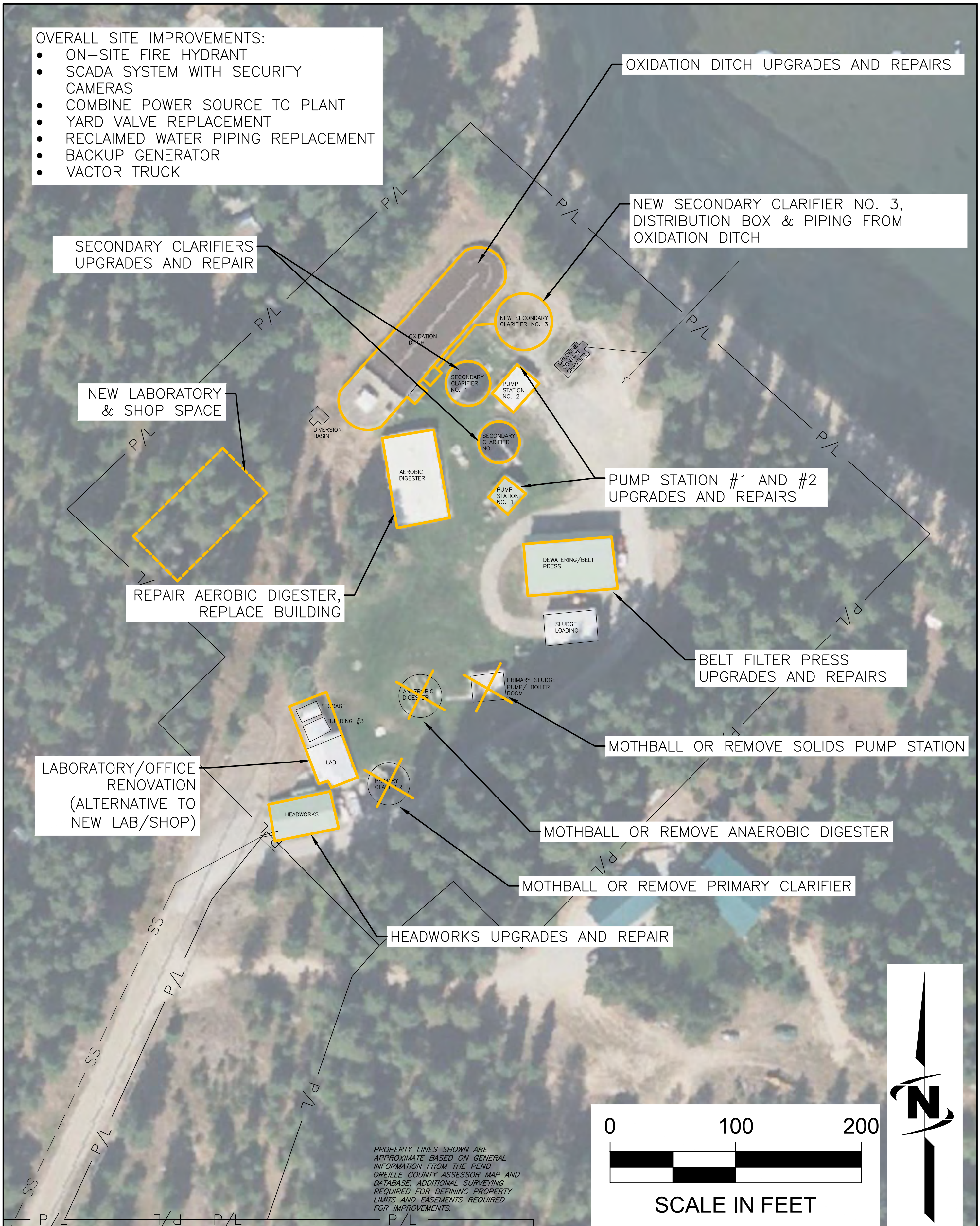
Appendix G – WWTP Improvement Alternatives Exhibits



NO.	REVISION DESCRIPTION	BY	APR.	DATE

FILE: 70-20-023_EXHIBIT
JUB PROJ. #: 70-20-023
DRAWN BY: STM
DESIGN BY: BMC
CHECKED BY: LLM
LAST UPDATED: 8/29/2023

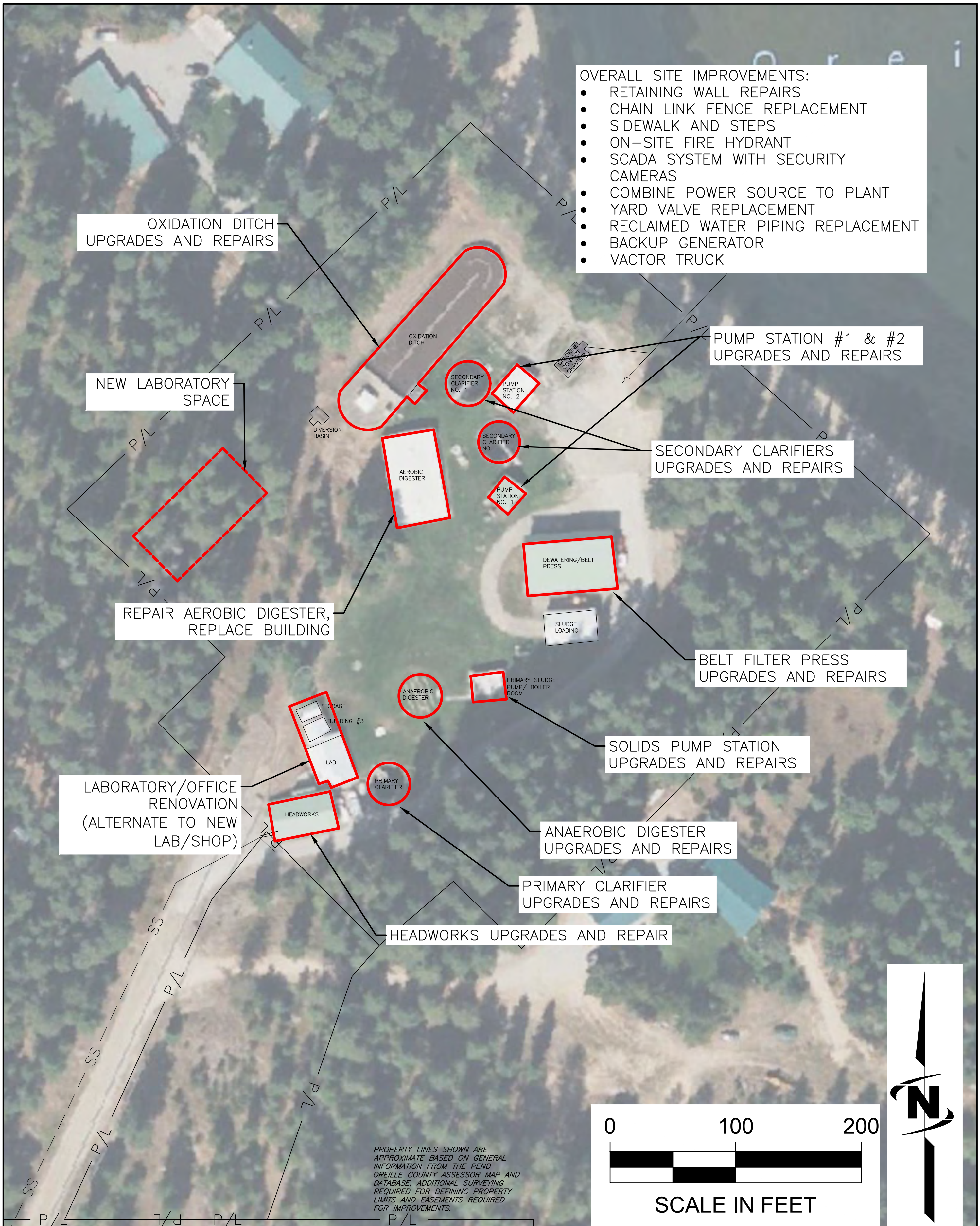
J-U-B ENGINEERS, INC.

WASTEWATER FACILITY PLAN UPDATE
CITY OF NEWPORT, WA

ALTERNATIVE B
REPAIR AND UPGRADE EXISTING PROCESSES

SHEET 1/1

Plot Date:8/29/2023 11:36 AM Plotted By: Jake Dial
Date Created:8/29/2023 \\JUB.COM\CENTRAL\CLIENTS\WA\NEWPORTCITY\PROJECTS\70-20-023_WASTEWATERMASTERPLAN\DESIGN\CAD\MODEL\70-20-023_EXHIBIT.DWG



Plot Date:5/30/2023 9:25 AM Plotted By: Sam Mineer
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NO.	REVISION DESCRIPTION	BY	APR.	DATE

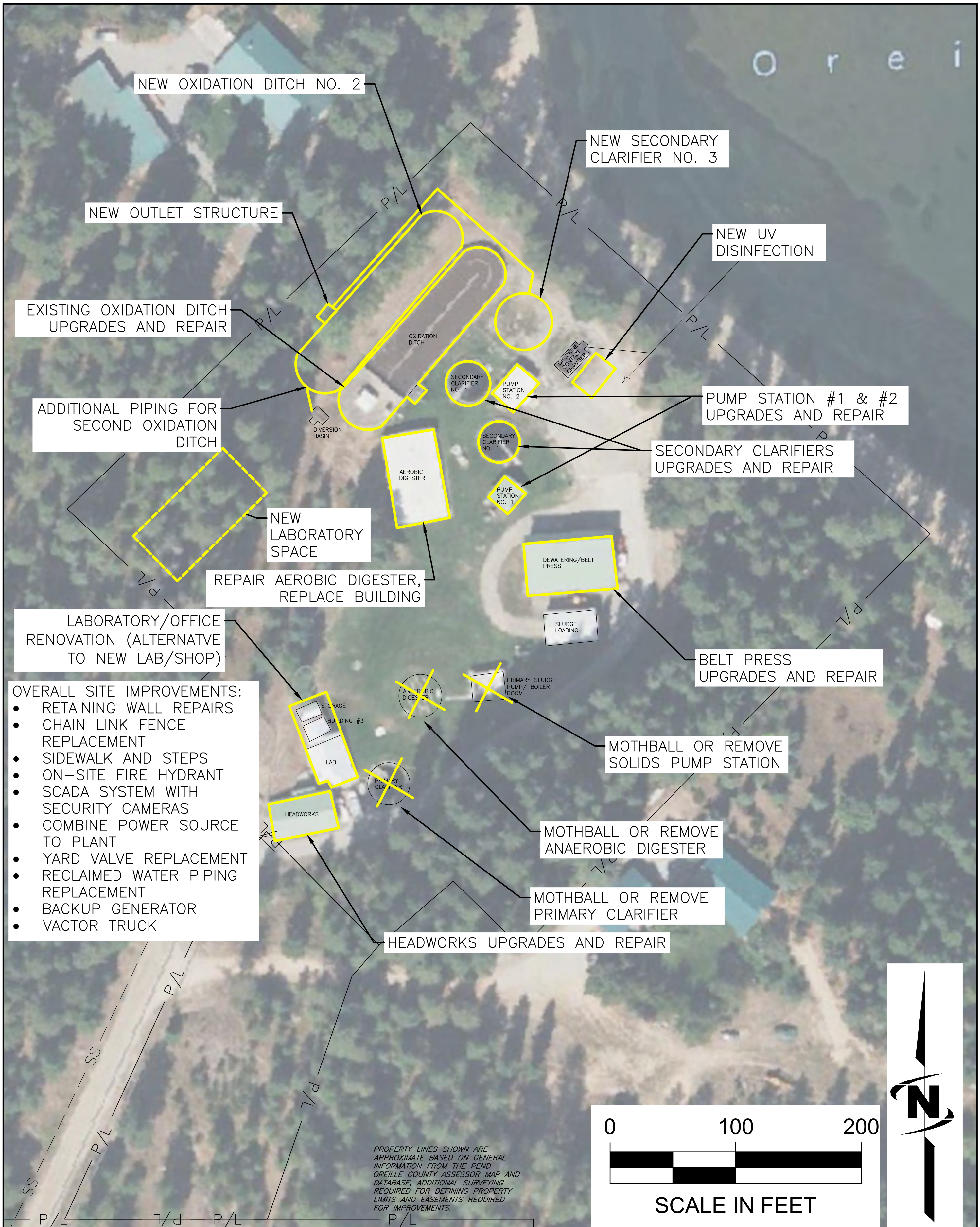
FILE: 70-20-023_EXHIBIT
JUB PROJ. #: 70-20-023
DRAWN BY: STM
DESIGN BY: BMC
CHECKED BY: LLM
LAST UPDATED: 5/30/2023

J-U-B ENGINEERS, INC.

