1~~
		~~＝ 1,716 m^3 ＞ 1666.7 m^3~~

~~[3] Equipment~~

~~(1)~~	~~Chlorinator~~	
	~~Number~~	~~2 W ＋ 1 S~~
	~~Design rate per unit~~	~~16.67 kg / h /unit ⇒ 17 kg / h /unit~~
~~(2)~~	~~Chlorine Tonner~~	
	~~Number~~	~~13 W ＋ 2 S~~
	~~Storage duration~~	~~15.00 days~~
	~~Available Capacity per unit~~	~~928.00 kg/unit~~
	~~Required Nos. of tonners~~	~~12.93 units ⇒ 13 units~~

10. Sludge Thickener

[1] Generated Sludge

(1)	Primary Sludge	23,122	kg/day	771	m3/day
(2)	WAS Sludge	12,020	kg/day	1,502	m3/day

[2] Gravity Thickener

(1) Number: 2 W + 0 S

(2) Consistency of Thickened Sludge: 5.00 %

(3) Design Solid Loading: 120 kg / m2/d

(4) Required Surface Area: $23{,}122 \times \frac{1}{120} = 192.70$ m2

(5) Required diameter: $\left(\frac{4}{\pi} \times 192.70 \times \frac{1}{2} \right)^{1/2} = 11.08$ m → 11.50 m

(6) Side Water Depth: 3.5 m

(7) Actual Volume of Tank: $\frac{\pi}{4} \times 11.50^2 = 103.87$ m3

(8) Retention Time: $\frac{103.87}{771} \times 4 \times 2 \times 24$

$= 22.64$ Hr < 24 h , > 12 h

[3] Mechanical Thickener

(1) Type of Thickener: Rotary Drum

(2) Number of thickeners: 2 W + 1 S

(3) Design Polyelectrolyte Dosage: 1.5 kg/t-DS·day

(4) Consistency of Thickened Sludge: 5.00 %

(5) Operation Time: 18 hours/day (7 days per week)

(6) Design Polyelectrolyte Dosage: 1.5 kg/t-DS·day

(7) Required Polyelectrolyte: 18.03 kg/day

(8) Dissolving concentration: 0.20 %

(9) Volume of Polyelectrolyte solution: 9.01 m3/day

(10) Capacity of Thickeners: $\frac{\text{Secondary Sludge volume}}{\text{Operation Time} \times \text{No}} \times$ Operation/week

$= \frac{1{,}502.5}{18 \times 2} \times \frac{7}{7} = 41.7$

⇒ 50 m^3/h

[4] WAS Sump

(1) WAS Sludge: 62.60 m^3/h

(2) Sludge feed flow rate to thickener: 50 m3/h × 2 = 100 m3/h

(3) Minimum deteision time: 3 hours

(4) Required sludge volume: 300.00 m^3

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

= 312.0 m^3

[5] Thickened Sludge Sump

(1) Thickened Sludge: 228.38 m^3/d

(2) Minimum deteision time: 12 hours

(3) Required sludge volume: 114.19 m^3

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

= 156.0 m^3

[5] **Equipment**	
(1) Gravity Thickened Sludge Pumps	
Transfer Time	12.00 times × 0.75 h/ time = 9.00 h/d
Number	2 W + 1 S
Required Capacity	771 m^3/d ／ 9.0 ／ 2
	42.8 m^3/Hr ⇒ 50 m^3/Hr /Unit
(2) Mixing Blower for WAS/Thickened Sludge Sump	
Required Volume	468.0 m^3
Agitate Rate	1.20 $m^3/Hr \cdot m^3$
Number	1 W + 1 S
Required Capacity	468 m^3 × 1.2 ／ 1
	= 561.6 m^3/h ⇒ 600 m^3/h /unit
(3) Mechanical Thickener	
Capacity	50 m^3/hr
Number	2 W + 1 S
(4) Mechanical Thickener Feed Pumps	
Capacity	50 m^3/hr
Number	2 W + 1 S
(5) Polyelectrolyte Dosing Pumps	
Safety Factor	1.5
Number	2 W + 1 S
Required Capacity	9.01 m^3/d ／ 18.0 ／ 2 × 7 ／ 7
	= 0.25 m^3/h
Specification Capacity	0.25 m^3/h × 1.5
	= 0.376 m^3/h ⇒ 0.45 m^3/h /unit

11. Sludge Digester (existing structure)	
[1] Design Condition	
(1) Generated Thickened Sludge	from Gravity Thickener 20,810 kg/day 416 m3/day
	from Mechanical Thickener 11,419 kg/day 228 m3/day
	Total 32,229 kg/day 645 m3/day
(2) Ratio of VSS	75 %
(3) Total VSS	= 24,172 kg/day
(4) Total inorganic sludge	= 8,057 kg/day
(5) Retention Time	20 days
(6) % Destruction in VSS	50 %
(7) VSS destroyed	= 12,086 kg/day
(8) Generated digested sludge	= 20,143 kg/day
(9) Solids Consistency	3.1250 %
(10) Volume of Digested Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
	= 645 m^3/day
[2] Geometry	
(1) Volume required	12,891 m^3
(2) No. of Basins	3 Basins
(3) Volume required per Basin	= 4,297 m^3
(4) Depth provided	7.0 m
(5) Area required per Basin	= 614 m^2
(6) Diameter required per Basin	= 28.0 m
(7) Basin Dimensions	Diameter 29.0 m · Depth 7.0 m
	× 3 Basins = 13,871 m^3
[3] Equipment	
(1) Mixers for Digestion Tanks	
Capacity	4624 m^3
Number	3 W + 0 S
(2) Digested Sludge Transfer Pumps	
Transfer Time	12.00 times × 0.5 h/ time = 6.00 h/d
Number	3 W + 3 S
Required Capacity	645 m^3 / 6.0 / 3
	= 35.8 m^3/Hr ⇒ 40 m^3/Hr /Unit

12.	**Biogas Power Generation**											
[1]	**Design Condition**											
(1)	Biogas generated per kg of VSS destroyed		0.9	m^3/kg								
(2)	VSS destroyed		12,086	kg/day								
(3)	Generated biogas		10,877	m^3/day								
[2]	**Biogas Holder (Existing)**											
(1)	Required volume		50	%	of generated biogas	=	5,439	m^3				
(2)	No. of Biogas Holders		2	Nos.								
(3)	Required volume per unit		####	m^3								
(4)	Dimension	Diameter	21.0	m	×	height	8.7	m	×		2 Basins	
		=	6,027	m^3	>		5,439	m^3			**OK**	
[3]	**Equipment**											
(1)	Biogas Power generators											
	Biogas Generation		0.126	m^3/sec								
	Biogas Caloric Value		22,000	KJ/m^3								
	Biogas Engine Conversion Efficiency		40.0	%								
	Number		2	W	+	1	S					
	Power Generation		0.126	m^3/sec	×	22000	KJ/m^3 ×		0.4	/	2	
		=	553.9	kW	⇒		600	kW				
(2)	Desulfurization Equipment											
	Biogas Generation		453.22	m^3/h								
	Peak Ratio		1.5									
	Number		2	W	+	0	S					
	Required Capacity		453.22	m3/h	×	1.5	/	2				
		=	339.9	m^3/h	⇒		360	m^3/h /unit				
(3)	Biogas Blowers											
	Biogas Generation		453.22	m^3/h								
	Safety Factor		1.5									
	Number		2	W	+	1	S					
	Required Capacity		453.22	m3/h	×	1.5	/	2				
		=	339.9	m^3/h	⇒		360	m^3/h/unit				
(4)	Biogas Flare											
	Biogas Generation		10,877	m^3/d								
	Operating hours		24	Hr								
	Safety Factor		150.0	%								
	Number		2	W	+	0	S					
	Power Generation		340	m^3/hr	⇒		360	m^3/hr				

13. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge	
(2)	Quantity of Digested Sludge generated	20,143	kg/day
(3)	Design Polyelectrolyte Dosage	1.5	kg/t-DS·day
(4)	Volume of Digested Sludge	644.6	m^3/day
(5)	Consistency of Dewatered Sludge	82.00	%
(6)	Operation Time	16	hours/day (6 days per week)

[2] Volume of Centrifuges

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

$$= \frac{644.6}{16 \times 2} \times \frac{7}{6} = 23.5$$

$\rightarrow$ 25 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 20,143 × (1 + 0.0015)

= 20,173 kg/day

[4] Dewatered Cake Volume

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

$$= 20.173 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 130.75 t/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	1.5	kg/t-DS·day
(2)	Required Polyelectrolyte	30.21	kg/day
(3)	Dissolving concentration	0.20	%
(4)	Volume of Polyelectrolyte solution	15.11	m3/day

[6] Equipment

(1) Centrifuge

Capacity 25 m^3/hr

Number 2 W + 1 S

(2) Centrifuge Feed Pumps

Capacity 25 m^3/hr

Number 2 W + 1 S

(3) Polyelectrolyte Dosing Pumps

Volume of Polyelectrolyte solution 15.11 m3/day

Operation Time 16 hours/day (6 days per week)

Safety Factor 1.5

Number 2 W + 1 S

Required Capacity 15.11 m^3/d × 16.0 ⁄ 2 × 7 ⁄ 6

= 0.55 m^3/h

Specification Capacity 0.55 m^3/h × 1.5

= 0.826 m^3/h ⇒ 0.90 m^3/h /unit

(4) Polyelectrolyte dosing System

Required chemical volume

for Mechanical Thickeners	0.25041375	m3/h	×	2	Nos.	×	18	h/day
for Centrifuges	0.55	m3/h	×	2	Nos.	×	16	h/day

Total 26.64 m3/day

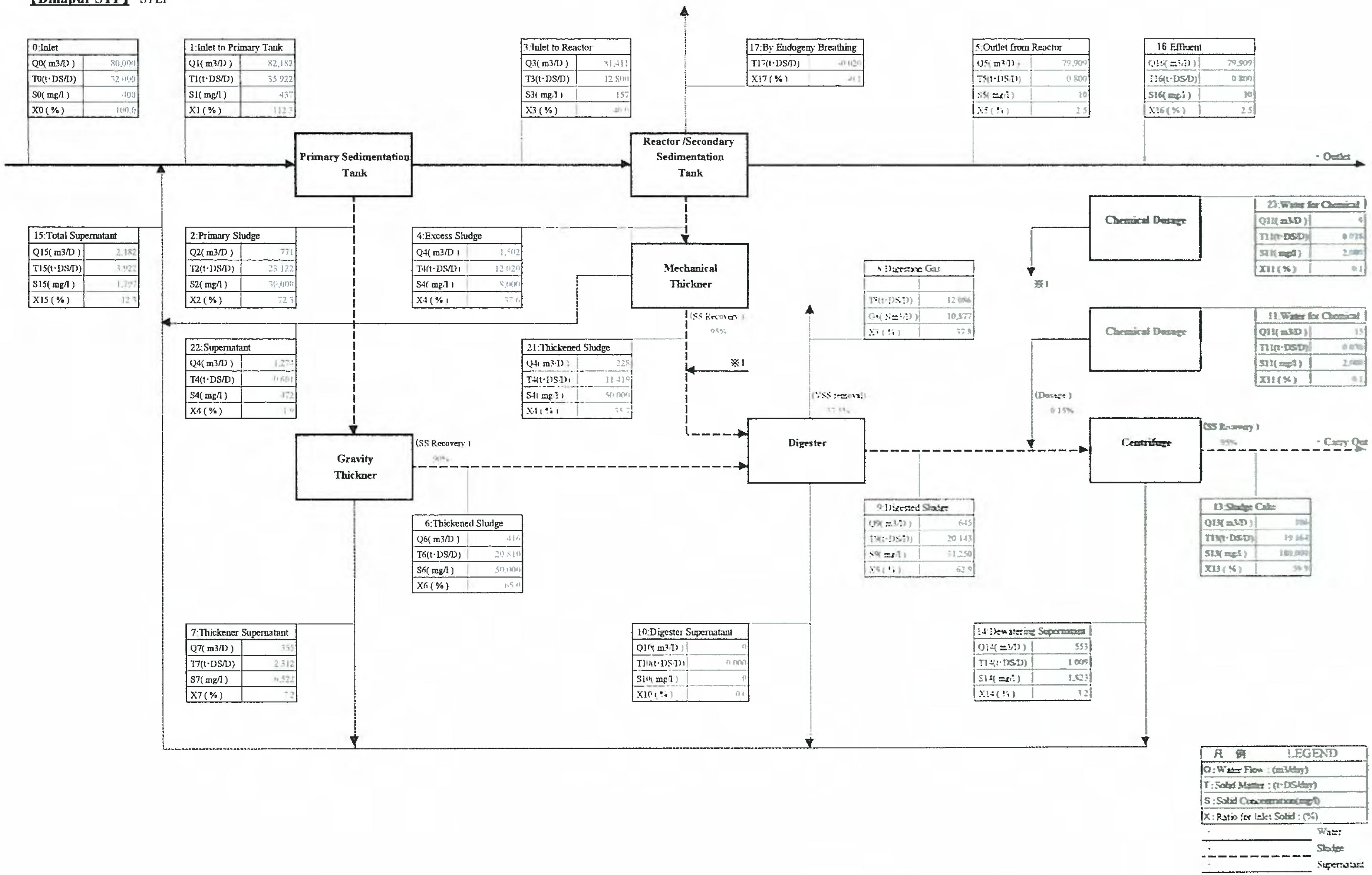
Tanks Dimensions Width 2.5 m × Length 2.5 m × Depth 2.5 m × 2

= 31.3 m^3

Number 2 W + 0 S

14. Centrifuge Feed Sump	
[1] Design Condition	
(1) Quantity of Digested Sludge generated	20,143 kg/day
(2) Solids Consistency	2.5 %
(3) Volume of Thickened Sludge	$\text{Total Solids} \times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
	$= 20{,}143 \times \frac{100}{3} \times 10^{-3}$
	= 806 m^3/day
	= 33.57 m^3/h
(4) Sludge feed flow rate	25 m3/h × 2 = 50 m3/h
(5) Centrifuge Operation Time	16 hours/day (6 days per week)
[2] Geometry	
(1) Required sludge volume for continuation	(50 - 33.57) x 16
	= 262.86 m^3
(2) 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	126.0 m^3
Number	2 W + 0 S

Material Balance Sheet
【Dinapur STP】 STEP



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	5.5^{W}	4.5^{L}	2.5^{SWD}
02	Main Screen Channel	3	1.5^{W}	7.5^{L}	1.3^{SWD}
03	Bypass Screen Channel	1	1.5^{W}	7.5^{L}	1.5^{SWD}
04	Grit Chamber	2	$5.0^{Dia.}$		3.0^{SWD}
05	Parshall Flume	1	****W	****L	****SWD
06	Distribution Chamber	1	****W	****L	****SDW
07	Primary Clarifier	3	$31.2^{Dia.}$		3.5^{SWD}
08	Anoxic Tank 1	3	20.0^{W}	15.0^{L}	5.5^{SWD}
09	Anoxic Tank 2	3	20.0^{W}	19.5^{L}	4.5^{SWD}
10	Aerobic Tank	3	20.0^{W}	40.0^{L}	4.5^{SWD}
11	Secondary Clarifier	3	$40.0^{Dia.}$		3.5^{SWD}
12	Chlorine Contact Tank	1	Not in scope of project		
13	Primary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
14	Secondary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
15	Sludge Thickener	2	$11.5^{Dia.}$		4.0^{SWD}
16	WAS Sump	2	6.0^{W}	6.5^{L}	4.0^{SWD}
17	Thickened Sludge Sump	1	6.0^{W}	6.5^{L}	4.0^{SWD}
18	Anaerobic Sludge Digester	3	$29.0^{Dia.}$		7.0^{SWD}
19	Biogas Holder	2	$21.0^{Dia.}$		8.7^{SWD}
20	Centrifuge Feed Sump	2	6.0^{W}	6.0^{L}	3.5^{H}
21	Sludge Drying Bed	*	****W	****L	****H
22	Filtrate Sump House	1	12.7^{W}	13.0^{L}	****H
23	Air Blower Room	1	12.0^{W}	25.0^{L}	6.0^{H}
24	Treated Effluent Pump House	1	12.7^{W}	13.0^{L}	****H
25	Chlorination Building	1	Not in scope of project		
26	Thickened Sludge Pump House	1	6.0^{W}	6.0^{L}	4.0^{H}
27	Mechanical Thickener Building	1	10.0^{W}	15.0^{L}	8.0^{H}
28	Centrifuge Building	1	15.0^{W}	30.0^{L}	10.0^{H}
29	Control Room for Digester	1	4.2^{W}	4.3^{L}	****H
30	Power House	1	29.5^{W}	31.6^{L}	****H
31	Biogas Flare	2			
32	Administration Building	1	12.6^{W}	25.2^{L}	****H
33	Electrical Building	1	15.0^{W}	20.0^{L}	8.0^{H}

Main Process Line
Sludge Line
Other Line
Proposed structure
Demolished structure
Existing structure

Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title
Dinapur STP 80MLD Layout (Alternative 1)

Scale: 1:2000

Drawing No. STP－21

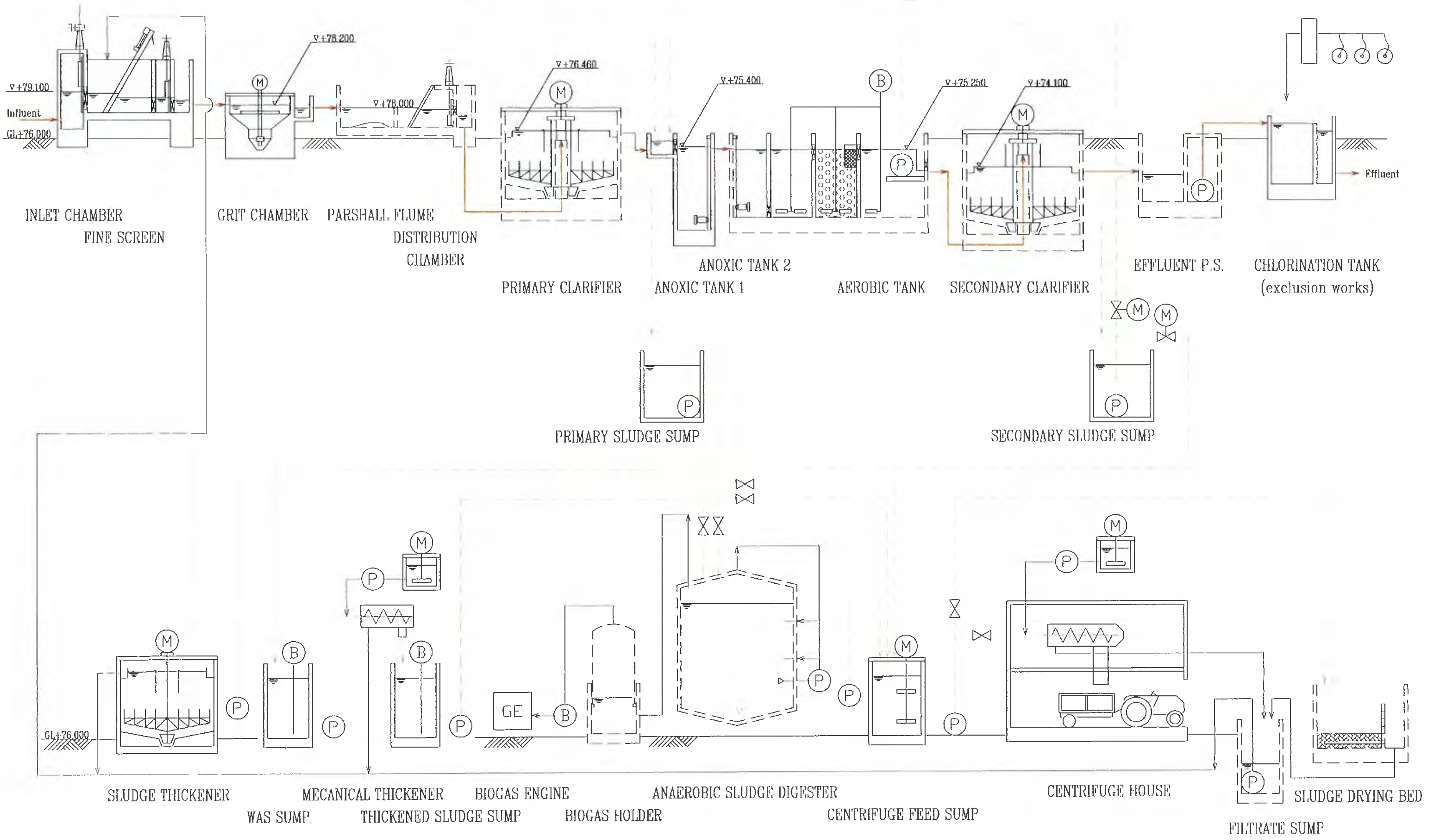
Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	5.5^{W}	4.5^{L}	2.5^{SWD}
02	Main Screen Channel	3	1.5^{W}	7.5^{L}	1.3^{SWD}
03	Bypass Screen Channel	1	1.5^{W}	7.5^{L}	1.5^{SWD}
04	Grit Chamber	2	$5.0^{Dia.}$		3.0^{SWD}
05	Parshall Flume	1	$****^{W}$	$****^{L}$	$****^{SWD}$
06	Distribution Chamber	1	$****^{W}$	$****^{L}$	$****^{SDW}$
07	Primary Clarifier	3	$31.2^{Dia.}$		3.5^{SWD}
08	Anoxic Tank 1,2	6	23.0^{W}	17.0^{L}	5.5^{SWD}
09					
10	Aerobic Tank 1,2	6	23.0^{W}	25.0^{L}	5.5^{SWD}
11	Secondary Clarifier	3	$40.0^{Dia.}$		3.5^{SWD}
12	Chlorine Contact Tank	1	Not in scope of project		
13	Primary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
14	Secondary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
15	Sludge Thickener	2	$11.5^{Dia.}$		4.0^{SWD}
16	WAS Sump	2	6.0^{W}	6.5^{L}	4.0^{SWD}
17	Thickened Sludge Sump	1	6.0^{W}	6.5^{L}	4.0^{SWD}
18	Anaerobic Sludge Digester	3	$29.0^{Dia.}$		7.0^{SWD}
19	Biogas Holder	2	$21.0^{Dia.}$		8.7^{SWD}
20	Centrifuge Feed Sump	2	6.0^{W}	6.0^{L}	3.5^{H}
21	Sludge Drying Bed	*	$****^{W}$	$****^{L}$	$****^{H}$
22	Filtrate Sump House	1	12.7^{W}	13.0^{L}	$****^{H}$
23	Air Blower Room	1	12.0^{W}	37.0^{L}	6.0^{H}
24	Treated Effluent Pump House	1	12.7^{W}	13.0^{L}	$****^{H}$
25	Chlorination Building	1	Not in scope of project		
26	Thickened Sludge Pump House	1	6.0^{W}	6.0^{L}	4.0^{H}
27	Mechanical Thickener Building	1	10.0^{W}	15.0^{L}	8.0^{H}
28	Centrifuge Building	1	15.0^{W}	30.0^{L}	10.0^{H}
29	Control Room for Digester	1	4.2^{W}	4.3^{L}	$****^{H}$
30	Power House	1	29.5^{W}	31.6^{L}	$****^{H}$
31	Biogas Flare	2			
32	Administration Building	1	12.6^{W}	25.2^{L}	$****^{H}$
33	Electrical Building	1	15.0^{W}	20.0^{L}	8.0^{H}

Main Process Line
Sludge Line
Other Line
Proposed structure
Demolished structure
Existing structure

Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title
Dinapur STP 80MLD Layout (Alternative 2)

Scale 1:2000
Drawing No. STP-22



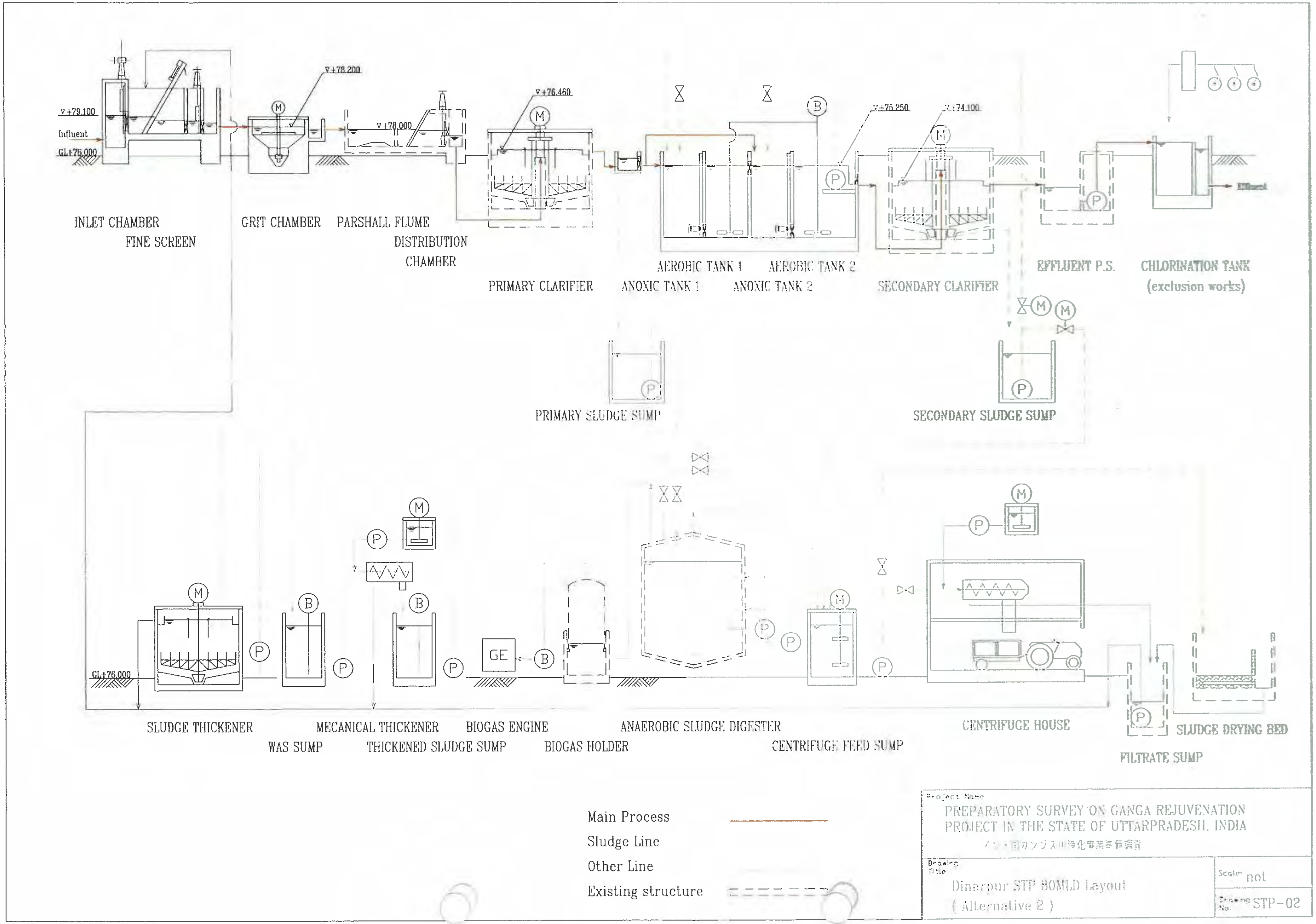
Main Process	
Sludge Line	
Other Line	
Existing structure	

Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title: Dinarpur STP 80MLD Layout (Alternative 1)

Scale: not

Drawing No. STP-01



∇+79.100
Influent
GL+76.000
∇+78.200
∇+78.000
∇+76.460
∇+75.250
∇+74.100
Effluent
INLET CHAMBER
FINE SCREEN
GRIT CHAMBER
PARSHALL FLUME
DISTRIBUTION
CHAMBER
PRIMARY CLARIFIER
AEROBIC TANK 1
AEROBIC TANK 2
ANOXIC TANK 1
ANOXIC TANK 2
SECONDARY CLARIFIER
EFFLUENT P.S.
CHLORINATION TANK
(exclusion works)
PRIMARY SLUDGE SUMP
SECONDARY SLUDGE SUMP
GL+76.000
GE
SLUDGE THICKENER
WAS SUMP
MECANICAL THICKENER
THICKENED SLUDGE SUMP
BIOGAS ENGINE
BIOGAS HOLDER
ANAEROBIC SLUDGE DIGESTER
CENTRIFUGE FEED SUMP
CENTRIFUGE HOUSE
FILTRATE SUMP
SLUDGE DRYING BED
Main Process
Sludge Line
Other Line
Existing structure
Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION
PROJECT IN THE STATE OF UTTARPRADESH, INDIA
Drawing Title
Dinapur STP 80MLD Layout
(Alternative 2)
Scale not
Drawing No. STP-02

2. Bhagwanpur STP (Varanasi)

Item	Bagwanpur-STP

1.Desin Condition

(1) Design Flow Rate

	Flow Rate		
	m3/d	m3/h	m3/sec
Average Daily	8,000	333	0.093
Max Daily	8,000	333	0.093
Max Hourly	18,000	667	0.208

(2) Design Sewage Quality and Effluent Quality

Unit: mg/L

	Water Quality						
	BOD	COD	SS	T-N			TP
				NH_4-N	org-N	NOx-N	
Inlet	250	450	400	37	13	0	-
Outlet	10	50	10	2	0	8	-
Removal rate	96.0%	88.9%	97.5%	80.0%			

(3) Inlet Water Quality at Reactor

Unit: mg/L

	Water Quality Item						
	BOD	COD	SS	T-N			TP
				NH_4-N	org-N	NOx-N	
Inlet at Primary Clarifier	250	450	400	37	13	0	-
Removal rate	30%	30%	60%	10.0%			-
Inlet at Reactor	175	315	160	33.3	11.7	0	-

2. Inlet Chamber (existing structure)

[1] Design Condition

(1) Design Wastewater Flow — Max Hourly = 18,000 m3/day

= 0.208 m3/day

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — - m

(3) Width of Basin — 1.200 m

(4) Length of Basin — 1.200 m

3.	**Medium Screen Channel (existing structure)**	
〔1〕Design Condition		
(1)	Design Flow Rate	Max Hourly = 18,000 m3/day
		= 0.208 m3/sec
[2]	**Geometry**	
(1)	Inlet Gate	
	Number	1 Main + 0 Bypass
	Width	1.000 m
	Height	1.000 m
	Floor Level	+ m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.208 ／ 1.000 ／ 0.500 ／ 1
		= 0.416 < 1.000 m/sec
(2)	Bypass Gate	
	Number	0 Main + 1 Bypass
	Width	0.500 m
	Height	1.000 m
	Floor Level	+ m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.208 ／ 0.500 ／ 0.500 ／ 1
		= 0.832 ≒ 1.000 m/sec
(3)	Screen Channel	
	Number	1 Main + 0 Standby
	Width	1.000 m approx.
	Side Water Depth	0.450 m approx.
	Velocity	0.208 ／ 1.000 ／ 0.450 ／ 1
		= 0.462 ≒ 0.450 m/sec
	Channel Dimensions	Width 1.0 m × Length m
		× SWD 0.5 m (Freeboard 0.5m)
(4)	Bypass Screen Channel	
	Number	0 Main + 1 Standby
	Width	0.500 m approx.
	Side Water Depth	0.450 m approx.
	Velocity	0.208 ／ 0.500 ／ 0.450 ／ 1
		= 0.924 > 0.450 m/sec **much higher than usual design**
	Channel Dimensions	Width 0.5 m × Length m
		× SWD 0.45 m (Freeboard 0.5m)
(5)	Outlet Gate	
	Number	1 Main + 0 Bypass
	Width	1.000 m
	Height	1.000 m
	Floor Level	+ m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.208 ／ 1.000 ／ 0.500 ／ 1
		= 0.416 < 1.000 m/sec
(6)	Bypass Outlet Gate	
	Number	0 Main + 1 Bypass
	Width	0.500 m
	Height	1.000 m
	Floor Level	+ m
	Bottom	+ 0.000 m
	Influent Water Level	+ 0.500 m
	Velocity	0.208 ／ 0.500 ／ 0.500 ／ 1
		= 0.832 < 1.000 m/sec

[3]	**Equipment**									
(1)	Inlet Gate									
	Number	1	W		+	0	S			
	Dimension	Width	1.0	m	×	Height	1.0	m		
	Design Water Level	-	m							
(2)	Bypass Gate									
	Number	0	W		+	1	S			
	Dimension	Width	0.5	m	×	Height	1.0	m		
	Design Water Level	-	m							
(3)	Medium Screens (Main Channel)									
	Number	1	W		+	0	S			
	Open Space	20	mm							
	Bar Thickness	6	mm							
	Channel Width	1.0	m	approx.						
	Width of side plate	50	mm							
	Side Water Depth	0.45	m							
	Height of Blind Plate at the bottom	50	mm	approx.						
	Velocity through screen	0.208	／	0.900	／	0.400	／	1		
		× (	20	+	6	) /	20			
		=	0.751	<	0.800	m/sec				
(3)	Medium Screens (Bypass Channel)									
	Number	0	W		+	1	S			
	Open Space	50	mm							
	Bar Thickness	6	mm							
	Channel Width	0.5	m	approx.						
	Side Water Depth	0.45	m	approx.						
	Velocity through screen	0.208	／	0.500	／	0.450	／	1		
		× (	50	+	6	) /	50			
		=	1.035	>	0.800	m/sec	**much higher than usual design**			
(4)	Outlet Gate									
	Number	1	W		+	0	S			
	Dimension	Width	1.0	m	×	Height	1.0	m		
	Design Water Level	-	m							
(5)	Bypass Gate									
	Number	0	W		+	1	S			
	Dimension	Width	0.5	m	×	Height	1.0	m		
	Design Water Level	-	m							

4.	**Grit Chamber (existing structure)**											
〔1〕	**Design Condition**											
(1)	Design Flow Rate	Max Hourly			=	18,000	m3/day					
					=	0.208	m3/sec					
(2)	Specific gravity of Sand	2.65										
(3)	Sedimentation Velocity	1000	m3/m2/day		=	0.0116	m/sec					
(4)	Average Velocity	0.3	m/sec									
[2]	**Grit Chamber**	**Rectangular Grit Chamber**										
(1)	Required Surface Area	0.208	／	0.0116	=	17.971	m2					
(2)	Number of Chambers	1	S	+	0	W						
(3)	Width	2.0	m	approx..								
(4)	Length	7.0	m	approx..								
(5)	Actual Surface Area	2.000	mW	×	7.000	m						
		=	14.000	m2	approx..	>	17.971	m2	**higher than usual design**			
[3]	**Distribution Weir Gate 1**	**to distribute flow between existing line and new line**										
(1)	Number	2	Main	+	0	Bypass						
(2)	Weir Width	0.500	m									
(3)	Stroke	0.500	m									
(4)	Overflow Height as usually operation	(	0.208	／	1.840	／	0.500	／	2	)	$^{2/3}$	
		=	0.234	<	0.500	m						
(5)	Overflow Height at maintenance of one line	(	0.208	／	1.840	／	0.500	／	1	)	$^{2/3}$	
		=	0.371	<	0.500	m						
[4]	**Distribution Weir Gate 2**	**to distribute flow between two existing Primary Clarifiers**										
(1)	Number	2	Main	+	0	Bypass						
(2)	Weir Width	0.300	m									
(3)	Stroke	0.400	m									
(4)	Overflow Height as usually operation	(	0.104	／	1.840	／	0.300	／	2	)	$^{2/3}$	
		=	0.207	<	0.400	m						
(5)	Overflow Height at maintenance of one line	(	0.104	／	1.840	／	0.300	／	1	)	$^{2/3}$	
		=	0.329	<	0.400	m						

5-1. Primary Clarifier (existing structure)

[1] Design Condition

(1)	Design Flow Rate	Average Daily		=	4,000	m^3/day	
				=	0.046	m^3/sec	
				=	2.78	m^3/min	
(2)	Type	Circular Clarifier					
(3)	Surface Overflow Rate required	35	m^3/m^2/day				
(4)	Number of Basins	2	Basins				

[2] Geometry

(1)	Surface Area required	4,000	/ 35	=	114	m^2	
(2)	Surface Area required/Basin	114	/ 2	=	57	m^2	
(3)	Side Water Depth	3.5	m				
(4)	Diameter required	8.5	m <	Existing structure	14.6	m	**OK**
(5)	Basin Dimensions	Diameter	14.6 m ×	Depth	3.0 m		

[3] Sludge generated per day

(1)	Inlet TSS	450	mg/L			
(2)	Reduction in TSS	30%				
(3)	Outlet TSS	315	mg/L			
(4)	Solids removed from Primary Clarifiers	2,374	kg/day	/ 2 =	1,187	kg/day
(5)	Solids Consistency	3.0	%			
(6)	Volume of Primary Sludge					

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

= 40 m^3/day

[4] Equipment

(1)	Primary Sludge Pumps							
	Sludge withdrawal	12	Times/day					
	Running Time	0.50	hr/Time					
	Number	1	W	+	1	S		
	Required Capacity	40	m^3/day	/	12.0	/	0.5 /	1
		= 6.6	m^3/Hr	⇒	10	m^3/Hr /Unit		

5-2. Primary Clarifier (new structure)	
[1] Design Condition	
(1) Design Flow Rate	Average Daily = 4,000 m^3/day
	= 0.046 m^3/sec
	= 2.78 m^3/min
(2) Type	Circular Clarifier
(3) Surface Overflow Rate required	35 m^3/m^2/day
(4) Number of Basins	1 Basins
[2] Geometry	
(1) Surface Area required	4,000 ／ 35 = 114 m^2
(2) Surface Area required/Basin	114 ／ 1 = 114 m^2
(3) Side Water Depth	3.5 m
(4) Diameter required	12.1 m < 14.6 m **OK**
(5) Basin Dimensions	Diameter 14.6 m × Depth 3.0 m
[3] Sludge generated per day	
(1) Inlet TSS	450 mg/L
(2) Reduction in TSS	30%
(3) Outlet TSS	315 mg/L
(4) Solids removed from Primary Clarifiers	2,374 kg/day ／ 2 = 1,187 kg/day
(5) Solids Consistency	3.0 %
(6) Volume of Primary Sludge	Solids removed $\times \frac{100}{\text{Solids Consistency}} \times 10^{-3}$
	= 40 m^3/day
[4] Equipment	
(1) Primary Sludge Pumps	
Sludge withdrawal	12 Times/day
Running Time	0.50 hr/Time
Number	1 W + 1 S
Required Capacity	40 m^3/day ／ 12.0 ／ 0.5 ／ 1
	= 6.6 m^3/Hr ⇒ 10 m^3/Hr /Unit

6-1. Reactor (existing Structure)

[1] Design Condition

(1) Design Flow	Q =	4,000	m^3/day (summer)	
	Q' =	4,000	m^3/day(Winter)	
(2) Design Sewage Quality				
Inlet BOD		175	mg/l	
Outlet BOD		10.0	mg/l	
Inlet S-BOD		117	mg/l	assumed as 2/3 of BOD
Inlet COD		315	mg/l	
Inlet S-COD :sCOD		210	mg/l	assumed as 2/3 of BOD
Outlet S-COD :nbsCODe		23	mg/l	=sCOD-1.6sBOD
Inlet rbCOD		47	mg/l	assumed as 15% of COD
bCOD/BOD		1.60		
Inlet bCOD :S_0		280	mg/l	
Inlet nbCOD		35	mg/l	
:nbpCOD		12	mg/l	=TCOD-bCOD-nbsCODe
Inlet TSS		160	mg/l	
Inlet VSS		112	mg/l	assumed as 70% of TSS
:VSS_{COD}		0.94	gCOD/gVSS	=TCOD-sCOD/VSS
:nbVSS		12.44	gnbVSS/m3	=nbpCOD/VSS_{COD}
:iTSS		48.00	gnbVSS/m3	=TSS-VSS
Inlet T-N		45	mg/l	
Inlet TKN		45	mg/l	
Inlet NH_4-N		33.3	mg/l	
Inlet T-P		6	mg/l	
Inlet Alkalinity as CaCO3		380	mg/l	assumed
Outlet Kjeldahl N		2.0	mg/l	
Outlet NH4-N		2.0	mg/l	
Outlet NO3-N		8.0	mg/l	
(3) Water Temperature	T=	20.0	°C	
(4) Safety Factor for Nitrogen	SF=	1.5		
(5) Return Sludge Concentration	Rs =	8,000	mg/l	
(6) MLSS	X_{TSS} =	3,000	mg/l	
(7) DO in the Reactor		2	mg/l	

[2] Design of Nitrification Process

(1) Activated sludge design kinetic coefficients at 20°C

Coefficient	Unit	COD oxidation	NH4 oxidation	NO2 oxidation
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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(2) μ_{AOB}: Specific Growth Rate of Ammonia Oxidizing Bacteria (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°C=	0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$	b at20°C=	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			

(3) Design SRT — SRT= 4.8387 day $=1/\mu_{AOB}\times SF$

(4) Biomass production					
$Px_{,VSS}$	$Px_{,VSS}$=	406.469	kg /d	=Px,bio+Q(nbVSS)	
$Px_{,TSS}$	$Px_{,TSS}$=	661.415	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)	
S	S=	0.4606	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}*$1.04^{(T-20)}$	μmax at20℃＝ 6.000
Yn	Yn=	0.150	gVSS/g Nox		
NOx	NOx=	32.300	mg/*l*	assumed	
$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	356.692	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)/[1+b_{AOB}(SRT)]	
		318.333		=Q･Y_H(S_0-S)/[1+b_H(SRT)]	
		27.726		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]	
		10.633		=QYn(Nox)/[1+b_{AOB}(SRT)]	
Nox'	Nox'=	32.299	mg/*l*	=TKN-Ne-0.12$P_{X,bio}$/Q	= NOx OK
(5) Required Aeration Tank Volume					
Va=	Va=	1,067	m3		
τ=	τ=	6.40	hr	=Va/Q×24	
(6) FractionVSS=	FractionVSS	0.615			
X_{VSS}･Va	X_{VSS}･Va=	1,967	kg VSS	=$Px_{,VSS}$･SRT	
X_{TSS}･Va	X_{TSS}･Va=	3,200	kg TSS	=$Px_{,TSS}$･SRT	
(7) MLVSS	MLVSS=	1844	mg/L		
(8) F/M	F/M=	0.356	kgBOD/kgMLVSS		
(9) BODloading	BODloading	0.656	kg/m3･d		
(10) Observed Yield					
$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	0.946	gTSS/gBOD		
$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.582	gVSS/gBOD		
bCODremoved=	bCODremov	1,118	kg/d		
(11) Effluent NH_4-N	NH_4-N=	0.5485	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}*$1.072^{(T-20)}$	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*		
(12) Ratio of Return Sludge	8,000*Rr/(1+Rr)＝	3,000	mg/L		
	3,000/(8,000-3,000)＝	0.60			
	Rr ＝	0.60			

[3] Design of Denitrification Process

(1) Active biomass concentration

X_b = $Q \cdot (SRT)/V \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
= 1,443.87 mg/l

(2) IR ratio

IR = NOx/Ne-1.0-R
= 2.44

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

Nox feed= (IR+R)·Q·Ne
= 97,197 kg/d

(4) The anoxic tank volume

Vnox= 667 m3 t_{nox}= 4.000 h

(5) F/M_b

F/M_b= 0.73 g/g·d

(6) Fraction of rbCOD

rbCOD/bCOD= 16.88%

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

(7) $SDNR_{b0}$

Specific Denitrification Rate base on biomass concentration at 20 ℃

SDNRb= 0.175 g/g·d $= b_0 + b_1[\ln(F/M_b)]$

b_0= 0.213
b_1= 0.118

(8) $SDNR_b$

corrected SNDR at design temperature and Internal Recycle

$SDNR_b$= 0.103 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= 0.175 g/g·d $=SDNR_b \cdot \theta^{(t-20)}$ θ= 1.026

(9) SDNR: base on MLVSS

SDNR= 0.080 g/g·d $=SDNR_b(MLVSS_b/MLVSS)$

(10) NOr: nitrate-nitrogen removal rate

NOr= 98,857.32 g/d $=V_{nox} \cdot SDNR_b \cdot X_b$
>Nox feed= 97,197 g/d OK

(11) Alkalinity to be added to maintain pH7

-166.13 mg/l < 0 No Alkalinity needed OK

Influent Alk	380.00	mg/l	
Alk used	230.62	mg/l	=7.14×Nox
Alk produce	86.75	mg/l	=3.57×(NOx-NOxe)
Alk to maint	70.00	mg/l	

[4] Geometry

(1) Determination of Dimensions of Basins

	Diameter		Depth	Basins
Anoxic tank	15.6		3.5	2
	Width	Length	Depth	Basins
Aerobic tank	9.5	10.5	5.5	2

(2) Volume and HRT of Basins

Item	unit	Anoxic	Aerobic	Total	
Cross Section	m^2	191.1	51.3		
Depth/Length	m	3.5	10.5	14.0	
Volume per Basin	m^3	669	538	1,207	
Total Volume	m^3	1,338	1,076	2,414	
Actual HRT	hour	8.03	6.46	14.49	
Required HRT	hour	4.00	6.40	10.40	OK

[5] 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 +	1		Standby	
(2) Circulation Pumps						
Circulation Ratio	244	%				
Required Capacity	4,000	m3/day×		244%	／ 24	／ 2
	= 203	m3/Hr ⇒		210	m3/Hr	
Number	2	Work +	2		Standby	

6-2. Reactor (new Structure)

