

# Appendix 3B- ESP Process Calculations

Your Reference	06-May
Water Company	JB BARRY
Our Reference	AS11407
Scheme Name	CASTLETROY
Option	78,000 PE REV02
Date	20/05/2020

P.E 78,000

Peaking Factor  
1.30

Flow Split 100%

Settled Load	Min Flow		DWF		Average		FFT	
Flow (m <sup>3</sup> /d)	8352		8352	97/s	12528	145/s	25920	300/s
Total COD <sub>5</sub> load (kg/d)	1019	122mg/L	1019	122mg/L	1530	122mg/L	4427	171mg/L
Total BOD <sub>5</sub> load (kg/d)	785	94mg/L	785	94mg/L	4680	374mg/L	6084	235mg/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	31mg/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	1530	122mg/L	4427	171mg/L
Phosphate (kg/d)	0	1mg/L	0	0mg/L	0	0mg/L	0	0mg/L
Min Wastewater Temperature (°C)	11							

Operating MLSS	3500	mg/l	<input checked="" type="checkbox"/> IFAS Enhancement
Anoxic Volume	0.0	m <sup>3</sup>	
Anaerobic Volume	0	m <sup>3</sup>	
Aerobic Volume	5800	m <sup>3</sup>	
No. of aeration cells	2		
Length (aerobic)	32.5	m	
Width	16.3	m	
Depth	5.49	m	
Suspended Biomass (anoxic)		0 kg	
Suspended Biomass (anaerobic)		0 kg	
Suspended Biomass (Aerobic)		20221 kg	
Sessile Biomass		31994 kg	
Total Biomass		52215 kg	
Eqv. MLSS		9003 mg/l	

Cleartec® IFAS accommodation		Total	per lane	
No. Cages		36	18	Media Specific Surface Area
no. Rows per Cage	2	m	2	Media Specific Surface Area/Vol.
Cage Width	6.60	m	6.60	Volumetric Loading
No. Textiles per row	156	/row	156	Total Media Surface Area
textile density	18.14	/m	Density OK	BOD Loading @ DWF
textile length	4.7	m	4.7	BOD Loading @ FFT
No. Support Loops	4.0		4.0	Volumetric Loading @ FFT
No. Textiles	11232		5616	Media Volume
Total Biotextil accommodated	52691	m	26345	BOD Loading @ DWF
				BOD Loading @ FFT
Total Media Displacement	13.17	m <sup>3</sup>	16099.94	kg
Total Cage Displacement	9.28	m <sup>3</sup>	2037.90	kg
Total Displacement	22.45	m <sup>3</sup>	18137.83	kg
				max sludge/cage
				cage weight
				Design Maximum Lift

**Calculate Actual Oxygen Demand**

(AOR)

$$AOR = 0.75B + 0.048MV + 4.3AmmN - 2.85Y(AmmN)$$

BOD oxygen demand =	0.75 x (BOD <sub>inf</sub> - BOD <sub>eff</sub> )
Endogenous respiration =	0.048 x M x V
Nitrification requirement =	4.3 x (NH <sub>3</sub> -N - NH <sub>3</sub> -N <sub>e</sub> )
Denitrification credit =	2.85 x 0.25 x (NH <sub>3</sub> -N - NH <sub>3</sub> -N <sub>e</sub> )

<input checked="" type="checkbox"/> Primary Settlement Tanks
25% BOD reduction
50% SS Reduction
<input checked="" type="checkbox"/> Anoxic Zone

Where

BODI =	Influent BOD (kg/d)
MLSS =	Mixed liquor suspended solids in aeration tank (mg/l)
BOD <sub>e</sub> =	Effluent BOD(kg/d)
NH <sub>3</sub> -N =	Effluent NH <sub>3</sub> as N (kg/d)
NO <sub>3</sub> -N =	Effluent NO <sub>3</sub> as N (kg/d)
P <sub>a</sub> =	Effluent P (kg/d)

	Target	Consent	
BOD	5.00	10.00	mg/l
NH3-H	2.50	5.00	mg/l
NO3Ne	0.00		mg/l
Pe	0.00		mg/l
SS	10.00	20.0	mg/l