WASTEWATER FACILITY PLAN UPDATE
CITY OF NEWPORT, WA

ALTERNATIVE C
RESTORE PRIMARY PROCESSES AND SITE REPAIRS

SHEET 1/1



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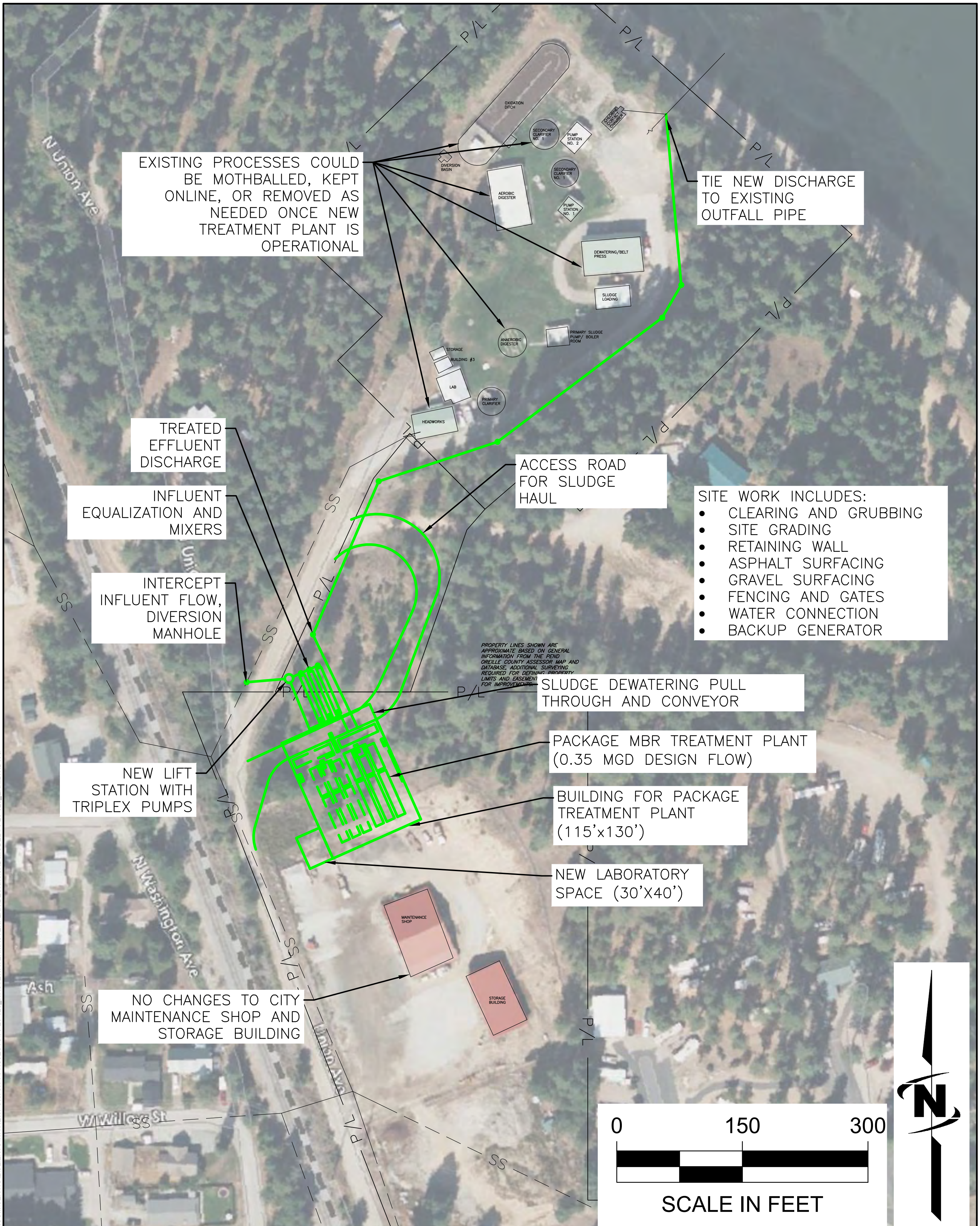
FILE: 70-20-023_EXHIBIT
JUB PROJ. #: 70-20-023
DRAWN BY: STM
DESIGN BY: BMC
CHECKED BY: LLM
LAST UPDATED: 5/30/2023

J-U-B ENGINEERS, INC.

WASTEWATER FACILITY PLAN UPDATE
CITY OF NEWPORT, WA

ALTERNATIVE D
UPGRADE SECONDARY PROCESSES ONLY

SHEET
1/1



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NO.	REVISION DESCRIPTION	BY	APR.	DATE

FILE: 70-20-023_EXHIBIT
JUB PROJ. #: 70-20-023
DRAWN BY: STM
DESIGN BY: BMC
CHECKED BY: LLM
LAST UPDATED: 5/30/2023

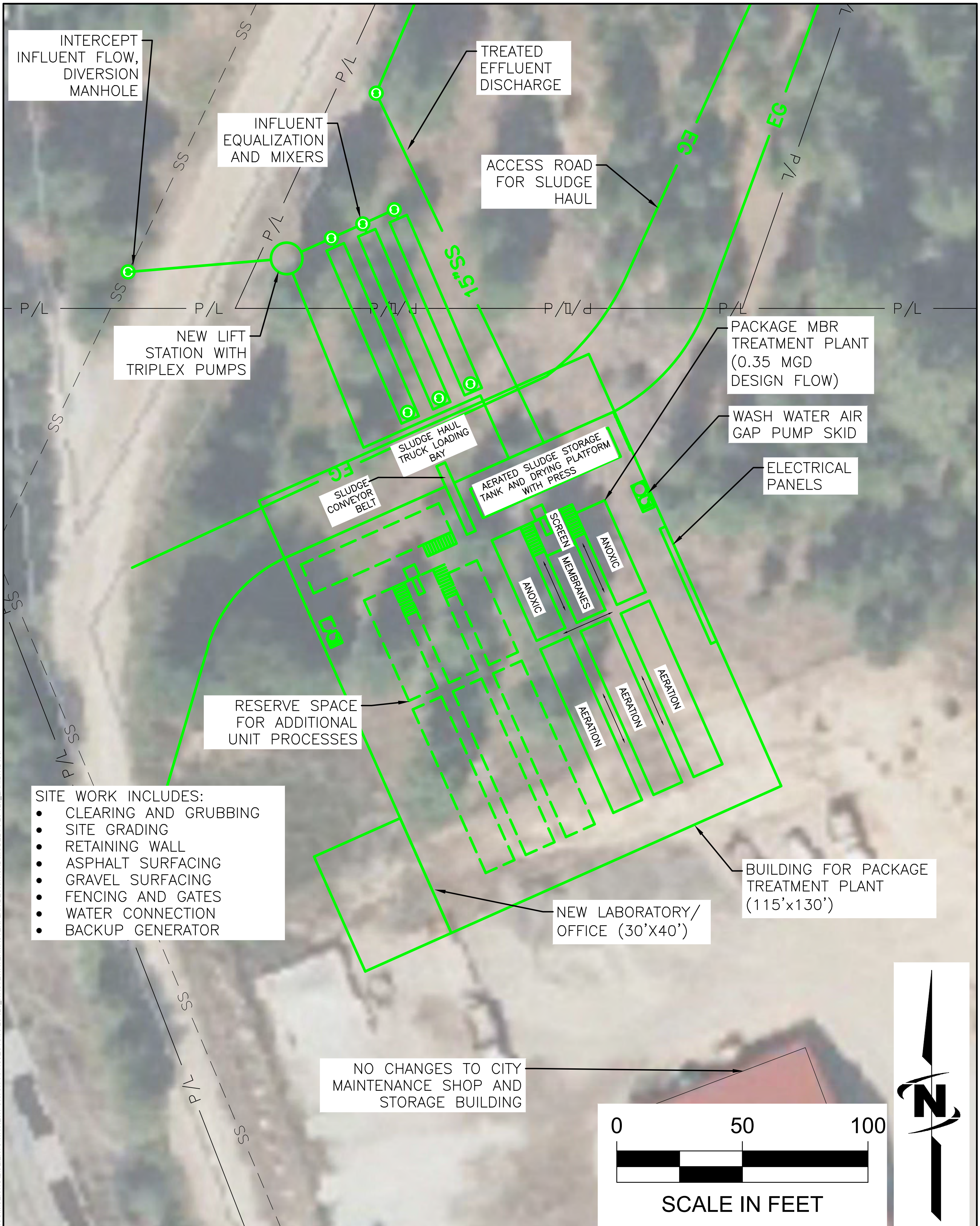
J-U-B ENGINEERS, INC.

WASTEWATER FACILITY PLAN UPDATE
CITY OF NEWPORT, WA

ALTERNATIVE E
PACKAGE MEMBRANE TREATMENT PLANT

SHEET

1/2



Plot Date:5/30/2023 9:36 AM Plotted By: Sam Mineer
Date Created:5/30/2023 \\JUB.COM\CENTRAL\CLIENTS\WA\NEWPORTCITY\PROJECTS\70-20-023_WASTEWATERMASTERPLAN\DESIGN\CAD\MODEL\70-20-023_EXHIBIT.DWG

REUSE OF DRAWINGS

NO.	REVISION DESCRIPTION	BY	APR.	DATE

FILE: 70-20-023_EXHIBIT
JUB PROJ. #: 70-20-023
DRAWN BY: STM
DESIGN BY: BMC
CHECKED BY: LLM
LAST UPDATED: 5/30/2023

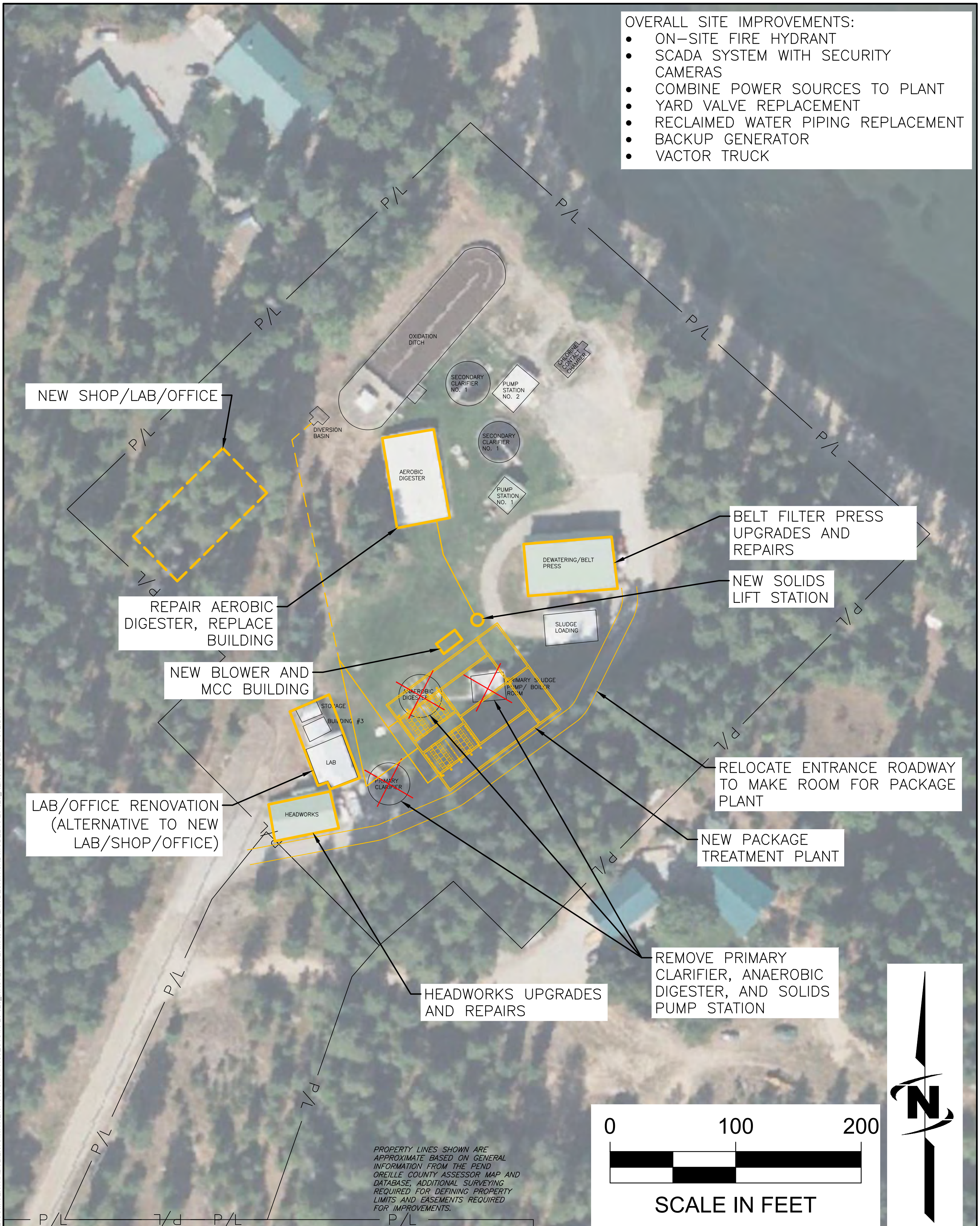
J-U-B ENGINEERS, INC.

WASTEWATER FACILITY PLAN UPDATE
CITY OF NEWPORT, WA

ALTERNATIVE E
PACKAGE MEMBRANE TREATMENT PLANT

SHEET

2/2



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NO.	REVISION DESCRIPTION	BY	APR.	DATE

FILE: 70-20-023_AEROMODLAYOUT2
JUB PROJ. #: 70-20-023
DRAWN BY: STM
DESIGN BY: BMC
CHECKED BY: LLM
LAST UPDATED: 10/17/2023

J-U-B ENGINEERS, INC.

WASTEWATER FACILITY PLAN UPDATE
CITY OF NEWPORT, WA

ALTERNATIVE G
AEROMODE PACKAGED PLANT SITE PLAN

SHEET
1/1

Appendix H –MBR Plant Design Calculations and Life Cycle Costs

CALCULATIONS BELOW FOR ENGINEERING USE ONLY

SUPPLYMENTAL CARBON CALCULATIONS {M&E Ed. 5, pgs. 848-859}

Chosen Supplemental Carbon Chemical	C_{CHEM}	=	Methanol 100%	
COD Concentration	[COD]	=	1,164,000	mgCOD/L
Chosen Dose Rate	DOSE	=	0	gCOD/d
Carbon Substrate Degrading Factor	η	=	0.80	
Carbon Substrate Biomass Yield	Y_H	=	0.41	
Max Substrate Utilization Rate	U_{max}	=	1.30	
Arrhenius Coefficient	θ	=	1.10	
Half-Saturation Coefficient	K_S	=	1.00	
Nitrate Half-Velocity Coefficient	K_{NO3}	=	0.10	
Effluent Nitrate Goal	$N_{e\ goal}$	=	3.00	mgNOx/L
Biodegredation Kinetic Variable (Yield)	Y	=	[1 - (1.42 x Y_H)] / (2.86)	
		=	0.15	
Biodegredation Kinetic Variable (Utilization)	U	=	(U_{max}) / (Y_H)	
		=	3.17	
Biodegredation Kinetic Variable (Nitrate Residual)	N	=	(S_{NO3}) / [K_{NO3} + S_{NO3}]	
		=	0.97	
Biodegredation Kinetic Variable (MLVSS)	X	=	Xm / Xvss	
		=	0.00	
Specific Denitrification Rate of External Carbon Source	$SDNR_{CARB}$	=	0	
*Assumed High Substrate Concentration			**0.0**	**g NO3 / g MLVSS-d**
Consumptive Ratio	$C_{R\ NO3}$	=	1 / Y	
		=	6.85	gCOD / gNO3
Effluent Carbon Substrate	S_S	=	{ (0,000 gCOD/d) - [(0.000 gNO3/gMLVSS-d) x (6,210 gMLVSS/m^3) x (0,000 gMLVSS/m^3) x (6.85 gCOD/gNO3)] } / (750,000 m^3/d) / (1.0 + 4.0)	
			0.000	gCOD/d
Design Effluent TSS	TSS_e	=	5.00	mg/L
VSS:TSS Ratio	VSS/TSS	=	0.80	gVSS / gTSS
Design Effluent Carbonaceous BOD	$cBOD_e$	=	2.00	mg/L
Estimated Effluent BOD	$\mathbf{BOD_e}$	=	(2.00 gcBOD/m^3) + [(0.60 gcBOD/gUBOD) x (1.42 gUBOD/gVSS) x (0.80 gVSS/gTSS) x (5.00 gTSS/m^3)] + [(0.00 gCOD/m^3) x (0.58 gBOD/gCOD)]	
		=	**5.41**	**mg/L**