[1] Design Condition

(1)	Design Flow		Q=	4,000	m^3/day (summer)	
			Q'=	4,000	m^3/day(Winter)	
(2)	Design Sewage Quality					
	Inlet BOD			175	mg/l	
	Outlet BOD			10.0	mg/l	
	Inlet S-BOD			117	mg/l	assumed as 2/3 of BOD
	Inlet COD			315	mg/l	
	Inlet S-COD	:sCOD		210	mg/l	assumed as 2/3 of BOD
	Outlet S-COD	:nbsCODe		23	mg/l	=sCOD-1.6sBOD
	Inlet rbCOD			47	mg/l	assumed as 15% of COD
	bCOD/BOD			1.60		
	Inlet bCOD	:S_0		280	mg/l	
	Inlet nbCOD			35	mg/l	
		:nbpCOD		12	mg/l	=TCOD-bCOD-nbsCODe
	Inlet TSS			160	mg/l	
	Inlet VSS			112	mg/l	assumed as 70% of TSS
		:VSS_{COD}		0.94	gCOD/gVSS	=TCOD-sCOD/VSS
		:nbVSS		12.44	gnbVSS/m3	=nbpCOD/VSS_{COD}
		:iTSS		48.00	gnbVSS/m3	=TSS-VSS
	Inlet T-N			45	mg/l	
	Inlet TKN			45	mg/l	
	Inlet NH_4-N			33.3	mg/l	
	Inlet T-P			6	mg/l	
	Inlet Alkalinity as $CaCO_3$			380	mg/l	assumed
	Outlet Kjeldahl N			2.0	mg/l	
	Outlet NH4-N			2.0	mg/l	
	Outlet NO3-N			8.0	mg/l	
(3)	Water Temperature		T=	20.0	°C	
(4)	Safety Factor for Nitrogen		SF=	1.5		
(5)	Return Sludge Concentration		Rs =	8,000	mg/l	
(6)	MLSS		X_{TSS} =	3,000	mg/l	
(7)	DO in the Reactor			2	mg/l	

[2] Design of Nitrification Process

(1) Activated sludge design kinetic coefficients at 20°C

Coefficient	Unit	COD oxidation	NH4 oxidation	NO2 oxidation
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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(2) μ_{AOB}: Specific Growth Rate of Ammonia Oxidizing Bacteria (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°C=	0.900
$b_{AOB,T}$	$b_{AOB,T}$=	0.1700		$=b*1.029^{(T-20)}$	b at20°C=	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			

(3) Design SRT

SRT= 4.8387 day $=1/\mu_{AOB}\times SF$

(4) Biomass production					
$Px_{,VSS}$	$Px_{,VSS}$=	406.469	kg /d	=Px,bio+Q(nbVSS)	
$Px_{,TSS}$	$Px_{,TSS}$=	661.415	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)	
S	S=	0.4606	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}*$1.04^{(T-20)}$	μmax at20℃= 6.000
Yn	Yn=	0.150	gVSS/g Nox		
NOx	NOx=	32.300	mg/*l*	assumed	
$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	356.692	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)/[1+b_{AOB}(SRT)]	
		318.333		=Q·Y_H(S_0-S)/[1+b_H(SRT)]	
		27.726		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]	
		10.633		=QYn(Nox)/[1+b_{AOB}(SRT)]	
Nox'	Nox'=	32.299	mg/*l*	=TKN-Ne-0.12$P_{X,bio}$/Q	≒ NOx OK
(5) Required Aeration Tank Volume					
Va=	Va=	1,067	m3		
τ=	τ=	6.40	hr	=Va/Q×24	
(6) FractionVSS=	FractionVSS	0.615			
X_{VSS}·Va	X_{VSS}·Va=	1,967	kg VSS	=$Px_{,VSS}$·SRT	
X_{TSS}·Va	X_{TSS}·Va=	3,200	kg TSS	=$Px_{,TSS}$·SRT	
(7) MLVSS	MLVSS=	1844	mg/L		
(8) F/M	F/M=	0.356	kgBOD/kgMLVSS		
(9) BODloading	BODloading	0.656	kg/m3·d		
(10) Observed Yield					
$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	0.946	gTSS/gBOD		
$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.582	gVSS/gBOD		
bCODremoved=	bCODremov	1,118	kg/d		
(11) Effluent NH_4-N	NH_4-N=	0.5485	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}*$1.072^{(T-20)}$	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*		

(12) Ratio of Return Sludge

8,000*Rr/(1+Rr)= 3,000 mg/L

3,000/(8,000-3,000)= 0.60

Rr = 0.60

[3] Design of Denitrification Process

(1) Active biomass concentration
$X_b = Q \cdot (SRT)/V \cdot Y_H(S_0 - S)/[1 + b_H(SRT)]$
= 1,443.87 mg/l

(2) IR ratio
IR = NOx/Ne-1.0-R
= 2.44

(3) The amount of NO3-N fed to the anoxic tank
Nox feed= $(IR+R) \cdot Q \cdot Ne$
= 97,197 kg/d

(4) The anoxic tank volume
V_{nox}= 667 m3 τ_{DN}= 4.000 h

(5) F/M_b
F/M_b= 0.73 g/g·d

(6) Fraction of rbCOD
rbCOD/bCOD= 16.88%

Percent rbCOD(%)	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

(7) $SDNR_{b0}$
Specific Denitrification Rate base on biomass concentration at 20 ℃
SDNRb= 0.175 g/g·d $= b_0 + b_1[\ln(F/M_b)]$
b_0= 0.213
b_1= 0.118

(8) $SDNR_b$
corrected SNDR at design temperature and Internal Recycle
$SDNR_t$= 0.103 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= 0.175 g/g·d $= SDNR_b \cdot \theta^{(t-20)}$ θ= 1.026

(9) SDNR: base on MLVSS
SDNR= 0.080 g/g·d $= SDNR_b(MLVSS_b/MLVSS)$

(10) NOr nitrate-nitrogen removal rate
NOr= 98,857.32 g/d $= V_{nox} \cdot SDNR_b \cdot X_b$
>Nox feed= 97,197 g/d OK

(11) Alkalinity to be added to maintain pH7
-166.13 mg/l < 0 No Alkalinity needed OK

Influent Alk 380.00 mg/l
Alk used 230.62 mg/l =7.14×Nox
Alk produce 86.75 mg/l =3.57×(NOx-NOxe)
Alk to maint 70.00 mg/l

[4] Geometry

(1) Determination of Dimensions of Basins

	Width	Length	Depth	Basins
Anoxic tank	12.0	10.5	5.5	1
Aerobic tank	12.0	16.5	5.5	1

(2) Volume and HRT of Basins

Item	unit	Anoxic	Aerobic	Total
Cross Section	m^2	65.0	65.0	
Length	m	10.5	16.5	27.0
Volume per Basin	m^3	683	1,073	1,755
Total Volume	m^3	683	1,073	1,755
Actual HRT	hour	4.10	6.44	10.54
Required HRT	hour	4.00	6.40	10.40

OK

[5] **Equipment**						
(1) Ras Pumps						
Ras Ratio	60	%				
Required Capacity	4,000	m3/day ×		60%	／ 24 ／ 1	
	= 100	m3/Hr ⇒		100	m3/Hr	
Number	1	Work +	1		Standby	
(2) Circulation Pumps						
Circulation Ratio	244	%				
Required Capacity	4,000	m3/day×		244%	／ 24 ／ 1	
	= 406	m3/Hr ⇒		410	m3/Hr	
Number	1	Work +	1		Standby	

7. **Air Requirement at Average Flow**	
[1] **Design Condition**	
(1) AOR : R_0	R0= = 1,878 kg/day
	= 78.3 kg/h
Qin : Design Average Flow m^3/d	8,000
Inlet bCOD : S0	280 mg/l
S=	S= 0.461 mg/l
Nox=	Nox= 32.300 mg/l
$P_{X,bio}$=	$P_{X,bio}$= 692.1 kg VSS/d does not include nitrifying bacteria
R_0=	R_0= $Q(S_0\text{-}S\text{-}k(NOx\text{-}NOxe)\text{-}1.42P_{X,bio}\text{+}4.57Q\cdot NOx$
R_0=	R_0= 1,878 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 6.93 mg/L at 35 ℃
	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 $1+0.40D_l/Pa$ 1.19357
	D_l : 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 : $\exp[-gM(z_b-z_a)/R*T]$ 0.992
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 70 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 Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \dfrac{14{,}279}{3.3913} =$ 4,210.52 kg/day
(3) SOTE for the above Effective Aeration Depth	30.5 %
(4) Fraction of O2 in Air	23.18 %
(5) Specific Gravity of Air at Standard Condition	1.293
(6) Safety Factor	10%
(7) Air required at Field Conditions	= 54,378 m^3/day = 2,265.7 m^3/hr

[2] Equipment	
(1) Air Blower	
Number	2 W + 1 S
Required Capacity	2265.7 m^3/Hr ／ 2
	＝ 1132.9 m^3/Hr ⇒ 1200 m^3/Hr /Unit
Pressure	65 kPa
Safety Factor	10 %
Heat capacity ratio	1.4
Atmospheric pressure at site elevation	100.542 kPa
Total inlet pressure	98.542 kPa
Volume rate of flow at inlet point	20.560 m3/min
Total discharge pressure	165.542 kPa
Overall adiabatic efficiency	0.65
Inlet air temperature (min.)	15 ℃
Shaft power	29.552 kW
Rated Output of Motor	32.507 kW ⇒ 37 kW

8-1. Secondary Clarifier (existing structure)

〔1〕 Design Condition

(1) Design Flow Rate	Average Daily				=	4,000	m^3/day	
					=	0.046	m^3/sec	
					=	2.78	m^3/min	
(2) Type	Circular Clarifier							
(3) Surface Overflow Rate required	25	m^3/m^2/day						
(4) Number of Basins	2	Basins						

[2] Geometry

(1) Surface Area required	4,000	/	25		=	160	m^2	
(2) Surface Area required/Basin	160	/	2		=	80	m^2	
(3) Side Water Depth	3.5	m						
(4) Diameter required	10.1	m	<	Existing structure		16.0	m	OK
(5) Basin Dimensions	Diameter	16.0 m	×	Depth		3.5 m		

8-2. Secondary Clarifier (New structure)

〔1〕 Design Condition

(1) Design Flow Rate	Average Daily				=	4,000	m^3/day	
					=	0.046	m^3/sec	
					=	2.78	m^3/min	
(2) Type	Circular Clarifier							
(3) Surface Overflow Rate required	25	m^3/m^2/day						
(4) Number of Basins	1	Basins						

[2] Geometry

(1) Surface Area required	4,000	/	25		=	160	m^2	
(2) Surface Area required/Basin	160	/	1		=	160	m^2	
(3) Side Water Depth	3.5	m						
(4) Diameter required	14.3	m	<	Existing structure		16.0	m	OK
(5) Basin Dimensions	Diameter	16.0 m	×	Depth		3.5 m		

9. Chlorination	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 8,000 m^3/day
(2) Contact Time	30 min
(3) Type of Chlorine	Bleaching Powder (Availtive chlorine 70%)
(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
(6) Consumption per day	114.3 kg/d as Bleaching Powder
[2] Chlorination Contact Tank	
(1) Volume required	Average Daily Flow ／ 1440 × Contact Time = 166.7 m^3 Contact Time 30 min
(2) Nos. of lanes	7 lanes
(3) Width of lane	1.00 m
(4) Length of lane	24.00 m
(5) Side Water Depth	1.00 m
(6) Nos. of Tanks	1 tank
(7) Total Width of Tank	10.80 m Approx..
(8) Average Velocity	Average Daily Flow ／ 86400 ／ Width ／ Depth = 8,000 ／ 86400 ／ 1.00 ／ 1.00 = 0.093 m/sec
(9) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks = 1.0 m × 24.0 m × 1.0 m × 7 × 1 = 168 m^3 > 166.7 m^3
[3] Equipment	
(1) Chlorine Solution Tank	
Number	2 W + 0 S
Chlorine concentration	2 %
Gravity of dissolved chlorine	1.10
Required solution volume	80.00 kg / d × 100 / 2 / 1.10 / 1000 = 3.64 m3/d = 145 l/h
Dimension of Tank	1.2 mW × 1.2 mL × 1.5 mSWD
Volume of Tank	2.2 m3/tank
Total Volume of Tanks	4.3 m3 (Duration= 1.19 day)
(2) Mixer for Chlorine Solution Tank	
Number	2 W + 0 S
(3) Chlorine Dosing Pump	
Number	1 W + 1 S
Capacity	145 l/h / 1 145 l/h/unit ⇒ 145 l/h/unit

10. 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 ($Na_2S_2O_3 \cdot 5H_2O$)
(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)
	= 19.0 kg/d
	= 0.79 kg/h

[2] Dechlorination Contact Tank

(1) Volume required	Average Daily Flow ／ 1440 × Contact Time
	= 55.6 m^3
	Contact Time 10 min
(2) Width of lane	10.00 m
(3) Length of lane	8.00 m
(4) Side Water Depth	1.00 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
	= 10.0 m × 6.0 m × 1.0 m
	= 60 m^3 > 55.6 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	19.04 kg / d × 100 / 10 / 1.10 / 1000
	= 0.17 m3/d
	= 7 l/h
Volume of Tank	0.5 m3/tank
Total Volume of Tanks	1.0 m3 (Duration= 5.78 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	6.92 l/h / 1
	6.92 l/h/unit ⇒ 7 l/h/unit

10.	**Sludge Thickener**											
[1]	**Design Condition**											
(1)	Primary Sludge	2,374	kg/day					79	m3/day			
(2)	Secondary Sludge	1,169	kg/day					146	m3/day			
(3)	Total Solids	3,543	kg/day					225	m3/day			
(4)	Operation Time	24	hours/day									
(5)	Thickened Sludge Moisture Content	96.0	%									
[2]	**Geometry**											
(1)	Type											
(2)	Number	1	W	+	0	S						
(3)	Design Solid Loading	50	kg / m2/d									
(4)	Required Surface Area	$3543 \times \frac{1}{50} = 70.90$	m2									
(5)	Required diameter	$\left(\frac{4}{\pi} \times 70.90 \times \frac{1}{1}\right)^{1/2} = 9.50$	m									
		→ 9.50	m									
(6)	Side Water Depth	3.5	m									
(7)	Actual Volume of Tank	$\frac{\pi}{4} \times 9.50^{2} = 70.88$	m3									
(8)	Retention Time	$\frac{70.88}{225} \times 4 \times 1 \times 24 = 26.44$	Hr									
[3]	**Volume of Thickened Sludge**	= 79.7	m^3/d									
[4]	**Quantity of Separation Liquid**	Inlet Sludge Volume − Thickened Sludge Volume										
		= 225.2 − 79.7 = 145.5	m^3/day									

11. Thickened Sump							
[1] Design Condition							
(1) Inlet Solids	3,189	kg/day					
(2) Inlet Sludge Volume	80	m^3/d					
[2] Geometry							
(1) Sludge withdraw	12	Times/day					
(2) Required Sump Volume	6.64	m^3					
(3) Number	1	Basins					
(4) Width	2.0	m					
(5) Length	2.0	m					
(6) Side Water Depth	2.5	m					
(7) Actual Sump Volume	2.0	×	2.0	×	2.5	×	1
	=	10.0 m^3					
[3] Equipment							
(1) Digested Sludge Feed Pumps							
Transfer Time	6.00	Hr					
Number	1	W	+	1	S		
Required Capacity	80	m^3	/	6.0	/	1	
	=	13.3	m^3/h	⇒	15	m^3/h /unit	

12. Sludge Digester (existing structure)	
〔1〕 Design Condition	
(1) Quantity of Thickened Sludge generated	3,189 kg/day
(2) Inlet Solids Consistency	4.00 %
(3) Volume of Thickened Sludge	Total Solids × 100 / Solids Consistency × 10^{-3}
	= 80 m^3/day
(4) Ratio of VSS	75 %
(5) Total VSS	= 2,391 kg/day
(6) Total inorganic Sludge	= 797 kg/day
(7) Retention Time	20 days
(8) % Destruction in VSS	50 %
(9) VSS destroyed	= 1,196 kg/day
(10) Quantity of Digested Sludge generated	= 1,993 kg/day
(11) Solids Consistency	2.5000 %
(12) Volume of Digested Sludge	Total Solids × 100 / Solids Consistency × 10^{-3}
	= 80 m^3/day
[2] Geometry	
(1) Volume required	1,594 m^3
(2) No. of Basins	2 Basins
(3) Volume required per Basin	= 797 m^3
(4) Depth provided	9.8 m
(5) Area required per Basin	= 82 m^2
(6) Diameter required per Basin	= 10.2 m
(7) Basin Dimensions	Diameter 18.0 m × Depth 9.8 m
	× 2 Basins = 4,975 m^3
[3] Equipment	
(1) Mixers for Digestion Tanks	
Capacity	2487 m^3
Number	2 W + 0 S
(2) Digested Sludge Transfer Pumps	
Transfer Time	8.00 Hr
Number	2 W + 2 S
Required Capacity	80 m^3 / 8.0 / 2
	= 5.0 m^3/h ⇒ 5 m^3/h /Unit

13. Biogas Power Generation

[1] Design Condition

(1)	Biogas generated per Kg of VSS destroyed	0.9	m^3/kg
(2)	VSS destroyed	1,196	kg/day
(3)	Biogas generated	1,076	m^3/day
(4)	Gas Holder Volume required	25 %	
		= 269	m^3
(5)	No. of Units provided	2	
(6)	Volume of each Gas Holder required	= 135	m^3

[2] Biogas Holder (Existing)

(1) Biogas Holder (Existing) — Diameter 7.5 m × height 4.0 m × 2 Basins

Sphere $V=\pi/4 \cdot D^2 \cdot h$

= 353 m^3 > 269 m^3 **OK**

[3] Equipment

(1) Biogas Power generators

Biogas Generation	0.012	m^3/sec
Biogas Caloric Value	22,000	KJ/m^3
Biogas Engine Conversion Efficiency	35.0	%
Number	2 W + 1 S	

Power Generation: 0.012 m^3/sec × 22000 KJ/m^3 × 0.35 / 2

= 48.0 kW ⇒ 70 kW

(2) Desulfurization Equipment

Biogas Generation	44.84	m^3/hr
Peak Ratio	1.5	
Number	1 W + 0 S	

Required Capacity: 44.84 m^3/Hr × 1.5 / 1

= 67.3 m^3/Hr ⇒ 70 m^3/Hr /Unit

(3) Biogas Blowers

Biogas Generation	44.84	m^3/hr
Safety Factor	1.5	
Number	1 W + 1 S	

Required Capacity: 44.84 m^3/Hr × 1.5 / 1

= 67.3 m^3/Hr ⇒ 70 m^3/Hr /Unit

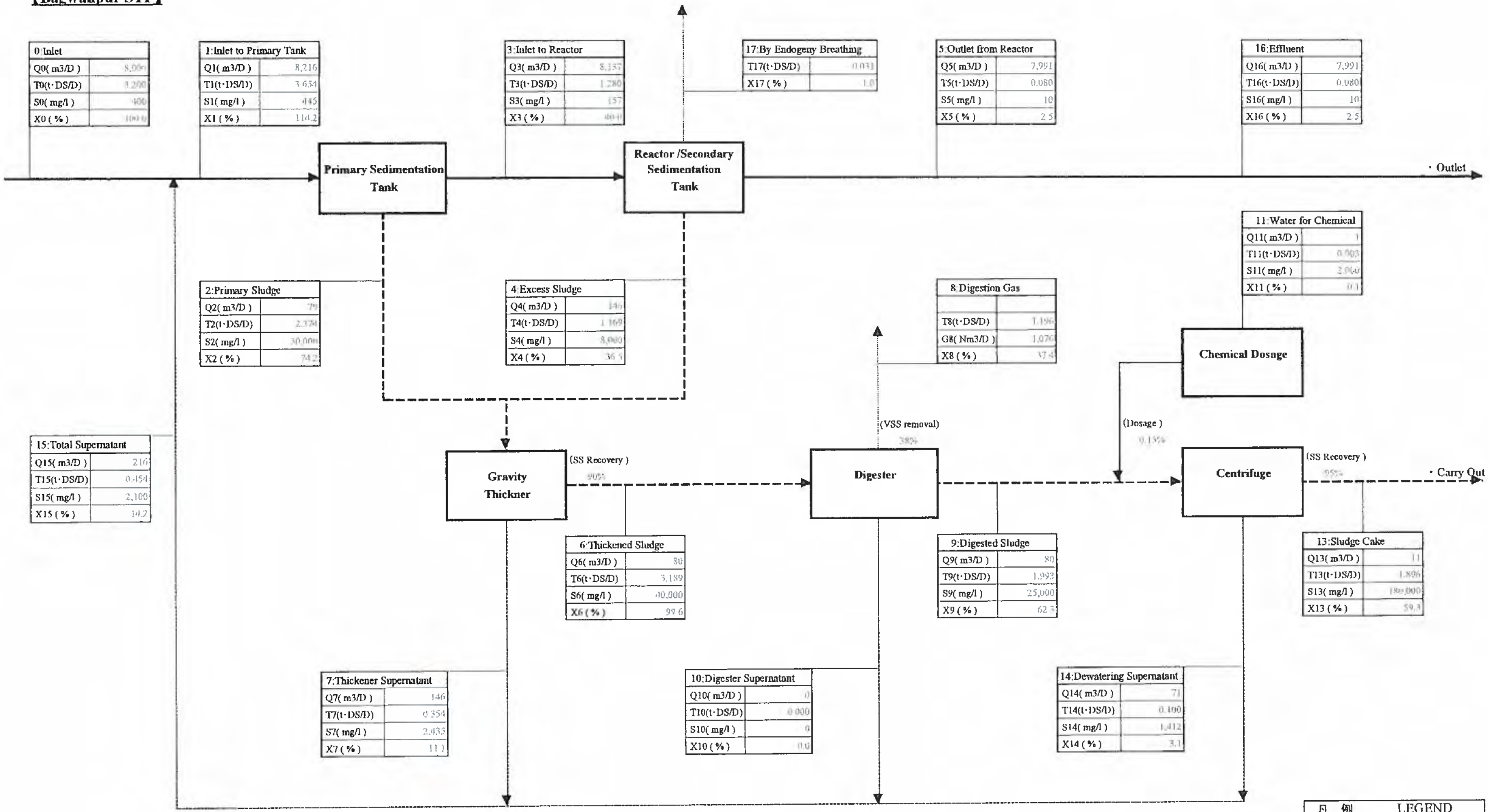
(4) Biogas Flare

Biogas Generation	1,076	m^3/sec
Operating hours	24	Hr
Safety Factor	150.0	%
Number	1 W + 0 S	
Power Generation	67 m^3/hr ⇒ 70	m^3/hr

14. Centrifuge	
〔1〕 Design Condition	
(1) Type of Dewatering	Centrifuge
(2) Quantity of Digested Sludge generated	1,993 kg/day
(3) Design Polyelectrolyte Dosage	1.5 kg/t-DS·day
(4) Volume of Digested Sludge	79.7 m^3/day
(5) Consistency of Dewatered Sludge	82.00 %
(6) Operation Time	8 hours/day (6 days per week)
〔2〕 Volume of Centrifuges	$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No.}} \times \text{Operation/week}$
	$= \frac{79.7}{8 \times 1} \times \frac{7}{6} = 11.6$
	→ 12 m^3/hour
〔3〕 Dewatered Solids	Digested Sludge × (1 + Injection Rate)
	= 1,993 × (1 + 0.0015)
	= 1,996 kg/day
〔4〕 Dewatered Cake Volume	$\text{Dewatered Solids} \times \frac{100}{100 - \text{Moisture Content}} \times \frac{7}{\text{6 days per week}}$
	$= 1.996 \times \frac{100}{100 - 82} \times \frac{7}{6}$
	= 12.94 t/day
〔5〕 Polyelectrolyte	
(1) Design Polyelectrolyte Dosage	1.5 kg/t-DS·day
(2) Required Polyelectrolyte	2.99 kg/day
(3) Dissolving concentration	0.20 %
(4) Volume of Polyelectrolyte solution	1.49 m3/day
〔6〕 Equipment	
(1) Centrifuge	
Capacity	12 m^3/hr
Number	1 W + 1 S
(2) Centrifuge Feed Pumps	
Capacity	12 m^3/h
Number	1 W + 1 S
(3) Polyelectrolyte Dosing Pumps	
Volume of Polyelectrolyte solution	1.49 m3/day
Operation Time	8 hours/day (6 days per week)
Safety Factor	1.5
Number	1 W + 1 S
Required Capacity	1.49 m^3/d × 8.0 ／ 1 × 7 ／ 6
	= 0.22 m^3/h
Specification Capacity	0.22 m^3/Hr × 1.5
	= 0.327 m^3/h ⇒ 0.40 m^3/h /unit
(4) Polyelectrolyte dosing System	
Tanks Dimensions	Width 1.2 m × Length 1.2 m
	× Depth 1.5 m × 2 (Freeboard 0.5m)
	= 4.3 m^3
Retention Time of Tanks	4.30 m^3 ／ 0.22 m^3/h ／ 1
	= 19.728 Hr
Number	2 W + 0 S

15. **Centrifuge Feed Sump**	
[1] **Design Condition**	
(1) Quantity of Digested Sludge generated	1,993 kg/day
(2) Solids Consistency	2.50 %
(3) Volume of Thickened Sludge	Total Solids × $\frac{100}{\text{Solids Consistency}}$ × 10^{-3}
	= 1,993 × $\frac{100}{2.50}$ × 10^{-3}
	= 80 m^3/day
	= 3.32 m^3/h
(4) Sludge feed flow rate	12 m3/h × 1 = 12 m3/h
(5) Centrifuge Operation Time	8 hours/day (6 days per week)
[2] **Geometry**	
(1) Required sludge volume for continuation	(12 - 3.32) x 8
	= 69.43 m^3
(2) Basin Dimensions	Width 4.0 m × Length 4.5 m
	× Depth 3.5 m × 2
	= 126.0 m^3
[3] **Equipment**	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	63.0 m^3
Number	2 W + 0 S

Material Balance Sheet
【Bagwanpur STP】



0:Inlet	
Q0(m3/D)	8,000
T0(t·DS/D)	3.200
S0(mg/l)	400
X0 (%)	100.0

1:Inlet to Primary Tank	
Q1(m3/D)	8,216
T1(t·DS/D)	3.654
S1(mg/l)	445
X1 (%)	114.2

3:Inlet to Reactor	
Q3(m3/D)	8,137
T3(t·DS/D)	1.280
S3(mg/l)	157
X3 (%)	40.0

17:By Endogeny Breathing	
T17(t·DS/D)	0.031
X17 (%)	1.0

5:Outlet from Reactor	
Q5(m3/D)	7,991
T5(t·DS/D)	0.080
S5(mg/l)	10
X5 (%)	2.5

16:Effluent	
Q16(m3/D)	7,991
T16(t·DS/D)	0.080
S16(mg/l)	10
X16 (%)	2.5

11:Water for Chemical	
Q11(m3/D)	1
T11(t·DS/D)	0.003
S11(mg/l)	2,000
X11 (%)	0.1

2:Primary Sludge	
Q2(m3/D)	79
T2(t·DS/D)	2.374
S2(mg/l)	30,000
X2 (%)	74.2

4:Excess Sludge	
Q4(m3/D)	146
T4(t·DS/D)	1.169
S4(mg/l)	8,000
X4 (%)	36.5

8:Digestion Gas	
T8(t·DS/D)	1.196
G8(Nm3/D)	1,076
X8 (%)	37.4

15:Total Supernatant	
Q15(m3/D)	216
T15(t·DS/D)	0.454
S15(mg/l)	2,100
X15 (%)	14.2

6:Thickened Sludge	
Q6(m3/D)	80
T6(t·DS/D)	3.189
S6(mg/l)	40,000
X6 (%)	99.6

9:Digested Sludge	
Q9(m3/D)	80
T9(t·DS/D)	1.993
S9(mg/l)	25,000
X9 (%)	62.3

13:Sludge Cake	
Q13(m3/D)	11
T13(t·DS/D)	1.896
S13(mg/l)	180,000
X13 (%)	59.3

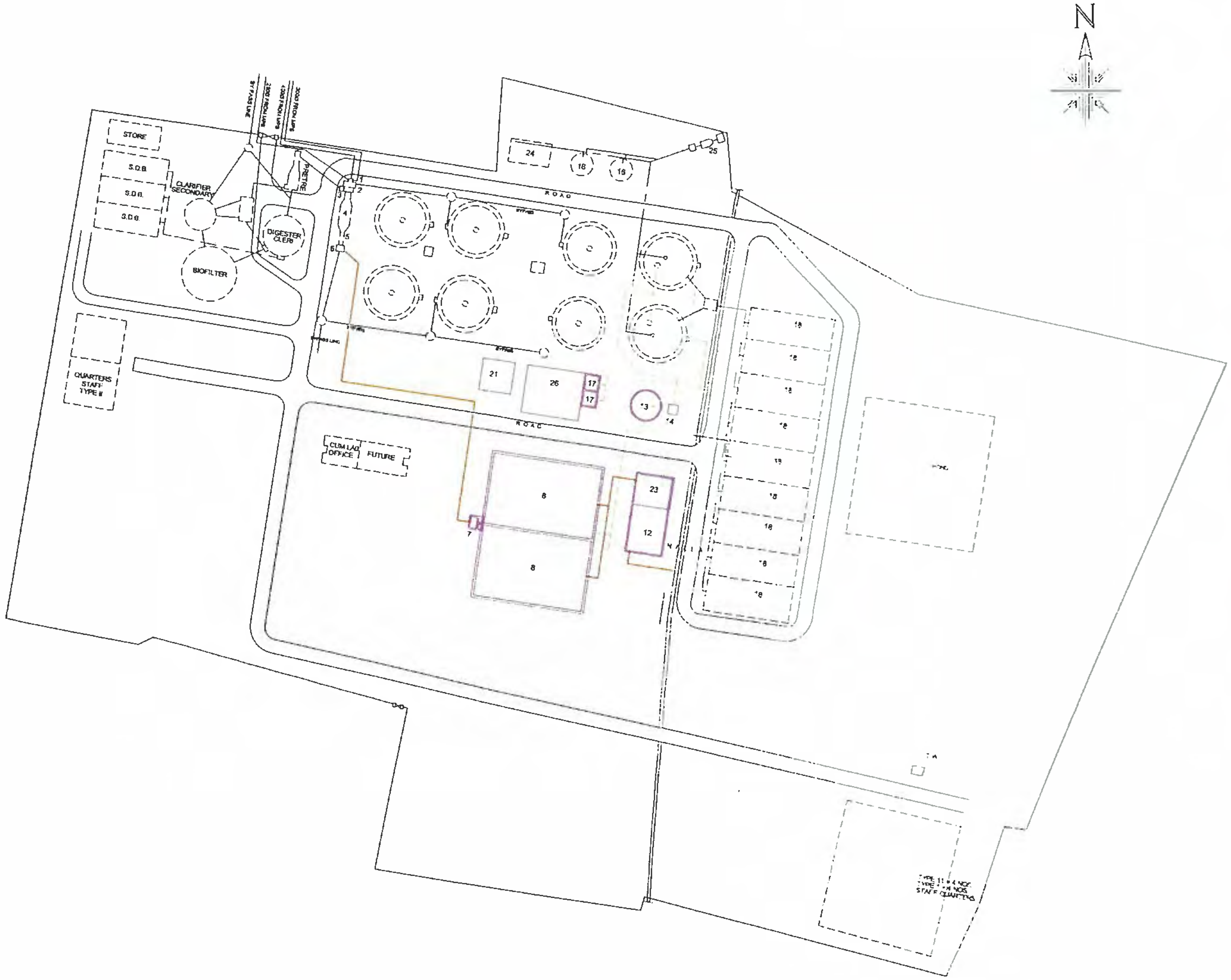
7:Thickener Supernatant	
Q7(m3/D)	146
T7(t·DS/D)	0.354
S7(mg/l)	2,433
X7 (%)	11.1

10:Digester Supernatant	
Q10(m3/D)	0
T10(t·DS/D)	0.000
S10(mg/l)	0
X10 (%)	0.0

14:Dewatering Supernatant	
Q14(m3/D)	71
T14(t·DS/D)	0.100
S14(mg/l)	1,412
X14 (%)	3.1

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



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	1.2^{W}	1.2^{L}	****^{H}
02	Main Screen Channel	1	****^{W}	****^{L}	****^{H}
03	Bypass Screen Channel	1	****^{W}	****^{L}	****^{H}
04	Grit Chamber	1	****^{W}	****^{L}	****^{H}
05	Parshall Flume	1	0.35^{W}	****^{L}	****^{SWD}
06	Distribution Chamber 1	1	****^{W}	****^{L}	****^{SWD}
07	Distribution Chamber 2	1	****^{W}	****^{L}	****^{SWD}
08	SBR	2	22.0^{W}	34.0^{L}	5.5^{SWD}
12	Chlorine Contact Tank	1	****$^{Dia.}$	****^{L}	****^{SWD}
13	Sludge Thickener	1	$9.5^{Dia.}$		3.5^{SWD}
14	Thickened Sludge Sump	1	2.0^{W}	2.0^{L}	2.5^{SWD}
15	Anaerobic Sludge Digester	2	$18.0^{Dia.}$		9.8^{SWD}
16	Biogas Holder	2	$7.5^{Dia.}$		4.0^{SWD}
17	Centrifuge Feed Sump	2	4.0^{W}	4.5^{L}	3.5^{H}
18	Sludge Drying Bed	9	12.0^{W}	28.0^{L}	****^{H}
19	Filtrate Sump	1	****^{W}	****^{L}	****^{H}
20	Primary Sludge Pump House	1	****^{W}	****^{L}	****^{H}
21	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
22	RAS Pump House	1	****^{W}	****^{L}	****^{H}
23	Chlorination Building	1	****^{W}	****^{L}	****^{H}
24	Engine Room	1	8.5^{W}	15.0^{L}	****^{H}
25	Biogas Flare	1			
26	Centrifuge Building	1	15.0^{W}	18.0^{L}	8.0^{H}

Main Process Line
Sludge Line
Other Line
Proposed structure
Demolished structure
Existing structure

Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title
Bagwanpur STP 8MLD Layout (SBR Plan)

Scale: not

Drawing No: STP-23

Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	1.2^{W}	1.2^{L}	****^{H}
02	Main Screen Channel	1	****^{W}	****^{L}	****^{H}
03	Bypass Screen Channel	1	****^{W}	****^{L}	****^{H}
04	Grit Chamber	1	****^{W}	****^{L}	****^{H}
05	Parshall Flume	1	0.35^{W}	****^{L}	****^{SWD}
06	Main Distribution Chamber	1	****^{W}	****^{L}	****^{SDW}
07	Sub-distribution Chamber	1	****^{W}	****^{L}	****^{SDW}
08-1	Primary Clarifier 1-1/2	2	$14.6^{Dia.}$		3.5^{SWD}
08-2	Primary Clarifier 2	1	$14.6^{Dia.}$		3.5^{SWD}
09-1	Anoxic Tank 1-1/2	2	$15.6^{Dia.}$		3.5^{SWD}
09-2	Anoxic Tank 2	1	12.0^{W}	10.5^{L}	5.5^{SWD}
10-1	Aerobic Tank 1-1/2	2	9.5^{W}	10.5^{L}	5.5^{SWD}
10-2	Aerobic Tank 2	1	12.0^{W}	16.5^{L}	5.5^{SWD}
11-1	Secondary Clarifier 1-1/2	2	$16.0^{Dia.}$		3.5^{SWD}
11-2	Secondary Clarifier 2	1	$16.0^{Dia.}$		3.5^{SWD}
12	Chlorine Contact Tank	1	****^{W}	****^{L}	****^{H}
13	Sludge Thickener	1	$9.5^{Dia.}$		3.5^{SWD}
14	Thickened Sludge Sump	1	2.0^{W}	2.0^{L}	2.5^{SWD}
15	Anaerobic Sludge Digester	2	$18.0^{Dia.}$		9.8^{SWD}
16	Biogas Holder	2	$7.5^{Dia.}$		4.0^{SWD}
17	Centrifuge Feed Sump	2	4.0^{W}	4.5^{L}	3.5^{H}
18	Sludge Drying Bed	9	12.0^{W}	28.0^{L}	****^{H}
19	Filtrate Sump	1	****^{W}	****^{L}	****^{H}
20	Primary Sludge Pump House	1	****^{W}	****^{L}	****^{H}
21	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
22	RAS Pump House	1	****^{W}	****^{L}	****^{H}
23	Chlorination Building	1	****^{W}	****^{L}	****^{H}
24	Engine Room	1	8.5^{W}	15.0^{L}	****^{H}
25	Biogas Flare	1			
26	Centrifuge Building	1	15.0^{W}	18.0^{L}	8.0^{H}

Main Process Line
Sludge Line
Other Line
Proposed structure
Demolished structure
Existing structure

Project Name

PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA

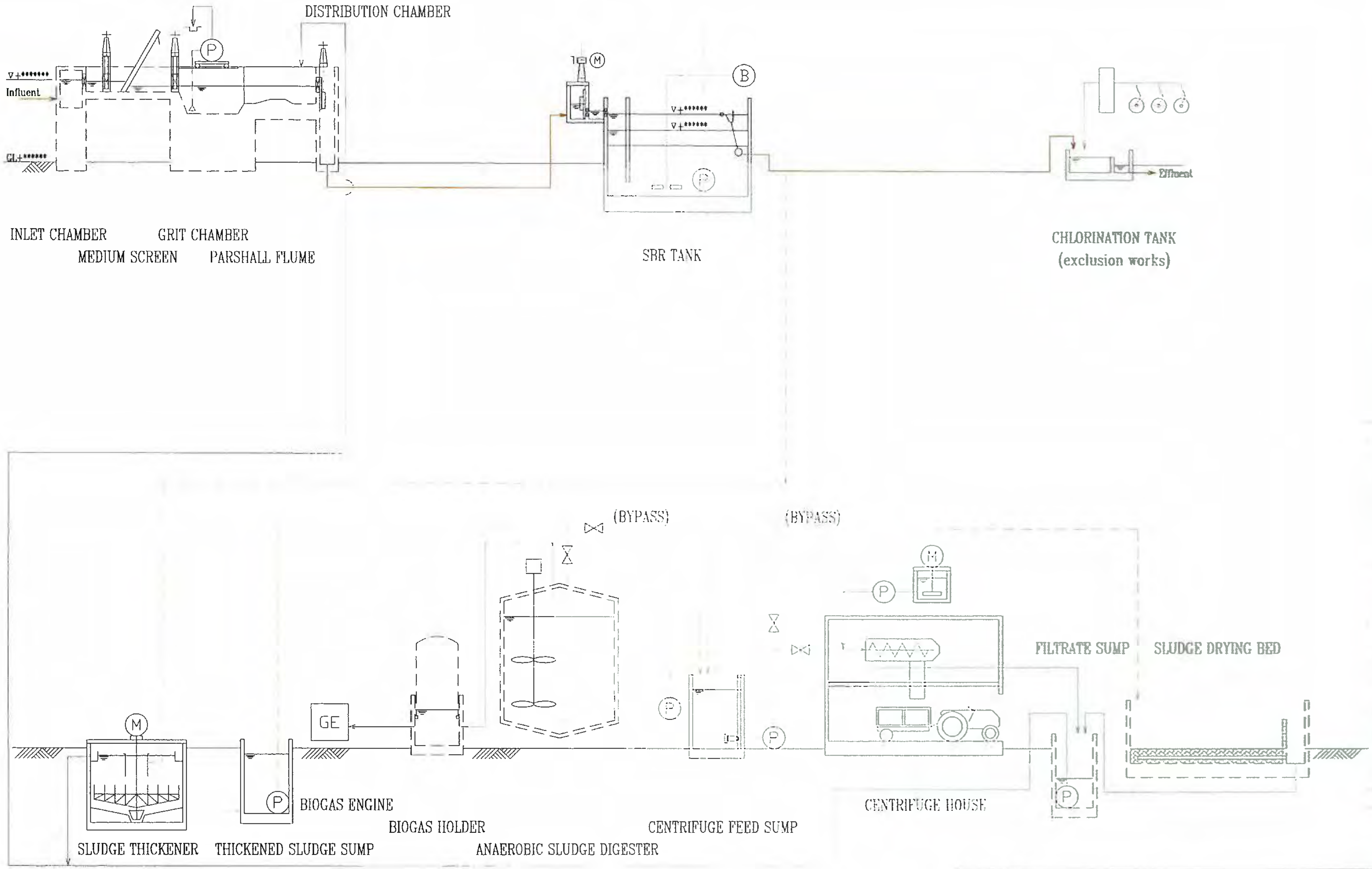
インド国ガンジス川浄化事業準備調査

Drawing Title

Bagwanpur STP 8MLD Layout (Alternative Plan)

Scale: not

Drawing No STP-24



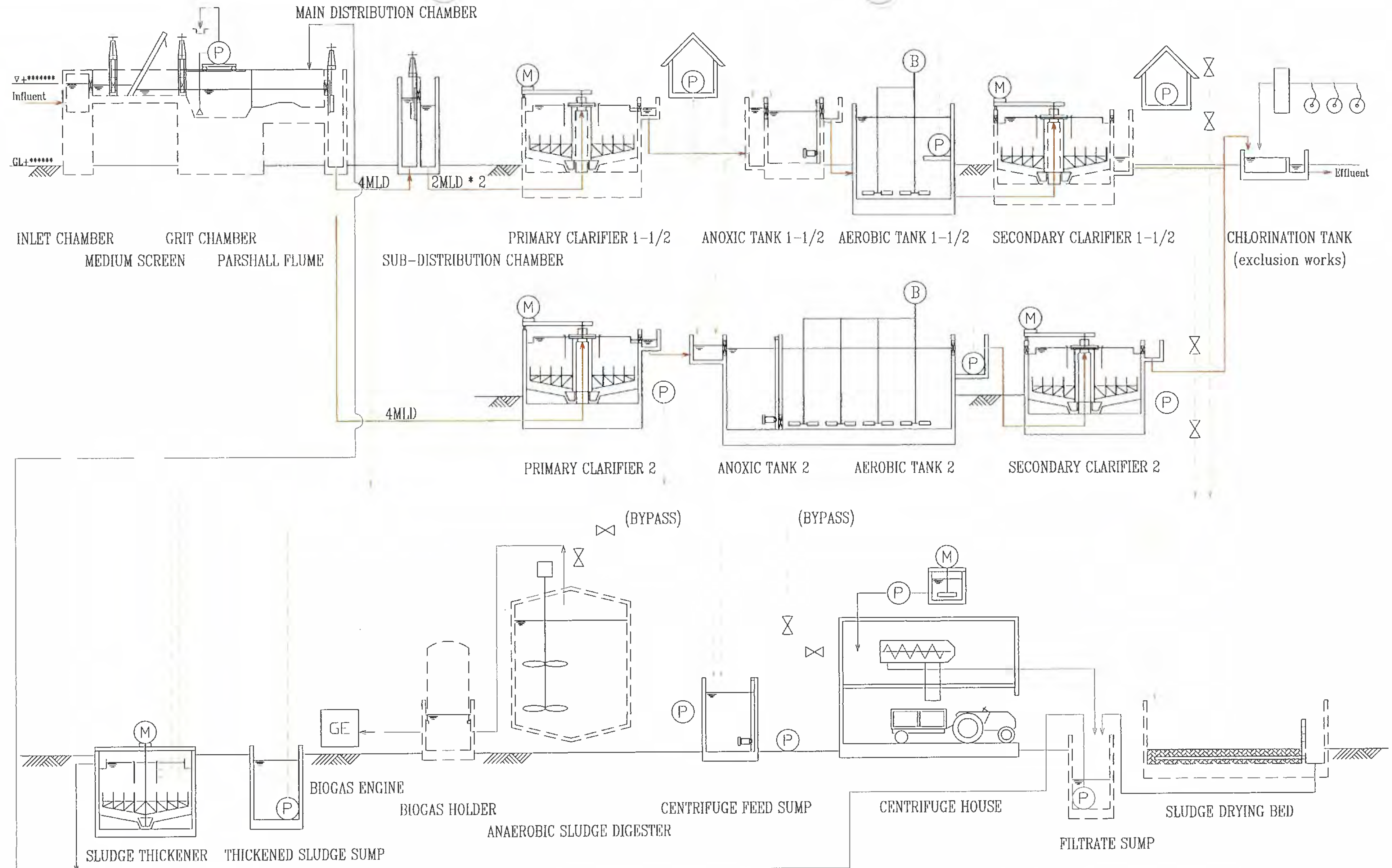
Main Process

Sludge Line

Other Line

Existing structure

Project Name: PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA インド国ガンジス川浄化事業準備調査	
Drawing Title: Bagwanpur STP 8MLD Layout (DPR plan)	Scale: not
	Drawing No.: STP－03



Main Process
Sludge Line
Other Line
Existing structure

Project Name: PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA インド国ガンジス川浄化事業準備調査	
Drawing Title: Bagwanpur STP 8MLD Layout (Alternative 1)	Scale: not Drawing No. STP-04

3. Ramna STP (Varanasi)

1.Desin Condition

Item	Ramna-STP
(1) Design Flow	

	Flow Rate		
	m^3/d		m^3/s
Average Daily	50,000		0.579
Max Dayly			0.000
Max Hourly	100,000		1.157

(2) Design Sewage Quality and Effuluent Quality

Unit : mg/L

	Water Quality Item					
	BOD	SS	T-N			TP
			NH_4-N	org-N	NOx-N	
Inlet	200	600	25	15	0	5
Outlet	10	10	1	0	9	2
Removal rate	95.0%	98.3%	75.0%			60.0%

(3) Inlet Quality of Reactor

Unit : mg/L

	Water Quality Item					
	BOD	SS	T-N			TP
			NH_4-N	org-N	NOx-N	
Inlet Of Primary Clarifier	200	600	25	15	0	5
Removal rate	35%	60%	0.0%			-
Inlet of Reactor	130	240	25	15	0	-

