BioWin Process Model Summary Report

Owner: Timpanogos Special Service District
Facility: Timpanogos Wastewater Treatment Plant
Project: 2009 Plant Expansion Project

BACKGROUND

Bowen Collins & Associates developed a computer model to simulate the biological treatment process selected for the 2009 Plant Expansion Project for the Timpanogos Special Service District. The computer model was developed using the BioWin Version 3.0.1.802 software package. The model simulates a steady state condition for the peak month flow and peak month loading conditions for BOD, TSS, TKN, and total phosphorus. This report summarizes the outcome of the process simulation.

DESIGN BASIS

Design Flows

The biological design is based on the design peak month flow rate of 30 MGD. The Timpanogos WWTP has eight (8) process trains that will each receive a proportionate share of the flow (1/8 of the influent flow). The BioWin process model was developed for an individual process train. Therefore, the flow rate modeled is 3.75 MGD (30 MGD divided by 8 trains).

Design Water Quality Parameters

The design water quality parameters and effluent requirements are summarized in Table 1. The influent loading values are based on the design peak month loadings applied to the design peak month flow.

Table 1
Design Water Quality Parameters and Effluent Requirements

Parameter	Influent Value	Effluent Requirement
BOD	210 mg/L	<25 mg/L
TSS	260 mg/L	<25 mg/L
VSS	220 mg/L	-----
TKN	35.7 mg/L	-----
Ammonia-N	24 mg/L	15.7 mg/L
Total Phosphorus	8 mg/L	1 mg/L (Goal)
Alkalinity	313 mg/L as $CaCO_3$	-----
pH	7.8	6.5 – 9.0

Design Assumptions

The modeling of a biological process is a simulation only and relies on a number of assumptions. The most significant assumptions applied to this process model are as follows:

- The BioWin default wastewater fractionation values were applied to specify the influent wastewater characteristics.

- The BioWin default kinetic, stoichiometric, and other parameters were applied.

PROCESS DESIGN SUMMARY

Process Configuration

The existing Timpanogos WWTP is an extended aeration activated sludge plant with eight (8) oxidation ditches. Four of the oxidation ditches, which make up the original East Side trains, use mechanical brush aerators to mix and supply oxygen to the process. The other four oxidation ditches, which make up the newer West Side trains, use mechanical slow speed surface aerators to mix and supply oxygen to the process.

The extended aeration process requires long hydraulic retention times. The basis of design is to change the process design to one using a shorter hydraulic retention time, while also biologically removing nitrogen and phosphorus. The process selected is the three-stage A^2/O process. The existing oxidation ditches will be reconfigured to provide three distinct treatment stages. The first stage will be an anaerobic stage. The raw influent wastewater will be mixed with the RAS flow in the bioreactor splitter box and discharged into the bioreactor. The contents will be mixed by submersible mixers without aerating the contents. The second stage will be an anoxic stage. The flow from the anaerobic stage will be mixed with nitrified mixed liquor from the aerobic third stage to develop an anoxic environment. The contents will be mixed by submersible mixers without aerating the contents. The third stage will be an aerobic (oxic) stage. The contents will be aerated by fine bubble diffusers. Each stage will be divided into multiple zones with baffle walls to reduce back-mixing and to improve treatment efficiencies. The anaerobic and anoxic stages will each be divided into three (3) zones and the oxic stage will be divided in to five (5) zones. The flow schematic is shown in Figure 1.

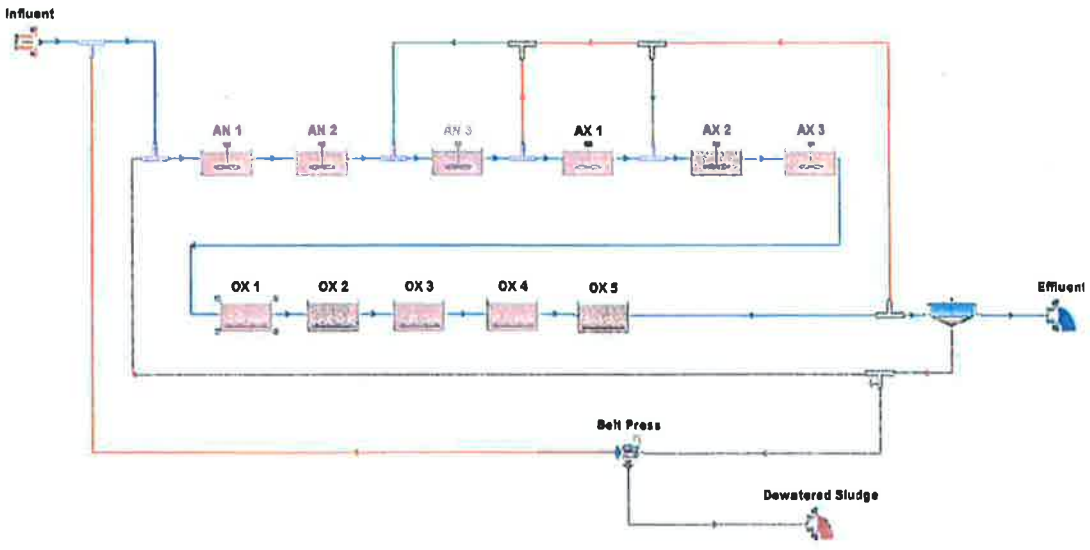


Figure 1
Process Flow Schematic

The A^2/O process configuration provides enhanced biological nutrient removal for both phosphorus and nitrogen, providing that there is a sufficient quantity of carbon in the raw influent. The wastewater characterization of the influent flow suggests that there is not enough available carbon for complete removal of both phosphorus and nitrogen. The design will promote full biological phosphorus removal, with limited denitrification based on remaining available carbon. There is a possibility that nitrates recycled to the anaerobic zone with the RAS flow may inhibit the biological phosphorus removal process. The process design has addressed this concern in four ways. First, the anaerobic stage volume was sized to provide RAS denitrification and fermentation of raw influent. Second, the design provides the ability to increase the anaerobic zone volume by converting anoxic zone volume into anaerobic zone volume if additional detention time is needed. Third, the design includes provisions to add methanol to the mixed liquor recycle piping to add additional carbon for denitrification. Finally, the design includes provisions to convert to the Johannesburg process by constructing new RAS denitrification basins to denitrify the RAS prior to mixing with the raw influent.

Process Volumes

The volumes and peak month design hydraulic retention times for the new process design are summarized in Table 2. The volumes and retention times for the East Side and West Side bioreactors vary slightly due to the differences in the existing tank geometry. Each stage volume is divided into multiple zones separated by fixed baffles to reduce back-mixing and to promote plug flow conditions.

