

Appendix 3B- ESP Process Calculations

Year Reference	06-May
Water Company	JE BARRY
Our Reference	AS11007
Scheme Name	CASTLETROY
Option	78,000 PE REV02
Date	26/05/2020

P.E. 78,000

Flow Split 100%

Peaking Factor 1.30

Settled Load	Min Flow		DWF		Average		FFT	
Flow (m ³ /d)	6302		5362	51%	12829	345%	25520	399%
Total COD ₅ load (kg/d)	1019	122mg/L	1019	122mg/L	1536	122mg/L	4427	171mg/L
Total BOD ₅ load (kg/d)	756	94mg/L	756	94mg/L	950	114mg/L	6084	233mg/L
Total TKN Load (kg/d)	0	0mg/L	0	0mg/L	0	0mg/L	0	0mg/L
Total Ammonia Load (kg/d)	418	50mg/L	418	50mg/L	624	50mg/L	811	30mg/L
Total dissolved solids Load (kg/d)	0	0mg/L	0	0mg/L	0	0mg/L	0	0mg/L
Suspended Solids (kg/d)	1019	122mg/L	1019	122mg/L	1536	122mg/L	4427	171mg/L
Phosphate (kg/d)	0	1mg/L	0	1mg/L	0	1mg/L	0	1mg/L
Min Wastewater Temperature (°C)	11							

Operating MLSS	3500	mg/l	4. FAS Disposal					
Anaerobic Volume	0.0	m ³						
Anaerobic Volume	0	m ³						
Aerobic Volume	6020	m ³						
No. of aeration cells	2							
Length (aerobic)	32.5	m						
Width	15.7	m						
Depth	5.49	m						
			Suspended Biomass (anaerobic)			0 kg		
			Suspended biomass (aerobic)			0 kg		
			Suspended Biomass (Aerobic)			20221 kg		
			Socle Biomass			31994 kg		
			Total Biomass			52215 kg		
			Equiv. MLSS			5093 mg/l		

Clarifier/FAS accommodation		Total	per lane				
No. Cages		36	18	Media Specific Surface Area		29.0 m ² /m ³	
No. Rows per Cage		2	2	Media specific surface Area/Vol		419.7 m ² /m ³	
Cage Width		5.60	5.60	Unitmetric Loading		0.0601 L/m ² /s	
No. Trusses per row		158	158	Total Media Surface Area		1211886.3 m ²	
Waffle density		18.16	Density OK	AOB Loading @	DWF	0.6 kg/m ² /d	
Waffle length		4.7	4.7	SOD Loading @	FFT	3.0 kg/m ² /d	
No. Support Loops		4.0	4.0	Unitmetric Loading @	FFT	21.4 L/m ² /s	
No. Trusses		11232	5616	Media Volume		2038.7 m ³	
Total Media accommodated		52951	29345	AOB Loading @	DWF	0.2 kg/m ² /day	
				SOD Loading @	DWF	0.1 kg/m ² /day	
Total Media Displacement		11.17	16694.84	kg	max sludge/cage		
Total Cage Displacement		9.59	2997.99	kg	cage weight		
Total Displacement		20.76	19172.83	kg	Design Maximum Lift		

Calculate Actual Oxygen Demand

$AOR = 0.75B + 0.025MV + 0.348NW - 2.35P(A/N/N)$

BOD oxygen demand = $0.75 \times (BOD_{in} - BOD_{eff})$
 Endogenous respiration = $0.048 \times M \times V$
 Nitrification requirement = $4.3 \times (NH_4-N - NH_3-N_e)$
 Denitrification credit = $2.85 \times 0.25 \times (NH_4-N - NH_3-N_e)$

Est.