2. Inlet Chamber

[1]Design Condition

(1) Design Wastewater Flow — Max Hourly = 100,000 m^3/day
= 1 157 m^3/sec

[2] Geometory

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 3.000 m

(3) Width of Basin — 4.800 m

(4) Length of Basin — 5.000 m

(5) Volume required of Basin — 3.000 × 4 800 × 5.000 = 2.9 m^3

(6) Retention Time — 3.000 × 4.800 × 5.000 ／ 1.157 × 1
= 62.2299049 sec

(7) Basin Demensions — Width 4 800 m × Length 5 000 m
× Depth 3.000 m

3. Fine Screen Channel	
〔1〕Design Condition	
(1) Design Wastewater Flow	Max Hourly = 100,000 m^3/day
	= 1.157 m^3/sec
[2] Geometory	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.800 m
Height	1.200 m
Floor Level	+ 76.700 m
Bottom	+ 73.700 m
Influent Water Level	+ 74.500 m
Velocity	1.157 ／ 0.800 ／ 0.800 ／ 2
	= 0.904 ≒ 1.000 m/sec
(2) Screen Channel	
Number	2 Main + 1 Bypass
Width	1.400 m
Side Water Depth	0.900 m
Velocity	1.157 ／ 1.400 ／ 0.900 ／ 2
	= 0.459 ≒ 0.450 m/sec
(3) Channel Dimensions	Width 1.4 m × Length 8.5 m
	× SWD 0.9 m (Freeboard 0.3m)
[3] Equipment	
(1) Inlet Gate	
Number	2 W + 1 S 0.2
Dimension	Width 0.8 m × Height 1.2 m
Design Water Level	3.00 m
(2) Fine Screens (Main Channel)	
Number	2 W + 0 S
Open Space	6 mm
Bar Thickness	2 mm
Channel Width	1.4 m
Width of side plate	50 mm
Side Water Depth	0.9 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	1.157 ／ 1.300 ／ 0.850 ／ 2
	× (6 + 2) / 6
	= 0.698 < 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	0.9 m
Velocity through screen	1.157 ／ 1.200 ／ 0.900 ／ 2
	× (20 + 9) / 20
	= 0.777 < 0.800 m/sec

4. **Grit Chamber**	
〔1〕 Design Condition	
(1) Design Flow	Max Hourly = 100,000 m^3/day
	= 1.157 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.01157407 m/sec = 1000 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	Square Grit Chamber
(1) Surface Area required	1.157 ／ 0.01157407 = 99.96 m^2
(2) Number of Basins	2 Basins
(3) Surface Area required/Basin	99.96 ／ 2 = 49.9824 m^2
(4) Length of Basin	49.9824 ^0.5 = 7.1 m → 7.1 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	1.157 × 60 sec ／ 2 = 34.7 m^3
(7) Depth required	34.7 ／ 7.1 ／ 7.1 = 0.689 → 0.8 m
(8) Basin Dimensions	Width 7.1 m × Length 7.1 m
	× Depth 0.8 m (Freeboard 0.3m)
(9) Retention Time	7.1 × 7.1 × 0.8 ／ 1.157 × 2
	= 69.71 sec
(10) Surface Overflow Rate at Peak Flow	100,000 ／ 7.1 ／ 7.1 ／ 2
	= 991.866693 < 1000 m^3/m^2/day
[3] Inlet Weir Gate	
(1) Number	2 Units
(2) Weir Width	2.400 m
(3) Stroke	0.600 m
(4) Overflow Height	0.500 m
(5) Overflow Height (actual)	$(1.157 ／ 1.840 ／ 2.400 ／ 2)^{2/3}$
	= 0.258 < 0.500 m

5.	**Primary Clarifire**								
〔1〕	Design Condition								
(1)	Design Wastewater Flow	Average Hourly		=	50,000	m^3/day			
				=	0.579	m^3/sec			
				=	34.72	m^3/min			
(2)	Type	Circular Clarifire							
(3)	Surface Overflow Rate required				35 m^3/m^2/day				
(4)	Number of Basins	2	Basins						
[2]	Design								
(1)	Surface Area required	50,000	／	35 =	1,429	m^2			
(2)	Surface Area required/Basin	1,429	／	2 =	714	m^2			
(3)	Depth required	3.0 m							
(4)	Diameter required	30.2 m							
(5)	Basin Demensions	Diameter	34.0 m	×	Depth	3.0 m			
[3]	Review								
(1)	Surface Area	907.920277 ×	2.0	=	1815.8	m^2			
(2)	Surface Overfloe Rate at Average Flow	50,000	／	1815.8	=	28	m^3/m^2/day		
[4]	Sludge generated per day								
(1)	Inlet TSS	600	mg/L						
(2)	Reduction in TSS	60%							
(3)	Outlet TSS	240	mg/L						
(4)	Solids removed from Primary Clarifiers	21,181	kg/day						
(5)	Solids Consistency	3 %							
(6)	Volume of Primary Sludge	Solids removed	×	100 / Solids Consistency	×	10^{-3}			
		=	706	m^3/day					
[5]	Equipment								
(1)	Primary Sludge Pumps								
	Sludge withdrawal	12	Times/day						
	Running Time	0.50	hr/Time						
	Number	2	W	+	1	S			
	Required Capacity	706	m^3/day	／	12.0	／	0.5	／	2
		=	58.8	m^3/Hr	⇒	65	m^3/Hr /Unit		

6. Reactor

[1] Design Condition

(1) Design Flow		Q =	50,000	m^3/day (summer)	
		Q' =	50,000	m^3/day(Winter)	
(2) Design Sewage Quality					
Inlet BOD			130	mg/l	
Outlet BOD			10.0	mg/l	
Inlet S-BOD			52	mg/l	
Inlet COD			228	mg/l	
Inlet S-COD	:sCOD		87	mg/l	
Outlet S-COD	:nbsCODe		4	mg/l	=sCOD-1.6sBOD
Inlet rbCOD			52	mg/l	
bCOD/BOD			1.60		
Inlet bCOD	:S_0		208	mg/l	
Inlet nbCOD			20	mg/l	
	:nbpCOD		16	mg/l	=TCOD-bCOD-nbsCODe
Inlet TSS			240	mg/l	
Inlet SS			240	mg/l	
Inlet VSS			180	mg/l	
	:VSS_{COD}		0.78	gCOD/gV	=TCOD-sCOD/VSS
	:nbVSS		20.68	gnbVSS/	=nbpCOD/VSS_{COD}
	:iTSS		60.00	gnbVSS/	=TSS-VSS
Inlet T-N			40	mg/l	
Inlet TKN			40	mg/l	
Inlet NH_4-N			25	mg/l	
Inlet T-P			6	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	
(3) Water Temperature		T=	20.0	°C	
(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°C

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	
(2) Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB}\times SF$

(3) Biomass production					
$Px_{,VSS}$	$Px_{,VSS}$=	4373.175	kg /d	=Px,bio+Q(nbVSS)	
$Px_{,TSS}$	$Px_{,TSS}$=	7962.433	kg /d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)	
S	S=	0.4606	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=	31.000	mg/l		
$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	3339.132	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)/[1+b_{AOB}(SRT)]	
		2954.259		=Q・Y_H(S_0-S)/[1+b_H(SRT)]	
		257.306		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]	
		127.566		=QYn(Nox)/[1+b_{AOB}(SRT)]	
NOx	NOx=	30.986	mg/l	=TKN-Ne-0.12$P_{X,bio}$/Q	
(4) Required Aeration Tank Volume					
Va=	Va=	12,843	m3		
τ =	τ =	6.16	hr	=Va/Q×24	
X_{VSS}・Va	X_{VSS}・Va=	21,161	kg VSS	=$Px_{,VSS}$・SRT	
X_{TSS}・Va	X_{TSS}・Va=	38,528	kg TSS	=$Px_{,TSS}$・SRT	
F/M	F/M=	0.307	kgBOD/kgMLVSS		
FractionVSS=	FractionVSS	0.549			
MLVSS=	MLVSS=	1648	mg/L		
(5) BODloading	BODloading	0.506	kg/m3・d		
(6) Observed Yield					
$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.228	gTSS/gBOD		
$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.674	gVSS/gBOD		
bCODremoved=	bCODremov	10,377	kg/d		
(7) effluent NO_2-N	NO_2-N=	0.2407	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=	0.5485	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			

[3] Design for Nitrification and Denitrification Process

(1) Active biomass concentration

X_b = $Q\cdot(SRT)/V\cdot Y_H(S_0-S)/[1+b_H(SRT)]$
= 1,113.07 mg/l

(2) IR ratio

IR = NOx/Nc-1.0-R
= 1.84

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

Nox feed= $(IR+R)\cdot Q\cdot Nc$
= 1,099,304.14 kg/d

(4) The anoxic tank volume

Vnor= 6,250 m3 τ_{DN}= 3.000 h

(5) F/M_b

F/M_b= 0.93 g/g·d

(6) Fraction of rbCOD

25.00% =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= 0.225 g/g·d $=b_0+b_1[\ln(F/M_b)]$

b_0= 0.235
b_1= 0.141

(8) SDNR

SDNR= 0.100 g/g·d $=SDNR_b(MLVSS_b/MLVSS)$

$SDNR_{adj}$= 0.149 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= 0.225 g/g·d $=SDNR_b\cdot\theta^{(t-20)}$ θ = 1.026

(9) NOr

NOr= 1,033,438.00 kg/d $=N_{nox}\cdot SDNR\cdot X_b$
>Nox feed= ####### kg/d

(10) Alkalinity to be added to maintain pH7

-167.15 mg/l

Influent Alk	380.00	mg/l	
Alk used	221.34	mg/l	=7.14×Nox
Alk produce(	78.49	mg/l	=3.57×(NOx-NOxe)
Alk to maint:	70.00	mg/l	

[5] **Reactor**

(1) Coagulant Dosage — 0.0 Mol

(2) Total volume of Aeration Basins

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

$= 12,843$ m^3

(3) Total volume of Anoxic Basins

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

$= 6,250$ m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m^3	hour	hour	
Anaerobic	V_{AN}	0	0.00	0.00	0.00
Anoxic	V_{DN}	6,250	3.00	3.00	1.00
Aerobic	V_A	12,840	6.16	6.16	2.05
Total	V	19,090	9.16	9.16	

[6] **Geometry**

(1) Basin Dimensions

	Width	Length	Depth	Basins
Aerobic tank	8.0	190.0	5.7	2
Anoxic tank	14.0	40.0	5.8	2

Cross Section: 8.0*5.7 = 45.6 m^2/Basin

Hantzsch Subtraction: = 1.0 m^2/Basin

after Subtraction: 45.6-1.0 = 44.6 m^2/Basin

Total Volume: 44.6*190.0 = 8,474 m^2/Basin 16,948 m^3/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m^2		80.2	44.6	
Length required	m		**39.0**	**143.9**	**182.9**
Volume required per Basin	m^3		3,125	6,420	9,545
Total Volume required	m^3		6,250	12,840	19,090
Actual Length	m		40.0	190.0	230.0
Actual Volume per Basin	m^3		3,208	8,474	11,682
Actual Total Volume	m^3		6,416	16,948	23,364
Actual Ratio of Volume			1.00	2.64	
Actual Retention Time	hour		3.08	8.14	11.22

[7]	Equipment							
(1)	Ras Pumps							
	Ras Ratio	60	%					
	Required Capacity	50,000	m3/day×	60%	／ 24	／	4	
		= 313	m3/Hr	⇒	320	m3/Hr		
	Number	4	Work					
		2	Stanby					
(2)	Circulation Pumps							
	Ras Ratio	184	%					
	Required Capacity	50,000	m3/day×	184%	／ 24	／	4	
		= 958	m3/Hr	⇒	960	m3/Hr		
	Number	4	Work					
		2	Stanby					
(3)	SAS Pumps							
	Excess Sludge	1,168	m3/day					
	Sludge withdraw	12	Times/day					
	Running Time	0.5	Hr/Time					
	Required Capacity	1,168	m3/day ／	12 ／		0.50 ／		2
		= 97.32	m3/Hr	⇒	100	m3/Hr		
	Number	2	Work					
		2	Stanby					

7. **Air Requirement at Average Flow**	
[1]Design Condition	
(1) AOR :R_0	R0= = 9,754 kg/day
	= 406.4 kg/h
Qin :Design Average Flow m^3/d	50,000
Inlet bCOD :S_0	208 mg/*l*
S=	S= 0.461 mg/*l*
Nox=	No› 31.000 mg/*l*
$P_{X,bio}$=	$P_{X,b}$ 3,211.6 kg VSS/ 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= 9,754 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 6.93 mg/L at 35 ℃
	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 $1+0.40D_j/Pa$ 1.20132
	D_j : Tank Liquid Depth 5.20 m
	P_a : Standard absolute pressure at s 10.332 m
	P_b : Absolute pressure at Plant Site Elevation 500 m
	P_b/P_a : exp[-gM(z_b-z_a)/R*T] 0.992
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 74 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 Wa 0.65
	β : relative DO Saturation to clean Wa 0.95
	F : Diffuser Fouling Factor 0.90
	$= \dfrac{74{,}629}{3.4189} =$ 21,828.47 kg/day
(3) No. of Basins	2 Basin
(4) Standard O2 required at Field Conditions per Bas =	10,914 kg/day
(5) SOTE for the above Effective Aeration Depth	30.5 %
(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	= 147,362 m^3/day = 6,140.1 m^3/hr

[2] Equipment

(1) Air Blower

Number	4	W + 2 S			
Required Capacity	6140.1	m^3/Hr·Basin /	2 unit/Basin		
	= 3070.0	m^3/h	⇒	3100	m^3/h /Unit
Pressure	65	kPa			
Safty Factor	10	%			
Heat capacity ratio	1.4				
Atmospheric pressuer at site elevation	100.497	kPa			
Total inlet pressure	98.497	kPa			
Volume rate of flow at inlet point	53.137	m3/min			
Total discharge pressure	165.497	kPa			
Overall adiabatic effeciency	0.65				
Inlet air temperature (min.)	15	℃			
Shaft power	76.371	kW			
Rated Output of Motor	84.008	kW	⇒	90	kW

8. Final Clarifire	
〔1〕Design Condition	Tube settlers
(1) Design Wastewater Flow	Q= 50,000 m^3/day
(2) Water Temperature	T= 20.0 ℃
(3) MLSS	Xef= 3,000 mg/*l*
(4) SVI	SVI= 200
(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 = 28.3 m/day → 15.0 $m^3/m^2 \cdot day$
(6) Surface Overflow Rate required	*S'*= v/(1.5*1)= 28.3/(1.5*1.0) = 18.9 $m^3/m^2 \cdot day$
[2]Geometory	
(1) Surface Area required	A= 50,000/15.0= = 3,333 m^2
(2) Demensions	Diameter Depth Basin **46.0** **3.2** **2**
(3) Actual Surface Area	S= 46.0^2 * 3.14 /4 * 2.0 = 3,324 m^2
(4) Ture Surface Overflow Rate	S= 50,000/3,324 = 15.0 $m^3/m^2 \cdot day$

9. **Chlorination Tank**	
[1]Design Condition	
(1) Design Wastewater Flow	Average Hourly 50,000 m^3/day
(2) No. Batch Basins	1 Basin
(3) No. of Cycles	- Cycles
(4) Contact Time	30 min
(5) Design Chlorine Dosage	5 mg/L
[2]Geometory	
(1) Volume required	Average Hourly ／ 1440 × Contact Time = 1041.7 m^3 Contact Time 30 min
(2) Tank Demensions	Width 18.0 m × Length 20.0 m × Depth 3.0 m (Freeboard 0.3m)
(3) No. of Tanks	1 Tank
[3]Review	
(1) Total Volume	Width × Length × Depth × No. of Tanks = 18.0 m × 20.0 m × 3.0 m × 1 = 1,080 m^3

10. Sludge Thikener				
〔1〕Design Condition				
(1) Primary Sludge	21,181 kg/day		706	m3/day
(2) Secondary Sludge	0 kg/day		0	m3/day
(3) Total Solids	21,181 kg/day		706	m3/day
(4) Operation Time	24 hours/day			
(5) Thikened Sludge Moisture Content	96.0 %			
[2]Geometory				
(1) Type				
(2) Number	2 W + 1 S			
(3) Design Solid Loadong	75 kg / m2/d			
(4) Required Surface Area	$21181 \times \frac{1}{75} = 282.40$ m2			
(5) Required diameter	$\left(\frac{4}{\pi} \times 282.40 \times \frac{1}{2}\right)^{1/2} = 13.41$ m			
	→ 13.50 m			
(6) Side Water Depth	3.5 m			
(7) Actual Volume of Tank	$\frac{\pi}{4} \times 13.50^2 = 143.14$ m3			
(8) Retention Time	$\frac{143.14}{706} \times 4 \times 2 \times 24 = 34.06$ Hr			
〔3〕Volume 0f Thikened Sludge	= 477 m^3/d			
〔4〕Quantity of Separation Liquid	Inlet Sludge Volume − Thikened Sludge Volume			
	= 706.0 − 476.6 = 229.5 m^3/day			

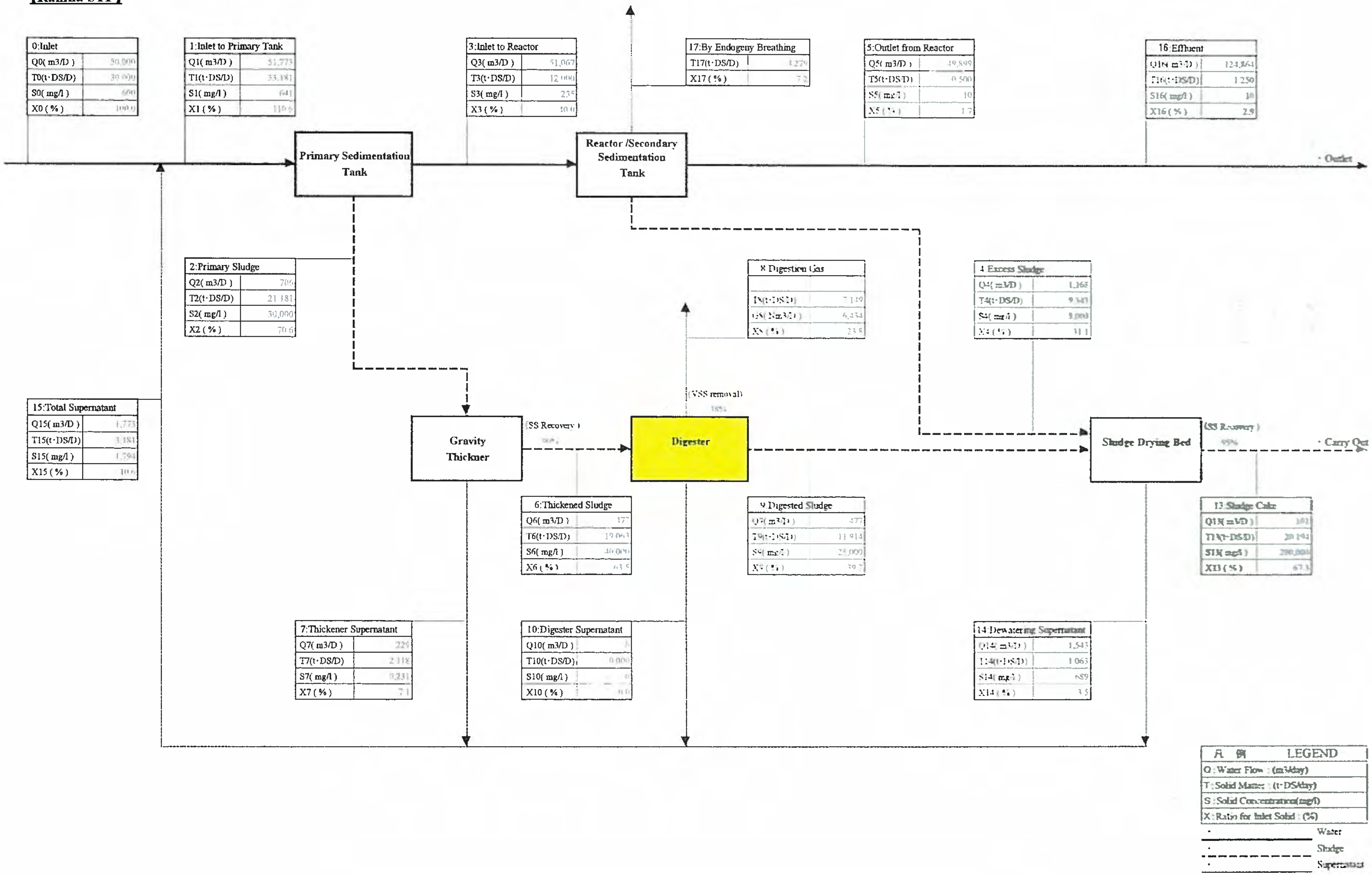
11. Thickened Sump								
[1]Design Condition								
(1) Inlet Solids	19,063	kg/day						
(2) Inlet Sludge Volume	477	m^3/d						
[2]Geometory								
(1) Sludge withdrawl	4	Times/day						
(2) Required Sump Volume	119	m^3						
(3) Number	2	Basins						
(4) Width	4.0	m						
(5) Length	4.5	m						
(6) Side Water Depth	3.5	m						
(7) Actual Sump Volume	4.0	×	4.5	×	3.5	×	2	
	=	126.0 m^3						
[3] Equipment								
(1) Mixing Air Blower								
Agitate Rate	1.20	$m^3/Hr \cdot m^3$						
Number	1	W	+	1	S			
Required Capacity	126	m^3	×	1.2	／	1		
	=	151.2	m^3/Hr	⇒	160	m^3/Hr /Unit		
(3) Digester Feed Pumps								
Transfer Time	8.00	Hr						
Number	2	W	+	1	S			
Required Capacity	477	m^3	／	8.0	／	2		
	=	29.8	m^3/Hr	⇒	30	m^3/Hr /Unit		

12. Sludge Digister	
〔1〕 Design Condition	
(1) Quantity of Thickened Sludge generated	19,063 kg/day
(2) Inlet Solids Consistency	4.00 %
(3) Volume of Thickened Sludge	Total Solids × 100 / Solids Consistency × 10^{-3}
	= 477 m^3/day
(4) Ratio of VSS	75 %
(5) Total VSS	= 14,297 kg/day
(6) Total inorganic Sludge	= 4,766 kg/day
(7) Retention Time	20 days
(8) % Destruction in VSS	50 %
(9) VSS destroyed	= 7,149 kg/day
(10) Quantity of Digested Sludge generated	= 11,914 kg/day
(11) Solids Consistency	1.5625 %
(12) Volume of Digested Sludge	Total Solids × 100 / Solids Consistency × 10^{-3}
	= 477 m^3/day
[2] Geometry	
(1) Volume required	9,531 m^3
(2) No. of Basins	2 Basins
(3) Volume required per Basin	= 4,766 m^3
(4) Depth provided	10.0 m
(5) Area required per Basin	= 477 m^2
(6) Diameter required per Basin	= 24.6 m
(7) Basin Dimensions	Diameter 25.0 m × Depth 10.0 m
	× 2 Basins = 9,817 m^3 (Freeboard 0.8m)
[3] Equipment	
(1) Mixers for Digestion Tanks	
Capacity	4909 m^3
Number	2 W + 0 S
(2) Digested Sludge Transfer Pumps	
Transfer Time	8.00 Hr
Number	2 W + 2 S
Required Capacity	477 m^3 ／ 8.0 ／ 2
	= 29.8 m^3/Hr ⇒ 30 m^3/Hr /Unit

13. **Biogas Power Generation**								
[1] Design Condition								
(1) Biogas generated per Kg of VSS destroyed	0.9	m^3/kg						
(2) VSS destroyed	7,149	kg/day						
(3) Biogas generated	6,434	m^3/day						
(4) Gas Holder Volume required	25 %							
	= 1,608	m^3						
(5) No. of Units provided	2							
(6) Volume of each Gas Holder required	= 804	m^3						
[2] Geometry								
(1) Biogas Holder	Diameter	12.0 m	×	height	8.0	m	×	2 Basins
	Sphere	$V=\pi/4*D^2*h$						
	= 1,810	m^3	(Freeboard 0.8m)					
[3] Equipment								
(1) Biogas Power generators								
Biogas Generation	0.074	m^3/sec						
Biogas Caloric Value	22,000	KJ/m^3						
Biogas Engine Conversion Efficiency	40.0	%						
Number	1	W	+	1	S			
Power Generation	0.074	m^3/sec	×	22000	KJ/m^3	×	0.4 /	1
	= 655.3	kW	⇒	660	kW			
(2) Desulfurization Equipment								
Biogas Generation	268.07	m^3/hr						
Peak Ratio	1.5							
Number	2	W	+	0	S			
Required Capacity	268.07	m^3/Hr	×	1.5	/	2		
	= 201.1	m^3/Hr	⇒	210	m^3/Hr /Unit			
(3) Biogas Blowers								
Biogas Generation	268.07	m^3/hr						
Safety Factor	1.5							
Number	2	W	+	1	S			
Required Capacity	268.07	m^3/Hr	×	1.5	/	2		
	= 201.1	m^3/Hr	⇒	210	m^3/Hr /Unit			
(4) Biogas Flare								
Biogas Generation	6433.73	m^3/sec						
Operating hours	24	Hr						
Safety Factor	150.0	%						
Number	1	W	+	1	S			
Power Generation	402	m^3/hr	⇒	410	m^3/hr			

14.	**Sludge Drying Bed**						
〔1〕	Design Condition						
(1)	Digested Sludge	11,914	kg/day			477	m3/day
(2)	Secondary Sludge	9,343	kg/day			1,168	m3/day
(3)	Total Solids	21,257	kg/day			1,644	m3/day
(4)	Solids Consistency	1.29%					
(5)	Sludge Drying Period	12.00	days				
(6)	Sludge Loading	20.00	kg/m2				
(7)	Required total area of beds	21,257	×	12.00 / 30.00			
		= 8,503 m^2					
(8)	No. of Sludge drying beds	12 W	+	0 S			
(9)	Basin Dimensions	Width 20.0 m	×	Length 36.0 m	×	12	
		= ##### m^3					

Material Balance Sheet
【Ramna STP】



List of Main Structures

Sr. No.	Description	Dimensions (Length/Dia. x Width x Depth/Height [m])
1	Inlet Chamber	5.4 x 4.3 x 3.5
2	Mechanical Fine Screen Channel	8.5 x 1.4 x 1.2
3	Grit Distribution Chamber	6.0 x 2.0 x 1.7
4	Grit Chamber	7.1 x 7.1 x 1.5
5	Parshall Flume	8.5 x 1.3 x 1.3
6	Primary Clarifier Distribution Chamber	4.0Dia. x 2.0Ht.
7	Primary Clarifier	34.0Dia. x 3.5Ht.
8	Bioreactor Distibution Chamber	4.5 x 2.5 x 2.0
9	Channel for Bioreactor	30.0 x 1.3 x 1.0
10	Anoxic Tank	14.0 x 40.0 x 6.4
11	Aeration Tank	38.0 x 40.0 x 6.3
12	Secondary Clarifier Distribution Chamber	4.0Dia. x 2.0Ht.
13	Secondary Clarifier	54.0Dia. x 3.7Ht.
14	Chlorine Mixing Tank	5.5 x 4.5 x 3.5
15	Chlorine Contact Tank	18.0 x 20.0 x 3.5
16	Dechlorination Chamber	5.5 x 4.5 x 3.5
17	Sludge Thickener	13.0Dia. x 4.7Ht.
18	Anaerobic Sludge Digester	30.0Dia. x 11.5Ht.
19	Gas Holder	12.0Dia. x 9.2Ht.
20	Sludge Drying Bed	36.0 x 20.0 x 0.6
21	Primary Sludge Sump	5.6Dia. x 2.5Ht.
22	Recirculation Sludge Sump	9.0Dia. x 4.7Ht
23	Thickened Sludge Sump	6.2Dia. x 3.5Ht.
24	Filterate Sump	5.5Dia. x 2.5Ht.
25	Effluent Pumping Station	15.0Dia. x 6.0Ht.
26	Effluent Overhead Tank	-
27	Gas Engine Building	20.0 x 9.0 x 4.0Ht.
28	Substation & Transformer Yard	33.0 x 16.5 x 4.0Ht.
29	Administration Building & LAB	35.0 x 18.0

0 20 40 60 80 100m

Project Name

PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTAR PRADESH, INDIA

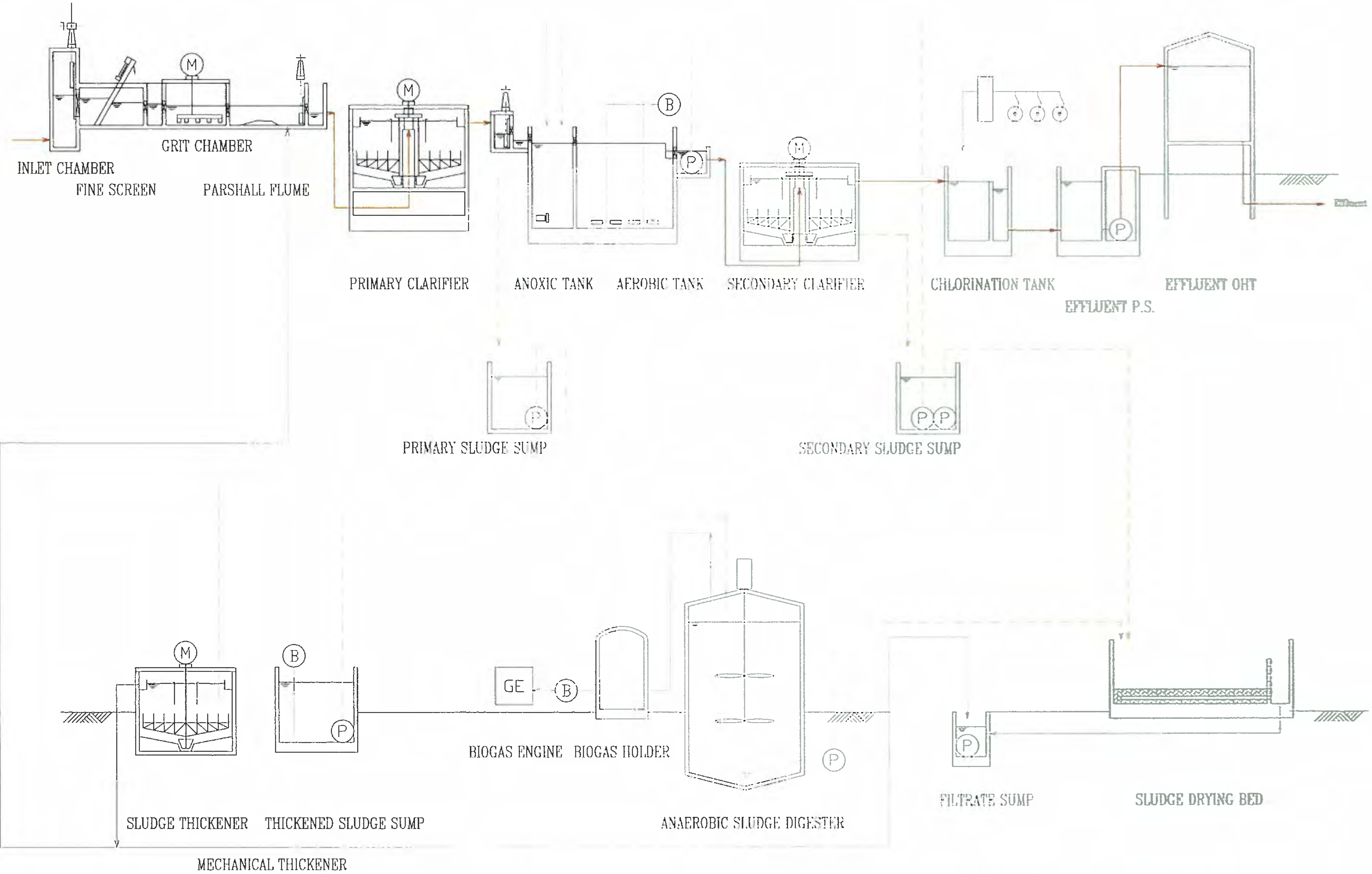
インド国ガンジス川浄化事業準備調査

Drawing Title

Ramna STP Layout

Scale: 1:2000 (A3)

Drawing No. STP-25



Main Process
Sludge Line
Other Line
Existing structure

Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title: Ramna STP 50MLD Layout	Scale: not
	Drawing No. STP-05

4. Mirzapur 14MLD STP

Item	Mirzapur-STP

1 **Desin Condition**

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	14,000	583.33	0.162
Max Dayly	14,000	583.33	0.162
Max Hourly Peak factor 2.25	31,500	1312.50	0.365

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP
				NH_4-N	org-N	NOx-N	
Inlet	250	450	400	25	10	5	5
Outlet	10	50	20	2	0	8	2
Removal rate	96.0%	88.9%	95.0%	75.0%			60.0%

2. Inlet Chamber (existing structure)

[1] Design Condition

(1) Design Wastewater Flow — Max Hourly = 14,000 m3/day
= 0.162 m3/day

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — - m

(3) Width of Basin — *** m

(4) Length of Basin — *** m

3.	**Fine Screen Channel (existing structure)**								
[1]	**Design Condition**								
(1)	Design Wastewater Flow	Max Hourly			=	14,000	m3/day		
					=	0.162	m3/sec		
[2]	**Geometry**								
(1)	Inlet Gate								
	Number	1	Main	+	1	Bypass			
	Width	0.800	m						
	Height	0.800	m						
	Floor Level	+	***	m					
	Bottom	+	85.500	m					
	Influent Water Level	+	86.200	m					
	Velocity	0.162	／	0.800	／	0.700	／	1	
		=	0.289	<	1.000	m/sec			
(2)	Screen Channel								
	Number	1	Main	+	1	Bypass			
	Width	2.000	m						
	Side Water Depth	0.600	m						
	Velocity	0.162	／	2.000	／	0.600	／	1	
		=	0.135	<	0.450	m/sec			
(3)	Channel Dimensions	Width	2.0	m	×	Length	5.0	m	
		×	SWD	0.7	m				
[3]	**Equipment**								
(1)	Inlet Gate								
	Number	1	units						
	Dimension	Width	0.8	m	×	Height	0.8	m	
	Design Water Level		m						
(2)	Fine Screens (Main Channel)								
	Number	1	W	+	0	S			
	Open Space	6	mm						
	Bar Thickness	2	mm						
	Channel Width	2.0	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	0.162	／	1.900	／	0.650	／	1	
		× (	6	+	2	) /	6		
		=	0.175	<	0.800	m/sec			
(3)	Fine Screens (Bypass Channel)								
	Number	0	W	+	1	S			
	Open Space	20	mm						
	Bar Thickness	9	mm						
	Channel Width	2.0	m						
	Side Water Depth	0.7	m						
	Velocity through screen	0.162	／	2.000	／	0.700	／	1	
		× (	20	+	9	) /	20		
		=	0.168	<	0.800	m/sec			

4. Grit Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 31,500 m^3/day
= 0.365 m3/sec

(2) Specific gravity of Sand — 2.65

(3) Sedimentation Velocity — 0.0521 m/sec = 4,500 m^3/m^2/day

(4) Average Velocity — 0.3 m/sec

[2] Grit Chamber — **Vortex Grit Chamber**

(1) Surface Area required — 0.365 ⁄ 0.0521 = 7.01 m^2

(2) Number of Basins — 1 S + 1 W

(3) Surface Area required/Basin — 7.0 ⁄ 1 = 7.01 m^2

(4) Diameter of Basin — (4 ⁄ π × 7.01) ^0.5 = 3.0 m
→ 3.0 m

(5) Basin Dimensions — Dia. 3.0 m × Depth m

[3] Parshall Flume

(1) Design Flow Rate — Q= 365.000 l/sec

(2) Throat width — W= 0.450 m

(3) Water depth Ha — Ha= (Q ⁄ 2264 ⁄ W) $^{2/3}$
Ha= 0.504 m

(4) Crest Level — + 85.27 m ≒ Minimum water level at downstream channel

(5) Water level at the crest — + 85.774 m

(6) Channel bottom level — + 85.000 m

(7) Upstream Channel width — 1.200 m

(8) SWD of Upstream Channel — 0.800 m

(9) Average velocity at upstream channel — 0.380 m/sec

(10) Total Length of channel — 10.000 m

5. UASB (existing)

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	14,000	583.33	0.162
Max Daily	14,000	583.33	0.162
Max Hourly Peak factor 2.25	31,500	1312.50	0.365

(2) Design Water Quality

Unit:mg/L

	BOD	COD	SS	T-N			TP
				NH_4-N	org-N	NOx-N	
Inlet	250	450	400	25	15	0	5
Outlet	10	50	20	2	0	8	2
Removal rate	96.0%	88.9%	95.0%	75.0%			60.0%

(3) Design Performance

Unit:mg/L

	BOD	COD	SS	T-N			TP
				NH_4-N	org-N	NOx-N	
Inlet of UASB	250	450	400	25	15	0	5
Removal rate	0%	0%	0%	0			-
Outlet of UASB	250.0	450.0	400.0	40.0			-

6.	**SBR**					
[1]	**Design Condition**					
(1)	Design Flow		Q=	14,000	m^3/day (summer)	
			Q'=	14,000	m^3/day(Winter)	
(2)	Design Sewage Quality					
	Inlet BOD			250	mg/l	when UASB process is skipped.
	Outlet BOD			10.0	mg/l	
	Inlet S-BOD			166.7	mg/l	assumed as 2/3 of BOD
	Inlet COD			450.0	mg/l	when UASB process is skipped.
	Inlet S-COD	:sCOD		300	mg/l	assumed as 2/3 of BOD
	Outlet S-COD	:nbsCODe		33	mg/l	=sCOD-1.6sBOD
	Inlet rbCOD			68	mg/l	assumed as 15% of COD
	bCOD/BOD			1.60		
	Inlet bCOD	:S_0		400	mg/l	=1.6BOD
	Inlet nbCOD			50	mg/l	
		:nbpCOD		17	mg/l	=TCOD-bCOD-nbsCODe
	Inlet TSS			400	mg/l	when UASB process is skipped.
	Inlet VSS			280	mg/l	assumed as 70% of TSS
		:VSS_{COD}		0.54	gCOD/gVSS	=TCOD-sCOD/VSS
		:nbVSS		31.11	gnbVSS/m3	=nbpCOD/VSS_{COD}
		:iTSS		120.00	gnbVSS/m3	=TSS-VSS
	Inlet T-N			40	mg/l	
	Inlet TKN			40	mg/l	
	Inlet NH_4-N			25	mg/l	
	Ammonia oxidized			65.00%	of TKN	assumed
	Inlet T-P			-	mg/l	
	Inlet Alkalinity as CaCO3			200	mg/l	
	Outlet Kjeldahl N			2.0	mg/l	
	Outlet NH4-N			2.0	mg/l	
	Outlet NO3-N			8.0	mg/l	
(3)	Water Temperature		T=	20.0	°C	
(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		2.40	h	
	td	Anoxic(denitrification) time		1.05	h	
	t_A	Aeration time		2.00	h	
	t_S	Settlement time		0.75	h	
	t_D	Decanting time		1.00	h	
(9)	Number of cycles			5.0	cycles/basin・day	× 2 tanks
			total	10	cycles/day	
(10)	Full volume per cycle			1,400.000	m3/fill	
(11)	Full liquid depth			5.50	m	
(12)	Decant depth			1.65	m	30.0% of full tank depth
(13)	Required aeration tank volume			4666.67	m3/tank	τa= 0.667 day; 16.000 h
(14)	Decant flow rate		1,400.000 m3/fill	/ 1.00 h	=	1400 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			583.33	m3/h	
(19)	Flow rate to each basin			583.33	m3/h	

[2] Design for Nitrification Process

(1) Activated sludge design kinetic 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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(2) SRT calculated with the assumed operating condition

SRT= 7.0733 day

a: $(Px_{,TSS})SRT$	28,000.000	kg	$=V \cdot X_{MLSS}$
b: $(Px_{,TSS})SRT$	27,994.272	kg	=SUM(①:⑤)
①=	11,332.322	kg	$=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]/0.85$
②=	3,080.815	kg	=Q(SRT)nbVSS
③=	253.851	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]/0.85$
④=	1,444.140	kg	$=f_d \cdot b_H \cdot QY_H(S_0-S)SRT^2/[1+b_H(SRT)]/0.85$
⑤=	11,883.144	kg	=Q(SRT)(TSS0-VSS0)

(3) Sludge production $Px_{,TSS}$

$Px_{,TSS}$= 3,957.739 kg/day

(4) Determine MLVSS concentration

$(Px,_{VSS})SRT$=

$(Px_{,VSS})SRT$	14,156.581	kg	=SUM(①:④)
①=	9,632.474	kg	$=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
②=	3,080.815	kg	=Q(SRT)nbVSS
③=	215.773	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]$
④=	1,227.519	kg	$=f_d \cdot b_H \cdot QY_H(S_0-S)SRT^2/[1+b_H(SRT)]$

X_{MLVSS}=	X_{MLVSS}=	1,517	mg/l		
NOx	NOx=	26.000	mg/l	=TKN× 65.00%	
S	S=	0.3644	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		
bn average	b_n=	0.1117		$=b_{NOB1} \cdot (ta/Tc)+b_{NOB2} \cdot (1-ta/Tc)$	
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	0.506	=MLVSS/MLSS		

(5) Determine amount of NH4-N oxidized

Biomass production Px,bio=

Px,bio=	1,565.856	kg	=SUM(①:③)
①=	1,361.808	kg	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
②=	30.505	kg	$=QYn(NOx)/[1+b_{AOB}(SRT)]$
③=	173.543		$=f_d \cdot b_H \cdot QY_H(S_0-S)SRT/[1+b_H(SRT)]$

NOx= 24.578 mg/l $=TKN_0-N_e-0.12P_{x,bio}/Q$

< 26.000 mg/l (assumed Nox) **OK**

(6) NO3-N Produced per cycles	At tank full	NO3-N =	34.410	gNOx/fill		
			7.374	g/m3	concentration	
		<	8.0	g/m3		OK
	After decant	NO3-N =	24.087	gNOx/decant		
			7.374	g/m3	concentration	
	At tank full	Xb=	1032.051	g/m3	$=P_{x,bio}*SRT/V_T$	
		Biomass=	4,816	kg		
		Q_F=	14,000	m3/d	$=V_F/t_F$	
		$Q_F \cdot S_O$=	3,500	kg/day		
(7) Initial NH4-N		N_O=	8.774	mg/l	$=[V_F(NOx)+V_{S(Ne)}]/V_T$	
$V_F(NOx)$=		$V_F(NOx)$=	34.410	kg		
Vs(Ne)=		Vs(Ne)=	6.533	kg		
(8) Nitrifier concentration		Xn=	21.9	mg/l	$=Q \cdot Yn \cdot NOx \cdot SRT/[1+b_{NOB}(SRT)]/V$	
b_{NOB}		b_{NOB}=	0.1117			
(9) Review of Aeration time for nitrification		t=	7.512809498	=	$K_{NH4}\ln(N_o/N_t)+(N_o-N_t)$	
			104.9015798		$X_n(\mu_{max,AOB}/Y_n)[S_o/(K_{o,AOB}+S_o)]$	
		t=	0.072	day		
			1.719	h		
		<	2.00	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=	0.727	g/g·d		
(2) Fraction of rbCOD			16.88%		=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=	0.175	g/g·d	$=SDNR_b \cdot \theta^{(t-20)}$	θ= 1.026
		SDNRb=	0.175	g/g·d	$=b_0+b_1[\ln(F/M_b)]$	
		b_0=	0.213			
		b_1=	0.118			
(4) NO3-N removal capacity during the fill period (per tank)		NOx=	844,435	g/g·d	$=SDNR_t(X_b)(V_T)$	
		td=	1.050	hr		
(5) NO3-N removal capacity .NOr		NOr=	36,944	g	$=NO_x \cdot td/24$	
		>Nox feed=	24,087	g		OK

[4] Geometry								
(1) Basin Dimensions	Width	Length		Depth	Basins			
	29.0		30.0	5.5	2			
Cross Section	29.0*5.5			=	159.5 m^2/Basin			
Total Volume	159.5*30.0			=	4,785 m3/Basin >		4,667 m3	
					9,570 m^3/Total			
[5] Equipment								
(1) RAS Pumps								
RAS Ratio	10	%						
Required Capacity	583	m3/h*		10%				
	= 58	m3/Hr	=>	60	m3/Hr			
Number	2	Work						
	1	Standby (Spare)						
(2) SAS Pumps								
Excess Sludge	669	m3/day						
Sludge withdraw	5	cycles/day						
Running Time	1.0	Hr/Time						
Required Capacity	669	m3/day /		5 /		1.00 /	2	
	= 66.88	m3/Hr	=>	12	m3/Hr			
Number	2	Work						
	1	Standby (Spare)						

SBR4/4

7.	**Air Requirement at Average Flow**		
[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=	4,944 kg O2/d
	Qin : Design Average Flow m^3/d		14,000
	Inlet bCOD	S0=	400 mg/l
	S=	S=	0.364 mg/l
	Nox=	NOx=	24.578 mg/l
	$P_{X,bio}$=	$P_{X,bio}$=	1,565.9 kg VSS/d *does not include nitrifying bacteria
(2)	SOR(Standard Oxygen Transfer Rate at site)	=	$\frac{R0 \times C_S\cdot a \times 1.024^{20-T}}{\alpha \times F (\beta\cdot C_{SW/CS}\cdot(Pb/Pa)a-C_A)}$
		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	: $\exp[-gM(z_b-z_a)/R*T]$ 0.991
		g	: Acceleration due to Gravity 9.80665 m/s^2
		M	: Mole of Air 28.97 kg/kg-mole
		z_b	: Plant Site Elevation 85 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
		=	$\frac{37,582}{3.3837}$ = 11,106.75 kg/day
(3)	No. of Basins		2 Basin
(4)	Number of cycles		5.0 cycles/basin·day × 2
		total	10 cycles/day
(5)	Standard O2 required at Field Conditions per cycle	=	1,110.7 kg/cycle/basin/day
(6)	SOTE for the above Effective Aeration Depth		30.5 %
(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	=	14,344 m3/cycle/basin/day
(11)	Aeration time per cycle t_A		2.00 h
		=	7,172.0 m^3/hr/basin

[2] **Equipment**

(1) Air Blower

Operating No. per basin		4	unit/Basin				
Operating No. per set of blowers		2	basin/set				
Required Capacity		7172.0	m^3/Hr·Basin	／		4	unit/Basin
	=	1793.0	m^3/Hr	⇒		2000	m^3/Hr /Unit
Number		4	W	+	2	S	
Pressure		65	kPa				
Safety Factor		10	%				
Heat capacity ratio		1.4					
Atmospheric pressure at site elevation		100.374	kPa				
Total inlet pressure		98.374	kPa				
Volume rate of flow at inlet point		34.325	m3/min				
Total discharge pressure		165.374	kPa				
Overall adiabatic efficiency		0.65					
Inlet air temperature (min.)		15	℃				
Shaft power		49.323	kW				
Rated Output of Motor		54.255	kW	⇒		75	kW