Table 2

East Side and West Side Bioreactor Process Volumes

	East Side Bioreactor			West Side Bioreactor		
Stage	Volume (million gallons)	Side Water Depth (feet)	Hydraulic Retention Time (hours)	Volume (million gallons)	Side Water Depth (feet)	Hydraulic Retention Time (hours)
Anaerobic	0.234	8.5	1.5	0.234	13.0	1.5
Anoxic	0.234	8.5	1.5	0.234	13.0	1.5
Oxic	1.353	8.5	8.7	1.281	13.0	8.2
Total	1.821	-----	11.7	1.749	-----	11.2
Note: The hydraulic retention time is based on the design peak month flow.						

Solids Retention Time

The solids retention time (SRT) was determined by calculating the required aerobic SRT for nitrification at the design temperature of 12°C and multiplying by a safety factor of 1.7. The design solids retention times for the three treatment stages is presented in Table 3.

Table 3
Solids Retention Time

Stage	Solids Retention Time (days)
Anaerobic	1.6
Anoxic	1.6
Oxic	9.1
Total	12.3

Secondary Clarification
The existing Timpanogos WWTP has secondary clarifiers dedicated to the East Side and West Side oxidation ditches. The secondary clarifiers are designed for the current plant flows and are too small for the new design flows. Additional secondary clarifier capacity is included with the project for the East Side and West Side process trains as shown in Table 4. The model was developed to simulate the biological process of one bioreactor out of a total of eight bioreactors. Therefore, the model simulated the equivalent clarifier area, which is one-eighth of the total secondary clarifier area. The side water depths of the existing clarifiers vary from 12 to 14 feet. The new clarifier side water depth is 16 feet. An average side water depth of 14 feet is used in the model.

Table 4
Secondary Clarifier Area

Criteria	East Side	West Side
Diameter Existing	E1: 90 feet E2: 90 feet E3: 110 feet	W1: 80 feet W2: 80 feet W3: 80 feet W4: 80 feet
Diameter New	E4: 130 feet	W5: 140 feet
Total Surface Area	35,500 square feet	35,500 square feet

RAS/WAS Pumping
The RAS pumping system is designed to provide a RAS recycle rate up to 100 percent of the design peak month plant influent flow. The process model is based on recycling 50 percent of the peak month flow.

STEADY STATE PROCESS SIMULATIONS

The steady state computer model for the new Timpanogos WWTP was run to simulate the operation of the biological treatment process under peak month flow and loading conditions. As noted earlier, the default model parameters were used for the simulation.

Effluent Quality

The results of the biological treatment simulation are presented in Table 5. The modeling results indicate that the reactor configuration and sizing are suitable to meet the effluent requirements and goals for the Timpanogos WWTP.

Table 5
Modeled Effluent Quality

Parameter	Influent Value	Predicted Effluent Value	Effluent Requirement
BOD	210 mg/L	2.9 mg/L	<25 mg/L
TSS	260 mg/L	7.8 mg/L	<25 mg/L
VSS	220 mg/L	-----	-----
TKN	35.7 mg/L	2.0 mg/L	-----
Ammonia-N	24 mg/L	0.14 mg/L	15.7 mg/L
Nitrate-N	-----	10.5 mg/L	-----
Total-N	-----	13.0 mg/L	-----
Total Phosphorus	8 mg/L	0.4 mg/L	1 mg/L (Goal)
Alkalinity	313 mg/L as $CaCO_3$	-----	-----
pH	7.8	6.89	6.5 – 9.0

The predicted concentration of phosphorus and nitrogen are presented in Figures 2 and 3, respectively. The phosphorus profile through the basin stages shows the expected phosphorus release in the anaerobic stage, followed by luxury uptake in the aerobic stage (see Figure 2). The model predicts that the soluble phosphorus remaining in the final oxic zone will be 0.06 mg/L. The effluent total phosphorus of 0.41 mg/L includes the phosphorus content of the effluent solids.

The predicted concentration of nitrogen is presented in Figure 3. As expected, the model finds that the available carbon content is too low to fully remove both phosphorus and nitrogen. The predicted effluent nitrate concentration is 10.5 mg/L at a mixed liquor recycle rate of 80% of influent flow. Higher recycle rates were modeled, but denitrification performance was not improved. This finding suggests that nitrogen removal is limited by the remaining amount of available carbon following the anaerobic stage. The bioreactor design includes provisions to add methanol to the mixed liquor recycle piping in the future if lower total nitrogen concentrations are required. The total nitrogen in the effluent is predicted to be 13.0 mg/L including the nitrogenous content of the effluent solids.

Figure 4 presents the pH profile of the basin stages. Based on the model results, it appears that the influent wastewater has sufficient alkalinity for the process to maintain reasonable nitrification rates and to meet effluent permit requirements.

In summary, the process simulation model demonstrates that under the peak month design flow and loading conditions, all of the effluent requirements and goals defined in Table 1 can be achieved.