SUPPLYMENTAL ALKALINITY CALCULATIONS

Primary Alkalinity	ALK	=	250	mg/L CaCO3
Alkalinity Needed to Maintain pH ≈ 6.8 - 7.0	ALK_{REC}	=	70.00	mg/L CaCO3
Alkalinity Used for Nitrification	ALK_{NIT}	=	7.14	gCaCO3 / gNH4
Total Alkalinity Used for Nitrification	$ALK_{NIT,TOT}$	=	(7.14 gCaCO3/gNH4) x (43.0 gNH4-NO3/m^3)	
		=	307	mg/L CaCO3
Alkalinity Produced During Denitrification	ALK_{DNIT}	=	3.57	gCaCO3 / gNO3
Total Alkalinity Produced During Denitrification	$ALK_{DNIT,TOT}$	=	(3.57 gCaCO3/gNO3) x (43.0 - 9.25 gNO3/m^3)	
		=	121	mg/L CaCO3
Supplemental Alkalinity Required	ALK_{ADD}	=	(70 mg/L Needed) - (250 mg/L Raw) + (307 mg/L Used) - (121 mg/L Produced)	
		=	7	mg/L CaCO3
Alkalinity Source Chemical Selected	ALK_{CHEM}	=	NaOH	
Density	$ALK_{CHEM\ D}$	=	1,267,700	mg/L
Purity	$ALK_{CHEM\ P}$	=	25	%
Chemical Required	$\mathbf{ALK_{REQ}}$	=	[(7 mg/L) x (750,000 gpd)] / [(1,267,700 mg/L) x (25 %)] / (24 h/d)	
		=	**0.7**	**gph**

$$NH_4^+ + 2\ O_2 + 2\ HCO_3^- \text{--->} NO_3^- + 2\ CO_2 + 3\ H_2O \quad \text{\{M\&E eq. 7-91\}}$$

$$NH_4^+(aq) + 2\ O_2(g) \text{--->} NO_3^-(aq) + 2\ H^+(aq) + H_2O(l)$$

AERATION CALCULATIONS

Maximum Air Required (Under MMF)

O2:BOD Consumption Ratio		=	1.25	lb O2/lb BOD
Oxygen Consumption from BOD Oxydation	$R_{O2,BOD}$	=	(2161.7 lbs-BOD/d) x (1.25 lbs O2/lbs N)	
		=	2,702	lbs/day O2
O2:N Consumption Ratio		=	4.60	lb O2/lb N
Oxygen Consumption from Nitrification (O2)	$R_{O2,NIT}$	=	(367.8 lbs-TKN/d) x (4.60 lbs O2/lbs N)	
		=	1,692	lbs/day O2
Oxygen Consumption from Carbon Addition	$R_{O2,CARB}$	=	0	lbs/day O2
Oxygen Requirement Ratio	AOR/SOR	=	0.40	
Maximum Total Oxygen Consumption	$O2_{TOT\ MAX}$	=	[(2702 lbs/d) + (1692 lbs/d) + (0 lbs/d)] / (0.40 AOR/SOR)	
			10,985	lbs/day O2
Molecular Weight of Air	M_{AIR}	=	28.97	lb/lb mol Air
Universal Gas Constant	R	=	1,544	ft-lb/lb-mol-R
Air Density	ρ_{air}	=	[(14.70 lb/in^2) x (144 in^2/ft^2) x (28.97 ft-lb/lb mol air-°R)] / [(1,544) x (460 + 68 °F)]	
		=	0.075	lbs / ft^3 Air
Maximum Air Flowrate	$\mathbf{SCFM_{MAX}}$	=	(10,985 lbs/d) / (0.075 lbs/ft^3) / (0.2058) / (0.188) / (1,440 min/d)	
			2,621	**scfm**

$$2\ C_{10}H_{19}O_3N + 25\ O_2 \text{--->} 20\ CO_2 + 16\ H_2O + 2\ NH_3$$

$$C_{10}H_{19}O_3N + 10\ NO_3^- \text{--->} 10\ CO_2 + 3\ H_2O + NH_3 + 10\ OH^- \quad \text{\{M\&E eq. 7-110\}}$$

$$2\ NO_3^- + 2\ H^+ \text{--->} N_2(gas) + H_2O + 2.5\ O_2$$

Oxygen Credit from Denitrification

			AVERAGE ANNUAL FLOW Q_{AA}	
Fraction $MLSS_b$	$P_{x,b}$ / $P_{x,TSS}$	=	(137.5 kg/d) / (378.3 kg/d)	
		=	0.36	
Nitrate MLVSS	$MLVSS_{NOx}$	=	(0.36) x (9000 mg/L)	
		=	3,270	mg MLVSS/L
Active Biomass Concentration	(SRT/V) x A_M	=	(24.6 d) / (674 m^3) x (137,479.2 g/d)	
		=	5,014.40	mg/L
Total Post-Anoxic Volume	V_{PAN}	=	0	m^3 **<-- No Post-Anoxic Volume**
Post-Anoxic NOx Removal Rate	R_{NOx}	=	[(0.000 gNO3/gMLVSS-d) x (6,210 gMLVSS/m^3) x (0 m^3)] + [(1.42 gO2/gVSS / 2.86 gO2/gNO3) x (0.06 gVSS/gVSS-d) x (5,014 g/m^3) x (0 m^3)]	
			0	g/d
Estimated Post-Anoxic NOx Removal	N_{PAN}	=	(0.000 g/d) / (1893 m^3/d) / (1.0 + 4.0)	
			0.0	mg/L
Post-Anoxic Biomass Decay Rate	R_{VSS}	=	(0.06 gNH4/gVSS) x (5,014 g/m^3) x (0 m^3)	
		=	0	gVSS/d
Ammonia Production	P_{NH4}	=	(0.06 gNH4/gVSS) x (0 gVSS/d)	
		=	0.00	gNH4/d
	Δ NH4	=	(0 gNH4/d) / [(1893 m^3/d) x (1.0 + 4.0)]	
		=	0.00	mg/L
Post-Anoxic Observed SDNR	$SDNR_b$	=	(0.000 g/d) / [(6,210 gMLVSS/m^3) x (0 m^3)]	
		=	0.000	gNO3/gVSS-d
Estimated Effluent NO3	Ne_1	=	[NOx / (1.0 + 0.0 + 4.0)] - (0.00 mg/L)	
*Soluble Nitrate in effluent		=	9.25	mg/L
Recycled NOx to Pre-Anoxic	NOx feed	=	(4.0) x (1893 m^3/d) x (9.25 mg/L)	
		=	70,057	g/d
Pre-Anoxic Volume	V_{NOx}	=	339	m^3
F/M in Pre-Anoxic	F/M_{NOx}	=	[(1893 m^3/d) x (346 mg/L BOD)] / [(339 m^3) x (3,270 mg/L)]	
			0.59	
Readily Biodegradable COD	rbCOD / bCOD	=	30.0	%
Standard Denitrification Rate	$SDNR_{20}$	=	bo + (b1 x [ln(1)]) => F/Mnox > 0.50	
	OR	=	(0.24) x (1) => F/Mnox < 0.50	
		=	0.160	g NO3 / g MLVSS-d
Specific Denitrification Rate	$SDNR_T$	=	(0.160 gNO3/gMLVSS-d) x 1.026^(15 - 20 °C)	
		=	0.141	g NO3 / g MLVSS-d
Adjusted SDNR	$SDNR_{adj}$	=	No Internal Recirc	
		=	0.141	g NO3 / g MLVSS-d
Overall SDNR	SDNR	=	$SDNR_{adj}$ x ($MLVSS_b$ / MLVSS)	
		=	0.074	g NO3 / g MLVSS-d
Pre-Anoxic NOx Removal	$NO_{x,rem}$	=	(339 m^3) x (0.074 gNO3/gMLSS-d) x (3270 mg MLSS/L)	
			156.640	g/d

MAXIMUM MONTHLY FLOW Q_{MM}

$P_{x.b}$ / $P_{x.TSS}$	=	(295.0 kg/d) / (658.1 kg/d)	
	=	0.45	
$MLVSS_{NOx}$	=	(0.45) x (9000 mg/L)	
	=	4,034	mg MLVSS/L
(SRT/V) x A_M	=	(14.1 d) / (674 m^3) x (294,976.0 g/d)	
	=	6,184.94	mg/L
V_{PAN}	=	0	m^3 **<-- No Post-Anoxic Volume**
R_{NOx}	=	[(0.000 gNO3/gMLVSS-d) x (6,210 gMLVSS/m^3) x (0 m^3)] + [(1.42 gO2/gVSS / 2.86 gO2/gNO3) x (0.06 gVSS/gVSS-d) x (6,185 g/m^3) x (0 m^3)]	
		0	g/d
N_{PAN}	=	(0,000 g/d) / (2839 m^3/d) / (1.0 + 4.0)	
		0.0	mg/L
R_{VSS}	=	(0.06 gNH4/gVSS) x (6,185 g/m^3) x (0 m^3)	
	=	0	gVSS/d
P_{NH4}	=	(0.06 gNH4/gVSS) x (0 gVSS/d)	
	=	0.00	gNH4/d
Δ NH4	=	(0 gNH4/d) / [(2839 m^3/d) x (1.0 + 4.0)]	
	=	0.00	mg/L
$SDNR_b$	=	(0,000 g/d) / [(6,210 gMLVSS/m^3) x (0 m^3)]	
	=	0.000	gNO3/gVSS-d
Ne_1	=	[NOx / (1.0 + 0.0 + 4.0)] - (0.00 mg/L)	
	=	8.60	mg/L
NOx feed	=	(4.0) x (2839 m^3/d) x (8.60 mg/L)	
	=	97,720	g/d
V_{NOx}	=	339	m^3
F/M_{NOx}	=	[(2839 m^3/d) x (346 mg/L BOD)] / [(339 m^3) x (4,034 mg/L)]	
		0.72	
rbCOD / bCOD	=	30.0	%
$SDNR_{20}$	=	bo + (b1 x [ln(1)]) => F/Mnox > 0.50	
OR	=	(0.24) x (1) => F/Mnox < 0.50	
	=	0.188	g NO3 / g MLVSS-d
$SDNR_T$	=	(0.188 gNO3/gMLVSS-d) x 1.026^(15 - 20 °C)	
	=	0.165	g NO3 / g MLVSS-d
$SDNR_{adj}$	=	No Internal Recirc	
	=	0.165	g NO3 / g MLVSS-d
SDNR	=	$SDNR_{adj}$ x ($MLVSS_b$ / MLVSS)	
	=	0.107	g NO3 / g MLVSS-d
$NO_{x.rem}$	=	(339 m^3) x (0.107 gNO3/gMLSS-d) x (4034 mg MLSS/L)	
		226.438	g/d

Mimimum Air Required (Under AAF)

O2:NO3 Consumption		=	2.86	gO2/gNO3-N
O2 Demand for BOD	$R_{O,BOD}$	=	Q x (S - S_0) - (1.42 x $P_{x,bio}$) + ~~(4.57 x Q x Nox)~~	
*Assume no nitrifying bacteria		=	32.4	kg/h
O2 Credit from Denitrification	$R_{O,Nox}$	=	(2.86 gO2/gNO3) x (43.0 - 9.3 mg/L) x (1893 m^3/d) / 1000 / 24	
		=	7.6	kg/h
Average Operational Total O2 Demand	Ro	=	(32.4 - 7.6) kg/h	
		=	**24.8**	**kg/h**
Standard Pressure	Ps	=	1.0	atm
		=	101.325	kPa
		=	14.70	lbs/in^2
		=	10.33	m
Pressure Factor	Pb/Ps	=	exp { - (9.81 m/s^2) x (28.97 g/mol) x (122 - 0 m) / (8,314) / [(273.15 + 15) K] }	
		=	0.986	
Mid-Depth Factor	de	=	0.40	
Depth of Diffusers	Df	=	8.083	ft
Standard DO SAT at 20°C	$C_{S,20}$	=	9.090	mg/L
DO SAT at 20°C	$C_{\infty,20}$	=	(9.090 mg/L) x [1 + 0.40 x (2.464 m / 10.33 m)]	
		=	9.957	mg/L
DO Transfer Rate	α	=	0.65	<--- **May need adjustment**
*Relative to clean water				
DO SAT Coefficient	β	=	0.95	
*Relative to clean water				
Diffuser Fouling Factor	F	=	0.90	
Temperature Correction Factor	θ	=	1.024	
DO SAT at Sea Level at T	Cst	=	10.084	
DO SAT at Sea Level at 20°C	Cs20	=	9.092	
Soluble O2 Transfer Rate	SOTR	=	24.8 kg/h / (0.65 x 0.90)	X 9.957 mg/L / [0.95 x (10.084 mg/L / 9.092 mg/L) x 0.986 x 9.957 mg/L - 2.0 mg/L)] X 1.024 x (20 - 15 °C)
		=	56.9	kg/h
Diffuser Efficiency Per Linear Foot of WSE	SOTE/WSE	=	2.21	% / ft
	SOTE	=	18.8	%
Average Operational Aeration Flowrate	$SCFM_{MIN}$	=	(56.9 kg/h) / (18.8 %) / (1.204 kg Air/m^3) / (0.2058) / (60 min/h) x (35.315 ft^3 / m^3)	
		=	**719**	**scfm**
*Optional: Insert Total O2 Requirement from GPS-X		=		**cfm**
Percent Difference from Maximum Air Flowrate	% MAX	=		
Percent Difference from Minimum Air Flowrate	% MIN	=		

REQUIRED PROCESS VOLUME at MMF

Desired F:M	$F{:}M_{DES}$	=	0.15
Desired Process MLSS	$MLSS_{DES}$	=	9,000 mg/L
*MLSS Max allowable = 9,600 mg/L @ FAS = 5Q.			
Required MLVSS	$MLVSS_{REQ}$	=	(2161.7 lbs/day BOD) / (0.15 d^-1)
		=	14,412 lbs MLVSS
Required MLSS	MLVSS / MLSS	=	0.69 lbs MLVSS / lb MLSS
	$MLSS_{REQ}$	=	(14,412 lbs MLVSS) / (0.69 lbs MLVSS/lbs MLSS)
		=	20,886 lbs MLSS
Required Process Volume (gal)	V_{REQ}	=	(20,886 lbs MLSS) / (9,000 mg/L MLSS) / (8.34 lbs/gal) x (1,000,000 mg/L)
*(Aeration + MBR + Anoxic)		=	**278,261** **gal**
		=	(278,261 gal) / (7.48 gal/cf)
		=	**37,201** **cf**