8. **Equialization Tank**

[1] **Geometry**

Design Flow Rate	Peak Flow		1312.5	m3/h	=	0.365	m3/sec		
Design Flow Rate	Average Flow		583.3	m3/h	=	0.162	m3/sec		
Width			7.00	m					
Length			30.00	m					
Pump Operating Depth			1.50	m					
Storage capacity		(	7.00	×	30.00	×	1.50	) ／	583.3
		=	0.54	h	>	0.5 h	Average Flow		
High Water Level		+	83.600	m					
Pump Off Level		+	82.100	m					

[2] **Equipment**

(1) CCT Feed Pump

Number		4	W	+	2	S
Discharge Flow		1312.5	／	4		
Design Flow for the year 2035	=	328	⇒	330	m3/h	

Air Requirement at Average Flow2/2

9. Chlorination	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 32,000 m^3/day included 18MLD STP
(2) Contact Time	30 min
(3) Type of Chlorine	Bleaching Powder (Availtive chlorine 70%)
(4) Design Chlorine Dosage Rate	10 mg/L
(5) Required Chlorine per day	Average Daily Flow ／ 1000 × Design Chlorine Dosage Rate
	＝ 320.0 kg/d
	＝ 13.33 kg/h
(6) Consumption per day	457.1 kg/d as Bleaching Powder
[2] Chlorination Contact Tank	
(1) Volume required	Average Daily Flow ／ 1440 × Contact Time
	＝ 666.7 m^3
	Contact Time 30 min
(2) Nos. of lanes	5 lanes
(3) Width of lane	2.00 m
(4) Length of lane	23.00 m
(5) Side Water Depth	3.00 m
(6) Nos. of Tanks	1 tank
(7) Total Width of Tank	13.00 m Approx..
(8) Average Velocity	Average Daily Flow ／ 86400 ／ Width ／ Depth
	＝ 32,000 ／ 86400 ／ 2.00 ／ 3.00
	＝ 0.062 m/sec
(9) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
	＝ 2.0 m × 23.0 m × 3.0 m
	× 5 × 1
	＝ 690 m^3 > 666.7 m^3
[3] Equipment	
(1) Chlorine Solution Tank	
Number	2 W + 0 S
Chlorine concentration	2 %
Gravity of dissolved chlorine	1.10
Required solution volume	320.00 kg / d × 100 / 2 / 1.10 / 1000
	＝ 14.55 m3/d
	＝ 582 l/h
Dimension of Tank	2.0 mW × 2.0 mL × 2.5 mSWD
Volume of Tank	10.0 m3/tank
Total Volume of Tanks	20.0 m3 (Duration= 1.38 day)
(2) Mixer for Chlorine Solution Tank	
Number	2 W + 0 S
(3) Chlorine Dosing Pump	
Number	2 W + 1 S
Capacity	582 l/h / 2
	291 l/h/unit ⇒ 300 l/h/unit

10. Dechlorination	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 32,000 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)
	＝ 76.2 kg/d
	＝ 3.17 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Daily Flow ／ 1440 × Contact Time
	＝ 222.2 m^3
	Contact Time 10 min
(2) Width of lane	13.00 m
(3) Length of lane	6.00 m
(4) Side Water Depth	3.00 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 13.0 m × 6.0 m × 3.0 m
	＝ 234 m^3 > 222.2 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	76.16 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.69 m3/d
	＝ 27.69 l/h
Volume of Tank	1.0 m3/tank
Total Volume of Tanks	2.0 m3 (Duration= 2.89 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	27.69 l/h / 1
	27.69 l/h/unit ⇒ 30 l/h/unit

11. Sludge Thickener

[1] Design Condition

(1)	UASB Sludge (14MLD STP)	0	kg/day	0	m3/day
(2)	Excess Sludge (14MLD STP)	5,351	kg/day	669	m3/day
(2)	Excess Sludge (18MLD STP)	5,882	kg/day	735	m3/day
(3)	Total Solids	11,233	kg/day	1,404	m3/day
(4)	Operation Time	24	hours/day		
(5)	Thickened Sludge Moisture Content	97.5	%		

[2] Geometry

(1) Type

(2) Number: 2 W + 0 S

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

(4) Required Surface Area: $11233 \times \frac{1}{40} = 280.80$ m2

(5) Required diameter: $\left(\frac{4}{\pi} \times 280.80 \times \frac{1}{2} \right)^{1/2} = 13.37$ m $\rightarrow$ 13.50 m

(6) Side Water Depth: 4 m

(7) Actual Volume of Tank: $\frac{\pi}{4} \times 13.50^{2} \times 4 = 572.56$ m3

(8) Retention Time: $\frac{572.56}{1404} \times 2 \times 24 = 19.58$ Hr

12. Thickened Sludge Sump

[1] Design Condition

(1) Inlet Solids: 4,816 kg/day + 5,294 kg/day = 10,109 kg/day

(2) Inlet Sludge Volume: 193 m^3/d + 212 m^3/d = 404 m^3/d

[2] Geometry

(1)	Sludge withdrawal	12	Times/day
(2)	Required Sump Volume	34	m^3/time
(3)	Number	2	Basins
(4)	Width	2.5	m
(5)	Length	2.5	m
(6)	Side Water Depth	3.0	m

(7) Actual Sump Volume: $2.5 \times 2.5 \times 3.0 \times 2 = 37.5\ m^3$

[3] Equipment

(1) Thickened Sludge Pumps

Transfer Time: 6.00 Hr

Number: 1 W + 1 S

Required Capacity: 404 m^3 / 6.0 / 1 = 67.4 m^3/Hr $\Rightarrow$ 70 m^3/Hr /Unit

13 Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge			
(2)	Quantity of Thickened Sludge generated	10,109	kg/day		
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte	1.5	kg/t-DS·day	
(4)	Volume of Thickened Sludge	404.4	m^3/day		
(5)	Consistency of Dewatered Sludge	82	%		
(6)	Operation Time	8	hours/day	(6 days per week)	

[2] Volume of Centrifuges

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

$$= \frac{404.4}{8 \times 2} \times \frac{7}{6} = 29.5$$

$\rightarrow$ 30 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)
= 10,109 × (1 + 0.0015)
= 10,125 kg/day

[4] Dewatered Cake Volume

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

$$= 10,125 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 65.63 t/day
apparent specific gravity 1.00

65.63 ／ 1.0 = 65.6 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte	1.5	kg/t-DS·day
(2)	Required Polyelectrolyte	15.16	kg/day	
(3)	Dissolving concentration	0.20	%	
(4)	Volume of Polyelectrolyte solution	7.58	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 7.58 m3/day

Operation Time 8 hours/day (6 days per week)

Safety Factor 1.5

Number 2 W + 1 S

Required Capacity 7.58 m^3/Hr ／ 8.0 ／ 2
= 0.47 m^3/Hr

Specification Capacity 0.47 m^3/Hr × 1.5
= 0.711 m^3/Hr ⇒ 0.80 m^3/Hr /Unit

(4) Polyelectrolyte dosing System

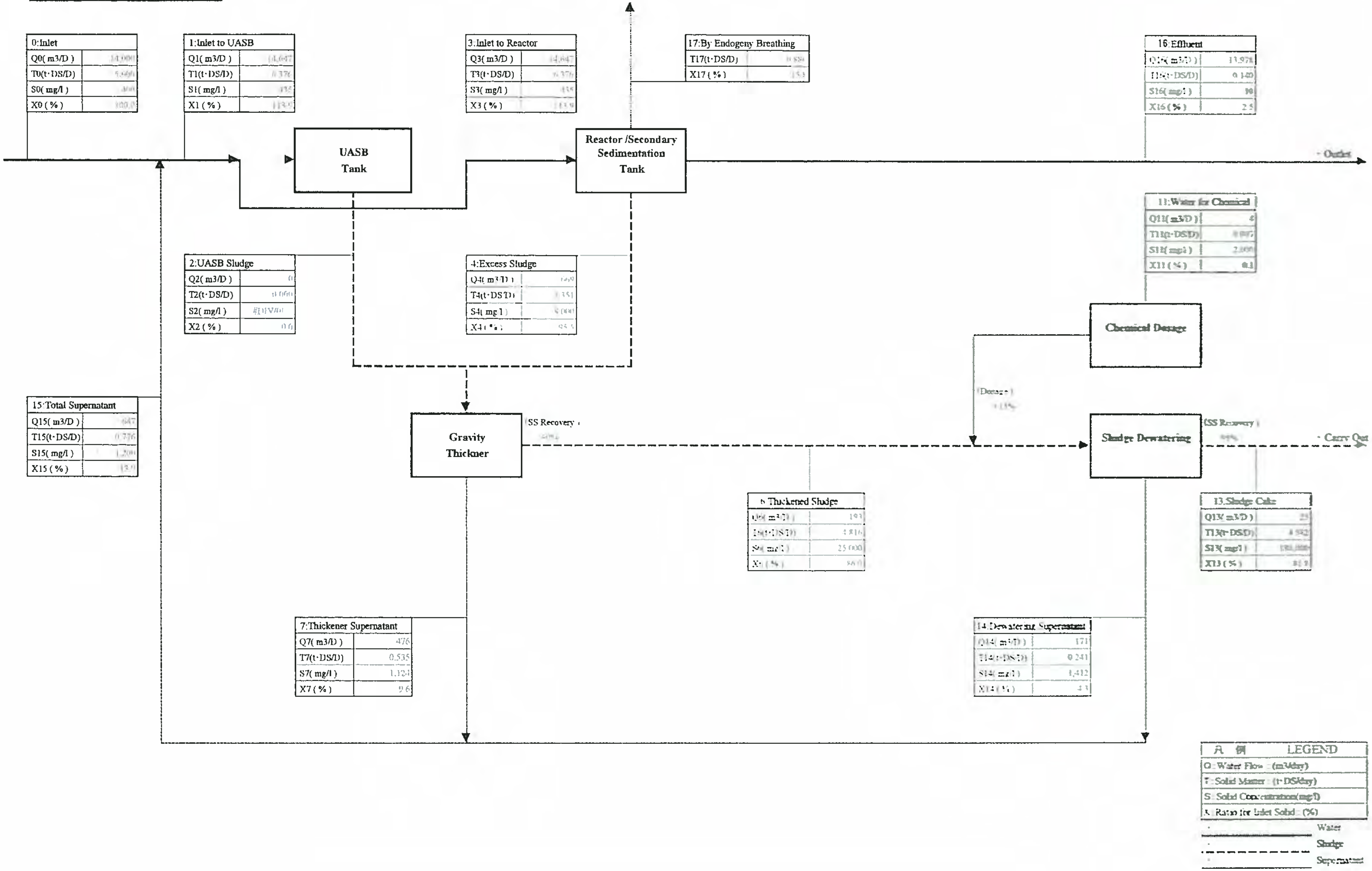
Tanks Dimensions Width 2.0 m × Length 2.0 m
× Depth 2.0 m × 2 (Freeboard 0.5m)
= 16 m^3

Retention Time of Tanks 16.00 m^3 ／ 0.47 m^3/Hr ／ 2
= 16.882 Hr

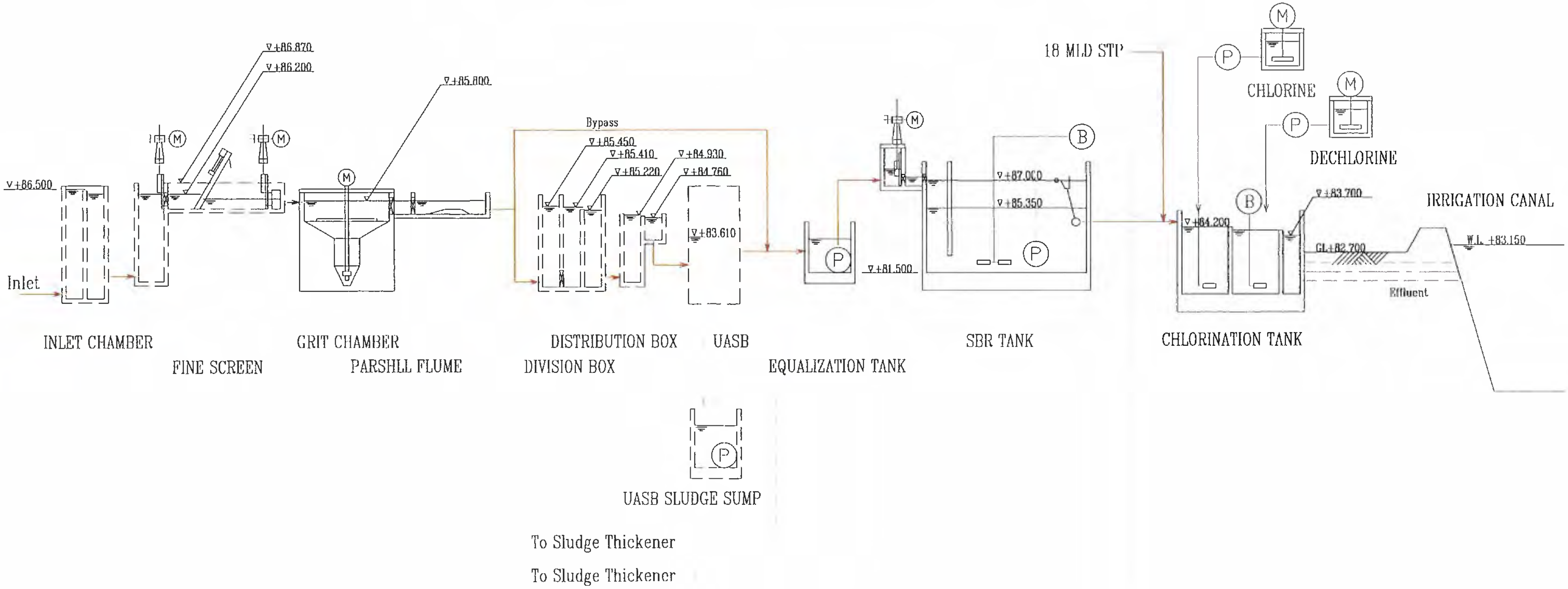
Number 2 W + 0 S

14. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	10,109 kg/day
(2) Solids Consistency	2.50 %
(3) Volume of Thickened Sludge	Total Solids × 100 / Solids Consistency × 10^{-3}
	= 10,109 × 100 / 2.50 × 10^{-3}
	= 404 m^3/day
	= 16.85 m^3/h
(4) Sludge feed flow rate	30 m3/h × 2 = 60 m3/h
(5) Centrifuge Operation Time	8 hours/day (6 days per week)
[2] Geometry	
(1) Required sludge volume for continuation	(60 - 16.85) x 8
	= 345.21 m^3
(2) Basin Dimensions	Width 5.0 m × Length 6.0 m
	× Depth 3.0 m × 4
	= 360.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	360.0 m^3
Number	1 W + 1 S

Material Balance Sheet
【Mirzapur 14MLD STP SBR】



MIRZAPUR UPGRADE OF EXISTING 14MLD STP



Main Process

Sludge Line

Other Line

Existing structure

Project Name	PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA インド国ガンジス川浄化事業準備調査
Drawing Title	Mirzapur STP 14MLD Layout
Scale	not
Drawing No.	STP-06

5. Mirzapur 18MLD STP

Design Condition

Item	Chunar-MPS
(1) Design Flow for the year 2050	

	Flow Rate		
	m^3/d	m3/h	m^3/s
Average Daily	22,580	941	0.261
Max Dayly	22,580	941	0.261
Max Hourly Peak factor 2.25	50,805	2117	0.588

Item	Chunar-MPS
(1) Design Flow for the year 2035	

	Flow Rate		
	m^3/d	m3/h	m^3/s
Average Daily	19,360	807	0.224
Max Dayly	19,360	807	0.224
Max Hourly Peak factor 2.25	43,560	1815	0.504

1. Inlet Chamber

Item	Chunar-MPS
[1]Design Condition	
(1) Design Flow for the year 2050	Max Hourly = 50,805 m^3/day
	= 0.588 m^3/sec
(2) Inlet Pipe	
Pipe Diameter	mm
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Formula)
Full Pipe Flow Rate	m^3/sec
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	1.000 m Approx
(3) Width of Basin	3.000 m Approx
(4) Length of Basin	2.000 m Approx.
(5) Volume required of Basin	1.000 × 3.000 × 2.000 = 1 5 m^3
(6) Retention Time	1.000 × 3.000 × 2.000 ／ 0.588 × 1
	= 10.20 sec
(7) Basin Demensions	Width 3.000 m × Length 2.000 m
	× Depth 1.000 m

2. Coarse Screen Channel

Item	Chunar-MPS
[1] Geometry	
(1) Inlet Gate	
Number	1 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 83.300 m
Bottom	+ 71.900 m
Influent Water Level	+ 72.800 m
Velocity whe Design Flow for the year 2050	0.588 ／ 0.600 ／ 0.900 ／ 1 = 1.089 < 1.000 m/sec OK
Velocity whe Design Flow for the year 2035	0.504 ／ 0.600 ／ 0.900 ／ 1 = 0.933 < 1.000 m/sec OK
(2) Screen Channel	
Number	1.0 Main + 1.0 Bypass
Width	1.200 m
Side Water Depth	1.000 m
Velocity whe Design Flow for the year 2050	0.588 ／ 1.200 ／ 1.000 ／ 1 = 0.490 ≒ 0.450 m/sec OK
Velocity whe Design Flow for the year 2035	0.504 ／ 1.200 ／ 1.000 ／ 1 = 0.420 < 0.450 m/sec OK
(3) Channel Dimensions	Width 1.2 m × Length 8.5 m × SWD 1.0 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	1 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	1.0 m
Height of Blind Plate at the bottom	50 mm
Velocity through screen	0.588 ／ 1.100 ／ 0.950 ／ 1 × (20 + 9) / 20 = 0.816 ≒ 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2035	0.504 ／ 1.100 ／ 0.950 ／ 1 × (20 + 9) / 20 = 0.699 < 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	1.0 m
Velocity through screen whe Design Flow for the year 2050	0.588 ／ 1.200 ／ 1.000 ／ 1 × (50 + 9) / 50 = 0.578 < 0.800 m/sec OK
Velocity through screen whe Design Flow for the year 2035	0.504 ／ 1.200 ／ 1.000 ／ 1 × (50 + 9) / 50 = 0.496 < 0.800 m/sec OK

3. Raw Sewage Sump

Item	Chunar-MPS
[2] Geometory	
(1) Raw Sewage Sump	
Number	1 Basin
Dia	10.00 m
Pump Operating Depth	1.700 m
Retention Time	(10.00 ^{2}× π／4 × 1.700)／ 0.588 ／60
whe Design Flow for the year 2050	= 3.78 > 3.75 min (=minimum time of one pump cycle) OK
Retention Time	(10.00 ^{2}× π／4 × 1.700)／ 0.504 ／60
whe Design Flow for the year 2035	= 4.42 > 3.75 min (=minimum time of one pump cycle) OK
High Water Level	+ 72.600 m
Pump Off Level	+ 70.900 m
[3] Equipment	
(1) Sewage Pumps	
Number	4 W + 2 S
Bore Diameter	150 mm
Discharge Flow	0.504 × 3600 ／ 4
whe Design Flow for the year 2035	= 454 => 460 m3/Hr
Total Head	21.0 m

Item	Mirzapur-STP 18MLD

1. STP Design Condition

(1) Design Flow Rate

	m3/d	m3/h	m3/s
Average Daily	18,000	750	0.208
Max Daily	18,000	750	0.208
Max Hourly Peak factor 2.25	40,500	1687.5	0.469

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP
				NH_4-N	Org-N	NOx-N	
Inlet	250	450	400	25	15	0	
Outlet	10	50	20	2	0	8	
Removal rate	96.0%	88.9%	95.0%	75.0%			-

2. Inlet Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 40,500 m3/day
= 0.469 m3/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 m3

(6) Retention Time — 2.000 × 3.200 × 4.500 ／ 0.469 × 1
= 61.4072495 sec

(7) Basin Dimensions — Width 3.200 m × Length 4.500 m × Depth 2.000 m

3. Fine Screen Channel	
[1] Design Condition	
(1) Design Flow Rate	Max Hourly = 40,500 m3/day
	= 0.469 m3/sec
[2] Geometry	
(1) Inlet Gate	
Number	2 Main + 1 Bypass
Width	0.600 m
Height	0.900 m
Floor Level	+ 91.800 m
Bottom	+ 88.600 m
Influent Water Level	+ 89.300 m
Velocity	0.469 ／ 0.600 ／ 0.700 ／ 2
	= 0.558 < 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 6.0 m
	× SWD 0.7 m
[3] Equipment	
(1) Inlet Gate	
Number	2 Units
Dimension	Width 0.6 m × Height 0.9 m
Design Water Level	3.20 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

4.	**Grit Chamber**	
[1]	**Design Condition**	
(1)	Design Flow Rate	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
[3]	**Parshall Flume**	
(1)	Design Flow Rate	Q= 469.000 l/sec
(2)	Throat width	W= 0.450 m ／ W) $^{2/3}$
(3)	Water depth Ha	Ha= (Q ／ 2264
		Ha= 0.596 m
(4)	Crest Level	+ 86.900 m ≒ Minimum water level at downstream channel
(5)	Water level at the crest	+ 87.496 m
(6)	Channel bottom level	+ 86.700 m
(7)	Upstream Channel width	1.500 m
(8)	SWD of Upstream Channel	0.800 m
(9)	Average velocity at upstream channel	0.391 m/sec
(10)	Total Length of channel	10.000 m

5.	SBR						
[1]	Design Condition						
(1)	Design Flow Rate		Q=	18,000	m^3/day (summer)		
			Q'=	18,000	m^3/day(Winter)		
(2)	Design Sewage Quality						
	Inlet BOD			250	mg/l		
	Outlet BOD			10.0	mg/l		
	Inlet S-BOD			167	mg/l		
	Inlet COD			450	mg/l		
	Inlet S-COD :sCOD			300	mg/l		
	Outlet S-COD :nbsCODe			33	mg/l	=sCOD-1.6sBOD	
	Inlet rbCOD			60	mg/l		
	bCOD/BOD			1.60			
	Inlet bCOD :S_0			400	mg/l	=1.6BOD	
	Inlet nbCOD			50	mg/l		
	:nbpCOD			17	mg/l	=TCOD-bCOD-nbsCODe	
	Inlet TSS			400	mg/l		
	Inlet VSS			280	mg/l		
	:VSS_{COD}			0.54	gCOD/gVSS	=TCOD-sCOD/VSS	
	:nbVSS			32.11	gnbVSS/m3	=nbpCOD/VSS_{COD}	
	:iTSS			120.00	gnbTSS/m3	=TSS-VSS	
	Inlet T-N			40	mg/l		
	Inlet TKN			40	mg/l		
	Inlet NH_4-N			25	mg/l		
	Ammonia oxidized			60.00%	of TKN assumed		
	Inlet T-P			-	mg/l		
	Inlet Alkalinity as $CaCO_3$			200	mg/l		
	Outlet Kjeldahl N			2.0	mg/l		
	Outlet NH4-N			2.0	mg/l		
	Outlet NO3-N			8.0	mg/l		
(3)	Water Temperature		T=	20.0	°C		
(4)	Excess Sludge Concentration		R_s =	8,000	mg/l		
(5)	MLSS	At tank full	X_{TSS} =	3,000	mg/l		
(6)	DO in the Reactor			2	mg/L		
(7)	Operating Cycle						
	Tc Total time			4.80	h		
	t_f Fill time			2.40	h		
	td Anoxic(denitrification) time			0.95	h		
	t_A Aeration time			2.10	h		
	t_S Settlement time			1.00	h		
	t_D Decanting time			0.75	h		
(8)	Number of cycles			5.0	cycles/basin・day	× 4	tanks
			total	20	cycles/day		
(9)	Full volume per cycle			900.000	m3/fill		
(10)	Full liquid depth			5.50	m		
(11)	Decant depth			1.65	m	30.0%	of full tank depth
(12)	Required aeration tank volume			3000.00	m3/tank	τa= 0.6667	day
						16	h
(13)	Decant flow rate		900.000	m3/fill	/ 0.75 h	= 1200	m3/h
(14)	No. of basins receiving flow simultaneously			2	nos.		
(15)	No. of basins Aerating simultaneously			2	nos.		
(16)	No. of basins Decanting simultaneously			1	nos.		
(17)	Flow rate			750	m3/h		
(18)	Flow rate to each basin			375	m3/h		

[2] Design for Nitrification Process

(1) Activated sludge design kinetic 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= 7.0600 day

a: $(P_{X,TSS})$SRT=	36,000.000	kg	$=V \cdot X_{MLSS}$
b: $(P_{X,TSS})$SRT=	36,034.873	kg	=SUM(①:⑤)
①=	14,555.283	kg	$=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]/0.85$
②=	4,080.115	kg	=Q(SRT)nbVSS
③=	298.502	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]/0.85$
④=	1,851.374	kg	$=f_d.b_H.QY_H(S_0-S)SRT^2/[1+b_H(SRT)]/0.85$
⑤=	15,249.600	kg	=Q(SRT)(TSS0-VSS0)

(4) Sludge production $P_{X,TSS}$=

$P_{X,TSS}$= 5,104.090 kg/day

(5) Determine MLVSS concentration

$(P_{X,VSS})$SRT=

$(P_{X,VSS})$SRT=	18,279.500	kg	=SUM(①:④)
①=	12,371.990	kg	$=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
②=	4,080.115	kg	=Q(SRT)nbVSS
③=	253.727	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]$
④=	1,573.668	kg	$=f_d.b_H.QY_H(S_0-S)SRT^2/[1+b_H(SRT)]$

X_{MLVSS}= 1,523 mg/l

NOx	NOx=	24.000	mg/l	=TKN× 60.00%
S	S=	0.3648	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	
bn average	b_n=	0.1138		$=b_{NOB1} \cdot (ta/Tc)+b_{NOB2} \cdot (1-ta/Tc)$
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	0.508		=MLVSS/MLSS

(6) Determine amount of NH4-N oxidized

Biomass production Px,bio=

Px,bio=	2,011.244	kg	=SUM(①:③)
①=	1,752.407	kg	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
②=	35.939	kg	$=QYn(NOx)/[1+b_{AOB}(SRT)]$
③=	222.899	kg	$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$

NOx= 24.592 mg/l $=TN_0-N_e-0.12P_{x,bio}/Q$

≒ 24.000 mg/l (assumed Nox) **OK**

(7) NO3-N Produced per cycles

At tank full	NO3-N =	22,133	gNOx/fill			
		7.378	g/m3	concentration		
	<	8.0	g/m3			OK
After decant	NO3-N =	15,493	gNOx/decant			
		7.378	g/m3	concentration		
At tank full	Xb=	1030.999	g/m3	$=P_{x,bio} \cdot SRT/V_1$		
	Biomass=	3,093	kg			
	Q_F=	9,000	m3/d	$=V_F/t_F$		
	$Q_F \cdot S_O$=	2,250	kg/day			

(8) Initial NH4-N

	N_O=	8.778	mg/l	$=[V_F(NOx)+V_{S(Ne)}]/V_1$
V_F(NOx)=	V_F(NOx)=	22.133	kg	
Vs(Ne)=	Vs(Ne)=	4.200	kg	

(9) Nitrifier concentration

Xn=	21.7	mg/l	$=Q \cdot Yn \cdot NOx \cdot SRT/[1+b_{NOB}(SRT)]/V$
b_{NOB}=	0.1138		

(10) Review of Aeration time for nitrification

$$t = \frac{7.517034349}{103.9928076} = \frac{K_{NH4}\ln(N_o/N_t)+(N_o-N_t)}{X_n(\mu_{max,AOB}/Y_n)[S_o/(K_{o,AOB}+S_o)]}$$

t=	0.072	day				
	1.735	h				
<	2.10	h (Aeration time)				OK
$\mu_{max,NOB,T}$=	0.9000	g/g·d	$=\mu_{max} \cdot 1.072^{(T-20)}$	μmax	at20°C =	0.900
$\mu_{NOB,T}$=	0.7200	g/g·d	$=\mu_{max\ NOB}[S_o/(S_o+K_{O2,NOB})]$			
S_o=	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= 0.727 g/g·d

(2) Fraction of rbCOD — 15.00% =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=	0.175	g/g·d	$=SDNR_b \cdot \theta^{(t-20)}$	θ=	1.026
SDNRb=	0.175	g/g·d	$=b_0+b_1[\ln(F/M_b)]$		
b_0=	0.213				
b_1=	0.118				

(4) NO3-N removal capacity during the fill period (per tank)

NOx= 542.670 g/g·d $=SDNR_t(X_b)(V_T)$

(5) NO3-N removal capacity :NOr

NOr=	21.481	g	$=NO_x \cdot td/24$	
>Nox feed=	15.493	g		OK
td=	0.950	hr		

[4]	**Geometry**							
(1)	Basin Dimensions	Width	Length		Depth	Basins		
		19.0		29.0	5.5	4		
	Cross Section	19.0*5.5		=		104.5 m^2/Basin		
	Total Volume	104.5*29.0		=		3,031 m3/Basin >	3,000 m3	
						12,124 m^3/Total		
[7]	Equipment							
(1)	RAS Pumps							
	RAS Ratio	10	%					
	Required Capacity	375	m3/h×	10%				
		= 38	m3/Hr ⇒	40	m3/Hr			
	Number	4	Work					
		2	Standby (Spare)					
(2)	SAS Pumps							
	Excess Sludge	735	m3/day					
	Sludge withdraw	5	cycles/day					
	Running Time	1.0	Hr/Time					
	Required Capacity	735	m3/day ／	5 ／		1.00 ／	4	
		= 36.76	m3/Hr ⇒	40	m3/Hr			
	Number	4	Work					
		2	Standby (Spare)					

6. Air Requirement at Average Flow

[1] Design Condition

(1) O2 demand

R_0 = $Q(S_0 - S - 2.86(Nox - NOxe)) - 1.42P_{X,bio} + 4.57Q \cdot NOx$

R_0 = 6,360 kg O2/d

Qin : Design Average Flow 18,000 m3/d

Inlet bCOD $S0$ = 400 mg/l

S = 0.365 mg/l

Nox = NOx = 24.592 mg/l

$P_{X,bio}$ = 2,011.2 kg VSS/d *does not include nitrifying bacteria

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

$$= \frac{R0 \times C_S \cdot a \times 1.024^{20-T}}{\alpha \times F \times (\beta \cdot C_{SW/CS} \cdot (Pb/Pa)a - C_A)}$$

C_S	:	Saturated DO at sea level and 20 °C 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 $1+0.40D_t/Pa$		1.19357
D_t	:	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	:	$\exp[-gM(z_b - z_a)/R^*T]$		0.991
g	:	Acceleration due to Gravity		9.80665 m/s²
M	:	Mole of Air		28.97 kg/kg-mole
z_b	:	Plant Site Elevation		85 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

$$= \frac{48,350}{3.3837} = 14,288.93 \text{ kg/day}$$

(3)	No. of Basins	4 Basin
(4)	Number of cycles	5.0 cycles/basin·day × 4
	total	20 cycles/day
(5)	Standard O2 required at Field Conditions per cycle	= 714.4 kg/cycle/basin/day
(6)	SOTE for the above Effective Aeration Depth	30.5 %
(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	= 9,227 m3/cycle/basin/day
(11)	Aeration time per cycle t_A	2.10 h
		= 4,393.8 m³/hr/basin

[2]	**Equipment**						
(1)	Air Blower						
	Operating No. per basin		2	unit/Basin			
	Operating No. per set of blowers		2	basin/set			
	Required Capacity		4393.8	m^3/Hr・Basin	／	2	unit/Basin
		=	2196.9	m^3/Hr	⇒	2200	m^3/Hr /Unit
	Number		4	W	+	2	S
	Pressure		65	kPa			
	Safety Factor		10	%			
	Heat capacity ratio		1.4				
	Atmospheric pressure at site elevation		100.374	kPa			
	Total inlet pressure		98.374	kPa			
	Volume rate of flow at inlet point		37.757	m3/min			
	Total discharge pressure		165.374	kPa			
	Overall adiabatic efficiency		0.65				
	Inlet air temperature (min.)		15	℃			
	Shaft power		54.255	kW			
	Rated Output of Motor		59.681	kW	⇒	75	kW

7. **Chlorination**	
[1] **Design Condition**	
(1) Design Flow Rate	Average Daily Flow 32,000 m^3/day included 18MLD STP
(2) Contact Time	30 min
(3) Type of Chlorine	Bleaching Powder (Availtive chlorine 70%)
(4) Design Chlorine Dosage Rate	10 mg/L
(5) Required Chlorine per day	Average Daily Flow ⁄ 1000 × Design Chlorine Dosage Rate
	= 320.0 kg/d
	= 13.33 kg/h
(6) Consumption per day	457.1 kg/d as Bleaching Powder
[2] Chlorination Contact Tank	
(1) Volume required	Average Daily Flow ⁄ 1440 × Contact Time
	= 666.7 m^3
	Contact Time 30 min
(2) Nos. of lanes	5 lanes
(3) Width of lane	2.00 m
(4) Length of lane	23.00 m
(5) Side Water Depth	3.00 m
(6) Nos. of Tanks	1 tank
(7) Total Width of Tank	13.00 m Approx.
(8) Average Velocity	Average Daily Flow ⁄ 86400 ⁄ Width ⁄ Depth
	= 32,000 ⁄ 86400 ⁄ 2.00 ⁄ 3.00
	= 0.062 m/sec
(9) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
	= 2.0 m × 23.0 m × 3.0 m
	× 5 × 1
	= 690 m^3 > 666.7 m^3
[3] Equipment	
(1) Chlorine Solution Tank	
Number	2 W + 0 S
Chlorine concentration	2 %
Gravity of dissolved chlorine	1.10
Required solution volume	320.00 kg / d × 100 / 2 / 1.10 / 1000
	= 14.55 m3/d
	= 582 l/h
Dimension of Tank	2.0 mW × 2.0 mL × 2.5 mSWD
Volume of Tank	10.0 m3/tank
Total Volume of Tanks	20.0 m3 (Duration= 1.38 day)
(2) Mixer for Chlorine Solution Tank	
Number	2 W + 0 S
(3) Chlorine Dosing Pump	
Number	2 W + 1 S
Capacity	582 l/h / 2
	291 l/h/unit ⇒ 300 l/h/unit

8. Dechlorination	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 32,000 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)
	＝ 76.2 kg/d
	＝ 3.17 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Daily Flow ／ 1440 × Contact Time
	＝ 222.2 m^3
	Contact Time 10 min
(2) Width of lane	13.00 m
(3) Length of lane	6.00 m
(4) Side Water Depth	3.00 m
(5) Nos. of Tanks	1 tank
(6) Total Volume	Width × Length × Depth
	＝ 13.0 m × 6.0 m × 3.0 m
	＝ 234 m^3 ＞ 222.2 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	76.16 kg / d × 100 / 10 / 1.10 / 1000
	＝ 0.69 m3/d
	＝ 27.69 l/h
Volume of Tank	1.0 m3/tank
Total Volume of Tanks	2.0 m3 (Duration= 2.89 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	27.69 l/h / 1
	27.69 l/h/unit ⇒ 30 l/h/unit

9. Sludge Thickener

[1] Design Condition

(1) UASB Sludge (14MLD STP)	0	kg/day		0	m3/day
(2) Excess Sludge (14MLD STP)	5,351	kg/day		669	m3/day
(2) Excess Sludge (18MLD STP)	5,882	kg/day		735	m3/day
(3) Total Solids	11,233	kg/day		1,404	m3/day
(4) Operation Time	24	hours/day			
(5) Thickened Sludge Moisture Content	97.5	%			

[2] Geometry

(1) Type

(2) Number: 2 W + 0 S

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

(4) Required Surface Area: $11233 \times \frac{1}{40} = 280.80$ m2

(5) Required diameter: $\left(\frac{4}{\pi} \times 280.80 \times \frac{1}{2} \right)^{1/2} = 13.37$ m $\rightarrow$ 13.50 m

(6) Side Water Depth: 4 m

(7) Actual Volume of Tank: $\frac{\pi}{4} \times 13.50^2 \times 4 = 572.56$ m3

(8) Retention Time: $\frac{572.56}{1404} \times 2 \times 24 = 19.58$ Hr

10. Thickened Sludge Sump

[1] Design Condition

(1) Inlet Solids: 4,816 kg/day + 5,294 kg/day = 10,109 kg/day

(2) Inlet Sludge Volume: 193 m^3/d + 212 m^3/d = 404 m^3/d

[2] Geometry

(1) Sludge withdrawal	12	Times/day
(2) Required Sump Volume	34	m^3/time
(3) Number	2	Basins
(4) Width	2.5	m
(5) Length	2.5	m
(6) Side Water Depth	3.0	m

(7) Actual Sump Volume: $2.5 \times 2.5 \times 3.0 \times 2 = 37.5\ m^3$

[3] Equipment

(1) Thickened Sludge Pumps

Transfer Time: 6.00 Hr

Number: 1 W + 1 S

Required Capacity: 404 m^3 / 6.0 / 1 = 67.4 m^3/Hr ⇒ 70 m^3/Hr /Unit

11 Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Quantity of Thickened Sludge generated	10,109 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 1.5 kg/t-DS·day
(4)	Volume of Thickened Sludge	404.4 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	8 hours/day (6 days per week)

[2] Volume of Centrifuges

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

$$= \frac{404.4}{8 \times 2} \times \frac{7}{6} = 29.5$$

→ 30 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)
= 10,109 × (1 + 0.0015)
= 10,125 kg/day

[4] Dewatered Cake Volume

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

$$= 10.125 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 65.63 t/day
apparent specific gravity 1.00

65.63 ⁄ 1.0 = 65.6 m^3/day

[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 1.5 kg/t-DS·day
(2)	Required Polyelectrolyte	15.16 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	7.58 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

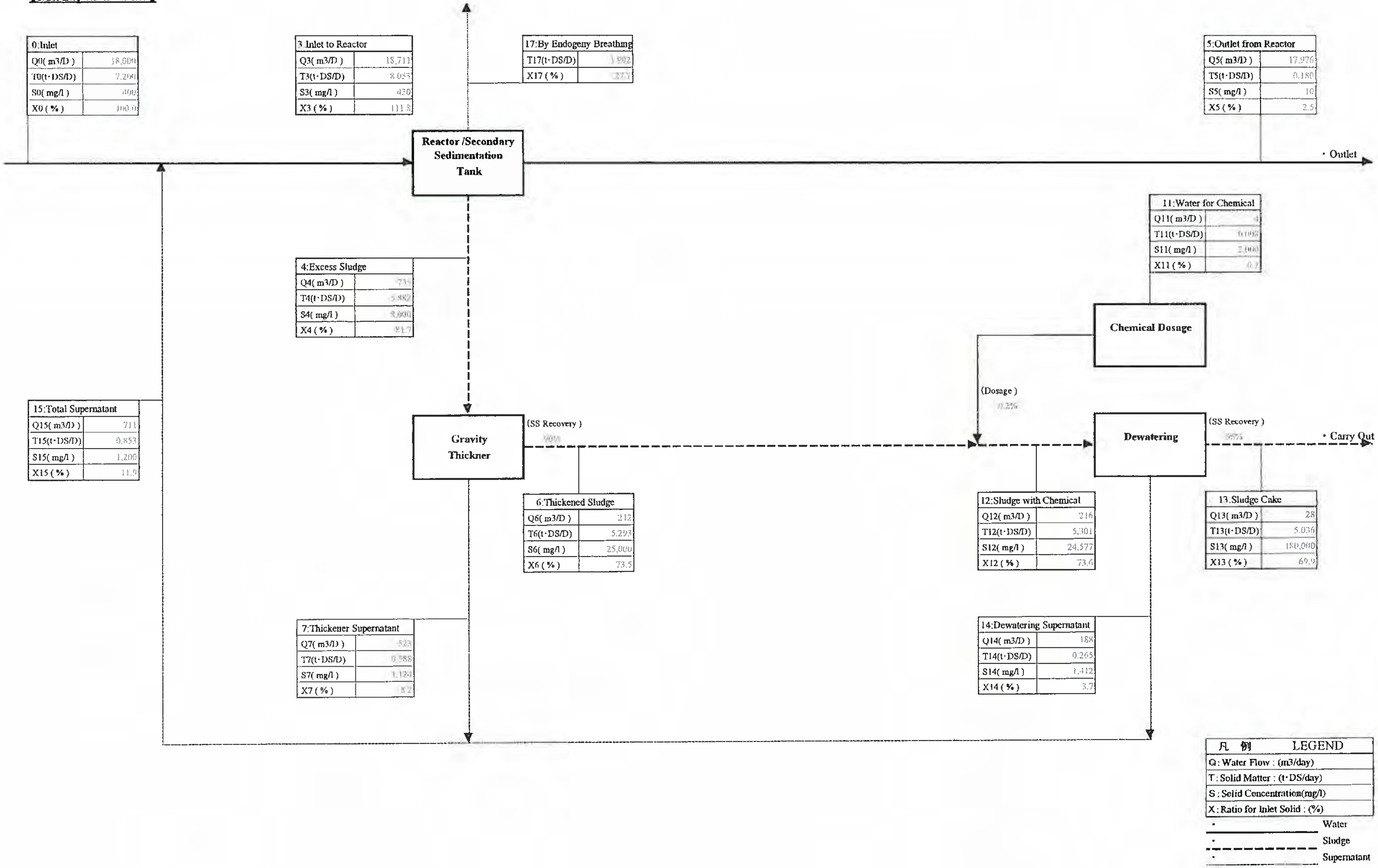
Volume of Polyelectrolyte solution	7.58 m3/day
Operation Time	8 hours/day (6 days per week)
Safety Factor	1.5
Number	2 W + 1 S
Required Capacity	7.58 m3/da × 7 ⁄ 6 ⁄ 8 ⁄ 2
	= 0.55 m^3/Hr
Specification Capacity	0.55 m^3/Hr × 1.5
	= 0.829 m^3/Hr ⇒ 0.83 m^3/Hr /Unit

(4) Polyelectrolyte dosing System

Tanks Dimensions	Width 2.0 m × Length 2.0 m
	× Depth 2.0 m × 2 (Freeboard 0.5m)
	= 16 m^3
Retention Time of Tanks	16.00 m^3 ⁄ 0.55 m^3/Hr ⁄ 2
	= 14.470 Hr
Number	2 W + 0 S

12. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	10,109 kg/day
(2) Solids Consistency	2.50 %
(3) Volume of Thickened Sludge	Total Solids × 100 / Solids Consistency × 10^{-3}
	= 10,109 × 100 / 2.50 · 10^{-3}
	= 404 m^3/day
	= 16.85 m^3/h
(4) Sludge feed flow rate	30 m3/h × 2 = 60 m3/h
(5) Centrifuge Operation Time	8 hours/day (6 days per week)
[2] Geometry	
(1) Required sludge volume for continuation	(60 - 16.85) x 8
	= 345.21 m^3
(2) Basin Dimensions	Width 5.0 m × Length 5.0 m
	× Depth 3.5 m × 4
	= 350.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	350.0 m^3
Number	1 W + 1 S

Material Balance Sheet
【Mirzapur 18 STP】



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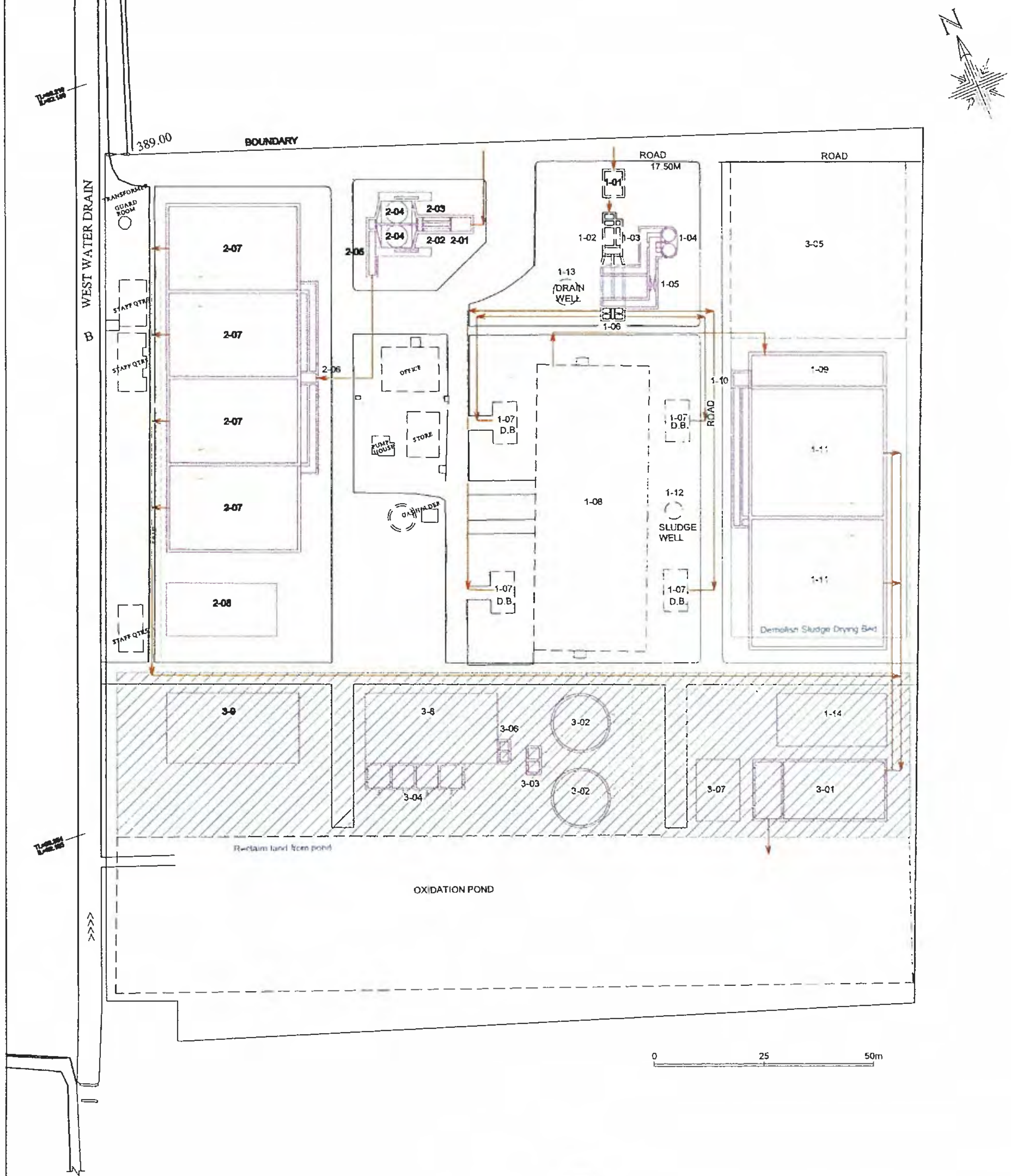


Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
14MLD STP					
1- 01	Inlet Chamber	1	4.0^{W}	5.5^{L}	4.0^{SWD}
1- 02	Main Screen Channel	1	2.0^{W}	5.0^{L}	0.7^{SWD}
1- 03	Bypass Screen Channel	1	•••W	•••L	•••SWD
1- 04	Grit Chamber	2	$3.0^{Dia.}$		3.0^{SWD}
1- 05	Parshall Flume	1	1.5^{W}	10.0^{L}	0.8^{SWD}
1- 06	Division Box	1	••••W	••••L	••••SDW
1- 07	Distribution Box	4	••••W	••••L	••••SWD
1- 08	UASB	2	17.0^{W}	28.0^{L}	5.5^{H}
1- 09	Equalization Tank	1	7.0^{W}	30.0^{L}	2.0^{SWD}
1- 10	Distribution Chamber	1	3.0^{W}	3.5^{L}	2.0^{SWD}
1- 11	SBR	2	29.0^{W}	30.0^{L}	5.5^{SWD}
1- 12	UASB Sludge Sump	1	••••Dia.		••••SWD
1- 13	Filtrate Sump	1	••••W	••••L	••••H
1- 14	Air Blower Room	1	12.0^{W}	25.0^{L}	6.0^{H}
18MLD STP					
2- 01	Inlet Chamber	1	3.2^{W}	4.5^{L}	2.0^{SWD}
2- 02	Main Screen Channel	2	0.8^{W}	6.0^{L}	0.7^{SWD}
2- 03	Bypass Screen Channel	1	0.8^{W}	6.0^{L}	0.7^{SWD}
2- 04	Grit Chamber	2	5.0^{W}	5.0^{L}	0.9^{SWD}
2- 05	Parshall Flume	1	1.5^{W}	10.0^{L}	0.8^{SWD}
2- 06	Distribution Chamber	1	2.0^{W}	3.5^{L}	2.0^{SWD}
2- 07	SBR	4	19.0^{W}	29.0^{L}	5.5^{SWD}
2- 08	Air Blower Room	1	12.0^{W}	25.0^{L}	6.0^{H}
COMMON					
3- 01	Chlorine Contact Tank	1	2.0^{W}	115.0^{L}	3.0^{SWD}
3- 02	Sludge Thickener	2	$13.5^{Dia.}$		4.0^{SWD}
3- 03	Thickened Sludge Sump	2	2.5^{W}	2.5^{L}	3.0^{SWD}
3- 04	Centrifuge Feed Sump	4	5.0^{W}	5.0^{L}	3.5^{SWD}
3- 05	Sludge Drying Bed	4	••••W	••••L	••••H
3- 06	Drain Sump	2	2.0^{W}	2.0^{L}	2.0^{SWD}
3- 07	Chlorination Building	1	10.0^{W}	14.0^{L}	6.0^{H}
3- 08	Centrifuge Building	1	16.0^{W}	30.0^{L}	10.0^{H}
3- 09	Electrical Building	1	16.0^{W}	30.0^{L}	10.0^{H}

Main Process Line

Sludge Line

Other Line

Proposed structure

Demolished structure

Existing structure

Project Name

PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA

インド国ガンジス川浄化事業準備調査

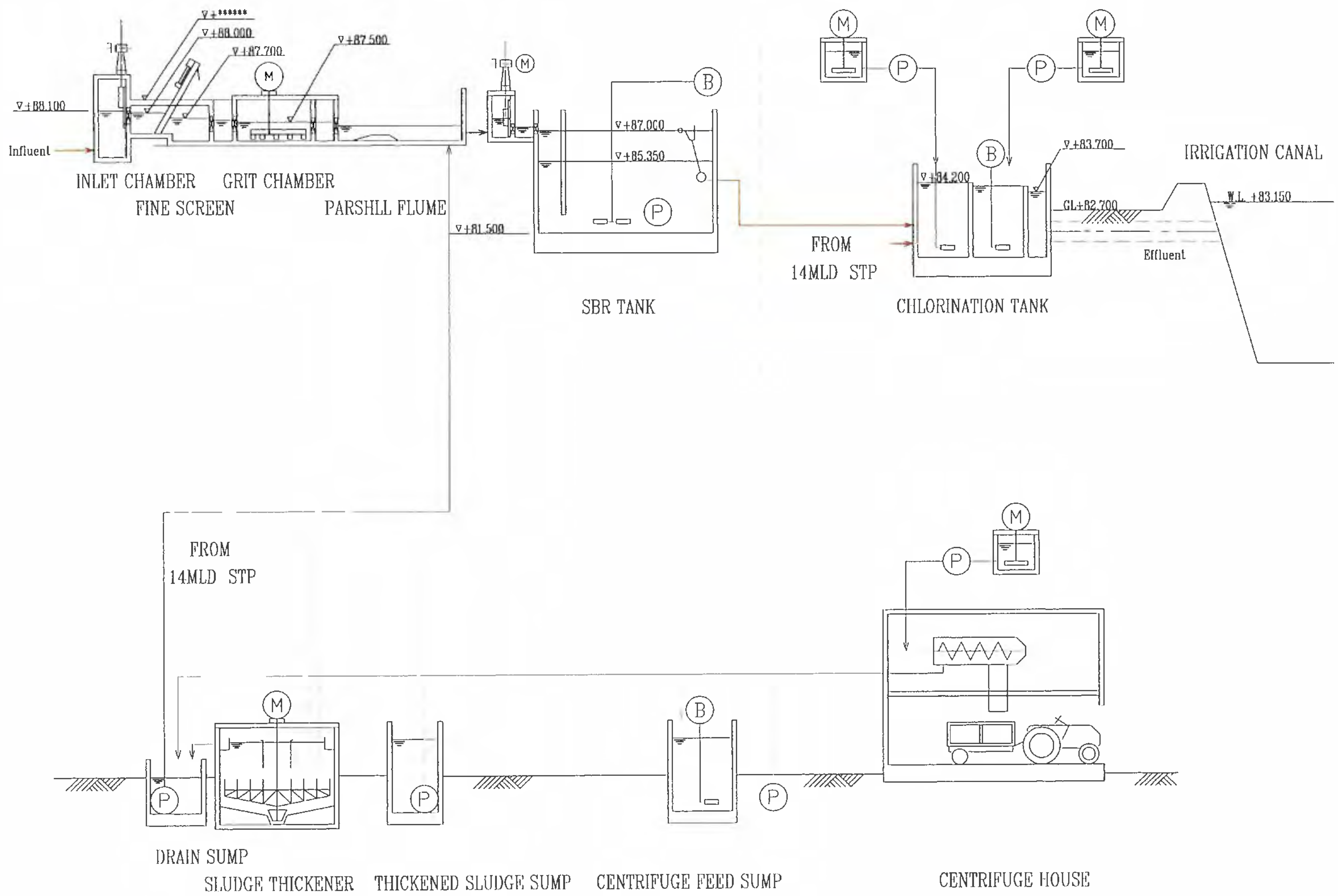
Drawing Title

Mirzapur STP 14MLD+18MLD Layout

Scale: 1:1000

Drawing No: STP-26

MIRZAPUR PROPOSED 18MLD STP



Main Process

Sludge Line

Other Line

Existing structure

Project Name: PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA インド国ガンジス川浄化事業準備調査	
Drawing Title: Mirzapur STP 18MLD Layout	Scale: not Drawing No. STP-07

6. Vindhyachal STP (Mirzapur)

Item	Vindhyachal-MPS

1 Design Condition

(1) Design Flow for the year 2050

	m3/d	m3/h	m3/s
Average Daily	8,990	375	0.104
Max Daily	8,990	375	0.104
Max Hourly Peak factor 2.25	20,228	843	0.234

(2) Design Flow for the year 2035

	m3/d	m3/h	m3/s
Average Daily	6,580	274	0.076
Max Daily	6,580	274	0.076
Max Hourly Peak factor 2.25	14,805	617	0.171

2. Inlet Chamber (existing structure)

[1] Design Condition

(1) Design Flow for the year 2050 — Max Hourly = 20,228 m3/day
= 0.234 m3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.000 m Approx

(3) Width of Basin — 2.000 m Approx

(4) Length of Basin — 3.700 m Approx

(5) Volume required of Basin — 1.000 × 2.000 × 3.700 = 0.5 m3

(6) Retention Time — 1.000 × 2.000 × 3.700 ⁄ 0.234 × 1
= 31.62 sec

(7) Basin Dimensions — Width 2.000 m × Length 3.700 m
× Depth 1.000 m

3. Raw Sewage Sump (existing structure)

[1] Geometry

(1) Raw Sewage Sump

Number — 1 Basin

Dia — 6.50 m

Pump Operating Depth — 1.200 m

Retention Time — (6.50 ² × π/4 × 1.200) ⁄ 0.000 ⁄60

whe Design Flow for the year 2050 — = #DIV/0! > 3.75 min (=minimum time of one pump cycle T/4) OK

Retention Time — (6.50 ² × π/4 × 1.200) ⁄ 0.000 ⁄60

whe Design Flow for the year 2035 — = #DIV/0! > 3.75 min (=minimum time of one pump cycle T/4) OK

High Water Level — + 1.200 m

Pump Off Level — + 0.000 m

[2] Equipment

(1) Sewage Pumps

Number — 2 W + 2 S

Bore Diameter — 150 mm

Discharge Flow — 0.000 × 3600 ⁄ 2

whe Design Flow for the year 2035 — = 0 ⇒ 310 m3/Hr

Total Head — 11.0 m

Item	Vindhyachal-STP 6.0MLD

1. STP Design Condition

(1) Design Flo

	m^3/d	m3/h	m^3/s
Average Daily	6,000	250	0.069
Max Daily	6,000	250	0.069
Max Hourly Peak factor 2.25	13,500	563	0.156

(2) Design Sewage Quality and Effluent Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP
				NH_4-N	Org-N	NOx-N	
Inlet	250	450	400	25	10	5	
Outlet	10	50	20	2	0	8	
Removal rate	96.0%	88.9%	95.0%	75.0%			-

(3) Inlet Quality of Reactor

Unit: mg/L

	BOD	COD	SS	T-N = 40			TP
				NH_4-N	Org-N	NOx-N	
Inlet of Primary clarifier	250	450	400	25	10	5	0
Removal rate	0%	0%	0%	0%	0%	0%	-
Inlet of Reactor	250	450	400	25	10	5	-

2. Stilling Chamber

[1] Design Condition

(1) Design Flow Rate — Max Hourly = 13,500 m^3/day
= 0.156 m^3/sec

[2] Geometry

(1) Number of Basins — 1 Basin

(2) Depth of Basin — 1.800 m

(3) Width of Basin — 2.100 m

(4) Length of Basin — 2.500 m

(5) Volume required of Basin — 1.800 × 2.100 × 2.500 = 1.5 m3

(6) Retention Time — 1.800 × 2.100 × 2.500 ⁄ 0.156 × 1
= 60.5769231 sec

(7) Basin Dimensions — Width 2.100 m × Length 2.500 m × Depth 1.800 m

3.	**Fine Screen Channel**										
[1]	**Design Condition**										
(1)	Design Flow Rate		Max Hourly		=		13,500		m3/day		
					=		0.156		m3/sec		
[2]	**Geometry**										
(1)	Inlet Gate										
	Number	1	Main		+		1	Bypass			
	Width	0.500	m								
	Height	0.750	m								
	Floor Level	+	84.500	m							
	Bottom	+	82.900	m							
	Influent Water Level	+	83.300	m							
	Velocity	0.156	／	0.500	／	0.400	／	1			
		=	0.780	≒	1.000	m/sec					
(2)	Screen Channel										
	Number	1	Main		+		1	Bypass			
	Width	0.800	m								
	Side Water Depth	0.500	m								
	Velocity	0.156	／	0.800	／	0.500	／	1			
		=	0.390	≒	0.450	m/sec					
(3)	Channel Dimensions	Width	0.8	m	×	Length	7.5	m			
			×	SWD	0.5	m	(Freeboard 0.3m)				
[3]	**Equipment**										
(1)	Inlet Gate										
	Number	2	Units								
	Dimension	Width	0.5	m	×	Height	0.75	m			
	Design Water Level	1.60	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	0.156	／	0.700	／	0.450	／	1			
		× (	6	+	2	) /	6				
		=	0.660	<	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	0.156	／	0.800	／	0.500	／	1			
		× (	20	+	9	) /	20				
		=	0.566	<	0.800	m/sec					

4. Grit Chamber	
[1] Design Condition	
(1) Design Wastewater Flow	Max Hourly = 13,500 m^3/day
	= 0.156 m^3/sec
(2) Specific gravity of Sand	2.65
(3) Sedimentation Velocity	0.01157 m/sec = 1,000 m^3/m^2/day
(4) Average Velocity	0.3 m/sec
[2] Grit Chamber	**Square Horizontal-Flow Grit Chamber**
(1) Surface Area required	0.156 ／ 0.01157407 = 13.48 m^2
(2) Number of Basins	2 S + 0 W
(3) Surface Area required/Basin	13.5 ／ 2 = 6.74 m^2
(4) Length of Basin	6.7392 ^0.5 = 2.6 m → 3.0 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.156 × 60 sec ／2 = 4.7 m^3
(7) Depth required	4.7 ／ 3.0 ／ 3.0 = 0.520 m
(8) Basin Dimensions	Width 3.0 m × Length 3.0 m
	× Depth 0.6 m
(9) Retention Time	3 × 3.0 × 0.6 ／ 0.156 × 2
	= 69.23 sec
(10) Surface Overflow Rate at Peak Flow	13,500 ／ 3.0 ／ 3.0 ／ 2
	= 750 < 1,000 m^3/m^2/day
[3] Parshall Flume	
(1) Design Flow Rate	Q= 156.000 l/sec
(2) Throat width	W= 0.225 m
(3) Water depth Ha	Ha= $(Q ／ 2264 ／ W)^{2/3}$
	Ha= 0.454 m
(4) Crest Level	+ 79 m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 79.454 m
(6) Channel bottom level	+ 78.700 m
(7) Upstream Channel width	0.800 m
(8) SWD of Upstream Channel	0.700 m
(9) Average velocity at upstream channel	0.279 m/sec
(10) Total Length of channel	6.000 m
5. Equalization Tank	
[1] Design Condition	
(1) Design Flow Rate	Average Daily = 6,000 m^3/day
	= 250.000 m^3/h
(2) Detention Time	2.00 h
[2] Geometry	
Number	1 Basin
Dia	15.00 m
Effective Depth	3.000 m
Detention Time	(15.00 ^{2}× π／4 × 3.000)／ 250.000
whe Design Flow for the year 2050	= 2.12 > 2.00 h **OK**

6.	**SBR**								
[1]	**Design Condition**								
(1)	Design Flow Rate			Q =	6,000	m^3/day (summer)			
				Q' =	6,000	m^3/day (Winter)			
(2)	Design Sewage Quality								
	Inlet BOD				250	mg/l			
	Outlet BOD				10.0	mg/l			
	Inlet S-BOD				167	mg/l			
	Inlet COD				450	mg/l			
	Inlet S-COD	:sCOD			290	mg/l			
	Outlet S-COD	:nbsCODe			23	mg/l	=sCOD-1.6sBOD		
	Inlet rbCOD				60	mg/l			
	bCOD/BOD				1.60				
	Inlet bCOD	:S_0			400	mg/l	=1.6BOD		
	Inlet nbCOD				50	mg/l			
		:nbpCOD			27	mg/l	=TCOD-bCOD-nbsCODe		
	Inlet TSS				400	mg/l			
	Inlet VSS				280	mg/l			
		:VSS_{COD}			0.57	gCOD/gVSS	=TCOD-sCOD/VSS		
		:nbVSS			46.67	gnbVSS/m3	=nbpCOD/VSS_{COD}		
		:iTSS			120.00	gnbTSS/m3	=TSS-VSS		
	Inlet T-N				40	mg/l			
	Inlet TKN				35	mg/l			
	Inlet NH_4-N				25	mg/l			
	Ammonia oxidized				70.00%	of TKN	assumed		
	Inlet T-P				-	mg/l			
	Inlet Alkalinity as $CaCO_3$				200	mg/l			
	Outlet Kjeldahl N				2.0	mg/l			
	Outlet NH4-N				2.0	mg/l			
	Outlet NO3-N				8.0	mg/l			
(3)	Water Temperature			T=	20.0	℃			
(4)	Excess Sludge Concentration			Rs =	8,000	mg/l			
(5)	MLSS		At tank full	X_{TSS} =	3,000	mg/l			
(6)	DO in the Reactor				2	mg/L			
(7)	Operating Cycle								
	Tc	Total time			4.80	h			
	t_f	Fill time			2.40	h			
	td	Anoxic(denitrification) time			0.95	h			
	t_A	Aeration time			2.10	h			
	t_S	Settlement time			1.00	h			
	t_D	Decanting time			0.75	h			
(8)	Number of cycles				5.0	cycles/basin·day	×	2	tanks
				total	10	cycles/day			
(9)	Full volume per cycle				600.000	m3/fill			
(10)	Full liquid depth				5.00	m			
(11)	Decant depth				1.50	m	30.0%	of full tank depth	
(12)	Required aeration tank volume				2000.00	m3/tank	τa=	0.6667	day
								16	h
(13)	Decant flow rate			600.000 m3/fill	/	0.75 h	=	800	m3/h
(14)	No. of basins receiving flow simultaneously			2		nos			
(15)	No. of basins Aerating simultaneously			2		nos			
(16)	No. of basins Decanting simultaneously			1		nos			
(17)	Flow rate			250.00		m3/h			
(18)	Flow rate to each basin			125.00		m3/h/basin			

[2] Design for Nitrification Process

(1) Activated sludge design kinetic 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= 6.6500 day

a: $(Px,_{TSS})$SRT 12,000.000 kg $=V \cdot X_{MLSS}$

b: $(Px,_{TSS})$SRT 12,005.630 kg =SUM(①:⑤)

①= 4,694.904 kg $=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]/0.85$

②= 1,862.000 kg =Q(SRT)nbVSS

③= 98.215 kg $=Q(SRT)Yn(NOx)/[1+b_n(SRT)]/0.85$

④= 562.511 kg $=f_d.b_H.QY_H(S_0-S)SRT^2/[1+b_H(SRT)]/0.85$

⑤= 4,788.000 kg =Q(SRT)(TSS0-VSS0)

(4) Sludge production $Px,_{TSS}$-

$Px,_{TSS}$= 1,805.358 kg/day

(5) Determine MLVSS concentration

$(Px,_{VSS})$SRT=

$(Px,_{VSS})$SRT 6,414.286 kg =SUM(①:④)

①= 3,990.668 kg $=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]$

②= 1,862.000 kg =Q(SRT)nbVSS

③= 83.483 kg $=Q(SRT)Yn(NOx)/[1+b_n(SRT)]$

④= 478.134 kg $=f_d.b_H.QY_H(S_0-S)SRT^2/[1+b_H(SRT)]$

X_{MLVSS}=

X_{MLVSS}= 1,604 mg/*l*

NOx	NOx=	24.500	mg/*l*	=TKN× 70.00%	
S	S=	0.3775	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		
bn average	b_n=	0.1138		$=b_{NOB1} \cdot (ta/Tc)+b_{NOB2} \cdot (1-ta/Tc)$	
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 0.535 =MLVSS/MLSS

(6) Determine amount of NH4-N oxidized

Biomass production Px,bio=

Px,bio= 684.554 kg =SUM(①:③)

①= 600.101 kg $=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$

②= 12.554 kg $=QYn(NOx)/[1+b_{AOB}(SRT)]$

③= 71.900 $=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$

NOx= 24.309 mg/*l* $=TN_0-N_e-0.12P_{x,bio}/Q$

< 24.500 mg/*l* (assumed Nox) **OK**

(7) NO3-N Produced per cycles	At tank full	NO3-N =	14,585	gNOx/fill		
			7.293	g/m3	concentration	
		<	8.0	g/m3		OK
	After decant	NO3-N =	10,210	gNOx/decant		
			7.293	g/m3	concentration	
	At tank full	Xb=	997.667	g/m3	$=P_{x,bio}*SRT/V_f$	
		Biomass=	1,995	kg		
		Q_F=	6,000	m3/d	$=V_F/t_F$	
		$Q_F \cdot S_O$=	1,500	kg/day		
(8) Initial NH4-N		N_O=	8.693	mg/l	$=[V_F(NOx)+V_{S(Ne)}]/V_T$	
V_F(NOx)=		V_F(NOx)=	14.585	kg		
Vs(Ne)=		Vs(Ne)=	2.800	kg		
(9) Nitrifier concentration		Xn=	20.7	mg/l	$=Q \cdot Yn \cdot NOx \cdot SRT/[1+b_{NOB}(SRT)]/V$	
b_{NOB}		b_{NOB}=	0.1138			
(10) Review of Aeration time for nitrification		t=	7.427341446 / 99.39814665		$= \frac{K_{NH}\ln(N_o/N_t)+(N_o-N_t)}{X_n(\mu_{max,AOB}/Y_n)[S_o/(K_{o,AOB}+S_o)]}$	
		t=	0.075	day		
			1.793	h		
		<	2.10	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=	0.752	g/g·d			
(2) Fraction of rbCOD		15.00%		=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=	0.179	g/g·d	$=SDNR_b \cdot \theta^{(t-20)}$	θ=	1.026
	SDNRb=	0.179	g/g·d	$= b_0+b_1[\ln(F/M_b)]$		
	b_0=	0.213				
	b_1=	0.118				
(4) NO3-N removal capacity during the fill period (per tank)	NOx=	357,822	g/g·d	$=SDNR_t(X_b)(V_T)$		
(5) NO3-N removal capacity :NOr	NOr=	14,164	g	$=NO_x \cdot td/24$		
	>Nox feed=	10,210	g			OK
	td=	0.950	hr			

SBR3/4

[4]	**Geometry**					
(1)	Side slope of pond is 1V : H	1.25				
(2)	Overall depth of basin	5.50	m			
(3)	Side Water Depth	5.00	m			
(4)	Width at top of basin	24.20	m			
(5)	Width at bottom of basin	17.33	m			
(6)	Width at mid water depth of basin	20.45	m			
(7)	Length at top of basin	27.90	m			
(8)	Length at bottom of basin	14.15	m			
(9)	Length at mid water depth of basin	20.40	m			
(10)	Area at mid water depth	417.18	m2			
(11)	Volume of basin	2085.90	m3		>	2,000 m3
[5]	**Equipment**					
(1)	RAS Pumps					
	RAS Ratio	10	%			
	Required Capacity	125	m3/h×	10%		
		= 12.50	m3/Hr ⇒	14 m3/Hr		
	Number	2	Work			
		1	Standby (Spare)			
(2)	SAS Pumps					
	Excess Sludge	245	m3/day			
	Sludge withdraw	5	cycles/day			
	Running Time	1.0	Hr/Time			
	Required Capacity	245	m3/day ／	5 ／	1.00 ／	2
		= 24.51	m3/Hr ⇒	30 m3/Hr		
	Number	2	Work			
		1	Standby (Spare)			

7.	Air Requirement at Average Flow				
[1]	Design Condition				
(1)	O2 demand				
	R_0=	R_0=	$Q(S_0 - S - 2.86(Nox - NOxe)) - 1.42P_{X,bio} + 4.57Q \cdot NOx$		
	R_0=	R_0=	2,092 kg O2/d		
	Qin :Design Average Flow m³/d		6,000		
	Inlet bCOD	S0=	400 mg/l		
	S=	S=	0.378 mg/l		
	Nox=	NOx=	24.309 mg/l		
	$P_{X,bio}$=	$P_{X,bio}$=	684.6 kg VSS/d	*does not include nitrifying bacteria	
(2)	SOR(Standard Oxygen Transfer Rate at site)	=	$\dfrac{R0 \cdot C_s \cdot a \cdot 1.024^{20-T}}{\alpha \times F \quad (\beta \cdot C_{SW/CS} \cdot (Pb/Pa)a - C_A)}$		
		C_s	: Saturated DO at sea level and 20 °C 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		
			$1+0.40D_1/Pa$	1.17422	
		D_1	: Liquid Depth at diffuser installatio 4.50 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	: $\exp[-gM(z_b-z_a)/R*T]$	0.992	
		g	: Acceleration due to Gravity	9.80665	m/s²
		M	: Mole of Air	28.97	kg/kg-mole
		Z_b	: Plant Site Elevation	74	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	
		=	$\dfrac{15,647}{3.3154}$ = 4,719.43 kg/day		
(3)	No. of Basins		2 Basin		
(4)	Number of cycles		5.0 cycles/basin·day × 2		
		total	10 cycles/day		
(5)	Standard O2 required at Field Conditions per cycle	=	471.9 kg/cycle/basin		
(6)	SOTE for the above Effective Aeration Depth		27.5 %		
(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	=	6,760 m3/cycle/basin/day		
(11)	Aeration time per cycle t_A		2.10 h		
		=	3,219.0 m³/hr/basin		

Air Requirement at Average Flow1/2

[2]	**Equipment**					
(1)	Air Blower					
	Operating No. per basin	2	unit/Basin			
	Operating No. per set of blowers	2	basin/set			
	Required Capacity	3219.0	m^3/Hr·Basin	/	2	unit/Basin
		= 1609.5	m^3/Hr	⇒	1700	m^3/Hr /Unit
	Number	2	W	+	1	S
	Pressure	60	kPa			
	Safety Factor	10	%			
	Heat capacity ratio	1.4				
	Atmospheric pressure at site elevation	100.497	kPa			
	Total inlet pressure	98.497	kPa			
	Volume rate of flow at inlet point	29.140	m3/min			
	Total discharge pressure	160.497	kPa			
	Overall adiabatic efficiency	0.65				
	Inlet air temperature (min.)	15	℃			
	Shaft power	39.228	kW			
	Rated Output of Motor	43.151	kW	⇒	55	kW

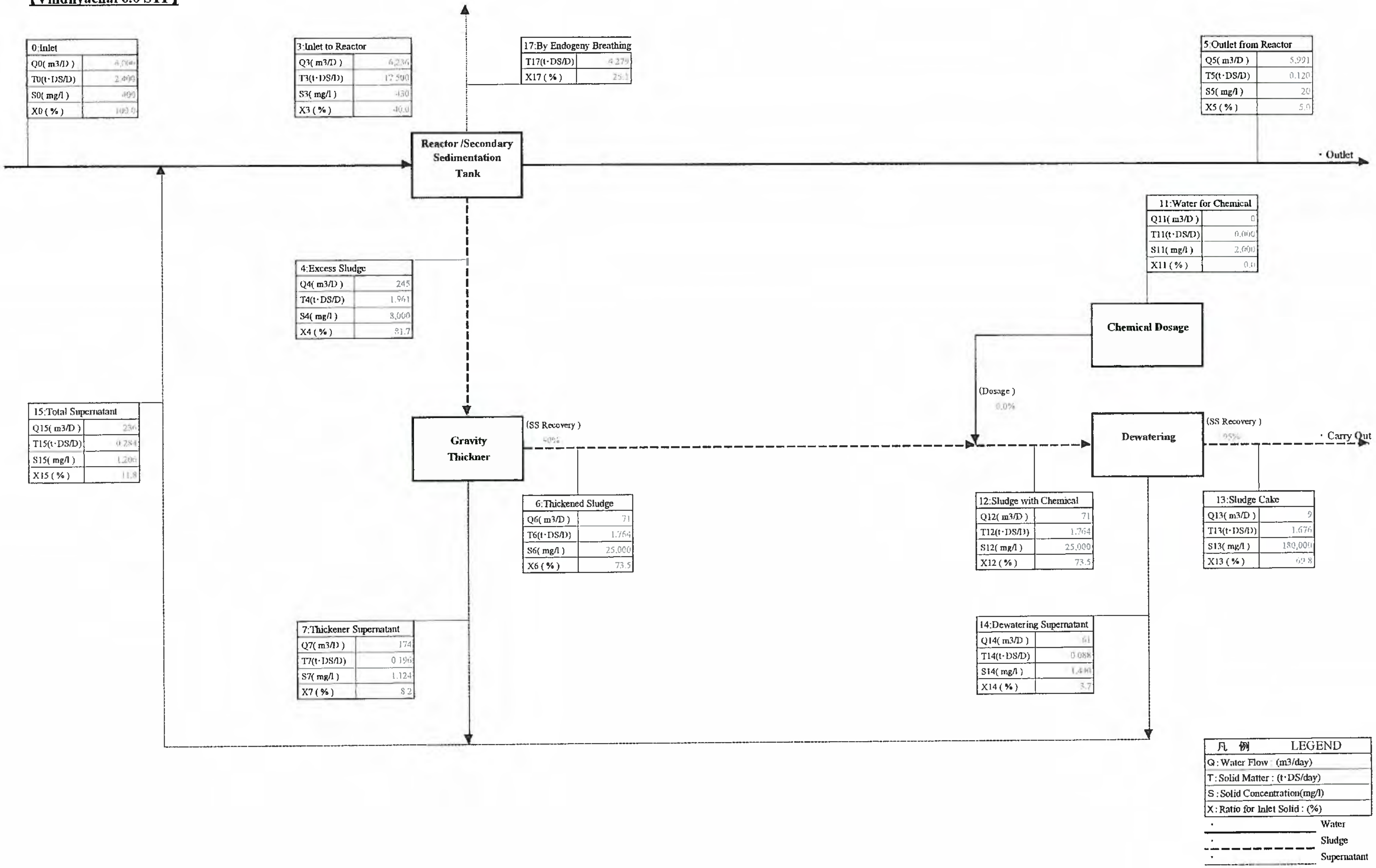
8. Chlorination Tank	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 6,000 m^3/day
(2) Contact Time	30 min
(3) Type of Chlorine	Bleaching Powder (Availtive chlorine 70%)
(3) Design Chlorine Dosage	10 mg/L
(4) No. SBR Basins	2 Basin
(5) No. of cycle per SBR Basin	5 cycles /day /Basin
(6) Decant flow rate from SBR basin	800.00 m3/h/cycle/basin
(7) Decant time per cycle	0.75 h/cycle
(5) Required Chlorine per day	Design Flow Rate ⁄ 1000 × Design Chlorine Dosage Rate
	= 60.00 kg/d
(6) Consumption per day	85.7 kg/d as Bleaching Powder
[2] Chlorination Contact Tank	
(1) Volume required	Decant flow rate from SBR basin ⁄ 60 × Contact Time
	= 400.0 m^3
(2) Nos. of lanes	3 lanes
(3) Width of lane	2.00 m
(4) Length of lane	46.00 m
(5) Side Water Depth	1.50 m
(6) Nos. of Tanks	1 tank
(7) Total Width of Tank	8.20 m Approx
(8) Average Velocity	Decant flow rate from SBR basin ⁄ 3600 ⁄ Width ⁄ Depth
	= 800 ⁄ 86400 ⁄ 2.00 ⁄ 1.50
	= 0.003 m/sec
(9) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
	= 2.0 m × 46.0 m × 1.5 m
	× 3 × 1
	= 414 m^3 > 400.0 m^3
[3] Equipment	
(1) Chlorine Solution Tank	
Number	2 W + 0 S
Dissolved Chlorine concentration	2 %
Gravity of dissolved chlorine	1.10
Required solution volume	60.00 kg / d × 100 / 2 / 1.10 / 1000
	= 2.73 m3/d
Dimension of Tank	1.0 mW × 1.0 mL × 1.5 mSWD
Volume of Tank	1.5 m3/tank
Total Volume of Tanks	3.0 m3 (Duration= 1.10 day)
(2) Mixer for Chlorine Solution Tank	
Number	2 W + 0 S
(3) Chlorine Dosing Pump	
Number	2 W + 1 S
Capacity	Decant flow rate from SBR basin × Design Chlorine Dosage /1000
	× 100 / Dissolved Chlorine concentration
	= 400.0 l/h
	400 / 2
	200 l/h/unit ⇒ 200 l/h/unit

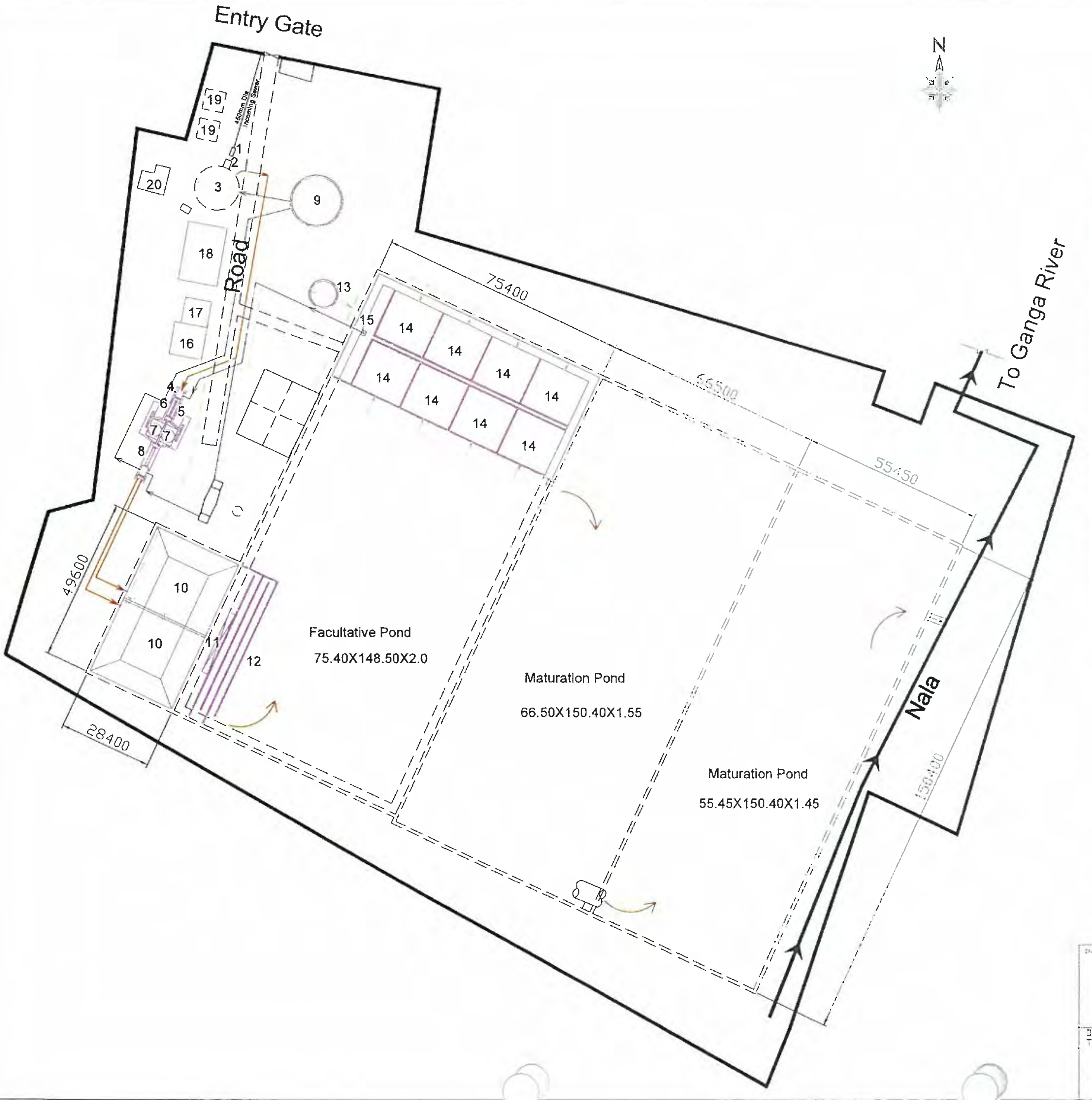
9. Sludge Thikener	
[1] Design Condition	
(1) Secondary Sludge	1,961 kg/day 245 m3/day
(2) Operation Time	24 hours/day
(3) Thickened Sludge Moisture Content	97.5 %
[2] Geometry	
(1) Type	Gravity sludge thickener
(2) Number	1 W + 0 S
(3) Design Solid Loading	40 kg / m2/d
(4) Required Surface Area	$1961 \times \frac{1}{40} = 49.00$ m2
(5) Required diameter	$\left(\frac{4}{\pi} \times 49.00 \times \frac{1}{1} \right)^{1/2} = 7.90$ m → 8.00 m
(6) Side Water Depth	4 m
(7) Actual Volume of Tank	$\frac{\pi}{4} \times 8.00^{2} \times 4 = 201.06$ m3
(8) Retention Time	$\frac{201.06}{245} \times 1 \times 24 = 19.69$ Hr
[3] Volume of Thickened Sludge	= 164 m^3/d
[4] Quantity of Separation Liquid	Inlet Sludge Volume − Thickened Sludge Volume = 245.1 − 163.8 = 81.3 m^3/day

10.	**Thickened Sludge Sump**								
[1]	**Design Condition**								
(1)	Inlet Solids	1,764	kg/day						
(2)	Inlet Sludge Volume	70.58	m^3/d						
[2]	**Geometry**								
(1)	Sludge withdrawal	10	Times/day						
(2)	Required Sump Volume	7.058	m^3/time						
(3)	Number	1	Basins						
(4)	Width	1.5	m						
(5)	Length	2.0	m						
(6)	Side Water Depth	2.0	m						
(7)	Actual Sump Volume	2.0	×	2.0	×	2.0	×	1	
		=	8.0	m^3					
[3]	**Equipment**								
(1)	Thickened Sludge Pumps								
	Transfer Time	5.00	Hr						
	Number	1	W	+	1	S			
	Required Capacity	71	m^3	/	5.0	/	1		
		=	14.1	m^3/h	⇒	15	m^3/h /unit		

10.	**Sludge Drying Bed**								
[1]	**Design Condition**								
(1)	Secondary Sludge	1,764.450	kg/day		70.578	m3/day			
(2)	Solids Consistency	2.50%							
(3)	Sludge Drying Period	12.00	days						
(6)	Sludge Loading	20.00	kg/m2						
[2]	**Geometry**								
(1)	Required total area of beds	1,764	×	12.00 / 20.00					
		=	1,059	m^2					
(2)	No. of Sludge drying beds	6	W	+	2	S			
(3)	Basin Dimensions	Width	15.0	m	×	Length	16.0	m	× 6
		=	1440.0	m2					

Material Balance Sheet
【Vindhyachal 6.0 STP】





Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
	MPS				
01	Inlet Chamber	1	1.1^{W}	2.6^{L}	3.4^{H}
02	Distribution Chamber	1	2.6^{W}	2.0^{L}	3.9^{H}
03	Wet Well	1	$6.5^{Dia.}$		6.5^{H}
	STP				
04	Inlet Chamber	1	2.1^{W}	2.5^{L}	1.8^{SDW}
05	Main Screen Channel	1	0.8^{W}	6.0^{L}	0.5^{SDW}
06	Bypass Screen Channel	1	0.8^{W}	6.0^{L}	0.5^{SDW}
07	Grit Chamber	2	3.0^{W}	3.0^{L}	0.6^{SDW}
08	Parshall Flume	1	0.8^{W}	6.0^{L}	0.7^{SWD}
09	Equalization Tank	1	$15.0^{Dia.}$		3.0^{SWD}
10	SBR *At middle depth	2	$*20.4^{W}$	$*20.4^{L}$	5.0^{SWD}
11	Decanted Water Pit	1	2.0^{W}	20.0^{L}	2.0^{SWD}
12	Chlorine Contact Tank	1	2.0^{W}	138.0^{L}	1.5^{SWD}
13	Sludge Thickener	1	$8.0^{Dia.}$		4.0^{SWD}
14	Sludge Drying Bed	8	15.0^{W}	16.0^{L}	2.5^{H}
15	Filtrate Sump	1	1.5^{W}	1.5^{L}	1.5^{H}
16	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
17	Chlorination Building	1	8.0^{W}	8.0^{L}	5.0^{H}
18	Administration Building	1	12.0^{W}	18.0^{L}	8.0^{H}
19	Staff Quarters	2	6.3^{W}	6.3^{L}	4.0^{H}
20	Laboratory	1	6.3^{W}	6.3^{L}	4.0^{H}

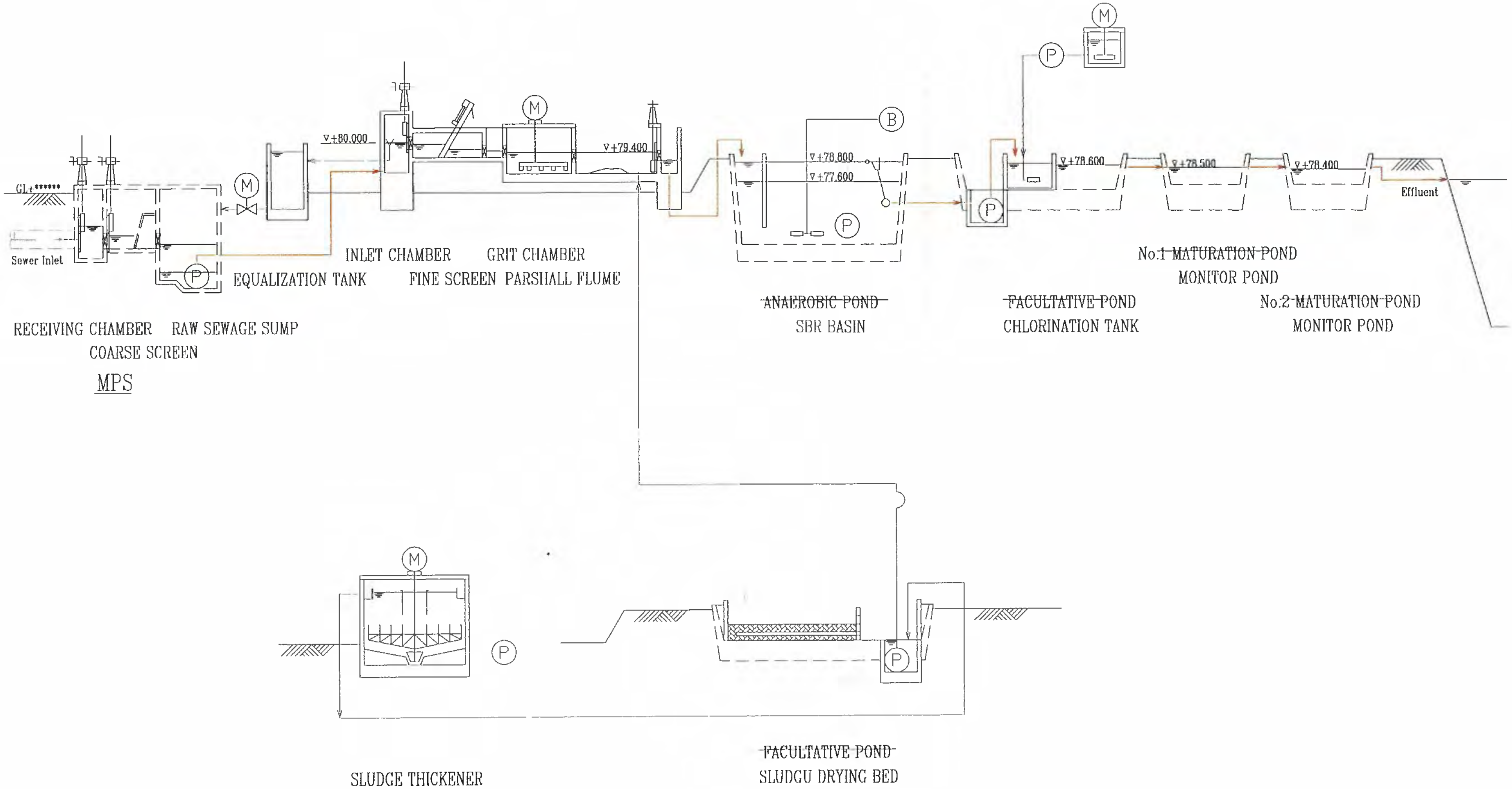
Main Process Line
Sludge Line
Other Line
Proposed structure
Demolished structure
Existing structure

Project Name: PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title: Vindhyachal STP 6MLD Layout

Scale: not

Drawing No.: STP-27



Main Process	
Sludge Line	
Other Line	
Existing structure	

Project Name

PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA

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Drawing Title: Vindhyachal STP 6MLD Layout

Scale: not

Drawing No. STP-08

7. Ghazipur STP

Design Condition

Item	Gazipur-MPS
(1) Design Flow for the year 2045	
(1) Design Flow for the year 2030	

Design Flow for the year 2045:

	Flow Rate		
	m3/d	m3/hr	m3/sec
Average Daily	24,354	1015	0.282
Max Dayly	24,354	1015	0.282
Max Hourly Peak factor 2.25	54,797	2283	0.634

Design Flow for the year 2030:

	Flow Rate		
	m3/d	m3/hr	m3/sec
Average Daily	19,602	817	0.227
Max Dayly	19,602	817	0.227
Max Hourly Peak factor 2.25	44,105	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 Formula)
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

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

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

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

	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

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	96.0%	88.9%	92.0%	75.0%			####