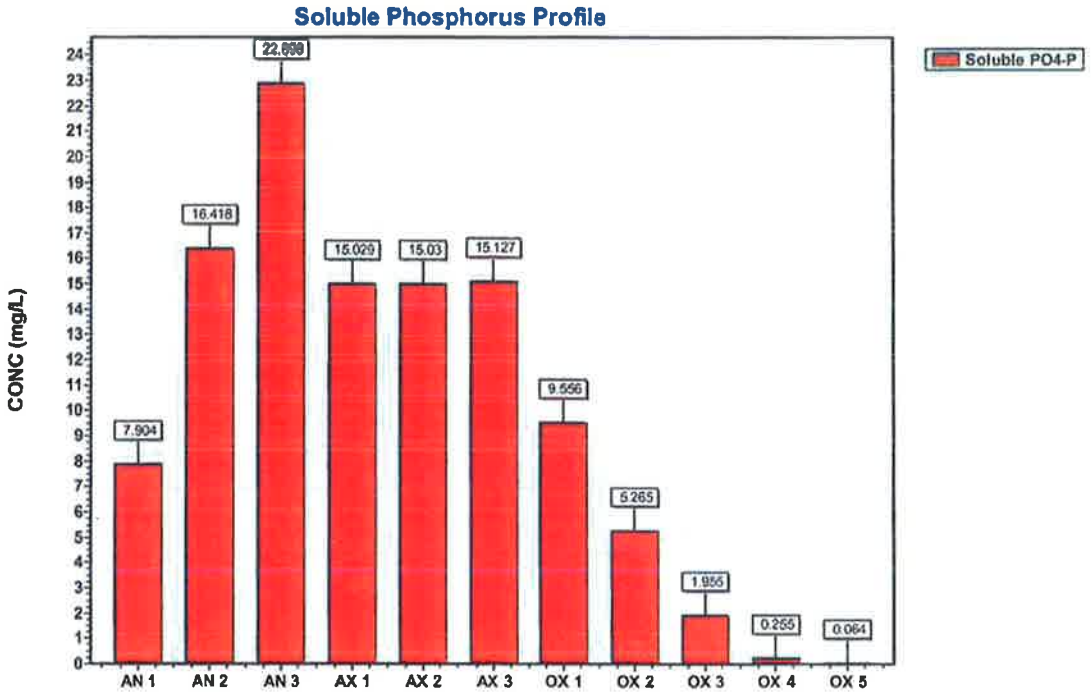


Figure 2
Steady State Phosphorus Profile

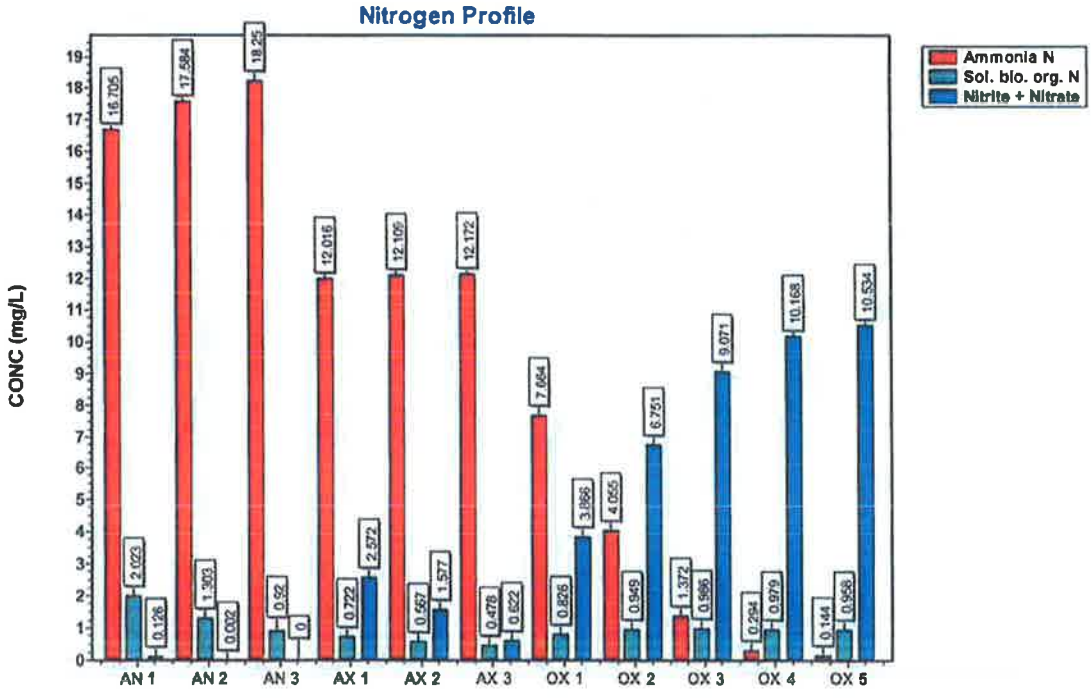


Figure 3

Steady State Nitrogen Profile

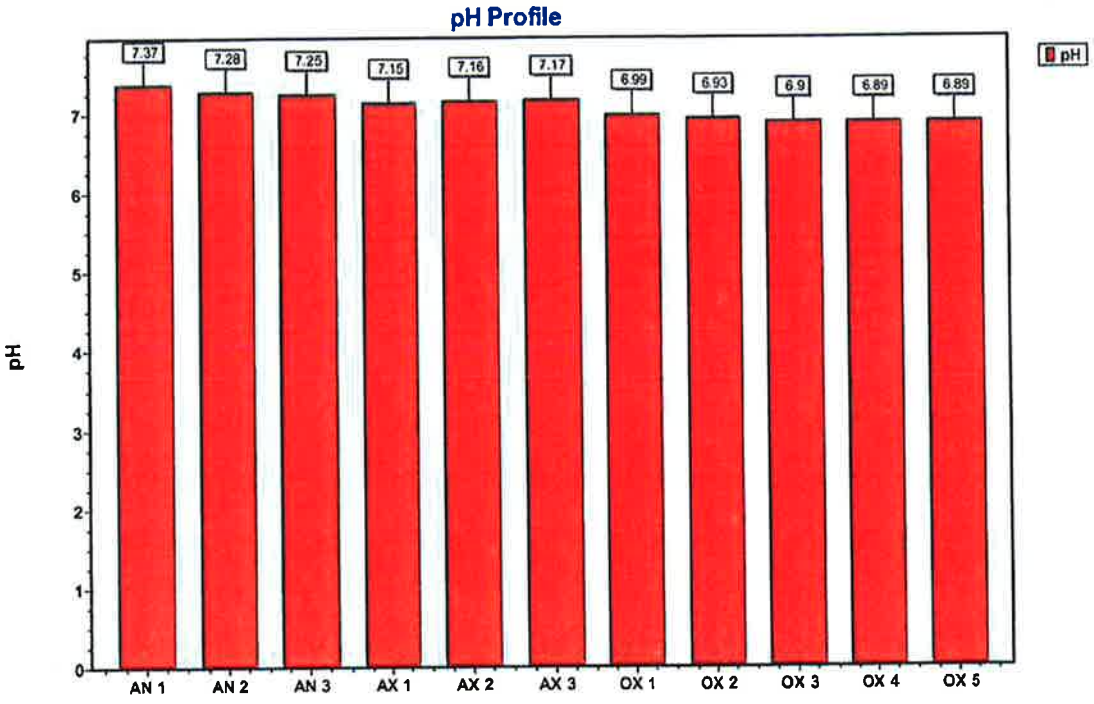


Figure 4
Steady State pH Profile

Observed Yield

The steady state biological process model predicts that each bioreactor will need to waste 5,606 pounds of total suspended solids each day (44,848 lbs TSS/day for the entire plant). The modeled BOD loading was 6,568 lbs/day (210 mg/L at 3.75 MGD). The observed yield of 0.85 lbs TSS/lb BOD was calculated by dividing the waste solids by the BOD loading. This calculation includes the inert suspended solids that pass through the process.

Oxygen Requirement

The process simulation calculates a total oxygen requirement for the biological process of 376 lbs O_2/hr for each bioreactor (3,010 lbs O2/hr for all bioreactors). For a 24-hour period, the total oxygen demand is calculated to be 9,024 lbs O_2/day (72,245 lbs O_2/day for all bioreactors). The total oxygen demand includes the carbonaceous and nitrogenous oxygen demand. Table 6 presents the detailed oxygen demand breakdown.