	Min Flow	DWF	Average	FFT
Effluent BOD (kg/d)	42	42	63	130
Effluent NH <sub>3</sub> (kg/d)	21	21	31	65
Effluent NO <sub>3</sub> (kg/d)	-	-	-	-
Effluent P (kg/d)	-	-	-	-
Effluent SS (kg/d)	84	84	84	84
Required Alkalinity (mg/l)	2,964	339	338	206
1. Growth oxygen demand (kgO <sub>2</sub> /d)	557.50	557.50	3,463	4,466
2. Endogenous respiration (kgO <sub>2</sub> /d)	2,506	2,506	2,506	2,506

3. Nitrification requirement (kgO <sub>2</sub> /d)	1,721.76	1,722	2,572	3,239
4. Denitrification credit (kgO <sub>2</sub> /d)	- 283	- 283	- 422	- 532
AOR (1+2+3-4) (kgO <sub>2</sub> /d)	4,503	4,503	8,119	9,680

Your Reference	06-May
Water Company	JB BARRY
Our Reference	AS11407
Scheme Name	CASTLETROY
Option	78,000 PE REV02
Date	20/05/2020

P.E	78,000
-----	--------

Peaking Factor	1.30
----------------	------

Flow Split	100%
------------	------

#### Conversion to SOTR

Alpha	0.60	Alpha (calculated)	
Beta	0.95		
Altitude (m)	100		
D.O field (mg/l)	1.5	1.7	2.0
Water Temp. (°C)	13	13	13
Omega, W	0.99		
Surface Saturation Csat <sub>20</sub> (mg/l)	9.09		
Surface Saturation Csat <sub>Tsurf</sub> (mg/l)	10.54	10.54	10.54 mg/l
Diffuser Submergence, Ds (m)	5.37		<input checked="" type="checkbox"/> Lift Out Grids
Probe depth Factor, F	0.367		
Corrected C* <sub>20</sub> (mg/l)	10.625		
Corrected C* <sub>T</sub> (mg/l)	12.546	12.546	12.546 mg/l
Theta, θ	0.847	0.847	0.847

	Min Flow	DWF	Average	FFT
SOTR (kgO2/d)	9326	9326	17149	21072
SOTR (kgO2/h)	388.58	388.58	714.55	877.99

F:M, q (kgBOD/kgMLSSd)	0.014	0.014	0.088	0.114
Aerobic F:M (kgBOD/kgMLSSd)	0.014	0.014	0.088	0.114
NH <sub>3</sub> Loading Factor (kgNH <sub>3</sub> -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	5.4
Theoretical Yield, Y (kg/kg)	0.99	0.99	0.99	0.99
WAS kg/d	735	735	4564	5885
	1.5640979	1.564097891	0.98150984	1.22195638

#### Airflow - Assumed SOTE

SOTE (%/m)	6.6	6.6	6.6	6.6
Airflow - Nm <sup>3</sup> /h (0°C, 1013mbar, 0%RH)	3,666	3,666	6,741	8,283
Airflow - m <sup>3</sup> /h (20°C, 1013mbar, 36%RH)	3,974	3,974	7,308	8,980

#### Final Settlement Tanks

SELECT MLSS	3500 mg/l	Given Capacity	
SSVI	80	Range 80-120	
max flow, Q <sub>0</sub>	25920 m <sup>3</sup> /d		
Velocity of sludge in water, V <sub>0</sub>	7.03 m/h		
Constant, k	0.0003666		
Max Upflow Velocity U <sub>max</sub>	1.56 m/h		
Area of Clarifiers	692.96 m <sup>2</sup>	Req'd Dia	20.0 25.0 m
Assumed RAS concentration	6000 mg/l		
Required Recycle ratio R	1.40	FST's	628.3 490.9 m <sup>2</sup>
Max size of RAS pumps	420.0 L/s		
Downward loading on Clarifier	2.18 m/h		
Critical downward loading (Q <sub>0</sub> /A) <sub>crit</sub>	0.95 m/h	Fmax	1.5157E+13 10.167885 kg/hm2
Critical RAS pump flowrate	183.2 L/s	V	1.94975631 m/h