REQUIRED AERATION & ANOXIC VOLUME at MMF

Desired Anoxic/Aeration Volume Ratio	ANX / AER	=	0.40
Req'd Aeration + MBR Volume	$V_{AER} + V_{MEM}$	=	(V_{REQ}) / (ANX/AER)
		=	(278,261 gal) / (0.40 + 1.0)
		=	**198,758** **gal**
Req'd Aeration Chamber Volume	$V_{AER\ REQ}$	=	($V_{AER} + V_{MEM}$) - ($V_{MEM\ AER}$)
*Dissociates volume in Membrane Chambers under aeration conditions		=	(198,758 gal) - (16,730 gal)
		=	**185,047** **gal**
Req'd Anoxic Chamber Volume	$V_{ANX\ REQ}$	=	(V_{REQ}) - ($V_{AER} + V_{MEM}$) - ($V_{PAN\ ANX}$)
*Dissociates volume in Pre-Anoxic Chambers under anoxic conditions		=	(278,261 gal) - (198,758 gal) - (0,000 gal)
		=	**79,503** **gal**

PROCESS CALCULATIONS

Minimum Allowable SRT - {M&E ed. 5, pgs 755-769}

12 degrees F, -11.1 degrees C

Min. Influent Temperature	T_{min}	=	5 °C
Max. Influent Temperature	T_{max}	=	30 °C
Design Process Temperature	T	=	15 °C
Effluent NH_4 Limit		=	0.0 mg/L
Design Effluent NH_4 Concentration	$NH4_{OUT}$	=	0.50 mg/L
DO in Aeration Basin(s)	DO	=	2.0 mg/L
1/2-Saturation Coeff. for DO	K_o	=	0.50 mg/L
Max Nitrifying Growth Rate @ T = °C	μ_{nm}	=	(0.90 g VSS/g VSS·d) x (1.072) ^ (T - 20)
		=	0.64 g VSS/g VSS·d
Nitrification 1/2-Velocity Const. (Substrate) @ T = °C	K_n	=	0.50 mg NH4/L
Nitrifying Decay Rate @ T = °C	k_{dn}	=	(0.17 g VSS/g VSS·d) (1.029) ^ (T - 20)
		=	0.15 g VSS/g VSS·d

Nitrifying Specific Growth Rate	μ_n	=	[(μ_{nm} x N) / (K_n + N)] x [DO / (K_o + DO)] - k_{dn}					
		=	0.11	g/g·d				
Theoretical SRT	SRT'	=	1 / μ_n					
		=	9.35	d				
Safety Factor	FS	=	TKN_{peak} / TKN_{ave}					
		=	1.5					
Minimum Allowable SRT	**SRT_{min}**	**=**	FS x SRT'					
		=	**14.0**	**d**				

Sludge Production

Wastewater Characteristics {M&E ed. 5, pgs 755-769}

Primary BOD	BOD	=	346	mg/L				
COD / BOD		=	1.72					
Primary COD	COD	=	596	mg/L				
Primary TKN	TKN	=	58.8	mg/L				
Assumed Portion of TKN that is converted to NOx		=	80	%				
Estimated Mixed Liquor NOx After Aeration	NO_x	≈	(0.80) x TKN					
		≈	47.0	mg/L				
Itterated Mixed Liquor NOx	AAF	=	**46.3**	**mg/L**	MMF	=	**43.0**	**mg/L**
Portion BOD that is soluble		=	80	%				
Soluble BOD	sBOD	=	(0.80) x BOD					
		=	276	mg/L				
Portion COD that is soluble		=	80	%				
	sCOD	=	(0.80) x COD					
		=	477	mg/L				
Eq. 1 Biodegradable COD	bCOD	=	(1.60) x BOD		rbCOD	=	(553 mg/L) x (30.0 %)	
		=	**553**	**mg/L**		=	**166**	**mg/L**
Non-biodegradable COD	nbCOD	=	COD - bCOD					
		=	43	mg/L				
Effluent Soluble COD	$sCOD_e$	=	sCOD - (1.6 x sBOD)					
		=	34	mg/L				
Primary TSS	TSS	=	319	mg/L				
VSS / TSS		=	0.80	mgVSS/mgTSS				
Volatile Suspended Solids	VSS	=	TSS * (VSS / TSS)					
		=	255	mg/L				
Biodegradable Particulate COD / Particulate COD	bpCOD / pCOD	=	1.6 x (BOD - sBOD) / COD - sCOD					
		=	0.93					
Eq. 2 Non-biodegradable VSS	nbVSS	=	$\left(1 - \frac{bpCOD}{pCOD}\right) x\, VSS$					
		=	**18**	**mg/L**				
Eq. 3 Inert Total Suspended Solids	iTSS	=	TSS - VSS					
		=	**64**	**mg/L**				
Heterotrophic Yield	Y	=	0.45	g VSS / g bCOD				
Max Heterotrophic Growth Rate @ T = °C	μ_m	=	(6.0 g VSS/g VSS·d) x (1.07) ^ (T - 20)					
		=	4.28	g VSS/g VSS·d				
Heterotrophic 1/2-Velocity Const. (Substrate) @ T = °C	K_s	=	8.0	mg bCOD/L				
Heterotrophic Decay Rate @ T = °C	k_d	=	(0.12 g VSS/g VSS·d) x (1.04) ^ (T - 20)					
		=	0.10	g VSS/g VSS·d				
Heterotrophic Fraction as Cell Debris	f_d	=	0.15					
Nitrifier Yield	Y_n	=	0.12	g VSS/g VSS·d				
Influent Substrate Concentration	S_o	=	bCOD					
		=	553	mg bCOD/L				

Influent Flow Regime

			AVERAGE ANNUAL FLOW Q_{AA}				MAXIMUM MONTHLY FLOW Q_{MM}	
Influent Flow	Q_{AA}	=	500,000	gpd	Q_{MMF}	=	750,000	gpd
		=	1,893	m^3/d		=	2,839	m^3/d
			2.0E+66				-5.4E+49	
Target SRT	SRT_{AA}	=	24.6	d	SRT_M	=	14.1	d
Effluent Substrate Concentration	S_{AA}	=	$\frac{K_s[1 + (k_d)SRT_{AA}]}{SRT_{AA}(\mu_m - k_d) - 1}$		S_M	=	$\frac{K_s[1 + (k_d)SRT_M]}{SRT_M(\mu_m - k_d) - 1}$	
		=	0.27	mg bCOD/L		=	0.33	mg bCOD/L
Eq. 4 Heterotrophic Biomass	A_{AA}	=	$\frac{Q_{AA}Y(S_o - S_{AA})}{1 + (k_d)SRT_{AA}}$		A_M	=	$\frac{Q_M Y(S_o - S_M)}{1 + (k_d)SRT_M}$	
		=	137.5	kg VSS/d		=	295.0	kg/d
		=	303.1	lb VSS/d		=	650.3	lb/d
Eq. 5 Cell Debris	B_{AA}	=	$\frac{(f_d)(k_d)Q_{AA}Y(S_o - S_{AA})SRT_{AA}}{1 + (k_d)SRT_{AA}}$		B_M	=	$\frac{(f_d)(k_d)Q_M Y(S_o - S_M)SRT_M}{1 + (k_d)SRT_M}$	
		=	50.0	kg VSS/d		=	61.7	kg VSS/d
		=	110.2	lb VSS/d		=	135.9	lb VSS/d
Eq. 6 Nitrifier Biomass	C_{AA}	=	$\frac{Q_{AA}Y_n(NO_x)}{1 + (k_{dn})SRT_{AA}}$		C_M	=	$\frac{Q_M Y_n(NO_x)}{1 + (k_{dn})SRT_M}$	
		=	2.1	kg VSS/d		=	4.8	kg VSS/d
		=	4.7	lb VSS/d		=	10.5	lb VSS/d
Eq. 7 Sludge Biomass Production	$P_{x, bio, AA}$	=	$A_{AA} + B_{AA} + C_{AA}$		$P_{x, bio, M}$	=	$A_M + B_M + C_M$	
		=	189.6	kg VSS/d		=	361.4	kg VSS/d
		=	418.0	lb VSS/d		=	796.7	lb VSS/d
Eq. 8 Sludge VSS Production	$P_{x, VSS, AA}$	=	$P_{x, bio, AA} + Q_{AA}(nbVSS)$		$P_{x, VSS, M}$	=	$P_{x, bio, M} + Q_{ADMM}(nbVSS)$	
		=	224.3	kg VSS/d		=	413.5	kg VSS/d
		=	494.5	lb VSS/d		=	911.6	lb VSS/d
Eq. 9 Sludge TSS Production	$P_{x, TSS, AA}$	=	$(P_{x, bio, AA})/0.85 + Q_{AA}(nbVSS) + Q_{AA}(iTSS)$		$P_{x, TSS, M}$	=	$(P_{x, bio, M})/0.85 + Q_M(nbVSS) + Q_M(iTSS)$	
		=	378.3	kg TSS/d		=	658.1	kg TSS/d
		=	834.1	lb TSS/d		=	1,450.9	lb TSS/d
	$P_{V, TSS, AA}$	=	$(P_{x, TSS, AA}) / (MLSS_{Membrane})$		$P_{V, TSS, M}$	=	$(P_{x, TSS, M}) / (MLSS_{Membrane})$	
		=	33.6	m^3/d		=	58.5	m^3/d
		=	8,883.8	gpd		=	15,453.4	gpd
Observed Yield	$\frac{(P_{x, TSS, AA})}{Q_{AA}BOD}$	=	0.58	lb TSS / lb BOD	$\frac{(P_{x, TSS, M})}{Q_M BOD}$	=	0.67	lb TSS / lb BOD
MLSS Mass	X_{MLSS}	=	$X_{MLSS, Aer} + X_{MLSS, Anox} + X_{MLSS, Mem}$					
		=	20,498.3	lbs				
Calculated SRT	SRT_{AA}	=	$(X_{MLSS}) / (P_{x, TSS, AA})$		SRT_M	=	$(X_{MLSS}) / (P_{x, TSS, M})$	
		=	24.6	d		=	14.1	d (OKAY)
	Difference	=	0.0	d	Difference	=	0.0	d
MLVSS Mass	X_{MLVSS}	=	$X_{MLVSS, Aer} + X_{MLVSS, Anox} + X_{MLVSS, Mem}$					
		=	14,143.8	lbs				
F/M Ratio	F/M_{AA}	=	$Q_{AA}BOD / X_{MLVSS}$		F/M_M	=	$Q_M BOD / X_{MLVSS}$	
		=	0.10	1/d		=	0.15	1/d
Hydraulic Residence Time	τ_{AA}	=	$\tau_{Aer, AA} + \tau_{Anox, AA} + \tau_{Mem, AA}$		τ_M	=	$\tau_{Aer, M} + \tau_{Anox, M} + \tau_{Mem, M}$	
		=	11.9	hr		=	7.9	hr

Nitrate Production via Nitrification

		AAF		MMF	
NOx	=	TKN - NH4e - (0.12 x $P_{x, bio}$ / Q_M)		TKN - NH4e - (0.12 x $P_{x, bio}$ / Q_M)	
	=	46.3	mg/L	43.0	mg/L
Difference	=	0.0		0.0	

AAF Membrane Hydraulic Flux Rates

w/o Redundancy	= (500,000 gpd)/(51,600 sq ft)	
	9.7	gfd
w/ Redundancy	= (3/4)(9.7 gfd)	
	7.3	gfd
AAF Permeate	376.2	gpm

MMF Membrane Hydraulic Flux Rates

w/o Redundancy	= (750,000 gpd)/(51,600 sq ft)	
	14.5	gfd
w/ Redundancy	= (3/4)(14.5 gfd)	
	10.9	gfd
MMF Permeate	564.2	gpm

Sludge Press Operation

WAS Percent Solids	Y_W	=	1.125	% Solids	SG_{WAS}	=	1.02	Weekly Operation	=	0	days/week	Solids Capture	=	95.0 %
Press Cake Percent Solids	Y_C	=	15.0	% Solids	SG_{CAKE}	=	1.07	Daily Operation	=	0	hours/day	Cake Density	=	63.1 lb/cf

Weekly Dry Solids Production	$P_{V, TSS, AA}$	=	(8884 gpd) x (7 d/wk) x (3.785 L/gal) x (1 kg/L) x (1.02) x (0.01125)							$P_{V, TSS, M}$	=	(15453 gpd) x (7 d/wk) x (3.785 L/gal) x (1 kg/L) x (1.02) x (0.01125)						
		=	2,701	kg/wk							=	4,698	kg/wk					
Daily Processed Dry Solids	P_{WAS}	=	(2701 kg/wk) / (0 d/wk)		Hourly Rate	=	#DIV/0!			P_{WAS}	=	(4698 kg/wk) / (0 d/wk)		Hourly Rate	=	#DIV/0!		
		=	#DIV/0!	kg/d		=	#DIV/0!	kg/h	Dry		=	#DIV/0!	kg/d		=	#DIV/0!	kg/h	Dry
						=	#DIV/0!	kg/h	Wet						=	#DIV/0!	kg/h	Wet
Daily Wet Cake Production	$P_{CAKE, WET}$	=	#DIV/0!		Press Rate	=	#DIV/0!	gpm		$P_{CAKE, WET}$	=	#DIV/0!		Press Rate	=	#DIV/0!	gpm	
		=	#DIV/0!	kg/d							=	#DIV/0!	kg/d					
		=	#DIV/0!	lb/d							=	#DIV/0!	lb/d					
Cake Volume Production	V_{CAKE}	=	#DIV/0!							V_{CAKE}	=	#DIV/0!						
		=	#DIV/0!	cf/d							=	#DIV/0!	cf/d					
		=	#DIV/0!	cy/d							=	#DIV/0!	cy/d					