Table 6 Steady State Oxygen Requirements (All Bioreactors)					
Oxic Zone	Total OUR mgO/L/hr	Carbonaceous OUR mgO/L/hr	Nigrogenous OUR mgO/L/hr	Hourly Oxygen Demand lb O2/hr	Daily Oxygen Demand lb O2/day
OX-1	45.25	26.46	18.79	804	19,303
OX-2	41.86	23.99	17.87	711	17,072
OX-3	35.91	21.16	14.75	638	15,319
OX-4	25.44	18.22	7.22	482	11,565
OX-5	19.90	16.15	3.75	374	8,986
Total	-----	-----	-----	3,010	72,245

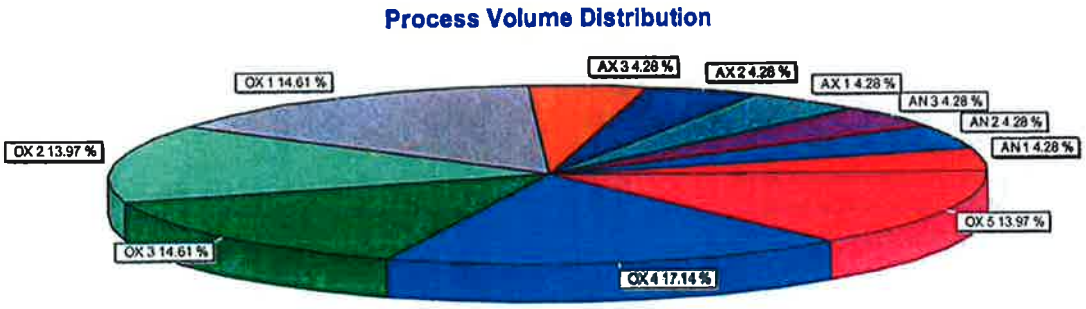
CONCLUSIONS

Based on the biological process simulation, the following conclusions are offered:

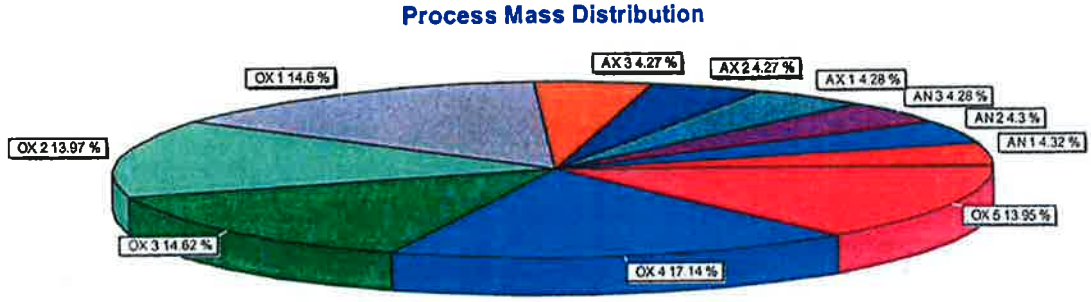
- Under steady state conditions and design peak month flows and loadings, all of the effluent requirements and goals can be met with the A^2/O process configuration.
- There is enough influent BOD to biologically remove phosphorus and some nitrogen.
- The existing oxidation ditches have enough volume to treat a design flow of 30 MGD.

BioWin Model Output

Album page - Vol/Mass



Album page - Vol/Mass



Album page - Influent

Influent			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	220.00	6884.96	
Total suspended solids	260.04	8138.00	
Particulate COD	351.95	11014.32	
Filtered COD	100.57	3147.35	
Total COD	452.52	14161.67	
Soluble PO4-P	4.00	125.18	
Total P	8.00	250.36	
Filtered TKN	28.94	905.82	
Particulate TKN	6.76	211.42	
Total Kjeldahl Nitrogen	35.70	1117.24	
Filtered Carbonaceous BOD	55.05	1722.91	
Total Carbonaceous BOD	210.03	6572.80	
Nitrite + Nitrate	0	0	
Total N	35.70	1117.24	
Total inorganic N	23.56	737.38	
Alkalinity	6.26	88.86	mmol/L and kmol/d
pH	7.80		
Volatile fatty acids	10.86	339.88	
Total precipitated solids	0	0	
Total inorganic suspended solids	40.04	1253.04	
Ammonia N	23.56	737.38	
Nitrate N	0	0	

Album page - Effluent

Effluent			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	5.08	158.90	
Total suspended solids	7.78	243.14	
Particulate COD	7.52	235.07	
Filtered COD	26.38	824.90	
Total COD	33.90	1059.97	
Soluble PO4-P	0.06	1.99	
Total P	0.41	12.84	
Filtered TKN	2.00	62.39	
Particulate TKN	0.43	13.57	
Total Kjeldahl Nitrogen	2.43	75.97	
Filtered Carbonaceous BOD	0.84	26.18	
Total Carbonaceous BOD	2.90	90.76	
Nitrite + Nitrate	10.53	329.36	
Total N	12.96	405.33	
Total inorganic N	10.68	333.86	
Alkalinity	3.86	54.69	mmol/L and kmol/d
pH	6.89		
Volatile fatty acids	0.00	0.01	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	2.69	84.24	
Ammonia N	0.14	4.50	
Nitrate N	10.52	328.86	

Album page - AN 1

AN 1			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	3029.48	142123.86	
Total suspended solids	4564.61	214142.84	
Particulate COD	4499.47	211086.96	
Filtered COD	53.98	2532.63	
Total COD	4553.46	213619.59	
Soluble PO4-P	7.90	370.78	
Total P	201.58	9457.05	
Filtered TKN	19.50	915.00	
Particulate TKN	250.56	11754.82	
Total Kjeldahl Nitrogen	270.07	12669.82	
Filtered Carbonaceous BOD	17.88	838.79	
Total Carbonaceous BOD	1295.70	60786.08	
Nitrite + Nitrate	0.13	5.93	
Total N	270.19	12675.75	
Total inorganic N	16.83	789.62	
Alkalinity	5.80	123.35	mmol/L and kmol/d
pH	7.37		
Volatile fatty acids	2.67	125.23	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1535.14	72018.98	
Ammonia N	16.70	783.69	
Nitrate N	0.08	3.93	

Parameters	**Value**	**Units**
Hydraulic residence time	0.3	hours
Flow	5.62	mgd
MLSS	4564.61	mg/L
Total solids mass	2975.11	lb
Total readily biodegradable COD	25.06	mg/L
Total oxygen uptake rate	2.00	mgO/L/hr
Carbonaceous OUR	1.94	mgO/L/hr
Nitrogenous OUR	0.06	mgO/L/hr
Net. ammonia removal rate	-2.82	mgN/L/hr
Nitrate production rate	0.00	mgN/L/hr
Nitrite production rate	10.27	mgN/L/hr
Nitrate removal rate	10.25	mgN/L/hr
Nitrite removal rate	10.16	mgN/L/hr
Net. nitrate production rate	-10.25	mgN/L/hr
Net. nitrite production rate	0.11	mgN/L/hr
Dissolved N2 gas production rate	10.15	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	3.35	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	7.22	mgN/gVASS/hr
OTE	100.00	%
OTR	0	lb/hr
SOTE	100.00	%
SOTR	0	lb/hr
Air supply rate	0	ft3/min (20C, 1 atm)
Air flow rate / diffuser	0	ft3/min (20C, 1 atm)
# of diffusers	0	
Off gas flow rate (dry)	0.68	ft3/min
Oxygen content	0	%
Carbon dioxide content	42.88	%
Ammonia content	0.04	%
Actual DO sat. conc.	9.78	mg/L