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

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

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 $m^3/m^2/day$

7. SBR

No.	Item		Gazipur-STP 18MLD				
[1]	**Design Condition**						
(1)	Design Wastewater Flow			Q=	18,000	m^3/day (summer)	
				Q' =	18,000	m^3/day(Winter)	
(2)	Design Sewage Quality						
	Inlet BOD				250	mg/l	
	Outlet BOD				10.0	mg/l	
	Inlet S-BOD				167	mg/l	
	Inlet COD				450	mg/l	
	Inlet S-COD	:sCOD			290	mg/l	
	Outlet S-COD	:nbsCODe			23	mg/l	=sCOD-1.6sBOD
	Inlet rbCOD				60	mg/l	
	bCOD/BOD				1.60		
	Inlet bCOD	:S_0			400	mg/l	=1.6BOD
	Inlet nbCOD				50	mg/l	
		:nbpCOD			27	mg/l	=TCOD-bCOD-nbsCODe
	Inlet TSS				250	mg/l	
	Inlet SS				250	mg/l	
	Inlet VSS				175	mg/l	
		:VSS_{COD}			0.91	gCOD/gVSS	=TCOD-sCOD/VSS
		:nbVSS			29.75	gnbVSS/m3	=nbpCOD/VSS_{COD}
		:iTSS			75.00	gnbTSS/m3	=TSS-VSS
	Inlet T-N				40	mg/l	
	Inlet TKN				[illegible]	mg/l	
	Inlet NH_4-N				25	mg/l	
	Ammonia oxidized				80.00%	of TKN	assumed
	Inlet T-P				6	mg/l	
	Inlet Alkalinity as CaCO3				200	mg/l	
	Outlet Kjeldahl N				2.0	mg/l	
	Outlet NH4-N				2.0	mg/l	
	Outlet NO3-N				8.0	mg/l	
(3)	Water Temperature			t =	20.0	C	
(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			2.40	h	
	td	Anoxic(denitrification) time			0.95	h	
	t_A	Aeration time			2.10	h	
	t_S	Settlement time			1.00	h	
	t_D	Decanting time			0.75	h	
(9)	Number of cycles				5.0	cycles/basin·day × 4 tanks	
				total	20	cycles/day	
(10)	Full volume per cycle				900.000	m3/fill	
(11)	Full liquid depth				5.50	m	
(12)	Decant depth				1.65	m	30.0% of full tank depth
(13)	Required aeration tank volume				3000.00	m3/tank	τa= 0.6667 day / 16 h
(14)	Decant flow rate			900.000 m3/fill	/	0.75 h	= 1200 m3/h
(15)	No. of basins receiving flow simultaneously				2	nos.	
(16)	No. of basins Aerating simultaneously				2	nos.	
(17)	No. of basins Decanting simultaneously				1	nos.	
(18)	Flow rate				750	m3/h	
(19)	Flow rate to each baisin				375	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= 8.8000 day

a: $(Px_{,TSS})SRT$	36,000.000	kg	$=V \cdot X_{MLSS}$
b: $(Px_{,TSS})SRT$	35,869.559	kg	=SUM(①:⑤)
①=	16,301.726	kg	$=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]/0.85$
②=	4,712.400	kg	=Q(SRT)nbVSS
③=	391.146	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]/0.85$
④=	2,584.287	kg	$=f_d.b_H.QY_H(S_0-S)SRT^2/[1+b_H(SRT)]/0.85$
⑤=	11,880.000	kg	=Q(SRT)(TSS0-VSS0)

(4) Sludge production $Px_{,TSS}$=

$Px_{,TSS}$= 4,076.086 kg/day

(5) Determine MLVSS concentration

$(Px_{,VSS})SRT$=

$(Px_{,VSS})SRT$	21,097.985	kg	=SUM(①:④)
①=	13,856.467	kg	$=Q(SRT) \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
②=	4,712.400	kg	=Q(SRT)nbVSS
③=	332.474	kg	$=Q(SRT)Yn(NOx)/[1+b_n(SRT)]$
④=	2,196.644	kg	$=f_d.b_H.QY_H(S_0-S)SRT^2/[1+b_H(SRT)]$

X_{MLVSS}=	X_{MLVSS}=	1,758	mg/l	
NOx	NOx=	28.000	mg/l	=TKN× 80.00%
S	S=	0.3241	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	
bn average	b_n=	0.1138		$=b_{NOB1} \cdot (ta/Tc)+b_{NOB2} \cdot (1-ta/Tc)$
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	0.586		=MLVSS/MLSS

(6) Determine amount of NH4-N oxidized

Biomass production Px,bio=

Px,bio=	1,861.998	kg	=SUM(①:③)
①=	1,574.598	kg	$=Q \cdot Y_H(S_0-S)/[1+b_H(SRT)]$
②=	37.781	kg	$=QYn(NOx)/[1+b_{AOB}(SRT)]$
③=	249.619		$=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]$

NOx= 25.587 mg/l $=TN_0-N_e-0.12P_{x,bio}/Q$

< 28.000 mg/l (assumed Nox) **OK**

(7) NO3-N Produced per cycles

At tank full NO3-N = 23,028 gNOx/fill
7.676 g/m3 concentration
< 8.0 g/m3 **OK**

After decant NO3-N = 16,120 gNOx/decant
7.676 g/m3 concentration

At tank full Xb= 1154.706 g/m3 $=P_{x,bio} \cdot SRT/V_T$
Biomass= 3,464 kg

Q_F= 9,000 m3/d $=V_F/t_F$
$Q_F \cdot S_O$= 2,250 kg/day

(8) Initial NH4-N

N_0= 9.076 mg/l $=[V_F(NOx)+V_{S(Ne)}]/V_T$

V_F(NOx)= V_F(NOx)= 23.028 kg
Vs(Ne)= Vs(Ne)= 4.200 kg

(9) Nitrifier concentration

Xn= 25.3 mg/l $=Q \cdot Yn \cdot NOx \cdot SRT/[1+b_{NOB}(SRT)]/V$

b_{NOB} b_{NOB}= 0.1138

(10) Review of Aeration time for nitrification

$$t = \frac{7.832246834}{121.5271311} = \frac{K_{NH} \ln(N_o/N_t) + (N_o - N_t)}{X_n(\mu_{max,AOB}/Y_n)[S_o/(K_{o,AOB}+S_o)]}$$

t= 0.064 day
1.547 h
2.10 h (Aeration time) **OK**

$\mu_{max(NOB),T}$= 0.9000 g/g·d $=\mu_{max} \cdot 1.072^{(T-20)}$ μmax at20℃= 0.900
$\mu_{NOB,T}$= 0.7200 g/g·d $=\mu_{max,NOB}[S_o/(S_o+K_{O2,NOB})]$
S_o= 2.000 mg/l
$K_{O2,NOB}$= 0.500 mg/l
K_{NH}= 0.500 mg/l

[3] **Design for Denitrification Process**

(1) F/M_b F/M_b= 0.650 g/g·d

(2) Fraction of rbCOD 15.00% =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= 0.162 g/g·d $=SDNR_b \cdot \theta^{(T-20)}$ θ= 1.026

SDNRb= 0.162 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= 561.465 g/g·d $=SDNR_b(X_b)(V_T)$

(5) NO3-N removal capacity :NOr

NOr= 22,225 g $=NO_x \cdot td/24$
>Nox feed= 16,120 g **OK**
td= 0.950 hr

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[5]	**Geometry**							
(1)	Basin Dimensions	Width	Length		Depth	Basins		
		17.0		33.0	5.5	4		
	Cross Section	17.0*5.5			=	93.5	m^2/Basin	
	Total Volume	93.5*33.0			=	3,086	m3/Basin >	3,000 m3
						12,344	m^3/Total	
[7]	Equipment							
(1)	RAS Pumps							
	RAS Ratio	10	%					
	Required Capacity	375	m3/h×		10%			
		= 38	m3/Hr ⇒		40	m3/Hr		
	Number	4	Work					
		2	Stanby (Spare)					
(2)	SAS Pumps							
	Excess Sludge	431	m3/day					
	Sludge withdraw	5	cycles/day					
	Running Time	1.0	Hr/Time					
	Required Capacity	431	m3/day ∕		5 ∕	1.00 ∕	4	
		= 21.57	m3/Hr ⇒		25	m3/Hr		
	Number	4	Work					
		2	Stanby (Spare)					

8. Air Requirement at Average Flow

Item	Gazipur-STP 18MLD
[1]Design Condition	
(1) O2 demand	
R_0=	R_0= $Q(S_0$-S-2.86(Nox-NOxe))-1.42$P_{X,bio}$+4.57Q·NOx
R_0=	R_0= 6,655 kg O2/d
Qin :Design Average Flow m^3/d	18,000
Inlet bCOD	S0= 400 mg/l
S=	S= 0.324 mg/l
Nox=	NOx= 25.587 mg/l
$P_{X,bio}$=	$P_{X,bio}$= 1,862.0 kg VSS/d *does not include nitrifying bacteria
(2) SOR(Standard Oxygen Transfer Rate at site)	$= \dfrac{R0 \cdot C_s \cdot a \cdot 1.024^{20-T}}{\alpha \cdot F \cdot (\beta \cdot C_{SW/CS} \cdot (Pb/Pa)a - C_A)}$
	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_t/Pa 1.19357
	D_t : 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-z_a)/R*T] 0.989
	g : Acceleration due to Gravity 9.80665 m/s^2
	M : Mole of Air 28.97 kg/kg-mole
	z_b : Plant Site Elevation 100 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
	$= \dfrac{50,589}{3.3762} =$ 14,984.07 kg/day
(3) No. of Basins	4 Basin
(4) Number of cycles	5.0 cycles/basin·day × 4
	total 20 cycles/day
(5) Standard O2 required at Field Conditions per cycle	= 749.2 kg/cycle/basin/day
(6) SOTE for the above Effective Aeration Depth	30.5 %
(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	= 9,676 m3/cycle/basin/day
(11) Aeration time per cycle t_A	2.10 h
	= 4,607.5 m^3/hr/basin

[2] Equipment

(1) Air Blower

Operating No. per basin		2 unit/Basin				
Operating No. per set of blowers		2 basin/set				
Required Capacity		4607.5 m^3/Hr･Basin		/	2 unit/Basin	
	=	2303.8	m^3/Hr	⇒	2400	m^3/Hr /Unit
Number		4 W	+	2	S	
Pressure	65	kPa				
Safty Factor	10	%				
Heat capacity ratio	1.4					
Atmospheric pressuer at site elevation	100.208	kPa				
Total inlet pressure	98.208	kPa				
Volume rate of flow at inlet point	41.260	m3/min				
Total discharge pressure	165.208	kPa				
Overall adiabatic effeciency	0.65					
Inlet air temperature (min.)	15	℃				
Shaft power	59.272	kW				
Rated Output of Motor	65.199	kW	⇒	75	kW	

8. Chlorination	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 18,000 m^3/day
(2) Decant Flow Rate	Decant Flow Rate 1,200 m^3/h Decant time 0.75 h/time
(3) Frequency of decant	20 times/ day
(4) Contact Time	30 min
(5) Type of Chlorine	Bleaching Powder (Availtive chlorine 70%)
(6) Design Chlorine Dosage Rate	10 mg/l
(7) Required Chlorine per day	Average Daily Flow ⁄ 1000 × Design Chlorine Dosage Rate
	= 180.0 kg/d
	= 7.50 kg/h
(8) Consumption per day	257.1 kg/d as Bleaching Powder
[2] Chlorination Contact Tank	
(1) Volume required	Average Daily Flow ⁄ 1440 × Contact Time
	= 375.0 m^3
	Decant Flow ⁄ 60 × Contact Time
	= 600.0 m^3
	Hence required volume is
	600.0 m^3
(2) Nos. of lanes	6 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	15.40 m Approx.
(8) Average Velocity	Decant Flow ⁄ 3600 ⁄ Width ⁄ Depth
	= 1,200 ⁄ 3600 ⁄ 2.00 ⁄ 2.00
	= 0.083 m/sec
(9) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
	= 2.0 m × 26.0 m × 2.0 m
	× 6 × 1
	= 624 m^3 > 600.0 m^3
[3] Equipment	
(1) Chlorine Solution Tank	
Number	2 W + 0 S
Chlorine concentration	2 %
Gravity of dissolved chlorine	1.10
Required solution volume	180.00 kg / d × 100 / 2 / 1.10 / 1000
	= 8.18 m3/d
	= 545 l/h × 0.75 h/time × 20 times/d
Dimension of Tank	1.7 mW × 1.7 mL × 2.0 mSWD
Volume of Tank	5.8 m3/tank
Total Volume of Tanks	11.6 m3 (Duration= 1.41 day)
(2) Mixer for Chlorine Solution Tank	
Number	2 W + 0 S
(3) Chlorine Dosing Pump	
Number	2 W + 1 S
Capacity	545 l/h / 2
	273 l/h/unit ⇒ 300 l/h/unit

9. **Dechlorination**	
〔1〕**Design Condition**	
(1) Design Flow Rate	Average Daily Flow 18,000 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)
	= 42.8 kg/d
	= 1.79 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Decant Flow Rate ／ 60 × Contact Time
	= 200.0 m^3
(2) Width of lane	15.00 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
	= 15.0 m × 7.0 m × 2.0 m
	= 210 m^3 > 200.0 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	42.84 kg / d × 100 / 10 / 1.10 / 1000
	= 0.39 m3/d
	= 25.96 l/h × 0.75 h/time × 20 times/d
Volume of Tank	1.5 m3/tank
Total Volume of Tanks	3.0 m3 (Duration= 7.70 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	25.96 l/h / 1
	25.96 l/h/unit ⇒ 30 l/h/unit

10. Sludge Thikener

Item	Gazipur-STP 18MLD
〔1〕Design Condition	
(1) Primary Sludge	0 kg/day 0 m3/day
(2) Secondary Sludge	3,452 kg/day 431 m3/day
(3) Total Solids	3,452 kg/day 431 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	$3452 \times \frac{1}{40} = 86.30$ m2
(5) Required diameter	$\left(\frac{4}{\pi} \times 86.30 \times \frac{1}{2} \right)^{1/2} = 7.41$ m → 7.50 m
(6) Side Water Depth	4 m
(7) Actual Volume of Tank	$\frac{\pi}{4} \times 7.50^{2} \times 4 = 176.71$ m3
(8) Retention Time	$\frac{176.71}{431} \times 2 \times 24 = 19.66$ Hr
〔3〕Volume 0f Thikened Sludge	= 164 m^3/d
〔4〕Quantity of Separation Liquid	Inlet Sludge Volume − Thikened Sludge Volume = 431.4 − 163.8 = 267.6 m^3/day

11. Thicked Sludge Sump

Item	Gazipur-STP 18MLD
〔1〕Design Condition	
(1) Inlet Solids	3,106 kg/day
(2) Inlet Sludge Volume	124 m^3/d
[2]Geometory	
(1) Sludge withdrawl	12 Times/day
(2) Required Sump Volume	10 m^3/time
(3) Number	2 Basins
(4) Width	2.0 m
(5) Length	1.5 m
(6) Side Water Depth	2.0 m
(7) Actual Sump Volume	2.0 × 1.5 × 2.0 × 2
	= 12.0 m^3
[3] Equipment	
(3) Thickened Sludge Pumps	
Transfer Time	6.00 Hr
Number	2 W + 2 S
Required Capacity	124 m^3 ／ 6.0 ／ 2
	= 10.4 m^3/Hr ⇒ 11 m^3/Hr /Unit

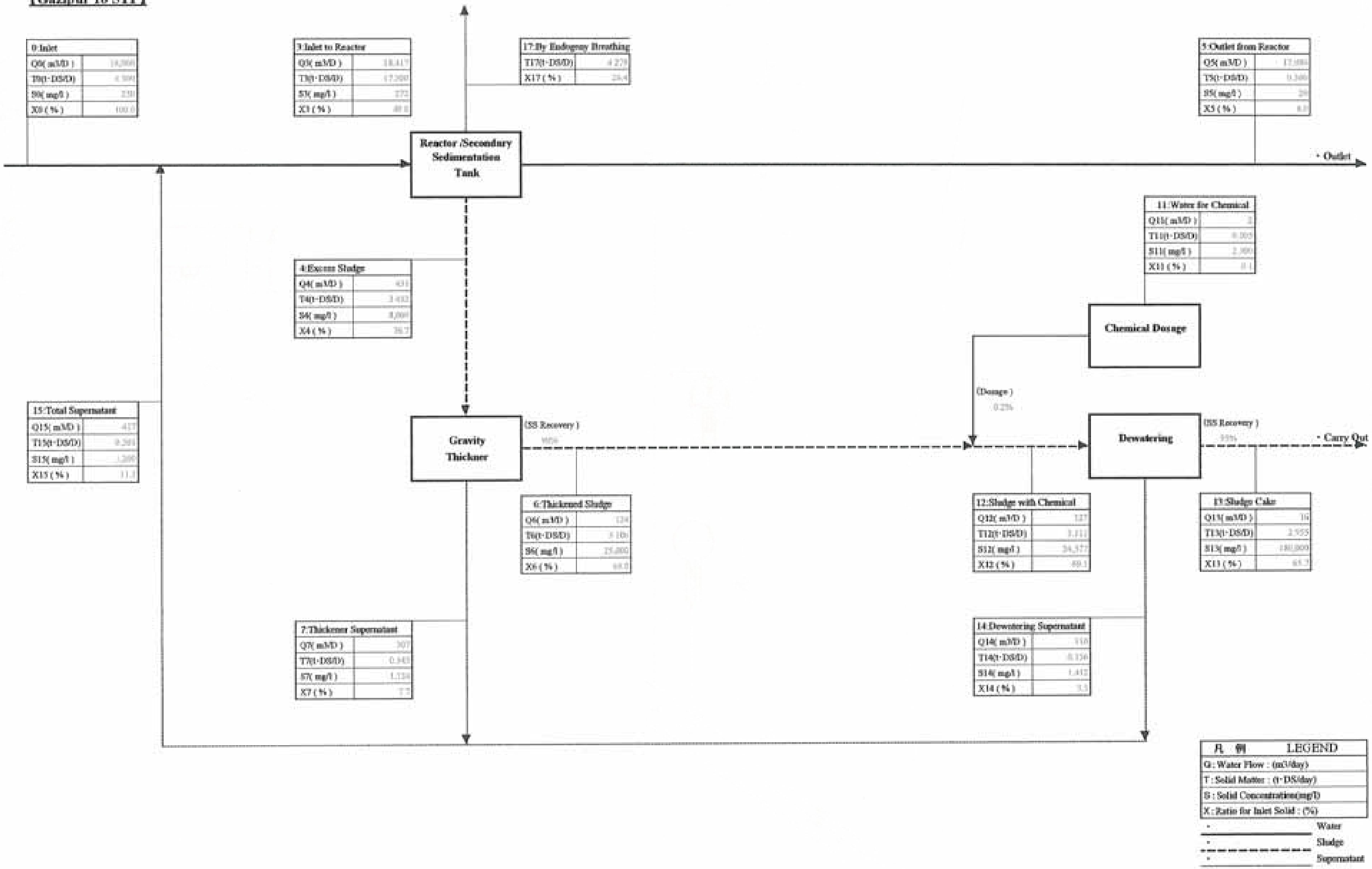
13. Centrifuge

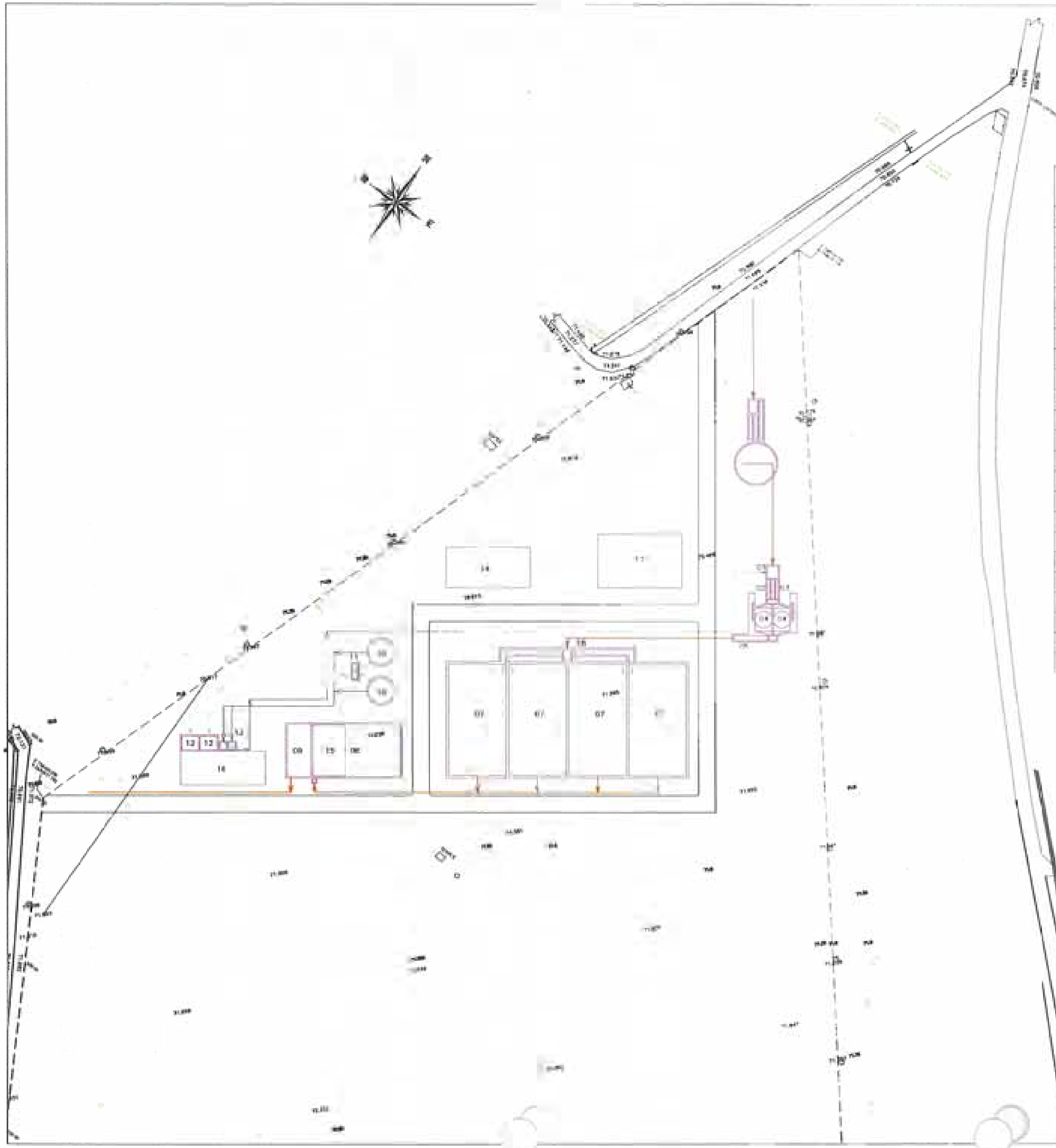
Item	Gazipur-STP 18MLD
〔1〕 Design Condition	
(1) Type of Dewatering	Centrifuge
(2) Quantity of Thickend Sludge generated	3,106 kg/day
(3) Design Polyelectrolyte Dosage	Polyelectrolyte 1.5 kg/t-DS·day
(4) Volume of Thickend Sludge	124.3 m^3/day
(5) Consistency of Dewatered Sludge	82 %
(6) Operation Time	8 hours/day (6 days per week)
〔2〕 Volume of Centrifuges	$\frac{\text{Digested Solids}}{\text{Operation Time} \times \text{No}}$ × Operation week $= \frac{124.3}{8 \times 2} \times \frac{7}{6} = 9.1$ → 10 m^3/hour
〔3〕 Dewatered Solids	Digested Sludge × (1 + Injection Rate) = 3,106 × (1 + 0.0015) = 3,111 kg/day
〔4〕 Dewatered Cake Volume	Dewatered Solids × $\frac{100}{100 - \text{Moisture Content}}$ × $\frac{7}{\text{6 days per week}}$ $= 3.111 \times \frac{100}{100 - 82} \times \frac{7}{6}$ = 20.16 t/day apparent specific gravity 1.00 20.16 / 1.0 = 20.2 m^3/day
〔5〕 Polyelectrolyte	
(1) Design Polyelectrolyte Dosage	Polyelectrolyte 1.5 kg/t-DS·day
(2) Required Polyelectrolyte	4.66 kg/day
(3) Dissolving concentration	0.20 %
(4) Volume of Polyelectrolyte solution	2.33 m3/day

【6】 Equipment									
(1) Centrifuge									
Capacity	10	m^3/hr							
Number	2	W		+		1	S		
(2) Centrifuge Feed Pumps									
Capacity	10	m^3/hr							
Number	2	W		+		1	S		
(3) Polyelectrolyte Dosing Pumps									
Volume of Polyelectrolyte solution	2.33		m3/day						
Operation Time	8		hours/day		(6 days per week)				
Safety Factor	1.5								
Number	2	W		+		1	S		
Required Capacity	2.33	m^3/Hr ×		7 ⁄		6 ⁄		8 ⁄	2
	=	0.17	m^3/Hr						
Specification Capacity	0.17	m^3/Hr		×		1.5			
	=	0.255	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		⁄		0.17 m^3/Hr		⁄	2
	=	26.490	Hr						
Number	2	W		+		0	S		

14. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	3,106 kg/day
(2) Solids Consistency	2.50 %
(3) Volume of Thickened Sludge	Total Solids × $\frac{100}{\text{Solids Consistency}}$ × 10^{-3}
	= 3,106 × $\frac{100}{2.50}$ × 10^{-3}
	= 124 m^3/day
	= 5.18 m^3/h
(4) Sludge feed flow rate	10 m3/h × 2 = 20 m3/h
(5) Centrifuge Operation Time	8 hours/day (6 days per week)
[2] Geometry	
(1) Required sludge volume for continuation	(20 - 5.18) x 8
	= 118.58 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

Material Balance Sheet
【Gazipur 18 STP】





Sr No	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
MPS					
01	Inlet Chamber	1	2.5^{W}	3.7^{L}	2.0^{SWD}
02	Main Screen Channel	2	1.0^{W}	7.5^{L}	0.7^{SWD}
03	Bypass Screen Channel	1	1.0^{W}	7.5^{L}	0.7^{SWD}
04	Wet Well	1	3.0^{Dia}		****^{SWD}
18MLD STP					
01	Inlet Chamber	1	3.2^{W}	4.5^{L}	2.0^{SWD}
02	Main Screen Channel	2	0.8^{W}	6.0^{L}	0.7^{SWD}
03	Bypass Screen Channel	1	0.8^{W}	6.0^{L}	0.7^{SWD}
04	Grit Chamber	2	5.0^{W}	5.0^{L}	0.9^{SWD}
05	Parshall Flume	1	1.5^{W}	10.0^{L}	0.8^{SWD}
06	Distribution Chamber	1	2.0^{W}	3.5^{L}	2.0^{SWD}
07	SBR	4	17.0^{W}	33.0^{L}	5.5^{SWD}
08	Chlorine Contact Tank	1	2.0^{W}	156.0^{L}	2.0^{SWD}
09	Dechlorine Mixing Tank	1	7.0^{W}	15.0^{L}	2.0^{SWD}
10	Sludge Thickener	2	7.5^{Dia}		4.0^{SWD}
11	Thickened Sludge Sump	2	2.0^{W}	1.5^{L}	2.0^{SWD}
12	Centrifuge Feed Sump	2	4.0^{W}	5.0^{L}	3.0^{SWD}
13	Centrate Sump	2	2.0^{W}	2.0^{L}	2.0^{SWD}
14	Air Blower Room	1	12.0^{W}	25.0^{L}	6.0^{H}
15	Chlorination Building	1	10.0^{W}	15.0^{L}	6.0^{H}
16	Centrifuge Building	1	10.0^{W}	25.0^{L}	10.0^{H}
17	Electrical Building	1	16.0^{W}	25.0^{L}	10.0^{H}

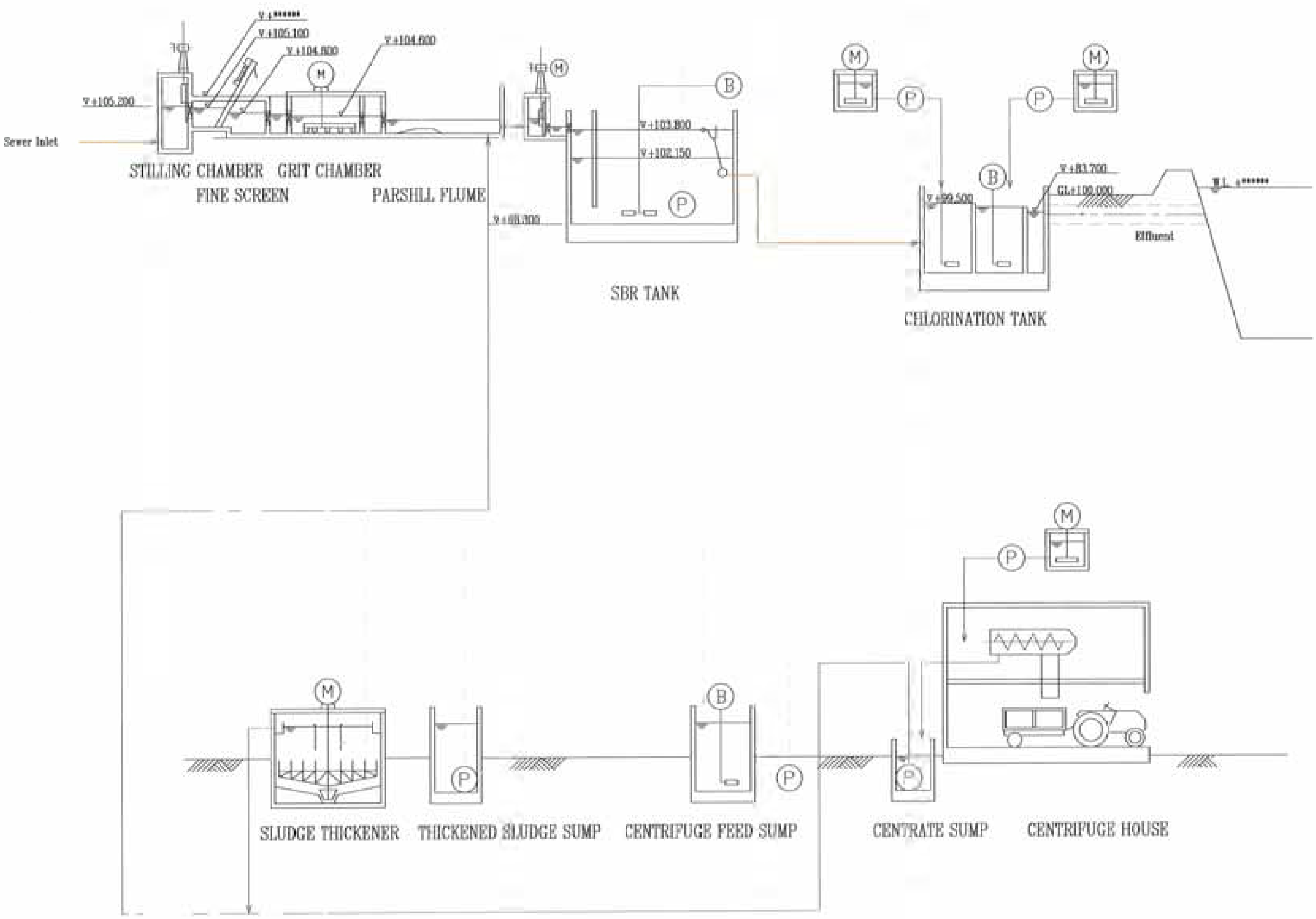
Main Process Line
Sludge Line
Other Line
Proposed structure
Demolished structure
Existing structure

Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title
Ghazipur STP 18MLD Layout

Scale 1:1200

Drawing No. STP-30



Main Process
Sludge Line
Other Line
Existing structure

Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA
インド国ガンジス川浄化事業準備調査

Drawing Title: Gazipur STP 18 MLD Layout

Scale: not

Drawing No.: STP-11

8. Ramnagar STP

Design Condition

Item	Ramnagar-MPS
(1) Design Flow for the year 2050	

	Flow Rate		
	m^3/d	m3/h	m^3/s
Average Daily	13,000	542	0.150
Max Dayly	13,000	542	0.150
Max Hourly Peak factor 2.25	29,250	1219	0.339

Item	Ramnagar-MPS
(1) Design Flow for the year 2035	

	Flow Rate		
	m^3/d	m3/h	m^3/s
Average Daily	10,000	417	0.116
Max Dayly	10,000	417	0.116
Max Hourly Peak factor 2.25	22,500	938	0.260

1. Inlet Chamber

Item	Ramnagar-MPS
[1]Design Condition	
(1) Design Flow for the year 2050	Max Hourly = 29,250 m3/d
	= 0.339 m3/sec
(2) Inlet Pipe	
Pipe Diameter	mm
Gradient	‰
Roughness Coefficient	n= 0.013 (Manning Formula)
Full Pipe Flow Rate	m^3/sec
(3) Influent Water Level	+ m
[2] Geometory	
(1) Number of Basins	1 Basin
(2) Depth of Basin	1.000 m Approx
(3) Width of Basin	3.000 m Approx
(4) Length of Basin	2.000 m Approx
(5) Volume required of Basin	1.000 × 3.000 × 2.000 = 15 m^3
(6) Retention Time	1.000 × 3.000 × 2.000 ／ 0.339 × 1
	= 17.70 sec
(7) Basin Demensions	Width 3.000 m × Length 2.000 m
	× Depth 1.000 m

2. Coarse Screen Channel

Item		Ramnagar-MPS									
[1]	Geometry										
(1)	Inlet Gate										
	Number		1	Main	+	1	Bypass				
	Width		0.600	m							
	Height		0.900	m							
	Floor Level	+	79.200		m						
	Bottom	+	68.600		m						
	Influent Water Level	+	69.300		m						
	Velocity		0.339	／	0.600	／	0.700	／	1		
	whe Design Flow for the year 2050	=	0.807	<	1.000	m/sec					OK
	Velocity		0.260	／	0.600	／	0.700	／	1		
	whe Design Flow for the year 2035	=	0.619	<	1.000	m/sec					OK
(2)	Screen Channel										
	Number		1.0	Main	+	1.0	Bypass				
	Width		1.000	m							
	Side Water Depth		0.800	m							
	Velocity		0.339	／	1.000	／	0.800	／	1		
	whe Design Flow for the year 2050	=	0.424	≒	0.450	m/sec					OK
	Velocity		0.260	／	1.000	／	0.800	／	1		
	whe Design Flow for the year 2035	=	0.325	<	0.450	m/sec					OK
(3)	Channel Dimensions	Width	1.0	m	×	Length	8.5	m			
			×	SWD	0.8	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		1	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		0.8	m							
	Height of Blind Plate at the bottom		50	mm							
	Velocity through screen		0.339	／	0.900	／	0.750	／	1		
			× (	20	+	9	) /	20			
		=	0.728	≒	0.800	m/sec					OK
	Velocity through screen		0.260	／	0.900	／	0.750	／	1		
	whe Design Flow for the year 2035		× (	20	+	9	) /	20			
		=	0.559	<	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		0.8	m							
	Velocity through screen		0.339	／	1.000	／	0.800	／	1		
	whe Design Flow for the year 2050		× (	50	+	9	) /	50			
		=	0.500	<	0.800	m/sec					OK
	Velocity through screen		0.260	／	1.000	／	0.800	／	1		
	whe Design Flow for the year 2035		× (	50	+	9	) /	50			
		=	0.384	<	0.800	m/sec					OK

3. **Raw Sewage Sump**

	Item	Ramnagar-MPS
[2]	Geometory	
(1)	Raw Sewage Sump	
	Number	1 Basin
	Dia	8.00 m
	Pump Operating Depth	1.600 m
	Retention Time	(8.00 ²× π／4 × 1.600)／ 0.339 ／60
	whe Design Flow for the year 2050	= 3.95 > 3.75 min (=minimum time of one pump cycle ' OK
	Retention Time	(8.00 ²× π／4 × 1.600)／ 0.260 ／60
	whe Design Flow for the year 2035	= 5.16 > 3.75 min (=minimum time of one pump cycle ' OK
	High Water Level	+ 69.100 m
	Pump Off Level	+ 67.500 m
[3]	Equipment	
(1)	Sewage Pumps 1	
	Number	2 W + 1 S
	Bore Diameter	150 mm
	Discharge Flow Q	0.260 × 3600 ／ 2.5 Q
	whe Design Flow for the year 2035	= 374 ⇒ 375 m3/Hr
	Total Head	20.0 m
(2)	Sewage Pumps 2	
	Number	1 W + 1 S
	Bore Diameter	150 mm
	Discharge Flow 0.5	375.000 ／ 2.0
	whe Design Flow for the year 2035	= 188 ⇒ 188 m3/Hr
	Total Head	20.0 m

Item	Ramnagar-STP 10MLD

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	937.5	0.260

(2) Design Water Quality

Unit: mg/L

	BOD	COD	SS	T-N			TP
				NH_4-N	Org-N	NOx-N	
Inlet	250	450	400	10	20	0	6
Outlet	10	50	10	2	0	8	2
Removal rate	96.0%	88.9%	97.5%	66.7%			-

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 — 2.000 m

(3) Width of Basin — 3.200 m

(4) Length of Basin — 3.500 m

(5) Volume required of Basin — 2.000 × 3.200 × 3.500 = 1.8 m3

(6) Retention Time — 2.000 × 3.200 × 3.500 ／ 0.260 × 1
= 86.1538462 sec

(7) Basin Dimensions — Width 3.200 m × Length 3.500 m
× Depth 2.000 m

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	0.500	m						
Height	0.750	m						
Floor Level	+		m					
Bottom	+		m					
Influent Water Level	+		m					
Velocity	0.260	／	0.500	／	0.500	／	2	
	=	0.520	≒	1.000	m/sec			

(2) Screen Channel

Number	2	Main	+	1	Bypass			
Width	0.800	m						
Side Water Depth	0.500	m						
Velocity	0.260	／	0.800	／	0.500	／	2	
	=	0.325	≒	0.450	m/sec			

(3) Channel Dimensions

Width	0.8	m	×	Length	7.5	m		
	×	SWD	0.5	m	(Freeboard 0.3m)			

[3] Equipment

(1) Inlet Gate

Number	2	W	+	1	S			
Dimension	Width	0.5	m	×	Height	0.75	m	
Design Water Level	0.00	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	0.260	／	0.700	／	0.450	／	2	
	× (	6	+	2	) /	6		
	=	0.550	<	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	0.260	／	0.800	／	0.500	／	2	
	× (	20	+	9	) /	20		
	=	0.471	<	0.800	m/sec			

4. Grit Chamber	
[1] Design Condition	
(1) Design Flow Rate	Max Hourly = 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	2 S + 0 W
(3) Surface Area required/Basin	23.4 ／ 2 = 11.71 m^2
(4) Length of Basin	11.71 ^0.5 = 3.4 m → 4.0 m
(5) HRT in Grit Chamber	60 sec
(6) Volume required of Basin	0.260 × 60 sec ／ 2 = 7.8 m^3
(7) Depth required	7.8 ／ 4.0 ／ 4.0 = 0.488 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 ／ 0.260 × 2
	= 60.00 sec
(10) Surface Overflow Rate at Peak Flow	22,500 ／ 4.0 ／ 4.0 ／ 2
	= 703.125 < 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 ／ W) $^{2/3}$
(3) Water depth Ha	Ha= (Q ／ 2264
	Ha= 0.402 m
(4) Crest Level	+ 75.400 m ≒ Minimum water level at downstream channel
(5) Water level at the crest	+ 75.802 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	0.500 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

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			250	mg/l	
	Outlet BOD			10.0	mg/l	
	Inlet S-BOD			167	mg/l	assumed as 2/3 of BOD
	Inlet COD			450	mg/l	
	Inlet S-COD	:sCOD		300	mg/l	assumed as 2/3 of COD
	Outlet S-COD	:nbsCODe		33	mg/l	=sCOD-1.6sBOD
	Inlet rbCOD			68	mg/l	assumed as 15% of COD
	bCOD/BOD			1.60		
	Inlet bCOD	: S_0		400	mg/l	
	Inlet nbCOD			50	mg/l	
		:nbpCOD		17	mg/l	=TCOD-bCOD-nbsCODe
	Inlet TSS			450	mg/l	
	Inlet SS			450	mg/l	
	Inlet VSS			315	mg/l	assumed as 70% of TSS
		: VSS_{COD}		0.48	gCOD/gV	=TCOD-sCOD/VSS
		:nbVSS		35.00	gnbVSS/	=nbpCOD/VSS_{COD}
		:iTSS		135.00	gnbVSS/	=TSS-VSS
	Inlet T-N			30	mg/l	
	Inlet TKN			30	mg/l	
	Inlet NH_4-N			10	mg/l	
	Inlet T-P			6	mg/l	
	Inlet Alkalinity as $CaCO_3$			380	mg/l	
	Outlet Kjeldahl N			2.0	mg/l	
	Outlet NH4-N			2.0	mg/l	
	Outlet NO3-N			8.0	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	$=\mu_{max}*1.072^{(T-20)}$ μmax 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	
(2)	Design SRT	SRT=	4.8387	day	$=1/\mu_{AOB}\times SF$

(3) Biomass production				
$Px,_{VSS}$	$Px,_{VSS}$=	1597.233	kg/d	=Px,bio+Q(nbVSS)
$Px,_{TSS}$	$Px,_{TSS}$=	3167.333	kg/d	=Px,bio/0.85+Q(nbVSS)+Q(TSS_0-VSS_0)
S	S=	0.4606	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}*$1.04^{(T-20)}$ μmax at20℃= 6.000
Yn	Yn=	0.150	gVSS/g Nox	
NOx	NOx=	13.000	mg/l	
$P_{X,bio,VSS}$	$P_{X,bio,VSS}$=	1247.233	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)]
		1137.464		=Q·Y_H(S_0-S)/[1+b_H(SRT)]
		99.069		=f_d.b_H.QY_H(S_0-S)SRT/[1+b_H(SRT)]
		10.699		=QYn(Nox)/[1+b_{AOB}(SRT)]
NOx	NOx=	13.033	mg/l	=TKN-Ne-0.12$P_{X,bio}$/Q
(4) Required Aeration Tank Volume				
Va=	Va=	5,109	m3	
τ =	τ =	12.26	hr	=Va/Q×24
X_{VSS}·Va	X_{VSS}·Va=	7,729	kg VSS	=$Px,_{VSS}$·SRT
X_{TSS}·Va	X_{TSS}·Va=	15,326	kg TSS	=$Px,_{TSS}$·SRT
F/M	F/M=	0.323	kgBOD/kgMLVSS	
FractionVSS=	FractionVSS	0.504		
MLVSS=	MLVSS=	1513	mg/L	
(5) BODloading	BODloading	0.489	kg/m3·d	
(6) Observed Yield				
$Y_{obs,TSS}$=	$Y_{obs,TSS}$=	1.268	gTSS/gBOD	
$Y_{obs,VSS}$=	$Y_{obs,VSS}$=	0.640	gVSS/gBOD	
bCODremoved=	bCODremov	3,995	kg/d	
(7) effluent NO_2-N	NO_2-N=	0.2407	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}*$1.04^{(T-20)}$ 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=	0.5485	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}*$1.072^{(T-20)}$ 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		

[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)]
= 1,077.37 mg/l

(2) IR ratio

IR = NOx/Ne-1.0-R
= 0.03

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

Nox feed= (IR+R)·Q·Ne
= 50,332.08 kg/d

(4) The anoxic tank volume

Vnor= 511 m3 = Va × 10%
Vnor= 1,667 m3 τ_DN= 4.000 h

(5) F/M_b

F/M_b= 1.39 g/g·d

(6) Fraction of rbCOD

16.88% =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= 0.252 g/g·d = b_0+b_1[ln(F/M_b)]

b_0= 0.213
b_1= 0.118

(8) SDNR

SDNR= 0.120 g/g·d =$SDNR_b$(MLVSS$_b$/MLVSS)

$SDNR_{adj}$= 0.169 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= 0.252 g/g·d =$SDNR_b$·$\theta^{(t-20)}$ θ = 1.026

(9) NOr

NOr= 302,664.85 kg/d =N_{nox}·SDNR·X_b
>Nox feed= 50,332 kg/d

(10) Alkalinity to be added to maintain pH7

-235.15 mg/l

Influent Alk	380.00	mg/l	
Alk used	92.82	mg/l	=7.14×Nox
Alk producet	17.97	mg/l	=3.57×(NOx-NOxe)
Alk to maint	70.00	mg/l	

[5] **Reactor**

(1) Coagulant Dosage — 0.0 Mol

(2) Total volume of Aeration Basins

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

$= 5,109$ m³

(3) Total volume of Anoxic Basins

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

$= 1,667$ m3

Item		Volume required	Retention Time required Summer	Retention Time required Winter	Ratio of Volume
unit		m³	hour	hour	
Anaerobic	V_{AN}	0	0.00	0.00	0.00
Anoxic	V_{DN}	1,670	4.01	4.01	1.00
Aerobic	V_A	5,110	12.26	12.26	3.06
Total	V	6,780	16.27	16.27	

[6] **Geometry**

(1) Basin Dimensions

Width	Length	Depth	Basins
8.0	116.0	5.0	2

Cross Section — 8.0*5.0 = 40.0 m²/Basin

Hantzsch Subtraction — = 1.0 m²/Basin

after Subtraction — 40.0-1.0 = 39.0 m²/Basin

Total Volume — 39.0*116.0 = 4,524 m²/Basin 9,048 m³/Total

(2) Partition of Basin

Item	unit	Anaerobic	Anoxic	Aerobic	Total
Cross Section	m²	39.0			
Length required	m	**0.0**	**21.4**	**65.5**	**86.9**
Volume required per Basin	m³	0	835	2,555	3,390
Total Volume required	m³	0	1,670	5,110	6,780
Actual Cross Section	m²	39.0	39.0	39.0	
Actual Length	m	0.0	29.0	87.0	116.0
Actual Volume per Basin	m³	0	1,131	3,393	4,524
Actual Total Volume	m³	0	2,262	6,786	9,048
Actual Ratio of Volume		0.00	1.00	3.00	
Actual Retention Time	hour	0.00	5.43	16.29	21.72

[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 — 60 %

Required Capacity — 10,000 m3/day× 60% ／24 ／ 2

= 125 m3/Hr ⇒ 125 m3/Hr

Number — 2 Work

2 Stanby

(3) SAS Pumps

Excess Sludge — 440 m3/day

Sludge withdraw — 12 Times/day

Running Time — 0.5 Hr/Time

Required Capacity — 440 m3/day ／ 12 ／ 0.50 ／ 2

= 36.63 m3/Hr ⇒ 40 m3/Hr

Number — 2 Work

2 Stanby

6. Air Requirement at Average Flow

[1]Design Condition

(1) AOR		AOR = 2,691 kg/day
		= 112.1 kg/h
Qin	:Design Average Flow m^3/d	10,000
Inlet bCOD	: S_0	400 mg/l
S=		S= 0.461 mg/l
Nox=		Nox 13.000 mg/l
$P_{X,bio}$=		$P_{X,b}$ 1,236.5 kg VSS/ 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= 2,691 kg O2/d
		k= 2.86