PROJECT NAME	West Bonner	DESIGN		ANNUAL COSTS											
PROJECT NUMBER	CL22-139			cost per KWH		0.1	Industrial Rate per electricitylocal.com								
DESIGN FLOW (Average GPD)	250,000						Consumables: Oil, Grease, Belts, Filters etc.		Spare Parts Annual Budget: Seals, bearings, wear strips, brushes, etc.						
EQUIPMENT	MEMPAC-M250	Operating Parameter at ADF	Unit	Hp	Daily Hours	Daily Cost	Item	Cost	Item	Cost	Replacement Schedule (years)	Unit cost	Annual Budget for replacement of component	Number of Components Supplied	Total
ASSET	PROCESS								Control Process						
Electrical Control Panel	MBR Train Equipment Skid			-	-	-									
Control Transmitter	MCC Panel										10	$4,385.00	$438.50	1	$438.50
Touch Screen Computer	MCC Panel			-	-	-					5	$2,500.00	$500.00	1	$500.00
Probe Wash Solenoid	MCC Panel			-	-	-			Rebuild Kit	$100.00	10	$500.00	$50.00	1	$50.00
Influent Flow Meter	Influent			-	-	-					10	$4,000.00	$400.00	1	$400.00
Dissolved Oxygen Sensor	Process Tank										5	$2,122.00	$424.40	2	$848.80
pH Sensor	Process Tank			-	-	-					5	$900.00	$180.00	1	$180.00
MLSS Probe	Process Tank										5	$3,989.00	$797.80	1	$797.80
Nitrate Sensor	Process Tank										5	$5,025.00	$1,005.00	1	$1,005.00
FAS Feed Flow Meter	Process Tank										10	$5,600.00	$560.00	3	$1,680.00
Level Transducer	Membrane Process										10	$800.00	$80.00	3	$240.00
Permeate Flow Meter	Membrane Process										10	$2,684.00	$268.40	3	$805.20
Permeate Pressure Transducer	Membrane Process										5	$875.00	$175.00	3	$525.00
Membrane CFM Meter	Membrane Process										5	$1,293.00	$258.60	3	$775.80
Level Transducer	Clear Well			-	-	-					10	$875.00	$87.50	1	$87.50
WAS Flow Meter	WAS Process										7	$2,600.00	$371.43	1	$371.43
Effluent Flow Meter	Final Effluent			-	-	-					10	$4,995.00	$499.50	1	$499.50
ASSET	PROCESS								Mechanical Equipment						
Influent Screen	Screen Platform	695.0	gpm	0.75	6.0	$0.34			Brushes	$500.00	15	$65,000.00	$4,333.33	1	$4,333.33
Aeration Blower	Aeration Process	250	scfm	15.0	8.0	$53.71	Oil and Grease	$0.00	Belt, Filter	$0.00	5	$3,200.00	$640.00	6	$3,840.00
FAS Pump	Aeration Process	620	gpm	20.0	8.0	$35.81	Grease	$25.00	Parts	$500.00	10	$12,500.00	$1,250.00	3	$3,750.00
Membrane Cassette	Membrane Process				-						10	$105,000.00	$10,500.00	3	$31,500.00
Permeate Pump	MBR Process	460.0	gpm	7.5	8.0	$13.43	Oil and Grease	$50.00	Rebuild Kit/Parts	$500.00	10	$9,000.00	$900.00	3	$2,700.00
Membrane Blower	MBR Process	300.0	scfm	10.0	16.0	$35.81	Oil and Grease	$50.00	Belt, Filter	$0.00	5	$3,200.00	$640.00	3	$1,920.00
Pressure Relief Equipment	MBR Process						Oil and Grease	$0.00			7	$1,500.00	$214.29	6	$1,285.71
WAS Pump	WAS Skid	20.0	gpm	0.85	5.0	$0.63			Rebuild Kit/Parts	$400.00	7	$3,530.00	$504.29	2	$1,008.57
CIP Chemical Pumps (4 Total)	MBR Train Equipment Skid					$0.00	Replacement Tubes	$400.00	Spare Head, valves	$600.00	5	$5,184.00	$1,036.80	6	$6,220.80
		Annual Budget		Daily Power Est.		$139.73	Consumables	$525.00	Spare Parts	$2,600.00				Replacement	$65,762.95

Annual Estimated Power				
Percentage of Average	Daily Flow (GPM)	Daily Power Cost	Days	Total
100%	250,000	$139.73	365	$50,999.82
100%	250,000	$139.73	0	$0.00
100%	250,000	$139.73	0	$0.00
100%	250,000	$139.73	0	$0.00
		Total Estimated Power Cost		$50,999.82

Annual Estimated Labor (Hours)							
Task		Daily (4 Days)	Weekly	Monthly	Quarterly	Annual	Total
Routine Operations		2.5	2.5	2.0			
Required Sampling/Analysis				2.0		2.0	
Preventative Equipment Maintenance			3.0	4.0	4.0	4.0	
Compliance and Reporting				4.0		4.0	
Annual Totals		520	220.0	144.0	16.0	10.0	910
Hourly Rate	$50.00	$26,000.00	$11,000.00	$7,200.00	$800.00	$500.00	$45,500.00

Annual Estimated Chemical					
Chemical	Process	Volume (Gal)	Cost per Gal	No. of Events	Total
Hypochlorite or Equal	Weekly CIP	19.4	$2.87	52	$2,895.26
Citric Acid	Weekly CIP	16.2	$10.95	52	$9,224.28
Hypochlorite or Equal	Recovery Clean	4	$2.87	4	$45.92
Citric Acid	Recovery Clean	4	$10.95	4	$175.20
			Total Estimated Annual CIP Chemical Cost		$12,340.66

Units Provided	2	Each Unit	Total
	Equipment Consumables	$525.00	$1,050.00
	Equipment Spare Parts	$2,600.00	$5,200.00
	Equipment Replacement	$65,762.95	$131,525.90
	Power	$50,999.82	$101,999.64
	Labor	$45,500.00	$91,000.00

PROJECT NAME	West Bonner	DESIGN		ANNUAL COSTS										
PROJECT NUMBER	CL22-139			cost per KWH		0.1	Industrial Rate per electricitylocal.com		Spare Parts Annual Budget: Seals, bearings, wear strips, brushes, etc.		Replacement Schedule (years)	Unit cost	Annual Budget for replacement of component	Number of Components Supplied
DESIGN FLOW (Average GPD)	250,000	Operating Parameter at ADF	Unit	Hp	Daily Hours	Daily Cost	Consumables: Oil, Grease, Belts, Filters etc.							
EQUIPMENT	MEMPAC-M250						Item	Cost	Item	Cost				Total
	Membrane CIP Chemicals	$12,340.66	$24,681.31											
	Annual Estimate	$177,728.42	**$355,456.85**											
	Operating Cost per 1,000 gallons of Capacity	$710.91	**$1,421.83**											

PROJECT NAME	West Bonner	DESIGN		ANNUAL COSTS											
PROJECT NUMBER	CL22-139			cost per KWH		0.1	Industrial Rate per electricitylocal.com								
Daily Sum of WAS from Both MEMPAC-M Units	9,000						Consumables: Oil, Grease, Belts, Filters etc.		Spare Parts Annual Budget: Seals, bearings, wear strips, brushes, etc.						
EQUIPMENT	DRYPAC	Operating Parameter at ADF	Unit	Hp	Daily Hours	Daily Cost	Item	Cost	Item	Cost	Replacement Schedule (years)	Unit cost	Annual Budget for replacement of component	Number of Components Supplied	Total
ASSET	PROCESS	Control Process													
Press Feed Flow Meter	Sludge Storage			-	-	-					10	$2,500.00	$250.00	1	$250.00
Level Transducer	Sludge Storage										10	$800.00	$80.00	1	$80.00
ASSET	PROCESS	Mechanical Equipment													
Aeration Blower	Sludge Storage	140	scfm	2.0	8.0	$2.39	Oil and Grease	$0.00	Belt, Filter	$0.00	5	$1,500.00	$300.00	2	$600.00
Transfer Pump	Sludge Storage	20	gpm	2.0	8.0	$1.19	Grease	$25.00	Spare Parts	$500.00	10	$4,650.00	$465.00	1	$465.00
Sludge Press	Sludge Drying	20.0	gpm	3.0	8.0	$1.79			Rebuild Kit/Parts	$1,000.00	20	$85,000.00	$4,250.00	1	$4,250.00
Polymer System	MBR Process		gpm	0.0	0.0	$0.00	Oil and Grease	$50.00	Rebuild Kit/Parts	$500.00	10	$12,000.00	$1,200.00	1	$1,200.00
		Annual Budget		Daily Power Est.		$5.37	Consumables	$75.00	Spare Parts	$2,000.00		Replacement	$6,845.00		

Annual Estimated Power

Percentage of Average (From MEMPAC)	Daily Flow (GPM)	Daily Power Cost	Days	Total
100%	9,000	$5.37	365	$1,960.49
100%	9,000	$5.37	0	$0.00
100%	9,000	$5.37	0	$0.00
100%	9,000	$5.37	0	$0.00
Average Sludge Production	**9,000**	**Total Estimated Power Cost**		**$1,960.49**

Annual Estimated Labor (Hours)

Task		Daily (4 Days)	Weekly	Monthly	Quarterly	Annual	Total
Routine Operations		1.0	2.0				
Required Sampling/Analysis							
Preventative Equipment Maintenance			1.0	2.0	3.0	3.0	
Compliance and Reporting							
Annual Totals		208	120.0	24.0	12.0	3.0	**367**
Hourly Rate	$50.00	**$10,400.00**	**$6,000.00**	**$1,200.00**	**$600.00**	**$150.00**	**$18,350.00**

Annual Estimated Chemical

Chemical	Process	AVG lbs/dry ton	Est. Dry Tons	lbs Polymer	Polymer cost per lb	Total
Polymer	Sludge Dewatering	12	137	1,644	$0.40	$657.53
		Total Estimated Annual CIP Chemical Cost				**$657.53**

Equipment Consumables	$75.00
Equipment Spare Parts	$2,000.00
Equipment Replacement	$6,845.00
Power	$1,960.49
Labor	$18,350.00
Chemicals	$657.53
Annual Estimate	**$29,888.01**

PROJECT NAME	West Bonner	DESIGN		ANNUAL COSTS											
PROJECT NUMBER	CL22-139			cost per KWH		0.1	Industrial Rate per electricitylocal.com								
DESIGN FLOW (Average GPD)	250,000						Consumables: Oil, Grease, Belts, Filters etc.		Spare Parts Annual Budget: Seals, bearings, wear strips, brushes, etc.						
ASSET	PROCESS	Operating Parameter at ADF	Unit	Hp	Daily Hours	Daily Cost	Item	Cost	Item	Cost	Replacement Schedule (years)	Unit cost	Annual Budget for replacement of component	Number of Components Supplied	Total
ASSET	**PROCESS**	**Control Process**													
Effluent Flow Meter	Effluent Disposal			-	-	-					10	$2,500.00	$250.00	1	$250.00
Level Transducer	Effluent Storage										10	$800.00	$80.00	1	$80.00
ASSET	**PROCESS**	**Mechanical Equipment**													
Effluent Pump	Effluent Disposal	400	gpm	10.0	8.0	$11.94	Oil and Grease	$0.00	Spare Parts	$500.00	10	$4,500.00	$450.00	2	$900.00
		Annual Budget		**Daily Power Est.**		**$11.94**	**Consumables**	**$0.00**	**Spare Parts**	**$500.00**		**Replacement**	**$1,230.00**		

Annual Estimated Power

Percentage of Average	Daily Flow (GPM)	Daily Power Cost	Days	Total
100%	250,000	$11.94	365	$4,356.64
100%	250,000	$11.94	0	$0.00
100%	250,000	$11.94	0	$0.00
100%	250,000	$11.94	0	$0.00
			Total Estimated Power Cost	**$4,356.64**

Annual Estimated Labor (Hours)

Task		Daily (4 Days)	Weekly	Monthly	Quarterly	Annual	Total
Routine Operations			0.5				
Required Sampling/Analysis							
Preventative Equipment Maintenance				1.0	1.0	1.0	
Compliance and Reporting							
Annual Totals		0	20.0	12.0	4.0	1.0	**37**
Hourly Rate	$50.00	**$0.00**	**$1,000.00**	**$600.00**	**$200.00**	**$50.00**	**$1,850.00**

Annual Estimated Chemical

Chemical	Process	Volume (Gal)	Cost per Gal	No. of Events	Total
					$0.00
				Total Estimated Annual CIP Chemical Cost	**$0.00**

Equipment Consumables	$0.00
Equipment Spare Parts	$500.00
Equipment Replacement	$1,230.00
Power	$4,356.64
Labor	$1,850.00
Chemicals	$0.00
Annual Estimate	**$7,936.64**

PROJECT NAME	West Bonner	DESIGN		ANNUAL COSTS											
PROJECT NUMBER	CL22-139			cost per KWH		0.1	Industrial Rate per electricitylocal.com		Spare Parts Annual Budget: Seals, bearings, wear strips, brushes, etc.						
Average Daily Sludge	250,000			kW per hr of	Daily						Replacement Schedule	Unit cost	Annual Budget for replacement of	Number of Components	
EQUIPMENT	UV DISINFECTION	Lamps per Unit	kW per Lamp	operation	Hours	Daily Cost			Item	Cost	(years)		component	Supplied	Total
UVLW-30800-24	Disinfection	30	0.8	24.0	20.0	$48.00					15	$110,000.00	$7,333.33	1	$7,333.33
								•	Wiper Rings		1	$34.00	$34.00	20	$680.00
									Quartz Sleeves		8	$414.00	$51.75	30	$1,552.50
									Thimble Support Seals		8	$47.00	$5.88	30	$176.25
									Electronic Ballasts		5	$580.00	$116.00	30	$3,480.00
		Annual Budget		Daily Power Est.		$48.00	Consumables	$0.00	Spare Parts	$0.00	Replacement		$13,222.08		

Annual Estimated Power				
Percentage of Average	Daily Flow (GPM)	Daily Power Cost	Days	Total
100%	250,000	$48.00	365	$17,520.00
100%	250,000	$48.00	0	$0.00
100%	250,000	$48.00	0	$0.00
100%	250,000	$48.00	0	$0.00
			Total Estimated Power Cost	$17,520.00

Annual Estimated Labor (Hours)							
Task		Daily (4 Days)	Weekly	Monthly	Quarterly	Annual	Total
Routine Operations							
Required Sampling/Analysis							
Preventative Equipment Maintenance			2.0				
Compliance and Reporting							
Annual Totals		0	80.0	0.0	0.0	0.0	80
Hourly Rate	$50.00	$0.00	$4,000.00	$0.00	$0.00	$0.00	$4,000.00

Annual Estimated Chemical					
Chemical	Process	Volume (Gal)	Cost per Gal	No. of Events	Total
					$0.00
				Total Estimated Annual CIP Chemical Cost	$0.00

Units Provided with Package	2	Each Unit	Total
	Equipment Consumables	$0.00	$0.00
	Equipment Spare Parts	$0.00	$0.00
	Equipment Replacement	$13,222.08	$26,444.17
	Power	$17,520.00	$35,040.00
	Labor	$4,000.00	$8,000.00
	Chemicals	$0.00	$0.00
	Annual Estimate per UV Unit	$34,742.08	$69,484.17

PROJECT NAME	**West Bonner**
PROJECT NUMBER	**CL22-139**

	MEMPAC	DRYPAC	Effluent Pump	UV	Totals
Equipment Consumables	$1,050.00	$75.00	$0.00	$0.00	$1,125.00
Equipment Spare Parts	$5,200.00	$2,000.00	$500.00	$0.00	$7,700.00
Equipment Replacement	$131,525.90	$6,845.00	$1,230.00	$26,444.17	$166,045.06
Power	$101,999.64	$1,960.49	$4,356.64	$35,040.00	$143,356.77
Labor	$91,000.00	$18,350.00	$1,850.00	$8,000.00	$119,200.00
Chemicals	$24,681.31	$657.53	$0.00	$0.00	$25,338.84
Annual Estimate	**$355,456.85**	**$29,888.01**	**$7,936.64**	**$69,484.17**	**$462,765.67**

Estimate assumes the system is operating at average daily flow 365 days per year.