Album page - AN 2

AN 2			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	3031.40	142214.04	
Total suspended solids	4540.62	213017.43	
Particulate COD	4502.73	211239.61	
Filtered COD	49.33	2314.37	
Total COD	4552.06	213553.98	
Soluble PO4-P	16.42	770.24	
Total P	201.58	9457.05	
Filtered TKN	19.67	922.62	
Particulate TKN	250.40	11747.19	
Total Kjeldahl Nitrogen	270.07	12669.81	
Filtered Carbonaceous BOD	8.36	392.20	
Total Carbonaceous BOD	1287.58	60405.07	
Nitrite + Nitrate	0.00	0.11	
Total N	270.07	12669.92	
Total inorganic N	17.59	825.06	
Alkalinity	5.86	124.61	mmol/L and kmol/d
pH	7.28		
Volatile fatty acids	6.79	318.62	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1509.23	70803.39	
Ammonia N	17.58	824.95	
Nitrate N	0.00	0.06	

Parameters	**Value**	**Units**
Hydraulic residence time	0.3	hours
Flow	5.62	mgd
MLSS	4540.62	mg/L
Total solids mass	2959.47	lb
Total readily biodegradable COD	11.82	mg/L
Total oxygen uptake rate	0.00	mgO/L/hr
Carbonaceous OUR	0.00	mgO/L/hr
Nitrogenous OUR	0.00	mgO/L/hr
Net. ammonia removal rate	-2.64	mgN/L/hr
Nitrate production rate	0.00	mgN/L/hr
Nitrite production rate	0.25	mgN/L/hr
Nitrate removal rate	0.25	mgN/L/hr
Nitrite removal rate	0.37	mgN/L/hr
Net. nitrate production rate	-0.25	mgN/L/hr
Net. nitrite production rate	-0.12	mgN/L/hr
Dissolved N2 gas production rate	0.37	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.12	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.26	mgN/gVASS/hr
OTE	100.00	%
OTR	0	lb/hr
SOTE	100.00	%
SOTR	0	lb/hr
Air supply rate	0	ft3/min (20C, 1 atm)
Air flow rate / diffuser	0	ft3/min (20C, 1 atm)
# of diffusers	0	
Off gas flow rate (dry)	1.25	ft3/min
Oxygen content	0	%
Carbon dioxide content	28.71	%
Ammonia content	0.02	%
Actual DO sat. conc.	9.78	mg/L

Album page - AN 3

AN 3			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	3029.78	142139.00	
Total suspended solids	4519.37	212021.66	
Particulate COD	4500.53	211137.47	
Filtered COD	49.98	2344.71	
Total COD	4550.51	213482.18	
Soluble PO4-P	22.90	1074.25	
Total P	201.58	9457.10	
Filtered TKN	19.95	936.00	
Particulate TKN	250.11	11733.85	
Total Kjeldahl Nitrogen	270.07	12669.86	
Filtered Carbonaceous BOD	4.52	212.15	
Total Carbonaceous BOD	1282.21	60153.36	
Nitrite + Nitrate	0.00	0.00	
Total N	270.07	12669.86	
Total inorganic N	18.25	856.19	
Alkalinity	5.91	125.68	mmol/L and kmol/d
pH	7.25		
Volatile fatty acids	4.52	211.92	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1489.59	69882.66	
Ammonia N	18.25	856.19	
Nitrate N	0.00	0.00	

Parameters	**Value**	**Units**
Hydraulic residence time	0.3	hours
Flow	5.62	mgd
MLSS	4519.37	mg/L
Total solids mass	2945.62	lb
Total readily biodegradable COD	6.40	mg/L
Total oxygen uptake rate	0.00	mgO/L/hr
Carbonaceous OUR	0.00	mgO/L/hr
Nitrogenous OUR	0.00	mgO/L/hr
Net. ammonia removal rate	-2.00	mgN/L/hr
Nitrate production rate	0.00	mgN/L/hr
Nitrite production rate	0.00	mgN/L/hr
Nitrate removal rate	0.00	mgN/L/hr
Nitrite removal rate	0.01	mgN/L/hr
Net. nitrate production rate	0.00	mgN/L/hr
Net. nitrite production rate	0.00	mgN/L/hr
Dissolved N2 gas production rate	0.01	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.00	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.01	mgN/gVASS/hr
OTE	100.00	%
OTR	0	lb/hr
SOTE	100.00	%
SOTR	0	lb/hr
Air supply rate	0	ft3/min (20C, 1 atm)
Air flow rate / diffuser	0	ft3/min (20C, 1 atm)
# of diffusers	0	
Off gas flow rate (dry)	1.61	ft3/min
Oxygen content	0	%
Carbon dioxide content	23.38	%
Ammonia content	0.01	%
Actual DO sat. conc.	9.78	mg/L

Album page - AX 1

AX 1			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	3001.89	215984.73	
Total suspended solids	4517.68	325045.51	
Particulate COD	4452.60	320362.97	
Filtered COD	39.01	2806.57	
Total COD	4491.61	323169.54	
Soluble PO4-P	15.03	1081.36	
Total P	201.58	14503.89	
Filtered TKN	13.56	975.61	
Particulate TKN	250.97	18057.01	
Total Kjeldahl Nitrogen	264.53	19032.62	
Filtered Carbonaceous BOD	1.38	99.48	
Total Carbonaceous BOD	1250.91	90002.72	
Nitrite + Nitrate	2.57	185.06	
Total N	267.10	19217.68	
Total inorganic N	14.59	1049.59	
Alkalinity	5.28	172.41	mmol/L and kmol/d
pH	7.15		
Volatile fatty acids	0.26	18.96	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1515.79	109060.78	
Ammonia N	12.02	864.54	
Nitrate N	2.32	166.95	