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

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

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	
		$1+0.40D_j/Pa$	1.18196
D_j	:	Tank Liquid Depth 4.70 m	
P_a	:	Standard absolute pressure at s	
			10.332 m
P_b	:	Absolute pressure at Plant Site Elevation	m
P_b/P_a	:	$\exp[-gM(z_b-z_a)/R^*T]$	0.991
g	:	Acceleration due to Gravity	9.80665 m/s^2
M	:	Mole of Air	28.97 kg/kg-mole
z_b	:	Plant Site Elevation	80 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

$$= \frac{28.908}{4.7456} = 6,091.59 \text{ kg/day}$$

(3)	No. of Basins	2 Basin
(4)	Standard O2 required at Field Conditions per Bas	= 3,046 kg/day
(5)	SOTE for the above Effective Aeration Depth	28.5 %
(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	= 44,010 m^3/day = 1,833.7 m^3/hr

[2]	Equipment						
(1)	Air Blower						
	Number	4	W	+	2	S	
	Required Capacity	1833.7	m^3/Hr･Basin	／	2	unit/Basin	
		= 916.9	m^3/h	⇒	920	m^3/h /Unit	
	Pressure	60	kPa				
	Safty Factor	10	%				
	Heat capacity ratio	1.4					
	Atmospheric pressuer at site elevation	100.385	kPa				
	Total inlet pressure	98.385	kPa				
	Volume rate of flow at inlet point	15.788	m3/min				
	Total discharge pressure	160.385	kPa				
	Overall adiabatic effeciency	0.65					
	Inlet air temperature (min.)	15	℃				
	Shaft power	21.250	kW				
	Rated Output of Motor	23.375	kW	⇒	30	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	Xcf=	3,000 mg/l			
(4)	SVI	SVI=	200			
(5)	Sedimentation Velocity	v=	4.899*10^6*T^(0.954)*Xcf^(-1.354)*SVI^(-0.77)			
		=	4.899*10^6*20.0^0.954*3,000^-1.354*150^-0.770			
		=	28.3 m/day	→		15.0 $m^3/m^2\cdot$day
(6)	Surface Overflow Rate required	S'=	v/(1.5*1)=	28.3/(1.5*1.0)	=	18.9 $m^3/m^2\cdot$day
[2]	**Geometory**					
(1)	Surface Area required	A=	10,000/15.0=		=	667 m^2
(2)	Demensions		Diameter	Depth	Basin	
			24.0	**3.5**	**2**	
(3)	Actual Surface Area	S=	24.0^2 * 3.14 /4 * 2.0		=	905 m^2
(4)	Surface Overflow Rate	S=	10,000/905		=	11.0 $m^3/m^2\cdot$day

8. Chlorination	
[1] Design Condition	
(1) Design Flow Rate	Average Daily Flow 10,000 m^3/day 416.67 m^3/h
(2) Contact Time	30 min
(3) Type of Chlorine	Bleaching Powder (Availtive chlorine 70%)
(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
(6) Consumption per day	142.9 kg/d as Bleaching Powder
[2] Chlorination Contact Tank	
(1) Volume required	Average Daily Flow ／ 1440 × Contact Time
	＝ 208.3 m^3
(2) Nos. of lanes	5 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	13.00 m Approx.
(8) Average Velocity	Decant Flow ／ 3600 ／ Width ／ Depth
	＝ 867 ／ 3600 ／ 2.00 ／ 2.00
	＝ 0.060 m/sec
(9) Total Volume	Width × Length × Depth × Nos. of lanes × Nos. of Tanks
	＝ 2.0 m × 14.0 m × 2.0 m
	× 5 × 1
	＝ 280 m^3 > 208.3 m^3
[3] Equipment	
(1) Chlorine Solution Tank	
Number	2 W + 0 S
Chlorine concentration	2 %
Gravity of dissolved chlorine	1.10
Required solution volume	100.00 kg / d × 100 / 2 / 1.10 / 1000
	＝ 4.55 m3/d
Dimension of Tank	1.5 mW × 1.5 mL × 1.5 mSWD
Volume of Tank	3.4 m3/tank
Total Volume of Tanks	6.8 m3 (Duration= 1.49 day)
(2) Mixer for Chlorine Solution Tank	
Number	2 W + 0 S
(3) Chlorine Dosing Pump	
Number	2 W + 2 S
Capacity	4.55 m3/d / 24 × 1000 / 2
	95 l/h/unit ⇒ 100 l/h/unit

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 × 1.19
	× 2 (safety factor)
	= 23.8 kg/d
	= 0.99 kg/h
[2] Dechlorination Contact Tank	
(1) Volume required	Average Flow Rate ⁄ 60 × Contact Time
	= 69.4 m^3
(2) Width of lane	13.00 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
	= 13.0 m × 4.0 m × 2.0 m
	= 104 m^3 > 69.4 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	23.80 kg/d × 100 / 10 / 1.10 / 1000
	= 0.22 m3/d
Volume of Tank	0.3 m3/tank
Total Volume of Tanks	0.6 m3 (Duration= 2.77 day)
(2) Mixer for Dechlorine Solution Tank	
Number	2 W + 0 S
(3) Dechlorine Dosing Pump	
Number	1 W + 1 S
Capacity	0.22 m3/d / 24 × 1000 / 1
	9.02 l/h/unit ⇒ 10 l/h/unit

10.	**Sludge Thikener**	
[1]	**Design Condition**	
(1)	Primary Sludge	0 kg/day 0 m3/day
(2)	Secondary Sludge	3,517 kg/day 440 m3/day
(3)	Total Solids	3,517 kg/day 440 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	$3517 \times \frac{1}{40} = 87.90$ m2
(5)	Required diameter	$\left(\frac{4}{\pi} \times 87.90 \times \frac{1}{2} \right)^{1/2} = 7.48$ m → 9.00 m
(6)	Side Water Depth	4 m
(7)	Actual Volume of Tank	$\frac{\pi}{4} \times 9.00^{2} = 63.62$ m3
(8)	Retention Time	$\frac{63.62}{440} \times 4 \times 2 \times 24 = 27.79$ Hr
[3]	**Volume of Thikened Sludge**	= 127 m^3/d
[4]	**Quantity of Separation Liquid**	Inlet Sludge Volume − Thikened Sludge Volume = 439.6 − 126.6 = 313.0 m^3/day

11.	**Thickener Feed Sump**							
[1]	**Design Condition**							
(1)	Inlet Solids	3,517	kg/day					
(2)	Inlet Sludge Volume	440	m^3/d					
[2]	**Geometory**							
(1)	Sludge withdrawl	12	Times/day					
(2)	Required Sump Volume	37	m^3/d					
(3)	Number	2	Basins					
(4)	Width	3.0	m					
(5)	Length	3.0	m					
(6)	Side Water Depth	3.0	m					
(7)	Actual Sump Volume	3.0	×	3.0	×	3.0	×	2
		=	54.0	m^3				
[3]	**Equipment**							
(1)	Thickened Sludge Transfer Pumps							
	Transfer Time	6.00	Hr					
	Number	2	W	+	2	S		
	Required Capacity	440	m^3	/	6.0	/	2	
		=	36.6	m^3/Hr	⇒	40	m^3/Hr /Unit	

12. Centrifuge

[1] Design Condition

(1)	Type of Dewatering	Centrifuge
(2)	Quantity of Thickend Sludge generated	3,165 kg/day
(3)	Design Polyelectrolyte Dosage	Polyelectrolyte 1.5 kg/t-DS·day
(4)	Volume of Thickend Sludge	126.6 m^3/day
(5)	Consistency of Dewatered Sludge	82 %
(6)	Operation Time	8 hours/day (6 days per week)

[2] Volume of Centrifuges

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

$$= \frac{126.6}{8 \times 1} \times \frac{7}{6} = 18.5$$

$\rightarrow$ 19 m^3/hour

[3] Dewatered Solids

Digested Sludge × (1 + Injection Rate)

= 3,165 × (1 + 0.0015)

= 3,170 kg/day

[4] Dewatered Cake Volume

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

$$= 3.170 \times \frac{100}{100 - 82} \times \frac{7}{6}$$

= 20.55 t/day

apparent specific gravity 1.00

20.55 / 1.0 = 20.5 m^3/day

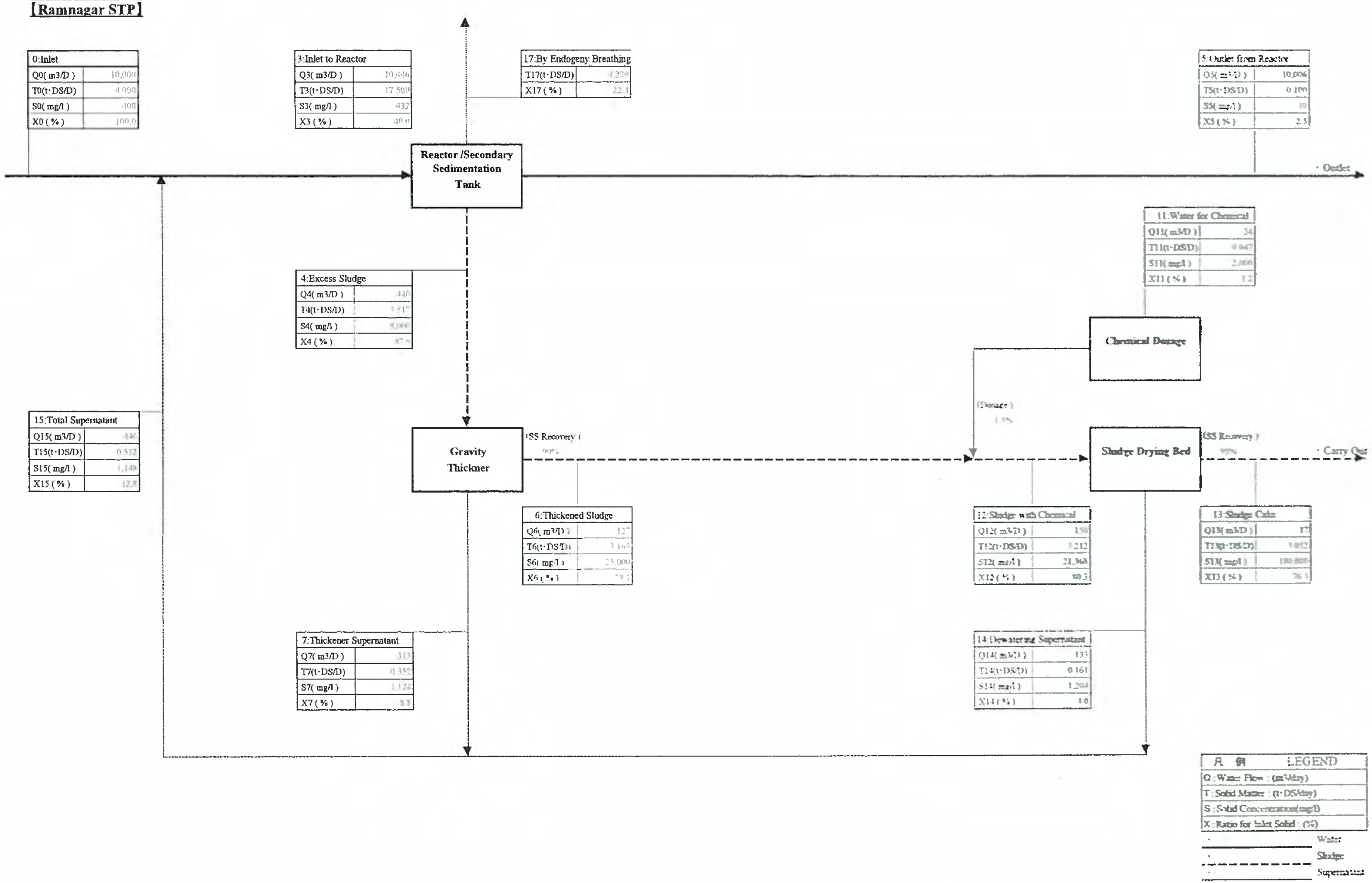
[5] Polyelectrolyte

(1)	Design Polyelectrolyte Dosage	Polyelectrolyte 1.5 kg/t-DS·day
(2)	Required Polyelectrolyte	4.75 kg/day
(3)	Dissolving concentration	0.20 %
(4)	Volume of Polyelectrolyte solution	2.37 m3/day

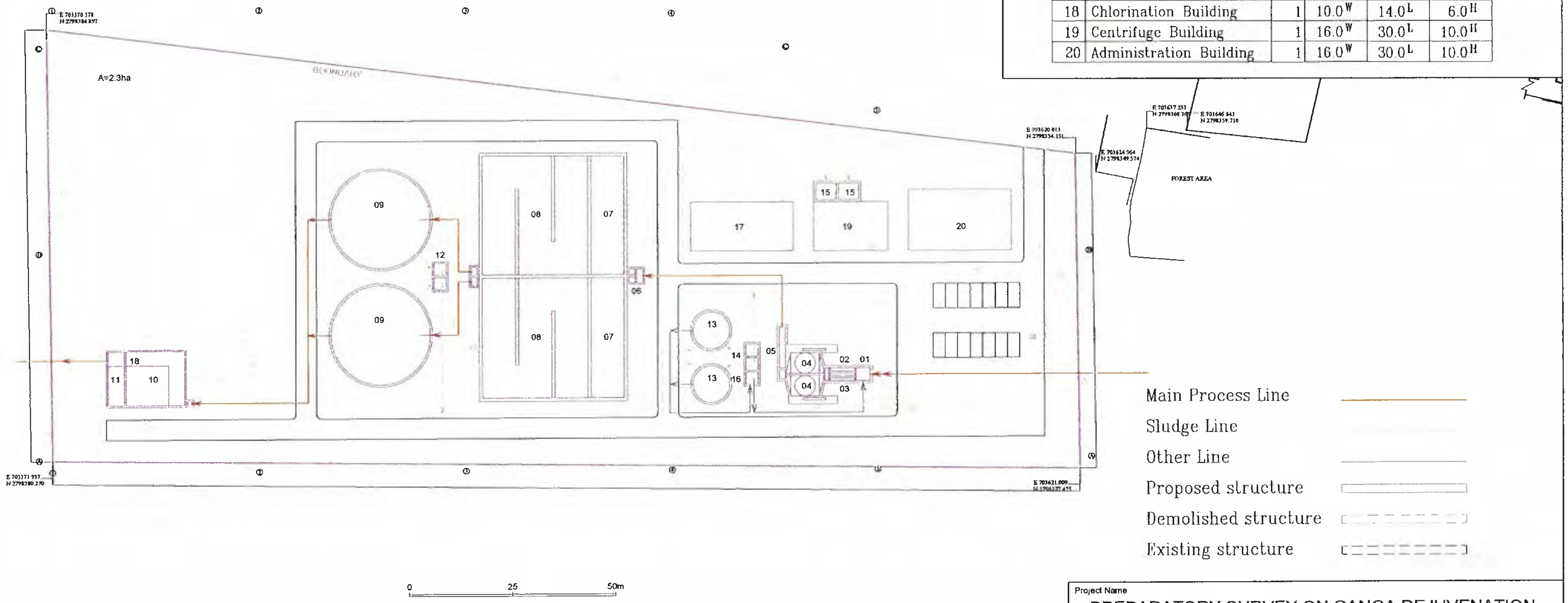
[6]	**Equipment**									
(1)	Centrifuge									
	Capacity	19	m^3/hr							
	Number	1	W		+	1	S			
(2)	Centrifuge Feed Pumps									
	Capacity	19	m^3/hr							
	Number	1	W		+	1	S			
(3)	Polyelectrolyte Dosing Pumps									
	Volume of Polyelectrolyte solution	2.37	m3/day							
	Operation Time	8	hours/day		(6 days per week)					
	Safety Factor	1.5								
	Number	1	W		+	1	S			
	Required Capacity	2.37	m3/dar ×	7	⁄	6	⁄	8	⁄	1
		=	0.35	m^3/Hr						
	Specification Capacity	0.35	m^3/Hr	×		1.5				
		=	0.519	m^3/Hr	⇒		0.52	m^3/Hr /Unit		
(4)	Polyelectrolyte dosing System									
	Tanks Dimensions	Width	1.5	m	×	Length	2.0	m		
		×	Depth	2.0	m	×	2 (Freeboard 0.5m)			
		=	12	m^3						
	Retention Time of Tanks	12.00	m^3	⁄		0.35	m^3/Hr	⁄		1
		=	34.665	Hr						
	Number	2	W		+	0	S			

13. Centrifuge Feed Sump	
[1] Design Condition	
(1) Generated Thickend Sludge	3,165 kg/day
(2) Solids Consistency	2.50 %
(3) Volume of Thickened Sludge	Total Solids × $\frac{100}{\text{Solids Consistency}}$ × 10^{-3}
	= 3,165 × $\frac{100}{2.50}$ × 10^{-3}
	= 127 m^3/day
	= 5.28 m^3/h
(4) Sludge feed flow rate	19 m3/h × 1 = 19 m3/h
(5) Centrifuge Operation Time	8 hours/day (6 days per week)
[2] Geometry	
(1) Required sludge volume for continuation	(19 - 5.28) x 8
	= 109.80 m^3
(2) Basin Dimensions	Width 4.0 m × Length 5.0 m
	× Depth 3.5 m × 2
	= 140.0 m^3
[3] Equipment	
(1) Mixers for Centrifuge Feed Sumps	
Required Volume	140.0 m^3
Number	1 W + 1 S

Material Balance Sheet
【Ramnagar STP】



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	4.0^{W}	5.5^{L}	4.0^{SWD}
02	Main Screen Channel	1	2.0^{W}	5.0^{L}	0.7^{SWD}
03	Bypass Screen Channel	1	$***^{W}$	$***^{L}$	$***^{SWD}$
04	Grit Chamber	2	$3.0^{Dia.}$		3.0^{SWD}
05	Parshall Flume	1	1.5^{W}	10.0^{L}	0.8^{SWD}
06	Distribution Chamber	4	$****^{W}$	$****^{L}$	$****^{SWD}$
07	Anoxic Tank	2	17.0^{W}	28.0^{L}	5.5^{H}
08	Aerobic Tank	1	7.0^{W}	30.0^{L}	2.0^{SWD}
09	Secondary Clarifier	1	$****^{Dia.}$		$****^{SWD}$
10	Chlorine Contact Tank	1	2.0^{W}	115.0^{L}	3.0^{SWD}
11	Dechlorine Mixing Tank	1	2.0^{W}	115.0^{L}	3.0^{SWD}
12	Secondary Sludge Sump	2	2.5^{W}	2.5^{L}	3.0^{SWD}
13	Sludge Thickener	2	$13.5^{Dia.}$		4.0^{SWD}
14	Thickened Sludge Sump	2	2.5^{W}	2.5^{L}	3.0^{SWD}
15	Centrifuge Feed Sump	4	5.0^{W}	5.0^{L}	3.5^{SWD}
16	Filtrate Sump	4	5.0^{W}	5.0^{L}	3.5^{SWD}
17	Air Blower Room	1	12.0^{W}	25.0^{L}	6.0^{H}
18	Chlorination Building	1	10.0^{W}	14.0^{L}	6.0^{H}
19	Centrifuge Building	1	16.0^{W}	30.0^{L}	10.0^{H}
20	Administration Building	1	16.0^{W}	30.0^{L}	10.0^{H}



Project Name

PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTAR PRADESH, INDIA

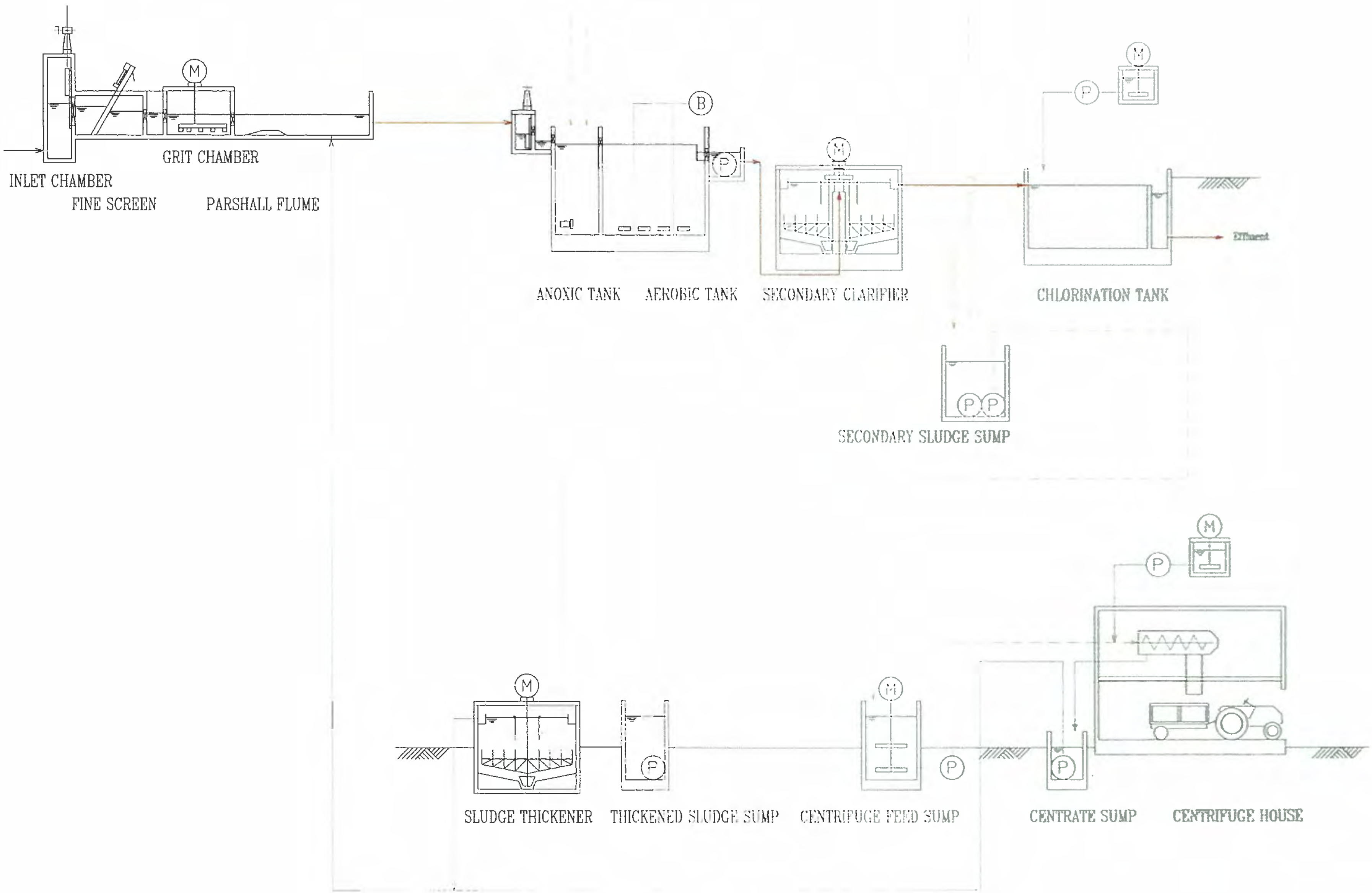
インド国ガンジス川浄化事業準備調査

Drawing Title

Ramnagar STP Layout

Scale: 1:1000 (A3)

Drawing No. STP-28



Main Process
Sludge Line
Other Line
Existing structure

Project Name: PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTARPRADESH, INDIA インド国ガンジス川浄化事業準備調査	
Drawing Title: Ramnagar STP 10MLD Layout	Scale: not Drawing No: STP-09

7. Integration back data

TABLE OF CONTENTS

1. District I
(Varanasi)

1 INR(India Rupee)=	1.57	JPY
1 US$=	105.5	JPY

Summary - Varanasi District 1

Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
				Unit	Amount	Unit	Amount	
Varanasi District 1		LS	1				2,747,775,976	
Cost of sewer cleaning equipments, Flushing Van		LS	1				4,055,000.00	
Hiring of Godown and Site Office		LS	1				1,020,000.00	
Communication & Public Outreach		LS	1				3,500,000.00	
Environmental and Management Plan		LS	1				1,000,000.00	
Governance and Accountibility Action Plan (GAAP)		LS	1				2,000,000.00	
Total							2,759,350,975.57	

1 INR(India Rupee)= 1.57 JPY
1 US$= 105.5 JPY

Varanasi District 1

Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
				Unit Price	Amount	Unit Price	Amount	
[Direct Cost]								
<Civil/Building work>								
1.1 DISMANTLING AND REINSTATEMENT OF EXISTING ROADS		pc	1		0		246,586,956.03	
1.2 EARTH WORK (SEWER)		pc	1		0		188,039,069.21	
1.3 TRENCHLESS		pc	1		0		124,646,016.53	
1.4 TIMBERING WORK		pc	1		0		503,088,295.84	
1.5 BEDDING WORK		pc	1		0		127,675,575	
1.6 LAYING OF R.C.C. PIPE		pc	1		0		234,236,465	
2.MANHOLES IN BRICK MASONARY		pc	1		0		405,190,433	
3. HOUSE CONNECTING CHAMBER		pc	1		0		337,036,834	
4. BARRICADING		pc	1		0		10,855,800	
5. DESILTING OF SEWER PIPE		pc	1		0		491,051	
6. REPAIRS/REHABILITATION OF EXISTING MANHOLE		pc	1		0		1,335,063	
7. DISMANTELING OF EXISTING SEWERS		pc	1		0		2,230,850	
8. TRANSFER OF EXISTING HOUSE CONNECTIONS TO SEWERS		pc	1		0		536,032,000	
9. MISCELLANEOUS		pc	1		0		30,331,566	
Sub-Total					0		2,747,775,976	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
<Civil/Building work>									
	SEWER LAYING								
	DISMANTLING AND REINSTATEMENT OF EXISTING ROADS								
	DISMANTLING WORK								
	Dismantling manually / by mechanical means including stacking of serviceable material and disposal of unserviceable material within 50 metres lead as per direction of Engineer-in-Charge.								
15.43.2 - DSR_2014	a) Bitumen Road		m2	29,864.27			159.05	4,749,911.61	
1266 - SOR_U.P. Jal Nigam Varanasi_2015-16	b) Cement Concrete Road		m3	11,577.44			1,013.71	11,736,165.59	
								0.00	
16.83 - DSR_2014	Taking out existing CC interlocking paver blocks from footpath/ central verge, including removal of rubbish etc., disposal of unserviceable material to the dumping ground, for which payment shall be made separately and stacking of serviceable material within 50 metre lead as per direction of		m2	278,112.89			48.30	13,432,852.65	
								0.00	
	REINSTATEMENT WORK							0.00	
UP PWD 2013	Reinstatement of Existing Bitumen Road - Owned by Nagar Nigam		m2	29,864.27			3,634.00	108,526,745.01	
								0.00	
1323 - SOR_U.P. Jal Nigam Varanasi_2015-16	Providing all Materials, Labours, T & P etc & construct 100mm thick (1:2:4) Cement Concrete Road for Reinstatement of patch & trench cuts in		m3	11,577			2,228.10	25,795,691.61	
								0.00	
16.68 - DSR_2014	Providing and laying 60 mm thick factory made cement concrete interlocking paver block of M -30 grade made by block making machine with strong vibratory compaction, of approved size, design & shape, laid in required colour and pattern over and including 50 mm thick compacted bed of coarse sand, filling the joints with fine sand etc. all complete as per the		m2	55,623			602.20	33,495,916.63	
								0.00	
16.84 - DSR_2014	Laying old cement cocrete interlocking paver blocks of any design/shape laid in required line, level, curvature, colour and pattern over and including 50 mm thick compacted bed of coarse sand, filling the joints with fine sand etc. all complete as per the direction of Engineer-in-charge. (Old CC paver blocks shall be supplied by the		m2	249,615			195.70	48,849,672.93	
								0.00	
	EARTH WORK (SEWER)							0.00	
								0.00	
	Excavation by manually or mechanically up to following depths below G.L. for laying sewer line, in ordinary soil (earth, sand, loam & clay) including cutting of joints pits ramming dressing, leveling by manually or mechanically, refilling of trenches in 15cm layer watering and ramming the same including removal of surplus earth or other dismantled material up to a distance of 50m from the centre of trenches. (Excavation for Manhole is							0.00	
3001 - SOR_U.P. Jal Nigam Varanasi_2015-16	a) 0.0 to 1.5 mtr B.G.L		m3	263,836.84			184.79	48,754,409.73	
3002 - SOR_U.P. Jal Nigam Varanasi_2015-16	b) 1.5 to 3.0 mtr B.G.L		m3	212,645.51			231.98	49,329,506.21	
3003 - SOR_U.P. Jal Nigam Varanasi_2015-16	c) 3.0 to 4.5 mtr B.G.L		m3	104,428.88			291.27	30,417,000.42	
3004 - SOR_U.P. Jal Nigam Varanasi_2015-16	d) 4.5 to 6.0 mtr B.G.L		m3	35,692.33			340.09	12,138,605.18	
3005 - SOR_U.P. Jal Nigam Varanasi_2015-16	e) 6.0 to 7.5 mtr B.G.L		m3	9,377.51			443.48	4,158,739.87	
3006 - SOR_U.P. Jal Nigam Varanasi_2015-16	f) 7.5 to 9.0 mtr B.G.L		m3	5,335.95			583.07	3,111,232.37	
								0.00	
								0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
RA16	Disposal of excavated excess earth away from the site including conveyance of material up to an average lead for 5km &above away from the site and corresponding required lift, loading, unloading etc complete as directed by the engineer-in-charge (The quantity is net quantity							0.00	
	By Mechanical Transport including loading , unloading and stacking (Lead upto 5 Km away from the site)		m3	21,155.28			366.10	7,744,946.71	
								0.00	
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc in layers not exceeding 20 cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m							0.00	
1003 - SOR_U P Jal Nigam Varanasi 2014-15	a) 0.0 to 1.5 mtr B G L		m3				51.86	0.00	
1003 &1006-SOR_U.P. Jal Nigam	b) 1.5 to 3.0 mtr B G L		m3				74.55	0.00	
1003 &1006-SOR_U.P. Jal Nigam	c) 3.0 to 4.5 mtr B G L		m3				97.24	0.00	
1003 &1006-SOR_U.P. Jal Nigam	d) 4.5 to 6.0 mtr B G L		m3				119.93	0.00	
1003 &1006 -SOR - U.P. Jal Nigam Varanasi 2014-15 and	e) 6.0 to 9.0 mtr B G L		m3				142.62	0.00	
								0.00	
RA16	Disposal of Road Cutting Rubbish / Malba / similar unserviceable, dismantled or waste material by mechanical means , including loading ,transportation , unloading to approved municipal dumping ground or as approved by Engineer - in charge, for 5km initial lead, for all leads including		m3	32,445.21			292.85	9,501,579.66	
								0.00	
Similar Project Exp	Carting of excavated earth to identified place and recarting the same where sufficient width of road is not available for stacking of excavated earth average lead 500 mtr.		m3	62,598.11			158.00	9,890,501.09	
								0.00	
RA13	Bailing out or pumping out water / liquid mud during trench execavation. This includes providing necessary fuel, labour T&P etc. required for proper running of well point equipment of required capacity for lowering the water table during excavation and laying of		m	21,713.96			598.35	12,992,547.97	
	TRENCHLESS								
	Supply of precast RCC NP4 jacking pipes manufactured by centrifugal spinning or vertical casting comply to BSEN 5911, pt. 120 or EN 1916 2002 and also meet the basic concrete testing requirements specified in IS 458, IS 3597 of 1966 and IS 7596 1998. Including supply of suitable couplings (nomally Built in Type collar) made of weldable structural stainless steel confoming to BS 4360 Grade 43, or relevant Code including supply of suitable rubber rings confiming to EN								
		200 mm dia pipe	m	840.00			12,066.11	10,135,534.75	
		250mm dis pipe	m	309.00			12,736.45	3,935,563.79	
		300 mm dia pipe	m				13,406.79	0.00	
		350 mm dia pipe	m	18.00			14,077.13	253,388.37	
		400 mm dia pipe	m	268.00			14,747.47	3,952,322.28	
		450 mm dia pipe	m	30.00			15,417.81	462,534.32	
		500 mm dia pipe	m	99.00			16,088.15	1,592,726.89	
		600 mm dia pipe	m	192.00			18,099.17	3,475,040.49	
		700 mm dia pipe	m	30.00			20,110.19	603,305.64	
		800 mm dia pipe	m	90.00			24,450.00	2,200,500.00	
								0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	Schedule of rates from Institute of trenchless Tehnology 2014)_2.8.2	Installation of product pipe by Trenchless Technology including making of entry and exit pits all related civil works like excavation, shoring/shuttering etc. and Ground to protect any exixting utilities at the pipe installation location and restoration						0.00	
		upto 300 mm dia.	m	1,149.00			48,200.00	55,381,800.00	
		300 to 450 mm dia.	m	316.00			53,000.00	16,748,000.00	
		450 to 600 mm dia.	m	291.00			58,300.00	16,965,300.00	
		600 to 900 mm dia	m	120.00			74,500.00	8,940,000.00	
								0.00	
								0.00	
								0.00	
								0.00	
								0.00	
								0.00	
	TIMBERING WORK							0.00	
	Providing and fixing open timbering in trenches up to 3m deep, consisting of 40mm thick approved country wood plank for poling board, 125x75mm Indian Sal wood wallers and 100mm diameter Sal wood ballies for shuttering at 1.50m c/c including removal after laying of sewers. (Measurement to be taken of the face area timbered)							0.00	
3041 - SOR_U.P. Jal Nigam Varanasi_2015-16	1.5 to 3.0 mtr B.G.L.		m2	541,643.25			393.91	213,358,690.92	
3042 - SOR_U.P. Jal Nigam Varanasi_2015-	b) 3.0 to 6.0 mtr B.G.L.		m2				488.08	0.00	
3043 - SOR_U.P. Jal Nigam Varanasi_2015-	a) 6.0 to 9.0 mtr B.G.L.		m2				600.54	0.00	
								0.00	
	Providing and fixing close timbering in trenches for the following depths below G.L. consisting of 40mm thick approved country wood plank for poling board 125x75mm Indian Sal wood walers and 100mm diameter Sal wood ballies for shuttering at 1.50m c/c including removal after laying of sewers (Measurement to be taken of the							0.00	
3032 - SOR_U.P. Jal Nigam Varanasi_2015-16	3.0 to 4.5 mtr B.G.L.		m2	116,532.63			649.06	75,636,668.85	
3033-SOR_U.P. Jal Nigam Varanasi_2015-16	4.5 to 6.0 mtr B.G.L.		m2	75,592			811.40	61,335,429.84	
3034-SOR_U.P. Jal Nigam Varanasi_2015-16	6.0 to 7.5 mtr B.G.L.		m2	64,077.27			935.01	59,912,889.63	
3034-SOR_U.P. Jal Nigam Varanasi_2015-16	7.5 to 9.0 mtr B.G.L.		m2	67,952			935	63,535,361.48	
3034-SOR_U.P. Jal Nigam Varanasi_2015-16	9.0 to 10.5 mtr B.G.L.		m2	0.00			935.01	0.00	
								0.00	
	Extra for planking and strutting in open timbering if required to be left pemanently inposition (Face area of the timber pemanently left to be measured)							0.00	
3047 - SOR_U.P. Jal Nigam Varanasi_2015-16	0.0 to 3.0 mtr B.G.L.		m2	10,832.86			899.99	9,749,470.09	
3048 - SOR_U.P. Jal Nigam Varanasi_2013-	b) 3.0 to 6.0 mtr B.G.L.		m2				1,074.34	0.00	
3049 - SOR_U.P. Jal Nigam Varanasi_2013-	a) 6.0 to 9.0 mtr B.G.L.		m2				1,301.66	0.00	
								0.00	
	Extra for planking and strutting in close timbering if required to be left pemanently inposition (Face area of the timber pemanently left to be measured)							0.00	
3038 - SOR_U.P. Jal Nigam Varanasi_2015-16	0.0 to 3.0 mtr B.G.L.		m2	0.00			1,542.03	0.00	
3039 - SOR_U.P. Jal Nigam Varanasi_2015-16	b) 3.0 to 6.0 mtr B.G.L.		m2	5,949.13			1,879.93	11,183,956.71	
3040 - SOR_U.P. Jal Nigam Varanasi_2015-16	a) 6.0 to 9.0 mtr B.G.L.		m2	3,961			2,114.32	8,375,828.32	
								0.00	
	BEDDING WORK							0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	Providing and laying PCC Bedding with 12-20mm gauge approved stone ballast, course sand and cement in M-15 (1:2:4) all work up to plinth level, including supply of all materials labour T&P etc. required for proper completion of work and excluding							0.00	
	200 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	284			472.76	134,216.56	
	1.5 to 3.0 Mtr B.G.L.		m	16,291			484.47	7,892,549.22	
	3.0 to 4.5 Mtr B.G.L.		m	29,577			500.08	14,791,091.20	
	4.5 to 6.0 Mtr B.G.L.		m	5,540			519.59	2,878,684.48	
	6.0 to 7.5 mtr B.G.L.		m	287			550.81	158,247.71	
	250 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	44			549.31	24,169.64	
	1.5 to 3.0 Mtr B.G.L.		m	2,361			563.02	1,329,290.22	
	3.0 to 4.5 Mtr B.G.L.		m	3,457			581.29	2,009,519.53	
	4.5 to 6.0 Mtr B.G.L.		m	1,679			604.12	1,014,317.48	
								0.00	
	300 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	18			628.77	11,317.86	
	1.5 to 3.0 Mtr B.G.L.		m	381			644.54	245,569.74	
	3.0 to 4.5 Mtr B.G.L.		m	1,714			665.56	1,140,769.84	
								0.00	
	350 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			711.13	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	616			729.03	449,082.48	
	3.0 to 4.5 Mtr B.G.L.		m	175			752.91	131,759.25	
	4.5 to 6.0 Mtr B.G.L.		m	74			782.76	57,924.24	
	6.0 to 7.5 mtr B.G.L.		m	202			830.51	167,763.02	
	7.5 to 9.0 mtr B.G.L.		m	0			890.21	0.00	
								0.00	
	400 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			796.38	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	436			816.50	355,994.00	
	3.0 to 4.5 Mtr B.G.L.		m	375			843.33	316,248.75	
	4.5 to 6.0 Mtr B.G.L.		m	0			876.86	0.00	
	6.0 to 7.5 mtr B.G.L.		m	189			930.51	175,866.39	
	7.5 to 9.0 mtr B.G.L.		m	132			997.58	131,680.56	
	9.0 to 10.5 mtr B.G.L.		m	0			1,064.64	0.00	
								0.00	
	450 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			884.54	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	148			906.94	134,227.12	
	3.0 to 4.5 Mtr B.G.L.		m	466			936.81	436,553.46	
	4.5 to 6.0 Mtr B.G.L.		m	502			974.15	489,023.30	
	6.0 to 7.5 mtr B.G.L.		m	0			1,033.89	0.00	
	7.5 to 9.0 mtr B.G.L.		m	128			1,108.57	141,896.96	
	9.0 to 10.5 mtr B.G.L.		m	0			1,183.25	0.00	
								0.00	
	500 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			975.59	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	98			1,000.35	98,034.30	
	3.0 to 4.5 Mtr B.G.L.		m	826			1,033.37	853,563.62	
	4.5 to 6.0 Mtr B.G.L.		m	496			1,074.63	533,016.48	
	6.0 to 7.5 mtr B.G.L.		m	0			1,140.66	0.00	
	7.5 to 9.0 mtr B.G.L.		m	79			1,223.19	96,632.01	
								0.00	
	600 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			1,166.41	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			1,196.10	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	583			1,235.68	720,401.44	
	4.5 to 6.0 Mtr B.G.L.		m	655			1,285.16	841,779.80	
								0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	700 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			1,368.82	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			1,403.73	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	114			1,450.27	165,330.78	
								0.00	
	750 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			1,474.38	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			1,512.00	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	62			1,562.17	96,854.54	
	4.5 to 6.0 Mtr B.G.L.		m	87			1,624.87	141,363.69	
								0.00	
	800 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			1,582.84	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			1,623.25	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	0			1,677.14	0.00	
	4.5 to 6.0 Mtr B.G.L.		m	233			1,744.49	406,466.17	
	6.0 to 7.5 mtr B.G.L.		m	84			1,852.26	155,589.84	
								0.00	
	Providing and laying RCC Bedding with 12-20mm gauge approved stone ballast, coarse sand and cement in M-15 (1:2:4) all work up to plinth level, including supply of all materials labour T&P etc. required for proper completion of work and excluding shuttering and centering with 0.4% of							0.00	
	250 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			566.79	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			580.49	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	0			598.76	0.00	
	4.5 to 6.0 Mtr B.G.L.		m	365			621.59	226,880.35	
	6.0 to 7.5 mtr B.G.L.		m	511			658.13	336,304.43	
								0.00	
	300 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			648.88	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			664.65	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	297			685.67	203,643.99	
	4.5 to 6.0 Mtr B.G.L.		m	1,843			711.95	1,312,123.85	
	6.0 to 7.5 mtr B.G.L.		m	490			754.00	369,460.00	
								0.00	
								0.00	
	350 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			733.96	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			751.87	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	171			775.75	132,653.25	
	4.5 to 6.0 Mtr B.G.L.		m	790			805.59	636,416.10	
								0.00	
	400 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			822.04	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			842.16	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	57			868.98	49,531.86	
	4.5 to 6.0 Mtr B.G.L.		m	836			902.52	754,506.72	
	6.0 to 7.5 mtr B.G.L.		m	312			956.17	298,325.04	
								0.00	
	450 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			935.51	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			935.51	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	0			965.38	0.00	
	4.5 to 6.0 Mtr B.G.L.		m	247			1,002.72	247,671.84	
	6.0 to 7.5 mtr B.G.L.		m	140			1,062.46	148,744.40	
	7.5 to 9.0 mtr B.G.L.		m	8			1,137.14	9,097.12	
								0.00	
	500 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			1,007.17	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			1,031.93	0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	3.0 to 4.5 Mtr B.G.L.		m	0			1,064.94	0.00	
	4.5 to 6.0 Mtr B.G.L.		m	163			1,106.20	180,310.60	
	6.0 to 7.5 mtr B.G.L.		m	120			1,172.23	140,667.60	
	7.5 to 9.0 mtr B.G.L.		m	330				0.00	
								0.00	
	600 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			1,204.27	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			1,233.95	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	0			1,273.54	0.00	
	4.5 to 6.0 Mtr B.G.L.		m	29			1,323.02	38,367.58	
	6.0 to 7.5 mtr B.G.L.		m	322			1,402.19	451,505.18	
	7.5 to 9.0 mtr B.G.L.		m	241			1,501.15	361,777.15	
								0.00	
	Providing and laying Granular bedding with carefully compacted graded hard crusher broken stone of 100% passing through 20mm sieve, 20-50% passing throgh 10mm sieve and 100% retained on 6mm sieve and Dimensions are as per Approved Drawing for Following							0.00	
	200 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	49,464			576.10	28,496,239.21	
	1.5 to 3.0 Mtr B.G.L.		m	91,724			580.34	53,230,815.99	
								0.00	
	250 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	297			672.77	199,812.69	
	1.5 to 3.0 Mtr B.G.L.		m	1,457			677.68	987,379.76	
								0.00	
	300 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	13			777.53	10,107.89	
	1.5 to 3.0 Mtr B.G.L.		m	52			783.13	40,722.76	
								0.00	
	500 mm Dia Sewer Pipe							0.00	
	0.0 to 1.5 Mtr B.G.L.		m	0			1,251.84	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	68			1,260.50	85,714.00	
								0.00	
								0.00	
	LAYING OF R.C.C. PIPE							0.00	
	Supply and carting to site RCC NP3 pipes (with s/s ends) as per IS: 458 - 2003 (Amended up to date) including all taxes (Central and Local) with Rubber gaskets (EPDM/SBR) as per IS: 5382-1985 or (Amended up to date), including cost of Rubber gaskets, labour required, transportation, loading, unloading & stacking etc (excluding cost of laying, jointing, testing and commissioning) The pipe shall be ISI							0.00	
								0.00	
	a) 200 mm dia RCC pipe		m	193,293.60			588.57	113,766,512.61	
	b) 250 mm dia RCC pipe		m	9,862.00			702.86	6,931,613.21	
	c) 300 mm dia RCC pipe		m	4,808.00			985.45	4,738,052.25	
	d) 350 mm dia RCC pipe		m	2,010			1,343	2,700,234.80	
	e) 400 mm dia RCC pipe		m	2,069.00			1,617.20	3,345,986.14	
	f) 450 mm dia RCC pipe		m	1,609.00			1,749.08	2,814,262.45	
	g) 500 mm dia RCC pipe		m	2,081.00			2,144.70	4,463,126.69	
	h) 600 mm dia RCC pipe		m	1,638.00			2,711.14	4,440,848.70	
	i) 700 mm dia RCC pipe		m	84			3,305.21	277,637.63	
	j) 750 mm dia RCC pipe		m	0.00			3,500.00	0.00	
	k) 800 mm dia RCC pipe		m	466.00			3,977.15	1,853,351.21	
								0.00	
	Lowering in trenches, aligning, laying & jointing of RCC pipes NP3 class (with s/s ends) as per IS: 458 - 1988 (Amended up to date) with Rubber gaskets (EPDM/SBR) including cost of all jointing materials, testing, commissioning etc, complete as per specifications and/or as directed by							0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
								0.00	
	200 mm dia RCC pipe							0.00	
3198- SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	49,748.0			356.53	17,736,636.61	
	1.5 to 3.0 Mtr B.G.L.		m	108,015			380	40,994,369.06	
	3.0 to 4.5 Mtr B.G.L.		m	29,577			403	11,921,403.14	
	4.5 to 6.0 Mtr B.G.L.		m	5,540			431	2,385,154.41	
	6.0 to 7.5 mtr B.G.L.		m	287			469	134,748.07	
	7.5 to 9.0 mtr B.G.L.		m	0			521.07	0.00	
								0.00	
								0.00	
	250 mm dia RCC pipe							0.00	
3199 - SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	341			371.62	126,722.42	
	1.5 to 3.0 Mtr B.G.L.		m	3,818			396	1,510,360.67	
	3.0 to 4.5 Mtr B.G.L.		m	3,457			420	1,452,342.43	
	4.5 to 6.0 Mtr B.G.L.		m	2,044.0			448.73	917,206.47	
	6.0 to 7.5 mtr B.G.L.		m	511.00			488.87	249,810.58	
	7.5 to 9.0 mtr B.G.L.		m	0			543	0.00	
								0.00	
								0.00	
								0.00	
	300 mm dia RCC pipe							0.00	
3200 SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	31.0			461.18	14,296.58	
	1.5 to 3.0 Mtr B.G.L.		m	433			491	212,571.01	
	3.0 to 4.5 Mtr B.G.L.		m	2,011			521	1,048,462.98	
	4.5 to 6.0 Mtr B.G.L.		m	1,843			557	1,026,320.35	
	6.0 to 7.5 mtr B.G.L.		m	490			607	297,274.32	
	7.5 to 9.0 mtr B.G.L.		m	0			674	0.00	
								0.00	
								0.00	
	350 mm dia RCC pipe							0.00	
3201 - SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	0			517	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	616			551	339,157.71	
	3.0 to 4.5 Mtr B.G.L.		m	346			585	202,312.15	
	4.5 to 6.0 Mtr B.G.L.		m	864			625	539,605.28	
	6.0 to 7.5 mtr B.G.L.		m	202			680	137,441.39	
	7.5 to 9.0 mtr B.G.L.		m	0			756	0.00	
								0.00	
								0.00	
	400 mm dia RCC pipe							0.00	
3202 SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	0			562	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	436			599	261,054.70	
	3.0 to 4.5 Mtr B.G.L.		m	432			636	274,696.85	
	4.5 to 6.0 Mtr B.G.L.		m	836			679	567,796.59	
	6.0 to 7.5 mtr B.G.L.		m	501			740	370,704.57	
	7.5 to 9.0 mtr B.G.L.		m	132			822	108,510.59	
								0.00	
								0.00	
	450 mm dia RCC pipe							0.00	
3203 SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	0			667	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	148			710	105,125.72	
	3.0 to 4.5 Mtr B.G.L.		m	466			754	351,526.51	
	4.5 to 6.0 Mtr B.G.L.		m	749			806	603,490.67	
	6.0 to 7.5 mtr B.G.L.		m	140			878	122,891.12	
	7.5 to 9.0 mtr B.G.L.		m	136			975	132,629.25	
								0.00	
								0.00	
	500 mm dia RCC pipe							0.00	
3204 - SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	0			744	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	166			792	131,496.51	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	3.0 to 4.5 Mtr B.G.L.		m	826			841	694,882.06	
	4.5 to 6.0 Mtr B.G.L.		m	659			899	592,151.78	
	6.0 to 7.5 mtr B.G.L.		m	120			979	117,471.52	
	7.5 to 9.0 mtr B.G.L.		m	409			1,088	444,818.27	
								0.00	
								0.00	
	600 mm dia RCC pipe							0.00	
3205 - SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	0			841	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			895	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	583			950	554,129.36	
	4.5 to 6.0 Mtr B.G.L.		m	684			1,015	694,408.91	
	6.0 to 7.5 mtr B.G.L.		m	322			1,106	356,138.37	
	7.5 to 9.0 mtr B.G.L.		m	241			1,229	296,133.75	
								0.00	
				0				0.00	
	700 mm dia RCC pipe			0				0.00	
3206 - SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	0			929	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			989	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	114			1,050	119,706.11	
	4.5 to 6.0 Mtr B.G.L.		m	0			1,122	0.00	
	6.0 to 7.5 mtr B.G.L.		m	0			1,222	0.00	
	7.5 to 9.0 mtr B.G.L.		m	0			1,357	0.00	
								0.00	
	800 mm dia RCC pipe							0.00	
3207- SOR_U.P. Jal Nigam Varanasi_2014-15	0.0 to 1.5 Mtr B.G.L.		m	0			1,338	0.00	
	1.5 to 3.0 Mtr B.G.L.		m	0			1,425	0.00	
	3.0 to 4.5 Mtr B.G.L.		m	62			1,513	93,811.90	
	4.5 to 6.0 Mtr B.G.L.		m	320			1,616	517,169.35	
	6.0 to 7.5 mtr B.G.L.		m	84			1,761	147,899.19	
	7.5 to 9.0 mtr B.G.L.		m	0			1,956	0.00	
								0.00	
	MANHOLES IN BRICK MASONARY								
	Construction of Brick Circular Manhole in first Class Brick of following Sizes in cemnt mortar 1:4, C.C. top slab with 1:1.5:3, Bed concrete 1:1.5:3, PCC 1:3:6,inside and outside plastering 12 mm thick with cement mortar 1:3 finished with floating coat of neat cement and making channels in Cement concrete with 1:1.5:3, finished with Floating coat of neat cement complete with including Plastic Encapsulated M.S. foot Rest staggered at 0.375 mtr interval, including excavation, reinforcement and Fomwork, SFRC							0.00	
	200 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	2,220			15,752	34,973,171.31	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	4,598.500			34,397	158,174,257.07	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	1,265			64,027	80,981,235.20	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	238			116,838	27,807,476.95	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	14			150,620	2,048,432.71	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	0			274,701	0.00	
								0.00	
								0.00	
	250 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	15			15,905	238,568.09	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	156			34,446	5,373,597.03	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	155			63,857	9,897,795.13	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	92			116,527	10,720,480.42	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	20			149,852	2,997,049.03	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	0			273,314	0.00	
								0.00	
								0.00	
	300 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	2			16,035	32,070.19	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	20			34,464	689,283.15	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	83			63,647	5,282,675.08	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	81.000			116,191	9,411,443.37	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	24			149,057	3,577,369.82	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	0			271,906	0.00	
								0.00	
								0.00	
	350 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	0			16,000	0.00	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	25			34,344	858,607.22	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	17			63,242	1,075,108.32	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	38			115,847	4,402,180.84	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	11			148,253	1,630,780.99	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	0			270,496	0.00	
								0.00	
								0.00	
	400 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	0			16,106	0.00	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	18			34,357	618,431.87	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	23			62,967	1,448,246.13	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	40			115,478	4,619,117.78	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	25			147,421	3,685,519.59	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	5.000			269,065	1,345,327.07	
								0.00	
								0.00	
	450 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	0			16,048	0.00	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	6			34,232	205,394.84	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	20			62,668	1,253,365.60	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	36			115,102	4,143,655.17	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	6			146,580	879,479.20	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	8			267,634	2,141,069.13	
								0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
								0.00	
	500 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	0			16,138	0.00	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	7			34,203	239,420.02	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	34			62,338	2,119,487.64	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	28			114,887	3,216,842.84	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	5			145,912	729,559.00	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	17			266,398	4,528,762.91	
								0.00	
								0.00	
	600 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 900 mm Manhole Dia		No	0			16,130	0.00	
	1.5 to 3.0 mtr ht with 900 mm Manhole Dia		No	0			34,001	0.00	
	3.0 to 4.5 mtr ht with 900 mm Manhole Dia		No	22			61,590	1,354,971.72	
	4.5 to 6.0 mtr ht with 900 mm Manhole Dia		No	29			114,062	3,307,789.09	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	14			144,148	2,018,068.75	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	10			263,489	2,634,887.08	
								0.00	
								0.00	
	700 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 1200 mm Manhole Dia		No	0			19,345	0.00	
	1.5 to 3.0 mtr ht with 1200 mm Manhole Dia		No	0			40,541	0.00	
	3.0 to 4.5 mtr ht with 1200 mm Manhole Dia		No	4			72,843	291,372.32	
	4.5 to 6.0 mtr ht with 1200 mm Manhole Dia		No	0			133,285	0.00	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	0			170,295	0.00	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	0			307,000	0.00	
								0.00	
								0.00	
	750 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 1200 mm Manhole Dia		No	0.000			19,388	0.00	
	1.5 to 3.0 mtr ht with 1200 mm Manhole Dia		No	0			40,483	0.00	
	3.0 to 4.5 mtr ht with 1200 mm Manhole Dia		No				72,350	0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	4.5 to 6.0 mtr ht with 1200 mm Manhole Dia		No				132,793	0.00	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No				168,569	0.00	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	0			303,915	0.00	
								0.00	
								0.00	
	800 mm dia Sewer Pipe							0.00	
	0.0 to 1.5 mtr ht with 1200 mm Manhole Dia		No	0			19,422	0.00	
	1.5 to 3.0 mtr ht with 1200 mm Manhole Dia		No	0			40,445	0.00	
	3.0 to 4.5 mtr ht with 1200 mm Manhole Dia		No	4			71,823	287,292.37	
	4.5 to 6.0 mtr ht with 1200 mm Manhole Dia		No	15			132,285	1,984,268.04	
	6.0 to 7.5 mtr ht with 900 mm Manhole Dia		No	4			168,270	673,078.48	
	7.5 to 9.0 mtr ht with 900 mm Manhole Dia		No	0			303,814	0.00	
								0.00	
	Providing uPVC drop connection for 60 cm drop from invert level of lateral/branch sewer line to maximum water line of main sewer in manhole including inspection and cleaning eye with chain and lid, drop pipe and bends, tees, encased all around with cement concrete 1:2:4 with all centering and shuttering required, cutting holes in wall and making good with brickwork in cement mortar 1:4, plastered with cement mortar 1:3 on inside of the manhole wall, stiff cement mortar 1:1 joints between uPVC (S/S) and RCC pipe (S/S), making required channels		Nos.	100			7,208	720,800.00	
								0.00	
								0.00	
	Additional cost for Manhole Cover for Providing of SFRC Extra HD 35 on Major roads instead of SFRC HD 20		No	2,622			218	572,644.80	
								0.00	
	HOUSE CONNECTING CHAMBER							0.00	
	Construction of road side inspection chamber for multiple property connections including excavation with clear opening of 600x400mm and upto the depth of 900mm in all types of soil with 230 mm thick brick masonry (first class brick) in CM (1:4), 100 mm thick PCC of M15 in foundation. 12mm thick inside and outside plastering with CM (1:3), finished with PCC M15 flooring of 75mm thick as per drawings, including covering of chamber by supplying and fixing SFRC frame and cover as per IS 12592 (Part I and II) including fixing 2 Nos. 110 OD uPVC pipe pieces and plugging the same and providing, laying one no. 150mm RCC NP2 pipe from road side chamber to manhole of required length including granular bedding and cost of materials, labour required, cost of specials, etc., complete as per drawing and directed by Employer's Representative.		unit	4,902			68,760	337,036,833.78	
								0.00	
	BARRICADING							0.00	
16.81 - DSR_2014	Providing and erecting 2.00 metre high temporary barricading at site as per		m	5,000			1,467	7,335,000.00	
								0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
Similar project exp	Supply of all material, labour and T&P to provide the barricading along trench during excavation and laying of pipe with eucalyptus ballies of 100mm dia in horizontal section in two rows and vertical post of 125 mm dia at 2 m C/C fastened with Nariyal rope including provision of caution board. (50% of		m	8,000			440	3,520,000.00	
								0.00	
	DESILTING OF SEWER PIPE							0.00	
Schedule of rates from Institute of Trenchless Technology 2014_1.7	Desilting the existing old sewer lines through jetting and suction machines including cleaning, barricading and reconstruction of manholes for section isolation by plugging and flow stoppage, setting up the over-pumping arrangements, traffic management, jetting and dislodging of acm3ulated silt from the pipelines, removal of silt through suction hose, disposal of removed silt from upto a distance of 20 km, necessary temporary repairs of sewers to stop locational collapses, ingress of ground water in desilted section of the pipelines all complete as per the instructions of the Employer's		m³	95			5,167	491,051.36	
								0.00	
	REPAIRS/REHABILITATION OF EXISTING MANHOLE							0.00	
	Refurbishment of existing brick masonry manhole in cement mortar 1:4, inside plastering 12mm thick with cement mortar 1:3 finished with floating coat of neat cement and making channels in cement concrete with 1:2:4, finished with floating coat of neat cement complete with including CI steps (PVC encapsulated) staggered at 0.3 m interval, including CI frame and		Nos	88			15,201	1,335,063.08	
								0.00	
	DISMANTELING OF EXISTING SEWERS							0.00	
	Excavation by manually or mechanically up to following depths below G.L. for taking out of old sewer line, in ordinary soil (earth, sand, loam & clay) including refilling of trenches in 15cm layer watering and ramming the same including supply of required earth to achieve the existing road level excluding of dismentling of old existing sewer line including supply all material, labour and T&P etc to complete the							0.00	
3001 - SOR_U.P. Jal Nigam Varanasi_2014-15	a) 0.0 to 1.5 mtr B.G.L		m3				185	0.00	
3002 - SOR_U.P. Jal Nigam Varanasi_2014-15	a)1.5 to 3.0 mtr B.G.L		m3	4,056			232	940,906.01	
3003 - SOR_U.P. Jal Nigam Varanasi_2014-15	b) 3.0 to 4.5 mtr B.G.L		m3	1,799			291	524,118.23	
	Dismantling of old existing sewer including taking out the same from the trench removal and stacking properly at site, as per direction of Engineer-in-charge of following sizes							0.00	
3117.i- SOR_U.P. Jal Nigam Varanasi_2015-16	250 mm dia		m				245	0.00	
3118.i- SOR_U.P. Jal Nigam Varanasi_2015-16	300 mm dia		m	795			294	233,465.33	
3119.i- SOR_U.P. Jal Nigam Varanasi_2015-16	400 mm dia		m				445	0.00	
3122i- SOR_U.P. Jal Nigam Varanasi_2015-16	600 mm dia		m	664			501	332,360.80	
								0.00	
3128- SOR_U.P. Jal Nigam Varanasi_2014-15	1200 mm dia		m					0.00	
	Supply of all labour, equipment and T&P for diversion of flow during dismentlling work and transportation of dismentlled old sewer pipe upto the required site as directed by the Engineer-in-charge.		LS	1			200,000	200,000.00	
								0.00	
	TRANSFER OF EXISTING HOUSE CONNECTIONS TO SEWERS							0.00	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	Transfer of existing house connecttion to sewers by laying of new connecting sewer of 160 mm OD HDPE pipe in suitable gradient upto the MH / House connecting chamber and repair of existing chamber / sewer line as required including supply of all materials, labour and T&P required for		No	38,288			14,000	536,032,000.00	
								0.00	
	MISCELLANEOUS							0.00	
UPJN SOR_1005	Filling of sand for 1m for depth across the main roads where greater than 5m		m3	24,198			917	22,189,566.00	
	Provision for shifting & reinstatement of utilities e.g. electric & telephone cable/ poles, water lines drains etc. during excavation & laying of sewers.		Ls	1			5,000,000	5,000,000.00	
								0.00	
Similar Project Exp	Provision for Land and supervision charges to railways for laying sewer crossing railway track		LS	1			3,142,000	3,142,000.00	
								2,747,775,976	

