

Table S1 – Microbiological Parameters Used in the Activated Sludge Process Design

Parameter (Unit)	BOD Heterotrophic Microorganisms	Nitrification Microorganisms (Nitrosomonas)	Nitrification Microorganisms (Nitrobacter)	Denitrification Microorganisms (Pseudomonas)	Phosphorous Accumulating Organisms
K (mg BOD _L /L)	10 ¹	1 ¹	1.3 ¹	12.6 ²	1 ¹
Y (mg VSS/mg BOD _L)	0.45 ¹	0.33 ¹	0.083 ¹	0.26 ¹	0.3 ³
$\hat{q}$ (mg BOD _L /mg VSS-day)	20 ¹	2.3 ¹	9.8 ¹	12 ¹	3.17 ¹
$\hat{\mu}$ (mg VSS/mg VSS-day)	9 ¹	0.76 ¹	0.81 ¹	3.12 ¹	0.95 ^{3, 4}
b (mg VSS/mg VSS-day)	0.15 ¹	0.11 ¹	0.11 ¹	0.05 ¹	0.04 ³
f_d (-)	0.8 ¹	0.8 ¹	0.8 ¹	0.8 ¹	0.8 ¹
$[\theta_x^{\min}]_{\lim}$ (day)	0.11299	1.54083	1.42167	0.32573	1.09890

Parameters: K = concentration giving one-half the maximum rate; Y = true yield for cell synthesis; $\hat{q}$ = maximum specific rate of substrate utilization; $\hat{\mu}$ = maximum specific growth rate; b = endogenous-decay coefficient; f_d = fraction of active biomass that is biodegradable; $[\theta_x^{\min}]_{\lim}$ = absolute minimum SRT for steady-state biomass

References: 1 ~ Rittmann, et al., 2001 [58]; 2 ~ U.S. EPA, 1993 [81]; 3 ~ WEF, 2011 [48]; 4 ~ Metcalf & Eddy, Inc, 2003 [47]

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Table S2 – Comparison of Published Data on Energy Consumption per Unit Flow in Water Reuse Plants

Water Reuse Plant Size	Energy Consumption per Unit Flow kWh/1000 m ³ (kWh/MG)								
	CAS Facilities					MBR Facilities			
	This Study	WEF, (2010b) ¹	EPRI, (2002)	Mizuta, et al., (2010)	Yang, et al., (2010)	This Study	Verrecht, et al., (2010)	Yang, et al., (2010)	Livingston, (2010)
2.63 m ³ /min (1 MGD)	389.9 (1476)	345.6 (1308)	779.6 (2951)	–	–	723.4 (2738)	–	–	–
5.26 m ³ /min (2 MGD)	368.6 (1395)	335.9 (1271.5 ²)	711.9 (2694.7 ²)	–	–	709.1 (2684)	–	–	–
10.5 m ³ /min (4 MGD)	360.1 (1363)	316.7 (1198.6 ²)	576.5 (2182.2 ²)	–	–	700.9 (2653)	–	–	–
13.14 m ³ /min (5 MGD)	–	307 (1162.2)	508.8 (1926)	–	–	–	–	–	–
15.77 m ³ /min (6 MGD)	357.9 (1355)	306.1 (1158.8 ²)	501.7 (1899 ²)	–	–	696.7 (2637)	–	–	–
23.13 m ³ /min (8.8 MGD)	358.8 (1358)	303.6 (1149.3 ²)	481.7 (1823.4 ²)	–	–	680 (2574)	–	–	–
26.3 m ³ /min (10 MGD)	–	302.6 (1145.2)	473.2 (1791)	–	–	–	–	–	–
28.9 m ³ /min (11 MGD)	356.4 (1349)	301.9 (1142.9 ²)	470.1 (1779.5 ²)	–	–	680 (2574)	–	–	–
52.6 m ³ /min (20 MGD)	–	296.6 (1122.6)	442.8 (1676)	–	–	–	–	–	–
Average	365.3 (1383)	318.4 (1205)	587 (2222)	300-1890 (1136–7154)	267 (1011)	698.3 (2643)	600-2000 (2271–7571)	329.9 (1249)	792.6 (3000)

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1: Total energy consumption was determined based off the addition of similar unit processes

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2: Values were interpolated from corresponding reference literature

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Table S3 – Sensitivity Table of Low-End Combined Motor and Wire Efficiencies for Energy Consuming Units for a 23.13 m³/min (8.8 MGD) Water Reuse Plant