4. Primary aeration tank

25% BOD reduction

50% SS Reduction

4.5. Inlet Zone

Where
 BOD_i =
 MLSS =
 BOD_e =
 NH₄-N =
 NO₃-N =
 P_a =

Influent BOD (kg/d)
 Mass equiv. suspended solids in aeration tank (mg/l)
 Effluent BOD (kg/d)
 Effluent NH₄ as N (kg/d)
 Effluent NO₃ as N (kg/d)
 Effluent P (kg/d)

	Target	Consent	mg/l
AOB	5.00	15.00	mg/l
NO ₃ -N	2.00	6.00	mg/l
NO ₂ -N	0.00		mg/l
Fe	0.00		mg/l
SS	10.00	20.0	mg/l

	Min Flow	DWF	Average	FFT
Effluent BOD (kg/d)	42	42	43	330
Effluent NH ₄ (kg/d)	21	21	21	60
Effluent NO ₃ (kg/d)	-	-	-	-
Effluent P (kg/d)	-	-	-	-
Effluent SS (kg/d)	64	64	64	64
Required Alkalinity (mg/l)	2,064	2,00	338	206
1. Growth oxygen demand (kgO ₂ /d)	557.50	557.50	3,463	4,456
2. Endogenous respiration (kgO ₂ /d)	2.506	2.506	2.506	2.506

3. Nitrification requirement (kgO ₂ /d)	1,721.76	1,722	2,573	3,239
4. Denitrification credit (kgO ₂ /d)	- 283	- 283	- 422	- 532
AOR (1+2+3-4) (kgO ₂ /d)	4,503	4,503	8,119	6,660

Your Reference	06-May
Water Company	JD BARRY
Our Reference	AS11407
Scheme Name	CASTLETRY
Option	78,000 PE REV02
Date	10/05/2020

P.E	78,000
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Flow Split	100%
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Peaking Factor	1.30
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Conversion to SOTR

Alpha	0.60	Alpha (calculated)	
Beta	0.95		
Altitude (m)	100		
D.O fed (mg/l)	1.5	1.7	2.0
Water Temp. (°C)	13	13	13
Omega, W	0.99		
Surface Saturation Csat ₂₀ (mg/l)	9.09		
Surface Saturation Csat _{water} (mg/l)	10.54	10.54	10.54 mg/l
Diffuser Submergence, D _s (m)	5.37		1.18 Our Gas
Probe depth Factor, F	0.357		
Corrected C* _w (mg/l)	10.825		
Corrected C* _w (mg/l)	12.545	12.545	12.545 mg/l
Theta, θ	0.847	0.847	0.847

	Min Flow	DWF	Average	FFT
SOTR (kgO ₂ /d)	5326	9326	17145	21972
SOTR (kgO ₂ /h)	388.58	388.58	714.55	877.99

F.M. q (kgBOD/kgMLSSd)	0.014	0.014	0.038	0.114
Aerobic F.M (kgBOD/kgMLSSd)	0.014	0.014	0.050	0.114
NH ₃ Loading Factor (kgNH ₃ -N/kgMLSS	0.008	0.008	0.011	0.014
Aerobic Sludge Age, θ (d)	71.0	71.0	11.4	8.9
HRT (hrs)	16.7	16.7	11.1	8.4
Theoretical Yield, Y (kg/kg)	0.99	0.99	0.99	0.99
WAS kg/d	715	715	4664	5885
	1.6540979	1.564097891	0.98150984	1.22195638

Airflow - Assumed SOTE

SOTE (h/m)	6.6	6.6	6.6	6.6
Airflow - Nm ³ /h (0°C, 1013mbar, 0%RH)	3,666	3,666	5,741	6,283
Airflow - m ³ /h (20°C, 1013mbar, 36%RH)	3,074	3,074	7,306	6,080

Final Settlement Tanks

SELECT MLSS	3500 mg/l	Given Capacity	
SSVI	80	Range 50-120	
max flow, Q ₂	25025 m ³ /d		
Velocity of sludge in water, V _s	7.83 m/h		
Constant, k	0.0003608		
Max Upflow Velocity, U _{max}	1.56 m/h		
Area of Clarifiers	692.96 m ²	Req'd Dia	20.0 25.0 m
Assumed RAS concentration	6000 mg/l		
Required Recycle ratio, R	1.40	FOTs	626.3 499.8 m ³
Max size of RAS pumps	426.0 L/s		
Downward loading on Clarifier	2.18 m/h		1.5157E+13
Critical downward loading (Q _c /A) _{crit}	0.95 m/h	Final	10.167855 kg/m ²
Critical RAS pump flowrate	193.2 L/s	Y	1.94575631 m/h