1 INR(India Rupee)= 1.57 JPY
1 US$= 105.5 JPY

Varanasi District 1-other works

Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
				Unit Price	Amount	Unit Price	Amount	
[Direct Cost]								
Other works								
Cost of sewer cleaning equipments, Flushing Van		pc	1				4,055,000.00	
Hiring of Godown and Site Office		pc	1				1,020,000.00	
Communication & Public Outreach		pc	1				3,500,000.00	
Environmental and Management Plan (EMP)		pc	1				1,000,000.00	
Governance and Accountibility Action Plan (GAAP)		pc	1				2,000,000.00	
Sub-Total							11,575,000	

2. District II
(Varanasi)

1 INR(India Rupee)=	1.57	JPY
1 US$=	105.5	JPY

Summary - Varanasi District 2

Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
				Unit	Amount	Unit	Amount	
Varanasi District 2		LS	1				4,161,128,431	
Cost of sewer cleaning equipments, Flushing Van		LS	1				4,055,000.00	
Hiring of Godown and Site Office		LS	1				1,020,000.00	
Communication & Public Outreach		LS	1				3,500,000.00	
Environmental and Management Plan		LS	1				1,000,000.00	
Governance and Accountibility Action Plan (GAAP)		LS	1				2,000,000.00	
Total							4,172,703,431	

1 INR(India Rupee)=	1.57	JPY
1 US$=	105.5	JPY

Varanasi District 2

Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
				Unit Price	Amount	Unit Price	Amount	
[Direct Cost]								
<Civil/Building work>								
1.1 DISMANTLING AND REINSTATEMENT OF EXISTIN(		pc	1				298,055,326.70	
1.2 EARTH WORK (SEWER)		pc	1				633,196,303.07	
1.3 TRENCHLESS		pc	1				314,635,020.39	
1.4 TIMBERING WORK		pc	1				338,319,172.22	
1.5 BEDDING WORK		pc	1				164,409,730	
1.6 LAYING OF R.C.C. PIPE		pc	1				307,527,173	
2.MANHOLES IN BRICK MASONARY		pc	1				459,333,727	
3. HOUSE CONNECTING CHAMBER		pc	1		0		1,176,315,708	
4. BARRICADING		pc	1				6,454,800	
5. DESILTING OF SEWER PIPE		pc	1				1,438,875	
6. REPAIRS/REHABILITATION OF EXISTING MANHOLI		pc	1				364,815	
7. DISMANTELING OF EXISTING SEWERS		pc	1				12,764,935	
8. TRANSFER OF EXISTING HOUSE CONNECTIONS TO		pc	1				399,176,360	
9. MISCELLANEOUS		pc	1				49,136,485	
Sub-Total					0		4,161,128,431	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
<Civil/Building work>									
	1. Sewer work								
	1.1 DISMANTLING AND REINSTATEMENT OF EXISTING ROADS								
	DISMANTLING WORK								
	Dismantling manually / by mechanical means including stacking of serviceable material and disposal of unserviceable material within 50 metres lead as per direction of Engineer-in-Charge								
15.43.2 - DSR_2014	a) Bitumen Road		m^2	36,231.09			159.05	5,762,554.69	
1266 - SOR_U.P. Jal Nigam Varanasi_2015-16	b) Cement Concrete Road		m^2	13,988.64			1,013.71	14,180,421.67	
16.83 - DSR_2014	Taking out existing CC interlocking paver blocks from footpath/ central verge, including removal of rubbish etc., disposal of unserviceable material to the dumping ground, for which payment shall be made separately and stacking of serviceable material within 50 metre lead as per direction of		m^2	335,366.91			48.30	16,198,221.76	
	REINSTATEMENT WORK								
UP PWD 2013	Reinstatement of Existing Bitumen Road - Owned by Nagar Nigam		m^2	36,231.09			3,634.00	131,663,776.97	
	Providing all Materials, Labours, T & P etc & construct 100mm thick (1:2:4) Cement Concrete Road for Reinstatement of patch & trench cuts in cement concret Roads		m^2	13,988.64			2,228.10	31,168,083.10	
1323 - SOR_U.P. Jal Nigam Varanasi_2015-16	Providing and laying 60 mm thick factory made cement concrete interlocking paver block of M -30 grade made by block making machine with strong vibratory compaction, of approved size, design & shape, laid in required colour and pattern over and including 50 mm thick compacted bed of coarse sand, filling the joints with fine sand etc. all complete as per the		m^2	67,073.38			602.20	40,391,590.66	
	Laying old cement cocrete interlocking paver blocks of any design/shape laid in required line, level, curvature, colour and pattern over and including 50 mm thick compacted bed of coarse sand, filling the joints with fine sand etc. all complete as per the direction of Engineer-in-charge. (Old CC paver blocks shall be supplied by the		m^2	299,901.27			195.70	58,690,677.85	
16.68 - DSR_2014									
	Total							298,055,326.70	
16.84 - DSR_2014									
	1.2 EARTH WORK (SEWER)								
	Excavation by manually or mechanically up to following depths below G.L. for laying sewer line, in ordinary soil (earth, sand, loam & clay) including cutting of joints pits ramming dressing, leveling by manually or mechanically, refilling of trenches in 15cm layer watering and ramming the same including removal of surplus earth or other dismantled material up to a distance of 50m from the centre of trenches. (Excavation for Manhole is								
3001 - SOR_U.P. Jal Nigam Varanasi_2015-16	0.0 to 1.5 mtr B.G.L		m^3	331,409			184.79	61,241,138.53	
3002 - SOR_U.P. Jal Nigam Varanasi_2015-16	1.5 to 3.0 mtr B.G.L		m^3	231,186.07			231.98	53,630,544.94	
3003 - SOR_U.P. Jal Nigam Varanasi_2015-16	3.0 to 4.5 mtr B.G.L		m^3	103,572.06			291.27	30,167,433.98	
3004 - SOR_U.P. Jal Nigam Varanasi_2015-16	4.5 to 6.0 mtr B.G.L		m^3	53,949.15			340.09	18,347,567.29	
3005 - SOR_U.P. Jal Nigam Varanasi_2015-16	6.0 to 7.5 mtr B.G.L		m^3	30,842.65			443.48	13,678,100.26	
3006 - SOR_U.P. Jal Nigam Varanasi_2015-16	7.5 to 9.0 mtr B.G.L		m^3	9,874.06			583.07	5,757,268.49	
3006 i - SOR_U.P. Jal Nigam Varanasi_2015-16	9.0 to 10.5 mtr B.G.L		m^3	1,859.42			769.65	1,431,104.72	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	Disposal of excavated excess earth away from the site including conveyance of material up to an average lead for 5km &above away from the site and corresponding required lift, loading, unloading etc complete as directed by the engineer-in-charge (The quantity is net quantity								
		By Mechanical Transport including loading , unloading and stacking (Lead upto 5 Km away from the site)	m^3	34,210.69			366.10	12,524,533.51	
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m								
1003 - SOR_U.P. Jal Nigam Varanasi_2014-15		0.0 to 1.5 mtr B.G.L	m^3	62,505.00			42 39	2,649,586 95	
1003 &1006-SOR_U.P. Jal Nigam		1.5 to 3.0 mtr B.G.L	m^3	102,240.00			2,247 07	229,740,436.80	
1003 &1006-SOR_U.P. Jal Nigam		3.0 to 4.5 mtr B.G.L	m^3	53,477.00			2,266 04	121,181,021.08	
1003 &1006-SOR_U.P. Jal Nigam		4.5 to 6.0 mtr B.G.L	m^3	11,603.50			2,285 01	26,514,113.54	
1003 &1006 -SOR - U.P. Jal Nigam Varanasi_2014-15 and		6.0 to 9.0 mtr B.G.L	m^3	6,129 50			2,764 78	16,946,694.49	
	Disposal of Road Cutting Rubbish / Malba / similar unserviceable, dismantled or waste material by mechanical means , including loading ,transportation , unloading to approved municipal dumping ground or as approved by Engineer - in charge, for 5km initial lead, for all leads including		m^3	39,183.00			292.85	11,474,742 87	
	Carting of excavated earth to identified place and recarting the same where sufficient width of road is not available for stacking of excavated earth average lead 500 mtr.		m^3	75,095.93			158.00	11,865,157.17	
	Bailing out or pumping out water / liquid mud during trench execavation. This includes providing necessary fuel, labour T&P etc. required for proper running of well point equipment of required capacity for lowering the water table during excavation and laying of		m	26,818 52			598.35	16,046,858.45	
	Total							633,196,303.07	
	1.3 TRENCHLESS								
	Supply of precast RCC NP4 jacking pipes manufactured by centrifugal spinning or vertical casting comply to BSEN 5911, pt 120 or EN 1916 2002 and also meet the basic concrete testing requirements specified in IS 458, IS 3597 of 1966 and IS 7596 1998. Including supply of suitable couplings (normally Built in Type collar) made of weldable structural stainless steel conforming to BS 4360 Grade 43, or relevant Code including supply of suitable rubber rings confirming to EN 681-1 as prescribed in BSEN 1916 or								
	Pipe material	PRR NC4							
	200 mm dia. pipe		m	332.00			12,066.11	4,005,949.45	
	300 mm dia pipe.		m	269.00			13,406.79	3,606,427.05	
	350 mm dia pipe		m	145.00			14,077.13	2,041,184.08	
	400 mm dia pipe		m	499.00			14,747 47	7,358,988.13	
	450 mm dia pipe		m	311.00			15,417.81	4,794,939.16	
	500 mm dia pipe		m	540.00			16,088.15	8,687,601.22	
	600 mm dia pipe		m	368.00			18,099.17	6,660,494 27	
	700 mm dia pipe		m	90.00			20,110.19	1,809,916.92	
	800 mm dia pipe		m	439.00			24,450.00	10,733,550.00	
	900 mm dia pipe		m	918.00			26,813.58	24,614,870 11	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
Schedule of rates from Institute of trenchless Tehnology 2014)_2.8.2	Installation of product pipe by Trenchless Technology including making of entry and exit pits all related civil works like excavation, shoring/shuttering etc. and Ground to protect any exixting utilities at the pipe installation location and restoration of								
	upto 300 mm dia		m	601.00			48,200.00	28,968,200.00	
	300 to 450 mm dia		m	955.00			53,000.00	50,615,000.00	
	450 to 600 mm dia.		m	908.00			58,300.00	52,936,400.00	
	600 to 900 mm dia		m	1,447.00			74,500.00	107,801,500.00	
	Total							314,635,020.39	
	1.4 TIMBERING WORK								
3041 - SOR_U.P. Jal Nigam Varanasi_2015-16	Providing and fixing open timbering in trenches up to 3m deep, consisting of 40mm thick approved country wood plank for poling board, 125x75mm Indian Sal wood wallers and 100mm diameter Sal wood ballies for shuttering at 1.50m c/c including removal after laying of sewers (Measurement to be taken of the face area timbered)	1.5 to 3.0 mtr B.G.L.	m^2	649,591.42			393.91	255,880,556.14	
3032 - SOR_U.P. Jal Nigam Varanasi_2015-16	Providing and fixing close timbering in trenches for the following depths below G.L. consisting of 40mm thick approved country wood plank for poling board 125x75mm Indian Sal wood walers and 100mm diameter Sal wood ballies for shuttering at 1.50m c/c including removal after laying of sewers (Measurement to be taken of the	3.0 to 4.5 mtr B.G.L.	m^2	52,844.30			649.06	34,299,122.28	
3033-SOR_U.P. Jal Nigam Varanasi_2015-16		4.5 to 6.0 mtr B.G.L.	m^2	20,670.44			811.40	16,771,994.67	
3034-SOR_U.P. Jal Nigam Varanasi_2015-16		6.0 to 7.5 mtr B.G.L.	m^2	12,218.52			935.01	11,424,442.99	
3034-SOR_U.P. Jal Nigam Varanasi_2015-16		7.5 to 9.0 mtr B.G.L.	m^2	2,712.37			935.01	2,536,092.07	
3034-SOR_U.P. Jal Nigam Varanasi_2015-16		9.0 to 10.5 mtr B.G.L.	m^2	457.54			935.01	427,800.83	
3047 - SOR_U.P. Jal Nigam Varanasi_2015-16	Extra for planking and strutting in open timbering if required to be left permanently inposition (Face area of the timber permanently left to be	0.0 to 3.0 mtr B.G.L.	m^2	12,991.83			899.99	11,692,515.64	
3039 - SOR_U.P. Jal Nigam Varanasi_2015-16	Extra for planking and strutting in close timbering if required to be left permanently inposition (Face area of the timber permanently left to be	b) 3.0 to 6.0 mtr B.G.L.	m^2	2,308.38			1,879.93	4,339,586.98	
3040 - SOR_U.P. Jal Nigam Varanasi_2015-16		a) 6.0 to 9.0 mtr B.G.L.	m^2	447.93			2,114.32	947,060.62	
	Total							338,319,172.22	
	1.5 BEDDING WORK								
	PCC Bedding								
	200mm	0.0 to 1.5 Mtr B.G.L	m	15			472.76	7,233.23	
		1.5 to 3.0 Mtr B.G.L	m	19,704			484.47	9,545,924.21	
		3.0 to 4.5 Mtr B.G.L	m	23,264			500.08	11,633,686.09	
		4.5 to 6.0 Mtr B.G.L.	m	2,430			519.59	1,262,681.64	
		6.0 to 7.5 mtr B.G.L	m	29			550.81	15,918.41	
	250mm	1.5 to 3.0 Mtr B.G.L	m	3,051			563.02	1,717,774.02	
		3.0 to 4.5 Mtr B.G.L	m	4,047			581.29	2,352,480.63	
		4.5 to 6.0 Mtr B.G.L	m	1,347			604.12	813,749.64	
	300mm	0.0 to 1.5 Mtr B.G.L	m	150			628.77	94,315.50	
		1.5 to 3.0 Mtr B.G.L	m	1,370			644.54	883,019.80	
		3.0 to 4.5 Mtr B.G.L	m	2,952			665.56	1,964,733.12	
	350mm	1.5 to 3.0 Mtr B.G.L	m	566			729.03	412,630.98	
		3.0 to 4.5 Mtr B.G.L	m	490			752.91	368,925.90	
		4.5 to 6.0 Mtr B.G.L	m	43			782.76	33,658.68	
	400mm	1.5 to 3.0 Mtr B.G.L	m	254			816.50	207,391.00	
		3.0 to 4.5 Mtr B.G.L	m	1,493			843.33	1,259,091.69	
	450mm	1.5 to 3.0 Mtr B.G.L	m	67			906.94	60,764.98	
		3.0 to 4.5 Mtr B.G.L	m	699			936.81	654,830.19	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
		4.5 to 6.0 Mtr B.G.L.	m	179			974.15	174,372.85	
		7.5 to 9.0 mtr B.G.L.	m	148			1,108.57	164,068.36	
		9.0 to 10.5 mtr B.G.L.	m	50			1,183.25	59,162.50	
	500mm	1.5 to 3.0 Mtr B.G.L.	m	87			1,000.35	87,030.45	
		3.0 to 4.5 Mtr B.G.L.	m	117			1,033.37	120,904.29	
		4.5 to 6.0 Mtr B.G.L.	m	113			1,074.63	121,433.19	
		7.5 to 9.0 mtr B.G.L.	m	243			1,223.19	297,235.17	
		9.0 to 10.5 mtr B.G.L.	m	326			1,305.72	425,664.72	
	600mm	4.5 to 6.0 Mtr B.G.L.	m	276			1,285.16	354,704.16	
	900mm	6.0 to 7.5 mtr B.G.L.	m	171			2,116.51	361,923.21	
	RCC Bedding								
	250mm	4.5 to 6.0 Mtr B.G.L.	m	105			621.59	65,266.95	
	300mm	3.0 to 4.5 Mtr B.G.L.	m	178			685.67	122,049.26	
		4.5 to 6.0 Mtr B.G.L.	m	1,051			711.95	748,259.45	
		6.0 to 7.5 mtr B.G.L.	m	288			754.00	217,152.00	
	350mm	3.0 to 4.5 Mtr B.G.L.	m	753			775.75	584,139.75	
		4.5 to 6.0 Mtr B.G.L.	m	1,193			805.59	961,068.87	
	400mm	3.0 to 4.5 Mtr B.G.L.	m	170			868.98	147,726.60	
		4.5 to 6.0 Mtr B.G.L.	m	1,811			902.52	1,634,463.72	
		6.0 to 7.5 mtr B.G.L.	m	161			956.17	153,943.37	
	450mm	4.5 to 6.0 Mtr B.G.L.	m	1,011			1,002.72	1,013,749.92	
		6.0 to 7.5 mtr B.G.L.	m	273			1,062.46	290,051.58	
	500mm	4.5 to 6.0 Mtr B.G.L.	m	1,100			1,106.20	1,216,820.00	
		6.0 to 7.5 mtr B.G.L.	m	502			1,172.23	588,459.46	
	600mm	6.0 to 7.5 mtr B.G.L.	m	776			1,402.19	1,088,099.44	
		7.5 to 9.0 mtr B.G.L.	m	314			1,501.15	471,361.10	
	700mm	6.0 to 7.5 mtr B.G.L.	m	1,723			1,646.04	2,836,126.92	
		7.5 to 9.0 mtr B.G.L.	m	201			1,762.39	354,240.39	
	800mm	6.0 to 7.5 mtr B.G.L.	m	413			1,903.79	786,265.27	
		7.5 to 9.0 mtr B.G.L.	m	157			2,038.50	320,044.50	
	900mm	6.0 to 7.5 mtr B.G.L.	m	345			2,175.44	750,526.80	
		7.5 to 9.0 mtr B.G.L.	m	728			2,329.47	1,695,854.16	
	Granular Bedding								
	200mm	0.0 to 1.5 Mtr B.G.L.	m	68,584			576.10	39,511,213.60	
		1.5 to 3.0 Mtr B.G.L.	m	122,664			580.34	71,187,028.88	
	250mm	0.0 to 1.5 Mtr B.G.L.	m	445			672.77	299,382.65	
		1.5 to 3.0 Mtr B.G.L.	m	2,067			677.68	1,400,764.56	
	300mm	0.0 to 1.5 Mtr B.G.L.	m	29			777.53	22,548.37	
	500mm	1.5 to 3.0 Mtr B.G.L.	m	387			1,260.50	487,813.50	
	Total							164,409,729.68	
	1.6 LAYING OF R.C.C. PIPE								
	Pipe Material								
	200 mm dia RCC pipe		m	236,690			588.57	139,308,352.35	
	250 mm dia RCC pipe		m	11,062			702.86	7,775,046.17	
	300 mm dia RCC pipe		m	6,018			985.45	5,930,448.93	
	350 mm dia RCC pipe		m	3,788			1,343.40	5,088,800.72	
	400 mm dia RCC pipe		m	4,132			1,617.20	6,682,269.08	
	450 mm dia RCC pipe		m	2,427			1,749.08	4,245,006.19	
	500 mm dia RCC pipe		m	2,875			2,144.70	6,166,020.78	
	600 mm dia RCC pipe		m	1,366			2,711.14	3,703,418.39	
	700 mm dia RCC pipe		m	1,924			3,305.21	6,359,223.89	
	800 mm dia RCC pipe		m	570			3,977.15	2,266,974.66	
	900 mm dia RCC pipe		m	1,244			4,873.90	6,063,136.53	
	Pipe installation								
3198- SOR_U.P. Jal Nigam Varanasi_2014-15	200 mm	0.0 to 1.5 Mtr B.G.L.	m	68,671			356.53	24,483,146.84	
		1.5 to 3.0 Mtr B.G.L.	m	142,297			379.53	54,005,361.64	
		3.0 to 4.5 Mtr B.G.L.	m	23,264			403.06	9,376,580.82	
		4.5 to 6.0 Mtr B.G.L.	m	2,430			430.51	1,046,203.82	
		6.0 to 7.5 mtr B.G.L.	m	29			469.02	13,554.54	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
3199 - SOR_U.P. Jal Nigam Varanasi_2014-15	250mm	0.0 to 1.5 Mtr B.G.L.	m	445			371.62	165,370.90	
		1.5 to 3.0 Mtr B.G.L.	m	5,118			395.59	2,024,627.01	
		3.0 to 4.5 Mtr B.G.L.	m	4,047			420.12	1,700,211.11	
		4.5 to 6.0 Mtr B.G.L.	m	1,452			448.73	651,557.63	
3200 SOR_U.P. Jal Nigam Varanasi_2014-15	300mm	0.0 to 1.5 Mtr B.G.L.	m	179			461.18	82,551.22	
		1.5 to 3.0 Mtr B.G.L.	m	1,370			490.93	672,568.77	
		3.0 to 4.5 Mtr B.G.L.	m	3,130			521.36	1,631,869.29	
		4.5 to 6.0 Mtr B.G.L.	m	1,051			556.87	585,275.47	
		6.0 to 7.5 mtr B.G.L.	m	288			606.68	174,724.50	
3201 - SOR_U.P. Jal Nigam Varanasi_2014-15	350mm	1.5 to 3.0 Mtr B.G.L.	m	566			550.58	311,628.67	
		3.0 to 4.5 Mtr B.G.L.	m	1,243			584.72	726,803.49	
		4.5 to 6.0 Mtr B.G.L.	m	1,236			624.54	771,935.33	
		6.0 to 7.5 mtr B.G.L.	m	694			680.40	472,199.62	
		7.5 to 9.0 mtr B.G.L.	m	49			755.92	37,039.93	
3202 SOR_U.P. Jal Nigam Varanasi_2014-15	400mm	1.5 to 3.0 Mtr B.G.L.	m	254			598.75	152,082.33	
		3.0 to 4.5 Mtr B.G.L.	m	1,663			635.87	1,057,455.69	
		4.5 to 6.0 Mtr B.G.L.	m	1,811			679.18	1,229,999.55	
		6.0 to 7.5 mtr B.G.L.	m	161			739.93	119,128.61	
		7.5 to 9.0 mtr B.G.L.	m	243			822.05	199,758.13	
3203 SOR_U.P. Jal Nigam Varanasi_2014-15	450mm	1.5 to 3.0 Mtr B.G.L.	m	67			710.31	47,590.70	
		3.0 to 4.5 Mtr B.G.L.	m	699			754.35	527,289.77	
		4.5 to 6.0 Mtr B.G.L.	m	1,190			805.73	958,816.94	
		6.0 to 7.5 mtr B.G.L.	m	273			877.79	239,637.68	
		7.5 to 9.0 mtr B.G.L.	m	148			975.22	144,331.84	
		9.0 to 10.5 mtr B.G.L.	m	50			1,067.63	53,381.60	
3204 - SOR_U.P. Jal Nigam Varanasi_2014-15	500mm	1.5 to 3.0 Mtr B.G.L.	m	474			792.15	375,478.00	
		3.0 to 4.5 Mtr B.G.L.	m	117			841.26	98,427.60	
		4.5 to 6.0 Mtr B.G.L.	m	1,213			898.56	1,089,954.64	
		6.0 to 7.5 mtr B.G.L.	m	502			978.93	491,422.52	
		7.5 to 9.0 mtr B.G.L.	m	243			1,087.58	264,280.78	
		9.0 to 10.5 mtr B.G.L.	m	326			1,190.64	388,148.64	
3205 - SOR_U.P. Jal Nigam Varanasi_2014-15	600mm	4.5 to 6.0 Mtr B.G.L.	m	276			1,015.22	280,200.09	
		6.0 to 7.5 mtr B.G.L.	m	776			1,106.02	858,271.35	
		7.5 to 9.0 mtr B.G.L.	m	314			1,228.77	385,834.01	
3206 - SOR_U.P. Jal Nigam Varanasi_2014-15	700mm	6.0 to 7.5 mtr B.G.L.	m	1,723			1,221.89	2,105,314.78	
		7.5 to 9.0 mtr B.G.L.	m	201			1,357.50	272,857.43	
3207- SOR_U.P. Jal Nigam Varanasi_2014-15	800mm	6.0 to 7.5 mtr B.G.L.	m	413			1,760.70	727,171.03	
		7.5 to 9.0 mtr B.G.L.	m	157			1,956.12	307,110.12	
3208- SOR_U.P. Jal Nigam Varanasi_2014-15	900mm	6.0 to 7.5 mtr B.G.L.	m	516			1,986.21	1,024,883.16	
		7.5 to 9.0 mtr B.G.L.	m	728			2,206.65	1,606,438.12	
	Total							307,527,173.40	
	2.MANHOLES IN BRICK MASONARY								
	Manhole installation								
	200mm, MH Dia. 900mm	0.0 to 1.5 mtr ht	pc	2,955			15,752.26	46,555,021.68	
		1.5 to 3.0 mtr ht	pc	5,912			34,396.92	203,346,018.11	
		3.0 to 4.5 mtr ht	pc	949			64,026.91	60,735,926.40	
		4.5 to 6.0 mtr ht	pc	101			116,838.14	11,818,177.70	
		6.0 to 7.5 mtr ht	pc	2			150,620.05	256,054.09	
	250mm, MH Dia. 900mm	0.0 to 1.5 mtr ht	pc	16			15,904.54	254,472.63	
		1.5 to 3.0 mtr ht	pc	204			34,446.13	7,027,011.50	
		3.0 to 4.5 mtr ht	pc	172			63,856.74	10,983,359.76	
		4.5 to 6.0 mtr ht	pc	59			116,526.96	6,875,090.71	
	300mm, MH Dia. 900mm	0.0 to 1.5 mtr ht	pc	7			16,035.10	112,245.67	
		1.5 to 3.0 mtr ht	pc	54			34,464.16	1,861,064.50	
		3.0 to 4.5 mtr ht	pc	127			63,646.69	8,083,129.33	
		4.5 to 6.0 mtr ht	pc	44			116,190.66	5,112,388.99	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
		6.0 to 7.5 mtr ht	pc	11			149,057.08	1,639,627.83	
	350mm, MH Dia. 900mm	1.5 to 3.0 mtr ht	pc	22			34,344.29	755,574.35	
		3.0 to 4.5 mtr ht	pc	53			63,241.67	3,351,808.31	
		4.5 to 6.0 mtr ht	pc	52			115,846.86	6,024,036.94	
		6.0 to 7.5 mtr ht	pc	28			148,252.82	4,151,078.88	
		7.5 to 9.0 mtr ht	pc	2			270,496.26	540,992.52	
	400mm, MH Dia. 900mm	1.5 to 3.0 mtr ht	pc	10			34,357.33	343,573.26	
		3.0 to 4.5 mtr ht	pc	69			62,967.22	4,344,738.39	
		4.5 to 6.0 mtr ht	pc	81			115,477.94	9,353,713.51	
		6.0 to 7.5 mtr ht	pc	7			147,420.78	1,031,945.49	
		7.5 to 9.0 mtr ht	pc	10			269,065.41	2,690,654.13	
	450mm, MH Dia. 900mm	1.5 to 3.0 mtr ht	pc	3			34,232.47	102,697.42	
		3.0 to 4.5 mtr ht	pc	27			62,668.28	1,692,043.57	
		4.5 to 6.0 mtr ht	pc	51			115,101.53	5,870,178.16	
		6.0 to 7.5 mtr ht	pc	13			146,579.87	1,905,538.27	
		7.5 to 9.0 mtr ht	pc	7			267,633.64	1,873,435.49	
		9.0 to 10.5 mtr ht	pc	2			339,782.59	679,565.19	
	500mm, MH Dia. 900mm	1.5 to 3.0 mtr ht	pc	21			34,202.86	718,260.07	
		3.0 to 4.5 mtr ht	pc	6			62,337.87	374,027.23	
		4.5 to 6.0 mtr ht	pc	47			114,887.24	5,399,700.48	
		6.0 to 7.5 mtr ht	pc	22			145,911.80	3,210,059.59	
		7.5 to 9.0 mtr ht	pc	9			266,397.82	2,397,580.36	
		9.0 to 10.5 mtr ht	pc	15			338,388.56	5,075,828.39	
	600mm, MH Dia. 900mm	4.5 to 6.0 mtr ht	pc	14			114,061.69	1,596,863.70	
		6.0 to 7.5 mtr ht	pc	37			144,147.77	5,333,467.40	
		7.5 to 9.0 mtr ht	pc	12			263,488.71	3,161,864.50	
	700mm, MH Dia. 900mm	6.0 to 7.5 mtr ht	pc	18			168,269.62	3,028,853.14	
		7.5 to 9.0 mtr ht	pc	6			303,813.56	1,822,881.39	
	800mm, MH Dia. 1200mm	6.0 to 7.5 mtr ht	pc	18			168,269.62	3,028,853.14	
		7.5 to 9.0 mtr ht	pc	6			303,813.56	1,822,881.39	
	900mm, MH Dia. 1200mm	6.0 to 7.5 mtr ht	pc	19			166,352.40	3,160,695.59	
		7.5 to 9.0 mtr ht	pc	28			300,779.68	8,421,831.09	
	uPVC drop connection		No	100			7,208.00	720,800.00	
	MH cover Installation		No	3,151			218.40	688,117.25	
	Total							459,333,727.49	
	3. HOUSE CONNECTING CHAMBER								
	inspection chamber installation		No.	17,108			68,760.00	1,176,315,708	
	4. BARRICADING								
	temporary barricading		m	2,000			1,467.00	2,934,000	
	barricade installation		m	8,000			440.10	3,520,800	
	total							6,454,800	
	5. DESILTING OF SEWER PIPE								
	desilting work		m^3	278			5,167.00	1,438,875	
	6. REPAIRS/REHABILITATION OF EXISTING MANHOLE								
	Repiar and rehabilitation of exsting MH		No.	24			15,200.61	364,814.53	
	7. DISMANTELING OF EXISTING SEWERS								
	excavation	1.5 to 3.0 mtr B.G.L	m^3	40,127			231.98	9,308,733.37	
		3.0 to 4.5 mtr B.G.L	m^3	2,203			291.27	641,799.46	
	dismantling pipe work	250 mm dia	m	3,850			244.60	941,763.81	
		300 mm dia	m	3,451			293.56	1,013,181.24	
		400 mm dia	m	567			445.09	252,152.39	
		600 mm dia	m	813			500.83	407,305.01	

	Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
					Unit Price	Amount	Unit Price	Amount	
	Supply of all labour, equipment and T&P for diversion of flow during dismentlling work and transportation of dismentlled old sewer pipe upto the required site as directed by the		Ls	1			200,000 00	200,000 00	
	Total							12,764,935 28	
	8. TRANSFER OF EXISTING HOUSE CONNECTIONS TO SEWERS								
	existing house connection work		No	39,918			10,000 00	399,176,360	
	9. MISCELLANEOUS								
	Embankment work		m^3	44,705			917	40,994,485	
	Provision for shifting & reinstatement of utilities e g electric & telephone cable/ poles, water lines drains etc during excavation & laying of sewers		Ls	1			5,000,000	5,000,000	
	Provision for Land and supervision charges to railways for laying sewer crossing railway track		Ls	1			3,142,000 00	3,142,000	
	Total							49,136,485	

1 INR(India Rupee)=	1.57	JPY
1 US$=	105.5	JPY

Varanasi District 2

Items	Specification	Unit	Qty	FC Portion (Yen)		LC Portion (INR)		Reference
				Unit Price	Amount	Unit Price	Amount	
[Direct Cost]								
<Civil/Building work>								
[Direct Cost]								
Other works								
Cost of sewer cleaning equipments, Flushing Van		pc	1				4,055,000.00	
Hiring of Godown and Site Office		pc	1				1,020,000.00	
Communication & Public Outreach		pc	1				3,500,000	
Environmental and Management Plan (EMP)		pc	1				1,000,000	
Governance and Accountibility Action Plan (GAAP)		pc	1				2,000,000	
Sub-Total					**0**		**11,575,000**	