Parameters	**Value**	**Units**
Hydraulic residence time	0.2	hours
Flow	8.62	mgd
MLSS	4517.68	mg/L
Total solids mass	2944.52	lb
Total readily biodegradable COD	1.96	mg/L
Total oxygen uptake rate	3.19	mgO/L/hr
Carbonaceous OUR	2.79	mgO/L/hr
Nitrogenous OUR	0.40	mgO/L/hr
Net. ammonia removal rate	-0.30	mgN/L/hr
Nitrate production rate	0.04	mgN/L/hr
Nitrite production rate	6.31	mgN/L/hr
Nitrate removal rate	6.20	mgN/L/hr
Nitrite removal rate	5.18	mgN/L/hr
Net. nitrate production rate	-6.16	mgN/L/hr
Net. nitrite production rate	1.13	mgN/L/hr
Dissolved N2 gas production rate	5.14	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	1.71	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	3.63	mgN/gVASS/hr
OTE	100.00	%
OTR	0	lb/hr
SOTE	100.00	%
SOTR	0	lb/hr
Air supply rate	0	ft3/min (20C, 1 atm)
Air flow rate / diffuser	0	ft3/min (20C, 1 atm)
# of diffusers	0	
Off gas flow rate (dry)	1.28	ft3/min
Oxygen content	0	%
Carbon dioxide content	34.77	%
Ammonia content	0.01	%
Actual DO sat. conc.	9.78	mg/L

Album page - AX 2

AX 2			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	3000.34	215874.12	
Total suspended solids	4516.15	324936.42	
Particulate COD	4450.11	320184.92	
Filtered COD	38.01	2734.61	
Total COD	4488.12	322919.52	
Soluble PO4-P	15.03	1081.39	
Total P	201.58	14503.95	
Filtered TKN	13.50	971.26	
Particulate TKN	251.03	18061.41	
Total Kjeldahl Nitrogen	264.53	19032.67	
Filtered Carbonaceous BOD	1.04	74.51	
Total Carbonaceous BOD	1249.07	89870.39	
Nitrite + Nitrate	1.58	113.44	
Total N	266.10	19146.11	
Total inorganic N	13.69	984.64	
Alkalinity	5.36	174.97	mmol/L and kmol/d
pH	7.16		
Volatile fatty acids	0.04	2.82	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1515.81	109062.29	
Ammonia N	12.11	871.21	
Nitrate N	1.29	93.13	
Parameters	**Value**	**Units**	
Hydraulic residence time	0.2	hours	
Flow	8.62	mgd	
MLSS	4516.15	mg/L	
Total solids mass	2943.52	lb	
Total readily biodegradable COD	1.47	mg/L	
Total oxygen uptake rate	0.04	mgO/L/hr	
Carbonaceous OUR	0.03	mgO/L/hr	
Nitrogenous OUR	0.01	mgO/L/hr	
Net. ammonia removal rate	-0.43	mgN/L/hr	
Nitrate production rate	0.00	mgN/L/hr	
Nitrite production rate	4.72	mgN/L/hr	
Nitrate removal rate	4.72	mgN/L/hr	
Nitrite removal rate	4.58	mgN/L/hr	
Net. nitrate production rate	-4.72	mgN/L/hr	
Net. nitrite production rate	0.14	mgN/L/hr	
Dissolved N2 gas production rate	4.58	mgN/L/hr	
Spec. dissolved N2 gas production rate per VSS	1.53	mgN/gVSS/hr	
Spec. dissolved N2 gas production per VASS	3.23	mgN/gVASS/hr	
OTE	100.00	%	
OTR	0	lb/hr	
SOTE	100.00	%	
SOTR	0	lb/hr	
Air supply rate	0	ft3/min (20C, 1 atm)	
Air flow rate / diffuser	0	ft3/min (20C, 1 atm)	
# of diffusers	0		
Off gas flow rate (dry)	1.27	ft3/min	
Oxygen content	0	%	
Carbon dioxide content	34.68	%	
Ammonia content	0.01	%	
Actual DO sat. conc.	9.78	mg/L	

Album page - AX 3

AX 3			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	2998.47	215739.38	
Total suspended solids	4514.02	324783.01	
Particulate COD	4447.14	319970.99	
Filtered COD	37.78	2718.38	
Total COD	4484.92	322689.37	
Soluble PO4-P	15.13	1088.36	
Total P	201.58	14503.95	
Filtered TKN	13.48	969.59	
Particulate TKN	251.05	18063.10	
Total Kjeldahl Nitrogen	264.53	19032.68	
Filtered Carbonaceous BOD	1.18	84.89	
Total Carbonaceous BOD	1247.45	89754.10	
Nitrite + Nitrate	0.62	44.73	
Total N	265.15	19077.41	
Total inorganic N	12.79	920.53	
Alkalinity	5.43	177.32	mmol/L and kmol/d
pH	7.17		
Volatile fatty acids	0.07	4.77	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1515.55	109043.63	
Ammonia N	12.17	875.81	
Nitrate N	0.44	31.68	

Parameters	**Value**	**Units**
Hydraulic residence time	0.2	hours
Flow	8.62	mgd
MLSS	4514.02	mg/L
Total solids mass	2942.13	lb
Total readily biodegradable COD	1.67	mg/L
Total oxygen uptake rate	0.01	mgO/L/hr
Carbonaceous OUR	0.01	mgO/L/hr
Nitrogenous OUR	0.00	mgO/L/hr
Net. ammonia removal rate	-0.29	mgN/L/hr
Nitrate production rate	0.00	mgN/L/hr
Nitrite production rate	3.93	mgN/L/hr
Nitrate removal rate	3.93	mgN/L/hr
Nitrite removal rate	4.39	mgN/L/hr
Net. nitrate production rate	-3.93	mgN/L/hr
Net. nitrite production rate	-0.46	mgN/L/hr
Dissolved N2 gas production rate	4.39	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	1.46	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	3.10	mgN/gVASS/hr
OTE	100.00	%
OTR	0	lb/hr
SOTE	100.00	%
SOTR	0	lb/hr
Air supply rate	0	ft3/min (20C, 1 atm)
Air flow rate / diffuser	0	ft3/min (20C, 1 atm)
# of diffusers	0	
Off gas flow rate (dry)	1.26	ft3/min
Oxygen content	0	%
Carbon dioxide content	34.57	%
Ammonia content	0.01	%
Actual DO sat. conc.	9.78	mg/L

Album page - OX 1

OX 1			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	2987.44	214946.21	
Total suspended solids	4521.06	325289.56	
Particulate COD	4427.32	318545.20	
Filtered COD	27.90	2007.33	
Total COD	4455.22	320552.54	
Soluble PO4-P	9.56	687.59	
Total P	201.58	14503.95	
Filtered TKN	9.33	671.18	
Particulate TKN	251.82	18118.74	
Total Kjeldahl Nitrogen	261.15	18789.92	
Filtered Carbonaceous BOD	1.47	105.55	
Total Carbonaceous BOD	1236.76	88984.63	
Nitrite + Nitrate	3.87	278.14	
Total N	265.02	19068.05	
Total inorganic N	11.53	829.54	
Alkalinity	4.88	159.28	mmol/L and kmol/d
pH	6.99		
Volatile fatty acids	0.00	0.17	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1533.61	110343.36	
Ammonia N	7.66	551.40	
Nitrate N	3.07	220.78	