	Energy Driving Units	Low Efficiency				Average Efficiency	
		Energy Consumption (kWh/day)	Efficiency; Pump -5, Blower -10 (%)	Energy Consumption (kWh/day)	Efficiency; Pump -3, Blower -5 (%)	Energy Consumption (kWh/day)	Efficiency (%)
<i>Coarse Screens</i>	Rake Motor	1.16	-	1.16	-	1.16	-
<i>Grit Chamber</i>	Air Blowers	286.46	70	268.56	75	250.66	80
<i>Fine Screens</i>	Screen Motor	35.81	-	35.81	-	35.81	-
<i>Bioreactor</i>	Mixers	680.38	-	680.38	-	680.38	-
	Air Blowers	10455.94	70	9739.78	75	9166.85	80
	IMLR Pumps	1862.02	75	1862.02	77	1790.40	80
	RAS Pumps	2721.41	75	2649.79	77	2506.56	80
	Total	15719.75	-	14931.97	-	14144.19	-
<i>Membranes</i>	Air Scour Blowers	5885.05	70	5510.85	75	5170.68	80
	Permeate Pumps	2177.13	65	2041.06	67	2041.06	70
	Backpulse Pumps	143.23	65	136.07	67	136.07	70
	WAS Pumps	35.81	75	35.81	77	35.81	80
	Total	8241.22	-	7723.79	-	7383.62	-
<i>Conventional Activated Sludge</i>	Mixers	680.38	-	680.38	-	680.38	-
	Air Blowers	7448.06	70	6946.75	75	6517.06	80
	IMLR Pumps	1862.02	75	1862.02	77	1790.40	80
	RAS Pumps	1432.32	75	1360.70	77	1360.70	80
	Total	11422.78	-	10849.85	-	10348.54	-
<i>Secondary Clarifier</i>	Rake Arm Torque	17.90	-	17.90	-	17.90	-
	WAS Pumps	35.81	75	35.81	77	35.81	80
	Total	53.71	-	53.71	-	53.71	-
<i>Dual Media Filters</i>	Backwash Blower	9.42	70	8.75	75	8.22	80
	Backwash Pump	21.62	73	20.95	75	20.16	78
	Total	31.04	-	29.70	-	28.38	-
<i>UV Disinfection – Membrane Effluent</i>	Low-Pressure	839	-	839	-	839	-
	Medium-Pressure	5184	-	5184	-	5184	-
<i>UV Disinfection – Filter Effluent</i>	Low-Pressure	1229	-	1229	-	1229	-
	Medium-Pressure	8496	-	8496	-	8496	-
<i>Chlorination – Membrane Effluent</i>	Pump	4.48	65	4.48	67	4.48	70
<i>Chlorination – Filter Effluent</i>	Pump	4.48	65	4.48	67	4.48	70
<i>MBR WRP</i>	With Low-Pressure UV Radiation	25123.40	-	23800.29	-	22654.44	-
	With Chlorination	24288.88	-	22965.77	-	21819.92	-
<i>CAS WRP</i>	With Low-Pressure UV Radiation	13059.96	-	12467.79	-	11947.26	-
	With Chlorination	11835.44	-	11243.27	-	10722.74	-

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2 Table S4 – Sensitivity Table of High-End Combined Motor and Wire Efficiencies for Energy Consuming
3 Units for a 23.13 m³/min (8.8 MGD) Water Reuse Plant

	Energy Driving Units	Average Efficiency		High Efficiency			
		Energy Consumption (kWh/day)	Efficiency (%)	Energy Consumption (kWh/day)	Efficiency; Pump +3, Blower +5 (%)	Energy Consumption (kWh/day)	Efficiency; Pump +5, Blower +10 (%)
<i>Coarse Screens</i>	Rake Motor	1.16	-	1.16	-	1.16	-
<i>Grit Chamber</i>	Air Blowers	250.66	80	232.75	85	214.85	90
<i>Fine Screens</i>	Screen Motor	35.81	-	35.81	-	35.81	-
<i>Bioreactor</i>	Mixers	680.38	-	680.38	-	680.38	-
	Air Blowers	9166.85	80	8593.92	85	8164.22	90
	IMLR Pumps	1790.40	80	1718.78	83	1647.17	85
	RAS Pumps	2506.56	80	2434.94	83	2363.33	85
	Total	14144.19	-	13428.02	-	12855.10	-
<i>Membranes</i>	Air Scour Blowers	5170.68	80	4864.52	85	4592.38	90
	Permeate Pumps	2041.06	70	1904.99	73	1904.99	75
	Backpulse Pumps	136.07	70	128.91	73	121.75	75
	WAS Pumps	35.81	80	35.81	83	35.81	85
	Total	7383.62	-	6934.23	-	6654.93	-
<i>Conventional Activated Sludge</i>	Mixers	680.38	-	680.38	-	680.38	-
	Air Blowers	6517.06	80	6158.98	85	5800.90	90
	IMLR Pumps	1790.40	80	1790.40	83	1647.17	85
	RAS Pumps	1360.70	80	1360.70	83	1289.09	85
	Total	10348.54	-	9990.46	-	9417.54	-
<i>Secondary Clarifier</i>	Rake Arm Torque	17.90	-	17.90	-	17.90	-
	WAS Pumps	35.81	80	35.81	83	35.81	85
	Total	53.71	-	53.71	-	53.71	-
<i>Dual Media Filters</i>	Backwash Blower	8.22	80	7.82	85	7.29	90
	Backwash Pump	20.16	78	19.50	81	18.96	83
	Total	28.38	-	27.32	-	26.25	-
<i>UV Disinfection – Membrane Effluent</i>	Low-Pressure	839	-	839	-	839	-
	Medium-Pressure	5184	-	5184	-	5184	-
<i>UV Disinfection – Filter Effluent</i>	Low-Pressure	1229	-	1229	-	1229	-
	Medium-Pressure	8496	-	8496	-	8496	-
<i>Chlorination – Membrane Effluent</i>	Pump	4.48	70	4.48	73	4.48	75
<i>Chlorination – Filter Effluent</i>	Pump	4.48	70	4.48	73	4.48	75
<i>MBR WRP</i>	With Low-Pressure UV Radiation	22654.44	-	21470.97	-	20600.85	-
	With Chlorination	21819.92	-	20636.45	-	19766.33	-
<i>CAS WRP</i>	With Low-Pressure UV Radiation	11947.26	-	11570.21	-	10978.32	-
	With Chlorination	10722.74	-	10345.69	-	9753.80	-

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