Appendix I – Gravity-Settling Package Treatment Plant Design Criteria Calculations

AEROMOD®
Wastewater Process Solutions

Sequox® ClarAtor® SR Diffuser Access System

DO optimizer™

Specializing in Custom Designed Wastewater Treatment Facilities

Newport, WA

WWTP Proposal

for

JUB Engineers

October 11, 2023

Aero-Mod, Inc.
7927 U.S. Highway 24
Manhattan, KS 66502 USA
Ph: (785) 537-4995
www.aeromod.com

Aero-Mod, Inc.

EQUIPMENT AND SERVICES COST ESTIMATE

Project:	Newport, WA	***Date:***	11-Oct-23
Engineer:	JUB Engineers	***Units:***	English

EQUIPMENT SUPPLIED

AERATION EQUIPMENT

2	Aeration pd blower/sound enclosure package, 100 HP - 460 V, 3 ph	
4	SEQUOX aeration control butterfly valve, pneumatically-actuated	
2	SEQUOX aeration throttling butterfly valve, gear-operated	
2	SEQUOX aeration control butterfly valve, electrically-actuated	
2	Aeration flow conditioner/flow sensor/SS flanged pipe spool	
32	Wall mounted aeration assembly, Model WA-PF6-2	- First Stage Aeration Basins
32	Wall mounted aeration assembly, Model WA-PS2-2	- Second Stage Aeration Basins

SELECTOR TANK EQUIPMENT

1	Aeration control butterfly valve, pneumatically-actuated
1	Aeration throttling butterfly valve, gear-operated
4	Wall mounted aeration assembly, Model WAD-HSS2A

CLARIFIER & RAS EQUIPMENT

2	Aero-Mod Split-ClarAtor Clarifier System - 800 sf/each

DIGESTION, SLUDGE HOLDING & WAS EQUIPMENT

2	WAS airlift pump, Model AL-600
2	Aeration control butterfly valve, pneumatically-actuated
2	Aeration control butterfly valve, electrically-actuated
2	Aeration flow conditioner/flow sensor/SS flanged pipe spool
18	Wall mounted aeration assembly, Model WAD-PS4-2

ELECTRICAL & CONTROLS EQUIPMENT

1	SEQUOX Process Control Panel w/ Allen Bradley PLC, Model SQC-100 Series - 115 V
2	Blower control panel w/ Allen Bradley 6-pulse VFD - 460 V, 3 ph
2	Air compressor, 2.0 HP with 80 gallon tank & auto-drain - 460 V, 3 ph
1	Air compressor alternation panel - 460 V
1	Regenerative desiccant dryer mounted on 60 gal dry storage tank - 115 V wall outlet
1	D.O. Control System - probe analyzer & sunshield w/ rail-mounted sensor probes

ANCILLARY EQUIPMENT

340	Wall mounted walkway & handrail, LF
2	Wall mounted stop plates & frames 2 SS wall-mounted frames 2 Aluminum stop plates
LS	Spare Parts
LS	Interior tank installation materials - SS brackets, SS bolts, PVC wall inserts, pneumatic tubing, misc.

SERVICES

LS	Freight to jobsite
LS	Aero-Mod equipment dry inspection/equipment start-up & training, two (2) days
LS	Aero-Mod PLC startup & training, two (2) days
LS	Aero-Mod biological training, two (2) days
LS	Operator training school - 2 days at Aero-Mod facilities in Manhattan, KS

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TOTAL EQUIPMENT COST **$1,370,000**

EST'D INSTALLATION of Aero-Mod EQUIPMENT by Contractor $330,000

(Includes Interior Tank PVC Piping)

ESTIMATED CONCRETE TANK COST by Contractor $1,320,000

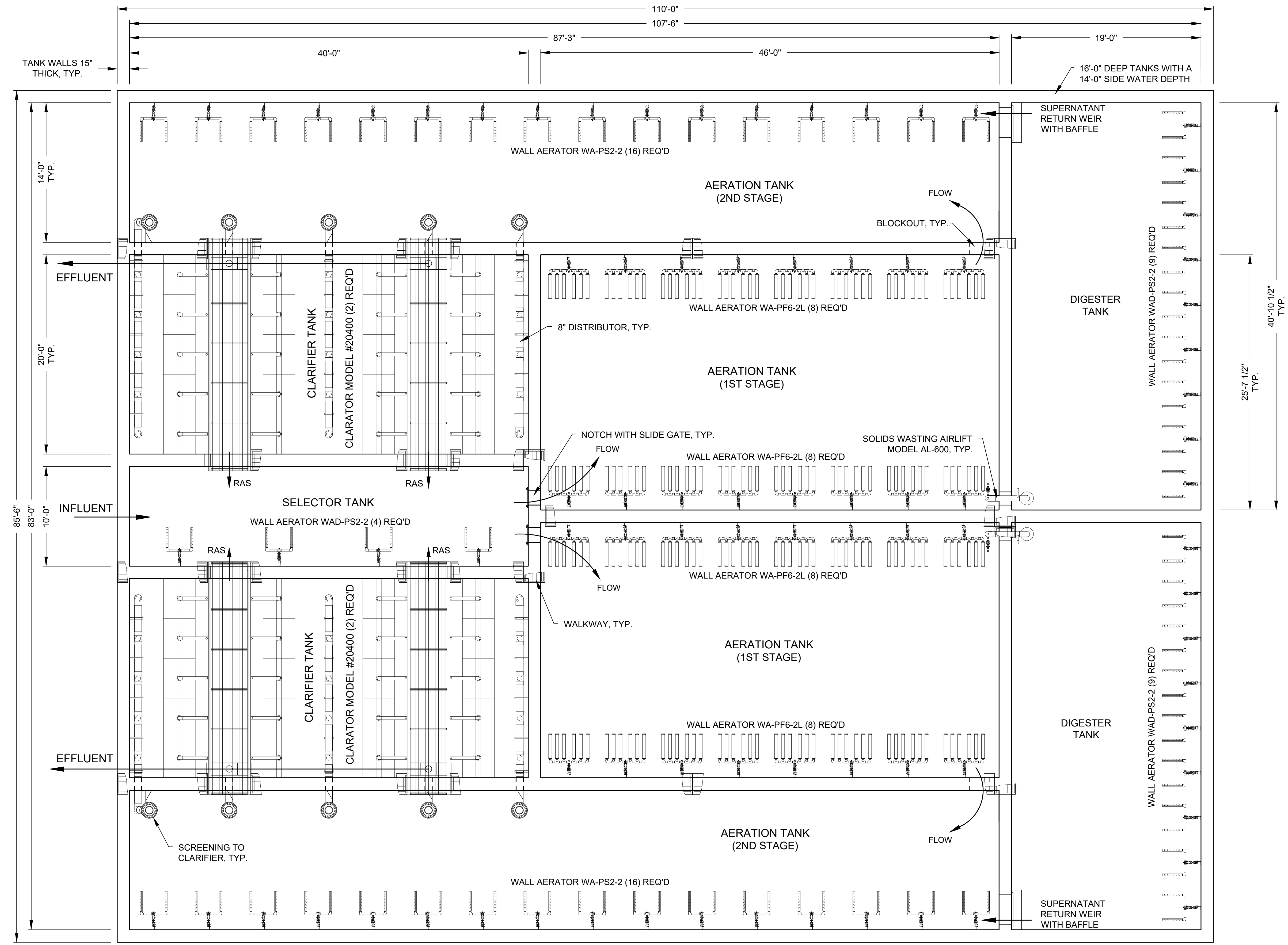
Concrete for Tank Walls, cy	628
Installed Concrete Cost, $/cy	$1,200
Concrete for Tank Slab, cy	544
Installed Concrete Cost, $/cy	$950
Grout for Clarifier Bottom, cy	50
Installed Concrete Cost, $/cy	$850

===========

ESTIMATED COST **$3,020,000**

PLEASE NOTE THE FOLLOWING

1. Buildings, site work, and auxiliary equipment are not included within this estimate.
2. No RAS pump station and associated electrical requirements are required.
3. Yard piping is not required between each Aero-Mod tank.
4. All associated walkways & handrail for the clarifier and tankage are included in the above estimate.
5. This estimate is valid for 90 days from the above date.



Drawn by: JB

Chk by:

Scale: NTS

Date: 10/10/23

Title:

NEWPORT, WASHINGTON
0.5 MGD
WASTE WATER TREATMENT PLANT

Aero - Mod, Inc.

7927 U.S. Highway 24
Manhattan, Kansas 66502

PHONE: (785) 537-4995

Aero-Mod, Inc.

ACTIVATED SLUDGE DESIGN CALCULATIONS

Project:	Newport, WA	***Date:***	11-Oct-23
Engineer:	JUB Engineers	***Units:***	English
Act. Sludge Process:	SEQUOX BNR		

DESIGN CONDITIONS & PARAMETERS

	ADF Influent	Clarifier Effluent
Flow (Q), MGD	**0.500**	
BOD_5, mg/l	**235**	**10.0**
BOD_5, lbs/day	980	41.7
BOD_L, mg/l	344	
TSS, mg/l	**275**	**15.0**
TSS, lbs/day	1,147	62.6
Ammonia-N, mg/l (as TKN)	**45**	**1.0**
Ammonia-N, lbs/day (as TKN	188	4.2
TN, mg/l (assumes rDON < 1.0 mg/l)		**10.0**
TN, lbs/day		41.7
Phosphorus-P, mg/l	6.0	**N/A**
Phosphorus-P, lbs/day	**25**	N/A
Net Alkalinity Loss, mg/l as $CaCO_3$		**(195)**

Aeration Basin	
Retention Time, hours	**24.0**
Aeration Tank Volume, Mgal	0.500
MCRT, days	**20.0**
Wastewater Temperature, ^oC	15
Aerobic Digester	
Volume, % of Aeration Tank	32.0
Maximum Solids Conc., mg/l	12,000
Maximum Solids Conc., %	1.20%
Digester Temperature, ^oC	15
Sludge Holding Tank	
Volume, % of Aeration Tank	0.0
Maximum Solids Conc., mg/l	25,000
Maximum Solids Conc., %	2.50%

PROJECTED OPERATING CONDITIONS - AERATION BASIN

Mixed Liquor Suspended Solids, mg/l		**3,469**
Excess MLSS due to Phos-P Uptake/Removal, mg/l	0	
Mixed Liquor Volatile Suspended Solids, %		71%
F/M Ratio, lbs BOD_5/lb MLVSS		0.10
F/M Ratio, lbs BOD_5/lb MLSS		0.07
Organic Loading, lbs BOD_5/1000 cf of tank/day		14.7
Oxygen Requirements (Carbonaceous), mg/l/hr		9.17
Oxygen Requirements (Nitrogenous), mg/l/hr		8.43
Solids Production, lbs/day		723
WAS - Solids Wasted per Day, lbs/day		661
WAS - Solids Wasted per Day, gal/day @	0.35%	22,838

PROJECTED OPERATING CONDITIONS - AEROBIC DIGESTER

Volatile Solids Loading in Digester, lbs VSS/1,000 cf of tank/day	22
Volatile Solids Reduction in Digester, %	28%
Solids Wasted from Digester, lbs/day	532
Mass Solids Yield in Process & Digester per Mass Influent BOD_5, %	61%
Volume Wasted from Digester, gallons/day	5,312
Digester Sludge Age, days	**30**
Air Required for Stabilization, scfm	196
Air Required for Mixing @ 30 cfm/1000 cf	642

Aero-Mod, Inc.

AERATION DESIGN CALCULATIONS

Project:	Newport, WA	***Date:***	11-Oct-23
Engineer:	JUB Engineers	***Units:***	English
Diffuser Type Used:	Tubular EPDM Fine Bubble		

	Design	Peak		Design	Peak
Q, MGD	0.500	N/A	TKN_o, mg/l	45.0	N/A
BOD_o, mg/l	235	N/A	$TKN_{assimilation}$, mg/l	9.7	N/A
BOD_{rem}, mg/l	235	N/A	TKN_{rem}, mg/l	45.0	N/A
BOD_{rem}, lb/day	980	N/A	TKN_{rem}, lb/day	187.7	N/A
O_2 Requirement, lb O_2/lb BOD_{rem}	1.500		O_2 Requirement, lb O_2/lb TKN_{rem}	4.60	

AERATION REQUIREMENTS - FIRST STAGE

	Design	Peak
Removal in First Stage	70%	70.0%
BOD_{oxy} - Oxygen Required for BOD [Q * BOD_{rem} * 8.34 * O_2 Req. / 24], lbs O_2/hr	42.9	N/A
TKN_{oxy} - Oxygen Required for TKN [Q * TKN_{rem} * 8.34 * O_2 Req. / 24], lbs O_2/hr	25.2	N/A
Actual Oxygenation Rate (AOR), lbs O_2/hr	**68.0**	**N/A**
Standard Oxygenation Rate (SOR), lbs O_2/hr	**172.4**	**N/A**

SOR = [(AOR * $C_{s,20}$) / (α * Θ^$^{(T-20)}$ * (Tau * Ω * β * $C_{s,20}$ - C_L))]

Where:

$C_{s,T,H}$	Actual Value of D.O. Saturation, mg/l	**9.08**	C_L	Residual D.O. Conc., mg/l	**2.0**
$C_{s,20}$	Steady State Value of D.O. Saturation, mg/l	9.08	T	Temperature of Water, °C	**20**
Tau	Oxygen Saturation Value ($C_{s,T,H}$/$C_{s,20}$)	1.000	F		
α	Alpha - Oxygen Transfer Correction Factor for Waste	0.60	Θ	Theta - Oxygen Transfer Coeff	1.024
β	Beta - Salinity-Surface Tension Correction Factor	0.95		Site Elevation, FASL	**2,160**
P_H	Atmospheric Pressure at Site Elevation, psi	13.59	Ω	Omega (P_H/P_s)	0.924

	Design	Peak
Air Requirement = [SOR / (Oxygen Density * TE% * Diffuser Depth) / 60], scfm	**702**	**N/A**

Where:

Oxygen Density, lbs O_2/cf	0.0175	Diffuser Depth Below Water Surface, ft	**13.0**
Transfer Efficiency per Foot of Submergence, %	**1.80%**		

	Design	Peak
Denitrification Credit = [Air Rqmt * (TKN_{oxy} / AOR) * 50% * ((TKN_o - TN_e) / TKN_o)], scfm	101	N/A

Where: TN_e = TKN_o / 2 (assumed when D.O. control is not used)

	Design	Peak
Total Aeration Required in Aeration Basin, scfm	**601**	**N/A**

Air Correction

icfm = scfm / [((T_{std} + 460) / (T_{air} + 460)) * ((P_H - (RH% * SVP_{Tair})) / (14.7 - ($RH\%_{std}$ * SVP_{std}))) * ((P_A / P_H)]

Where:

T_{std}, °F	68	T_{air}	Maximum Air Temperature, °F	**104**
$RH\%_{std}$	36%	RH%	Maximum Relative Humidity, %	**90%**
SVP_{std}, psi	0.34	SVP_{Tair}	Saturated Vapor Pressure of Air @ T_{air}, psi	1.058
		P_A	Actual Atmospheric Pressure after Blower Inlet, psi	13.39

Minimum Air Required for Mixing in First Stage Aeration Basin, cfm	330	Side Roll
Minimum Air Required for Mixing in Second & Third Stage Aeration Basin, cfm	342	Side Roll
Minimum Air Required for Operating Full Plant, cfm (mixing requirement for 24 hrs)	1,029	

	Design	Peak	Design	Peak
Aeration Pressure, in. H_2O			204	204
psi, std (does not include blower inlet/outlet)			**7.4**	**7.4**

		scfm	scfm	icfm	icfm
Aeration Basin - Fine Bubble		601	0	752	0
Aeration Basin - Coarse Bubble		469	0	586	0
Aerobic Digester Tank	(sequenced aeration)	321	0	321	0
Selector Tank		56	0	56	0
Post Aeration Tank		0	0	0	0
Clarifier RAS Airlift Pumps & Skimmers		87	0	87	0
	Total Air Required	1,533		1,802	
	Total Air Available			**2,123**	

POWER REQUIREMENTS

	Unit	Power	Power
Operating Power for Aeration Basin, HP	Blower	64.0	
Operating Power for Digester, HP	Blower	15.4	
Operating Power for Bio-P Fermentation Zone, HP	Blower	2.7	
Operating Power for Post Aeration Tank, HP	Blower	0.0	
Operating Power for Clarifier, HP	Blower	4.2	
Operating Power for Pneumatic System, HP	Air Compr.	0.4	
Operating Power Required at Full Loading, HP		**86.6**	
Minimum Power Required to Operate Full Plant , HP		**49.9**	

Aero-Mod, Inc.