Parameters	**Value**	**Units**
Hydraulic residence time	0.7	hours
Flow	8.62	mgd
MLSS	4521.06	mg/L
Total solids mass	10051.28	lb
Total readily biodegradable COD	2.08	mg/L
Total oxygen uptake rate	45.25	mgO/L/hr
Carbonaceous OUR	26.46	mgO/L/hr
Nitrogenous OUR	18.79	mgO/L/hr
Net. ammonia removal rate	6.08	mgN/L/hr
Nitrate production rate	3.69	mgN/L/hr
Nitrite production rate	4.69	mgN/L/hr
Nitrate removal rate	0.15	mgN/L/hr
Nitrite removal rate	3.86	mgN/L/hr
Net. nitrate production rate	3.54	mgN/L/hr
Net. nitrite production rate	0.83	mgN/L/hr
Dissolved N2 gas production rate	0.17	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.06	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.12	mgN/gVASS/hr
OTE	7.41	%
OTR	106.60	lb/hr
SOTE	22.80	%
SOTR	320.74	lb/hr
Air supply rate	1378.87	ft3/min (20C, 1 atm)
Air flow rate / diffuser	0.47	ft3/min (20C, 1 atm)
# of diffusers	2915.00	
Off gas flow rate (dry)	1347.98	ft3/min
Oxygen content	19.30	%
Carbon dioxide content	1.00	%
Ammonia content	0.00	%
Actual DO sat. conc.	9.75	mg/L

Album page - OX 2

OX 2			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	2978.12	214275.10	
Total suspended solids	4525.73	325625.57	
Particulate COD	4410.76	317353.94	
Filtered COD	26.61	1914.94	
Total COD	4437.38	319268.88	
Soluble PO4-P	5.27	378.85	
Total P	201.58	14503.95	
Filtered TKN	5.85	421.27	
Particulate TKN	252.30	18152.86	
Total Kjeldahl Nitrogen	258.15	18574.12	
Filtered Carbonaceous BOD	1.29	92.84	
Total Carbonaceous BOD	1227.21	88297.76	
Nitrite + Nitrate	6.75	485.75	
Total N	264.90	19059.87	
Total inorganic N	10.81	777.50	
Alkalinity	4.42	144.13	mmol/L and kmol/d
pH	6.93		
Volatile fatty acids	0.00	0.06	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1547.61	111350.46	
Ammonia N	4.05	291.74	
Nitrate N	5.65	406.49	

Parameters	**Value**	**Units**
Hydraulic residence time	0.7	hours
Flow	8.62	mgd
MLSS	4525.73	mg/L
Total solids mass	9619.77	lb
Total readily biodegradable COD	1.83	mg/L
Total oxygen uptake rate	41.86	mgO/L/hr
Carbonaceous OUR	23.99	mgO/L/hr
Nitrogenous OUR	17.87	mgO/L/hr
Net. ammonia removal rate	5.09	mgN/L/hr
Nitrate production rate	3.78	mgN/L/hr
Nitrite production rate	4.38	mgN/L/hr
Nitrate removal rate	0.14	mgN/L/hr
Nitrite removal rate	3.95	mgN/L/hr
Net. nitrate production rate	3.64	mgN/L/hr
Net. nitrite production rate	0.43	mgN/L/hr
Dissolved N2 gas production rate	0.16	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.05	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.11	mgN/gVASS/hr
OTE	6.08	%
OTR	88.99	lb/hr
SOTE	18.71	%
SOTR	267.75	lb/hr
Air supply rate	1402.48	ft3/min (20C, 1 atm)
Air flow rate / diffuser	1.07	ft3/min (20C, 1 atm)
# of diffusers	1314.00	
Off gas flow rate (dry)	1364.40	ft3/min
Oxygen content	19.67	%
Carbon dioxide content	1.19	%
Ammonia content	0.00	%
Actual DO sat. conc.	9.75	mg/L

Album page - OX 3

OX 3			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	2969.28	213639.55	
Total suspended solids	4527.80	325774.45	
Particulate COD	4395.47	316253.41	
Filtered COD	26.38	1897.89	
Total COD	4421.84	318151.30	
Soluble PO4-P	1.95	140.64	
Total P	201.58	14503.95	
Filtered TKN	3.22	231.87	
Particulate TKN	252.51	18168.14	
Total Kjeldahl Nitrogen	255.73	18400.01	
Filtered Carbonaceous BOD	1.10	79.45	
Total Carbonaceous BOD	1218.10	87642.16	
Nitrite + Nitrate	9.07	652.68	
Total N	264.80	19052.69	
Total inorganic N	10.44	751.39	
Alkalinity	4.06	132.40	mmol/L and kmol/d
pH	6.90		
Volatile fatty acids	0.00	0.04	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1558.51	112134.91	
Ammonia N	1.37	98.71	
Nitrate N	8.31	598.22	
Parameters	**Value**	**Units**	
Hydraulic residence time	0.7	hours	
Flow	8.62	mgd	
MLSS	4527.80	mg/L	
Total solids mass	10066.27	lb	
Total readily biodegradable COD	1.56	mg/L	
Total oxygen uptake rate	35.91	mgO/L/hr	
Carbonaceous OUR	21.16	mgO/L/hr	
Nitrogenous OUR	14.75	mgO/L/hr	
Net. ammonia removal rate	3.62	mgN/L/hr	
Nitrate production rate	3.73	mgN/L/hr	
Nitrite production rate	3.44	mgN/L/hr	
Nitrate removal rate	0.14	mgN/L/hr	
Nitrite removal rate	3.90	mgN/L/hr	
Net. nitrate production rate	3.59	mgN/L/hr	
Net. nitrite production rate	-0.46	mgN/L/hr	
Dissolved N2 gas production rate	0.13	mgN/L/hr	
Spec. dissolved N2 gas production rate per VSS	0.05	mgN/gVSS/hr	
Spec. dissolved N2 gas production per VASS	0.09	mgN/gVASS/hr	
OTE	5.67	%	
OTR	79.85	lb/hr	
SOTE	17.44	%	
SOTR	240.25	lb/hr	
Air supply rate	1349.90	ft3/min (20C, 1 atm)	
Air flow rate / diffuser	1.38	ft3/min (20C, 1 atm)	
# of diffusers	975.00		
Off gas flow rate (dry)	1312.52	ft3/min	
Oxygen content	19.77	%	
Carbon dioxide content	1.16	%	
Ammonia content	0.00	%	
Actual DO sat. conc.	9.75	mg/L	

Album page - OX 4

OX 4			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	2959.90	212964.20	
Total suspended solids	4524.32	325524.40	
Particulate COD	4379.79	315125.15	
Filtered COD	26.34	1895.47	
Total COD	4406.13	317020.62	
Soluble PO4-P	0.26	18.36	
Total P	201.58	14503.95	
Filtered TKN	2.15	155.02	
Particulate TKN	252.44	18162.85	
Total Kjeldahl Nitrogen	254.59	18317.87	
Filtered Carbonaceous BOD	0.94	67.46	
Total Carbonaceous BOD	1208.35	86940.95	
Nitrite + Nitrate	10.17	731.58	
Total N	264.76	19049.45	
Total Inorganic N	10.46	752.76	
Alkalinity	3.90	127.19	mmol/L and kmol/d
pH	6.89		
Volatile fatty acids	0.00	0.03	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1564.42	112560.20	
Ammonia N	0.29	21.19	
Nitrate N	10.10	726.79	
Parameters	**Value**	**Units**	
Hydraulic residence time	0.9	hours	
Flow	8.62	mgd	
MLSS	4524.32	mg/L	
Total solids mass	11802.93	lb	
Total readily biodegradable COD	1.33	mg/L	
Total oxygen uptake rate	25.44	mgO/L/hr	
Carbonaceous OUR	18.22	mgO/L/hr	
Nitrogenous OUR	7.22	mgO/L/hr	
Net. ammonia removal rate	1.24	mgN/L/hr	
Nitrate production rate	2.27	mgN/L/hr	
Nitrite production rate	1.60	mgN/L/hr	
Nitrate removal rate	0.21	mgN/L/hr	
Nitrite removal rate	2.40	mgN/L/hr	
Net. nitrate production rate	2.05	mgN/L/hr	
Net. nitrite production rate	-0.79	mgN/L/hr	
Dissolved N2 gas production rate	0.05	mgN/L/hr	
Spec. dissolved N2 gas production rate per VSS	0.02	mgN/gVSS/hr	
Spec. dissolved N2 gas production per VASS	0.04	mgN/gVASS/hr	
OTE	5.06	%	
OTR	66.36	lb/hr	
SOTE	15.58	%	
SOTR	199.66	lb/hr	
Air supply rate	1255.70	ft3/min (20C, 1 atm)	
Air flow rate / diffuser	2.05	ft3/min (20C, 1 atm)	
# of diffusers	613.00		
Off gas flow rate (dry)	1220.63	ft3/min	
Oxygen content	19.90	%	
Carbon dioxide content	1.02	%	
Ammonia content	0.00	%	
Actual DO sat. conc.	9.75	mg/L	

Album page - OX 5

OX 5			
Parameters	**Conc. (mg/L)**	**Mass rate (lb/d)**	**Notes**
Volatile suspended solids	2952.83	212455.72	
Total suspended solids	4518.29	325090.89	
Particulate COD	4368.33	314300.62	
Filtered COD	26.38	1898.27	
Total COD	4394.71	316198.89	
Soluble PO4-P	0.06	4.59	
Total P	201.58	14503.95	
Filtered TKN	2.00	143.58	
Particulate TKN	252.22	18147.12	
Total Kjeldahl Nitrogen	254.21	18290.70	
Filtered Carbonaceous BOD	0.84	60.24	
Total Carbonaceous BOD	1201.01	86412.88	
Nitrite + Nitrate	10.53	757.94	
Total N	264.75	19048.64	
Total inorganic N	10.68	768.29	
Alkalinity	3.86	125.84	mmol/L and kmol/d
pH	6.89		
Volatile fatty acids	0.00	0.02	
Total precipitated solids	0	0.00	
Total inorganic suspended solids	1565.47	112635.17	
Ammonia N	0.14	10.35	
Nitrate N	10.52	756.78	

Parameters	**Value**	**Units**
Hydraulic residence time	0.7	hours
Flow	8.62	mgd
MLSS	4518.29	mg/L
Total solids mass	9603.97	lb
Total readily biodegradable COD	1.19	mg/L
Total oxygen uptake rate	19.90	mgO/L/hr
Carbonaceous OUR	16.15	mgO/L/hr
Nitrogenous OUR	3.75	mgO/L/hr
Net. ammonia removal rate	0.21	mgN/L/hr
Nitrate production rate	0.95	mgN/L/hr
Nitrite production rate	0.95	mgN/L/hr
Nitrate removal rate	0.36	mgN/L/hr
Nitrite removal rate	1.02	mgN/L/hr
Net. nitrate production rate	0.59	mgN/L/hr
Net. nitrite production rate	-0.07	mgN/L/hr
Dissolved N2 gas production rate	0.02	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.01	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.01	mgN/gVASS/hr
OTE	5.07	%
OTR	42.30	lb/hr
SOTE	15.61	%
SOTR	127.28	lb/hr
Air supply rate	798.97	ft3/min (20C, 1 atm)
Air flow rate / diffuser	1.90	ft3/min (20C, 1 atm)
# of diffusers	420.00	
Off gas flow rate (dry)	776.62	ft3/min
Oxygen content	19.90	%
Carbon dioxide content	1.02	%
Ammonia content	0.00	%
Actual DO sat. conc.	9.75	mg/L

E4. Were any of the following alternatives feasible and affordable?

Alternative	Feasible	Reason Not Feasible/Affordable
Pollutant Trading	No	Not Feasible/Affordable
Water Recycling/Reuse	No	Not Feasible/Affordable
Land Application	No	Not Feasible/Affordable
Connection to Other Facilities	No	Not Feasible/Affordable
Upgrade to Existing Facility	Yes	
Total Containment	No	Not Feasible/Affordable
Improved O&M of Existing Systems	Yes	
Seasonal or Controlled Discharge	No	Not Feasible/Affordable
New Construction	Yes	
No Discharge	No	Not Feasible/Affordable

E5. From the applicant's perspective, what is the preferred treatment option?

Existing wastewater treatment processes.

E6. Is the preferred option also the least polluting feasible alternative?

☒ **Yes**

☐ **No**

If no, what were less degrading feasible alternative(s)? ☐

If no, provide a summary of the justification for not selecting the least polluting feasible alternative and if appropriate, provide a more detailed justification as an attachment.

☐

Part F. Optional Information

F1. Does the applicant want to conduct optional public review(s) in addition to the mandatory public review? Level II ADRs are public noticed for a thirty day comment period. More information is available in Section 3.7.1 of the Implementation Guidance.

☒ **No**

☐ **Yes**

F2. Does the project include an optional mitigation plan to compensate for the proposed water quality degradation?

☒ **No**

☐ **Yes**

Report Name: ☐

Part G. Certification of Antidegradation Review

G1. Applicant Certification

The form should be signed by the same responsible person who signed the accompanying permit application or certification.

Based on my inquiry of the person(s) who manage the system or those persons directly responsible for gathering the information, the information in this form and associated documents is, to the best of my knowledge and belief, true, accurate, and complete.

Print Name: Jon E. ADAMS

Signature: Jon G. Adams

Date: 4/30/2014

G2. DWQ Approval

To the best of my knowledge, the ADR was conducted in accordance with the rules and regulations outlined in UAC R-317-2-3.

Water Quality Management Section

Print Name: _____

Signature: _____

Date: _____