AERATION DESIGN CALCULATIONS

Project:	Newport, WA	***Date:***	11-Oct-23
Engineer:	JUB Engineers	***Units:***	English
Diffuser Type Used:	Stainless Steel Coarse Bubble		

AERATION REQUIREMENTS - SECOND & THIRD STAGE	**Design**	**Peak**
Removal in Second Stage	30%	30.0%
Oxygen Required for BOD [Q * BOD_{rem} * 8.34 * O_2 Req. / 24], lbs O_2/hr	18.4	N/A
Oxygen Required for TKN [Q * TKN_{rem} * 8.34 * O_2 Req. / 24], lbs O_2/hr	10.8	N/A
Actual Oxygenation Rate (AOR), lbs O_2/hr	**29.2**	**N/A**
Standard Oxygenation Rate (SOR), lbs O_2/hr	**59.1**	**N/A**

$$SOR = [(AOR * C_{s,20}) / (\alpha * \Theta^{(T-20)} * (Tau * \Omega * \beta * C_{s,20} - C_L))]$$

Where:

$C_{s,T,H}$	Actual Value of D.O. Saturation, mg/l	9.08	C_L	Residual D.O. Conc, mg/l	**2.0**
$C_{s,20}$	Steady State Value of D.O. Saturation, mg/l	9.08	T	Temperature of Water, °C	20
Tau	Oxygen Saturation Value ($C_{s,T,H}$/$C_{s,20}$)	1.000	F		
α	Alpha - Oxygen Transfer Correction Factor for Waste	0.75	Θ	Theta - Oxygen Transfer Coeffi	1.024
β	Beta - Salinity-Surface Tension Correction Factor	0.95		Site Elevation, FASL	**2,160**
P_H	Atmospheric Pressure at Site Elevation, psi/FASL	13.59	Ω	Omega (P_H/P_s)	0.924

	Design	Peak
Air Requirement = [SOR / (Oxygen Density * TE% * Diffuser Depth) / 60], scfm	**521**	**N/A**

Where:

Oxygen Density, lbs O_2/cf	0.0175	Diffuser Depth Below Water Surface, ft	**13.5**
Transfer Efficiency per Foot of Submergence, %	**0.80%**		

	Design	Peak
Denitrification Credit = [Air Rqmt * (TKN_{oxy} / AOR) * 50% * ((TKN_o - TN_e) / TKN_o)], scfm	53	N/A

Where: TN_e = TKN_o / 2 (assumed when D.O. control is not used)

	Design	Peak
Total Aeration Required in Aeration Basin, scfm	**469**	**N/A**

Air Correction

$$icfm = scfm / [((T_{std} + 460) / (T_{air} + 460)) * ((P_H - (RH\% * SVP_{Tair})) / (14.7 - (RH\%_{std} * SVP_{std}))) * ((P_A / P_H)]$$

Where:

T_{std}, °F	68	T_{air}	Maximum Air Temperature, °F	**104**
$RH\%_{std}$	36%	RH%	Maximum Relative Humidity, %	**90%**
SVP_{std}, psi	0.34	SVP_{Tair}	Saturated Vapor Pressure of Air @ T_{air}, psi	1.058
		P_A	Actual Atmospheric Pressure after Blower Inlet, psi	13.39

	Design	Peak
Minimum Air Required for Mixing in Second & Third Stage Aeration Basin, cfm	342	Side Roll
Aeration Pressure, in. H_2O	189	189
psi, std (does not include blower inlet/outlet)	**6.8**	**6.8**

	Design scfm	**Peak** scfm	**Design** icfm	**Peak** icfm
Aeration Basin - Coarse Bubble	469	0	586	0

Aero-Mod, Inc.

CLARIFIER DESIGN CALCULATIONS

Project:	Newport, WA	***Date:***	11-Oct-23
Engineer:	JUB Engineers	***Units:***	English
Clarifier Type Used:	Split-ClarAtor		

FLOW CONDITIONS

Design Flow, MGD	0.500	
Peaking Factor, hourly	4.20	2.100 MGD
Duration, min	60	
Peaking Factor, sustained	3.00	1.500 MGD
Aeration Tank Volume, Mgal	0.500	
MLSS, mg/l	3,469	
Avg. RAS Recycle Rate, %	150%	

EQUIPMENT SIZING & SELECTION

Number of Clarifiers	**2**	Surface Area per Clarifier, sf	800
Clarifier Unit Model	**20400**	Total Surface Area, sf	**1,600**
Bridge Length, ft	20	Total Weir Length, ft	148
Clarifier Unit Width, ft	20	Tank Wall Depth, ft	16.0
Number of Units per Clarifier	2	Tank Water Depth, ft	14.0

SURFACE OVERFLOW RATE

	ADF	
Design Flow, gpd/sf	**313**	
Peak Day Flow, gpd/sf	938	
Peak Hour Flow, gpd/sf	1,000	* Max allowed to leave clarifier
Max. Flow Allowed Through Clarifier Orifice, gpd/sf	1,000	* Max allowed to leave clarifier

WEIR OVERFLOW RATE

Design Flow, gpd/lin. ft	**3,378**
Peak Flow, gpd/lin. ft	10,811

SOLIDS LOADING RATE

Design Flow, lbs/day/sf	**22.6**
Peak Flow, lbs/day/sf	42.5

RETENTION TIME - including RAS

Design Flow, hr	**3.2**
Peak Flow, hr	1.7

PEAK FLOW HANDLING - IN-BASIN SURGE STORAGE

Hourly Peak Flow, MGD	2.100	Vol. of In-Basin Surge Storage, gal	21,195
Max. Flow Through Clarifier, MGD	1.600	Capacity of Surge Storage, hr.	1.0
Stored Peak Flow, gpm	347		

Peak Hour Capacity, hr. **1.0**

PEAK FLOW HANDLING - SIDE-LINE SURGE TANK

Aero-Mod, Inc.

TANKAGE DESIGN CALCULATIONS

Project:	Newport, WA	***Date:***	11-Oct-23
Engineer:	JUB Engineers	***Units:***	English
Tank Construction:	Cast-in-Place Concrete		

SELECTOR TANK

Anoxic Selector — Volume Required, gal **41,667**

Number of Tanks	1	Tank Length, ft	40.0
Tank Wall Height, ft	16.0	Tank Width, ft	10.0
Tank Water Depth, ft	14.0	Total Volume, gallons	**41,888**
Freeboard, ft	2.0	Retention Time (Forward Flow) min.	121

AERATION TANK — Volume Selected, gal **500,000**

Tank Wall Height, ft	16.0	Number of Trains	2
Tank Water Depth, ft	14.0	Number of Stages	2

Stage 1		*Stage 2*	
Number of Tanks	2	Number of Tanks	2
Tank Length, ft	46.0	Tank Length, ft	87.3
Tank Width, ft	25.625	Tank Width, ft	14.0
Area of Each Tank, sf	1,179	Area of Each Tank, sf	1,222
Total Volume, gallons	**246,877**	Total Volume, gallons	**255,831**

Total volume provided, gal **502,708**

CLARIFIER TANK

Number of Tanks	2	Tank Width, ft	20.0
Tank Wall Height, ft	16.0	Tank Length, ft	40.0
Tank Water Depth, ft	14.0	Total Volume, gallons	**167,552**

AEROBIC DIGESTER TANK — Volume Selected, gal **160,000**

Number of Tanks	2	Tank Length, ft	19.0
Tank Wall Height, ft	16.0	Tank Width, ft	40.875
Tank Water Depth, ft	14.5	Total Volume, gallons	**168,465**

OVERALL TANKAGE DIMENSIONS

Total Length, ft	110.0	Wall Thickness, in	15.0
Total Width, ft	85.50	Floor Thickness, in	18.0
Total Area, sf	9,405	Total Concrete for Walls, cy	**628**
Total Wall Length, LF	847	Total Concrete for Slab, cy	**544**
		Total Grout for Clarifier, cy	**50**

AEROMOD
Wastewater Process Solutions

SEQUOX® Biological Nutrient Removal

Activated Sludge Process Provides Nutrient Removal with High Quality Treatment and Energy Savings

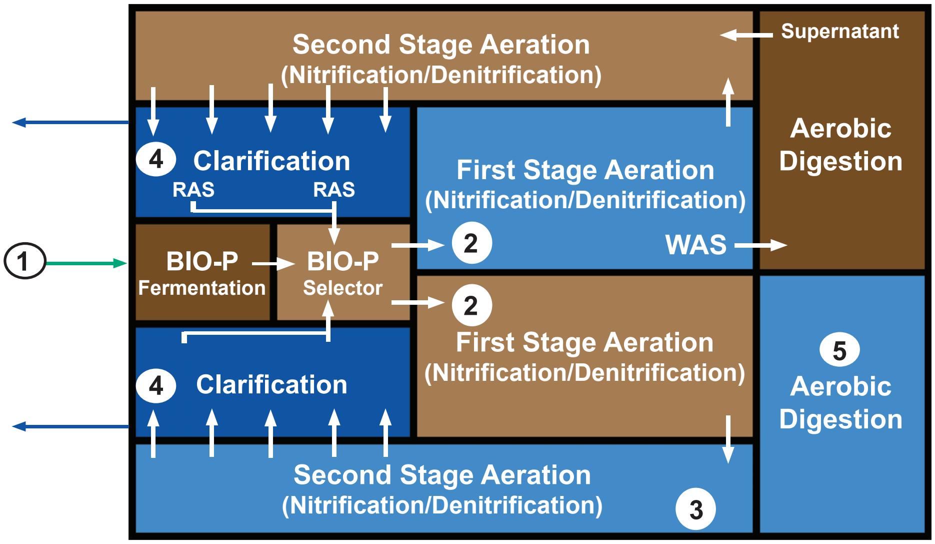
Holton, KS 0.528 MGD

FEATURES

- Biological Nutient Removal
- Plug flow kinetics
- Continuous clarification with sequencing aeration
- Sequential reactions without turning blowers on/off
- Superior energy control
- Operator friendly and low maintenance
- Automatic back-up controls should PLC fail
- Selector tank promotes better settling characteristics
- No moving parts below the water surface

Aero-Mod believes nutrient removal requires energy efficiencies. The SEQUOX® Biological Nutrient Removal Process along with the DOptimizer® control meets this requirement. It is the latest innovation for biological nutrient removal from Aero-Mod. SEQUOX (SEQUential OXidation) offers the benefits of sequencing aeration with plug flow kinetics and the reliability of continuous clarification. Consistent superior effluent quality is achieved with total nitrogen levels as low as 3 mg/L. Phosphorus removal can be achieved by incorporating a fermentor/anaerobic selector and/or chemical addition. The process is energy efficient and has a small footprint. Furthermore, it requires no recycle pumps or mixers.

The SEQUOX® process often incorporates the ClarAtor® clarifier technology which is low-maintenance and operator friendly. Featuring stainless steel and fiberglass components with no moving parts below the water, its unique flow regulation system provides in-basin surge storage. The DOptimizer® control system maximizes energy efficiency by balancing organic demand with mixing energy requirements.



SEQUOX® Biological Nutrient Removal

1 – Flow enters into an **Anoxic- Selector Tank** or **BIO-P Fermentor/Anaerobic Selector Tank,** where the raw sewage is combined with returned activated sludge (RAS) from the clarifiers.

2 – This mixture then flows into the **First Stage Aeration Basins** where the air is sequenced on/off on a 2 hour cycle. During peak organic loadings the DOptimizer controls the alternation of air and can activate both 1st Stage Aeration Basins.

3 – Flow continues into the **Second Stage Aeration Tanks**. The aeration is sequenced on/off on a 2 hour cycle between these two basins. The sequencing of this on/off air is opposite to the 1st Stage Aeration Basins. The end result of the plug flow process with sequential reactions is excellent nitrification/denitrification without having blowers turned on and off nor have dedicated internal recycle pumps and associated mixers in separate anoxic tanks.

The combination of cyclical aeration in the four (4) basins creates excellent aerobic conditions for BOD and ammonia removal when aerating. When the air is off, the nitrate laden MLSS settles and becomes oxygen deprived, creating anoxic conditions for the nitrates to become the oxygen source and allow for denitrification to occur. The plug flow process repeats this cyclical on/off aeration several times as the liquid mass progresses through the SEQUOX® process and on to the clarifier.

4 – The flow then enters the **ClarAtor Clarifier** where the biomass is settled and returned to the Selector Tank. The clarified effluent is withdrawn and discharged.

5 – At regular intervals solids are automatically or manually wasted to an **Aerobic Digester/Aerated Sludge Holding Tank.** Supernatant is simultaneously decanted back to the aeration process over a fixed level weir.

The SEQUOX® process with our innovative DOptimizer control strategy offers optimal energy efficiencies. It has more turn down for under loaded plants than ever before. The control philosophy allows the plant to mimic the actual organic loading coming to it. A plant is driven either in an organically "ACTIVE" mode; or, it is in a mixing "SEMI-ACTIVE" mode; or, it is virtually under no organic load and can "REST". Energy savings is the result of operating the minimum required basins and reducing blower usage for minimum mixing energy, or, no energy as the blowers are turned off in the "REST" mode.

LOAD TUNE YOUR PLANT WITH THE

DOptimizer™

CONTROL STRATEGY

ClarAtor® Clarifier

Combining the SEQUOX process with the ClarAtor clarifier technology offers cost effective compact solution. Other ClarAtor advantages include:

- No moving parts below the water
- Unique ability to regulate effluent flow rate for in-basin surge storage
- Uniform influent distribution and collection
- Stainless steel and fiberglass fabrication
- Rapid and positive sludge withdrawal
- Minimal maintenance

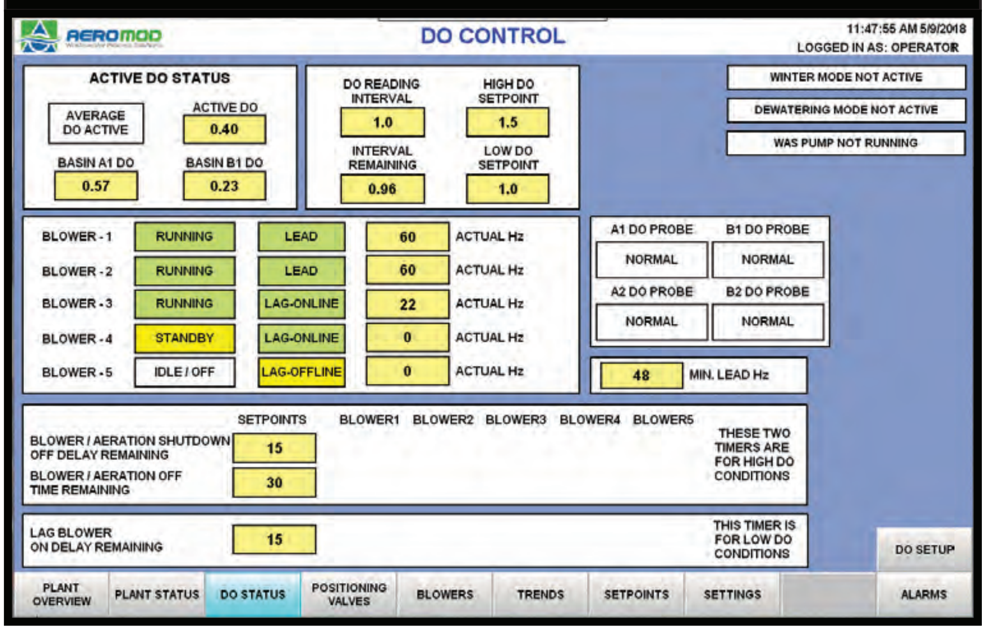
Aero-Mod, Inc. • 7927 U.S. Highway 24, Manhattan, KS 66502 • Phone: 785.537.4995 • Fax: 785.537.0813
www.aeromod.com • aeromod@aeromod.com

DO2ptimizer™ Process Control

Use the SEQUOX® Process and DO$_2$ptimizer™ D.O. Control to "Load-Tune" Your Process

Aero-Mod's SEQUOX® process has a continuous, plug-flow pattern with sequential reactions. Sequential reactions means the aeration basins are aerated intermittently to minimize the mixing requirements to half of the tankage. Sequential reactions also means that with the alternating conditions of aerobic and anoxic, nitrification and denitrification will occur in the aeration basins. Denitrification will reclaim a portion of the oxygen used in nitrification. Use of the DO$_2$ptimizer™ D.O. Control System provides control of the air supplied to the aeration system in the tankage to provide the minimum air necessary for proper treatment and operation. At all times the Dissolved Oxygen (D.O.) level in the aeration basins is monitored, and the proper blower operation is correspondingly controlled. During periods of high loading (organic driven), the blower speed and quantity are adjusted to maintain the D.O. level within a set range. During periods of low loading (mixing driven), the blower speed and quantity are adjusted to maintain mixing intensity while limiting the D.O. to a maximum level. During periods of minimal or no loading (rest), the blowers are turned off to allow the process to "rest". The combination of the SEQUOX Process and the DO$_2$ptimizer D.O. Control System provide a cost-effective way of maintaining the most power-efficient operation of the wastewater treatment plant while achieving Total Nitrogen removal to the lowest levels attainable biologically.

Operator-friendly settings give the operator full control of the process.



- TN levels to lowest achieved biologically
- Mimics/matches actual demand to achieve energy efficiency
- Able to reduce energy consumption over conventional D.O. control
- Operates with energy efficiency even on plants well below design capacity

AEROMOD Wastewater Process Solutions

7927 E. US Highway 24, Manhattan, KS 66502
Phone: (785) 537-4995
www.aeromod.com

ClarAtor® Clarifier Technology

Headache Free Clarifier With No Moving Parts

The ClarAtor clarifier equipment is installed into concrete tankage, utilizing common-wall aeration basin construction, helping to lower capital and construction costs.

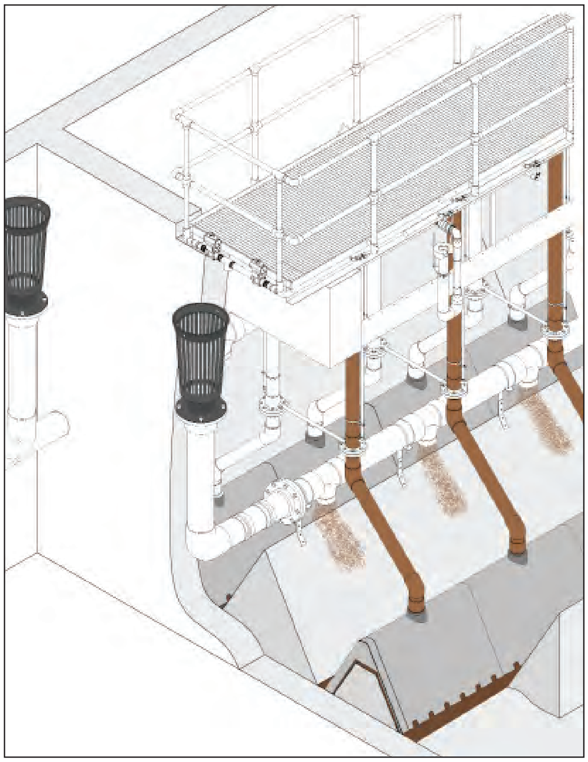
ClarAtor® Clarifier

- No moving parts below the water surface
- No motors, gears or electrical components
- Stainless steel and fiberglass fabrication
- No field welding or painting
- Uniform influent distribution
- Unique ability to regulate effluent flow rate provides in-basin surge storage
- Rapid and positive sludge withdrawal
- Minimal maintenance
- Applicable over a wide range of flows

Aero-Mod's proven ClarAtor® clarifier technology puts the operator in the best position to succeed. It features no moving parts below the water, a uniform distribution of the influent, and a uniform collection of the effluent. It also offers the unique ability to regulate the effluent flow rate. It is applicable to municipal and industrial biological wastewater treatment plants.

This secondary clarifier technology can be used for a wide range of flows (including infiltration and inflow problems) and can be applicable for retrofitting rectangular clarifiers.

The clarifier equipment is typically installed in conjunction with the SEQUOX nutrient removal process. It is installed into concrete tankage that is common wall to the activated sludge process. The equipment is fabricated of stainless steel, fiberglass and associated PVC piping with a bridge that includes grating and aluminum handrails. Typical operator attention required is periodic cleaning of the walkways, skimmers, and effluent discharge weirs. Because no mechanical equipment is below water, maintenance is virtually eliminated.



Distribution and removal system creates the optimal settling environment for wastewater treatment plant clarification. Futhermore, the ClarAtor's unique effluent regulation system allows more flow to enter the plant than is exiting, creating in-basin surge storage.

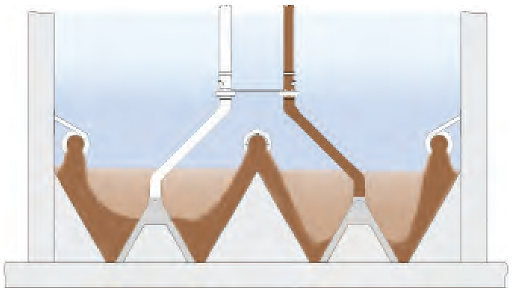
within the basins or in a sideline surge tank. This flow control system limits the upward velocity in the clarifier, producing a better quality effluent with a more regulated flow rate to downstream tertiary treatment or disinfection systems.

With no moving parts under the water and common-wall construction of the process tanks; a complete treatment plant fits in a rectangular configuration. This greatly reduces yard piping, electrical requirements, transfer pump stations and treatment footprint. The end result can be significant savings in capital and maintenance costs.

Settling occurs under ideal conditions because there is not a moving sludge scraper. Settled solids are rapidly removed from the bottom of the clarifier through stationary hydraulic suction hoods evenly spaced across the floor of the clarifier. Airlifts attached to the top of these suction hoods provide the pumping mechanism. The return activated sludge (RAS) rate is controlled by a timer which controls the airlifts in a "minutes on/minutes off" mode. The return activated sludge is discharged back to the selector/aeration tank through the RAS trough on the bridge.

Effluent is evenly withdrawn across the clarifier through submerged launders and discharges through a flow regulation system. This unique system with the ClarAtor technology creates a clarifier able to regulate the effluent flow rate on the downstream end and absorb the excess flow

The hydraulic suction hood assemblies have ports along the bottom of the clarifier to allow solids removal via airlifts evenly spaced along the length of the suctions hoods.



SEQUOX® Process

Combining the ClarAtor Clarifier with the SEQUOX process offers a compact low maintenance plant. Other SEQUOX advantages include:

- Biological nutrient removal
- Continuous clarification with sequencing aeration
- Operator friendly, low mechanical process
- Reduced energy requirements
- Superior effluent quality

SR Diffuser Access System

An Innovative Solution to the Challenge of Diffuser Inspection and Maintenance

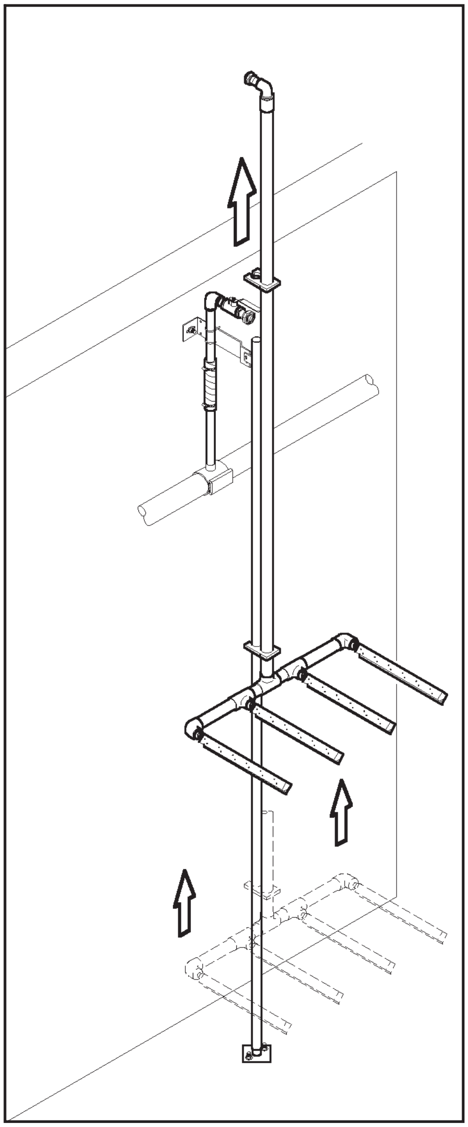
The SR (Slide Rail) Diffuser Access System provides simple removal of the aeration diffusers within a tank without turning off the blowers or draining the tank(s). Applications for the system are typically for aeration or digester basins.

Isolation and air control are provided by a ball valve on each assembly. Removal is achieved by loosening a stainless steel union and lifting up the PVC assembly on guides. Rigidity is provided by a permanently mounted stainless steel slide rail firmly bolted to the tank wall and floor. The result is a low maintenance, operator friendly system for diffuser upkeep.

SR Diffuser Access System

- Lightweight diffuser system
- Provides access to diffusers without turning off the blowers or draining tanks
- Individual isolation and control
- Constructed from long lasting, non-corrodible materials - SS and PVC
- Excellent for retrofits of existing aeration basins
- Eliminates the need for hoist or winching systems
- Provides access to an individual drop pipe without affecting the entire system

Diffuser inspection is easily accomplished without draining the tanks, turning off the blowers, or using a hoist. Diffuser cleaning and maintenance can be performed without affecting the operation of the treatment plant or shutting off other diffuser assemblies.



Typical installations include the tubular type of coarse or fine bubble diffusers. Two to six diffuser assemblies are usually mounted to a common slide rail system.

Installation of the SR Diffuser Access System can include new construction or retrofits to existing mixing or aeration basins. Systems can be designed for "wet installation" in retrofit applications with all hardware mounted above the water.

PVC Drop Pipe

Typically, a two inch schedule 40 PVC pipe is used to transfer air to the diffusers below the surface of the water in the tank. Supports are mounted to the drop pipe that direct the assembly along the guide rail for inspection and maintenance. At the top, a stainless steel union is installed on the pipe that can be easily disconnected for removal of the assembly. Additionally, a stainless steel shut-off throttling ball valve is located at the top of the assembly to isolate the assembly from the air line.

Guide Rail Mounting System

The rigidity needed for operation of the SR Diffuser Access System is provided by the 1.5" stainless steel guide rail. The guide rail is attached to the side of the tank near the top by a stainless steel wall bracket and then secured to the bottom of the tank by a stainless steel floor mounted support.

Diffusers

The SR Diffuser Access System can be used with stainless steel coarse or tubular membrane diffusers. The arrangement of the diffusers per drop pipe is usually two, four or six diffusers in either 12" or 24" diffuser lengths. The number of diffusers and the total number of slide rail assemblies are contingent on the air requirements. This flexible system readily accepts most types of diffusers in varying amounts.

Aero-Mod Treatment

The SR Diffuser Access System is an innovative component of an Aero-Mod wastewater treatment solution. Every Aero-Mod system is custom designed to your exact specifications and features.

- 304 Stainless steel fabrication for long term reliability and reduced maintenance.
- Simple, operator friendly processes and equipment for operational consistency.
- Common-wall, cast-in-place concrete tank construction for easy expansion.